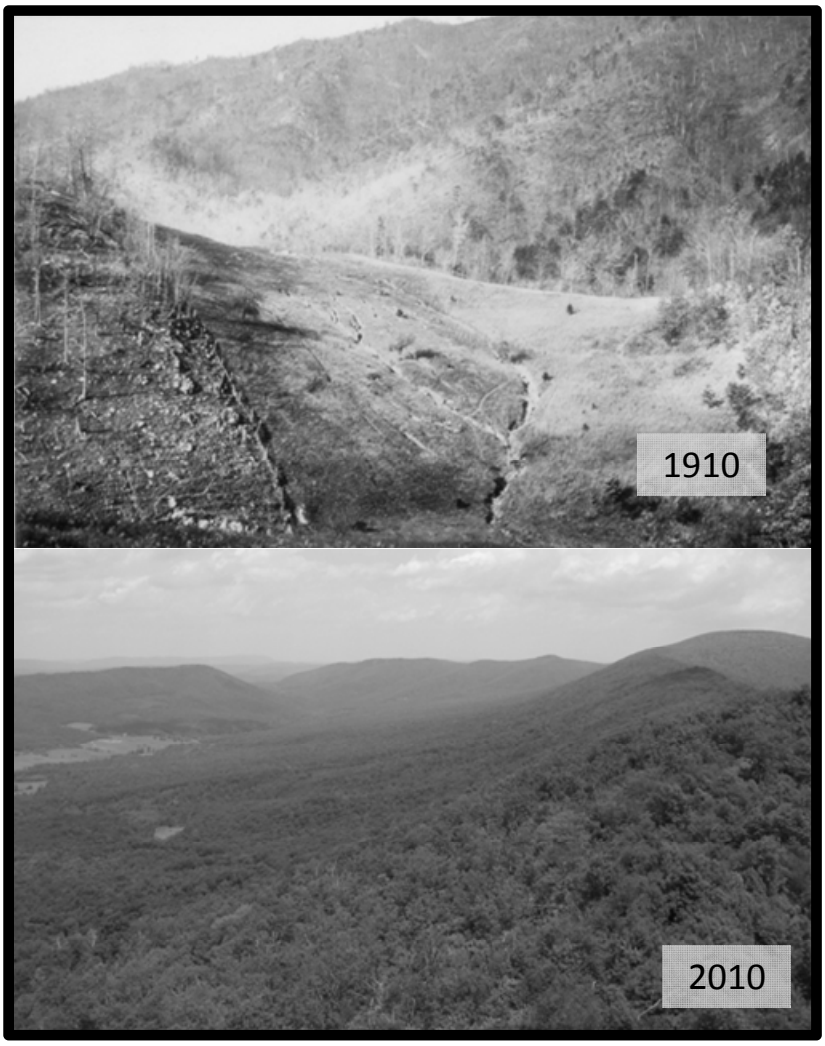
U.S. Department of Agriculture
Forest Service
Southern Region

Appendices

Draft Environmental Impact Statement

for the Revised Land and Resource Management Plan

George Washington National Forest



R8-MB 137D

April 2011

Supervisor's Office
5162 Valleypointe Parkway
Roanoke, VA 24019

540-265-5100

www.fs.fed.us/r8/gwj

Glenwood-Pedlar Ranger District
27 Ranger Lane
Natural Bridge Station, VA 24579
540-291-2188

James River Ranger District
810A Madison Avenue
Covington, VA 24426
540-962-2214

Lee Ranger District
95 Railroad Avenue
Edinburg, VA 22824
540-984-4101

North River Ranger District
401 Oakwood Drive
Harrisonburg, VA 22801
540-432-0187

Warm Springs Ranger District
422 Forestry Road
Hot Springs, VA 24445
540-839-2521

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Appendices
Draft Environmental Impact Statement for the George Washington National Forest
Draft Revised Land and Resource Management Plan

Alleghany, Amherst, Augusta, Bath, Botetourt, Frederick, Highland, Nelson, Page, Rockbridge, Rockingham, Shenandoah, and Warren Counties in Virginia.
Hampshire, Hardy, Monroe and Pendleton Counties in West Virginia.

Responsible Agency:	**USDA Forest Service**
Responsible Official:	**Liz Agpaoa, Regional Forester** **Southern Region** **1720 Peachtree Road, NW** **Atlanta, GA 30309**
Cooperating Agency:	**USDI Bureau of Land Management**
For Information Contact:	**Maureen Hyzer, Forest Supervisor** **George Washington & Jefferson National Forest** **5162 Valleypointe Parkway** **Roanoke, VA 24019**

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APPENDIX A - Summary of Public Involvement

A. INTRODUCTION

This document is included to show the public involvement effort for the revision of the 1993 George Washington National Forest (GWNF) Land Management Plan, herein referred to as the Plan.

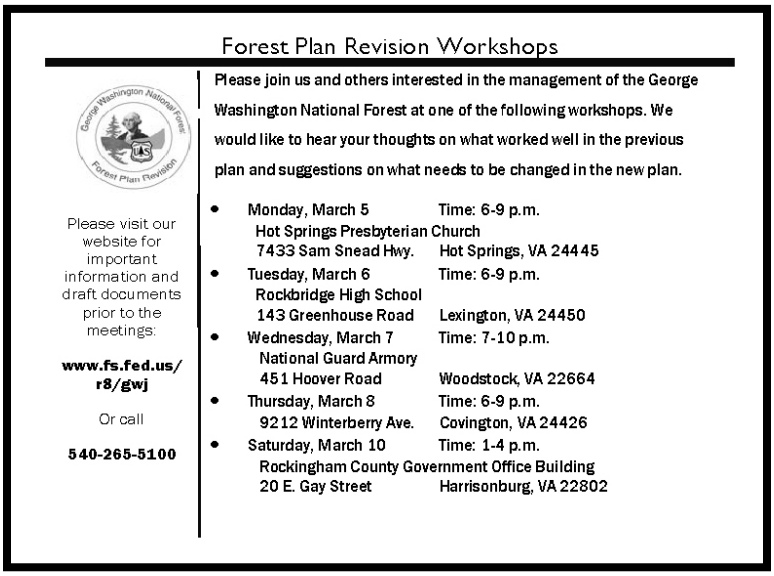
B. ENGAGING INTERESTED INDIVIDUALS AND ORGANIZATIONS

1. Public Meetings

a. Public Meetings in March 2007

Public involvement was initiated when the Forest Supervisor invited the public to a series of meetings to comment on whether there was a need for change to the 1993 George Washington Resource Management Plan.

First, over 900 organizations, groups, county governments, state governments, and individuals were sent a post card the third week of February 2007 inviting them to a series of meetings to begin dialogue on what amount needed to change.


Forest Plan Revision Workshops

Please join us and others interested in the management of the George Washington National Forest at one of the following workshops. We would like to hear your thoughts on what worked well in the previous plan and suggestions on what needs to be changed in the new plan.

- Monday, March 5 Time: 6-9 p.m.
  Hot Springs Presbyterian Church
  7433 Sam Snead Hwy. Hot Springs, VA 24445
- Tuesday, March 6 Time: 6-9 p.m.
  Rockbridge High School
  143 Greenhouse Road Lexington, VA 24450
- Wednesday, March 7 Time: 7-10 p.m.
  National Guard Armory
  451 Hoover Road Woodstock, VA 22664
- Thursday, March 8 Time: 6-9 p.m.
  9212 Winterberry Ave. Covington, VA 24426
- Saturday, March 10 Time: 1-4 p.m.
  Rockingham County Government Office Building
  20 E. Gay Street Harrisonburg, VA 22802

Please visit our website for important information and draft documents prior to the meetings:

www.fs.fed.us/r8/gwj

Or call

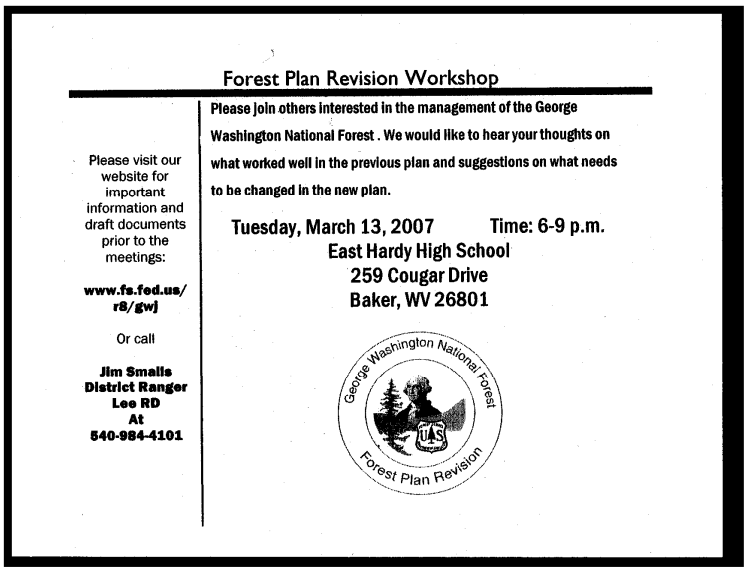
540-265-5100

On February 15, 2007 the Federal Register contained the Forest's "Notice of Intent" to revise the GW Plan. This officially started the GW Revision process. To meet a regulation requirement, a Legal Notice also appeared in the Forest's newspaper of record, namely the Roanoke Times, on March 31, 2007.

In addition, a news release was sent on February 16, 2007 to all newspapers, TV stations and radio stations that serve the counties where the GWNF is located.

Given the amount of land in West Virginia, the agency decided to hold two West Virginia meetings. A news release was sent to various media on February 22, 2007 that an informal meeting would be held in Brandywine, WV on March 9, 2007.

Likewise, a news release was sent to various media on February 28, 2007 that a meeting would be held in Baker, WV on March 13, 2007, and reminded people of the Brandywine meeting. Furthermore, all persons from West Virginia on the Forest's planning mailing list (about 72 individuals or organizations) were sent a postcard announcing the Baker WV meeting.


Forest Plan Revision Workshop

Please join others interested in the management of the George Washington National Forest . We would like to hear your thoughts on what worked well in the previous plan and suggestions on what needs to be changed in the new plan.

Tuesday, March 13, 2007 Time: 6-9 p.m.
East Hardy High School
259 Cougar Drive
Baker, WV 26801

Please visit our website for important information and draft documents prior to the meetings:

www.fs.fed.us/r8/gwj

Or call

Jim Smalls
District Ranger
Lee RD
At
540-984-4101

George Washington National Forest
Forest Plan Revision

Due to unprecedented attendance at the workshops, a news release of March 8, 2007 announced that the Harrisonburg meeting would be held at James Madison University rather than at the Rockingham County Government Office building. Agency law enforcement personnel were stationed at the county office to direct individuals to the new location. To accommodate the extra time needed to get to the new location, the news release announced that the meeting would start 30 minutes later than originally planned.

Attendance at the public meetings is shown in the following table.

Meeting Date	Meeting Location	Approximate Attendance
March 5, 2007	Warm Springs, VA	56
March 6, 2007	Lexington, VA	112
March 7, 2007	Woodstock, VA	250+
March 8, 2007	Covington, VA	35
March 9, 2007	Brandywine, WV	22
March 10, 2007	Harrisonburg, VA	135+
March 13, 2007	Baker, WV	25

In addition, other organizations alerted their members about the meetings and the revision process. For instance, the Wilderness Society created a link on their web page for their members to submit a form letter electronically to agency officials. The agency did not count the number of electronic form letters received from this endeavor, nor did it solicit electronic comments on this proposal. A random review of the letters showed that they all had the about the same “file size” with various differences attributed to electronic “signatures”. Otherwise, the form letter provided one set of comments for the agency to analyze with respect to determining significant issues.

Meeting Presentation

For all meetings except Brandywine, the following program was given. The Brandywine meeting was an informal discussion of these same topics.

GEORGE WASHINGTON FOREST PLAN REVISION
PUBLIC WORKSHOPS
MARCH 5-13, 2007

Your Hosts:
Maureen Hyzer, Forest Supervisor
Ken Landgraf, Planning Staff Officer

Welcome.....District Ranger..... 5 minutes

Overview of Plan Revision... Ken .....15 minutes

Remarks from the
Forest Supervisor..... Maureen.....15 minutes

Intro to Group Activity.....Ken .....5 minutes

Group Activity #1.....All.....40 minutes

Break.....All.....15 minutes

Group Activity #2.....All.....40 minutes

Wrap-Up.....Maureen.....10 minutes

What's Next.....Ken.....10 minutes

The overview was a PowerPoint presentation on the 2005 planning rule.

Attendees were distributed among numerous groups and each group was asked the same following two questions about on-the-ground management of their National Forest:

#1: What do you like about the current management of the GWNF?
#2: What do you think needs to change in how the GWNF is managed?

Comments were captured on flip charts. All comments were then typed and posted to the Forest's internet site. Comment forms were also given to meeting attendees and comments written at the meeting could either be placed into a comment box or sent at a later date to the Forest Supervisor's office. Comments were also then summarized by the agency for its use in determining which issues from the CER would be carried forward as significant issues for the rest of the public involvement and revision process.

Summary

The summary of this effort was then used as an addendum to the Comprehensive Evaluation Report (CER.)

Availability of the Draft Comprehensive Evaluation Report

The public was notified of the availability of the initial February 15, 2007 version of the Comprehensive Evaluation Report (CER) by three methods. First notification was posted on February 15, 2007 to the Forest's internet "Planning" page stating that an initial draft of the CER was available for downloading or available on a CD-ROM upon request. Secondly, this report was also mentioned in the agency's 2/15/07 Federal Register Notice. Thirdly, the agency's initial 2/22/07 news release mentioned that the CER was on the world-wide-web at http://www.fs.fed.us/r8/gwj. Business cards showing the WWW address were available for the public at all of the public meetings.

Written Comments on the Draft Comprehensive Evaluation Report

The agency also accepted public comments. Public comments could either be mailed through the Post Office to the Forest Supervisor's Office or electronically mailed to the agency.

All public comments on the "Need for Change" are available for review in the project file located at the Supervisor's Office in Roanoke, Virginia.

b. Postponement and Resumption of GW Planning Process

Postponement of GW Planning Process

On March 30, 2007, a federal judge enjoined (prohibited) the Forest Service from implementation of the 2005 Planning Rule. The GWNF's planning process, including the workshops, was initiated under this 2005 Rule. On April 3, 2007, the agency posted a letter on its web site postponing the planned public meetings in scheduled in late April and early May 2007 because of the federal court decision.

As the Forest Supervisor stated in this letter "We have decided to wait until our Agency has time to assess the situation and provide us with some guidance on how to proceed with the revision. We hope that this will be a short postponement. We will keep you updated with information on this web page."

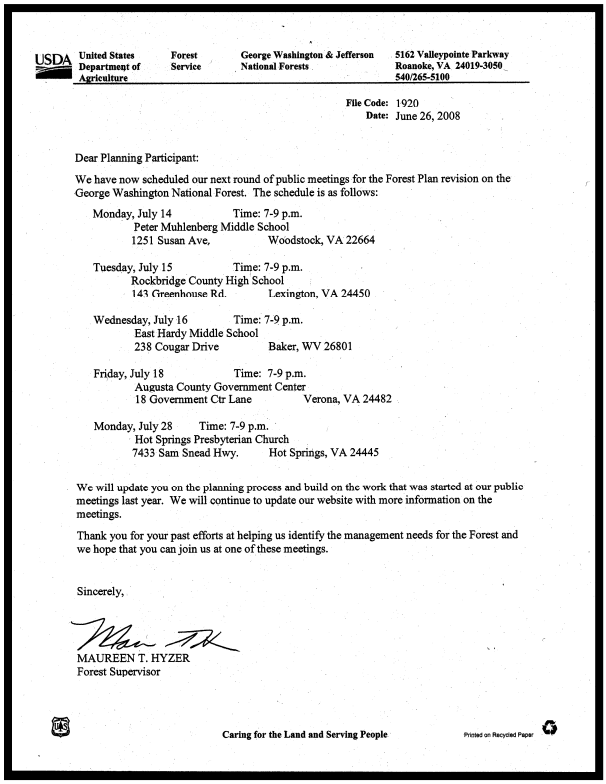
Resumption of GW Planning Process

On April 10, 2008 the Forest posted a letter to the Internet that work on a new nationwide planning rule has been completed. The letter also announced that public meetings would start in early summer 2008.

On April 21, 2008 the Forest Service adopted a new planning rule by announcement in the Federal Register. This rule (36 CFR 219 (2008)) was adopted following completion of an environmental impact statement and consultation under the Endangered Species Act. This new planning rule explicitly allowed the resumption of plan revisions started under the previous rule (36 CFR 219 (2005)) based on a finding that the revision process conforms to the new planning rule (36 CFR 219.14(b) (3) (ii)).

On June 24, 2008 the Federal Register (73 FR 35632) contained the Forest's "Notice of Adjustment for Resuming the Land Management Plan Revision Process" to revise the GW Plan. This officially restarted the GW revision process. To meet a regulation requirement, a Legal Notice also appeared in the Forest's newspaper of record, namely the Roanoke Times, on June 25, 2008. The Federal Register notice also requested additional public comments on the Draft CER of February 15, 2007. Comments were requested to be postmarked within 45 days after publication in the Federal Register. Thus, comments on the draft Comprehensive Evaluation Report were requested to be postmarked or received by August 8, 2008.

c. Public Meetings in July 2008



USDA United States Department of Agriculture | Forest Service | George Washington & Jefferson National Forests | 5162 Valleypointe Parkway Roanoke, VA 24019-3050 540/265-5100

File Code: 1920
Date: June 26, 2008

Dear Planning Participant:

We have now scheduled our next round of public meetings for the Forest Plan revision on the George Washington National Forest. The schedule is as follows:

Monday, July 14 Time: 7-9 p.m.
Peter Muhlenberg Middle School
1251 Susan Ave, Woodstock, VA 22664

Tuesday, July 15 Time: 7-9 p.m.
Rockbridge County High School
143 Greenhouse Rd. Lexington, VA 24450

Wednesday, July 16 Time: 7-9 p.m.
East Hardy Middle School
238 Cougar Drive Baker, WV 26801

Friday, July 18 Time: 7-9 p.m.
Augusta County Government Center
18 Government Ctr Lane Verona, VA 24482

Monday, July 28 Time: 7-9 p.m.
Hot Springs Presbyterian Church
7433 Sam Snead Hwy. Hot Springs, VA 24445

We will update you on the planning process and build on the work that was started at our public meetings last year. We will continue to update our website with more information on the meetings.

Thank you for your past efforts at helping us identify the management needs for the Forest and we hope that you can join us at one of these meetings.

Sincerely,

MAUREEN T. HYZER
Forest Supervisor

Caring for the Land and Serving People

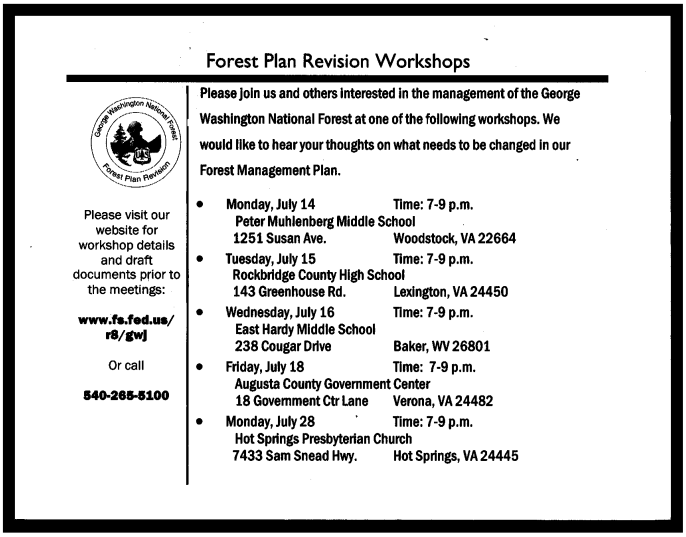
Printed on Recycled Paper

Topic – Place-Based Desired Conditions

On June 26, 2008 a letter announcing the dates and times of the meetings was posted on the Internet.

To resume the process and notify people without internet access, a post card was also sent the first week of July 2008 to over 1,200 organizations, groups, county governments, state governments, and individuals inviting them to a series of meetings to begin a place-based dialogue on where management on-the-ground needed to change.

The meetings had small groups discussing what they would like to see changed on the Forest. The meetings were place-based with attendees reviewing district maps. There was a host for each small group. Rather than being a neutral facilitator, the host was able to enter into discussions to answer basic questions and describe how the agency currently manages the National Forest in that particular area.



Forest Plan Revision Workshops

George Washington National Forest – Forest Plan Revision

Please visit our website for workshop details and draft documents prior to the meetings:

www.fs.fed.us/r8/gwj

Or call

540-265-5100

Please join us and others interested in the management of the George Washington National Forest at one of the following workshops. We would like to hear your thoughts on what needs to be changed in our Forest Management Plan.

- **Monday, July 14** **Time: 7-9 p.m.**
  Peter Muhlenberg Middle School
  1251 Susan Ave. **Woodstock, VA 22664**
- **Tuesday, July 15** **Time: 7-9 p.m.**
  Rockbridge County High School
  143 Greenhouse Rd. **Lexington, VA 24450**
- **Wednesday, July 16** **Time: 7-9 p.m.**
  East Hardy Middle School
  238 Cougar Drive **Baker, WV 26801**
- **Friday, July 18** **Time: 7-9 p.m.**
  Augusta County Government Center
  18 Government Ctr Lane **Verona, VA 24482**
- **Monday, July 28** **Time: 7-9 p.m.**
  Hot Springs Presbyterian Church
  7433 Sam Snead Hwy. **Hot Springs, VA 24445**

Attendance at the July 2008 public meetings is shown in the following table.

Meeting Date	Meeting Location	Approximate Attendance
July 14, 2008	Woodstock, VA	125
July 15, 2008	Lexington, VA	64
July 16, 2008	Baker, WV	29
July 18, 2008	Verona, VA	69
July 28, 2008	Hot Springs, VA	33

Meeting Presentation

A short PowerPoint presentation occurred that repeated what was done for the first round of planning and gave attendees a summary of the key topics from that first round of meetings. A frame work was presented from the Forest's perspective of what resources were important in the planning process. The agency discussed some topics that are outside the planning process such as user fees and law enforcement.

The agency displayed the sideboards within which the decisions will be made on approving the revised plan. These sideboards are that the GW will continue to be a multiple use forest with managing for an emphasis on high quality water, wildlife habitat, diversity of recreation settings, timber for vegetation management and to produce wood, minerals resources, TES species, and fire for vegetation management

Participants were divided into small groups and gathered around tables that were covered with maps of the forest (by ranger district) showing the management areas under the current 1993 Forest Plan. The groups were asked the following questions: "**What areas of the x District would you like to see managed in a different way and how would you like them to be managed? Why?"** Participants were asked to record their ideas directly on the maps, highlighting specific areas of interest. Comment sheets were also provided to capture responses. The maps and comment sheets were later scanned for the record.

Summary

The July 2008 round of meetings were summarized into a document that is available in the planning records. Generally, the following activities were noted for the following places on the Forest.

PLACE	WILDERNESS	ROADLESS AREA CHARACTERISTICS	MOUNTAIN BIKING	HORSEBACK RIDING	4WD ACCESS	ATV ACCESS	VEGETATION MGMT	WIND
DISTRICT: Pedlar								
Kelly Mtn Roadless Area		X - high protection or nat'l scenic area	X	X	X			
Adams Peak Roadless Area	X		X					
Three Sisters Roadless Area	X							
St Mary's Wilderness Addition	X							
DISTRICT: North River								
Crawford Roadless Area	x		x					

PLACE	WILDERNESS	ROADLESS AREA CHARACTERISTICS	MOUNTAIN BIKING	HORSEBACK RIDING	4WD ACCESS	ATV ACCESS	VEGETATION MGMT	WIND
Elliott Knob Roadless Area	X		X					
Little River Roadless Area	X		keep existing use					
Ramseys Draft Roadless Area	X							
Jerkemtight Roadless Area	X		keep existing use - conflicts with horse use	keep existing use - conflicts with bike use				
Skidmore Fork Roadless Area	X	X	keep existing use		X		x	
Snake Ridge		X						
Beech Lick/Marshall Run	X							
Dry River Roadless Area	X							
Gum Run Roadless Area			keep existing use					
Oak Knob Roadless Area			keep existing use					
DISTRICT: Lee								
Northern Massanutten Roadless Area - Stephens Trail and Kennedy Peak			keep existing use					
Big Schloss Roadless Area	X		keep existing use	several major events			x	
Southern Massanutten Roadless Area		X - national scenic area					x	
Three High Heads	X							
Stony Creek	X							
DISTRICT: Warm Springs								
MA 14 between Rough Mt and Rich Hole Wildernesses		X - large block					X	
Mill Mtn Roadless Area	X							
MA 14 area along Route 125 (west of Douthat State Park)							for grouse	
Rough Mtn Wilderness Addition	X							
Beards Mtn Roadless Area	X - or national scenic area		X					
Little Alleghany Roadless Area	X							
DISTRICT: James River								
Dolly Ann Roadless Area	X		X					

PLACE	WILDERNESS	ROADLESS AREA CHARACTERISTICS	MOUNTAIN BIKING	HORSEBACK RIDING	4WD ACCESS	ATV ACCESS	VEGETATION MGMT	WIND
Oliver Mtn Roadless Area	X		X					
MA 15 northeast of Hoop Hole Roadless Area			X					
MA 17 southwest of Hematite/Jinglin g Rock	X							

c. Public Meetings in September 2008

Topic – Potential Wilderness Areas and Roadless Areas

Given that the intent of these meetings were to start focusing more on individual issues, only two locations were selected for discussing the topic of the potential wilderness inventory and inventoried roadless areas. The July workshops were held in five locations but there were a large number of people that came to more than one, even though the agenda was the same at each location. This time, there were no postcards mailed out since the public had been told at the July workshops that we would post the September workshop information on our website and we thought we would be able to save postage. However, this resulted in some people not receiving proper notification of the meetings. It was discussed how we could improve notification in the future without a costly mailing each time, including the possibility of sending a postcard with the option of sending an e-mail to the electronic Revision Comments inbox so an electronic mailing list could be initiated or with the option of receiving a postcard in the future.

The purpose of the September workshops was to discuss the 37 Potential Wilderness Areas (370,000 acres) and the two Inventoried Roadless Areas (14,000 acres) not part of the current inventory. Each participant was given the following handout that had a list of the areas, their acreages and the table where the area would be discussed.

POTENTIAL WILDERNESS INVENTORY
George Washington National Forest
Sept 2008

Potential Wilderness Area	Also Known As...	Total Acres	District - Table
Adams Peak		8,226	Pedlar
Archer Knob		7,110	North River - 2
Beards Mountain		10,152	Warm Springs - 2
Beech Lick Knob		14,087	North River - 1
Big Schloss		28,347	Lee
Crawford Knob		14,851	North River - 2
Dolly Ann		9,524	James River
Duncan Knob	Catback Mtn, Waterfall	5,973	Lee
Elliott Knob		11,070	North River - 2

Galford Gap	Scaffold Run	6,689	Warm Springs - 1
Gum Run		14,547	North River - 1
High Knob	Skidmore, Dry River	18,447	North River - 1
Jerkemtight		27,314	North River - 2
Kelley Mountain	Big Levels	12,892	Pedlar
Laurel Fork		10,236	Warm Springs - 1
Little Alleghany		15,395	Warm Springs - 1
Little Mare Mountain		11,918	Warm Springs - 2
Little River		30,227	North River - 1
North Massanutten		16,530	Lee
Oak Knob - Hone Quarry Ridge		16,343	North River - 1
Oliver Mountain		13,049	James River
Paddy Knob	Paddy Lick	5,987	Warm Springs - 1
Potts Mountain	Toms Knob	7,019	James River
Ramseys Draft Addition	Bald Ridge, Lynn	19,072	North River - 2
Rich Hole Addition	Mill Mtn	12,165	Warm Springs - 2
Rich Patch		871	James River
Rough Mountain Addition		2,063	Warm Springs - 2
St Mary's North		3,006	Pedlar
St Mary's South		1,651	Pedlar
St Mary's West		278	Pedlar
Shaws Ridge		7,268	North River - 2
Shawvers Run Addition		84	James River
Three Ridges Addition North		83	Pedlar
Three Ridges Addition South		187	Pedlar
Three Ridges Addition Southwest		9	Pedlar
Three Ridges Addition West		90	Pedlar
Three Sisters		9,871	Pedlar
TOTAL ACRES		372,631	

The Planning Staff Officer gave a 20 minute presentation on the history of roadless area inventory and wilderness designation at the national level and on the forest level, the definition of various terms related to wilderness and roadless, and described the process used to go from an inventoried potential wilderness area to a Congressionally-designated Wilderness. The participants were then asked to visit tables that had detailed maps of the areas and discuss the following three questions:

1) What are the characteristics that make this area a good wilderness?
2) What are the resource uses that might be foregone if this area became wilderness?

3) If not wilderness, how would you like to see this area managed?

Each table was hosted either by a District Ranger or someone who was familiar with the areas on the maps. Each table also had a poster showing a table highlighting other resource information for each area, such as the amount of timber currently suitable, presence of structural improvements, presence of acidified streams, etc. Participants were asked to record their ideas directly on the maps, highlighting specific areas of interest. Boundary adjustments were also encouraged to show where needs of other resources could be met. Comment sheets were also provided to capture responses. The September 2008 round of meetings were summarized into a document that is available in the planning records.

Attendance at the September 2008 public meetings is shown in the following table.

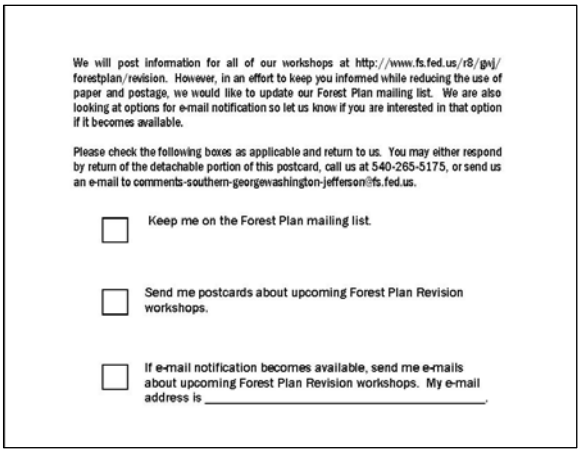
Meeting Date	Meeting Location	Approximate Attendance
Sept. 11, 2008	Bridgewater, VA	94
Sept. 13, 2008	Lexington, VA	39

The second meeting was held on a Saturday and there was a general consensus that Saturdays were not an ideal day for a public meeting. When we are at the point of discussing the Draft Plan with a probable larger number of participants, Saturday meetings might be more worthwhile.

d. Public Meetings in October 2008

Topic – Access (Roads and Trails)

Postcards were mailed out to announce the two workshops for access and to update the Revision mailing list.

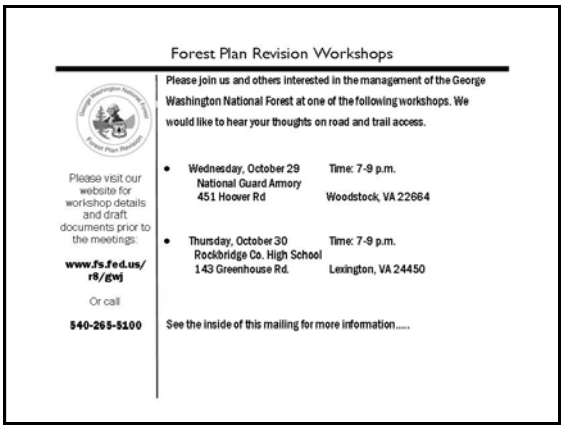

We will post information for all of our workshops at http://www.fs.fed.us/r8/gwj/forestplan/revision. However, in an effort to keep you informed while reducing the use of paper and postage, we would like to update our Forest Plan mailing list. We are also looking at options for e-mail notification so let us know if you are interested in that option if it becomes available.

Please check the following boxes as applicable and return to us. You may either respond by return of the detachable portion of this postcard, call us at 540-265-5175, or send us an e-mail to comments-southern-georgewashington-jefferson@fs.fed.us.

☐ Keep me on the Forest Plan mailing list.

☐ Send me postcards about upcoming Forest Plan Revision workshops.

☐ If e-mail notification becomes available, send me e-mails about upcoming Forest Plan Revision workshops. My e-mail address is _____.



Forest Plan Revision Workshops

Please join us and others interested in the management of the George Washington National Forest at one of the following workshops. We would like to hear your thoughts on road and trail access.

- Wednesday, October 29 — Time: 7-9 p.m.
  National Guard Armory
  451 Hoover Rd — Woodstock, VA 22664
- Thursday, October 30 — Time: 7-9 p.m.
  Rockbridge Co. High School
  143 Greenhouse Rd. — Lexington, VA 24450

See the inside of this mailing for more information.....

Please visit our website for workshop details and draft documents prior to the meetings:

www.fs.fed.us/r8/gwj

Or call

540-265-5100

Purpose

- Discuss management of the road and trail systems on the Forest
- Discuss options for any needed changes in desired conditions, suitability, objectives, and guidelines regarding roads and trails

The Planning Staff Officer gave a 15 minute presentation on road and trail access issues. The participants were then asked to visit tables to discuss the road and trail access concerns on the Ranger District. They were asked to discuss the following questions:

Road Group Questions Asked:

1) What areas of the Forest should be suitable for road construction?
2) Are there areas of the Forest that should be high priority for decommissioning existing roads? What should the objective be for decommissioning roads?
3) Are there key areas where roads should not be decommissioned in order to maintain OHV opportunities?
4) Are there guidelines that need to be added to the plan to address road access issues?

Trail Groups Questions Asked:

1) Are there areas of the forest where additional trails are needed (hiking, biking, horseback riding) or should be emphasized? Are there trails that could be decommissioned so that maintenance funding can be used to higher priority trails?
2) Are there guidelines that need to be added to the plan to address trail access issues?

Small Group Sessions:

Lee - Roads
Lee & North River - Trails
North River - Roads
Warm Springs - Roads
Warm Springs & James River - Trails

James River - Roads
Pedlar - Roads
Pedlar - Trails
Guidelines and Monitoring
General Access Concerns

Attendance at the October 2008 public meetings is shown in the following table.

Meeting Date	Meeting Location	Approximate Attendance
Oct. 29, 2008	Woodstock, VA	55
Oct. 30, 2008	Lexington, VA	50

e. Public Meetings in November and December 2008

Topic – Vegetation Management (Timber harvest, Prescribed fire, Non-native Invasive Species)

Postcards were mailed out to announce the two workshops

Forest Plan Revision Workshops

Please visit our website for any date/time changes, workshop details and draft documents prior to the meetings:

www.fs.fed.us/r8/gwj

Or call

540-265-5100

Please join us and others interested in the management of the George Washington National Forest at one of the following workshops.

TOPIC: VEGETATION MANAGEMENT (Wildlife habitat improvement, timber harvest, prescribed fire)

- Thursday, November 13 — Time: 6:30 9:00 p.m.
  Augusta County Government Center
  18 Government Lane
  Verona, VA 24482
- Wednesday, December 3 — Time: 6:30 9:00 p.m.
  Rockbridge Co. High School
  143 Greenhouse Rd.
  Lexington, VA 24450

TOPIC: FOREST PLAN COMPONENTS (Fitting the workshops and other information together toward a Draft Plan)

- Thursday, January 29 — Time: 6:30 9:00 p.m.
  Rockbridge Co. High School
  143 Greenhouse Rd.
  Lexington, VA 24450

Purpose:

Discuss management of vegetation on the forest including timber harvest, prescribed fire, wildlife habitat, non-native invasive plants, and special biologic areas.

Items to discuss:

Spatial concerns about prescribed fire and timber harvest (Where are we managing?)
Level of activity or objectives for prescribed fire and timber harvest (How much are we managing?)
Concerns with the effects of prescribed fire and timber harvest
Rationale for vegetation management (What are we managing for?)

The Planning Staff Officer gave a 30 minute presentation on the purpose of vegetation management and current vegetation management activities. The participants were then

asked to visit tables to discuss the vegetation management concerns on the Ranger District. They were asked to discuss the following question:

Question for the small groups:
What is important to you about managing vegetation on the Forest?

Small Group Setups:

Table
Wildlife discussion – Lee and North River Maps
Wildlife discussion – James River, Warm Spr, Pedlar Maps
Timber discussion – Lee and North River Maps
Timber discussion – James River, Warm Spr, Pedlar Maps
Fire discussion – Lee and North River Maps
Fire discussion – James River, Warm Spr, Pedlar Maps

Meeting Date	Meeting Location	Approximate Attendance
Nov. 13, 2008	Verona, Va	
Dec. 3, 2008	Lexington, VA	

f. Public Meetings in January and February 2009

Topic – Forest Plan Components

Purpose

- Inform people of how the Forest Service has evaluated the discussions to date and putting the information into the Forest Plan components
- Provide a forum to discuss options that should be considered differently than above
- Identify monitoring or guidelines to improve the Plan

Meeting Format

The first meeting in Lexington was done with a 30-40 minute presentation on the Plan Components, followed by small group discussions that focused on topics identified by the public. A handout was provided that summarized the highlights of where we are headed with the revised plan, such as the areas we are seriously considering for wilderness recommendation and the objectives for timber harvest. The group discussions at the first meeting were good but many people wanted to talk about more than two topics. Therefore the second meeting, in Woodstock, used a different format where the presentation was followed by opening up the discussion to questions, answers, comments to the entire group. This format suited the discussions much more and was more appropriate for the place we were at in the revision process.

Meeting Date	Meeting Location	Approximate Attendance
Jan. 29, 2009	Lexington, VA	54
Feb. 5, 2009	Woodstock, VA	79

g. Postponement and Resumption of GW Planning Process

Postponement of GW Planning Process

On June 30, 2009, the 2008 planning rule was enjoined by the United States District Court for the Northern District of California (*Citizens for Better Forestry* v. *United States Department of Agriculture*, No. C 08–1927 CW (N.D. Cal. June 30, 2009)) and the revision of the GWNF Forest Plan was again suspended. The Forest Supervisor posted a letter on its website on July 8, 2009 informing the public of the postponement.

Resumption of GW Planning Process

The Department determined that the 2000 planning rule is now back in effect. The 2000 Rule's transition provisions (36 CFR 219.35), amended in 2002 and 2003 and clarified by interpretative rules issued in 2001 and 2004, and reissued on December 18, 2009 [74 FR 67059–67075] allow use of the provisions of the National Forest System land and resource management planning rule in effect prior to the effective date of the 2000 Rule (November 9, 2000), commonly called the 1982 planning rule, to amend or revise plans. The GWNF elected to use the provisions of the 1982 planning rule, including the requirement to prepare an EIS, to complete its plan revision.

On March 7, 2010 the Forest posted a letter to the Internet that the Notice of Intent to prepare an Environmental Impact Statement and Forest Plan had just been published in the Federal Register. The letter also announced public meetings in the following locations:

Monday, April 12, 2010
Valley Elementary School
98 Panther Drive
Hot Springs, VA

Wednesday, April 14, 2010
East Hardy High School
Baker, WV

Monday, April 19, 2010
Rockbridge Co. High School
143 Greenhouse Rd.
Lexington, VA 24450

Wednesday, April 28, 2010
Woodstock National Guard Armory
541 Hoover Road
Woodstock, VA 22664

Thursday, April 29, 2010
Augusta County Government Center
18 Government Lane
Verona, VA

The letter also reiterated the public comment period and identified a number of documents available for review on the GWNF website.

An additional meeting was added on Tuesday, April 27 at the Fairfax County Government Center in Fairfax, Virginia.

The Notice of Intent was published in the Federal Register on March 10, 2010. The Notice requested comments on the Forest Plan by May 7, 2010.

h. Public Meetings in April, 2010

Topic – Scoping for the Notice of Intent

Postcards were mailed out to announce the two workshops for the five meetings. The Fairfax meeting was posted on the website.

Purpose

The Notice of Intent was published in the Federal Register on March 10, with a 60 day comment period ending May 7, 2010. The purpose of these meetings was to scope issues and potential alternatives for preparation of the EIS.

Meeting Format

The meeting began with a 30-minute powerpoint presentation that described how we are starting the revision again for the third time, this time under the 1982 planning regulations. However, it was stressed that we are not discarding any public input from the past three years. Information regarding preliminary issues and three potential alternatives was presented. These alternatives included the current 1993 Forest Plan, the Need for Change (that was presented at Jan/Fed 2009 meetings), and a Remote Habitats and Access alternative. The presentation was followed by small group discussions that answered two questions: 1) What issues would you like to see addressed in the Forest Plan; and 2) How would you like to see that issue addressed in the Forest Plan?

Meeting Date	Meeting Location	Approximate Attendance
April 12, 2010	Hot Springs, VA	25
April 14, 2010	Baker, WV	20
April 19, 2010	Lexington, VA	51
April 27, 2010	Fairfax, VA	44
April 28, 2010	Woodstock, VA	51
April 29, 2010	Verona, VA	53

i. Public Workshop with Interdisciplinary Team in July, 2010

Topic – Alternative Refinement

A notice was posted on the GWNF website on June 18, 2010 announcing a workshop to be held on July 14 in the Supervisor's Office.

Purpose

The purpose of the workshop was to give interested parties the opportunity to review the current list of alternatives and suggest modifications or additions to the alternatives.

Meeting Format

The meeting was conducted as an interactive meeting with the public and the IDT actively engaged in discussion. Twenty-one members of the public attended the meeting and engaged in discussion with the IDT on the alternatives and ways to improve them.

j. Public Workshop on October 5, 2010

Topic – Alternatives

Postcards were mailed out to announce the workshop to be held on October 5, 2010 at the Augusta County Government Center in Verona, Virginia. The workshop was held from 6:30 until 8:30.

Purpose

The purpose of the workshop was to describe the six alternatives developed for the Draft Environmental Impact Statement and to discuss the alternatives and effects analysis with GWNF staff.

Meeting Format

The meeting began with a 30 minute presentation by the Planning Staff Officer about the alternatives. Then there was an hour for attendees to discuss the alternatives and review the alternative maps with GWNF staff. The attendees then broke into groups to discuss the following questions:

> You have heard and participated in a number of discussions about how the Forest Plan should address a variety of issues. If you were going to pick an alternative that appropriately balances the varied interests,
>
> a. What are the key criteria you would use to make your decision?
> b. What are the important benefits or consequences in the six alternatives that are under consideration and how would these affect your decision?

About 77 people attended the workshop.

C. STATE AND LOCAL GOVERNMENTS & FEDERAL AGENCY COORDINATION AND ASSISTANCE

Federal Agency Coordination and Assistance

Correspondence

Date	From	To	Subject
11/16/06	Forest	VA USFWS	Request for Accuracy of Forest T&E species
11/16/06	Forest	WV USFWS	Request for Accuracy of Forest T&E species
1/4/07	VA USFWS	Forest	List of Forest T&E species accurate
3/14/07	VA USFWS	Forest	At this point, Revised Plan may be to general to conduct Section 7 Consultation
5/9/2010	Forest	BLM	Request to be a cooperating agency
5/12/2010	Forest	VA USFWS	Restarting revision and request for review of species to consider
5/12/2010	Forest	WV USFWS	Restarting revision and request for review of species to consider
5/12/2010	USGS	Forest	USGS will assist in providing information for the Reasonably Foreseeable Development Scenario

Meetings

Date	With	Subject
4/10/06	Shenandoah & Cedar Cr. / Belle Grove NP	Revising the GW Plan
5/25/06	Various State and Federal Agencies (USFWS, WV & VA Heritage, WVDNR, VDGIF)	Introduce the 2005 Planning Regulations
12/6/2006	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
3/26/2007	VA Department of Forestry	Update on Plan Revision
10/07/2007	West Virginia Cooperative Stamp Meeting (WVDNR, Monongahela NF)	Update on Plan Revision
10/18/2007	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
10/01/2008	West Virginia Cooperative Stamp Meeting (WVDNR, Monongahela NF)	Update on Plan Revision
10/29/2008	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
5/13/2009	US F&WS	Update on Plan Revision
9/9/2009	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
10/27/2009	West Virginia Cooperative Stamp Meeting (WVDNR,	Update on Plan Revision

	Monongahela NF)	
9/28/2010	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, NRCS, VT	Update on Plan Revision

NPS representatives participated in the Woodstock workshop of March 7, 2007.

State Government Coordination and Assistance

Correspondence

Date	From	To	Subject
1/3/07	USFS	VA & WV State Game Agencies	Informal Review of Draft Working Copy of GW Comprehensive Evaluation Report

Meetings

Date	With	Subject
4/17/06	WVDNR & VDGIF	Revising the GW Plan
5/25/06	Various State and Federal Agencies (USFWS, WV & VA Heritage, WVDNR, VDGIF)	Introduce the 2005 Planning Regulations
12/6/2006	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
12/14/06	WVDNR	Introduce Agency to Draft CER
1/22/07	VDGIF	Introduce Agency to Draft CER
10/07/2007	West Virginia Cooperative Stamp Meeting (WVDNR, Monongahela NF)	Update on Plan Revision
10/18/2007	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
8/27/2008	VA Dept of Game and Inland Fisheries	Update on Plan Revision
9/10/08	VDGIF and VDNH	Update on the Plan Revision process
10/01/2008	West Virginia Cooperative Stamp Meeting (WVDNR, Monongahela NF)	Update on Plan Revision
10/29/2008	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
11/07/2008	VA Natural Heritage Program	Special Biological Areas
9/9/2009	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, VT)	Update on Plan Revision
10/27/2009	West Virginia Cooperative Stamp Meeting (WVDNR,	Update on Plan Revision

Date	With	Subject
	Monongahela NF)	
6/23/2010	VDGIF	Review of ecological sustainability analysis
6/24/2010	WVDNR	Review of ecological sustainability analysis
9/28/2010	Virginia Partners (USFWS, Shenandoah NP, VDGIF, VDOF, VDCR, NRCS, VT	Update on Plan Revision

VDGIF and WV DNR representatives participated in many of the public workshops, as did VA DOF personnel.

Local Government Coordination and Assistance

Correspondence

Date	From	To	Subject
6/22/05	USFS	Var. Cty Planning Districts	Request for County Master Plans, Land Use Maps
8/2/05	USFS	Var. County Planning Dept	Request for County Master Plans, Land Use Maps
8/4/05	Page County	USFS	Response to Request for County Master Plan
8/15/05	Shenandoah Cty	USFS	Response to Request for County Master Plan

Meetings

Date	With	Subject
9/22/08	Augusta County Board of Supervisors	Update on the Planning Process
10/08/2008	Amherst County Planning Director	Update on the Planning Process
10/08/2008	Nelson County Administrator and Planning Director	Update on the Planning Process
10/09/2008	Alleghany County Administrator	Update on the Planning Process
11/3/2008	Page County Planner	Update on the Planning Process
11/6/2008	Shenandoah County Property and Public Works Committee	Update on the Planning Process
10/8/2008	Rockingham County Board of Supervisors	Update on the Planning Process
12/2/2008	Hardy County planner and a member of the County Commission	Update on the Planning Process
1/26/2009	Bath County Planning Commission	Update on the Planning Process
2/10/2009	Bath County Board of Supervisors	Update on the Planning Process

Date	With	Subject
1/29/2009	Rockbridge County Planner and Administrator	Update on the Planning Process
4/13/2009	Rockbridge County Board of Supervisors	Update on the Planning Process
6/22/2009	Bath County Planning Commission	Update on potential wilderness
6/22/2009	Augusta County Administrator	Update on potential wilderness
5/22/2009	Rockbridge County Administrator	Answer questions about wilderness
7/27/2009	Rockbridge County Board of Supervisors	Answer questions about wilderness

Representatives of various counties, including planners and members of the Board of Supervisors, participated in the public workshops either held in their counties or near their counties. For example, representatives from Augusta and Botetourt Counties participated in the Lexington meeting of March 6, 2007.

D. TRIBAL GOVERNMENT CONSULTATION

The Eastern Band of Cherokee and the Cherokee Nation of Oklahoma were contacted through mailings of post cards about the March 2007 meetings.

Furthermore, the Forest was contacted by the Tribal Historic Preservation Officer of the Eastern Band of Cherokee in February 2007 that the George Washington National Forest was not in the Cherokee's aboriginal territory and that the tribe no longer needed to be consulted for projects or activities on the GWNF.

The following eight Virginia recognized tribes were contacted through mailings of post cards about the March 2007 meetings. Nothing was heard further from these state-recognized tribes. The United Keetoowah Band of Cherokee Indians and the Virginia Council on Indians were also contacted.

Virginia-Recognized Tribes

Chickahominy Tribe
Eastern Chickahominy Tribe
Mattaponi Tribe
Monacan Indian Nation
Nansemond Tribe
Pamunkey Tribe
Rappahannock Tribe
Upper Mattaponi Tribe

Letters were sent on October 20, 2010 to the Virginia Council on Indians, the Eastern Shawnee, the Shawnee Tribe and the Absentee-Shawnee Tribe of Indians in Oklahoma inviting them to participate in the forest plan revision.

E. OFFICIAL PUBLIC NOTIFICATION

Federal Register and Newspaper of Record Notifications

Required Notices	Federal Register Publication Date
Initiation of Plan Revision	2/15/2007
Notice of Readjustment and Resumption	2/24/2008
Notice of Intent	3/10/2010

F. PRESENTATIONS TO ORGANIZATIONS

February 7, 2007: An overview of the Revision process and timelines was presented to representatives of various environmental groups, including, Wildlaw, Southern Environmental Law Center, Virginia Wilderness Committee, Southern Appalachian Forest Coalition, Virginia Forest Watch, Wild Virginia, and the Sierra Club.

Date	From	To	Subject
2/7/07	Planning Staff Officer	Various Environ. Groups	Revision Process and Timeline
2/16/2007	Planning Staff Officer	Virginia Chapter of The Wildlife Society	Plan Revision Update
2/24/2007	Planning Staff Officer	Virginia Council Trout Unlimited	
3/31/2007	Planning Staff Officer	Virginia Loggers Association	
9/10/08	Planning Staff Officer, Forest Planner	Various wilderness-interest groups	Question and answer regarding Potential Wilderness Areas at their request
12/10/2008	Planning Staff Officer	Regional Water Resources Policy Committee	Drinking water protection
3/12/2009	Planning Staff Officer	Various Groups in northern Virginia – held in Arlington, VA	Plan Revision, summary of recent meetings

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Appendix B Analysis Process

INTRODUCTION

Land and resource management planning requires that processes formerly used to make individual resource decisions be combined into integrated management decisions. It also requires that mathematical modeling techniques be used to identify the most economically efficient solution to meet the goals and objectives of any alternative. Appendix B presents a technical discussion of the analysis process and computer models used in the Revision planning effort. The appendix focuses on the quantitative methods used to perform the analysis and documents how the analysis was done. The results from the modeling processes are estimates of what can be expected if alternatives are implemented and facilitate comparison of alternatives.

The Forest's major analysis goal is to provide enough information to help decision-makers and the public determine which combination of goods, services, and land allocations will maximize Net Public Benefits (NPB). The regulations (36 CFR 219) developed under the National Forest Management Act (NFMA) provide the analytical framework within which these decisions are made.

The NFMA and its regulations also state that the requirements of the National Environmental Policy Act (NEPA) and its regulations (40 CFR 1500-1508) must be applied in this analytic process. The NEPA regulations require that the environmental effects of a proposed action and alternatives to that proposed action must be disclosed in an Environmental Impact Statement (EIS).

Information presented in this chapter supplements the broader and less technical descriptions included in the body of the EIS. This discussion includes basic assumptions, modeling components and inputs, rules, methods, and constraints. Additional information and documents used in the analysis process are contained in the planning process records. The planning record in its entirety is incorporated here by reference.

FRAMEWORK OF THE PLANNING PROCESS

The general planning process described in 36 CFR 219.12 was used to guide the revision of the George Washington National Forest Land and Resource Management Plan. This 10-Step process is described briefly below, followed by a more detailed discussion of the analytical processes used in Steps 3, 4, and 6.

STEP 1, Identification of purpose and need: Issues, Concerns, and Opportunities. The Forest Interdisciplinary Team assessed changes in public issues, management concerns, and resource use and development opportunities since the Plan was initially developed and subsequently amended. To gain an understanding of public issues, 28 workshops were held for collaboration on issues and management options, as described in Appendix A of this EIS. In addition, information was reviewed and evaluated from numerous assessments, reports, action plans and initiatives from state and local government entities, such as the Virginia and West Virginia Statewide Forest Assessments, State Wildlife Action Plans, the Southern Appalachian Assessment, and County Comprehensive Plans for the counties with National Forest System lands.

STEP 2, Planning Criteria. Criteria are designed to guide the collection and use of inventory data and information; the analysis of the management situation; and the design, formulation, and evaluation of alternatives. This step establishes guidelines for accomplishing the next five steps. Planning criteria are based on:

- Laws, executive orders, regulations and agency policy as set forth in the Forest Service Manual
- Goals and objectives in the USDA Forest Service's Strategic Plan.
- Recommendations and assumptions developed from public issues, management concerns, and resource use and development opportunities.

- The plans and programs of other federal agencies, state and local governments, and Indian tribes.
- Ecological, technical and other factors.
- The resource integration and management requirements in 36 CFR 219.13 through 219.27.
- Alternatives that are technically possible to implement.
- Alternatives that meet management requirements or standards.
- Various levels of multiple-use objectives and outputs achieved.

STEP 3, Inventory Data and Information Collection - The kind of data and information needed is determined in Step 3 based on the issues, concerns, and opportunities identified and the resulting assessment of the management situation and determination of what needs to change. Data collection is part of normal Forest operations. Existing data is used whenever possible and supplemented with new data, when practicable. Data accuracy is continually evaluated. Much of this data and background documentation is on file in the planning records on file in the Supervisor's Office.

STEP 4, Analysis of the Management Situation - This step describes the existing situation on the Forest and determines if there is a need to change current management direction. It examines supply potentials and market assessments for goods and services, assesses demand for goods and services from National Forest lands, and determines suitability and feasibility for meeting needs. This information provides the basis for formulating an appropriate range of reasonable alternatives.

STEP 5, Formulation of Alternatives - A reasonable range of alternatives is formulated according to NEPA procedures. Alternatives are formulated to assist in identifying one that comes nearest to maximizing net public benefits (NPB). They provide for the resolution of significant issues and concerns identified in Step 1. Chapter 2 of the EIS describes the formulation of alternatives for the George Washington National Forest in more detail.

The alternatives reflect a range of resource management programs. Each identified major public issue and management concern is addressed in different ways in the alternatives. The programs and land allocations in each alternative represent the most cost-efficient way of attaining the goals and objectives for that alternative. Both priced and non-priced goods and services (outputs) are considered in formulating each alternative.

STEP 6, Estimated Effects of Alternatives - The physical, biological, economic and social effects of implementing each alternative are described in Chapter 3 of the EIS in an effort to evaluate how well each alternative responds to issues, concerns and opportunities and what the potential impacts to resources might be.

STEP 7, Evaluation of Alternatives - Significant physical, biological, economic and social effects of implementing alternatives are used to evaluate each alternative and compare them with one another. Typically, each alternative can be judged on how it addresses the significant issues identified in Chapter 1.

STEP 8, Preferred Alternative - The Forest Supervisor reviews the Interdisciplinary Team evaluation of each alternative and the public issues and concerns. The Forest Supervisor then recommends a preferred alternative to the Regional Forester. The Regional Forester either selects the Forest Supervisor's recommendation, another alternative, or modifies the alternative recommended by the Forest Supervisor. This alternative is described as the Preferred Alternative in this EIS and is displayed as the Proposed Revised Forest Plan. Public comments are solicited and will be considered in the finalizing of the draft Revised Forest Plan and EIS.

STEP 9, Plan Approval and Implementation - After the Interdisciplinary Team has reviewed public comments and incorporated any necessary changes into the Final EIS and the Revised Forest Plan, the Regional Forester reviews and approves the Revised Forest Plan and Final Environmental Impact Statement. A Record of

Decision documents this step.

STEP 10, Monitoring and Evaluation - The Revised Forest Plan establishes a system of measuring, on a sample basis, actual activities and their effects, and compares these results with projections contained in the Revised Forest Plan. Monitoring and evaluation comprises an essential feedback mechanism to ensure the Revised Forest Plan is dynamic and responsive to change. Chapter 5 of the Revised Forest Plan displays the Monitoring and Evaluation program.

INVENTORY DATA AND INFORMATION COLLECTION (STEP 3)

Several Interdisciplinary Team meetings were held to evaluate what data were needed to address the significant issues, concerns and opportunities identified in Chapter 1 of the EIS. Existing inventories were reviewed and updated and new information needs were identified and collected, if available. Most of the information was stored in databases, spreadsheets and a geographic information system (GIS).

GIS Data Layers

A geographic information system (GIS) was used to develop the primary Forest Plan revision database. GIS links natural resource tabular information with spatial (map) information. This linkage enabled complex spatial analyses and rapid display for many different physical, biological or administrative resources. The resulting database was used to preliminarily map the allocation of the management prescriptions, analyze suitable timber lands, build the forest planning model Spectrum analysis areas, and perform other analyses for the revision. To develop the database, the following layers were overlaid in GIS:

1. **The Field Sampled Vegetation database (FSVEG, previously known as CISC)** – the Southern Region's primary forest vegetation and stand inventory information that relates to forest cover type, age, site index, and land classification. The mapping of the management prescriptions for each alternative and the identification of Spectrum analysis areas used FSVEG data from 2006 (the latest update).
2. **Land Status** – This layer contains information on Forest surface ownership and subsurface mineral rights. The latest update for mapping of management prescriptions and Spectrum analyses was the spring of 2010.
3. **Watersheds** – This layer included Hydrologic Unit Code (HUC) mapping at both the fifth and sixth levels.
4. **Riparian** – This layer is an approximation of the riparian habitat on the forest. It is impossible to map the true riparian corridor through the use of GIS due to the complexity of slope, vegetation and other factors that help define the corridor. This coverage was generated by buffering perennial streams and lakes by 100 feet and intermittent streams were buffered by 50 feet on each side.
5. **Potential Wilderness Areas** - Appendix C of the EIS incorporates all the data used in the potential wilderness area evaluations.
6. **Developed Recreation Sites**
7. **Scenery Management System (SMS)** – This layer addressed the visual resources and included attributes related to scenic integrity, distance zone, scenic attractiveness, and concern level.
8. **Recreation Opportunity Spectrum (ROS)** – This layer represented the recreation experience expected in a particular area and included attributes such as rural, roaded natural, semi-primitive motorized and semi-primitive non-motorized. The ROS inventory was updated in 2009.
9. **Transportation** – This layer included state and Forest Service roads and trails within the Forest boundary.
10. **Special Biological Areas** – This layer included known areas with special biological or zoological resources or rare communities.
11. **Current Plan Management Areas** – This layer included all of the management areas and prescription areas from the 1993 George Washington National Forest Plan.

12. **Soils**
13. **Geology**
14. **Cultural Resources** – This layer included areas with special historical or cultural emphases.
15. **Streams and Watercourses** – This layer included intermittent and perennial streams, lakes, rivers and ponds.
16. **Special Uses** – This layer included existing special use permits and utility corridors.
17. **LANDFIRE -** (also known as Landscape Fire and Resource Management Planning Tools) is an interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior (DOI) and the United States Department of Agriculture, Forest Service. LANDFIRE produces a comprehensive, consistent, scientifically credible suite of spatial data layers for the entire United States. LANDFIRE data products consist of over 50 spatial data layers in the form of maps and other data that support a range of land management analysis and modeling. Specific data layer products include: Existing Vegetation Type, Canopy, and Height; Biophysical Settings; Environmental Site Potential; Fire Behavior Fuel Models; Fire Regime Classes; and Fire Effects layers based on regional models and sample plot data. The original LANDFIRE Project was designed to use peer-reviewed, consistent, and repeatable scientific methods. Data products are developed through integrating a collection of advanced scientific procedures, including relational databases, georeferenced land-based plots and polygons representing field conditions, satellite-enabled remote sensing, systems ecology, gradient analysis, predictive landscape modeling, and vegetation and disturbance dynamics. (www.landfire.gov)

Ecological Zones Mapping

Ecological Zones are units of land that can support a specific plant community or plant community group based upon environmental and terrain factors that control vegetation distribution. They may or may not represent existing vegetation, but instead, the vegetation that could occur on a specific site with historical disturbance regimes. They are basically equivalent to LANDFIRE's Biophysical Settings which "represent the vegetation that may have been dominant on the landscape prior to Euro-American settlement and are based on both the current biophysical environment and an approximation of the historical disturbance regime" (LANDFIRE, 2009). Ecological Zones in the Southern Appalachian Mountains, identified from plant community composition and cover data, are associated with unique environmental variables and these variables can be characterized by digital models to predict distribution of ecological zones across the landscape (Simon et al. 2005).

Since 2001, Ecological Zones have been mapped in the Southern and Central Appalachian Mountains on over 10 million acres by applying logistic regression coefficients to digital terrain models within a geographic information system. These areas include portions of eastern Kentucky, western North Carolina, northeastern Tennessee, eastern West Virginia, and western Virginia. Much of this work was done in cooperation with The Nature Conservancy (TNC) under the Fire Learning Network (FLN) program. Using the same methodology and framework, ecological zone mapping of the Alleghany Highland Fire Learning Network area in Virginia and West Virginia, which covers approximately 60% of the GWNF, began (by Steve Simon) during the revision of the George Washington NF Forest Plan. The results of that mapping have been included in the analysis for the Draft EIS. Mapping is continuing for the remainder of the GWNF and that data will be incorporated into the Final EIS.

Mapping Methodology for the Alleghany Highland Fire Learning Network Area

Development of the individual Ecological Zone models for the area covered by the Alleghany Highland Fire Learning Network began with the creation of a spatial database that described the study area environment using landform and environmental variables. Twenty-five landform/environmental models (DTMs) were used to characterize these variables as shown in the following table.

Table B-1. Environmental variables evaluated for Ecological Zone model inclusion

Elevation (10 meter DEM)
Aspect (degrees)
Aspect (cosine of slope direction)
Surface curvature
Surface curvature profile (direction of slope)
Surface curvature planiform (perpendicular to slope)
Slope steepness
Solar radiation (yearly), Solar radiation (growing season)
Relative slope position (from Wilds 1997)
Terrain relative moisture index (from Iverson et al. 1997)
Landform index (from McNab 1993)
Distance to stream
Distance to limestone lithology
Distance to acidic shale lithology
Distance to non-acidic shale lithology
Distance to sandstone lithology
Average annual precipitation
Difference in elevation from nearest stream
Local relief
Valley position
Surface curvature roughness
Distance to high snowfall zones
Distance to rivers
Difference in elevation from nearest river
River influence

Field plots were sampled on over 1,200 sites and combined with an additional 400 plots collected within the project area during the past 15 years by the Virginia and West Virginia Natural Heritage programs.

Results

The relationships between Ecological Zone field plots and environmental variables were analyzed and predictive equations developed. Field plots were used as reference data to evaluate the accuracy of the final Ecological Zone map. The relationship between plant community type and the environments in which they occur (and hence the Ecological Zone) can be evaluated by examining the relative importance of environmental variables found to be the best predictors of Ecological Zone location. Some of these relationships were fairly straight-forward, others were not. For example, elevation was the primary environmental factor to define the Spruce and Northern Hardwood distribution but for Shale barrens & Acidic woodlands, it was their association with acidic shale lithology primarily and secondarily with aspect (acidic woodlands) and rivers (shale barrens). Similarly, the primary environmental factor that drove the distribution of Pine-oak heath, on both sides of major ridges, is aspect but for Alluvial forests, it is the distance above streams and valley position. Geologic substrate strongly influenced the distribution of Rich cove and Dry-mesic calcareous forests, i.e., both are centered on limestone lithologies, while elevation and valley position explained nearly three-quarters of the variation in the High elevation red oak model. These relationships were all obvious in the field and from viewing digital terrain data in comparison to individual Ecological Zone models. Not so obvious in the field was the influence of high

snowfall areas and the distribution of Northern hardwood coves or why multiple lithologic types contribute information for so many types.

Use of the Ecological Zones in the Forest Plan

Twenty-one different Ecological Zones were identified and mapped in the study area. This mapping was compared with ecological mapping from LANDFIRE, mapping of forest types from the FSVEG database, and mapping from the Virginia and West Virginia GAP datasets. Although the FSVEG database includes forest types as an attribute of stand delineation, there are several reasons why it is not always the best indicator of the ecosystem on the ground. Not all lands on the Forest have received the same level of inventory (e.g. land suitable for timber production versus Wilderness) and stand examinations do not cover as much area as they did in the past. Therefore, it was concluded that the ecological zone mapping was a more adequate representation of the current condition of ecosystems across all lands on the Forest, since it was based on field plots and models with high correlation from key terrain and environmental variables. However, the conditions predicted using the models were adjusted to reflect known on the ground conditions, such as areas planted to white pine, wildlife openings, other types of permanent openings, etc. It was also concluded that the ecological zone mapping did the best at identifying the ecosystem that could occur on a specific site, given historical disturbance regimes. The ecological zones were then crosswalked to NatureServe Ecological Systems and Virginia Natural Heritage Program Ecological Groups or Community Types. The NatureServe Ecological Systems were the basis for the models used in LANDFIRE for the Biophysical Settings. These models formed the basis for developing desired attributes and indicators for the GW ecosystems used in the Ecological Sustainability Evaluation (ESE) analysis tool, which were translated into the ecosystem desired conditions and objectives in the Forest Plan.

Transportation Analysis Process (TAP)

As defined in 36 CFR 212.5(b)(1), each national forest must identify the minimum road system needed for safe and efficient travel and for administration, utilization, and protection of National Forest System lands. The minimum system is the road system determined to be needed to meet resource and other management objectives adopted in the relevant land and resource management plan (36 CFR part 219), to meet applicable statutory and regulatory requirements, to reflect long-term funding expectations, and to ensure that the identified system minimizes adverse environmental impacts associated with road construction, reconstruction, decommissioning, and maintenance. In 36 CFR 212.5(b)(2), it states that roads no longer needed to meet forest resource management objectives must be identified and therefore, should be considered for decommissioning or for other uses, such as for trails.

A Travel Analysis Process (TAP) was conducted for the George Washington National Forest, concurrent with the Plan revision analysis, to identify the minimum road system. The TAP is intended to be a broad scale comprehensive look at the transportation network across the Forest. It is important to note that the TAP does not make any decisions related to roads or motorized trail systems, but it will be used to inform travel management decisions made for individual roads or motorized trails, which will be subject to site-specific environmental analysis through the NEPA process.

The TAP established Forest and District Interdisciplinary Teams (IDTs). The Forest IDT consisted of staff specialists who provided science-based evaluations and coordination with the development of the Forest Plan. The Forest IDT accomplished the following:

- utilized a science based approach prescribed by 36 CFR 212.5(b)(1), addressing the questions at the forest level that are listed in Publication FS-643, "Roads Analysis: Informing Decisions About Managing the National Forest Transportation System;"
- identified indicators that are most relevant to the George Washington National Forest to help determine what risks and benefits should be used to analyze each road. Risks identified included impacts to, or from: 1) Wildlife, 2) Sediment Delivery, 3) Invasive Plants, 4) Aquatic Passage, 5) Public Safety, and 6) Law Enforcement. Benefits identified included: 1) Resource access; 2) Recreation access; 3) Fire/Emergency access; and 4) Wildlife/Plants;

- established criteria for each risk and benefit category based on a high, medium, or low metric. See example below:

Indicator: Invasive Species Risks	
Risk assessment for new introduced populations of undesirable plant or animal species. Vehicles can carry and spread plant parts or seeds or animals into disturbed areas along roads or in the road bed.	**HIGH RISK:** Roads accessing or within Special Biological Areas Roads accessing/bordering Wilderness Roads along known infestations of highly invasive species which co-occur with known TES locations Roads accessing campgrounds and heavily used dispersed recreation areas
	MEDIUM RISK: Roads along known infestations (including fishing access in known locations of aquatic invasives) Roads in riparian areas for less than 500 feet (includes crossings)
	LOW RISK: Other Roads

The District IDTs evaluated each road as to its purpose and its rankings related to the risk and benefits metrics for each indicator. The purpose(s) for each road could include: future resource program needs; current resource program needs; dispersed recreation access; developed recreation access; private property access; arterial roads that are a major through road or highly used spur road that a joins with collector roads; long-term special use access; or could be a potential forest highway (arterial connecting state roads with adjacent private property, used for commuting or recurrent non-forest commercial traffic, etc). Budget information, maintenance costs, and strategies to mitigate risks and reduce costs were evaluated as well.

Although the TAP identified a final score and recommendation for each road and motorized trail on the GWNF that led to a determination as to whether it should be part of the minimum road system, actual travel management decisions will be made on a project level with site-specific environmental analysis and public involvement. However, the cumulative results of the TAP were used to identify the minimum road system miles needed to implement each alternative, including the amount of new construction and the amount of decommissioning.

ANALYSIS OF THE MANAGEMENT SITUATION (STEP 4)

In addition to the emerging issues, the need for change was identified through the Analysis of the Management Situation for the George Washington National Forest (AMS). This analysis considered the results of monitoring and evaluation, other policy and direction since the previous Plan, the current condition of the resources, and supply and demand factors to determine the need for change in management direction, as well as the ability of the planning area covered by the Forest Plan to supply goods and services. It provided a basis for formulating a broad range of reasonable alternatives. The processes and results for the supply and demand analyses are briefly discussed below. The process records contain the full supply and demand analyses.

Determination of Demand Estimates

Recreation

Estimates for the demand of various recreation opportunities came from several sources, including the National Visitor Use Monitoring (NVUM) data collected in 2006 on the Forest, the 2000-2004 National Survey on Recreation and the Environment (NRSE), the outdoor Recreation participation projections 2010 to 2060 as provided in Outdoor Recreation Trends and Futures: Technical Document Supporting the Forest Service 2010 RPA Assessment, the *2007 Virginia Outdoors Plan* and the *2006 Virginia Outdoors Survey,* and the *2009 Statewide Comprehensive Outdoor Recreation Plan (SCORP) for West Virginia.* Results of the recreation supply and demand analysis can be found in the Analysis of the Management Situation report.

Range

The range program on the George Washington NF is so small in scope that supply and demand conditions were not considered necessary.

Timber

Estimates for the demand for timber products came from Forest Product Directories for the counties included in the market area and the George Washington and Jefferson National Forests Appraisal Schedule. Results of the timber supply and demand analysis can be found in the Analysis of the Management Situation report.

Minerals

Future projections of the kind and amount of oil and gas activity that could be reasonably anticipated were identified in the Reasonable Foreseeable Development Scenario (RFD) report prepared by the Bureau of Land Management (BLM). The RFD is based on the assumption that all lands on the Forest would be available for oil and gas leasing under standard lease terms and conditions, except for those areas withdrawn from leasing by law (Wilderness and National Scenic Area). It covers a time period of 15 years and includes all lands within the boundaries of the George Washington National Forest (GWNF) regardless of mineral estate ownership. The RFD is found in Appendix K of the EIS.

Wilderness

Appendix C of the EIS contains the potential wilderness area evaluations. One of the three major factors in these evaluations is the identification of need and a consideration of the amount of Wilderness already in the area, regionally and nationally.

Wildlife and Fisheries

Projections for hunting and fishing are included in the analysis for recreation.

Benchmark Analysis

Benchmark analysis is specified in the NFMA regulations in 36 CFR 219.12(e) as part of the Analysis of the Management Situation. Benchmarks approximate maximum economic and biological resource production opportunities and are useful in evaluating the compatibilities and conflicts between individual resource objectives and in defining the range within which integrated alternatives can be developed. The following benchmark analyses are consistent with the minimum applicable management requirements of 36 CFR 219.27.

Minimum Level of Management Benchmark - 36 CFR 219.12(e)(1)(i). This benchmark represents the minimum level of management needed to maintain and protect the GWNF as part of the National Forest System. This level of management does involve some activities and costs in order to meet the following minimum management requirements:

- Protect the life, health, and safety of incidental users;
- Prevent environmental damage to the land or resources of adjoining lands of other ownerships or downstream users;
- Conserve soil and water resources;
- Prevent significant or permanent impairment of the productivity of the land; and

- Administer unavoidable non-Forest Service special uses and mineral leases, licenses, permits, contracts, and operating plans.

Alternative C in the DEIS embodies most of the elements of a minimum level of management; however some activities are allowed in this alternative to make it a more realistic and viable option. The activities in Alternative C that involve more than a minimum level of management include: the continued operation of three ATV use areas; more of an emphasis on non-motorized recreation that would include an increase in trail miles; and continued operation of some developed recreation sites.

Maximum Physical and Biological Production Potential Benchmarks - 36 CFR 219.12(e)(1)(ii) These benchmarks identify the maximum physical and biological production potentials of significant individual goods and services together with associated costs and benefits. For ecological systems, the maximum biological production is represented by the desired conditions for the cove, spruce, northern hardwood, oak and pine systems in Chapter 2 of the Plan.

Maximum Timber Benchmark. This benchmark is used to identify the maximum timber production potential of the Forest, subject to these specifications:

- The objective function maximizes timber volume in the first five decades, with a rollover to maximize present net value for 15 decades.
- All tentatively suitable acres are included, without any management prescription allocations, so every tentatively suitable acre is eligible for harvest.
- No successional habitat constraints are applied.

Several key results of the maximum timber benchmark are:

- 910,000 tentatively suitable acres are allocated to timber production
- Annual harvest is 19.68 MMCF (98.4 MMBF)
- Annual harvest is 10,331 acres
- Cumulative Present Net Value over five decades is $117,447,000
- Long-term sustained yield is 23.66 MMCF

Maximum Wilderness Benchmark. This benchmark is used to identify the maximum potential of the Forest to provide areas that meet the definition of wilderness according to the 1964 Wilderness Act. In Chapter 2 of the DEIS, Alternative C represents this benchmark, with the recommendation for wilderness study all of the 37 areas in the Potential Wilderness Area inventory as well as Southern Massanutten Mountain and the Friars Inventoried Roadless Areas. This benchmark represents 386,800 acres recommended for wilderness study and 20,000 existing Wilderness acres.

Maximum Natural Gas Production Benchmark. This benchmark is used to identify the maximum potential for the Forest for natural gas production. This benchmark is represented by the Reasonably Foreseeable Development (RFD) prepared by the Bureau of Land Management that is based on the assumption that all lands on the Forest would be available for oil and gas leasing under standard lease terms and conditions, except for those areas withdrawn from leasing by law. The RFD is described in more detail in Chapter 3 of the DEIS. This benchmark represents the construction of 20 vertical exploration/evaluation wells and 50 vertical and 249 horizontal development wells.

Present Net Value Benchmarks – The following benchmarks are described in the 36 CFR 219 regulations.

- 36 CFR 219.12(e)(1)(iii) Monetary benchmarks which estimate the maximum present net value of those resources having an established market value or an assigned value;
- 36 CFR 219.12(e)(1)(iii)(A) For forest planning areas with major resource outputs that have an established market price, monetary benchmarks shall include an estimate of the mix of resource

uses, combined with a schedule of outputs and costs, which will maximize the present net value of those major outputs that have an established market price;

- 36 CFR 219.12(e)(1)(iii)(B) For all forest planning areas, monetary benchmarks shall include an estimate of the mix of resource uses, combined with a schedule of outputs and costs, which will maximize the present net value of those major outputs that have an established market price or are assigned a monetary value;
- 36 CFR 219.12(e)(1)(iii)(C) For forest planning areas with a significant timber resource, estimates for paragraphs (e)(1)(iii)(A) and (B) of this section shall be developed both with and without meeting the requirements for compliance with a base sale schedule of timber harvest, as described in s 219.16(a)(1), and with and without scheduling the harvest of even-aged stands generally at or beyond culmination of mean annual increment of growth, as described in s 219.16(a)(2)(iii). The George Washington NF does not have a significant timber resource.

Timber Maximum PNV Benchmark. This benchmark was established to estimate the schedule of outputs and costs that would maximize the present net value of timber production without any constraints, subject to these specifications:

- The objective function maximizes net present value over the entire planning horizon.
- All tentatively suitable acres are included, without any management prescription allocations.
- No successional habitat constraints are applied.

Several key results of the maximum timber PNV benchmark are:

- 910,000 tentatively suitable acres are allocated to timber production
- Annual harvest is 17.66 MMCF (88.3 MMBF)
- Cumulative Present Net Value over five decades is $112,392,000
- Long-term sustained yield is 19.53 MMCF

Maximum Present Net Value Benchmarks were not modeled for resources other than timber since use of the Spectrum Model (linear programming model that determines the best mix of outputs and activities to maximize an objective function, such as present net value) was confined to timber harvest outputs and activities. There is no method to maximize the present net value of other resources but the present net values of several resource programs under each alternative that was evaluated in the DEIS is presented in the following table.

Table B-2. Cumulative Decadal Present Net Values of Benefits and Costs (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)

Present Value Benefits by Program:	**Alt A**	**Alt B**	**Alt C**	**Alt D**	**Alt E**	**Alt F**	**Alt G**
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$36	$68	$0	$123	$38	$22	$68
Minerals	$24	$19	$4	$20	$6	$16	$6
Recreation	$1,163	$1,181	$1,007	$1,242	$1,111	$1,244	$1,205
Wildlife	$661	$669	$562	$713	$640	$698	$684
Total Present Value Benefits	**$1,884**	**$1,937**	**$1,573**	**$2,098**	**$1,795**	**$1,980**	**$1,963**
Present Value Costs by Program:							

Present Value Benefits by Program:	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$41	$47	$0	$80	$27	$17	$47
Roads/Engineering	$29	$30	$25	$32	$29	$28	$30
Minerals	$4	$4	$4	$5	$4	$4	$4
Recreation	$84	$84	$78	$90	$78	$90	$84
Wildlife	$12	$14	$8	$15	$14	$14	$14
Soil, Water and Air	$30	$29	$15	$29	$29	$29	$29
Protection/Forest Health	$26	$42	$26	$33	$48	$42	$42
Lands	$9	$9	$9	$9	$9	$9	$9
Planning/Inventory/Monitoring	$9	$9	$9	$9	$11	$9	$9
Total Present Value Costs	**$244**	**$268**	**$174**	**$302**	**$249**	**$242**	**$268**
Cumulative Total Present Net Value	**$1,640**	**$1,669**	**$1,399**	**$1,796**	**$1,546**	**$1,738**	**$1,695**

Lands Suitable for Timber Production

During forest land and resource management planning, the Forest Service is required to identify lands unsuited for timber production (16 USC 1604(k); 36 CFR 219.14). This identification process involves three stages of analysis. Stage I analysis identifies lands tentatively suitable for timber production. Stage II analysis is designed to explore the financial aspect of varying intensities of timber management on lands identified as tentatively suitable for timber production from Stage I. Stage III analysis identifies lands as unsuited for timber production under the alternative selected in the revised Forest Land and Resource Management Plan.

Stage I: Physical Suitability

The first stage of the timber suitability analysis addresses the administrative and physical suitability of the land to be managed for the production of timber. Stage I lands unsuitable for timber production included:

- Lands that do not meet the definition of forest land.
- Lands that have been administratively or congressionally withdrawn from timber production by an act of Congress, the secretary of agriculture, or the chief of the Forest Service.
- Forest lands incapable of producing industrial wood.
- Lands where technology is not available to ensure timber production from the land without irreversible soil and water resource damage.
- Lands where there is no reasonable assurance that they can be adequately restocked.
- Lands where there is inadequate information, primarily due to recent acquisition.

The codes in Table B-3 from the Field Sampled Vegetation database (FSVEG) were used to define the five categories used to determine the Stage I tentatively suitable lands.

Table B-3. Stage I Acres Tentatively Suitable for Timber Production

Categories of Stage I Unsuitable Lands	Defining Information	Current Net Acres
Total National Forest System Lands:		1,065,000
1. Non Forest Land	FSVeg Land Class Codes: 110-Lake 120-Reservoir 140-River 210-Cemetery 220-Powerline 230 Road/Railroad 240-Special Use 250-Wildlife Clearing	(7,000)
2. Withdrawn	Designated Wilderness (1A) Mt. Pleasant National Scenic Area (4F) Research Natural Areas (4B)	(54,000)
3. Irreversible Damage	Land Class Code: 826 - Physical barriers AND Site Index < 70	(28,000)
4. Can't Restock	Forest Type: 99 – Brush AND Stand Condition Class: 15 – Non Stocked	(1,000)
5. Incapable of producing industrial wood	Land Class Code: 900 – Incapable of Industrial Wood OR Site Index < 40	(65,000)
Tentatively Suitable Forest Lands		**910,000**

Stage II: Financial Analysis

The second stage analysis is designed to explore the financial efficiency of different timber intensities on the lands identified as tentatively suitable for timber production in Stage I. It does not identify any lands as unsuitable for timber production. Stage III analysis considers the results of these financial efficiencies in making the final determination of lands suited for timber production.

The financial analysis identifies the present net value (PNV) for different Spectrum analysis areas. For the purpose of this analysis, PNV is a measure of the discounted timber benefits less the discounted timber management costs, using a 4 percent discount rate. The actual PNV analysis consisted of a Spectrum run which examined all of the silvicultural prescriptions for all of the Spectrum analysis areas. There are many

factors that determine the economic efficiency of a timber sale that cannot possibly be modeled using a landscape level planning model such as Spectrum. However, based on this financial analysis, the following primary conclusions were made:

- Clearcutting with natural regeneration has the highest PNV for all analysis areas.
- The analysis areas with the lowest PNV were site index 50 in yellow pine.
- All site index 40 lands were economically inefficient.
- Site index 50 lands that had slopes greater than 55%, with the exception of forest types 48, 53, 56 and 81 (northern red oak-hickory-yellow pine, white oak-northern red oak-hickory, yellow poplar-white oak-red oak, and sugar maple-beech-yellow birch) were economically inefficient.

Stage III—Identification of Suitable Acres

The third stage analysis is accomplished during the formulation of alternatives (Table B-4). Several criteria were used during this stage to identify lands as unsuitable for timber production:

- Based upon consideration of multiple-use objectives for an alternative, the land is proposed for resource uses that preclude timber production. However, in some management prescriptions that are classified as unsuitable for timber production, timber harvest may occur to meet the desired condition of other resources.
- Other management objectives for an alternative may limit timber production activities to the point where management requirements set forth in 36 CFR 219.27 cannot be met.
- The lands are not cost-efficient, over the planning horizon, in meeting forest objectives, which includes timber production.

Table B-4. Stage III Suitability for All Alternatives

Alternative	Acres Unsuitable for Production	Acres Suitable for Production	Percent Suitable for Production
A	715,000	350,000	33%
B	579,000	486,000	46%
C	1,065,000	0	0%
D	583,000	482,000	45%
E	699,000	366,000	34%
F	787,000	278,000	26%
G	626,000	439,000	41%

ESTIMATED EFFECTS OF ALTERNATIVES (STEP 6)

Analysis Tools Used

The primary tools used to estimate the effects of alternatives include several established computer models, numerous spreadsheets and GIS.

Pre-Suppose

Pre-Suppose is a program used to query and sort Forest Inventory and Analysis (FIA) data for use in the growth and yield model. The program allows the user to evaluate, select or discard plots that fit desired criteria and create support files to directly be linked into the Suppose interface for the Forest Vegetation Simulator model.

Forest Vegetation Simulator Model

The primary tool for estimating growth and yield used in the Spectrum model is the Forest Vegetation Simulator (FVS) model. FVS is an individual-tree, distance-independent, growth and yield model. It has its structural roots in the Stand Prognosis Model developed by Albert Stage from the Intermountain Research Station. Staff at the USFS Forest Management Service Center in Fort Collins have now calibrated many variants of the model to specific geographic areas throughout the United States. Each variant used different species-specific growth and yield equations and assumptions. The Southern Variant was used for developing yield tables for the Spectrum model. The Southeastern and Northeastern Variants were also evaluated for use but the Southern Variant provided the best fit for tree species on the George Washington National Forest. The yield tables developed for the Jefferson Forest Plan were used for the GWNF.

FVS allows the user to calculate estimates of forest stand structure and species composition over time and quantify this information to: 1) describe current and future forest stand conditions; 2) simplify complex concepts of forest vegetation into user-defined indices, attributes, etc.; and 3) allow the manager to ask better questions about growth and yield of forested stands and complete analyses to answer those questions. For the purposes of the Southern Appalachian Forest Plan Revisions, Forest Inventory and Analysis (FIA) data for the Southern Region was converted into a format that FVS could use. This data is collected by the Forest Inventory and Analysis Unit of the Southern Research Station for each State on a 10 year cycle in order to provide unbiased, accurate, current, and relevant forest resource information that meets the diverse needs of land stewardship.

Stratification of FIA data was performed based on geological province, forest type, and site index. The dataset from which FIA data could potentially be selected was limited to the Blue Ridge, Ridge and Valley, and/or Cumberland Plateau provinces of Virginia, Kentucky, North Carolina, Tennessee, South Carolina, and Georgia. Forest Type was used to group the data into one of four working groups; upland oak, cove hardwoods, white pine/hemlock, and southern yellow pine. These working groups correspond to analysis area identifiers used in the Spectrum model. Three categories of site indices were used to further stratify the data within these working groups; 50 to 65, 66 to 85, and 86 t0 100. Whenever possible, data selected for a simulation was limited to FIA plots on National Forest System lands in Virginia to simulate conditions on the George Washington National Forest as closely as possible. For common working group/site index combinations (e.g. upland oak in the 66 to 85 site index group) this resulted in an adequate number of stands to provide statistically sound conclusions. However, in some cases (e.g. southern yellow pine on site index 86 to 100) very few FIA plots were found within those constraints. In such cases, selection criteria were broadened to include first, all of Virginia, then to all of the remaining States until an adequate number of FIA plots meeting the working group/site index criteria were selected.

The FVS model structure contains modules for growing trees, predicting mortality, simulating growth reductions due to stocking, calculating tree volumes, and producing reports. Extensions that simulate the effects of Oak Decline and the Southern Pine Beetle on forested stands are also available for use with the Southern Variant. These Pest Extensions predict the number of events, expected mortality, and residual stand structure and composition. In addition to providing input for the Spectrum model, FVS was used in combination with these pest extensions to disclose impacts to the Forest expected from Oak Decline and the Southern Pine Beetle.

Implan

The economic effects to local counties, primarily in terms of employment and income, were estimated using an economic input-output model developed with IMPLAN Professional 2.0 (IMPLAN). IMPLAN (Impact Analysis for Planning) is a commercial software package for personal computers that uses the latest national input-output tables from the Bureau of Economic Analysis. The data consists of national-level technology matrices and estimates of industrial sector activity for final demand, final payments, industry outputs and employment for each county in the U.S. along with state and national trends. The software was originally developed by the Forest Service and is now maintained by the Minnesota IMPLAN Group, Inc (MIG). Data used for the impact analysis was from secondary data for those counties considered to be in the forest's impact areas. The assumption used in this modeling process was that the impact area comprised the counties within the forest's designated county boundaries. The data source used in developing the Southern Appalachian Forest models for impact purposes was the most recent data available from MIG (1998).

Input-output analysis gives estimates of employment and income for an increase in final demand on certain sectors of the economy. For Forest Service timber, we have looked at the sawmill and pulpwood industries where our timber goes as the first processing step in manufacturing. Impacts include all those industries initially impacted as well as those industries linked with supplying inputs to production, as well as workers in those industries who then spend wages in their households (known as direct, indirect and induced effects, respectively). A Forest Service-developed spreadsheet known as "FEAST" (Forest Economic Analysis Spreadsheet Tool) was used to apply the IMPLAN results to each alternative, expressed in units of output. FEAST transformed the dollar impact for a given industry from IMPLAN to the various resource outputs by alternative into a specific employment and dollar output.

Development of the Forest Planning Model (Spectrum)

Land management planning is the major mechanism for making large-scale and long-term forest land allocations and resource management decisions. Planning consists largely of exploring a national forest's productive potential and experimenting with various allocation choices. Modeling is an important planning tool because it permits studying the consequences of choices without actually committing valuable resources to experimentation or having to wait many years to observe an outcome. It can also evaluate whether desired future conditions are feasible when taking all resource management goals and objectives into consideration. However, decisions about land allocations, choosing and pursuing trade-offs, and accepting one result instead of another are made by people, not the model. The model is merely a device for organizing elements of the decision problem, discovering possible choices and identifying potential conflicts. The Spectrum model is an evolved version of FORPLAN, a linear programming model that solves for an overall objective, such as maximizing present net worth of benefits and costs or maximizing the amount of certain yields. It is an excellent tool for determining the most cost-efficient way to reach some objectives and for analyzing the impacts to vegetative conditions over time from various management activities.

In the past, this model has been used to make land allocation decisions; however, for this Forest Plan, those land allocations were essentially determined through the mapping of the management prescriptions that varied for each alternative. Therefore, within Spectrum, the land allocation/management prescription assigned to every acre was already made in the model through the use of analysis areas. Because silvicultural treatments are one of the primary means of managing vegetation and wildlife habitat, and are easily modeled, the Spectrum model was constructed principally to examine how timber management could be used to achieve the goals and objectives for each alternative and for the individual management prescriptions. The George Washington Spectrum model was therefore constructed to be a timber harvest allocation model, i.e. it was used to model management constraints and determine the most efficient way of meeting management objectives through the use of silvicultural prescriptions. Only benefits and costs pertaining to the timber program were included in the model. The effects from other type treatments on vegetation and other resources, as well as other resource benefits and costs, were addressed outside of the model, based on the timber-related outputs from the Spectrum model.

Spectrum Model Overview

The model was designed and solved in the following steps:

- Model creation - Designing a Spectrum model was the most intensive of the four steps. In this step the modeler input resource data, specified resource interactions, set goals and objectives, outlined management actions, defined activities and outputs, set the planning horizon, stratified the landscape into similar response areas, and input economic data.
- Matrix Generation - Generating the matrix was the process of converting the input from step one to a matrix of rows and columns that the optimization software could solve.
- Optimization of the Solution - The commercial software C-Whiz was used to solve the matrix. The linear programming solver found the best mix of management actions to meet the management objectives.

- Interpretation of the Solution- The final step in the modeling process was to use the reports created in Spectrum and spreadsheets to interpret the results of the optimization and perform sensitivity analyses.

The eight basic components of the Spectrum model include the following and are discussed individually in this section:

1) the planning horizon;
2) land stratification;
3) silvicultural prescriptions;
4) activities and outputs and their associated costs and benefits;
5) rotation ages;
6) yield coefficients;
7) constraints;
8) the overall management objectives.

Planning Horizon

Each Spectrum model has a specified time frame called a 'planning horizon' that may be as short or long as desired and is broken into time periods of 10 years each. The George Washington Spectrum model used a planning horizon of 200 years, with 20 time periods, or decades. Activities and outputs are primarily represented in Spectrum on a decadal basis, occurring at the midpoint of the decade.

Land Stratification (Analysis Areas)

Analysis areas are defined as units of land, not necessarily contiguous, which can be considered to be homogeneous with respect to responses to treatment in terms of yields, costs, and values received for resource outputs. Management objectives or constraints are also expected to be relatively the same throughout an analysis area. In Spectrum, each analysis area is allowed up to six stratification categories to identify its unique responses to treatments, yields, costs, values and constraints. Table B-5 describes the six strata used to determine the analysis areas. The George Washington used a combination of Geographic Information System (GIS) data layers to construct its analysis areas. Initially, a polygon layer of stand information from the Field Sampled Vegetation database (FSVEG) was intersected with layers representing slope, the Recreational Opportunity Spectrum (ROS), the Scenery Management System (SMS), the ecological subsections, and the allocation of the Forest Plan management prescriptions mapped for each alternative. A stratum may have two resource layers combined in order to keep the number of strata to six.

The Old Growth Community Type classification was used to define the forest cover types. This allowed tracking of changes in these vegetation groupings over time. Yield tables were developed for the four aggregate groupings of these community types. Site index was used to differentiate the growth and yield estimates and the appropriate silvicultural prescriptions allowed. Scenic class and the Recreation Opportunity Spectrum (ROS) was incorporated to apply constraints by management prescription. The beginning successional class of an analysis area was used to track the movement of acres, by community type, in the various successional classes over the planning horizon. Only the management prescriptions that are unsuitable for timber production were not included in the model.

Table B-5. Spectrum Analysis Areas

Stratum of Land	Description	Definition or Code
LEVEL 1 - Vegetation	**SAA Old Growth Community Type**	**CISC Forest Type(s)**
NH	Northern Hardwoods	81
CNH	Conifer-Northern Hardwoods	2, 3, 4, 5, 8, 9, 10
MMWM	Mixed Mesophytics and Western Mesophytics	41, 50, 56, 70, 71, 82
ERH	Eastern Riverfront and River Floodplain	58, 63, 69, 72, 73, 74, 75
DMO	Dry Mesic Oaks	51, 53, 54, 55
DXO	Dry Xeric Oaks	49, 52, 57, 60

Stratum of Land	Description	Definition or Code
XPPO	Xeric Pine and Pine-Oaks	11, 12, 15, 16, 20, 21, 31, 32, 33, 35, 38, 39, 88
DDMO	Dry and Dry Mesic Oak-Pines	42, 43, 44, 45, 46, 47, 48
MSF	Montane Spruce-Fir	6, 7, 17
SCOAK	Scarlet Oak	59
LEVEL 1 *AGGREGATES	**Working groups for timber yield tables**	**Combinations of Community Types**
*CVH	Cove Hardwoods	NH, MMWM, ERH
*UPH	Upland Hardwoods	DMO, DXO, DDMO, SCOAK
*YPN	Yellow Pines	XPPO, MSF
*WPN	White Pines	CNH
	Ecological system	**Combinations of Community Types**
* COVESYS	Cove Forests	CNH, MMWM
UPH	Oak Forests	DMO, DXO, DDMO
XPPO	Pine Forests	XPPO
NH	Hemlock-Northern Hardwoods	NH
MSF	Appalachian Spruce-Fir	MSF
LEVEL 2 – Site Productivity and Scenery	**Site Index and Scenic Class**	**CISC and Scenery Mgmt System**
SI4	Very low productivity	Site Index 40
SI5	Low to moderate productivity	Site Index 50-60
SI7	Moderate to high productivity	Site Index 70-80
SI9	High productivity	Site Index 90 and higher
SC1	Very high scenic class	Scenic Class 1
SC2	High scenic class	Scenic Class 2
SC37	Moderate to low scenic class	Scenic Classes 3 through 7
LEVEL 3 – Recreation Experience and Slope	**Recreation Opportunity Spectrum and Slope**	**Recreation Opportunity Spectrum and Areas <= 25% Slope suitable for Group Selection**
SPNM	Most primitive	Semi-primitive Non-motorized
SPM	Somewhat primitive	Semi-primitive Motorized
RN	Roaded	Roaded Natural
G	Gentle slopes and accessible, suitable for group selection	Slope <=25%, near existing roads
LEVEL 4 – Management Prescription that are Suitable for Timber Production		
	Primary Management Emphasis	**Description**
7A1	Scenic	Highlands Scenic Byway
7B	Scenic	Scenic Corridors and Viewsheds
7C	Recreation	OHV Use Areas

Stratum of Land	Description	Definition or Code
7E2	Recreation	Dispersed Recreation
7F	Scenic	Blue Ridge Parkway
8A1	Wildlife	Mid- to Late-Successional Habitat
8B	Wildlife	Early Successional Habitat
8C	Wildlife	Black Bear Habitat
8E4b	Wildlife	Indiana Bat Secondary Cave Areas
10B	Timber	High Quality Forest Products
13	Wildlife, Timber	Mosaics of Habitat
LEVEL 5 – Successional Stage	**Successional Stage**	**Description**
EARLY	Early Successional	Age 0-10, All community types
SAP1	Sapling/Pole Succ.	Age 11-40, Community types NH, CNH, MMWM, DMO, DXO, DDMO, MSF
SAP2	Sapling/Pole Succ.	Age 11-20, Community types ERH, XPPO, SCOAK
MID1	Mid Successional	Age 41-80, Community types NH, CNH, MMWM, DMO, DXO, DDMO, MSF
MID2	Mid Successional	Age 21-60, Community types ERH, XPPO, SCOAK
LATE1	Late Successional	Age 81-100, Community type NH
LATE2	Late Successional	Age 81-110, Community type DXO
LATE3	Late Successional	Age 81-120, Community types MMWM, DDMO, MSF
LATE4	Late Successional	Age 81-130, Community type DMO
LATE5	Late Successional	Age 81-140, Community type CNH
LATE6	Late Successional	Age 61-100, Community types ERH, XPPO, SCOAK
OLD1	Old Successional	Age 101+, Community types NH, ERH, XPPO, SCOAK
OLD2	Old Successional	Age 110+, Community type DXO
OLD3	Old Successional	Age 120+, Community types MMWM, DDMO, MSF
OLD4	Old Successional	Age 130+, Community type DMO
OLD5	Old Successional	Age 140+, Community type CNH
LEVEL 6 - ELEVATION	**Description**	
HIELEV	Elevation above 3,000 feet	

Silvicultural Prescriptions

The array of potential vegetative treatments applied to an analysis area is represented in the model by sets of actions known as management actions. Generally, a management action in Spectrum refers to a set of treatments or practices designed to develop or protect some combination of resources on a particular land type.

In addition to the 'no action' management action, the management actions incorporated in the George Washington's Spectrum model were the various silvicultural treatments that could be used to meet vegetation manipulation objectives and are referred to as the *silvicultural prescriptions* in Table B-6. All lands were given

the option of being assigned to a minimum level of management where no timber harvest would occur.

Table B-6. Spectrum Silvicultural Prescriptions

Management Prescription	Scenic Class	Minimum Level/No Action	Clearcut	SW-CWR	SW-2ST	SW-2A2	SW-2A4	Thin Only	GS
7A1 Scenic Byway	1-2	X			X	X	X	X	X
	3-7	X		X	X	X	X	X	X
7B Scenic Corridors and Sensitive Viewsheds	1-7	X				X	X	X	X
7C ATV Use Area	1	X			X	X	X	X	X
	2-7	X		X	X	X	X	X	X
7E2 Dispersed Recreation Areas - Suitable	1	X					X	X	X
	2	X				X	X	X	X
	3-7	X		X	X	X	X	X	X
7F Blue Ridge Parkway	1-2	X					X	X	X
	3-7	X		X	X	X	X	X	X
8A1 Mix of Successional Habitats	1-2	X		X	X	X	X	X	X
	3-7	X		X	X	X	X	X	X
8B Early-Successional Habitat Emphasis	1-2	X			X	X	X	X	X
	3-7	X	X	X	X	X	X	X	X
8C Black Bear /Remote Habitat	1-7	X		X	X	X	X	X	X
8E4b Indiana Bat Secondary Conservation Area	1	X					X	X	X
	2-7	X			X	X	X	X	X
9A1 Source Water Watershed Protection Area	1	X					X	X	X
	2-7	X			X	X	X	X	X
10B Timber Production	1	X		X	X	X	X	X	X
	2-7	X	X	X	X	X	X	X	X
13 Mosaics of Habitat	1	X		X	X	X	X	X	X
	2-7	X	X	X	X	X	X	X	X

- SW-CWR – Shelterwood Coppice with Reserves where the preparatory cut leaves 20 square feet of basal area of primarily non-commercial species which are later removed at a commercial thinning of the new stand or at the final rotation of the new stand.
- SW-2ST – Shelterwood 2-Step with a residual basal area of 40-50 square feet left after the preparatory cut. The overstory removal occurs 10-20 years later.
- SW-2A2 – Shelterwood 2–Aged with a residual basal area of 20 square feet left after the preparatory cut. The overstory removal occurs 30-40 years later.
- SW-2A4 – Shelterwood 2-Aged with a residual basal area of 40 square feet left leaving 8-14 inch trees after the preparatory cut. The overstory removal occurs 40-60 years later.
- GS – Group Selection, uneven-aged management.

Activity Costs and Output Benefits

Management of a national forest yields a variety of public goods and services, many of which can be assigned cost and benefit values, such as timber and minerals. Environmental settings and maintaining or protecting long-term biological productivity of forested lands are examples of public goods created through forest management that cannot be assigned monetary values. Table B-7 and Table B-8 show activity and output variables used in the George Washington Spectrum model, and their assigned activity unit costs and priced output benefits. Since Spectrum was designed to model timber management, other resource activity costs and output values were estimated outside of the model.

Costs for timber activities were derived by examining historical budget costs and target attainment estimates and comparing these with the costs used in the Jefferson Plan Spectrum model. In 2004, the timber program was examined in detail during a realignment study and an effort was made to quantify the actual costs per timber activity. Because the relationship between budgets and targets can contain inconsistent variables, it was decided that the costs from the timber program realignment study were more accurate.

Table B-7. Spectrum Silvicultural Costs

Spectrum Activity	Unit of Measure	Range of Costs per Unit in the Model
Timber Sale Coordination with Other Resources	MCF (million cubic feet)	$309-$340
Harvest Administration	MCF	$31-40
Pre-commercial Thinning	Acre	$161
Timber Sale Preparation	MCF	$139-174
Site Preparation	Acre	$213-245
Timber Stand Improvement	Acre	$161-186

Timber revenues were estimated from a review of volume weighted average high bid values by species from 1997-2009. From this data, species were grouped into the following appraisal groups with similar revenues: high value hardwood sawtimber, moderate value hardwood sawtimber, low value hardwood sawtimber, white pine sawtimber, southern yellow pine sawtimber, hardwood pulpwood and softwood pulpwood. Examples of high value hardwood sawtimber included white oak, northern red oak, ash, and yellow poplar. Moderate value included hickory, chestnut oak, and birch.

Table B-7. Spectrum Revenues

Spectrum Output	Unit of Measure	Value per Unit in the Model
High Value Hardwood Sawtimber	MCF (million cubic feet)	$1,432
Moderate Value Hardwood Sawtimber	MCF	$926
Low Value Hardwood Sawtimber	MCF	$632
Southern Yellow Pine Sawtimber	MCF	$527
White Pine Sawtimber	MCF	$675
Hardwood Roundwood	MCF	$53
Pine Roundwood	MCF	$86

The amounts of road construction and reconstruction needed to access future timber harvests were not calculated in the Spectrum model for several reasons. Permanent road construction for the alternatives analyzed in the EIS ranged from 0 to 4.1 miles per year. Spectrum is not a spatial model, therefore it is difficult to address accessibility. However, costs of roads were included in the Present Net Value analysis.

Timber Yields

Since the yield tables that were developed for the Jefferson Forest Plan were used for this Forest Plan, the following describes the development of those tables. There were several steps in building the growth and yield tables. The first step was to select the Forest Inventory and Analysis (FIA) stands to be used in simulations in the Forest Vegetation Simulator (FVS model). Stratification of this data was performed based on geological province, forest type, and site index. The dataset from which FIA data could potentially be selected was limited to the Blue Ridge, Ridge and Valley, and/or Cumberland Plateau provinces of Virginia, Kentucky, North Carolina, Tennessee, South Carolina, and Georgia. Forest Type was used to group the data into one of four working groups: upland oak, cove hardwoods, white pine/hemlock, and southern yellow pine. These working groups correspond to analysis area identifiers used in the Spectrum model. Three categories of site indices were used to further stratify the data within these working groups: 50 to 60, 70 to 80, and 90 to 100.

Whenever possible, data selected for a simulation was limited to FIA plots on National Forest System lands in Virginia to simulate local conditions as closely as possible. For common working group/site index combinations (e.g. upland oak in the 70-80 site index group) this resulted in an adequate number of stands to provide statistically sound conclusions. However, in some cases (e.g. southern yellow pine on site index 90 to 100) very few FIA plots were found within those constraints. In such cases, selection criteria were broadened to include first, all of Virginia, then to all of the remaining southern states until an adequate number of FIA plots meeting the working group/site index criteria were selected.

The summary statistics for individual plots meeting the selection criteria were then reviewed for any obvious outliers. Stocking (basal area), trees per acre, and average diameter values were compared to published stocking charts (USDA Forest Service Agricultural Handbook 355) to identify selected FIA plots that were understocked. These understocked plots were eliminated from the simulation as needed.

The next step was to calibrate FVS to provide growth rates, volumes yielded, and mortality due to competition based on past and professional experience. Through a number of parameters, FVS can be customized to reflect local conditions. Based on volumes yielded from past harvesting data on the Forest coupled with professional experience with the average stand densities and diameters commonly found on the Forest, FVS was calibrated to simulate the forest stand dynamics that can be expected on the forests in this area.

The selected sets of FIA plots within these working group/site index combinations were then run through the calibrated FVS Southern Variant to show present volumes and predict growth and yield 150 years into the future. These were termed the “grow only” simulations. While the total volume output by FVS matched historical yield data from past timber harvests quite well, the allocation of that total volume between sawtimber and pulpwood volumes was not acceptable based on past harvest yield data. Therefore, the total volume output by FVS was then imported into a spreadsheet that allocated the division of pulpwood and sawtimber based on past harvest data considering working group and site index. For each of the four working groups, the spreadsheet also summarized the volume into the six appraisal groups that were modeled in Spectrum (high value hardwood sawtimber, moderate value hardwood sawtimber, low value hardwood sawtimber, white pine sawtimber, southern yellow pine sawtimber, hardwood pulpwood and softwood pulpwood). It also converted cubic feet, the unit output by FVS, into thousand cubic feet, the unit required by Spectrum. A comma-delimited file was then taken from the spreadsheet and imported into Spectrum.

The impact of some harvesting practices in growth and yield were also simulated using FVS. While the even-aged regeneration harvest methods (shelterwoods) were simulated simply by taking a percentage of the total standing volume from the grow only yield tables, partial harvests such as thinnings needed to be simulated in FVS. This is because thinning a stand significantly alters the growth and yield of the residual stems that would then be captured in a final harvest. While the same is true for shelterwood harvests, the length of time elapsing from the first entry to the final harvest is too small for this effect to be meaningful. In the case of the

shelterwood with reserves and coppice with reserves treatments, so little standing volume is left and is not harvested in this rotation, that any growth accrued on those stems was deemed inconsequential. Three thinning regimes were modeled; a pre-commercial thinning at age 15, a commercial thinning at age 55, and a combination of both the pre-commercial and commercial thinning. Separate yield tables were produced following a similar process described above for each of these regimes. The plots selected for these simulations were further stratified by age; only stands less than 15 years old were selected for the pre-commercial and combined simulations and only stands less than 55 years old were used in the commercial thinning simulations. Uneven-aged management was also simulated for a subset of the working group/site index combinations in the form of group selection. When we compared these outputs to the grow only runs, it was apparent that simply taking a percentage (i.e. 10% of the volume for a 10 year entry cycle and 100 year rotation scenario) yielded results very close to those produced by FVS. Based on this comparison and in the interest of simplifying the modeling process, it was decided to simulate uneven-aged management by simply taking a percentage of the grow only yield tables. The prescription of managing open woodland conditions was simulated by initiating a shelterwood harvest, including a pre-commercial thinning costs and eliminating the final overstory removal harvest.

Constraints

The land allocation mapping of management prescriptions for each alternative essentially applied that alternative's overall goals, objectives and resource constraints to the land base. Therefore the Spectrum models constructed for each alternative were initially identical, with the exception of a new set of analysis areas for each alternative that resulted from a different mix of management prescriptions. The same set of silvicultural prescriptions, costs, benefits, yields, rotation ages and constraints related to successional stages, scenery and recreation opportunity spectrum were used for each alternative.

Constraints identified as "management requirements" (36 CFR 219.27) were applied to all alternatives. Additional constraints common to all alternatives were applied to insure an implementable solution. These common constraints fell into four categories: 1) constraints which assign congressionally and administratively designated areas to specific prescriptions, 2) constraints which ensure that the management requirements are met in each alternative, 3) timber scheduling constraints, and 4) operational constraints which constrain timber harvest to a realistic solution.

The following requirements, or constraints, were applied to all Spectrum model alternatives:

- Silvicultural prescriptions were not modeled within the riparian habitat within any of the management prescriptions. They were also not modeled within any semi-primitive motorized or non-motorized areas in any management prescription, whether the management prescription was suitable for timber production or not.
- Although lands with a site index below 50 were represented in the model for growth and yield estimates, those lands were not allowed to be scheduled for harvest.
- Group selection was prohibited from occurring in yellow pine stands and old successional stage stands. Only those lands with a gentle slope near an existing road network were made available for group selection.
- The Long-Term Sustained Yield (LTSY) constraint was used to ensure that the harvest of timber in the last decade is not greater that the long-term timber production capacity of the Forest. Long-term sustained yield capacity was computed using the acreage scheduled to each regeneration prescription applied in the model.
- The perpetual timber harvest constraint was used to ensure that the remaining timber inventory would allow achievement of non-declining harvest levels beyond the modeling horizon. To achieve this condition the constraint required that the Forest contain as much timber inventory volume at the end of the last period as the Forest would have, on the average, under the management intensities selected in the analysis. Without this constraint the Spectrum model would have no reason to leave enough inventory at the end of the planning period to sustain timber harvest levels into perpetuity.

- The non-declining yield constraint was used to ensure that the harvest of timber in a decade was greater than or equal to the harvest of timber in the previous period. This constraint indirectly limited the model to a lower present net value and reduced flow of timber in the early decades but also provided community economic and social stability through the controlled flow of timber.
- Timber harvests on lands classified as suitable for timber production were not scheduled for regeneration before the culmination of mean annual increment (CMAI). This constraint, indirectly applied through the harvest timing options allowed, ensured that relatively large sawtimber would be produced and ensured that smaller trees were not harvested before the site was completely utilized.
- The Allowable Sale Quantity (ASQ) was constrained to be no greater or less than 10 percent of that in the previous decade in order to provide a more even flow.
- A possible range for total acres harvested per year (except for thinning) was constrained for each alternative.

Alternative					
A	B	D	E	F	G
3000	1800-3000	3000-5000	1800-3000	1000-1800	1800-3000

- The amount of clearcutting was constrained to a maximum of 5% of the total acres harvested.
- The proportion of harvest between the oak, pine and cove hardwoods ecological systems was constrained to reflect the desired conditions and objectives.
- The amount of thinning only was constrained between 200-400 acres per year to meet open canopy desired conditions.

Objective Functions

The objective function allows specification of an overall objective of the alternative to be met in a given run of the model while all constraints otherwise specified are met. The objective function chosen for Alternative A was to maximize present net value. The objective function chosen for Alternative B, E, F, and G was to maximize the amount of early successional habitat. The objective function chosen for Alternative D was to maximize volume.

Sediment Effects Analysis

The most important soil resource issue/concern regarding the effects from the management activities proposed in the various alternatives of the Forest Plan Revision is soil productivity. The impacts to soil productivity are determined by estimates of areal extent (acres) that is affected. Some of the impacts will be short-term (<100 years) and some will be long-term.

A significant impact to soil productivity would be a fifteen percent reduction in productivity in areas that are actively managed. The threshold for allowable impacts to soil productivity has been identified by most regions of the Forest Service as 15 percent of an activity area. Long-term soil productivity must be maintained on at least 85 percent of an activity area. The activity area varies by alternative since each one has different levels of management on different areas of the Forest. When long-term soil productivity is reduced on fifteen percent or more of an area, then this would not be in compliance with the laws and policy guiding FS protection of soil productivity and ecosystem sustainability.

Table B-8. Activity Area for Sedimentation Analysis

Plan Alternative	A	B	C	D	E	F	G
GW Acres included in Activity Area*	991,328	945,909	610,203	952,091	938,690	861,267	726,192

*Activity Area: The area on the Forest where soil disturbing management activity can occur.

By determining the acres of long-term effects to soil productivity for each alternative, we can compare the alternatives and show how extensive the effects are. Each alternative affects long-term soil productivity to some degree. Key indicators used for determining effects to the soil resource were:

- Acres of timber harvest
- Miles of road construction and decommissioning
- Acres of prescribed burning
- Miles of trail construction
- Acres of watershed improvement work
- Mineral development
- Acres of dispersed recreation use

Within each of the key indicators, the following activities were assumed to affect the long-term productivity of the soils for this effects analysis.

- Temporary roads - long-term effect is width of travel way, 12 feet.
- Skid roads have 10 feet of travel way with long-term effects.
- 25% of log landing areas are long-term impact to soil productivity due to blading.
- 75% of the total proposed and existing trail system is a long-term effect to soil productivity due to soil displacement and land use change.
- The acres of developed recreation that is cleaned and checked for trash is used for total existing acres of developed recreation which have long-term effects on soil productivity.
- Construction of oil and gas well sites - all acres are long-term impacts to soil productivity, due to blading.
- Access roads and parallel pipeline construction
- Long-term effects from oil and gas development are due to well pad and road construction.
- Existing oil and gas long-term effects resulting from existing well sites.
- Fire lines constructed with dozer have 8' width with long-term effects.
- Constructed road long-term effect is width of travel way and ditchline/cutslope, 19 feet
- New road right-of-way is 40 feet.

For each alternative a spreadsheet was prepared to show proposed management activities, types of effects, long and short-term effects, existing long-term effects, cumulative long-term effects and the percent of the GWNF area that would be affected long-term.

Other assumptions specific to each indicator include the following, where LT=long-term effect to soil productivity and ST=short-term effect to soil productivity:

Timber management assumptions

- Temp road LT is width of travel way= 12 feet.
- Temp road ST is ROW-12' travel way= 18 feet.
- Skid roads are bladed. Skid trails are not.
- Skid roads have 10 feet of travel way and 12 feet cleared right-of-way.
- Log landings are long-term impact to soil productivity due to blading.
- Skid trails are unbladed, 10 feet wide and are short-term impact due to compaction.
- Effects from a temporary timber road are the same as a FS system road.

Recreation management assumptions

- 100% of the total proposed and existing trail system is a long-term effect to soil productivity due to soil displacement and land use change.
- Existing new trail construction includes motorized and non-motorized trails.
- Long-term impact on 20 acres of dispersed recreation use per District assumed.
- Trails widths: motorized-6 feet, non-motorized-3 feet.

Mineral development assumptions

- Construction of well sites, all acres are long-term impacts to soil productivity, due to blading.
- Pipeline construction, short-term impact due to replacement of topsoil over pipe.
- Existing roads for oil and gas development are included in the effects of FS system roads.
- Long-term effects from oil and gas development are due to well pad and road construction.

Prescribed burning assumptions

- Fire lines constructed with dozer have 8' width, estimates based on 1998, 1999, 2000 on GW and JNF's.
- During a 10-year period, 50% P-burned acres are new and the rest is reburned using existing dozer fire lines.

Watershed improvement assumptions

- Existing soil improvement acres are calculated using 1993-2009 @ 40 per year.

Road management assumptions

- New road ROW is 40 feet. LT 15 feet, ST 25 feet.
- System road long-term effect is width of travel way and ditchline/cutslope= 19 feet
- System road short-term effect is ROW-19' travel way= 21 feet. (40'-19')
- Existing road system is 1818 miles.
- Roads decommissioned have 19 feet width for calculating acres of soil improvement.

Wildlife management assumptions

- Long-term effects from wildlife management are covered in skid road and log landing estimates.

Grazing management assumptions

- No long-term effects to soil productivity from grazing.

Present Net Value Analysis

The 1982 National Forest Management Act (NFMA) implementing regulations (36 CFR 219.1) state that forest plans must "…provide for multiple-use and sustained yield of goods and services from the National Forest System in a way that maximizes long-term net public benefits in an environmentally sound manner." Net public benefits is defined as the overall value to the Nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Present net value (PNV) is one of the criteria used to determine net public benefits (NPB) in benchmarks and alternatives. It is the difference between the discounted value of all outputs which were assigned a price in the revision and all Forest Service management and investment costs over the analysis period. The PNV converts all costs and benefits over a 50 year planning period to a common point in time. Other benefits of public land management cannot be measured using dollar values. These non-priced benefits are another criteria used to determine NPB. Each alternative was determined and analyzed to achieve its goals and objectives in a manner that produced the greatest PNV while meeting all specified costs and objectives for non-priced benefits. Thus, the PNV of each alternative estimated the highest value of priced benefits while accounting for the costs of producing priced benefits, non-priced benefits, and meeting management requirements. The PNV of each alternative can then be compared directly, even though the actual costs and benefits occur at different times.

Two parameters were used in PNV analysis: Base year dollars — All monetary values entered into Spectrum and the PNV analysis were in 2010 dollars. Discount rate — A four percent discount rate was used. It approximates the return on long-range investments above the rate of inflation. All costs and benefits were discounted from the midpoint of each decade.

The output estimates for timber, minerals, recreation and wildlife under each alternative were identified in Chapter 3 of the EIS for the effects analysis. The benefit values for each of these resources came from different sources and are displayed in Table B-9. Timber benefits were the same as used in Spectrum (from historical timber sale data). The mineral benefits were from market prices for minerals from the Minerals Management Agency. Recreation, hunting and fishing benefits were estimated from the U.S. Forest Service's National Visitor Use and Monitoring data (NVUM).

Table B-9. Economic Benefits and Financial Revenue Values used in the PNV Analysis (year 2010 dollars)

Output	Unit	Value
Timber		
Sawtimber-Softwood Price	$/MCF	$650.64
Sawtimber-Hardwood-Price	$/MCF	$1,031.39
Roundwood-Softwood-Price	$/MCF	$52.60
Roundwood-Hardwood-Price	$/MCF	$85.50
Minerals		
Dimension Stone (Limestone)	$/Metric Ton	$8.98
Natural Gas-Petroleum	$/Cubic Meter	$0.15
Recreation/Wilderness		
Camping	$/Visit	$51.26
Driving/Motorized	$/Visit	$43.84
General	$/Visit	$80.03
Hiking	$/Visit	$51.26
Nature/Historical	$/Visit	$51.26
Off-Highway Vehicles	$/Visit	$51.26
Primitive Camping	$/Visit	$76.10
Picnicking	$/Visit	$90.55
Trails	$/Visit	$205.34
Viewing Scenery	$/Visit	$60.01
Wilderness	$/Visit	$76.10

Socio-Economic Analysis

Economic effects to local counties were estimated using an economic input-output model developed with IMPLAN Professional 3.0 (IMPLAN) and are disclosed in Chapter 3 of the EIS. The IMPLAN model was used to determine total consequences of dollar, employment, and income changes in selected sectors. Because input-output models are linear, multipliers or response coefficients need only be calculated once per model and then applied to the direct change in final demand. A Forest Service-developed spreadsheet known as "FEAST" (Forest Economic Analysis Spreadsheet Tool) was used to apply the IMPLAN impact results to each alternative, expressed in units of output. FEAST transformed the dollar impact for a given industry from IMPLAN to the resource output by alternative into a specific employment and dollar output.

An impact analysis describes what happens when a change in final sales (e.g. exports and residents) occurs for

goods and services in the model region. Changes in final sales are the result of multiplying production data (e.g., head months of grazing or recreation visitor trips) by sales. Economic impacts were estimated for 2010, using the expenditure data for recreation, wildlife and hunting (U.S. Forest Service's National Visitor Use and Monitoring data, (NVUM), and the Fish & Wildlife Service's wildlife use data, respectively); stumpage estimates for timber, and market prices for minerals. NVUM data were used by J. Michael Bowker et al. (2009), Estimating the Net Economic Value of National Forest Recreation: An Application of the National Visitor Use Monitoring Database, FS 09-02, September 2009, The University of Georgia to estimate spending profiles of recreation users.

Impacts to local economies are measured in two ways: employment and total income. Employment is expressed in jobs. A job can be seasonal or year-round, full-time or part-time. The income measure used was total income expressed in 2000 dollars. Total income includes both employee compensation (pay plus benefits) and proprietors income (e.g. self-employed). Impacts to local employment and income were estimated from outputs from the timber, range, recreation and wildlife/fisheries programs, total forest service expenditures and employment, and estimated 25% payments to local counties.

TIMBER PROGRAM

Sales data was determined by using timber values multiplied by estimated production levels for each alternative. Hardwood and softwood sawtimber were processed through the sawmill industry. Hardwood and softwood roundwood were processed at the pulp mill. Impacts represent the economic activity occurring in all backward linking sectors associated with the final demand output of the timber industries described above.

RECREATION and WILDLIFE/FISH PROGRAMS

Recreation and Wildlife and Hunting trips were derived from the National Visitor Use and Monitoring survey, 2006 (NVUM). The resulting calculations yielded trips for Resident and Non-resident Day Use, On National Forest Overnight Use, and Off National Forest Overnight Use. These use metrics were entered into FEAST to link with IMPLAN impact response coefficients to yield an impact for recreation and wildlife resources.

While some analysts may not include resident participation in local economy impacts because there may be substitution opportunities for local residents to spend their discretionary dollar, it was decided to include resident expenditures in the local economy with the caveat that these expenditures were "associated" with the impacts not "responsible" for causing the impacts. "Associated" is used instead of "responsible" because local recreation users have many choices in an impact area for recreation. If some people choose not to recreate on national forest system lands, they may recreate in another manner such as go to sporting events or a movie. The dollars would still be spent in the local economy causing a similar impact, but the provider of recreation would be a different party. Local residents are defined as recreation users within 50 miles of the forest boundary.

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APPENDIX C POTENTIAL WILDERNESS AREA EVALUATIONS

CHAPTER 1: POTENTIAL WILDERNESS AREA INVENTORY

The following inventory identifies areas meeting certain criteria for potential wilderness areas. Only the Congress can make the decision to designate wilderness. The responsible official is to consider all NFS lands possessing wilderness characteristics for recommendation as potential wilderness areas during plan revision.

Identification of potential wilderness areas and wilderness recommendations has always been an integral part of the NFS planning process. The first step in the evaluation of potential wilderness is to identify an inventory of all areas within National Forest System lands that satisfy the definition of wilderness. This study identifies those NFS lands possessing wilderness characteristics.

The Forest Service directives (FSH 1909.12, chapter 70) provide the detailed criteria for the identification of potential wilderness areas. Interpretation of these criteria is contained in the Forest's Guidance paper.

Table 1. George Washington NF Potential Wilderness Inventory

Potential Wilderness Name	Total GWJEFF Acres	Jeff NF Acres	Road Mileage Per 1,000 Acres	Total Miles of Road	Subsurface Federal Mineral Percentage	Subsurface Private Mineral Right Acres
Adams Peak	8,226	0	0.45	3.7	100	0
Archer Knob	7,110	0	0.32	2.3	100	0
Beards Mountain	10,152	0	0.26	2.6	100	0
Beech Lick Knob	14,087	0	0.46	6.5	92	1,158
Big Schloss	28,347	0	0.50	14.1	75	7,118
Crawford Knob	14,851	0	0.21	3.1	100	0
Dolly Ann	9,524	0	0.48	4.6	100	0
Duncan Knob	5,973	0	0.46	2.8	100	0
Elliott Knob	11,070	0	0.39	4.3	100	0
Galford Gap	6,689	0	0.30	3.3	100	0
Gum Run	14,547	0	0.37	5.4	83	2,529
High Knob	18,447	0	0.46	8.6	100	0
Jerkemtight	27,314	0	0.46	12.5	90	2,617
Kelley Mountain	12,892	0	0.15	2.0	84	2,126

Potential Wilderness Name	Total GWJEFF Acres	Jeff NF Acres	Road Mileage Per 1,000 Acres	Total Miles of Road	Subsurface Federal Mineral Percentage	Subsurface Private Mineral Right Acres
Laurel Fork	10,236	0	0.21	2.1	100	0
Little Alleghany	15,395	0	0.18	2.8	98	374
Little Mare Mountain	11,918	0	0.50	6.0	100	0
Little River	30,227	0	0.40	12.1	90	3,128
Massanutten North	16,530	0	0.49	8.1	91	1,465
Oak Knob - Hone Quarry Ridge	16,343	0	0.44	7.3	96	617
Oliver Mountain	13,049	0	0.19	2.4	100	0
Paddy Knob	5,987	0	0.28	1.7	100	0
Potts Mountain	7,863	844	0.33	2.6	99	91
Ramseys Draft Addition	19,072	0	0.29	5.6	70	5,784
Rich Hole Addition	12,165	0	0.38	4.6	100	0
Rich Patch	5,625	4,754	0.04	0.2	100	0
Rough Mountain Addition	2,063	0	0.30	0.6	100	0
Saint Mary's North	3,006	0	0.00	0.0	79	630
Saint Mary's South	1,651	0	0.00	0.0	80	333
Saint Mary's West	278	0	0.00	0.0	100	0
Shaws Ridge	7,268	0	0.39	2.8	100	4
Shawvers Run Addition	84	0	0.00	0.0	100	0
Three Ridges Addition North	83	0	0.00	0.0	100	0
Three Ridges Addition South	187	0	0.00	0.0	100	0
Three Ridges Addition Southwest	9	0	0.00	0.0	100	0
Three Ridges Addition West	90	0	0.00	0.0	100	0
Three Sisters	9,871	0	0.44	4.4	95	491
TOTAL GWJEFF ACRES	378,229	5,598				
TOTAL GW ACRES ONLY	372,631					

Table 2. Potential Wilderness Area Inventory with Recreation Opportunity Spectrum Settings

Potential Wilderness Name	Total GWJEFF Acres	Jeff NF Acres	Roaded Natural Acres	Semi Primitive Motorized Acres	Semi Primitive Non Motorized Acres	Semi Primitive Core Total Acres
Adams Peak	8,226	0	3,801	407	4,018	4,425
Archer Knob	7,110	0	2,669	4,441	0	4,441
Beards Mountain	10,152	0	3,173	1,851	5,128	6,978
Beech Lick Knob	14,087	0	4,585	3,775	5,726	9,502
Big Schloss	28,347	0	8,632	9,974	9,741	19,715
Crawford Knob	14,851	0	3,023	2,522	9,306	11,828
Dolly Ann	9,524	0	3,491	1,361	4,672	6,033
Duncan Knob	5,973	0	2,741	3,232	0	3,232
Elliott Knob	11,070	0	3,978	3,402	3,691	7,093
Galford Gap	6,689	0	1,770	1,132	3,787	4,919
Gum Run	14,547	0	3,750	6,631	4,166	10,797
High Knob	18,447	0	6,686	8,032	3,729	11,761
Jerkemtight	27,314	0	11,473	8,574	7,268	15,841
Kelley Mountain	12,892	0	5,103	2,792	4,997	7,789
Laurel Fork	10,236	0	3,240	631	6,365	6,996
Little Alleghany	15,395	0	6,613	1,501	7,280	8,782
Little Mare Mountain	11,918	0	6,934	3,043	1,941	4,984
Little River	30,227	0	9,727	4,385	16,116	20,500
Massanutten North	16,530	0	5,382	4,563	6,585	11,148
Oak Knob - Hone Quarry Ridge	16,343	0	7,539	4,273	4,531	8,804
Oliver Mountain	13,049	0	3,852	20	9,176	9,197
Paddy Knob	5,987	0	2,703	1,259	2,026	3,284
Potts Mountain	7,863	844	3,372	4,491	0	4,491
Ramseys Draft Addition	19,072	0	8,075	1,717	9,280	10,997
Rich Hole Addition	12,165	0	5,072	480	6,613	7,093
Rich Patch	5,625	4,754	1,617	0	4,008	4,008
Rough Mountain Addition	2,063	0	1,311	498	254	752
Saint Mary's North	3,006	0	1,020	1,983	3	1,986
Saint Mary's South	1,651	0	762	0	889	889
Saint Mary's West	278	0	278	0	0	0
Shaws Ridge	7,268	0	3,315	1,878	2,076	3,954

Potential Wilderness Name	Total GWJEFF Acres	Jeff NF Acres	Roaded Natural Acres	Semi Primitive Motorized Acres	Semi Primitive Non Motorized Acres	Semi Primitive Core Total Acres
Shawvers Run Addition	84	0	84	0	0	0
Three Ridges Addition North	83	0	79	3	0	3
Three Ridges Addition South	187	0	131	0	56	56
Three Ridges Addition Southwest	9	0	9	0	0	0
Three Ridges Addition West	90	0	90	0	0	0
Three Sisters	9,871	0	3,647	1,249	4,975	6,224
TOTAL GWJEFF ACRES	378,229	5,598				
TOTAL GW ACRES ONLY	372,631					

AREAS EXCLUDED FROM THE PWA INVENTORY

Fourteen areas were reviewed and subsequently excluded from the inventory for not having attainable NFS subsurface ownership patterns that could ensure perpetuation of identified Wilderness characteristics. Each of these areas has less than 70% federal ownership of mineral rights. These areas are Long Mountain, Great North Mountain, Church Mountain, and Massanutten South (Lee RD), Cow Knob, Dunkle Knob, Radar Mountain, Kretchie Mountain, Hog Pen, Feedstone Mountain, and Hankey Mountain (North River RD), The Priest Addition (Pedlar RD), Back Creek Mountain East (Warm Springs RD) and Panther Ridge (James River RD).
Six areas were identified that exceed 5,000 acres in size and meet the road density requirement, but were not included in the inventory due to a lack of outstanding opportunities for solitude or a primitive and unconfined type of recreation. In addition, the location of these areas is not conducive to the perpetuation of Wilderness values. These areas are Dyers Knob, Sidling Hill (North River RD), Warm Springs Mountain, Back Creek Mountain West (Warm Springs RD), Middle Mountain (Warm Springs and James River RDs), and Jerry's Run (James River RD).

- Dyers Knob (WVA) is 5,057 acres in size and is surrounded by Forest Service Roads. It is long and narrow. For about one-third of its length, the width between the boundary roads is less than 1 mile and is only 2 miles wide at its widest. It is located along the side of Shenandoah Mountain and so does not encompass an entire watershed or mountain. Due to its configuration it is entirely in a Roaded Natural ROS class. Thus the sights, sounds and other impacts of the adjacent roads would not provide solitude or a primitive and unconfined recreation experience.
- Sidling Hill is 5,204 acres in size but it is long and extremely narrow, only 1.5 miles wide at its widest section. In addition, over half its boundary is shared with private lands. The area has some core solitude (2,310 acres) but its long and narrow shape is the limiting factor and does not provide for a Wilderness experience.
- Warm Springs Mountain is 6,194 acres in size with 2,220 acres of core solitude. While this area currently has some relatively good opportunities for solitude, private development is encroaching

along the southwest border of this area adjacent to the area of core solitude and additional future development is (expected) for this area by Bath County. As this development increases, the opportunities for solitude in this area will be further diminished.

- Back Creek Mountain West is 5,906 acres in size but is almost completely bisected by undeveloped private land which divides this area into two parcels connected only by a very narrow strip (700 feet) of National Forest land. The already limited opportunities for solitude are also divided and further limited by this configuration.
- Middle Mountain is a 5,959 acre area situated to the west of Douthat State Park. It is long and very narrow which severely limits opportunities for solitude. The northern portion is less than ½ mile wide at its narrowest and never exceeds 1 mile in width with no opportunities for solitude. The southern portion provides some semi-primitive recreation experience, but it is only a small (1,169 acres) portion of the area.
- Jerry's Run is 5,450 acres in size but is entirely within the Roaded Natural ROS class with no opportunities for solitude. The northern portion is long and very narrow, rarely exceeding ½ mile in width and is bordered by seasonally open roads and Interstate 64. The southern portion also borders I-64 and has a long, undulating border with private land which is isolates it from the central portion of the area and further limits opportunities for unconfined recreation.

Nine areas between 4,000 and 5,000 acres in size were reviewed to determine if they can be preserved due to physical terrain and natural conditions or are self-contained ecosystems that can be effectively managed as separate units of the National Wilderness Preservation System. Three of these areas have cores larger than 2,500 acres in size that provide a semi-primitive recreation experience. These areas are Green Mountain (Lee RD), Elliott Knob South (North River RD) and Mud Run Mountain (James River RD). Green Mountain and Mud Run were not included in the inventory since their ownership pattern cannot ensure perpetuation of identified Wilderness characteristics. At Elliott Knob South there are no terrain features that can make up for the lack of acreage in managing for Wilderness. In addition, the lower portion of the area is where the roads are concentrated and it has been actively managed.

- Green Mountain is a 4,506 acre area. It is long and narrow and more than half of its boundary is an undulating border with private lands in the Fort Valley area that are quickly developing. The western portion is adjacent to Peters Mill ATV/OHV area. These factors severely limit opportunities for solitude and therefore eliminating this area from further consideration.
- Elliott Knob South is a 4,718 acre area bounded largely by administrative use roads. Hog Back road and the Elliott Knob fire tower access road (and fire tower) separate this area from the adjacent Elliott Knob North area to the north. The upper elevations of this area provide some solitude however the southern portion of this area is heavily roaded and has been actively managed in recent years.
- Mud Run is a 4,295 acres area which is entirely surrounded by private lands. With a 2,929 acre semi-primitive core, there are good opportunities for solitude and unconfined recreation. However, the access into this parcel is very limited, accessible only from short section of State Route 619 across Hays Creek into steep terrain. There are no rights-of-way across private lands. This presents a situation where managing the area as Wilderness would be nearly impossible. We could not enforce rules regarding unauthorized access to the area.

Four of these areas (between 4,000 and 5,000 acres in size) contain smaller cores (less than 2,500 acres in size) providing a semi-primitive recreation experience: Signal Knob (Lee RD), Dameron

Mountain (James River RD), Short Mountain (Warm Springs RD), and North Mountain (James River RD). None of these areas have terrain features or natural conditions that lead to preserving Wilderness characteristics or effectively managing them as separate Wilderness units. Their size, shape, and location in relation to roads, railroads and private lands are not conducive to perpetuating Wilderness values, particularly the value of providing outstanding opportunities for solitude or unconfined recreation.

- Signal Knob is a 4,908 acre area with a core of 2,340 acres of semi-primitive recreation experience. The southern portion, south of Little Passage Creek, is rather narrow (not exceeding 1 mile in width) and is separated from the northern portion by a 30 foot Shenandoah Valley Electric Cooperative transmission line authorized by special use permit.
- Dameron Mountain is a 4,092 acre area with a core of 2,378 acres of semi-primitive recreation experience. The majority of the area is surrounded by private lands and illegal ATV use has been an ongoing problem. The upper elevations of this area provide some areas of core solitude but the long and somewhat narrow shape of the area restricts the capacity of this area to provide enough unconfined recreation opportunities to be suitable for Wilderness recommendation.
- North Mountain is 4,764 acre area which is long and narrow having a width that rarely exceeds 1 mile. Most of the eastern boundary of this area is adjacent to private land and the southern portion of the area has been actively managed in recent years. With only 1,751 acres of semi-primitive core, opportunities for solitude are limited.

The last three areas between 4,000 and 5,000 acres in size are Snake Run Ridge (James River RD), Short Mountain (Warm Springs), and Whites Run (Pedlar RD) and they contain no semi-primitive core areas. These areas are small, narrow, bounded by roads, and as such lack any measurable core solitude.

CHAPTER 2: EVALUATION OF POTENTIAL WILDERNESS AREAS

INTRODUCTION

The 37 Potential Wilderness Areas (PWAs) evaluated meet the inventory criteria set forth in Chapter 70 of Forest Service Handbook (FSH) 1909.12 (WO Amendment 1909.12-2007-1, effective January 31, 2007). Section 71 of FSH 1909.12 Chapter 70 provides direction on the inventory process. It is summarized in Table 3.

Table 3: Summary of Inventory Criteria as Provided in FSH 1909.12, Chapter 70, Section 71:

FSH 1909.12 Chapter 70	Potential Wilderness Criteria
71.1 Par. (1)	1) Areas contain 5,000 acres or more, OR
71.1 Par. (2)	2) Areas contain less than 5,000 acres, but can meet one or more of the following criteria: a. Areas can be preserved due to physical terrain and natural conditions; b. Areas are self-contained ecosystems, such as an island, that can be effectively managed as a separate unit of the National Wilderness Preservation System; c. Areas are contiguous to existing Wilderness, primitive areas, Administration-endorsed Wilderness, or potential Wilderness in other Federal ownership, regardless of their size.
71.1 Par. (3)	3) Areas do not contain forest roads (36 CFR 212.1) or other permanently authorized roads, except as permitted in areas east of the 100th meridian (sec. 71.12), (Less than 1/2 mile of system road per 1000 acres).
71.12 Par. (4) (1995 R8 Guidance)	4) Areas have semi-primitive (SP) core solitude greater than 2500 acres on NFS lands or otherwise provide solitude (e.g. topography). Eliminates smaller and/or narrower areas with small SP cores (limited solitude). Smaller or narrower SP core areas often indicate private land influenced core.
71.11 Par. (6)	5) Areas are not excessively fragmented by interior private land. (Greater than 70% NFS land).
71.11 Par. (6)	6) Areas are not excessively fragmented by interior private mineral rights. (Greater than 70% NFS mineral rights and not currently leased).
71.12 Par. (3,4)	7) Area boundaries are less than 60% private.

The PWAs evaluated include 26 stand alone potential Wildernesses and 11 potential additions to existing Wildernesses for a total of 37 areas containing 378,229 acres. Table 4 lists the Potential Wilderness Areas (PWAs) identified in 2008, using the criteria provided in FSH 1909.12. Of these,

23 "inventoried roadless areas" (IRAs) totaling 239,784 acres are included that were identified at the time of implementation of the 1993 George Washington National Forest Plan (GW Plan). Two of the IRAs are now designated Wilderness (The Priest and Three Ridges) and one IRA is now designated National Scenic Area (Mount Pleasant) and therefore were not evaluated as Potential Wilderness Areas (PWAs). One other IRA, The Friars, at only 2,035 acres does not meet the requirements provided in FSH 1909.12, Section 71.1 paragraph (2) for areas less than 5,000 acres in size. Therefore, it was not given further evaluation as potential Wilderness.
The inventory criteria for PWAs are less restrictive than the inventory criteria for identifying IRAs that was used during the 1993 revision of the GWNF Forest Plan. PWAs were identified for areas that did not qualify as IRAs. Where IRAs do overlap the PWAs, the PWAs are typically larger. Table 4 lists all of the PWAs that were inventoried in 2008 as well as the 1993 IRAs that overlap them.

Table 4: Inventoried Potential Wilderness Areas (PWAs) with Crosswalk of 1993 Inventoried Roadless Areas (IRAs):

Potential Wilderness Area	2008 PWA Acres	1993 IRA Acres
Adams Peak	8,226	7,133
Archer Knob	7,110	
Beards Mountain	10,152	7,501
Beech Lick Knob	14,087	
Big Schloss	28,347	20,755
Crawford Knob	14,851	9,889
Dolly Ann	9,524	7,850
Duncan Knob (Massanutten South IRA)	5,973	11,966
Elliott Knob	11,070	9,377
Galford Gap	6,689	
Gum Run	14,547	12,617
High Knob (Dry River and Skidmore IRAs)	18,447	12,971
Jerkemtight	27,314	16,680
Kelley Mountain	12,892	7,589
Laurel Fork	10,236	9,961
Little Alleghany	15,395	10,208
Little Mare Mountain	11,918	
Little River	30,227	27,285
Massanutten North	16,530	9,448
Oak Knob - Hone Quarry Ridge	16,343	10,880
Oliver Mountain	13,049	13,081
Paddy Knob	5,987	
Potts Mountain	7,863	
Ramseys Draft Addition	19,072	12,777
Rich Hole Addition (Mill	12,165	10,834

Potential Wilderness Area	2008 PWA Acres	1993 IRA Acres
Mountain IRA)		
Rich Patch	5,625	
Rough Mountain Addition	2,063	1,385
Saint Mary's North	3,006	
Saint Mary's South	1,651	1,451
Saint Mary's West	278	
Shaws Ridge	7,268	
Shawvers Run Addition	84	
Three Ridges Addition North	83	
Three Ridges Addition South	187	
Three Ridges Addition SW	9	
Three Ridges Addition West	90	
Three Sisters	9,871	8,146

Site specific maps for each Potential Wilderness Area are found at the GW Plan Revision internet site (http://www.fs.fed.us/r8/gwj/forestplan/revision/plan-home.shtml.

EXISTING SITUATION

Existing Wildernesses on the George Washington National Forest (GWNF) amount to 42,674 acres in 6 units, comprising about 4 percent of the total National Forest System land of 1,065,389 acres. All designated Wildernesses on the GWNF are within the Commonwealth of Virginia. No designated Wilderness on the GWNF is in West Virginia.

The Jefferson National Forest (JNF) in Virginia, with portions in West Virginia and Kentucky, offers 96,787 acres of designated Wilderness. That is about 13.4% of its total area of 723,300 acres. The combined acres for the George Washington & Jefferson National Forests (GW&J) are 139,461, about 7.8% of the total area of these two national forests. In addition, Shenandoah National Park and the Monongahela National Forest administer 195,358 acres of designated Wilderness in Virginia and West Virginia. Tables 5 and 6 provide summary and details, respectively, of the designated Wildernesses administered by Federal land managing agencies in Virginia and West Virginia. Neither the George Washington National Forest nor the Jefferson National Forest administers any Wilderness in Kentucky.

Table 5: Summary of Units and Acres of Existing Designated Wilderness in Virginia and West Virginia Administered by Federal Land Managing Agencies:

AGENCY	Acres of Wilderness in Virginia	Number of Wilderness Units in VA	Acres of Wilderness in West Virginia	Number of Wilderness Units in WV	Total Acres (VA and WV)
George Washington NF	42,674	6	0	0	42,674
Jefferson NF	94,066	17	2,721	1	96,787
Monongahela NF	0	0	115,779	8	115,779
Shenandoah NP	79,579	1	0	0	79,579
Grand Total	**216,319**	**24**	**118,500**	**9**	**334,819**

Table 6: Existing Designated Wilderness Administered by Federal Agencies in Virginia and West Virginia (by Agency):

WILDERNESS NAME	George Washington National Forest	Jefferson National Forest	Monongahela National Forest	Shenandoah National Park	Total Acres by Agency
Barbours Creek Wilderness		5,382			5,382
Beartown Wilderness		5,609			5,609
Big Draft Wilderness			5,144		5,144
Brush Mountain East Wilderness		3,743			3,743
Brush Mountain Wilderness		4,794			4,794
Cranberry Wilderness			47,815		47,815
Dolly Sods Wilderness			17,371		17,371
Garden Mountain Wilderness		3,291			3,291
Hunting Camp Creek Wilderness		8,470			8,470
James River Face Wilderness		8,886			8,886
Kimberling Creek Wilderness		5,805			5,805
Laurel Fork North Wilderness			6,055		6,055
Laurel Fork South Wilderness			5,874		5,874
Lewis Fork Wilderness		5,926			5,926
Little Dry Run Wilderness		2,858			2,858

WILDERNESS NAME	George Washington National Forest	Jefferson National Forest	Monongahela National Forest	Shenandoah National Park	Total Acres by Agency
Little Wilson Creek Wilderness		5,458			5,458
Mountain Lake Wilderness		16,511			16,511
Otter Creek Wilderness			20,698		20,698
Peters Mountain Wilderness		4,531			4,531
Priest Wilderness	5,963				5,963
Raccoon Branch Wilderness		4,223			4,223
Ramseys Draft Wilderness	6,518				6,518
Rich Hole Wilderness	6,450				6,450
Roaring Plains West Wilderness			6,792		6,792
Rough Mountain Wilderness	9,300				9,300
Saint Mary's Wilderness	9,835				9,835
Shawvers Run Wilderness		5,686			5,686
Shenandoah Wilderness				79,579	79,579
Spice Run Wilderness			6,030		6,030
Stone Mountain Wilderness		3,270			3,270
Three Ridges Wilderness	4,608				4,608
Thunder Ridge Wilderness		2,344			2,344
Total Acres by Agency	42,674	96,787	115,779	79,579	334,819

PROCESS FOR EVALUATION AND PRELIMINARY ADMINISTRATIVE RECOMMENDATION

Section 72 of Chapter 70 of FSH 1909.12 provides direction for evaluation of potential Wilderness. This report evaluates Wilderness potential in three main categories: capability, availability, and need.

Capability is defined as the degree to which the area contains the basic natural characteristics that make it suitable for Wilderness designation without regard to its availability for or need as Wilderness. There are six basic characteristics to evaluate the capability of an area east of the 100th meridian. These six characteristics are:

- Natural - ecological systems are substantially free of modern civilization and are affected primarily by forces of nature;
- Undeveloped – degree to which the area is without permanent improvements or human habitation;
- Primitive – ability of the area to provide outstanding opportunities for solitude or primitive and unconfined recreation;
- Special features or values - ability to provide ecologic, geologic, scientific, educational, scenic, historical, or cultural features or values of significance.
- Manageability – the ability of the area to be managed as an enduring resource of Wilderness and be protected for its natural character;
- Noncomforming uses (for areas in the East) – ability for noncomforming uses, structures and/or improvements to be effectively mitigated or terminated.

Availability for potential Wilderness is an assessment of the value of and need for the area as a Wilderness resource compared to the value of and need of the area for other resources. To be available for Wilderness, the tangible and intangible values of the Wilderness resource should offset the value of resources that formal Wilderness designation would forego. In essence, other resources could be satisfied in the area that may conflict with Wilderness designation.

Constraints, encumbrances and nonconforming uses as well as structures and improvements on lands are considerations in assessing the availability of lands for Wilderness designation. Generally, PWAs that contain subsurface or outstanding mineral rights are deemed a risk for Wilderness designation, as those legal rights could result in the construction of non-comforming facilities such as roads and structures. The need to actively manage for Threatened or Endangered Species in compliance with the Endangered Species Act and its associated regulations often conflicts with some of the restrictions that result from Wilderness designation. Another consideration is the effect of management on adjacent lands outside the area (FSM 1923.03, WO Amendment 1900-2006-2, effective 01/31/2006).

The other resources included in the availability evaluation were chosen due to one or more of the following reasons: (1) they have been discussed historically on this National Forest, internally and with the public, regarding which should take priority – the other resource or the Wilderness resource; (2) comments were received from the public on the need to change the GWNF Forest Plan; and (3) comments were received during or resulting from the Forest Plan public meetings conducted from 2007 to 2009.

Need is the degree to which an area contributes to the local or regional distribution of Wilderness and to the overall national Wilderness preservation system. The factors considered include: demand based on visitor pressure in existing Wilderness areas; proximity to other designated Wilderness; ability of a PWA to provide solitude, physical and mental challenge, inspiration and research opportunities; improving the quality and characteristics of an existing Wilderness; and expanding the representations of various ecosystems within the region and within the national Wilderness preservation system.

This analysis includes information and data from several sources. One of which is the public involvement done throughout the revision effort. Others include reports of Forest Service social science researchers in collaboration with the University of Tennessee and University of Georgia based on data collected during the last two National Surveys on Recreation and the Environment (NSRE). Also considered is data from gathered during the last two National Visitor Use Monitoring surveys (NVUM). Data for the existing distribution of Wildernesses, their acreages, and relative rankings between states as pertains to Wilderness designation came from www.Wilderness.net. Overall state land area rankings were obtained from the U.S. Census website at www.census.gov. Data on existing level of Wilderness use was obtained from the Southern Appalachian Assessment. The distribution of existing and potential wilderness areas and ecosystems is accomplished using geographic information systems (GIS) data.

Preliminary Administrative Recommendations from the Responsible Official will be documented in the agency's decision that approves the Revised Forest Plan. An area must meet the tests of capability, availability, and need (FSH 1909.12, Chapter 72). In addition to the inherent Wilderness quality a potential wilderness area might possess, the area must also provide opportunities and experiences that are dependent upon and enhanced by a Wilderness environment. Furthermore, the area and boundaries must allow the area to be managed as Wilderness.

An area meeting the criteria stated above may be included in a preliminary administrative recommendation that may or may not receive further review and possible modification by the Chief of the Forest Service, Secretary of Agriculture, and the President of the United States. The Congress has reserved the authority to make final decisions on Wilderness designation.

It is important to note that any areas being recommended for wilderness study designation may have their initial Potential Wilderness Area inventory boundaries adjusted as a result of this evaluation process (FSH 1909.12, Chapter 72.5).

RESULTS

A. Capability and Availability Results

Evaluation of each of the 37 PWAs was performed by Forest Supervisor's Office and District resource specialists with consideration of personal knowledge of the areas and resources, data contained in the forest's geographic information system (GIS), comments provided by the public (both individuals and groups through public workshops and letters), and information provided in the Virginia Mountain Treasures report.

While all six of the basic characteristics for capability were evaluated for each PWA, only the characteristics that most contributed to each PWA's meeting, or to not meeting, the capability for Wilderness are given in this report. This includes providing information helpful in making relative comparisons between PWAs, such as the size of the semi-primitive core. Data for all of the characteristics are included in Table C – 1 at the end of this Appendix

In the Availability evaluation, there may be additional other competing uses documented, although not all are included in this summary report. Those that caused the most concern to the Forest Service and/or to members of the public are included here.

For the purpose of summarizing the evaluations, Capability and Availability are grouped together for each PWA. Each was evaluated individually. The areas are listed alphabetically. The evaluation of Need follows separately as it was evaluated on a Forestwide, regional and national level.

ADAMS PEAK (8,226 acres)

Capability: This area meets the minimum requirements for size and opportunities for remoteness. It has a relatively small core of 4,000 acres of semi-primitive area.

Availability: There are two TESLR species that would benefit from management activities. There is heavy mountain bike use on Whetstone Ridge Trail. More than half of the boundary interfaces with private land.

ARCHER KNOB (7,110 acres)

Capability: This area meets minimum requirements for size. Its core of semi-primitive is relatively small at 4,440 acres. There are opportunities within this area for primitive recreation and solitude.

Availability: Two TESLR species could benefit from management activities. The North Mountain Trail is popular with mountain bikers. About 1,322 acres are suitable for timber production and the area contains 1,734 acres of pine species that benefit from prescribed burning.

BEARDS MOUNTAIN (10,152 acres)

Capability: While this is a moderately large area, the shape and location are poor for providing Wilderness qualities. The area is narrow and located along a mountainside with views to exterior private lands, many with developments such as cabins, camps, houses and farms. Close proximity to Douthat State Park with a connector trail into Wilderness may result in unacceptably high levels of user interaction that diminish the mental challenge and need to rely on one's own primitive recreation skills and abilities.

Availability: There are shale barren species, at least one of which is a TESLR, that benefit from management including prescribed burning. There are over 1,400 acres of pine species that also benefit from fire, and over 1,300 acres are suitable for timber production. The Beards Mountain Trail is used by mountain bikers coming out of Douthat State Park.

BEECH LICK (14,087 acres)

Availability: Beech Lick is a large area with shape, size and topography that provides outstanding opportunities for solitude and physical challenge as well as for natural processes to dominate within the area. There is a large unbroken core of nearly 9,500 acres of semi-primitive ROS class. There are no current recreational uses that are incompatible with Wilderness.

Availability: About 1,158 acres have private sub-surface mineral rights. This area is near the western boundary and could be excluded. Plans have been approved and NEPA analysis completed for construction of a trail in the western portion of this PWA. The trail is intended for use by mountain bikers, equestrians and hikers. Beech Lick is currently suitable for wildlife habitat and timber management with past investments made for both of these resources. Almost 5,600 acres of this PWA is suitable for timber production primarily in the eastern portion. There are almost 1,300 acres of pine species that benefit from prescribed fires. An estimated 75-80% of the boundary is adjacent to private land.

BIG SCHLOSS (28,347)

Capability: This is a huge PWA with a semi-primitive core of almost 20,000 acres. There are outstanding opportunities in the interior for primitive recreation and physical challenge. However, the dense system of existing, popular trails results in a high number of encounters with other users, diminishing or eliminating the opportunity for remoteness and relying on one's own skills and abilities. The odd overall configuration of the PWA along with a high percentage of the boundary being adjacent to private lands are not conducive to the area's capability to provide outstanding scenic qualities.

Availability: There are 7,118 acres of privately owned sub-surface mineral rights. There is a private inholding near the east boundary. Almost 5,550 acres are suitable for timber production. There have been investments in wildlife habitat (openings and prescribed fire). The Wood turtle exists in the area and some habitat management might be needed. Due to acidification, Little Stony Creek is limed. West Virginia has the Cove Deer Management Area. Multiple trails exist throughout the area and some are popular with mountain bikers.

CRAWFORD KNOB (14,851 acres)

Capability: This area has the substantial size and compact for natural processes to dominate the landscape. The semi-primitive core is about 11,830 acres in size. The area is essentially a mountain offering many external views to non-Wilderness Forest Service lands and to private lands, although drainages offer interior views and remoteness. Opportunities exist for primitive recreation and physical challenge.

Availability: There is a ridgetop private inholding in southeast portion of the area. It is not very near a boundary, so it would remove a large area to exclude it without cherry-stemming. There are multiple trails in southern portion of the area, some used by mountain bikers. There are views to

Staunton and a powerline on the north side. About 3,800 acres are suitable for timber and there has been active management such as timber harvesting and prescribed burning.

DOLLY ANN (9,542)

Capability: This is a moderately sized PWA with a core of 5,850 acres of semi-primitive land. There are opportunities for interior views and remoteness, but most of the area consists of mountaintop area with external views to private. The northern portion of the area is very narrow. The overall size and configuration are not ideal for ecological processes to dominate. There are sights and sounds of the interstate and U.S. highways located on three sides. The prevailing winds often carry a reminder that the paper mill in Covington is nearby.

Availability: This is the southernmost range for Variable sedge (TESLR) that requires fire, as well as one other TESLR species that may benefit from active management. It has been 15 years since timber and prescribed fire activities, and these activities are due again in the typical cycle. About 3,424 acres are suitable for timber production. Trails exist that are used by mountain bikers and horseback riders.

DUNCAN KNOB (5,973)

Capability: This area meets minimum requirements for size. Its core of semi-primitive is small at 3,232 acres. It is comprised of a steep mountaintop with knobs, primarily with views outside of the Wilderness. The entire east boundary is adjacent to private land. The area is not large or wide enough for natural processes to dominate.

Availability: One sensitive species exists in the area and it benefits from active management. Three trails exist within this area and all are used by mountain bikers, including technical trails. Maintenance is performed by volunteers.

ELLIOTT KNOB (11,070 acres)

Capability: This is a moderately large PWA with a semi-primitive area of about 7,100 acres. It is very rugged and offers great opportunities for remoteness and challenge. It is marginally large enough for ecological processes to dominate. There is very little boundary adjacent to private land.

Availability: There are three TESLR or FS sensitive species that benefit from active management. There is also the Smooth green snake that requires open grassy areas. There are multiple roads as well as some mountain biking trails within the area. There is a trout stocked stream popular with anglers. Active management has occurred around the west, north and northeast perimeter and 3,468 acres are suitable for timber management. There are multiple access opportunities on roads and trails used by visitors engaging in activities that are not allowed in Wilderness.

GALFORD GAP (6,689 acres)

Capability: This meets the minimum size requirements for Wilderness and has a core of 4,920 acres of semi-primitive land. The area is oddly configured, long and narrow. It consists of mostly mountainside and mountaintop high elevation views to exterior private lands. Approximately 80% of the boundary is adjacent to private. Due to size and primarily due to shape and configuration, this area does not provide a great opportunity for ecological processes to dominate.

Availability: There was active timber and prescribed burning activities from 1993 to 2000 and it is nearing time to return to these areas. About 4,467 acres are suitable for timber management.

GUM RUN (14,547)

Capability: Despite its relatively large size, the semi-primitive area consists of only about 6,700 acres. The shape of this area, small percentage of boundary adjacent to private, and rugged terrain with large interior drainages provide good opportunities for remoteness and primitive recreation. The area is arguably large enough for ecological processes to dominate.

Availability: There are 2,529 acres with private sub-surface mineral rights across the north portion of the PWA. There is one small private inholding with a cabin near the south boundary. There are acidified streams in the area that would benefit from liming; there are approximately 24 miles of native brook trout streams. There is a mountain bike trail on Chestnut Ridge. There are 2.2 miles of open road currently providing public access into the interior of the area.

HIGH KNOB (18,447 acres)

Capability: This large PWA has a core area of 11,760 acres of semi-primitive lands. The area consists of mountainsides with views to external areas, although the deep, rugged drainages do offer opportunities for solitude and physical challenge. The area is large enough for ecological processes to dominate. This PWA has a sizeable cherry stem around the Skidmore Fork Road on the east. In the northwest portion of the area, Brandywine Lake Recreation Area and a block of private land jut into the PWA, creating an oddly shaped boundary.

Availability: There are two TESLR or FS sensitive species in the area that benefit from active management. There have been a lot of wildlife management activities (about 15 openings) as well as a large prescribed burn. About half of this area is in West Virginia, and the Department of Natural Resources has strong reservations about Wilderness designation. About 4,300 acres are suitable for timber management. Shenandoah Mountain Trail, used by mountain bikers, traverses the ridge of the mountain through the middle of this PWA.

JERKEMTIGHT (27,314 acres)

Capability: This is the third largest PWA in the assessment. It has a huge core of 15,840 acres of semi-primitive land. It is rugged with multiple ridges and twisting drainages, offering excellent opportunities for remote recreation and physical challenge. The area is large enough for ecological processes to dominate. The shape is odd with multiple corners and curves along the boundary, many of them plunging deeply into the PWA. However, a very small percent of the boundary is adjacent to private land.

Availability: There are six TESLR or FS sensitive species within the area that benefit from human intervention. The 1,280 acre Special Biological Area on the south end requires prescribed burning. There are 2,617 acres of private subsurface mineral rights in three blocks from roughly the center of the PWA up to the northwest portion. To exclude these would require reducing the size of the PWA by nearly half. There are two National IMBA mountain bike trails within the area. There have been significant investments in timber and wildlife projects dating 1993 to 2000.

KELLEY MOUNTAIN (12,892 acres)

Capability: This moderately large area has a core of about 7,300 acres of semi-primitive land. In conjunction with the existing Saint Mary's Wilderness and Saint Mary's Wilderness Addition North, this could establish a large area of Wilderness. Within this area there are multiple ridges and valleys providing good opportunities for remoteness and physical challenge, with most views being to the interior of the area. This PWA, with its topography and natural features, can be dominated by ecological processes. There is a large, wide cherry stem on Turkey Pen Ridge, which is not a desirable quality in a Wilderness boundary.

Availability: There are three large blocks of private sub-surface mineral rights totaling 2,126 acres along the northern portion of the area. There are three TESLR or FS sensitive species that exist in the area that benefit from habitat management activities. There are several trails running parallel to each other spread across the area, one of which is accessed by a road that penetrates deeply into the interior. An OHV road separates Kelley Mountain from Saint Mary's Wilderness. There has been significant past investments in wildlife habitat improvements.

LAUREL FORK (10,236 acres)

Capability: This moderately sized PWA has a core semi-primitive area of about 6,700 acres. The PWA is located in a fairly isolated area. The terrain within the PWA allow for opportunities for remoteness and physical challenge. The area is biologically unique on the GWNF and is the southernmost range for some northern species. There is a concern that climate change will result in these northern species migrating to the north and out of the area. There are large plantations of red pine and spruce. The area is marginally large enough for ecological processes to dominate.

Availability: The area has multiple trails, many used by mountain bikers. This area is the southernmost range for some of the northern animal species found in this area, and some may

benefit from management activities, particularly as more is learned about the effects on them of global warming. It is important to keep management options open to maintain these species in this area.

LITTLE ALLEGHANY (15,395 acres)

Capability: This PWA has about 8,780 acres of semi-primitive which is oddly shaped and protruding down each "leg" of this PWA. The area is rugged and does provide opportunities for remote, primitive recreation. The odd configuration impedes the area's ability to have ecological processes dominate the landscape. Almost the entire boundary of this area is adjacent to private land.

Availability: There are two TESLR or FS sensitive species that are enhanced by active management. There are private sub-surface mineral rights on 374 acres. While this is not a large amount, due to its location, the entire southeast "leg" would need to be excluded. Approximately 5,621 acres are suitable for timber management.

LITTLE MARE MOUNTAIN (11,918 acres)

Capability: Less than half of this area, a total of about 5,000 acres, is in the semi-primitive ROS class and it is pushed toward the northern half. The narrow panhandle on the south portion has steep topography, but it is along a mountainside with external views to private. The larger block at the north end offers opportunities for remoteness, but the topography is not as rugged for offering physical challenges. The oddly shaped area is not conducive to allowing ecological processes to dominate the landscape. Close proximity to Douthat State Park with connector trails into the area may result in unacceptably high levels of user interaction for a quality Wilderness experience.

Availability: There is one TESLR or FS sensitive species that is enhanced by management activity. The Nature Conservancy opposes Wilderness as they work with the State in controlled burning projects outside of the western boundary. There are existing and planned mountain bike and equestrian trails in the area. More than half of the area is suitable for timber production and there have been active management activities within the area.

LITTLE RIVER (30,227 acres)

Capability: This is the largest area in the inventory and possibly the largest block of land to meet potential Wilderness criteria in the east. It has a huge core of about 20,500 acres of semi-primitive ROS class that offers significant opportunities for isolation, primitive recreation and physical challenge. This is the largest PWA; and with its proximity to existing Ramseys Draft Wilderness, offers a significant opportunity on the GWNF to provide adjacent Wildernesses that cumulatively are a substantial size.

Availability: Five TESLR species are found within the area that benefit from human intervention or disturbance. There are over 3,100 acres of private sub-surface mineral rights. There is a long, narrow inholding with a cabin near the north boundary; it can be excluded. A network of popular trails is found within the area that offers outstanding mountain biking opportunities. The area is very popular with bear hunters.

MASSANUTTEN NORTH (16,530 acres)

Capability: This area contains about 11,150 acres of semi-primitive land, but it is in a linear strip along a mountainside with views to the exterior private land. Almost the entire boundary of this PWA is adjacent to private lands, much of which has been developed with farms, residential areas, cabins, etc. The area is too narrow to provide outstanding opportunities for remote and physically challenging recreation. The area is too narrow to allow ecological processes to dominate the landscape.

Availability: There are reserved sub-surface mineral rights in five blocks totaling 1,465 acres. Two of these blocks stretch from boundary to boundary at the center of the area and at the north end of the area. To exclude them would mean reducing the area by half its size. The area contains premiere technical mountain biking trails maintained by volunteers. There is one TESLR or FS sensitive species that may benefit from active management.

OAK KNOB-HONE QUARRY RIDGE (16,343 acres)

Capability: This large PWA offers a core semi-primitive area of about 8,800 acres. There are excellent opportunities for remoteness and primitive recreation that is physically challenging. The area is of a size and shape that ecological processes can dominate the landscape. There is an undesirable cherry stem for the Hone Quarry recreation area. A roadbed through the area evidences past human activities.

Availability: There are reserved sub-surface mineral rights on 617 acres near the east boundary. It can be excluded; however it is on a ridgetop and any exploration or production activities may be visible from within the PWA. Some exploration occurred in the 1980's. There is one TESLR or FS sensitive species that would benefit from active management. Mountain bike trails exist throughout the area. There is a rock climbing area with permanent anchors. The area provides access for bear hunters. There are 5.7 miles of open or seasonally open roads in the area. There have been multiple prescribed fires between 1979 and 1999, encompassing about 35-40% of the area. About 882 acres are suitable for timber management.

OLIVER MOUNTAIN (13,049 acres)

Capability: This area has a semi-primitive core of about 9,200 acres, most of that situated to the west away from Lake Moomaw. While that is positive for escaping the sounds of motorized ski boats and personal watercraft, this portion of the PWA is surrounded by private land with many views to the exterior rather than to the interior. The topography is not rugged; it rates fairly low for providing physical and mental challenge. The area is marginally capable of allowing natural processes to dominate.

Availability: There are four TESLR or FS sensitive species within the area that would benefit from management activity, particular shale barren species. A road used by four-wheel-drive enthusiasts runs along Hughes Draft. There are multiple trails in the area used by mountain bikes, although some are not system trails and use of those is not authorized.

PADDY KNOB (5,987 acres)

Capability: This area has a small core of 3,300 acres of semi-primitive land; however the area is deeply incised and can offer physical challenge. The area is small for allowing ecological processes to dominate.

Availability: The area has been actively managed to provide outstanding habitat for the Mourning warbler that requires a fire cycle. The very hot prescribed fire of the late 1990's also released a large component of American chestnut. The area has been actively managed for timber, with 2,149 acres currently being suitable for timber production.

POTTS MOUNTAIN (7,863 acres)

Capability: This area has a core of about 4,500 acres of semi-primitive land. The PWA is situated on the side of a mountain with many exterior views. This mountainside is not deeply incised with steep, twisting drainages to offer physical and mental challenge. There are some moderate drainages along the lower slopes of the southwest portion. The northern part of the PWA is very oddly shaped around private lands that jut into the north boundary.

Availability: There are 91 acres of private subsurface mineral rights land jutting into the center of the area from the southern boundary. To exclude it would nearly divide the area in half. A very popular jeep road exists along the south boundary between Potts Mountain and existing Barbours Creek Wilderness. A large area of private land that juts into the north boundary contains several houses and a road. Over half of the area, 4,143 acres, is suitable for timber production although there have not been any activities in the area since prior to 1993. There are about 190 acres of pine species that would benefit from prescribed burning.

RAMSEYS DRAFT ADDITION (19,072 acres)

Capability: This PWA offers the largest addition to an existing Wilderness, collectively offering a significant area with outstanding opportunities for primitive recreation, remoteness, physical and mental challenge, and for natural processes to dominate. It meets the GWNF goal of establishing a large block of Wilderness in the east that can enhance the NWPS.

Availability: The west side of this PWA is almost entirely underlain by privately owned minerals. The southern portion of the area contains popular mountain biking trails. The eastern portion of the PWA has 4,753 acres of land suitable for timber production. Timber and some wildlife habitat projects have occurred in the past. The North River Road is within the floodplain and should be relocated which would put it inside the northern boundary of this PWA.

Augusta County Board of Supervisors passed a resolution opposing any additional designation of Wilderness in Augusta County.

RICH HOLE ADDITION (12,165 acres)

Capability: In line with the GWNF's goal of expanding the size of existing Wildernesses to improve their Wilderness qualities and enhance the NWPS system, this area offers the opportunity to expand the acreage of a small Wilderness. Furthermore, it will almost connect the Rich Hole and Rough Mountain Wildernesses, generally increasing the area of designated Wilderness that is currently relatively small.

Availability: There are management concerns about the southern portion of the area that has an extensive boundary with private land and is irregularly shaped. The northern section along Forest Road 129 has been actively managed with timber production and prescribed burning. Forest Road 129 is also a popular forest access route for hunters and anglers.

RICH PATCH (5,625 acres)

Capability: This extremely narrow sliver of land, in and of itself, is not capable of providing for ecological or recreational Wilderness qualities. The majority of the PWA is on the Jefferson National Forest.

Availability: One TESLR or FS sensitive species exists in the area that might benefit from management activity. There are many trails, including a National Recreation Trail, used by mountain bikers.

ROUGH MOUNTAIN ADDITION (2,063 acres)

Capability: Same as Rich Hole above.

Availability: There are shale barrens on the north end that would benefit from prescribed fire. North end also has a boundary adjacent to private land.

SAINT MARY'S ADDITION NORTH (3,006 acres)

Capability: This addition would increase the size of the existing Saint Mary's Wilderness. It has a semi-primitive core of almost 2,000 acres. The area consists primarily of a north facing mountainside with exterior views. However, here is rugged terrain and two very deep and winding drainages providing opportunities for physical challenge and remoteness.

Availability: About 630 acres, or 21%, of the area has private subsurface mineral rights. The area is bordered on the east side by a popular Forest Service road and on the west and north by VA 42. A Forest Service road runs along most of the southern border of the area currently providing motorized access.

SAINT MARY'S ADDITION, SOUTH (1,651 acres)

Capability: This small addition contains rugged topography with multiple ridges and deeply incised drainages.

Availability: There are 333 acres of private subsurface mineral rights in two large blocks occupying much of the northern portion of the PWA.

SAINT MARY'S ADDITION, WEST (278 acres)

This area was acquired by the Forest Service for the express purpose of providing an addition to the existing Wilderness.

SHAWS RIDGE (7,268 acres)

Capability: This area has a core area of about 3,950 acres of semi-primitive land. The area is desirable for expanding the block of Wilderness with Ramseys Draft and its Addition. However, the area is comprised of a mountain with views east toward Ramseys Draft and about half of the area has views west toward private land. There is a substantial amount of private interface. The area is not deeply incised to offer outstanding opportunities for physical challenge.

Availability: There is one TESLR or FS sensitive species that is enhanced by prescribed fire (shale barren species). A private inholding exists near the center of the area on the west slope. There are 1.3 miles of road used for public access. There are 396 acres of pine species that benefit from fire.

SHAWVERS RUN ADDITION (84 acres)

Capability: This area would not appreciably add to the Wilderness qualities of Shawvers Run. If designated, it would add a length of road to the boundary and it would add some additional boundary adjacent to private land.

Availability: There are no concerns for other resources or recreational uses.

THREE RIDGES ADDITIONS, ALL (369 acres)

Capability: These areas would not appreciably add to the Wilderness qualities or improve ability to manage the Three Ridges Wilderness.

Availability: There are no significant concerns for other resources or incompatible recreation opportunities.

THREE SISTERS (9,871 acres)

Capability: The area offers a semi-primitive core of about 5,500 acres. There is rugged terrain and multiple drainages to offer remote primitive recreation opportunities (if one goes off of trails) and physical challenge. The presence of the popular Appalachian National Scenic Trail may result in unacceptably high encounters with other users, by Wilderness standards. The area is arguably large enough to allow natural processes to dominate.

Availability: There are 491 acres of sub-surface mineral rights. This is in one block on the northwest boundary and could be excluded. The Appalachian Trail is maintained by volunteers who use chainsaws. The local maintaining trail club does not support designation. Furthermore, there is an overnight shelter for backpackers within the area. There are 1.3 miles of road that currently provides motorized public access. Wildlife management activities have occurred in the area in recent years, and 879 acres are suitable for timber production. Streams within the area are acidified, and there are 10 miles of native brook trout stream present. These streams may benefit from future liming. There has been a significant investment in mine reclamation just outside of the eastern boundary. Additional work may be needed there.

C. Evaluation of Need for Additional Wilderness on the GWNF

The concept of Wilderness is multifaceted as envisioned by the authors and framers of the 1964 Wilderness Act. As such there are a number of factors to consider in assessing the need for additional Wilderness including evaluating use trends and current visitation pressures on existing wilderness; the location, size and type of other Wildernesses in the general vicinity; the need to provide a refuge for species that have demonstrated an inability to survive in less than primitive surroundings (included in Capability evaluation); and ecosystems that are not represented or are under-represented in the NWPS. Agency direction in assessing need is that it is most informative and meaningful when performed at a forest scale or regional scale.

The Eastern Wilderness Areas Act (1975) pointed out that "in the more populous eastern half of the United States there is an urgent need to identify, study, designate, and preserve areas for addition to the National Wilderness Preservation System". That Act established 15 additional areas as Wilderness and states further that "Congress finds and declares that . . . these *and similar areas* in the eastern half of the United States be promptly designated Wilderness…" (emphasis added). The need for such designation, as provided in this Act, is to preserve such areas as an enduring resource of Wilderness, which shall be managed to promote and perpetuate the Wilderness character of the land and its specific values of:

- solitude,
- physical and mental challenge,
- scientific study,
- inspiration,
- primitive recreation

for the benefit of all the American people of present and future generations. The GWNF did not have any Wildernesses designated in that 1975 Eastern Wilderness Areas Act. The JNF had one area designated at that time, the James River Face Wilderness. Since then, 22 Wildernesses have been designated on the GWNF and JNF.

Before going further, it should be stated that certain assumptions and observations are made in this assessment of need:

1. No target or formula has been provided for determining the appropriate distribution of Wilderness that should be provided in our region. The 4% of the GWNF that is designated Wilderness is below the 6% of Wilderness designated on Forest Service lands in the Southern Region. The Southern and Eastern Regions combined have over 8% of NFS lands designated as Wilderness.
2. Some demand for primitive recreation opportunities can be met on non-Wilderness back-country lands. However, research data indicate that the public finds the permanence of Congressional Wilderness designation to be very important.
3. The ability to provide outstanding opportunities for solitude, inspiration and primitive recreation is to a great extent dependent on the size and shape of the Wilderness. A relatively large area of land with relatively little to no private interface is better suited to providing this type of experience than irregularly shaped, small areas that are adjacent to private land.
4. The demands for various uses of public lands are constantly increasing. Forest Service lands once referred to as "the lands nobody wanted" now seem to be the lands everybody wants. As this occurs, the lands meeting the criteria for PWAs may decrease.

For a look at the distribution of roadless areas and Wildernesses in the southeast United States, see the Southern Appalachian Assessment, Chapter 5 (SAMAB, 1996) at http://sunsite.utk.edu/samab/saa/reports/ social/chapter5.pdf. This document discusses the location, size and type of other Wilderness and roadless areas, existing recreation use of Wilderness, occurrences of ecosystem subsections in Wilderness in the local and regional area. See also discussion of Wilderness at http://www.Wilderness.net/.

Table 7 provides information about the existing Wildernesses and their distribution by County in Virginia. None of the GWNF Wildernesses are in West Virginia.

Table 7: Existing Congressionally-Designated Wildernesses on the GWNF

Wilderness (alphabetically)	Ranger District	Total Acres	County	Acres by County	Year Designated
Priest	Glenwood Pedlar	5,963	Nelson	5,963	2000
Ramseys Draft	North River	6,518	Augusta	6,518	1984
Rich Hole	James River	6,450	Rockbridge	3,200	1988
			Alleghany	3,250	
Rough Mountain	Warm Springs	9,300	Bath	9,096	1988
			Alleghany	204	
Saint Mary's	Glenwood Pedlar	9,835	Augusta	9,835	1984
Three Ridges	Glenwood Pedlar	4,608	Nelson	4,590	2000
			Augusta	18	
Totals	4 Ranger Districts	42,674 acres	5 Counties		

The GWNF is not the only provider of Wilderness in the vicinity. The Shenandoah National Park is in closer proximity to the large urban population of Washington, D.C., and northern Virginia. It is also a short distance from populations west in the Shenandoah Valley. The Shenandoah National Park offers 79,579 acres of designated Wilderness, or approximately 40.4% of the 197,000 acres in its ownership.

Just to the west of the GWNF is the Monongahela National Forest (MNF) in West Virginia, the northern portion of which is within a few hours' drive or less of the Washington DC metropolitan area and the Shenandoah Valley. The southern end is within a few hours' drive or less of most of the George Washington National Forest and the population that resides within and adjacent to it. The MNF offers 115,779 acres of designated Wilderness. Just to the south of the GWNF is the Jefferson National Forest in Virginia, West Virginia and Kentucky. It offers 17 Wildernesses totaling 96,787 acres.

In an effort to determine if demand for Wilderness-based recreation is increasing, the results of the last two National Visitor Use Monitoring Results (NVUM) for George Washington-Jefferson National Forest are used (USDA Forest Service, Region 8, data collected fiscal years 2000 and 2006, published August 2001 and July 2007 respectively). In 2000, 34 days were sampled in Wilderness, and in 2006, 37 days were sampled.

Based on the statistical data, the Wilderness visits in 2000 were estimated to be 69,406, and the Wilderness visits in 2006 were estimated to be 61,200, a decrease of 10.38% over 6 years.

Both years' reports include a survey of perceived crowding in Wilderness. Table 8 shows the results of that portion of the surveys. Seemingly in contrast to the decreased visitation reported, visitors in

2006 perceived Wilderness to be more crowded than did the visitors to Wilderness in 2000, although not overwhelmingly.

Table 8: Perceived Crowding in Wilderness from NVUM Reports:

Crowding Rating	2000 % of site visits	2006 % of site visits
10 Overcrowded	0	0.0
9	3	6.2
8	0	0.3
7	13	12.1
6	10	19.5
5	15	24.8
4	12	6.5
3	6	0.3
2	26	30.0
1 Hardly anyone there	15	0.3

The NVUM provides a list of visitors' home zip codes. In the 2000 survey, there were a total of 7 home zip codes provided by visitors; in 2006, there were a total of 89 and 1 foreign country, indicating that visitors are coming from a broader and more diverse area than previously.

Another source of information about demand for Wilderness recreation opportunities is the July 2002 report by Ken Cordell titled "A Survey of Residents of the Greater Southern Appalachian Region to Describe: Public Use and Preferred Objectives for Southern Appalachian National Forests, Public Survey Report, George Washington and Jefferson National Forests", commonly referred to as the Public Survey Report (Web Series: SRS-4901-2002-5). This report provides the findings of a telephone survey of residents of counties located within 75 miles of each of the 13 southern Appalachian national forests. A minimum of 400 telephone interviews were conducted for each of these national forests. The report indicates that 41% of local residents 16 and older who responded that they had visited the GWNF in the prior 12 months had visited a Wilderness area. Over 64% of local respondents 16 years of age or older indicated that designating additional acres of Wilderness was important to them, and over 42% indicated that it was extremely important to them. Since the completion of the 2006 NVUM and the 2002 Public Survey Reports cited above, six new Wildernesses and six additions to existing Wildernesses were Congressionally designated on the Jefferson National Forest totaling 40,340 acres. Three new Wildernesses were added and three were expanded on the Monongahela National Forest as well.

With 24 Wildernesses, Virginia ranks 1st of the states east of the Mississippi with the most Wilderness units, and 10th nationally. While Virginia is ranked 35th nationally for total area (U.S. Census), it ranks 17th nationally for total acres of designated Wilderness. Virginia also ranks 17th for percent of the state's total land area that is designated Wilderness (www.Wilderness.net).

Wilderness is valued for, among other reasons, preserving representative natural ecosystems. In terms of ecological classification, all of the PWAs are within the Central Appalachian Broadleaf-Coniferous Forest Meadow Province. Within this province, the GWNF contains portions of the Northern Blue Ridge, Ridge and Valley and the Appalachian Plateau physiographic regions. All of these physiographic regions are well represented with existing Wilderness. Wilderness in the Northern Blue Ridge include St. Mary's, The Priest, Three Ridges and Shenandoah Wilderness. Wilderness in the Ridge and Valley include Ramseys Draft, Rough Mountain and Rich Hole. And the Monongahela's Wildernesses are found in both the Appalachian Plateau as well as the Alleghany Highlands.

At the regional and the local scales, there are no known visitor use pressures on existing Wilderness on the GWNF that would potentially be alleviated by additional Wilderness designation near population centers. In fact, per the NVUM surveys data cited above, use of Wilderness appears to have decreased between 2001 and 2006. St. Mary's Wilderness receives the highest use on the George Washington NF, while Ramseys Draft receives moderate use. The other four Wildernesses receive low use (SAA Chapter 5 at page 193, 1996). St. Mary's has always been popular and receives repeat visitation by people familiar with this Wilderness. Sixteen years after St. Mary's designation, two Wildernesses, The Priest and Three Ridges, were designated near to and in the same physiographic region as St. Mary's, yet there was no apparent decline of visitation in St. Mary's. Other management actions will be required if the pressures of use in St. Mary's result in unacceptable numbers of encounters with other visitors or unacceptable impacts to resources. Designating new Wilderness will not solve those issues.

The primary benefit that could be achieved through additional designation of Wilderness on the GWNF would be to expand the size of one or more existing Wilderness to provide better opportunities for solitude, remoteness, challenge, and the ability of natural processes to dominate. This expansion could include designating adjacent areas as well. Though not as effective as contiguous blocks, adjacent Wilderness separated by a narrow road corridor could be effective in meeting this goal.

Appendix D – Wild and Scenic Rivers Eligibility Determination

The 1993 Forest Plan Revision included an extensive review and evaluation of the rivers of the George Washington National Forest. Appendix D of the 1993 Forest Plan was reviewed. The information and determinations documented in Appendix D remain valid with minor changes in conditions. Therefore, the Appendix is repeated here.

Public comments did identify some additional rivers for consideration. These included Trout Run, Waites Run, Stony Creek (North of Bayse), German River, Benson Run, Stuart Run (with Buck Lick and Bolshers Run), Mill Creek (Maury River), Wilson Creek, Mill Creek (Cowpasture River), Jim Dave Run, Potts Creek, Little Back Creek, Crow Run (with Little Crow Run), and Big Marys. A review of these streams identified no nationally or regionally outstandingly remarkable values in recreation, scenery, wildlife, geology, botany or heritage resources. Under the fisheries resource we did identify that Potts Creek and Mill Creek provide habitat for the James spinymussel. However, in both of these cases, the location of the mussel is downstream of National Forest System lands.

I. INTRODUCTION

This appendix contains evaluations of 14 rivers located in or close to the George Washington National Forest. These evaluations determine which of the 14 rivers have qualities that make them eligible for inclusion in the National Wild and Scenic River System. The evaluations also determine whether the eligible rivers should receive wild, scenic, or recreational river classification.

A determination locally that a river is eligible does not necessarily mean that it will meet suitability criteria when, in the final stages, it is evaluated from a national perspective. Eligibility evaluations are an initial step in a process that ultimately requires action by Congress to include a river in the National Wild and Scenic River System.

The Forest Service completed the eligibility and classification evaluations contained in this appendix. Suitability evaluations for each of the eligible rivers are being performed by a combination of state and federal agencies and will be published at a later date. The suitability studies are the final step in determining whether or not a river is recommended to Congress for further consideration.

The evaluations presented here are in accord with the National Wild and Scenic Rivers Act of 1968 (the Act) and in response to the Nationwide Rivers Inventory (National Park Service, January 1982) and the concerns of the American Rivers Conservation Council.

II. THE EVALUATIONS: WILD AND SCENIC DESIGNATION FOR LOCAL RIVERS

Stream miles listed are approximate and were taken from maps on a scale of 1/2 inch = 1 mile.

BACK CREEK

For evaluation purposes, Back Creek is divided into three segments. Back Creek is described in this report from its confluence with the Jackson River, north to its headwaters. A total of 32.79 miles is considered in this evaluation. The majority of the stream corridor is in private ownership. George Washington National Forest land is on both sides of the creek for a total of 2.35 miles and on one side of the creek for an additional 1.52 miles. Both the streambanks and the stream are subject to riparian rights, since the stream is not considered navigable. This limits river access and use to property owners and guests. Back Creek is located entirely within Bath County, where officials express concern about additional federal control of land in the county.

Segment A - From Lake Moomaw to State Route 39 (5.59 miles)

This 5.59-mile segment flows through Back Creek Gorge. Blowing Springs Campground at State Route 39 provides the only public access until Lake Moomaw. The Virginia Commission of Outdoor Recreation found this segment eligible for inclusion in the Virginia Scenic Rivers System. This free-flowing stream traverses 2.35 miles (both banks) and 0.01 miles (one bank) of the Forest. There is little development along this segment and little disturbance. Water quality is considered average to good. There is some canoe use along Segment A when the water is high. There are several jeep trails, but no developed roads along this segment of Back Creek.

Eligibility of Segment A by:

Scenic Value: There is little development along this section of Back Creek. The corridor is considered attractive where the stream passes through the gorge. Overall the stream is small-to-medium in size, with a few medium-size pools. The rate of flow is medium except during storm periods. Topography along this segment is relatively steep. The forest cover consists of hardwoods mixed with hemlock and pine. Understory species are those common to the area. Large boulders add visual variety to the streambed in several locations. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Recreation use along Segment A consists of fishing, canoeing, and kayaking. Most of this use comes from adjacent landowners who post their property and prevent public access. During periods of high water, the segment through Back Creek Gorge from Blowing Springs to Lake Moomaw is used by both canoeists and kayakers. With Class 2 and 3 rapids present, this is an excellent white-water creek. This section is not classed as navigable. A Class A-Distinctive rating is assigned to the recreation values.

Geologic Value: This segment contains interesting geological formations, including outcroppings and high cliffs through the gorge area. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: This segment is not considered to be an outstanding fishery. Some fish do enter Back Creek from Lake Moomaw, including spawning rainbow trout. Because the adjacent private property is posted, access is limited. This corridor provides habitat for wildlife species typical of the Forest. A Class B- Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric and historic sites along this segment that are eligible for the National Register of Historic Places. It is probable that additional prehistoric sites exist. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment A of Back Creek is eligible for designation under the Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable scenic, recreational, geologic, historic, and cultural values.

Classification Determination:

Because Segment A of Back Creek is eligible for designation, it is necessary to determine the appropriate classification. According to the criteria in FSH 1909, Chapter 8, the entire 5.59 miles can qualify for inclusion in the system under the scenic classification. This classification is based primarily on the fact that development along the river is sparse and existing roads are inconspicuous.

Segment B - From Blowing Springs Campground to Pump Storage Lake (9.96 miles)

This 9.96-mile segment is located within Bath County. The majority of land along this segment is privately owned. Back Creek touches National Forest System land at four locations on one side for a total distance of 1.51 miles. This segment is not considered to be navigable. There are no impoundments along this segment. State Highway 39 and County Road 600 parallel the shoreline and are evident from the stream. Open farm land, houses and bridges are common features. The size of the stream is medium to small. The flow is regulated by the Back Creek Pump Storage project and is extremely low during the summer months. Most of the private property is posted. Forest and agricultural practices are evident within the stream corridor. Water quality is average to good. The segment is suitable for fish and wildlife propagation and some recreational activities.

Eligibility of Segment B by:

Scenic Value: Segment B of Back Creek is typical of many streams in the area. It is an attractive creek, but has no distinctive or outstanding features. The stream is shallow with small pools with a gradual gradient. The current is fairly slow with uniform flow characteristics. During storm periods and when water is released from the pump storage lake, the rate of flow increases. The gently rolling valley is bordered by steep mountain terrain and varies in width. The forest cover consists of mixed hardwoods and pine with

common understory species. Open farm land borders the creek in many locations. A Class B-Common rating is assigned for scenic values.

Recreational Value: Current recreation use includes swimming, canoeing and fishing by adjacent landowners. Virginia Power has developed a trout fishery and recreation facilities along this segment and provides public access to the river along the upper mile of the segment. This segment is not considered navigable. A Class B-Common rating is assigned for recreational values.

Geologic Value: This segment has no unusual rock outcroppings or other geologic features. The corridor consists primarily of farm land and forest land typical of the area. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: This segment of Back Creek supports a trout fishery from the dam, downstream for one mile. The area provides habitat for wildlife species typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric and historic sites located along this segment. Information on these sites is documented in studies conducted by the Archaeology Laboratory at James Madison University. Additional sites probably exist. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of Back Creek is eligible for designation under the Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable historic and cultural values.

Classification Determination:

Because Segment B of Back Creek is eligible for designation, it is necessary to determine the classification that would result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 9.96 miles can qualify for inclusion in the system under the recreational classification. This determination is based primarily on the fact that much of the private land adjacent to the river contains residential structures and agricultural facilities.

Segment C - Back Creek Pump Storage Project to Headwaters (17.24 miles)

The majority of this 17.24-mile segment is in Highland County; approximately 1.5 miles are located in Bath County. The portion in Highland County serves as the Forest boundary. This entire segment has been extensively channelized as a result of the floods of 1969, 1972, and 1985. This segment is not considered navigable. The stream is small with low rates of flow except during major storm events. There is no National Forest System land along this segment. State roads parallel and cross this segment in several locations. The stream is free-flowing.

Eligibility of Segment C by Value:

Scenic Value: Segment C of Back Creek is attractive, but has no features that rate as distinctive or outstanding. The stream is shallow with a few small pools and a gradual gradient. The current is fairly slow with uniform flow characteristics. During storm periods,

the rate of flow increases considerably. The gently rolling valley is bordered by steep mountains that vary the width of the valley. The forest cover is typical mixed hardwoods and pine with common understory species. There is a lot of open farm land adjacent to the Creek. A Class C-Minimal rating is assigned for scenic values.

Recreational Value: Current recreation use is limited to swimming and fishing by adjacent landowners. This segment is not considered navigable. Public access is not available on this segment. A Class C-Minimal rating is assigned for recreational values.

Geologic Value: This segment has no unusual rock outcroppings or other geologic features. The corridor consists of farm land and forest land typical of the area. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: This segment does not support a sport fishery. The area provides habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are no known prehistoric or historic sites along this segment, but there is a probability that prehistoric sites do exist within the corridor. Since no systematic survey has been conducted along this section, a Class B-Common rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment C of Back Creek is not eligible for designation under the National Wild and Scenic Rivers Act due to the amount of disturbance to the stream channel and the lack of outstandingly remarkable values. For these reasons, this segment will not be studied further for designation under the Wild and Scenic River Act.

BULLPASTURE RIVER

The Bullpasture River is divided into two sections for purposes of this evaluation. The Bullpasture is described from its confluence with the Cowpasture River north to its headwaters. There is no federal land ownership along the Bullpasture River. The lower two miles of the Bullpasture are located in Bath County with the remainder in Highland county. A total of 18 miles is studied for eligibility for the National Wild and Scenic River System.

Segment A - The Bullpasture Gorge.

There is no federal ownership along this 3-mile segment of the Bullpasture River. The segment stretches from the confluence with the Cowpasture River to a ford where Route 609 departs from Route 678. The majority of this segment is in Bath County and is inside the Forest boundary. The gorge is scenic with large boulders and cliffs and presents a challenge to the white-water enthusiast. This area is stocked with trout under the state put-and-take system.

Eligibility of Segment A by:

Scenic Value: The section of the Bullpasture River in the gorge contains rock bluffs and large boulders. The stream is typically shallow and small. The rate of flow can vary greatly with periods of rain and drought. For the most part, however, it is relatively slow. There is

a fairly steep gradient through this section. Forest types include mixed hardwoods and some pine and hemlock. The paved state road is adjacent to the stream and is very evident from the stream. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: This section is stocked by the VDGIF with trout under the put-and-take program. According to the book Virginia White Water by H. Roger Corbett, this section offers big white-water consisting of Class 3, 4 and 5 rapids. The gorge is not navigable year-round and is considered dangerous during periods of high water. The stream is shallow with large boulders in this section. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: This section has rock bluffs and cliffs. There are large boulders in the stream. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: This section is stocked with trout by the VDGIF under the put-and take program. The wildlife species of the area is typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are no known prehistoric or historical sites along this section. No survey has been conducted along the Bullpasture River. A Class B-Common rating is assigned to the historic and cultural values.

Eligibility Determination:

Section A of the Bullpasture River, including the Bullpasture Gorge, is eligible for designation under the National Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable scenic, recreational, and geologic values.

Classification Determination:

Because Segment A is eligible for designation, it is necessary to determine the classification that would result from designation. According to the criteria established in FSH 1909, Chapter 8, the entire three-mile segment qualifies under the scenic classification. The determination is based on the fact that the segment has outstanding scenic values, but is bordered by paved Route 678.

Segment B - North of the Bullpasture Gorge to the headwaters.

This 15-mile segment of the Bullpasture River has been heavily channelized from the Highland Wildlife Management Area to the headwaters. There are paved state roads adjacent to the stream and sections of the road have heavy limestone rip-rap for flood protection. Due to disturbances including channelization, Segment B does not qualify under the National Wild and Scenic Rivers Act.

CACAPON - LOST RIVER

The 89-mile segment described in the Nationwide Rivers Inventory begins at the dam below Great Cacapon and ends at Baker, West Virginia. A segment of this river is a congressionally mandated study river. The study was completed by the U.S. Department of Interior, Park Service, in the summer of 1982. The Department of Interior study team found the river

unsuitable because of lack of public support for designation and did not recommend inclusion in the national system.

Based on findings in the National Park System report, the Cacapon-Lost River will not be considered further.

CEDAR CREEK

This 25-mile evaluation segment of Cedar Creek is located in Shenandoah and Frederick counties. The section begins at the State Route 622 bridge and ends at its headwaters in the Lee District of the Forest. The majority of land along the creek is privately owned. The Forest Service owns land adjacent to the headwaters for a total of 2.65 miles. The majority of the stream is located outside the Forest boundary.

Cedar Creek is a small stream with sections in its headwaters that go dry every year. Private property within the corridor is largely undeveloped and is a mixture of agriculture and forest land. Forest and agricultural practices are evident along most of the stream. Development on the private property is starting to occur. There are houses, cabins, and two private fish hatcheries. Most private property is posted. Water quality is average. A small native brook trout population is in the extreme headwaters. The stream has been stocked with trout under the state's put-and-take program in the past, but due to littering, parking problems, and acid deposition, the program was halted. Both regular and low-water bridges cross the stream.

Eligibility of the 25-mile Segment by:

Scenic Value: Cedar Creek flows over gently rolling terrain where mountains are visible in the background. There are no distinctive or outstanding features within the corridor. The stream is relatively small and shallow at the headwaters, but becomes larger with pools toward the end of the evaluation segment. The majority of the reach on the Forest goes dry during the summer. Because of the gently rolling terrain, the creek has uniform flow characteristics. During storm periods, the flow is faster and higher. The adjacent forest cover is typical mixed hardwood and pine with common understory species. A Class B-Common rating is assigned to scenic values.

Recreational Value: Current recreation use consists of fishing, canoeing, and kayaking. Fishing activity is curtailed since the stream is no longer stocked under the state's put-and-take program. There is some bass fishing along the lower reach outside of the Forest boundary. Most of the private property along the creek is posted so there is little public access outside the Forest. The stream is not classified as navigable. A Class B-Common rating is assigned to the recreational values.

Geologic Value: There are no unusual or outstanding rock outcroppings, cliffs or other geological formations along the stream. The "Three High Heads" of Paddy Mountain are visible from Cedar Creek Valley. A Class B-Common rating is assigned to the geologic values.

Fish and Wildlife Values: The stream is no longer stocked with trout under the state's put-and-take program. Smallmouth bass, rock bass, sunfish, and some other species occur in the lower reach of the stream. There is a small population of brook trout in the headwaters. The headwaters are badly impacted by acid deposition. The area provides

habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Values: Stevens Fort, an old iron furnace, and two tannery sites are located within the corridor and have the potential for historical significance. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

With the exception of the intermittent headwaters, Cedar Creek is eligible for designation under the National Wild and Scenic Rivers Act. The intermittent headwaters are defined as that section of the creek from its headwaters down to where the creek crosses the boundary between the Forest and private land at approximately the 1,330-foot contour. The creek is free-flowing and has outstandingly remarkable historic and cultural values.

Classification Determination:

Because Cedar Creek is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, a total of 20 miles qualifies for inclusion in the system under the scenic classification.

COWPASTURE RIVER

For evaluation purposes, the Cowpasture River is divided into four segments. The Cowpasture is described in this report from its confluence with the James River to its headwaters to the north. The Forest Service currently owns a total of 3.5 miles of land on one side of the river only. This 3.5 miles of riverbank land is divided among 10 tracts and is not contiguous. Forest Service ownership of the land on both sides of the river totals 4.5 miles on three tracts which are not contiguous. A total of 78.11 miles is studied for eligibility for the National Wild and Scenic River System.

The State of Virginia selected the portion of the Cowpasture River from Panta to Route 42 for further evaluation as a component of the Virginia Scenic Rivers System. Banks and stream are subject to riparian rights since the majority of the stream is not declared navigable. The Virginia Department of Game and Inland Fisheries (VDGIF) states that the section from the U.S. Route 60 bridge to the confluence with the Jackson River is declared navigable.

Citizen interest in designation of the Cowpasture River is strong. The Cowpasture Property Owners Association is a group of landowners who organized for the purpose of participating in the designation process.

Segment A - Confluence with the Jackson River to Route 42 Bridge

The majority of this 16-mile segment is within Alleghany County. National Forest System land borders the river on one side only for three miles and at three different locations. The VDGIF states that the portion between U. S. Route 60 bridge and the confluence with the Jackson River is navigable. There are no impoundments along this segment. Portions of Segment A are paralleled by roads, including State Highway (SH) 42. It is crossed by roads and/or highways four times, including Interstate 64, and by a railroad line three times. There is no developed trail

access to the river. Most of the shoreline along this segment currently consists of forest and agricultural land where management of these lands is evident. There is some development along the river including cabins, houses, and a private campground. Most of the adjacent private land is posted against trespassing. This segment is suitable for fish and wildlife propagation, wading, and canoeing.

Eligibility of Segment A by:

Scenic Value: Segment A of the Cowpasture River is an attractive river that is typical of rivers within the George Washington National Forest and the surrounding area. It has no features that rate as distinctive or outstanding. The stream is shallow, medium in width with some large pools, and has a gradual gradient. The current is fairly slow with no waterfalls, cascades of significant whitewater. The valley bottom is gently rolling with steep mountain terrain bordering it on one side. Several shale bluffs are evident from the river. Forest cover along the river is mixed hardwood and pine with common understory species. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment A is limited to fishing, canoeing, tubing, and swimming by adjacent landowners. The section between the U.S. Route 60 bridge and the confluence with the Jackson River is considered navigable by the VDGIF. This segment receives high use by tubers and canoeists. Public access is limited to two locations: from the Route 42 bridge and from national forest land on the Evans Tract off State Road 633. This limited access keeps river use down. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: This segment has no unusual rock outcroppings. Two shale bluffs are visible from a short segment of the stream. The corridor consists of farm land and forest types typical of the George Washington National Forest. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: This segment supports a sport fishery of smallmouth bass and muskellunge with other species such as sunfish. Spawning muskellunge -- a rarity in the state -- are present in this segment. The area provides habitat for wildlife species typical of the Forest. A Class A-Distinctive rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric sites on the main terraces of the river on National Forest System land. It is likely that additional prehistoric sites exist on private property along the river. Evidence of an antebellum mansion can be found on the government owned Evans (#1657) Tract. Again, there is a high probability that undiscovered and potentially significant prehistoric sites exist within this river corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment A of the Cowpasture River is eligible for designation under the Wild and Scenic Rivers Act. It is free-flowing and determined to have outstandingly remarkable recreational and fish and wildlife values.

Classification Determination:

Because Segment A of the Cowpasture River is eligible for wild and scenic river system, it is necessary to determine its potential classification as either wild, scenic, or recreational. According to criteria in FSH 1909, Chapter 8, the entire 16 miles qualifies for inclusion in the system under the recreational classification. This determination is based primarily on the fact that several major highways and railroad bridges cross and parallel this section of the river.

Segment B - From Route 42 Bridge to the confluence with the Bullpasture River

This 48.11-mile segment is located entirely within Bath County. National Forest System land borders on one side only for 4.33 miles and is spread out over seven locations. Forest Service lands border both sides for 4.28 miles at two locations. There is one small dam near Millboro Springs, a few low-water bridges and a few swinging foot-bridges, including one on national forest land. Portions of Segment B are paralleled by roads. Other roads provide access to the river. There is one foot-trail on National Forest System land that provides access to the river.

The shoreline is largely undeveloped and is a mixture of forested and agricultural land. The development that exists includes cabins, houses, and tilled farm land. The majority of the adjacent private land is posted. Forest and agricultural practices are evident within the stream corridor. The segment is suitable for fish and wildlife propagation, wading, canoeing, and other uses. Water quality is average. Three locations provide public access along this segment. This segment has not been declared navigable.

Eligibility of Segment B by:

Scenic Value: Segment B of the Cowpasture River is typical of many rivers in the Forest and the area. The stream is small-to-medium in width and shallow, with some large pools of water. It has a gradual gradient and no stretches of whitewater. The current is fairly slow with uniform flow characteristics. The valley bottom is gently rolling with steep mountain terrain bordering one side. No cliffs or other rock formations are evident along this segment. The forest cover is typical mixed hardwood and pine with common understory species. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment B consists of fishing, canoeing, tubing, and swimming by adjacent landowners and the general public along tracts owned by the Forest Service. Public access is limited. This river segment has not been declared navigable. Due to these factors, recreational use is limited. A Class B-Common rating is assigned to the recreational values.

Geologic Value: This segment has no unusual rock outcroppings. The corridor consists of farm land and forest typical of the George Washington National Forest. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: This segment supports a sport fishery of smallmouth bass, muskellunge, and other species such as sunfish. Spawning muskellunge--a rarity in the state--are present in this segment. The area provides habitat for wildlife species typical of the Forest. The majority of the private property along this segment is posted and severely limits fishing-and-wildlife-related access. A Class A-Distinctive rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric archeological sites on the Forest. There is a high probability that additional prehistoric sites exist in the corridor on both private and federal lands. A known historic site exists on the Forest-Service-owned Wallace Tract. The tract includes an old brick house which may have historical value and may qualify for the National Register of Historical Places. Another historical site with potential exists on the Walton Tract. The tract contains the remains of several old homesites. Dickinson Fort is another potentially significant site located within the corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of the Cowpasture River is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable fish and wildlife and historic and cultural values.

Classification Determination:

Because Segment B of the Cowpasture River is eligible for designation, it is necessary to determine its potential classification as either wild, scenic, or recreational. According to the criteria in FSH 1909, Chapter 8, the entire 48.11-mile segment qualifies for inclusion in the system under the recreational classification. This classification is based on the fact that several roads cross the river and that concentrated development exists along the river in the area of Millboro Springs. In addition, there is a small dam on the river in the Millboro Springs area.

Segment C - Confluence with Bullpasture River to Patna

The majority of this six-mile segment is within Highland County. It is not considered navigable. The river is free-flowing, but small. Segment C is inside Forest boundaries. There is no public access and the majority of the adjacent private property is posted. Roads parallel and cross the river at several locations. Upper reaches of the river go dry during extended dry periods. Adjacent land is farm land with sections of hardwood and pine and is used for pasture, primarily. Little opportunity exists for fish propagation, wading, canoeing, and other forms of recreation. The river passes through a section of a state wildlife management area for about 1.5 miles. Of note, the section downstream from Panta to the end of segment C and part of Segment B has been selected by the state for further evaluation as part of the Virginia Scenic Rivers System.

Eligibility of Segment C by:

Scenic Value: Segment C is typical of the upper reaches of rivers in the area. It is attractive, but has no distinctive or outstanding features. It is small-to-medium in size with low-flow except during major storm periods. The current is fairly slow with uniform flow characteristics. The topography of the valley is gently rolling with steep bordering mountains. No rock outcroppings are evident. The forest cover is typical hardwood and pine with common understory species. A state highway parallels the stream and several houses are scattered along its banks. A Class C-Minimal rating is assigned to the scenic values.

Recreational Value: Current recreation use is limited to adjacent landowners and consists of fishing and swimming. There is no public access to Segment C. The stream does not

have sufficient flow for boating except during major storm periods. A Class C-Minimal rating is assigned to the recreational values.

Geologic Value: This section has no unusual rock outcroppings except near the confluence with the Bullpasture River. The corridor consists of farm land and forest types typical of the area. A Class C- Minimal rating is assigned to the geologic values.

Fish and Wildlife Value: This section does not support a sport fishery. The area provides habitat for wildlife species typical of the area. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Value: There are no known archeological or historical sites along this section, but there is a probability for archeological sites. Since no survey has been conducted, a Class B-Common rating is assigned.

Eligibility Determination:

With no outstandingly remarkable values present, Segment C of the Cowpasture River is not eligible for designation under the National Wild and Scenic Rivers Act. Segment C will not be studied further for designation.

Segment D - Patna to the headwaters

The majority of this 8-mile segment is within Highland County. From Patna to the headwaters, the stream has been channelized in many locations. Channelization was done in response to the floods of 1969, 1972, and 1985. Segment D is not considered navigable. The river is free-flowing, but small in size. This segment is within the Forest boundary. There is no public access and the majority of adjacent private property is posted. Roads parallel and cross the river at several locations. Upper reaches of the river go dry during extended dry periods. Adjacent land is farm land that is used primarily for pasture, with sections of hardwood and pine woodlands. Little opportunity exists for fish propagation, wading, canoeing, or other forms of recreation.

Due to channelization of the river, the section from Panta to the headwaters will not qualify for wild and scenic river designation and will not be considered further.

DRY RIVER

This stream is not on the National Rivers Inventory. In response to an appeal by the American Rivers Conservation Council, this river was reviewed on-the-ground by the Forest and American Rivers. A 22-mile segment of the Dry River was studied, including the portion from the headwaters to where the river exits the Forest boundary. This river received major damage during the floods of 1969, 1972, 1985, and several earlier floods. The river is heavily channelized. There are some impoundments on the river, including the city of Harrisonburg water supply diversion dam at Riven Rock Park and dams on the upper mainstem, Skidmore Fork, and Dry Run.

Because of the extensive channelization, Dry River is not free-flowing and is not eligible for inclusion in the wild and scenic river system.

IRISH CREEK

This stream is not on the National Rivers Inventory. In response to an appeal by the American Rivers Conservation Council, Irish Creek was reviewed on-the-ground by representatives of the George Washington National Forest and American Rivers. An 8.5-mile segment was studied, from the headwaters to where Irish Creek exits the Forest boundary. An on-the-ground evaluation of this stream showed that it was heavily damaged during the floods of 1969, 1972, and 1985. Extensive channelization and gabion structures dominate the entire evaluation segment. Because of the extensive channelization, Irish Creek is not free-flowing and is not eligible for inclusion in the wild and scenic river system.

JACKSON RIVER

The 42.69 miles of the Jackson River being considered here was divided into four segments for evaluation purposes. The Jackson is described in this report from its headwaters south to an area called Clearwater Park, located just north of Covington, Virginia. Forest Service ownership along the Jackson River is non-contiguous. Segments of the Jackson have been evaluated by the Virginia Commission of Outdoor Recreation and found worthy of inclusion in the Virginia Scenic River System. Citizen interest in any proposed wild and scenic river designations would be extremely high.

Segment A - U.S. Forest Service lands at the northern boundary of the Hidden Valley Tract to the headwaters

This segment is within Bath and Highland counties and contains approximately 14.3 miles. The majority of property along this segment is privately-owned and 75 percent of this segment is outside the Forest boundary. The private property is posted. This segment is not considered navigable. The portion in Highland County is outside the Forest boundary. This segment touches Forest land at two locations for an approximate distance of 0.66 miles in Bath County near Star Chapel. This segment is paralleled by State Highway 220 and is bridged by Highway 220 and county roads 607 (twice), 606, and 608. The segment was heavily channelized in several locations after the floods of 1969, 1972, and 1985. The disturbed sections are short, but scattered over the entire length.

Eligibility of Segment A by:

Scenic Value: Segment A of the Jackson River is typical of the rivers in this part of the state. Although attractive, it has no distinctive or outstanding features. The stream is medium-to-small and for the most part, shallow. A few pools are scattered along this reach. The current is slow, with uniform flow characteristics. The valley is gently rolling with steep mountain terrain on one side near the river. There are no rock cliffs, ledges or shale bluffs evident from the stream. The forest cover is typical mixed hardwood and pine with common understory plants. The majority of the bordering land is private farming with pasture land along the river. Many of these bordering properties are developed with houses, barns, bridges, and other structures. This segment is paralleled by State Highway 220. A Class C-Minimal rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment A is limited to fishing and swimming by adjacent landowners. This segment is not considered navigable. A Class C-Minimal rating is assigned to the recreational values.

Geologic Value: This segment has no unusual or outstanding geological features. The corridor consists of farm land and forests typical of the GWNF area. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: Parts of this segment support smallmouth bass, sunfish and other species. Fishing access is limited due to adjacent private property. The area provides habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Values: Although a systematic survey has not been conducted along this segment, there are known prehistoric sites located on private land adjacent to the river. Because these sites have not been evaluated for significance, a Class B-Common rating is assigned to the historic and cultural values.

Eligibility Determination:

Due to channelization and development along the river, Segment A of the Jackson River is not eligible for designation. This same conclusion was reached by the Virginia Commission of Outdoor Recreation in their study. For these reasons this segment will not be evaluated further for designation under the National Wild and Scenic Rivers Act.

Segment B - From Hidden Valley southern boundary to U.S. Forest Service lands at the northern boundary of the Hidden Valley Tract (7.06 miles)

This 7.06-mile segment is located in Bath County. A total of 6.56 miles of this segment is located on the Forest. Property along the remaining .5 miles is posted. This section is not legally declared navigable, however, the section inside the Forest is in public ownership and, therefore, is de facto navigable. Public vehicle access is available at either end. A jeep trail parallels a portion of the stream and is used by hikers and for administrative purposes by the Forest Service. Most of the shoreline is forested. One low-water bridge crosses the stream at the Warwick Mansion. A swinging foot-bridge on the Forest crosses the stream above Muddy Run. There are a few open fields and structures adjacent to or bordering this segment of the river.

Eligibility of Segment B by:

Scenic Value: Segment B of the Jackson River is an attractive river. Forest cover along the river is nearly continuous. Open fields border the river in several locations, adding variety to the environment. There is a variety of plant species, including large trees. The streambed is medium in width. The rate of flow is medium and there is little-to-no white-water, except during storm periods. Several structures are visible within the river corridor. The old jeep road is not highly visible from the stream. There is one low water bridge. There are flats adjacent to the stream, with some steep side slopes to add to the variety. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current recreation use consists of trout fishing, wading, canoeing, hunting, and hiking. Most land along this segment is public, under Forest Service management, accessible, and available for recreational use. Much of the length of this segment is a walk-in fishery, providing a somewhat unique recreation opportunity for the area. Outstanding white-water canoeing and kayaking opportunities exist along this

segment in Hidden Valley. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: A few rock outcroppings are present, but most are not visible from the river. The corridor consists primarily of forest interspersed with open fields. Forest types along the river are typical of the George Washington National Forest. A Class B-Common rating is assigned to the geologic values.

Fish and Wildlife Values: This segment is stocked with trout by the Virginia Division of Game and Inland Fisheries (VDGIF) under the state's put-and-take system. This section of the river is an otter re-introduction site, one of several in Virginia. A Class A-Distinctive rating is assigned to the fish and wildlife values.

Historic and Cultural Values: This segment contains the Warwick Mansion that is on the National Register of Historic Places. A low-water bridge across the river provides access to the mansion. A rock shelter with a significant prehistoric component is located in the corridor along this segment and is on the National Register of Historic Places. There is a high probability that additional archeological sites exist within this corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of the Jackson River is eligible for designation under the National Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable scenic, recreational, fish and wildlife, and historic and cultural values.

Classification Determination:

Because Segment B of the Jackson River is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 7.06 miles qualifies for designation under the scenic classification. The segment has outstanding scenic qualities and is bordered and accessed by paved state highways.

Segment C - Hidden Valley to McClintic Bridge (8.33 miles)

This 8.33-mile segment is bordered almost entirely by private property. The exception is 0.27 miles of Forest ownership. While there are numerous access points to the river, most are located on posted private property and are not available to the general public. Many private roads parallel the stream. A few structural improvements such as farm buildings, houses, and hunt cabins exist along the stream. Existing use along the river consists primarily of hunting camps and agriculture. The shoreline is a mixture of forest land and open fields. This segment is suitable for fish and wildlife propagation, wading, canoeing, and other uses. The water clarity ranges from average to good. This segment is not considered navigable, therefore, public access to the river is controlled by the landowners.

Eligibility of Segment C by:

Scenic Value: Segment C of the Jackson River is an attractive area. The size ranges from small-to-medium in width and is mostly shallow with some large pools. The rate of flow ranges from slow to fast. There are large boulders in some sections of the stream channel and cliffs are evident in some locations. Topography ranges from gently-rolling valley to steep-sided gorge. Richardson Gorge has outstanding scenery. Roads are evident along sections of this segment. The forest cover consists of hardwoods, hemlock, some pine. Understory species are those common to the GW. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current recreation along Segment C consists of fishing, canoeing, kayaking, and swimming by adjacent landowners and guests. There is little public land along this segment. The segment is not considered navigable and access is controlled by adjacent landowners who have posted their property. Through Richardson Gorge, the river drops 40 feet per mile for two miles, making it an excellent river for white-water enthusiasts. There is some trout fishing in this segment. A Class A-Distinctive rating is assigned to the recreational values. If access problems can be resolved, this segment has excellent potential for public recreation use.

Geologic Value: There are several rock outcroppings along this segment. Richardson Gorge has many interesting and beautiful geological formations. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: Segment C contains smallmouth bass and bluegills as well as stocked and wild trout. The area is posted and access for fishing is not available to the general public. There is evidence that the special strain of rainbow trout stocked in Lake Moomaw are beginning to make spawning runs into this section of the river. If this spawning run continues to build, this would dramatically increase the fishery value of this section. This area provides habitat for wildlife species that are typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known historic and prehistoric sites along this segment. These include Fort Dinwiddie and the Hirsch Mound, both located on private land. There is a high probability that additional prehistoric sites exist. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment C of the Jackson River is eligible for designation under the National Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable scenic, recreational, geologic, and historic and cultural values.

Classification Determination:

Because Segment C of the Jackson River is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 8.33 miles qualifies for inclusion in the system under the scenic classification. This determination is based primarily on the fact that development along the river is sparse and roads are inconspicuous.

Segment D - Gathright Dam to Clearwater Park (13.0 miles)

This segment is 13.0 miles long. It begins at Gathright Dam and ends at the bridge where State Route 687 crosses the river at Clearwater Park. The majority of the river frontage is privately owned and posted. The first 1/2-mile is bordered by public land administered by the Corps of Engineers. There is one canoe access point on Corps lands. The Forest Service administers five access points along this segment of the river. These are located on small tracts purchased by the Corps of Engineers and later transferred to the Forest Service to provide public access to the river. This segment was declared navigable by the federal courts in 1982. In contrast to the federal court's determination that this segment is navigable, adjacent landowners maintain that they own the bottom of the river. They do not permit fishing or recreation access to the river by the general public. Only two of the publicly owned access points have been developed to date.

County and private roads parallel the river and county roads 687 and 638 cross it. An abandoned railroad grade parallels the segment for its entire length. Several farms and private homes are located along this segment, including a few private subdivisions. This segment of the river is used by canoeists, kayakers, tubers, and swimmers.

Eligibility of Segment D by:

Scenic Value: Segment D of the Jackson River is an attractive stream. It is medium in size and the depth ranges from shallow to deep where the river pools. The rate of flow ranges from average to fast and is regulated by the discharge at Gathright Dam. In some sections, there are large boulders and rapids. Shale cliffs are evident at three or four locations. The river valley is gently rolling and bordered by steep mountains. Roads parallel the river and are visible from the river along most of this segment. Several houses are located along the river. Forest cover is typical of the area and consists of mixed hardwoods and pine, including several hemlock groves. The understory species are common to the forest type. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Canoeing, kayaking, and tubing are becoming popular along this segment of the Jackson River. Fishing and swimming are popular in a few locations, but adjacent landowners discourage these uses. This segment is navigable and has six public access points. Most of the private property is posted. Bass fishing is good and the VDGIF plans to turn this segment into trout fishing waters. VDGIF maintains that this could be one of the best trout streams in the East due to Gathright Dam and Lake Moomaw and the ability to control temperature and oxygen levels of the water. This segment has good potential for river recreation use. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: At least four outstanding shale and limestone bluffs within the corridor are visible from this segment. Many users consider them outstanding geological features. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: At present, there is an outstanding fishery in this segment. The river contains smallmouth bass and panfish. A trout fishery is being developed. The river has been legally declared navigable, but adjacent landowners maintain they own the bottom of the river. Due to Lake Moomaw and Gathright Dam, water flow is regulated and the released water is typically colder than it would be without the release from the lake. The ability to release cold water into this segment provides for outstanding trout waters.

The corridor provides habitat for wildlife species typical of the Forest. With the trout fishery being developed, this segment qualifies for a Class A-Distinctive rating.

Historic and Cultural Values: There are known historic and prehistoric archeological sites along this segment. There is high probability that additional prehistoric sites exist. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment D of the Jackson River is eligible for designation under the National Wild and Scenic Rivers Act because it is free-flowing and has outstandingly remarkable historical, cultural, recreational, geologic, and fish and wildlife values.

Classification Determination:

Because Segment D of the Jackson River is eligible for designation, it is necessary to determine the segment's classification. According to the criteria in FSH 1909, Chapter 8, the entire 13.0 miles qualifies for inclusion in the system under the recreational classification. This determination is based primarily on the fact that this segment of the river is paralleled by roads and is developed by private landowners.

NORTH RIVER

This evaluation will examine a 16-mile segment of the North River from its headwaters to the point it exits the Forest approximately one mile east of the town of Stokesville, Virginia. The segment is located in Augusta County and Forest ownership of land along the river is almost complete. Private property does border the river for approximately 1.5 miles in the vicinity of Stokesville. The river is small and shallow except during major storm periods. Normally, the current is fairly slow with uniform flow characteristics. Steep mountain terrain is on both sides of the river. State and Forest roads exist in the stream corridor. Portions of the stream are stocked with trout under the state's put-and-take program. Much of the river has been heavily damaged by the floods of 1969, 1972, and 1985. Floods prior to these resulted in many gabions being installed along sections of the stream. The river is not considered navigable.

Segment A - From the headwaters to North River Campground.

The streambed and channel along the nine-mile section from the headwaters to the North River Campground show heavy flood damage and are channelized with gabions in some locations. Two dams are located within this section. Therefore, this section of the North River cannot be considered free-flowing and does not qualify for eligibility under the Act. As defined in the Act, free-flowing "means existing or flowing in natural condition without impoundment, diversion, straightening, rip-rapping, or other impoundment of the waterway."

Segment B - From North River Campground to Camp May Flather

This section is approximately 5.0 miles long. It is free-flowing and small in size. The average flow is relatively low. Flood damage along this segment is relatively absent. The adjoining property is owned entirely by the Forest Service. The shoreline is undeveloped. Some past forest management practices are evident along a short section of this stream. A Forest Service trail

follows this section, part of which is an old jeep road that is used to stock trout. The surrounding forest is typical hardwood and pine with common understory species.

Eligibility of Segment B by:

Scenic Value: Segment B of North River is an attractive segment with many outstanding rock formations and cliffs. The stream is typically shallow as it flows between a series of small pools. During periods of high water, usually in the spring and following moderate rains, North River provides a challenging white-water experience, including several Class 4 rapids. The stream flows over varying terrain, which adds to its attractiveness. Located in the North River gorge, this section is bordered by steep, mountainous terrain on both sides. A Forest Service trail, once a jeep trail, follows this section and crosses it at nine locations. The trail is still used by VDGIF vehicles to stock trout in the spring. There are signs of timber cutting in the corridor. The cutting was to salvage ice-damaged timber and most was on an individual tree selection basis. One small clearcut is evident. The surrounding forest cover is typical mixed hardwood and pine with common understory species. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current recreation use consists of hunting, fishing, hiking, and seasonal canoeing and kayaking. During high water, this section is capable of providing good white-water canoeing and kayaking. This section traverses public land and has adequate access at both ends. The North River Gorge hiking trail receives heavy use. Camping is available at the North River Campground. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: This segment through the North River Gorge contains several cliffs and outstanding rock formations. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: This segment is stocked in the spring with trout under the state's put-and-take program. It is also stocked in the fall if there is enough water to support fish. Several wildlife clearings are in the North River Gorge. For the most part, they are located away from the streambed and are not readily visible from the river. The area provides habitat for wildlife species typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are no known prehistoric archeological sites along this segment. Camp May Flather dates back to the 1930s and North River Campground is an old CCC camp site. There is an old logging railroad grade in the gorge area. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

The North River Gorge area of North River is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable scenic, recreation, geologic, historic, and cultural values.

Classification Determination:

Because the North River Gorge segment of North River is eligible for designation, it is necessary to determine the classification that could result from designation. According to

criteria in FSH 1909, Chapter 8, a total of 5.0 miles qualifies for inclusion in the system under the scenic classification.

Segment C - From Camp May Flather to the Forest's proclamation boundary.

This 2-mile section is located below the Forest boundary and crosses private property. The streambed and channel contain extensive flood-related damage and channelization. As with Segment A, this section of the North River cannot be considered free-flowing and therefore, is not eligible under the Act.

PASSAGE CREEK

Passage Creek is divided into three segments for evaluation purposes. Passage Creek is described in this report from its headwaters north to its confluence with North Fork Shenandoah River. This evaluation covers 34.5 miles from the confluence of the North Fork of the Shenandoah River to the beginning point of perennial stream flow. Within this 34.5-mile segment, the Forest Service owns 0.9 miles of land on one side and 9.7 miles on both sides of the creek. The majority of Passage Creek is located within the ridge commonly referred to as Massanutten Mountain. It flows north through Fort Valley and into the North Fork of the Shenandoah River. It is not considered navigable. State of Virginia studies do not consider Passage Creek eligible the Virginia Scenic Rivers System.

Segment A - Headwaters to State Route 730 (6.3 miles)

This 6.3-mile segment is bordered on both sides by National Forest System land except for 0.9 miles of private property on one bank. This segment is located in Page and Shenandoah counties. Segment A is a very small stream with low flows and a slow moving current. During periods of drought, some sections of Segment A become dry. The stream is free-flowing and the shoreline is entirely wooded. Crisman Hollow Road parallels the entire segment. Hiking trails parallel and cross the creek at several locations. Forest management practices are evident along several sections of this segment. Part of this segment is stocked by the VDGIF under the Virginia's put-and-take program. Sections are suitable for wading and trout fishing. Water quality is average.

Eligibility of Segment A by:

Scenic Value: Segment A of Passage Creek is a typical small mountain stream. It has no distinctive or outstanding features. The stream is small and shallow, following a gradual gradient. Sections go dry during periods of drought. The current is slow with uniform flow characteristics. Steep mountain slopes border the creek on both sides. From a visual standpoint, there are no outstanding rock formations, cliffs, or bluffs. Forest cover along the creek consists of mixed hardwood and pine. The understory consists of common species. A Class C-Minimal rating is assigned to the scenic values.

Recreational Value: Current recreation use consists of wading and trout fishing under the put-and-take program. Land based recreation activities that occur in the corridor include hiking and big and small game hunting. A Class C-Minimal rating is assigned to the recreational values.

Geologic Value: There are no outstanding geological formations within the corridor. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: This segment is stocked with trout by the VDGIF put-and-take program. The area provides habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are no known archeological sites in the corridor of this segment. Crisman Hollow Road is one of the many Forest roads constructed by the Civilian Conservation Corps (CCC). Camp Roosevelt is located just south of the end of this segment. A Class C-Minimal Rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment A of Passage Creek is not eligible for designation under the National Wild and Scenic Rivers Act. The segment does not have outstandingly remarkable values. For this reason, Segment A will not be studied further for designation under the National Wild and Scenic Rivers Act.

Segment B - From State Route 730 to Forest Boundary

This 21.3-mile segment is located in Shenandoah County. It runs the length of Fort Valley and is bordered entirely by private property. Route 678 parallels this segment of the stream for the entire length. A few roads cross the stream by means of low-water bridges. The corridor consists of agricultural and forest land with several houses and a few subdivisions. It is not considered navigable. Because most of the private property is posted, the stream is not accessible to the general public. The segment is suitable for fish and wildlife propagation, wading, and canoeing during periods of high water. Water quality is average. There are no impoundments.

Eligibility of Segment B by:

Scenic Value: Segment B of Passage Creek is typical of many streams on the George Washington National Forest. It is an attractive creek, but has no features that rate as distinctive or outstanding. This is a small stream that meanders through Fort Valley. The stream is shallow with occasional small pools. There are mountains on both sides of the broad, four-mile wide valley. The valley is gently rolling and supports a number of farms and houses. The forest cover is typical mixed hardwoods and some pine, with common understory species. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment B is limited to fishing and swimming by the adjacent landowners. There is some canoeing during periods of high water. The stream is not classified as navigable and use is controlled by the landowners. This reduces the recreational use of the stream. A Class B-Common rating is assigned to the recreational values.

Fish and Wildlife Values: This segment supports smallmouth bass and sunfish populations but is not considered a significant sport fishery due to its small size. The area provides habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Geologic Value: This segment has no outstanding visible geological formations. This segment of Passage Creek flows through Fort Valley which is about 22 miles long by four miles wide. There are not many natural entrances into the valley. Mountains are visible on both sides. A Class B-Common rating is assigned to the geologic values.

Historic and Cultural Values: Camp Roosevelt, the site of the first Civilian Conservation Corps camp in the nation, is located at the beginning of this segment. Caroline Furnace, an old iron furnace site, is also located near the beginning of this segment. Fort Valley derives its name from and has historical significance relating back to the Revolutionary War period. There are additional known historical sites in this corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of Passage Creek is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable historic and cultural values.

Classification Determination:

Because Segment B of Passage Creek is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 21.3 miles qualifies for inclusion in the system under the recreational classification. This determination results from the relatively large number of houses and farms located along the river.

Segment C - From Forest Boundary downstream to North Fork Shenandoah

This 6.9-mile segment flows through a narrow gorge located in Shenandoah County. It is bordered by Forest lands for 4.3 miles and by private land for 2.6 miles. Adjacent National Forest System land is used primarily for recreation and timber production. State Route 678, a two-lane paved road, parallels the stream through the gorge. One small dam exists between Forest land and the state fish hatchery. Private land bordering the creek is typically used for agriculture. There are some houses and other developments in the corridor. Elizabeth Furnace Recreation Area is a relatively large developed recreation site located on the creek on Forest land. The state has a fish hatchery in the corridor outside the Forest boundary. Most of the private property is posted. The segment on the Forest is stocked with trout under the state's put-and-take program. The segment is suitable for fish and wildlife propagation, wading, and canoeing during periods of high water. Water quality is average.

Eligibility of Segment C by:

Scenic Value: Segment C of Passage Creek is an attractive creek located within a narrow gorge. The gorge area is scenic and bordered by cliffs and rock formations that enhance the visual resource. The creek is shallow with occasional pools. Part of the stream has a fairly steep gradient and during storm periods, usually in the spring, the current is fast. The stream is bordered by steep mountain slopes as it passes through the gorge, then through rolling terrain before flowing into the Shenandoah River. Forest cover along the creek includes mixed hardwood and pine with common understory species. A Class-A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment C consists of trout fishing under the state's put-and-take program, wading, and swimming. During periods of high water, the section in the gorge is also used for canoeing and kayaking. The stream is not considered navigable. A small dam is located just outside the Forest boundary. Adjacent private lands are posted so public access is limited to the part of the creek that crosses the Forest. Elizabeth Furnace Recreation Area is located in the corridor of this segment and offers both camping and picnicking. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: This segment contains some outstanding cliffs and rock formations in the gorge area. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: The section on National Forest System land is stocked with trout under the state's put-and-take program. The creek also supports smallmouth bass and sunfish populations. A state fish hatchery is located within the corridor just outside the Forest. The area provides habitat for wildlife species common to the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: This segment of Passage Creek and its corridor contain several potentially significant historical sites. Elizabeth Furnace, an old iron furnace, is located within the corridor. The Elizabeth Furnace recreation area was constructed by the CCC. An old log cabin from the charcoal iron furnace era, a slave cemetery, and prehistoric sites are also located within the corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment C of Passage Creek is eligible for designation under the National Wild and Scenic Rivers Act. With the exception of a small dam located between the state fish hatchery and national forest land, it is free-flowing. As is stated in FSH 1909, Chapter 8.21b, "...the existence of low dams...at the time any river is proposed for inclusion...does not automatically disqualify it for designation...." Also, this segment of the creek has outstandingly remarkable scenic, recreational, geologic, historic, and cultural values.

Classification Determination:

Because Segment C of Passage Creek is eligible for designation, it is necessary to determine the classification that could result. According to the criteria in FSH 1909, Chapter 8, the entire 6.9 miles qualifies for inclusion in the system under the recreational classification. This classification is for several reasons, including the presence of the Elizabeth Furnace Recreation Area and a number of houses and farms along the creek.

ST. MARY'S RIVER

A total of 8.6 miles of St. Mary's River is considered in this evaluation. St. Mary's is divided into two segments for evaluation purposes. St. Mary's is described in this report from its headwaters west to its confluence with the South River. The first segment includes the headwaters down to where the river exits the St. Mary's Wilderness boundary. The second segment includes that portion from the St. Mary's Wilderness boundary to its confluence with the South River. National Forest System land along the upper reaches borders the St. Mary's on both sides for 4.60 miles

and on one side for 0.50 miles. St. Mary's is a small stream with low rates of flow except during major storm events. The upper segment, all on the Forest, is currently designated as a State Scenic River. This section is also within the St. Mary's Wilderness.

The stream is not classified as navigable. The water quality is average for the Blue Ridge Mountains. There is some disturbance as a result of floods outside the Forest boundary. A road parallels most of the portion on private property and there are some private developments. There are no impoundments. This stream is suitable for normal fish and wildlife propagation. There is trout fishing and wading in the St. Mary's.

Segment A - From the headwaters to the St. Mary's Wilderness boundary (4.6 miles).

Eligibility of Segment A by:

Scenic Value: There are rock formations and small waterfalls within this segment of the St. Mary's River. The stream is designated as a State Scenic River. A Class B-Common rating is assigned to scenic values.

Recreational Value: Current recreation use consists of fishing for brook trout, wading, bathing, hiking, and camping. Recreation use along the river is high. In addition, this segment is located within St. Mary's Wilderness and, as such, offers a unique recreation opportunity not available on most of the Forest. The stream is not large enough to permit canoeing and there is no record of such use. There is an old mining railroad grade that has been developed into a trail along a portion of the stream . A Class A-Distinctive rating is assigned to recreational values.

Geologic Values: Within the wilderness area, there are rock outcrops and small waterfalls. The river also flows through a small gorge. While these features add to the geological value of the river, they are not uncommon in the Blue Ridge Mountain area. A Class B-Common rating is assigned to the geologic values.

Fish and Wildlife Values: This stream contains native brook trout and a few wild rainbow trout. Segment A of St. Mary's River is a Featured Brook Trout Stream. Acid deposition has almost completely eliminated rainbow trout and brown trout. Several minnow species have been eliminated. If acid deposition continues to destroy the fishery, the value of the river from a fisheries standpoint will be reduced. The area provides habitat for wildlife species typical of the Forest. A Class A-Distinctive rating is assigned to the fish and wildlife values.

Historic and Cultural Values: An old mining railroad grade parallels the stream. There are known archeological sites in the corridor. There is evidence of iron ore washers in the stream channel. Since no systematic survey has been conducted in this corridor, a Class B - Common rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment A of St. Mary's River is eligible because it is free-flowing and has outstandingly remarkable recreational and fish and wildlife values.

Classification Determination:

Because St. Mary's River is eligible for designation, it is necessary to determine the classification that would result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 4.6 miles qualifies for inclusion in the system under the wild classification. This determination is based primarily on the fact that little or no man-made disturbances exist within the river corridor inside St. Mary's Wilderness.

Segment B - From the St. Mary's Wilderness Area boundary to the confluence with the South River (4 miles).

Eligibility of Segment B by:

Scenic Value: No outstanding features are present. The scenery is common for the area. There are some man-made intrusions along the stream. A Class B-Common rating is assigned to scenic values.

Recreational Value: Current recreation use consists of fishing for brook trout and some wading and bathing. The stream is not large enough to permit canoeing and there is no record of such use. A Class B-Common rating is assigned to recreational values.

Geologic Value: A Class B-Common rating is assigned to the geologic values.

Fish and Wildlife Values: This stream contains a few trout. The area provides habitat for wildlife species typical of the Forest. A Class C-Minimal rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are no known archeological sites in the corridor. However, since it is in the Blue Ridge Mountains, the potential for archeological sites is strong. A Class C-Minimal rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of St. Mary's River is not eligible for designation under the National Wild and Scenic Rivers Act because of the lack of outstandingly remarkable values. For this reason, Segment B of St. Mary's River will not be studied further for designation.

NORTH FORK SHENANDOAH RIVER

The section of the North Fork of the Shenandoah River evaluated here consists of a 39-mile segment between State Highway 55 at Strasburg and State Route 675 at the town of Edinburg. The segment is located in Shenandoah and Frederick counties. Of note, the segment of the North Fork Shenandoah River from Burnshire Bridge to the Route 55 crossing in Strasburg, Virginia, qualifies for inclusion in the state's scenic river system. Forest property borders the east side of the river at three locations for a total of 0.6 miles. Each of these sites consists of

steep bluffs and, as such, is not suitable for canoe access. Most of the river lies outside the Forest.

From a structural standpoint, there are two old power dams on the river and several low water bridges. Roads cross the river in four locations and additional roads end adjacent to the river. There is no developed trail access. The town of Woodstock obtains its water from the river. Water from the river is also used for irrigation of corn west of Edinburg. The stream is shallow between pools. Overall, the river follows a gradual gradient and the flow is fairly slow with uniform flow characteristics. Development along the shoreline includes farm land, subdivisions, and vacation cabins. Forest management practices are also evident at certain points along the river. The river is suitable for fish and wildlife propagation, wading, canoeing, and other uses. Water quality is average. The segment is considered navigable. The state has marked the segment from New Market to Riverton for further study.

Eligibility of the 39-mile Segment by:

Scenic Value: The evaluation segment includes the "Seven Bends" of the Shenandoah River, an interesting and scenic area where the river makes a series of sharp bends, at times almost turning back on itself. The surrounding valley is gently rolling with the Massanutten Ridge rising steeply on the east side. There are several shale bluffs evident from the river. The adjacent forest cover is typical mixed hardwood and pine with common understory species. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current recreation use is limited due to the lack of public access. There is fishing, canoeing and swimming, mostly by adjacent landowners and guests. The river is considered to be navigable. A Class B-Common rating is assigned to the recreational values.

Geologic Value: This segment contains the "Seven Bends," a significant physiographic/geographic feature. A few shale bluffs are located along the river. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: This segment supports a sport fishery of smallmouth bass, sunfish, and catfish. The smallmouth bass fishing is not as well known or as good as in other rivers in the state. The area provides habitat for wildlife species typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric sites along the river. Historic sites are plentiful as the river meanders through the historic Shenandoah Valley. There are several old houses within the corridor. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

This 39-mile section of the North Fork of the Shenandoah River is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable scenic, geologic, historic, and cultural values.

Classification Determination:

Because the North Fork Shenandoah River is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 39 miles qualifies for inclusion in the system under the recreational classification. This determination is based on the large number of houses and other developments located within the corridor.

SOUTH FORK SHENANDOAH RIVER

This evaluation covers 36 miles of the South Fork of the Shenandoah River. Because the river and the surrounding corridor are so physically similar, the entire 36 miles will be studied as one segment. The segment begins at the Bixler Bridge located on Virginia secondary road 675, approximately 3 miles northwest of Luray. It ends at Karo Landing, approximately 6 miles south of the town of Front Royal. The evaluation segment is located within Page and Warren counties and is considered navigable. Forest property borders the west side of the river for 9.5 miles and borders both sides for 0.4 miles. Two low water bridges cross this segment. The area under consideration has good public access. Land uses along the river include agriculture, summer homes, and year-round residences. Evidence of human activity is abundant and increasing.

The river is suitable for fish and wildlife propagation, wading, canoeing, and other uses. Water quality is average. Portions of roads parallel the river and are evident from the river. A railroad is evident from the river in two locations. Page Power Company, now Potomac Edison, acquired flowage easements for a proposed dam at Overall in 1930. These easements are still in effect even though the dam has never been constructed. The state has recognized the segment of the South Fork from Goods Mill to Overall for inclusion in the Virginia Scenic Rivers System.

Eligibility of a 36-mile Segment by:

Scenic Value: The South Fork of Shenandoah River is typical of the larger rivers in and around the Forest. It is an attractive river. A couple of cliffs along the river add to the scenery. The river meanders over a gradual gradient from pool to pool. There are a few locations where the gradient increases and the flow becomes faster. The surrounding valley is gently rolling with mountains in the background. Forest cover consists of mixed hardwoods and pine with common understory species. There are numerous summer camps along the river. All in all, there are no features that rate as distinctive or outstanding. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Current recreation use consists of fishing, canoeing, tubing, swimming, and hunting. There are canoe rental businesses at Bealers Ferry and Bentonville. There are also two canoe camps and a family campground at Hazard Mill that are accessible from the river. Several canoe launch sites are available to the public and canoe use is high. The river is considered navigable. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: This river and its corridor contain no unusual rock outcroppings or other geological formations. There are a couple of small cliffs and several ledges that cross the channel. A Class B- Common rating is assigned to the geologic values.

Fish and Wildlife Values: This river supports a top quality smallmouth bass population. Catfish and sunfish are also important species in the Shenandoah River. The area provides habitat for wildlife species typical of the Forest. A Class A-Distinctive rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are several known archeological sites within the corridor. The area was settled in the 1700s and there are several old houses along the river. Additionally, the river was used to carry pig iron and farm products before the coming of the railroads. An Indian fish weir can still be seen at one location on the river. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

The South Fork of the Shenandoah River is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable recreation, fish and wildlife, and historic and cultural values.

Classification Determination:

Because the South Fork of the Shenandoah River is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 36 miles qualifies for inclusion in the system under the recreational classification. This potential classification is based on the large number of houses and other developments located within the corridor.

TYE RIVER

The Tye River is described in this evaluation from the town of Nash to its headwaters. Two segments of the Tye River, totaling 13 miles, are reviewed in this evaluation. These segments include those portions of the Tye River and the South Fork of the Tye River that are west of and within the George Washington National Forest boundary. East and south of the boundary, the Tye River was heavily disturbed by the floods of 1969, 1972, and 1985. Forest land ownership along this 13-mile segment of the river includes 1.00 mile on both sides of the stream (3 locations) and 0.2 miles on one side (4 locations). The river is not classified as navigable. The state did not find this stream worthy of inclusion in the Virginia Scenic River System.

Segment A - From Nash to Proclamation Boundary (8.3 miles)

This 8.3-mile segment is located within Nelson County. The majority of land bordering this segment is privately owned. Forest land borders both sides of the stream in two locations for approximately 0.5 miles The river is medium in size and except during storm periods, the rate of flow is slow. There are no impoundments along this section. State Highway 56 parallels and is visible along the entire segment from Nash to the boundary. The Appalachian Trail crosses the stream via a swinging foot bridge. There are several houses located within the corridor along this section. The stream and surrounding floodplain were heavily damaged during the floods of 1969, 1972, and 1985. Channelization of the river is prevalent along this segment. Lands bordering the river include a mixture of undeveloped forest and agricultural land. Some of the adjacent private land is posted. A section of this segment is stocked with trout under the state's put-and-take program.

Eligibility of Segment A by:

Scenic Value: Segment A of the Tye River is typical of many rivers on the George Washington National Forest. It is an attractive river but has no distinctive or outstanding features. The stream is shallow with some small pools. For the most part, it has a gradual gradient so the rate of flow is fairly slow and uniform except during storm periods. Steep mountains rise above the river on both sides. No rock bluffs are evident. The forest cover is typical mixed hardwood and pine with common understory species. This segment has been heavily channelized. State Highway 56 is adjacent to this segment and several houses exist within the river corridor. A Class B-Common rating is assigned to the scenic values.

Recreational Value: Current recreation use of Segment A consists of fishing (put-and-take) and some canoeing and kayak use during early spring. There is also some swimming by adjacent landowners. This segment is not considered navigable. Public access for recreation purposes is limited. The Appalachian Trail crosses this segment by means of a swinging foot bridge. A Class B-Common rating is assigned to the recreational values.

Geologic Value: This segment contains no unusual geological formations. The corridor consists of farm land and forest typical of the George Washington National Forest. A Class C-Minimal rating is assigned to the geologic values.

Fish and Wildlife Values: A large portion of this segment is stocked with trout under the state's put-and-take system. The segment provides habitat for wildlife species typical of the Forest. A Class B-Common Rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known prehistoric and historic sites along this segment. Since no systematic survey has been conducted along this section to determine their significance, a Class B-Common rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment A of the Tye River is not eligible for designation under the National Wild and Scenic Rivers Act. It has been channelized in many locations and does not have any outstandingly remarkable scenic, recreational, geologic, fish and wildlife or historic and cultural values. For these reasons, Segment A will not be studied further for designation under the National Wild and Scenic Rivers Act.

Segment B - From headwaters to Nash (4.7 miles)

This 4.7-mile segment is located within Nelson County. The majority of lands bordering this segment of the river are privately owned. Forest property touches this segment at several locations and totals approximately 0.70 miles. This segment of the river ranges in size from small to medium. The steep gradient along this segment results in small rapids, drop-offs, and cascades. Portions of the segment are paralleled by State Highway 56. The Crabtree Falls developed recreation site is located within the corridor where Crabtree Creek enters the river. The site consists of paved parking facilities, restrooms, and an observation trail to the top of Crabtree Falls.

While the majority of the shoreline is privately owned, the shoreline remains mostly undeveloped. With few exceptions, the adjacent private property is posted. Forestry and agricultural practices occur and are evident within the river corridor. The segment is suitable for fish and wildlife propagation, canoeing, and other water-based recreation uses. Water quality is average.

Eligibility of Segment B by:

Scenic Value: Segment B of the Tye River is attractive. This segment is characterized by swift water, rapids, and cascades. The river bed is littered with large boulders that add variety to the visual resource. The upper portion of this segment flows through a gorge that contains waterfalls. The stream valley is relatively narrow and is bordered on both sides by steep mountains. Forest cover along the river consists of mixed hardwoods and pine and common understory species. A Class A-Distinctive rating is assigned to the scenic values.

Recreational Value: Current water based recreation use consists of fishing and white water canoeing when water levels are sufficient. There is an established wild trout population within this segment. Many people hike this segment to view the scenery. A Class A-Distinctive rating is assigned to the recreational values.

Geologic Value: The gorge area has some outstanding rock outcroppings. Scattered along the streambed are numerous boulders and rocks. A Class A-Distinctive rating is assigned to the geologic values.

Fish and Wildlife Values: This segment supports a wild trout fishery. The area provides habitat for wildlife species typical of the Forest. A Class B-Common rating is assigned to the fish and wildlife values.

Historic and Cultural Values: There are known archeological sites within this segment, including at least one potentially significant prehistoric site. A Class A-Distinctive rating is assigned to the historic and cultural values.

Eligibility Determination:

Segment B of the Tye River is eligible for designation under the National Wild and Scenic Rivers Act. It is free-flowing and has outstandingly remarkable scenic, recreational, geologic, and historic and cultural values.

Classification Determination:

Because Segment B of the Tye River is eligible for designation, it is necessary to determine the classification that could result from designation. According to the criteria in FSH 1909, Chapter 8, the entire 4.7 miles qualifies for inclusion in the system under the scenic classification.

TABLE D-1. SUMMARY OF RIVER ELIGIBILITY DETERMINATIONS

RIVER	COUNTY AND STATE	LENGTH (Miles)	ELIGIBLE	POTENTIAL CLASSIFICATION
BACK CREEK				
Segment A	Bath, VA	5.59	YES	Scenic
Segment B	Bath, VA	9.96	YES	Recreational
Segment C	Highland, VA	17.24	NO	Recreational
BULLPASTURE RIVER				
Segment A	Bath/High, VA	3.00	YES	Scenic
Segment B	Highland, VA	15.00	NO	
CEDAR CREEK	Shen/Fred, VA	25.00	YES	Scenic
COWPASTURE RIVER				
Segment A	Alleghany, VA	16.00	YES	Recreational
Segment B	Bath, VA	48.11	YES	Recreational
Segment C	Bath/High, VA	6.00	NO	
Segment D	Highland, VA	8.00	NO	
DRY RIVER	Rockingham, VA	22.00	NO	
IRISH CREEK	Rockbridge, VA	8.50	NO	
JACKSON RIVER				
Segment A	Bath/High, VA	14.30	NO	
Segment B	Bath, VA	7.06	YES	Scenic
Segment C	Bath, VA	8.33	YES	Scenic
Segment D	Alleghany, VA	13.00	YES	Recreational
NORTH RIVER				
Segment A	Augusta, VA	9.00	NO	
Segment B	Augusta, VA	5.00	YES	Scenic
Segment C	Augusta, VA	2.00	NO	
PASSAGE CREEK				
Segment A	Shenandoah, VA	6.30	NO	
Segment B	Shenandoah, VA	21.30	YES	Recreational
Segment C	Shenandoah, VA	6.90	YES	Recreational
ST. MARY'S RIVER				
Segment A	Augusta, VA	4.60	YES	Wild
Segment B	Augusta, VA	4.00	NO	
NORTH FORK SHENANDOAH	Shen/Fred, VA	39.00	YES	Recreational
SOUTH FORK SHENANDOAH	Page/Warren VA	36.00	YES	Recreational
TYE RIVER				
Segment A	Nelson, VA	8.30	NO	
Segment B	Nelson, VA	4.70	YES	Scenic

TABLE D-2.NATIONAL FOREST OWNERSHIP BY RIVER

RIVER	LENGTH (Miles)	ONE BANK (Miles)	BOTH BANKS (Miles)
BACK CREEK			
Segment A	5.59	0.01	2.35
Segment B	9.96	1.51	0.00
Segment C	17.24	0.00	0.00
BULLPASTURE RIVER	18.00	0.00	0.00
CEDAR CREEK	25.00	0.10	2.65
COWPASTURE RIVER			
Segment A	16.00	3.00	0.00
Segment B	48.11	4.33	4.28
Segment C	6.00	0.00	0.00
Segment D	8.00	0.00	0.00
DRY RIVER	22.00	0.00	0.00
IRISH CREEK	8.50	0.00	5.50
JACKSON RIVER			
Segment A	14.30	0.66	0.00
Segment B	7.06	0.42	6.62
Segment C	8.33	0.27	0.00
Segment D	13.00	0.25	0.00
NORTH RIVER		0.00	14.50
Segment A	9.00	To be determined	To be determined
Segment B	5.00	To be determined	To be determined
Segment C	2.00	To be determined	To be determined
PASSAGE CREEK			
Segment A	6.30	0.90	5.40
Segment B	21.30	0.00	0.00
Segment C	6.90	0.00	4.30
ST. MARY'S RIVER			
Segment A	4.60	To be determined	To be determined
Segment B	4.00	To be determined	To be determined
NORTH FORK SHENANDOAH	39.00	0.60	0.00
SOUTH FORK SHENANDOAH	36.00	9.50	0.40
TYE RIVER			
Segment A	8.30	0.00	0.50
Segment B	4.70	0.20	0.50

TABLE D-3.LEAD AGENCY IN CONDUCTING SUITABILITY STUDIES

AGENCY	RIVER SEGMENT
Virginia Department of Conservation	Bullpasture River - Segment A
and Recreation	Cedar Creek
	Cowpasture River - Segments A and B
	Jackson River - Segments C and D
	Passage Creek - Segment B
	South Fork Shenandoah
	North Fork Shenandoah
	Tye River - Segment B
USDA Forest Service	Jackson River - Segment B
	North River - Segment B
	St. Mary's River
USDA Forest Service/Virginia	Back Creek - Segments A and B
Department of Conservation and	Passage Creek - Segment C
Recreation joint study	

III. THE PROCESS: HOW RIVERS ARE EVALUATED FOR WILD AND SCENIC DESIGNATION

The National Wild and Scenic River designation process is a three-step process. The first step is the eligibility study. If a river is determined to be eligible, step two determines the potential classification of the river. The three potential classifications are wild, scenic, or recreational. Upon completion of steps one and two, step three assesses the suitability of the river for inclusion in the national system. The criteria associated with each step are discussed on the following pages.

Eligibility Criteria:

The Wild and Scenic Rivers Act sets no specific requirements concerning the length of a river segment being considered, but states that a river segment is of sufficient length if, when managed as a wild, scenic, or recreational river area, the "outstandingly remarkable" values are protected.

The determination of whether a river or river segment contains outstandingly remarkable values is, for the most part, a judgement based on the qualities of a river relative to qualities of other rivers in the Forest and on adjoining private and state lands.

Rivers eligible for wild and scenic designation must be free-flowing and possess, with their adjoining land, one or more outstandingly remarkable values. The value categories are SCENIC, RECREATIONAL, GEOLOGIC, FISH AND WILDLIFE, HISTORIC, CULTURAL.

Within each value category, rivers are rated as either:

CLASS A - DISTINCTIVE with outstanding qualities when compared to other rivers;
CLASS B - COMMON with qualities common to most rivers;
CLASS C - MINIMAL with few or no outstanding qualities.

Scenic Values, for instance, that are rated:

Class A-Distinctive indicate complex landforms with unusual or outstanding topographic features. Rock features, when present, stand out on the landform and are unusual or outstanding in size, color, or location. Forest cover is continuous or if broken, has a high degree of vegetative patterns and an unusual or outstanding diversity in plant species. Large or old-growth timber may be present. The stream volume ranges from medium to high with a variety of flow characteristics.

Class B-Common indicate some variety in the terrain, but landform features typical of the area. Rock features, when present, are obvious, but do not stand out and have no unusual characteristics. Forest cover is continuous with some variety in vegetative patterns and a common diversity in plant species. The stream volume ranges from medium to low with some variety in flow characteristics.

Class C-Minimal indicate terrain with little variety in slope, dissection, or features. Rock features are generally lacking. Forest cover is continuous with little diversity in the number or pattern of plant species. The stream typically has little or no variety in flow characteristics.

Recreational Values that are rated:

Class A-Distinctive indicate rivers and surrounding lands that provide both water-based and land-based activities and recreation experiences unique to a stream or to a limited number of

streams, or which can occur only because of the character of the stream. The river might contain a high quality sport fishery.

Class B-Common indicate rivers and surrounding lands that provide water-oriented activities typical of most streams in the area. Activities include fishing, swimming, boating (motorized and non-motorized), and waterfowl hunting.

Class C-Minimal indicate stream size, flow or other characteristics that limit opportunities for water-based and land-based recreation.

Geological Values that are rated:

Class A-Distinctive indicate river corridors that clearly display significant or unusual geologic features. Also included are rivers that clearly expose geologic formations which are visible in few other sites. The amount of exposed rock is significant in that it provides excellent opportunities for geologic study.

Class B-Common indicate geomorphic features and formations that are typical of those commonly found in the area. There is some opportunities for geologic study.

Class C-Minimal indicate rivers with few or no exposed rock formations and no significant geologic features.

Fish and Wildlife Values that are rated:

Class A-Distinctive indicate resident fish and wildlife populations that occur only because of the character of the stream. This category includes streams identified as habitat for federally-listed threatened and endangered species.

Class B-Common indicate resident fish and wildlife populations that are common to the area.

Class C-Minimal indicate stream characteristics that limit the number and type of fish and wildlife species present. Included here are streams stocked by the states on a put-and-take basis.

Historical and Cultural Values that are rated:

Class A-Distinctive indicate river corridors that contain known sites of local, state, or national significance and meet criteria for the National Register of Historic Places.

Class B-Common indicate sites that are similar to sites in other locations and that contain limited scientific information. Some sites may have been disturbed prior to scientific investigation. Also included are known sites that have not been evaluated.

Class C-Minimal indicate sites that are not of local, state, or national significance and do not meet criteria for the National Register of Historic Places.

Classification Criteria:

The Act (Section 2(b)) states that "if included (in the National Wild and Scenic Rivers System, each river) shall be classified, designated, and administered" as either a WILD, a SCENIC, or a RECREATIONAL river area. The classification selected is based on the conditions of the river and the adjacent land at the time of the evaluation. A river may be divided into segments by these classifications, based on current conditions.

The criteria to be met under each classification are: WATER RESOURCES DEVELOPMENT, SHORELINE DEVELOPMENT, ACCESSIBILITY, AND WATER QUALITY. These criteria are from the revised guidelines for Wild and Scenic Rivers developed jointly by the departments of Interior and Agriculture (Federal Register, Vol. 47, No. 173, September 7, 1982).

Classification as a WILD River requires under:

Water Resources Development -- a river that is free of impoundments.

Shoreline Development -- a shoreline that is essentially primitive with little or no evidence of human activity. However, the presence of a few inconspicuous structures is acceptable. There is to be little or no evidence of past timber harvests and no ongoing timber harvests.

Accessibility -- a river area that is generally inaccessible except by trail. There are to be no roads, railroads, or other provisions for vehicular travel. However, a few existing roads leading to the boundary of the river corridor are acceptable.

Water Quality -- a river that meets or exceeds federally-approved state standards for aesthetics, propagation of fish and wildlife normally adapted to the river, and primary contact recreation.

Classification as a SCENIC River requires under:

Water Resources Development -- a river that is free of impoundments.

Shoreline Development -- a shoreline that is largely primitive and undeveloped with no substantial evidence of human activity. However, the presence of small communities, dispersed dwellings or farm structures is acceptable. Evidence of past or ongoing timber harvests is acceptable if the Forest appears natural from the riverbank.

Accessibility -- a river area that may be accessible in places by roads. Roads may occasionally reach or bridge the river. The existence of short stretches of conspicuous or longer stretches of inconspicuous roads or railroads is acceptable.

Water Quality -- no criteria for water quality is prescribed in the Act. Poor water quality does not preclude classification provided a water quality improvement plan exists or is being developed.

Classification as a RECREATIONAL River requires under:

Water Resources Development -- a river that may have some existing impoundments or diversions. The existence of low dams, diversions, or other modifications is acceptable if the waterway remains generally natural and riverine in appearance.

Shoreline Development -- a shoreline that may have some development with substantial evidence of human activity. The presence of extensive residential developments and a few commercial structures is acceptable. Lands may have been developed for a full range of agricultural or forestry uses and may show evidence of past or ongoing timber harvests.

Accessibility -- a river area readily accessible by roads or railroads. Parallel roads or railroads on one or both banks and bridge crossings are acceptable.

Water Quality -- no criteria for water quality is prescribed in the Act. Poor water quality does not preclude classification provided a water quality improvement plan exists or is being developed.

Suitability Criteria:

Determinations of suitability for inclusion in the National Wild and Scenic Rivers System are made by state agencies, the Forest Service, and other federal agencies. Criteria that determine suitability include the following:

-the current status of land ownership and use in the area;

-the reasonably foreseeable uses of the land and water that would be enhanced, foreclosed, or curtailed if the area were included in the National Wild and Scenic Rivers System;

-the estimated cost of acquisition of land or of an interest in the land if the river area cannot be administered as a wild and scenic river without acquisition or easement as a means of control;

-the public, state, and local government interest in and potential involvement in management and administration;

-the amount and status of outstanding minerals;

-other issues and concerns that surface during scoping for public input.

Protection Under the Forest Plan:

The segments of rivers within Forest Service boundaries that are determined eligible for designation are managed in a manner that protects the values that made them eligible. The land adjacent to the river segments is afforded the same protection. The protection lasts until a final suitability determination is made by the responsible agency. Direction for management is in the standards for the Wild and Scenic River Management Prescriptions.

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U.S. Department of Agriculture
Forest Service
Southern Region

Ecosystem Diversity Report

George Washington National Forest

April 2011

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1.0 Introduction

The ecological sustainability framework used to support Forest Plan revision for the George Washington National Forest (GWNF) is built on a foundation of ecosystem diversity. By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should be able to maintain and improve ecosystem diversity and also provide for the needs of diverse plant and animal species on the forest.

This Ecosystem Diversity Report describes the analysis process used to identify, evaluate, and develop guidance for sustaining ecological diversity. This report, and the Ecological Sustainability Evaluation database information from which it was derived, not only provide the overall framework for many of the plan components and the systems-based direction in the revised Forest Plan, but they are also expected to be an important source of data and guidance for sustaining native ecosystems and species when implementing the Plan.

The overall goal for ecological sustainability is to sustain native ecological systems and support diversity of native plant and animal species. Ecosystem diversity is defined as the variety and relative extent of ecosystem types including their composition, structure, and processes. The major characteristics of forest-wide ecosystem diversity and descriptions of the 20 ecological systems found across the GWNF are presented in this Ecosystem Diversity Report.

While most plant and animal species needs are expected to be met by sustaining ecosystem diversity, a corresponding species-specific analysis was also conducted to evaluate whether additional provisions were needed for federally listed species, sensitive species and locally rare species. This species-specific sustainability analysis is described in more detail in the companion document to this report entitled Species Diversity Report. These two reports focus on the terrestrial environment. The analysis of the aquatic systems is covered in the Aquatic Ecological Sustainability Analysis.

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2.0 Ecological Sustainability Evaluation Process

The ecological sustainability framework for the GWNF was built around principles developed by The Nature Conservancy (TNC) in their Conservation Action Planning Workbook (TNC 2005). This basic structure was chosen because it is conceptually simple, flexible, and able to encompass guidance from the Planning Rule and Forest Service Manual and Handbook. It was also expected that its use would enhance opportunities for collaboration with TNC and other conservation partners in the future. Although built on the TNC structure, this document generally uses Forest Service terminology rather than TNC terms to refer to parts of the framework. Table 1 provides a crosswalk between relevant Forest Service and TNC terminology.

Table 1. Crosswalk between conservation planning terms used in Forest Service Planning direction and The Nature Conservancy's Conservation Action Planning Workbook (2005).

Forest Service Terms	The Nature Conservancy Terms
Native ecological systems, Threatened and endangered species, Sensitive species, locally rare species and other species of management concern	Conservation Targets
Characteristics of ecosystem diversity (key attributes), Key ecological or habitat attributes for species or species groups	Key Ecological Attributes
Indicators	Indicators
Indicator Ratings	Indicator Ratings
Strategies (plan components)	Strategies

The Forest Service developed a relational database, the Ecological Sustainability Evaluation (ESE) tool, based on the structure of the TNC planning tool. The ESE tool served as the primary process record for ecological sustainability analysis. It included documentation of scientific and other sources consulted, uncertainties encountered, and strategic choices made during development of the database. In addition, the tool documented the many relationships among parts of the framework. For example, species were often related to one or more characteristics of ecosystems, and a given plan component frequently contributed to multiple ecological systems or species.

The following steps were used to build an ecological sustainability framework, with each step documented within the ESE tool. Although these steps are presented sequentially, the process required much iteration.

1. Identify and define ecological systems

To define terrestrial ecosystem diversity, all terrestrial ecological systems on the GWNF were identified using NatureServe's International Ecological Classification Standards (NatureServe 2004). Each system was defined in terms of existing Forest Service forest types and in terms of the LANDFIRE Vegetation Dynamic Models. Current acreage of each system was calculated

using Forest Service GIS data. All identified terrestrial ecological systems were included in the ecological sustainability framework. These systems were also crosswalked with the Virginia Department of Conservation and Recreation Natural Heritage Program Vegetation Community types. The framework for diversity of aquatic ecological systems is described in the Aquatic Ecological Sustainability Analysis.

2. Identify species

To assess species diversity, a comprehensive list of plant and animal species was compiled by combining species lists from a variety of sources. These sources included federally-listed threatened and endangered (T&E) species obtained from the U.S. Fish and Wildlife Service; species that are tracked by the Virginia Department of Conservation and Recreation Natural Heritage Program and the West Virginia Department of Natural Resources; species identified in the Virginia and West Virginia State Comprehensive Wildlife Conservation Strategies as species of conservation concern: the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service; and the Regional Forester's list of sensitive species for the Southern Region. Species were then screened for inclusion in the framework. The criteria and process for identifying, screening and grouping species are detailed in the Species Diversity Report.

3. Identify and define characteristics of ecosystem diversity and related performance measures

To identify key characteristics and performance measures for terrestrial ecological systems, Forest Service biologists reviewed information in NatureServe, LANDFIRE, Virginia Department of Conservation and Recreation Natural Heritage Program community types, and other information.

4. Link species to the ecological systems and identify any additional needs of species

Species were then linked to terrestrial ecological systems. Where useful, species were grouped before linking them to systems. Where ecological conditions for these species were not covered by the ecosystem diversity framework, additional characteristics, performance measures, and rating criteria were added to the framework to cover these needs. All species have at least some of their needs covered by ecosystem diversity, but some species required additional plan components based on their major limiting factors. The ways in which individual species needs were addressed by ecosystem diversity components and additional Plan provisions are described in the Species Diversity Report.

5. Assess current condition of performance measures

Current values and ratings of all performance measures were estimated using a variety of methods. Many current values were derived through analysis of existing GIS databases. Assumptions and methods for determining current values and ratings are recorded in the ESE tool.

6. Develop Forest Plan components

In this step, Forest Plan components were proposed that would be expected to provide for characteristics of ecosystem diversity and ecological conditions for species. This Plan direction was then linked with characteristics and conditions within the ESE tool. In some cases, we identified where relevant provisions are made outside of the Forest Plan through other current

requirements and processes. We ensured that all elements of the framework were addressed by appropriate management direction.

This report serves as a description of background, current status, and desired conditions for ecological systems on the GWNF. Current conditions for ecosystem characteristics reported here are based on a "snapshot in time." Conditions on the GWNF are constantly changing and new techniques improve how data can be used to measure progress. Ecosystem characteristics provide support for species diversity, and this report should be used in conjunction with the Species Diversity Report to obtain an accurate picture of ecological diversity on the GWNF.

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3.0 Ecological Systems

3.1 Background and Distribution of Ecosystems

The GWNF is interspersed with tracts of private and other publicly administered lands. National forest lands are significant from an ecological perspective in being relatively large parcels of vegetated and undeveloped lands with focused management goals. National forest lands contain a range of habitats and natural features that support a variety of locally rare species. These aspects plus the continued loss of forested land to developed uses on private lands is likely to make national forest lands even more important in the future for supporting ecological diversity.

Table 2 lists the 20 ecological systems which were identified for the GWNF. Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. These systems have similar potential and opportunities for management. Ecosystems are specifically defined as a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. The ecological systems for the GWNF represent both major and rare community types. Many of our rare communities are currently not completely mapped or inventoried; however they are important components for sustaining ecological and species diversity.

These ecological systems are fully described at NatureServe Explorer at www.natureserve.org/explorer/. The descriptions of structure and disturbance regimes were derived from LANDFIRE (www.landfire.gov/). As discussed previously, these systems can also be related to the communities described by the Virginia Natural Heritage Program.Descriptions of the systems identified and described by the Virginia Department of Conservation and Recreation Natural Heritage Program (VADNH) are found in their online edition of The Natural Communities of Virginia Classification of Ecological Community Groups Second Approximation (Version 2.3) found at http://www.dcr.virginia.gov/natural_heritage/ncintro.shtml.

Table 2. Distribution of ecological systems on the George Washington National Forest.

Ecological System	Associated VA Natural Heritage Community Types				
Central and Southern Appalachian Spruce-Fir Forest	Spruce and Fir Forests				
Appalachian (Hemlock)-Northern Hardwood Forest	Central Appalachian Northern Hardwood Forests				
Southern and Central Appalachian Cove Forest	Rich Cove and Slope Forests	Eastern Hemlock-Hardwood Forests	Acidic Cove Forests	High-Elevation Cove Forests	
Northeastern Interior Dry-Mesic Oak Forest	Eastern White Pine-Hardwood Forests	Acidic Oak-Hickory Forests	Dry-Mesic Calcareous Forests	Basic Oak-Hickory Forests	Basic Mesic Forests
Northeastern Interior Dry-Mesic Oak Forest	Montane Dry Calcareous Forests and Woodlands	Mountain/Piedmont Basic Woodlands			
Central and Southern Appalachian Montane Oak Forest	High-Elevation Boulderfield Forests and Woodlands	Northern Red Oak Forests	Montane Mixed Oak and Oak-Hickory Forests		
Central Appalachian Dry Oak-Pine Forest	Oak/Heath Forests				
Southern Appalachian Montane Pine Forest and Woodland					
Central Appalachian Pine-Oak Rocky Woodland	Pine-Oak/Heath Woodlands	Montane/Piedmont Acidic Woodlands	Low-Elevation Boulderfield Forests		
Southern and Central Appalachian Mafic Glade and Barrens					
Central Appalachian Alkaline Glade and Woodland					
Appalachian Shale Barrens	Central Appalachian Shale Barrens				
North-Central Appalachian Circumneutral Cliff and Talus	Northern White-Cedar Slope Forests	Low-Elevation Basic Outcrop Barrens	Mountain/Piedmont Calcareous Cliffs		
North-Central Appalachian Acidic Cliff and Talus	High-Elevation Outcrop	Low-Elevation Acidic	Mountain/Piedmont Acidic Cliffs	Lichen/Bryophyte Boulderfields	

Ecological System	Associated VA Natural Heritage Community Types				
	Barrens	Outcrop Barrens			
Central Appalachian Floodplain	Piedmont/Mountain Floodplain Forests	Piedmont/Mountain Alluvial Forests			
Central Appalachian Riparian	Sand/Gravel/ Mud Bars and Shores	Rocky Bars and Shores	Semipermanent Impoundments	Spray Cliffs	Montane Woodland Seeps
Central Interior Highlands and Appalachian Sinkhole and Depression Pond	Montane Depression Wetlands				
Southern and Central Appalachian Bog and Fen	Appalachian Bogs				
North-Central Appalachian Acidic Swamp	Montane/Piedmont Acid Seepage Swamps	High-Elevation Seepage Swamps	Piedmont/Mountain Swamp Forests		
North-Central Appalachian Seepage Fen	Montane/Piedmont Basic Seepage Swamps	Calcareous Fens and Seeps	Calcareous Spring Marshes and Muck Fens	Mafic Fen and Seeps	Wet Prairies and Prairie Fens
Caves and Karstlands					

As we developed the ecosystem diversity analysis, we identified that many of the ecological systems had similar key attributes, indicators, species associates and resulting forest plan components. For purposes of analysis we combined the systems into Ecological System Groups to use in the the following ESE Tool:

Table 3. Ecological Sustainability Evaluation Tool Ecological Systems

Ecological System Groups	Ecological System
Spruce Forest	Central and Southern Appalachian Spruce-Fir Forest
Northern Hardwood Forest	Appalachian (Hemlock)-Northern Hardwood Forest
Cove Forest	Southern and Central Appalachian Cove Forest
Oak Forests and Woodlands	Northeastern Interior Dry-Mesic Oak Forest
	Central and Southern Appalachian Montane Oak Forest
	Central Appalachian Dry Oak-Pine Forest
Pine Forests and Woodlands	Southern Appalachian Montane Pine Forest and Woodland
	Central Appalachian Pine-Oak Rocky Woodland
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Southern and Central Appalachian Mafic Glade and Barrens
	Central Appalachian Alkaline Glade and Woodland
Cliff, Talus and Shale Barrens	North-Central Appalachian Circumneutral Cliff and Talus
	North-Central Appalachian Acidic Cliff and Talus
	Appalachian Shale Barrens
	Central Appalachian Floodplain

Ecological System Groups	Ecological System
Floodplains, Wetlands, and Riparian Areas	Central Appalachian Riparian
	Central Interior Highlands and Appalachian Sinkhole and Depression Pond
	Southern and Central Appalachian Bog and Fen
	North-Central Appalachian Acidic Swamp
	North-Central Appalachian Seepage Fen
Caves and Karstlands	Caves and Karstlands

3.2 Descriptions of the Ecological Systems

The following information on descriptions of the ecological systems is derived largely from NatureServe.

3.2.1 Spruce Forest: Central and Southern Appalachian Spruce-Fir Forest

Background

Environment: This system occurs at elevations typically above 1300 m (4300 feet), up to the highest peaks. It occurs on most of the landforms that are present in this elevational range; most sites are strongly exposed and convex in shape. Elevation and orographic effects make the climate cool and wet, with heavy moisture input from fog as well as high rainfall. Strong winds, extreme cold, rime ice, and other extreme weather are periodically important. Concentration of air pollutants has been implicated as an important anthropogenic stress in recent years. Soils are generally very rocky, with the matrix ranging from well-weathered parent material to organic deposits over boulders. Soils may be saturated for long periods from a combination of precipitation and seepage. Any kind of bedrock may be present, but most sites have erosion-resistant felsic igneous or metamorphic rocks. **Vegetation:** Vegetation consists primarily of forests dominated by Picea rubens or occasionally by Sorbus americana. Betula alleghaniensis, Tsuga canadensis, and Quercus rubra are the only other locally common canopy species. Acer rubrum, Betula lenta, Magnolia acuminata, and Magnolia fraseri may occur. Lower strata are most typically dominated by mosses, ferns or forbs, but a few associations have dense shrub layers of Rhododendron catawbiense, Rhododendron maximum, or Vaccinium erythrocarpum. **Dynamics:** This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase generation on a fine scale. Despite the extreme climate, Picea rubens is long-lived (300-400 years). Both Picea and Abies seedlings are shade-tolerant, and advanced regeneration is important in stand dynamics. Natural disturbances include lightning fire, debris avalanches, wind events, and ice storms. Occasional extreme wind events disturb larger patches on the most exposed slopes. Fire is a very rare event under natural conditions, due to the wetness and limited flammability of the undergrowth, and return intervals have been estimated between 500-1000 years. If fires occur, they are likely to be catastrophic, because few of the species are at all fire-tolerant. Anthropogenic disturbances and stresses, beyond the effects of logging, have had major effects on dynamics in these systems in recent decades. Stress caused by concentrated air pollutants on the mountain tops has been suggested as a cause of observed growth declines in Picea rubens. Earlier, unnatural fires fueled by logging slash turned large expanses of this system into grass-shrub-hardwood scrub (e.g., Dolly Sods) that has not recovered to conifer dominance after 90 years but that in places has recovered to northern

hardwoods forests. Climatic changes may affect this system severely. Climate change can be expected to raise the lower elevational limit and greatly reduce the land area available to this system.

Stresses and Threats

This system is very limited in extent on the Forest. It is currently only located in the Laurel Fork area. This system occupies about one-half of the area where it likely has the potential to exist. While the system is very limited on the GWNF, in adjacent West Virginia and on the Monongahela National Forest, it is more extensive. The greatest stresses and threats to this system include climate change and acid deposition.

3.2.2 Northern Hardwood Forest : Appalachian (Hemlock)- Northern Hardwood Forest

Background

Environment: This system occurs on somewhat protected low and midslopes and valley bottoms. In the central Appalachian center of its range, its ecological amplitude is somewhat broader, and it approaches matrix forest in some areas. It is considered a system of intermediate moisture regime. **Vegetation:** The canopy is characterized and often usually dominated by northern hardwoods (e.g., Fagus grandifolia and Acer saccharum), often with Tsuga canadensis, but may also contain large amounts of Pinus strobus and Quercus spp. The understory varies quite a bit, in some places dominated by evergreen shrubs and in others by herbs. **Dynamics:** This system is currently being devastated in large parts of its range by the hemlock woolly adelgid (Adelges tsugae). This sucking insect is continuing to cause close to 100% mortality as it spreads from the north into the southern United States. The insect will most likely cause canopy hemlocks to be replaced by other canopy trees. Historically, this system was probably only subject to occasional fires. Fires that did occur may have been catastrophic and may have lead to even-aged stands of pine and hemlock. Fire suppression appears to have increased the extent of this system at the expense of oak-pine systems.

Stresses and Threats

The greatest stresses and threats to this system include climate change, acid deposition and invasive species (hemlock woolly adelgid).

3.2.3 Cove Forest: Southern and Central Appalachian Cove Forest

Background

Environment: This system occurs below 1525 m (5000 feet) elevation and generally below 1375 m (4500 feet) in low topographic positions such as valley bottoms and ravines. This cove type has two primary components, an acid cove of lower soil fertility that ranges from the lowest slope positions up the slope on north-facing protected slopes, and a rich, high-fertility cove forest that tends to occur only at the lowest slope positions. Both are sheltered from wind and may be shaded by topography, promoting moist conditions. Local slopes are usually concave. Bedrock may be of virtually any type. Acidic rocks, such as felsic igneous and metamorphic rocks, support rich cove forests in a more limited range of sites than do basic rocks, such as mafic metamorphic rocks or marble. Soils may be rocky or fine-textured, and may be residual, alluvial, or colluvial. In the southern Appalachians, the hemlock "phase" of this ("acidic cove forest")

often occurs between "richer" examples of Southern and Central Appalachian Cove Forest (CES202.373) in the lowest areas and Southern Appalachian Oak Forest (CES202.886) on the midslopes. **Vegetation:** Vegetation consists of forests dominated by various combinations of mesophytic species, usually with many different species of primarily deciduous trees present. Liriodendron tulipifera, Tilia americana, Tilia americana var. heterophylla, Fraxinus americana, Aesculus flava, Betula lenta, Magnolia acuminata, Magnolia fraseri, Halesia tetraptera, Prunus serotina, and Tsuga canadensis are the most frequent dominant canopy species. Canopies are generally very diverse, with all species potentially occurring in one 20x50-meter plot in rich cove areas. A well-developed herb layer, often very dense and usually high in species richness, is present in all but the acid coves. Well-developed and fairly diverse subcanopy and shrub layers are often also present in all but the acid coves. Ulrey (1999) listed Caulophyllum thalictroides, Actaea racemosa (= Cimicifuga racemosa), Laportea canadensis, Osmorhiza claytonii, Sanguinaria canadensis, Viola canadensis, Acer saccharum, Aesculus flava, Carya cordiformis, and Tilia americana var. heterophylla as characteristic species. **Dynamics:** This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase regeneration on a fine scale. Occasional extreme wind or ice events may disturb larger patches. Natural fire dynamics are not well-known and probably only occurred in years that were extremely dry. Fires may have occurred at moderate frequency but were probably usually low enough in intensity to have only limited effects. Most of the component species are among the less fire-tolerant in the region.

Stresses and Threats

The greatest stresses and threats to this system are invasive plants due to the moist, rich soil conditions of these sites. Wild pigs are also a threat.

3.2.4 Oak Forests and Woodlands

3.2.4.a. Northeastern Interior Dry-Mesic Oak Forest

Background

Environment: These oak-dominated forests are one of the matrix forest systems in the northeastern and north-central U.S. Occurring in dry-mesic settings, they are typically closed-canopy forests, though there may be areas of patchy-canopy woodlands. They cover large expanses at low to mid elevations, where the topography is flat to gently rolling, occasionally steep. The typical landscape position is midslope to toeslope, transitioning to more xeric systems on the upper slopes and ridges. Soils are acidic and relatively infertile but not strongly xeric. **Vegetation:** Mature stands are dominated by oak species characteristic of dry-mesic conditions (e.g., Quercus rubra, Quercus alba, Quercus velutina, and Quercus coccinea), along with various Carya spp. Quercus prinus may be present but is generally less important than the other oak species. Castanea dentata was a prominent tree before chestnut blight eradicated it as a canopy constituent. Acer rubrum and Betula lenta are frequently common associates. Local areas of calcareous bedrock may support forests typical of richer soils (e.g., with Acer saccharum and/or Quercus muehlenbergii). In addition, Pinus strobus may be prominent in some stands in the absence of fire.

3.2.4.b. Central and Southern Appalachian Montane Oak Forest

Background

Environment: The habitat for this system includes high ridgelines and exposed upper slopes, primarily on south- to west-facing aspects, mostly between 915 and 1372 m (3000-4500 feet) elevation, and less commonly ranging up to 1680 m (5500 feet). It generally occurs as a transition between Southern Appalachian Oak Forest (CES202.886) and more mesic Southern Appalachian Northern Hardwood Forest (CES202.029) that occurs on less-exposed ridgetops and cooler, moister upper slopes (e.g., north- and east-facing aspects). At high elevations (e.g., above 1372 m [4500 feet]), this system is generally less common than Southern Appalachian Northern Hardwood Forest (CES202.029) since the habitat on most slopes at this elevation tends to favor those species adapted to a more mesic environment. **Vegetation:** This system is dominated by Quercus rubra and, more rarely, Quercus alba. Often the trees are stunted or at least not as tall as they would be in other systems farther downslope. Species richness is low to moderate. Tree associates include Prunus serotina, Betula lenta, and Betula alleghaniensis. Typical small trees and shrubs include Ilex montana, Hamamelis virginiana, Acer pensylvanicum, Menziesia pilosa, Rhododendron prinophyllum, Vaccinium pallidum, Corylus cornuta var. cornuta, and sprouts of Castanea dentata. The understory is usually dominated by ericaceous shrubs, but some communities are dominated by graminoid species or ferns. Dennstaedtia punctilobula, Carex pensylvanica, and Deschampsia flexuosa are common. Only rarely are the communities dominated by other herbs. **Dynamics:** The communities of this system inhabit some of the most inhospitable parts of the Appalachians. Their occurrence on exposed high ridges means they are subject to frequent ice and wind storms in the summer and high winds throughout the year. This probably explains the forests' stunted appearance. In addition, lightning-caused fires may create ground fires that change the understory composition and inhibit some ericaceous shrub species in some areas. Presettlement forests are likely to have

experienced lightning-caused fires every 40-60 years (Fleming et al. 2005). In some locations, fire exclusion and competing understory vegetation are a factor in poor oak regeneration, with replacement by more mesophytic species such as Acer saccharum (Fleming et al. 2005). Despite the high elevation, chestnut had been a fairly substantial component of this system and can still be seen as rotting stumps in the forest. In the northern Blue Ridge, gypsy moth infestations have caused widespread tree mortality and pose a threat to these systems (Fleming et al. 2005).

3.2.4.c Central Appalachian Dry Oak-Pine Forest

Background

Environment: These oak and oak-pine forests cover large areas in the low- to mid-elevation central Appalachians and middle Piedmont. The topography and landscape position range from rolling hills to steep slopes, with occasional occurrences on more level, ancient alluvial fans. The soils are coarse and infertile; they may be deep (on glacial deposits in the northern part of the system's range), or more commonly shallow, on rocky slopes of acidic rock (shale, sandstone, other acidic igneous or metamorphic rock). The well-drained soils and exposure create dry conditions. **Vegetation:** Stands of this forest system are mostly closed-canopied but can include more open woodlands. They are dominated by a variable mixture of dry-site oak and pine species, including Quercus prinus, Pinus virginiana, and Pinus strobus. The system may include areas of pine forest and mixed oak-pine forest. Heath shrubs such as Vaccinium pallidum, Gaylussacia baccata, and Kalmia latifolia are common in the understory. Within these forests, hillslope pockets with impeded drainage may support small isolated wetlands with Acer rubrum and Nyssa sylvatica characteristic. **Dynamics:** Disturbance agents include fire, windthrow, and ice damage.

Stresses and Threats

The greatest stresses and threats to this system are lack of disturbance to create regeneration and open woodland structure and non-native invasive species including the gypsy moth.

3.2.5 Pine Forests and Woodlands

3.2.5.a Southern Appalachian Montane Pine Forest and Woodland

Background

Environment: This system occurs on ridgetops, usually only on the sharpest and narrowest spur ridges, and adjacent convex upper slopes. These sites are the extreme of convex landforms. Rapid drainage of rainfall and exposure to wind, sun and lightning are probably the important characteristics. Bedrock may be of any acidic type, including felsic igneous and metamorphic rocks, sandstone and quartzite. Soils are shallow and rocky residual soils. Fire appears to be an important factor. **Vegetation:** Vegetation consists of open forests or woodlands dominated by Pinus pungens, often with Pinus rigida or less commonly Tsuga caroliniana, and sometimes with Pinus virginiana or rarely Pinus echinata codominant. In examples that have not had fire in a long time, Quercus prinus, Quercus coccinea, or other oaks are usually present and are sometimes abundant, as are Nyssa sylvatica and Acer rubrum. Castanea dentata may also have once been abundant. A dense heath shrub layer is almost always present. Kalmia latifolia is the most typical dominant, but species of Rhododendron, Vaccinium, or Gaylussacia may be

dominant. Herbs are usually sparse but probably were more abundant and shrubs less dense when fires occurred more frequently. **Dynamics:** Fire is apparently a very important process in this system (Harrod and White 1999). Pines may be able to maintain dominance due to shallow soils and extreme exposure in some areas, but most sites appear eventually to succeed to oak dominance in the absence of fire. Fire is also presumably a strong influence on vegetation structure, producing a more open woodland canopy structure and more herbaceous ground cover. Occurrence in highly exposed sites may make this system more prone to ignition, but most fires probably spread from adjacent oak forests. Fires could be expected to show more extreme behavior in this system than in oaks forests under similar conditions, due to the flammability of the vegetation and the dry, windy and steep location. Both intense catastrophic fires and lower-intensity fires probably occurred naturally. Natural occurrences probably include both even-aged and uneven-aged canopies. Southern pine beetles are an important factor in this system, at least under present conditions. Beetle outbreaks can kill all the pines without creating the conditions for the pines to regenerate. If the pines are lost, the distinction between this system and Southern Appalachian Oak Forest (CES202.886) or Central Appalachian Pine-Oak Rocky Woodland (CES202.600) becomes blurred.

3.2.5.b Central Appalachian Pine-Oak Rocky Woodland

Background

Environment: This system encompasses open or sparsely wooded hilltops and outcrops or rocky slopes in the Central Appalachians, High Allegheny Plateau, and Lower New England / Northern Piedmont. It occurs mostly at lower elevations, but occasionally up to 1220 m (4000 feet) in West Virginia. **Vegetation:** The vegetation is patchy, with woodland as well as open portions. Pinus rigida and (within its range Pinus virginiana are diagnostic and often are mixed with xerophytic Quercus spp. and sprouts of Castanea dentata. Some areas have a fairly well-developed heath shrub layer, others a graminoid layer. **Dynamics:** Conditions are dry and nutrient-poor, and at many, if not most, sites, a history of fire is evident. In the Central Appalachians ecoregion, this system is sometimes found on sandy soils rather than rock. The southern extent overlaps with Southern Appalachian Montane Pine Forest and Woodland (CES202.331), which is characterized by Pinus pungens. This type is differentiated from the similar Central Appalachian Dry Oak-Pine Forest CES202.591) by its mosaic nature of wooded and open patches, as opposed to being merely a "thin forest."

Stresses and Threats

The greatest stresses and threats to this system are lack of disturbance to create regeneration and open woodland structure and invasive species including the native pine bark beetle and climate change that could reduce rainfall and make insect outbreaks more common.

3.2.6 Mafic Glade and Barrens and Alkaline Glades and Woodlands

3.2.6.a Southern and Central Appalachian Mafic Glade and Barrens

Background

Environment: Occurs on upper to mid slopes, usually on gentle to moderate slopes but occasionally steeper. The ground is mostly shallow soil over bedrock, usually with significant areas of rock outcrop. The rock usually has few fractures but may have a pitted or irregular surface. This rock structure supports more extensive and deeper soil development than in Southern Appalachian Granitic Dome (CES202.297), but has few of the crevices and deeper rooting sites available in Southern Appalachian Rocky Summit (CES202.327). Micro-scale soil depth and presence of seepage are important factors in determining the vegetation patterns. Shallow soil, unable to support a closed tree canopy, separates this system from forest systems. Bedrock includes a variety of igneous and metamorphic rock types. Some examples are on mafic substrates such as amphibolite, some are on felsic rock such as granitic gneiss but have flora that suggests a basic influence, and a few occur on felsic rocks and are clearly acidic. Rock or soil chemistry appears to be the most important factor affecting different associations on sites that have the physical structure to belong to this system. Elevation may also be an important factor causing variation. **Vegetation:** Vegetation is a fine mosaic of different physiognomies, with open woodland and grassy herbaceous vegetation or short shrubs predominating. Some instances may have closed canopies of small trees or large shrubs, but no examples have large canopy trees with a closed canopy. Bare rock outcrops are usually present in a minority of the area. The canopy species are species tolerant of dry, shallow soils, most commonly Quercus prinus, Pinus spp., and Juniperus virginiana. Basic examples may also have Carya glabra, Fraxinus americana, and other species abundant. Shrubs may be dense, with species determined by soil chemistry. The herb layer is usually fairly dense and dominated by grasses, both in treeless areas and beneath open canopy. An abundant forb component is also usually present, especially in the more basic examples. The forbs include species characteristic of other rock outcrops and grassland species, with a smaller number of forest species present. **Dynamics:** The dynamics of this system are not well known. The occurrence of the system appears to be primarily determined by site physical properties, with physical and chemical properties determining vegetational variation. Fire may be an important influence on vegetation, and may in the long run be important for keeping the vegetation structure open, though the patchy distribution of vegetation might limit fire intensity. Periodic drought and wind storms may also be an important factor limiting canopy density and stature. The shallow soil would make these sites particularly prone to all three. These glades do not appear to be undergoing the kind of cyclic succession that has been described for granitic domes, but some balance of soil accumulation and destruction may be occurring on a longer term or coarser scale. It is possible that the slightly irregular curved surface of some examples represents a late stage in the weathering of old exfoliation surfaces that once supported granitic domes, but most known examples are not spatially associated with existing granitic domes.

3.2.6.b Central Appalachian Alkaline Glade and Woodland

Background

Environment: This system occupies mid-elevation rocky ridges, slopes, and outcrops with thin soils and calcareous bedrock. Large amounts of exposed mineral soils and/or gravel are characteristic. Soils are high in pH and rich in calcium and magnesium. Although these areas are subject to prolonged droughts, local areas of ephemeral vernal seepage occur in microtopographic concavities, and they may have distinctive vegetation (e.g., colonies of Dodecatheon meadia). A series of glades in western Virginia is somewhat distinctive because of the dolostone, which contains a high magnesium content. These glades are located on low dolomite knobs and foothills of Elbrook dolomite that occupy middle to upper slopes and crests of south- or southwest-facing spur ridges at relatively low elevations. **Vegetation:** In some cases, the woodlands grade into closed-canopy forests. Juniperus virginiana is a common tree, filling in in the absence of fire, and Quercus muehlenbergii is indicative of the limestone substrate. Rhus aromatica, Cercis canadensis, and Ostrya virginiana may occur. Prairie grasses are the dominant herbs (Andropogon gerardii, Schizachyrium scoparium, Bouteloua spp.); forb richness is often high. Characteristic forbs include Asclepias verticillata, Monarda fistulosa, Salvia lyrata, Symphyotrichum oblongifolium, and Brickellia eupatorioides (Braun 1950). **Dynamics:** Fire is an important natural disturbance vector.

Stresses and Threats

These systems are uncommon on the Forest so their limited distribution is a stress. Other important stresses and threats to these systems include the lack of fire, non-native invasive plants, and trampling from excessive recreation use.

3.2.7 Cliff, Talus and Shale Barrens

3.2.7.a North-Central Appalachian Circumneutral Cliff and Talus

Background

Environment: This cliff system occurs at low to mid elevations from central New England south to Virginia and West Virginia. It consists of vertical or near-vertical cliffs and steep talus slopes where weathering and/or bedrock lithology produce circumneutral to calcareous pH and enriched nutrient availability. Substrates include limestone, dolomite and other rocks. **Vegetation:** The vegetation varies from sparse to patches of small trees, in places forming woodland or even forest vegetation. Fraxinus spp., Tilia americana, and Staphylea trifolia are woody indicators of the enriched setting. Thuja occidentalis may occasionally be present but is more characteristic of the related Laurentian-Acadian system to the north. The herb layer is typically not extensive but includes at least some species that are indicators of enriched conditions, e.g., Impatiens pallida, Pellaea atropurpurea, Asplenium platyneuron, or Woodsia obtusa.

3.2.7.b North-Central Appalachian Acidic Cliff and Talus

Background

Environment: This system comprises sparsely vegetated to partially wooded cliffs and talus slopes in the Central Appalachians and adjacent ecoregions, occurring on rocks of acidic lithology and lacking any indicators of enriched conditions. This cliff system occurs at low to mid elevations from central New England south to Virginia, and up to 1500 m in West Virginia. It consists of vertical or near-vertical cliffs and the talus slopes below, formed on hills of granitic, sandstone, or otherwise acidic bedrock. In some cases, especially in periglacial areas, this system may take the form of upper-slope boulderfields without adjacent cliffs, where talus forms from freeze/thaw action cracking the bedrock. Most of the substrate is dry and exposed, but small (occasionally large) areas of seepage are often present. **Vegetation:** Vegetation in seepage areas tends to be more well-developed and floristically different from the surrounding dry cliffs. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places. Juniperus virginiana is a characteristic tree species, Toxicodendron radicans a characteristic woody vine, and Polypodium virginianum a characteristic fern. Within its range, Pinus virginiana is often present.

3.2.7.c Appalachian Shale Barrens

Background

Environment: This system is found at low to mid elevations in the central and southern Appalachians. Most shale barrens occur between 305 and 610 m (1000-2000 feet) elevation and have a generally southern exposure. Slopes are steep and often undercut by a stream at the base. Soils are thin, with a layer weathered rock fragments covering the surface. The exposure and lack of soil create extreme conditions for plant growth. The chemistry and pH vary somewhat from site to site, and this variability may be reflected in the vegetation. The substrate includes areas of solid rock as well as unstable areas of shale scree, usually steeply sloped. **Vegetation:** Although stunted trees of several species such as Quercus prinus, Pinus virginiana, and Carya

glabra are common, Central Appalachian Shale Barrens are strongly characterized by their open physiognomy and by a suite of uncommon and rare plants found almost exclusively in these habitats (Fleming et al. 2004). Endemic or near-endemic shale barren species include shale-barren rock-cress (Arabis serotina), white-haired leatherflower (Clematis albicoma), Millboro leatherflower (Clematis viticaulis; also endemic to Virginia), shale-barren wild buckwheat (Eriogonum allenii), shale-barren evening-primrose (Oenothera argillicola), shale-barren ragwort (Packera antennariifolia), and Kate's Mountain clover (Trifolium virginicum). Other more-or-less widespread and characteristic herbaceous species of Virginia shale barrens include Pennsylvania sedge (Carex pensylvanica), little bluestem (Schizachyrium scoparium), poverty oatgrass (Danthonia spicata), wavy hairgrass (Deschampsia flexuosa var. flexuosa), moss phlox (Phlox subulata), mountain nailwort (Paronychia montana), rock spike-moss (Selaginella rupestris), shale-barren pussytoes (Antennaria virginica), Canada cinquefoil (Potentilla canadensis), smooth sunflower (Helianthus laevigatus), false boneset (Brickellia eupatorioides var. eupatorioides), hairy woodmint (Blephilia ciliata), and western wallflower (Erysimum capitatum var. capitatum; Bath and Alleghany counties). **Dynamics:** Aspect with increased exposure to drying and extremes in temperature plus dynamic downslope creep of shale fragements along with water erosion when undercut by a stream are the primary natural dynamics influencing this system. Fire may play a role in surrounding xeric to dry pine-oak woodlands by limiting ecroachment of trees and shrubs onto barren.

Stresses and Threats

The major stresses and threats to these systems include the lack of fire, non-native invasive plants, problematic native species (deer browsing), trampling from excessive recreation use, and altering the normal disturbance regimes that maintain the character of the cliff, talus and barren features (rock slides, stream erosion).

3.2.8 Floodplains, Wetlands, and Riparian Areas

This group consists of a number of relatively small systems that can be difficult to map. All known locations of these systems are included in the group along with all lands within 100 feet of perennial streams, lakes, seeps and wetlands and all lands within 50 feet of intermittent streams.

3.2.8.a Central Appalachian Floodplain

Background

Environment: This system encompasses floodplains of medium to large rivers in Atlantic drainages from southern New England to Virginia. This system can include a complex of wetland and upland vegetation on deep alluvial deposits and scoured vegetation on depositional bars and on bedrock where rivers cut through resistant geology. **Vegetation**: This complex includes floodplain forests in which Acer saccharinum, Populus deltoides, and Platanus occidentalis are characteristic, as well as herbaceous sloughs, shrub wetlands, riverside prairies and woodlands. Most areas are underwater each spring; microtopography determines how long the various habitats are inundated. Depositional and erosional features may both be present depending on the particular floodplain.

3.2.8.b Central Appalachian Riparian

Background

Environment: This riparian system ranges from southern New England to Virginia and West Virginia and occurs over a wide range of elevations. It develops on floodplains and shores along river channels that lack a broad flat floodplain due to steeper sideslopes, higher gradient, or both. It may include communities influenced by flooding, erosion, or groundwater seepage. **Vegetation**: The vegetation is often a mosaic of forest, woodland, shrubland, and herbaceous communities. Common trees include Betula nigra, Platanus occidentalis, and Acer negundo. Open, flood-scoured rivershore prairies feature Panicum virgatum and Andropogon gerardii, and Carex torta is typical of wetter areas near the channel. Classification Comments: This is a high-gradient system, unlike the low-gradient system described in Central Appalachian River Floodplain (CES202.608). To the south in the Appalachians and interior, this system is replaced by South-Central Interior Small Stream and Riparian (CES202.706).

3.2.8.c Central Interior Highlands and Appalachian Sinkhole and Depression Pond

Background

Environment: Examples of this system occur in basins of sinkholes or other isolated depressions on uplands. Soils are very poorly drained, and surface water may be present for extended periods of time, rarely becoming dry. Water depth may vary greatly on a seasonal basis, and may be a meter deep or more in the winter. Some examples become dry in the summer. Soils may be deep (100 cm or more), consisting of peat or muck, with parent material of peat, muck or alluvium. **Vegetation:** Ponds vary from open water to herb-, shrub-, or tree-dominated types. Tree-dominated examples typically contain Quercus species, Platanus occidentalis, Fraxinus pennsylvanica, Acer saccharinum, or Nyssa species, or a combination of these. In addition, Liquidambar styraciflua may be present in southern examples. Cephalanthus occidentalis is a typical shrub component. The herbaceous layer is widely variable depending on geography. **Dynamics:** Water depth may vary greatly on a seasonal basis, and may be a meter deep or more in the winter. Some examples become dry in the summer.

3.2.8.d Southern and Central Appalachian Bog and Fen

Background

Environment: This system occurs in patches in flat valley bottoms, usually on the outer edges of stream floodplains at elevations below 1220 m (4000 feet). The soil is saturated most or all of the year, at least in the wettest parts, and may be very mucky. Although sites rarely flood, wetness results from a combination of groundwater input, rainfall, seepage from adjacent slopes, and impeded drainage. The groundwater is usually highly acidic and low in dissolved bases, but one or a few examples have somewhat calcareous water input because groundwater flows through mafic rock substrates. Overland flow and stream flooding are presumably only rare events. The geologic substrate is usually alluvium. Often, but not always, there is an adjacent slope with a seep at its base or some visible microtopographic feature, such as a stream levee or ridge, that

impedes water drainage out of the area. Some occurrences have substantial microtopography of abandoned stream channels or ridge-and-swale systems that pond water in low areas. **Vegetation**: Vegetation is a complex of zones or patches with a mix of physiognomies. The wettest areas have herbaceous vegetation dominated by Carex spp., usually with abundant Sphagnum. Scattered trees and shrubs may be present in the herbaceous zones. Most examples also have a dense shrub zone around the edges. Some examples have forest zones as well, around the edges or as a matrix in which numerous small herbaceous openings are embedded. Characteristic tree species are Tsuga canadensis, Acer rubrum, Nyssa sylvatica, and Pinus rigida. Characteristic shrubs include Rhododendron maximum, Alnus serrulata, Viburnum nudum var. cassinoides, Viburnum nudum var. nudum, and Toxicodendron vernix. A number of plant species are shared with northern bogs, including some that are disjunct long distances and occur in the south only in bogs. Other species are narrow endemics, such as Helonias bullata. In the more southern examples, some species are shared with bog communities in the Coastal Plain. The very rare richer fen examples have very distinctive vegetation, sharing a number of species with northern rich fens. **Dynamics:** The natural dynamics of this system are not well known and are subject to debate. The factors that created and naturally maintain this system are unclear. Most examples show a strong tendency at present for shrubs and trees to increase in density in the open areas, threatening to eliminate the characteristic herb species. This suggests that an important process has been altered or lost. One hypothesis is that bogs are an ephemeral feature developing from abandoned beaver ponds. Another hypothesis is that they result from a narrow combination of moisture and nutrient conditions, which have been widely altered in an obscure way that has changed ecosystem stability. The cattle grazing that was nearly universal in examples of this system in the past appears to have delayed woody succession but may also have altered the natural characteristics. Fire is sometimes considered as a factor, but most examples do not appear flammable enough to burn. Besides woody encroachment, bogs may be altered by changes in adjacent drainage, such as entrenchment by streams.

3.2.8.e North-Central Appalachian Acidic Swamp

Background

Environment: These swamps are distributed from central New England through the Central Appalachians south to Virginia and west to Ohio. They are found at low to mid elevations (generally <700 m) in basins or on gently sloping seepage lowlands. The acidic substrate is mineral soil, often with a component of organic muck; if peat is present, it usually forms an organic epipedon over the mineral soil rather than a true peat substrate (although peat layers up to 1 m deep have been found in some of these swamps). **Vegetation:** Tsuga canadensis is usually present and may be dominant. It is often mixed with deciduous wetland trees such as Acer rubrum or Nyssa sylvatica. Sphagnum is an important component of the bryoid layer. Basin swamps tend to be more nutrient-poor and less species-rich than seepage swamps; in some settings, the two occur adjacent to each other with the basin swamp vegetation surrounded by seepage swamp vegetation on its upland periphery.

3.2.8.f North-Central Appalachian Seepage Fen

Background

Environment: This system is found in scattered locations in the central Appalachians and eastern Great Lakes regions. Mostly non-forested, these open fens develop on shallow to deep peat over a sloping substrate, where seepage waters provide nutrients. Conditions are often circumneutral to alkaline. **Vegetation:** Sedges are the major dominants. Packera aurea, Symplocarpus foetidus, and Lobelia kalmii are among the characteristic forbs. **Dynamics:** Some of these areas are kept open by grazing, and succession to shrublands may occur in the absence of disturbance.

Stresses and Threats

The greatest threat or stress on the systems is alteration of the hydrology that supports the system. This includes the loss of beaver activity that is important to many of these systems. Other stresses and threats include recreation use (including off road vehicles), acid deposition, and climate change. Non-native invasive plants are another stress and riparian areas can provide important dispersal corridors for many species.

3.2.9 Caves and Karstlands

Background

This system includes the terrestrial and aquatic subterranean habitat. The landscapes are formed in limestone and dolostone bedrock and are generally found in valley bottoms but occassionally on ridges and mountains depending on bedrock geology, strata location and outcrops. Passages are formed by water flowing over many millennia and can provide habitat for a variety of species, some quite rare and specialized.. It is not a separate ecological system from the others, since it has vegetation defined by the previously discussed systems. It is the underground environment and the features that sometimes manifest themselves at the surface, like sinkholes, caves and springs. The location is defined by broad scale geologic mapping, so the actual areas of caves and karst terrain occupy only a small portion of the entire area.

Stresses and Threats

The greatest threats or stresses on the system are alteration of the hydrology that supports the system and degradation of water quality. This includes changes to the groundwater and surface water flow and human caused impacts to water quality such as improper pesticide use or disposal of harmful materials in sinkholes.

A summary of the stresses and threats identified for each ecosystem are displayed in Appendix 1.

4.0 Special Biological Areas

Special Biological Areas

The 108 Special Biological Areas on the GWNF support ecosystem diversity at a fine scale by recognizing and managing for rare natural communities and assemblages of rare plant and animal species. Some of these areas represent the best representatives of ecological systems and other represent unique assemblages of vegetation, animals and the physical environement. These areas include rare habitats such as sinkhole ponds, seepage swamps, bogs, and fens, mafic and limestone outcrops, spruce forest, shale barrens, and, in limited situations, habitat for single species such as sweet pinesap, coal skink, sword-leaved phlox, and Bentley's coralroot. All known locations of T&E plant species on the Forest are included in Special Biological Areas. The following table summarizes the communities represented.

Table 4. Community Types Represented in Special Biological Areas

Community Type	Acres
Montane Depression Wetlands	1,558
Montane Depression Wetlands (included in larger acreage	17,751
appalachian bog	254
calcareous fen	525
calcareous muck fen	147
Seepage swamp	1,307
Seepage swamp, calcareous	304
spring	37
seep	102
stream	173
riparian	27
cave/karst	1,799
Central Appalachian Shale Barren	10,191
outcrop	17
Central Appalachian Shale Barren, calcareous	732
outcrop barren	179
Calcareous Forests, Calcareous cliff, cave	627
Dry calcareous forest, cave/karst	1,074
cliff talus, calcareous	56
Calcareous cliff	633
cliff talus	751
dry calcareous forest	422
Calcareous	24
mafic glade	366
spruce fir	6,694
Juniper woodland	163
sandstone glade	141
high elevation	1,709
Shenandoah Mountain Crest	54,323

5.0 Forest-wide Ecosystem Diversity – Alternatives and Effects

5.1 Ecosystem Diversity Characteristics

Attributes and Indicators

The following key attributes were identified for each ecosystem along with the indicator to be used to measure the key attribute.

Table 5. Key Attributes and Indicators for ESE Ecological Systems

Ecosystem	Key Attribute	Indicator
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Ecological System Abundance	Total Occurrences at Desired Condition
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Fire Regime	% Burned at Desired Frequency
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Invasive Species Abundance	Compliance with Invasive Species Guidelines
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Vegetation Structure	% Open Canopy
Caves and Karstlands	Ecological System Abundance	Total Occurrences at Desired Condition
Caves and Karstlands	Physical Structure	Compliance with cave, karst physical settings including hydrologic, biologic and chemical setting
Cliff, Talus and Shale Barrens	Ecological System Abundance	Total Occurrences at Desired Condition
Cliff, Talus and Shale Barrens	Invasive Species Abundance	Compliance with Invasive Species Guidelines
Cliff, Talus and Shale Barrens	Vegetation Structure	% Open and Open Canopy
Cove Forest	Forest Age Diversity	% in mid to late successional stages
Cove Forest	Forest Age Diversity	% Late Successional
Cove Forest	Forest Age Diversity	% Regenerating Forest
Cove Forest	Vegetation Structure	% open canopy in mid to late successional stages
Northern Hardwood Forest	Forest Age Diversity	% in mid to late successional stages
Northern Hardwood Forest	Forest Age Diversity	% Late Successional
Northern Hardwood Forest	Forest Age Diversity	% Regenerating Forest
Northern Hardwood Forest	Vegetation Structure	% open canopy in mid to late successional stages

Ecosystem	Key Attribute	Indicator
Oak Forests and Woodlands	Fire Regime	% Burned at Desired Frequency
Oak Forests and Woodlands	Forest Age Diversity	% in mid to late successional stages
Oak Forests and Woodlands	Forest Age Diversity	% Mature Forest
Oak Forests and Woodlands	Forest Age Diversity	% Regenerating Forest
Oak Forests and Woodlands	Vegetation Structure	% open canopy in mid to late successional stages
Oak Forests and Woodlands	Vegetation Structure	% open grasslands or forbs
Pine Forests and Woodlands	Fire Regime	% Burned at Desired Frequency
Pine Forests and Woodlands	Forest Age Diversity	% in mid to late successional stages
Pine Forests and Woodlands	Forest Age Diversity	% Regenerating Forest
Pine Forests and Woodlands	Vegetation Structure	% open canopy in mid to late successional stages
Floodplains, Wetlands and Riparian Areas	Habitat Element Abundance	Compliance with Riparian Guidelines
Spruce Forest	Ecological System Abundance	Total System Acres at Desired Condition

Abundance and Distribution

Table 6. —Current abundance of ecological systems on the George Washington National Forest

Ecological System	Approximate Existing Acres
Spruce Forest	526
Northern Hardwood Forest	10,723
Cove Forest	60,296
Oak Forests and Woodlands	756,267
Pine Forests and Woodlands	159,660
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933
Cliff, Talus and Shale Barrens	23,401
Floodplains, Wetlands, and Riparian Areas	53,560
Total Acres	1,065,366
Caves and Karstlands (included in above acres)	119,000

Structure and Tree Age Diversity

Structure and tree age diversity are both characteristics that are important to all forested ecological systems. Structure is also important to non-forested systems. Every forested community requires a balance of age-class conditions representing a diversity of vertical structure that allows for recruitment of young growth to replace losses due to storm events, pest infestations, wildfires, and loss of over-mature trees. An appropriate balance of vertical structure within each community provides critical habitat for associated species that require either grass/forb-seedling/shrub (early seral), and/or trees (late seral).

Canopy structure reflects the general health and sustainability of the community by the amounts and arrangement of early seral and mature stands. Canopy closure, as a surrogate for horizontal structure, was measured as a combination of stem density, basal area and extent of canopy cover. This measure was used primarily to delineate forested (closed canopy) from open canopy and woodland conditions.

Table 7. Definitions of Structural Classes

Open	Land with less than 10 percent canopy cover in permanent or long-term open condition (grasslands, barrens, etc.; not newly cut forest regeneration.)
Early Successional or Regenerating Forest	Stands developing after a major disturbance, generally less than 11 years in age in the most common systems, but can be up to 24 years.
Mid-Successional Open Canopy	Stands beyond regeneration that stay in a relatively open canopy (canopy closure of 25-60%)
Mid-Successional Closed Canopy	Stands beyond regeneration where the canopy closes (canopy closure of 61% or greater)
Late Successional Closed Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with a largely closed canopy (all layers) greater than 60 percent. Includes natural canopy gaps.
Late Successional Open Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with overall open canopy (canopy closure of 25-60 percent; typical of thinned forests)

Old Growth

Summary of Old Growth Guidance

In 1989 then-Chief Dale Robertson issued a national position statement on old growth. This included a national generic definition and description of old growth forests that is still applicable today:

> Old growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics that may include tree size, accumulation of large dead woody material, number of canopy layers, species composition, and ecosystem function.
>
> The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type with climate, site conditions, and disturbance regime. For example, old growth in fire-dependent forest types may not differ greatly from younger forests in the number of canopy layers or accumulation of downed woody material.

Old growth is typically distinguished from younger growth by the following structural attributes and characteristics:

1. Large trees for that species and site.
2. Uneven age structure with tree species in several size classes resulting in multiple canopy layers.
3. Accumulations of large-size dead standing and fallen trees that are high relative to earlier stages and in all stages of decay.
4. Broken or deformed tops or bole and root decay primarily resulting from weather phenomena such as ice or wind storms.
5. Single or multiple tree-fall gaps usually resulting from windthrow and resulting in understory patchiness and increased micro-topography relief.
6. Undisturbed soils and soil macropores usually with a well developed surface organic layer (0 horizon).
7. On mesic sites a well developed fungal component.

Beginning in 1990, the Southern and Eastern Regions of the Forest Service; the Forest Service Southern, Northeastern, and North Central research stations; and The Nature Conservancy began efforts to develop science-based old growth definitions for the east. The effort proved to be problematic in large part because so few representatives of old growth conditions exist and their history for their entire life so poorly known that quantifying the range of natural variability was imprecise. But after five years of effort, in December of 1995, the Southern Regional Forester chartered the Region 8 Old Growth Team to make the draft scientific old growth definitions 'operational and useful'. In June of 1997 the Team completed a report entitled *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region*, hereafter called the 'old growth report' (Forest Service, 1997). It is this report that continues to guide management of old growth on the Southern Region Forests.

The old growth report recognized old growth forests as a valuable natural resource worthy of protection, restoration, and management that provides a variety of ecological, social, and spiritual values. Old growth communities are rare or largely absent in the southeastern forests from Virginia south to Florida. Existing old growth areas (referred to as 'primary forests') may represent around 0.5% (approx. 482,000 acres) of the total forested acreage of 88,079,000 acres (Davis 1996). For these reasons the Southern Region's National Forests are making efforts to restore more of this portion of forest ecosystems.

The old growth report gave operational definitions for sixteen old growth community types that encompassed nearly all of the forest cover types in the Southeast. Factors used to define old growth forest type (OGFT) groups are those that most strongly influence the structural and functional characteristics of old growth forests. These include site factors that directly or indirectly affect productivity and spacing of trees, disturbance regimes, physiognomy, dominant tree species, and geography (in that geography is related to climate, which controls productivity, in part). A few forest cover types were not included such as those considered rare communities plus the tropical forests of the Caribbean.

For each old growth forest type, minimum ages were determined at which a stand will begin to develop attributes characteristic of old growth conditions. Several accepted definitions used to

describe old growth state that a given old growth forest type will begin to develop old growth characteristics at an age approximately one-half the maximum longevity (Iifespan) of the dominate tree(s) found in that type (Cogbill 1983, Leverett 1996, Loehle 1988)**.** The nine old growth forest type groups that occur on the Forest have five different ages at which they begin to develop old growth characteristics ranging from 100 to 140 years. These groups not only reflect the longevity of dominate trees, but natural disturbance regimes (fire, ice storms, gap formation, etc.) and edaphic conditions (rainfall, slope, aspect, etc.) where they're found.

The operational definitions established four criteria which had to be met before a stand would be considered 'existing' old growth: (1) AGE - minimum age in the oldest age class; (2) PAST DISTURBANCE - no obvious human-caused disturbance that conflicts with old growth characteristics for that type; (3) BASAL AREA - minimum basal areas of stems 5" d.b.h. and larger; and (4) TREE SIZE - a minimum diameter at breast height (d.b.h.) of the largest trees. Except for number two, the values for these criteria vary by old growth type. The report also generally charged each Forest to provide: (1) a distribution of large (more than 2,500 acres), medium (100 thru 2,500 acres), and small (1 thru 99 acres) potential old growth patches; and (2) representation of all potential and applicable old growth forest types for each ecological section unit (e.g. physiographic region). An exception to the large block requirement was made for forests in the Northern and Southern Cumberland Plateau and the Appalachian Piedmont ecological sections because of land ownership patterns. The distribution guidance did not specify an amount, such as acres or percent of area, to be in each patch size. In addition, old growth patches were assumed to be occurring on National Forests in a matrix of mid- to late successional forest conditions, providing connectivity without old growth allocations being physically contiguous. Representation was limited to ensuring that old growth community types were present, not a total amount nor an amount per each type. Amounts (i.e. acres) were to be based on public issues and ecological capabilities of the land.

The Biological Significance of Old Growth

To date no species of plant or animal had been identified in the Southeastern United States that is considered an old growth obligate; that is, requiring old growth for some portion or all of their life cycle. Therefore, the provision of existing or future old growth is not directly linked in a cause and effect relationship to the viability of any species.

However, old growth and associated late successional forests & woodlands are a condition that is particularly rich in habitat attributes for a variety of species and these attributes occur in close association (intra-stand) with one another as opposed to a landscape scale (inter-stand) distribution. A wider variety of habitat niches are available than in earlier life stages of the same community. The long development period is conducive to the formation of complex vertical structure that may include 'emergent' trees, dominant and co-dominant trees, suppressed trees, and a forest floor shrub layer and/or a herb/forb/grass layer. Canopy gaps of various sizes caused by: (a) the death in-place of a single tree; or (b) the deaths in-place of small groups of trees; or (c) the falling of a group of trees, in comparison with their immediate surroundings provide micro-sites with higher light regimes, higher stem counts, and an 'edge effect' both around the edge of the gap and back into the surrounding stand. Standing dead trees provide large and small diameter snags for foraging, perching, and cavity excavation. Down logs and limbs provide a substrate for wood decomposing fungi and insects; cover for small mammals, amphibians, and insects; and in later stages a 'nurse log' for the establishment of new tree seedlings. Large-

diameter living trees, with a long-term exposure to natural damaging agents, have the potential through wood-rotting fungi activity for the formation of large cavities suitable for bear, raccoon, squirrel, bats, or other cavity users. The heavy limb structure that develops in some tree species as they age provides sturdy nest platforms for species such as bald or golden eagles.

The Social Significance of Old Growth

Whether biologically necessary to species or not, old growth is of value. There seems to be a general sense that it is intelligent to be sure to have this habitat condition on the landscape. In Aldo Leopold's words, '*The first rule of intelligent tinkering is to keep all the parts.'* As with Wilderness, there also appears to be a desire for places almost completely unmodified by humans whether or not those holding such a value ever visit them; that is, an 'existence' value. There can be, and often is, a historical, cultural or spiritual value associated with old growth whether it's a few acres, hundreds of acres, or even thousands of acres. There also is value in providing old growth of different types on a variety of landscapes that each person holding that value can readily relate to. That is, it is not enough to say something valued is being provided simply 'somewhere'.

In more pragmatic terms, old growth has other recognized social values. It is a desirable recreation setting, both for its biological variety and for the associated state of mind from knowing one is in an 'old growth' setting perhaps surrounded by an open forest of big trees. It serves as a 'biological time machine' in that it is a reference area for what ecologically-comparable areas may have been previously and can be restored to given a similar amount of time and disturbance history. They are a valuable part of showing a comprehensive whole of ecological dynamics in conservation education. They are also a source of scientific information for research such as dendrochronology (tree ring analysis) used in studies of disturbance regimes and climate fluctuations.

Implementation of Old Growth Guidance in Forest Plan

The GWNF has used the 1997 Regional Guidance to help address this component of biodiversity and in the delineation of old growth, both potential and existing. Small, medium, and large sized patches have been identified using stand ages contained in FSVeg and analyzed their spatial arrangement using GIS. Existing Wilderness, recommended Wilderness study areas, Remote Backcountry, and other prescriptions with large acreages, such as Special Biological Areas and Shenandoah Mountain Crest, provide for the large blocks both now and in the future.

Successional Forests, Early Successional Habitat, Openings, OpenWoodlands

Successional stages of forests are the determining factor for presence, distribution, and abundance of a wide variety of wildlife. Some species depend on early successional forests, some depend on late successional forests, and others depend on a mix of both occurring within the landscape (Franklin 1988, Harris 1984, Hunter et al. 2001, Hunter 1988, Litvaitis 2001). These habitat conditions are also important as wintering and stopover habitats for migrating species (Kilgo 1999, Suthers 2000, Hunter et al. 2001). Therefore, it is important that varying amounts of both types of habitat be provided within national forest landscapes.

For analysis purposes, forest succession is generally divided into three stages: early, mid, and late. Early successional forest is defined as regenerating forest of 0 to 24 years of age for depending upon the ecological system. It is characterized by dominance of woody growth of regenerating trees and shrubs, often with a significant grass/forb component, and relatively low density or absent overstory. This condition is distinguished from most permanent opening habitats by dominance of relatively dense woody vegetation, as opposed to dominance of grasses and forbs. Such conditions may be created by even-aged and two-aged regeneration cutting, and by natural disturbance events, such as windstorms, severe wildland fire, and some insect or disease outbreaks. Ages defining the remaining successional stages vary by ecological system. Mid-successional forest often begins to develop with the sapling/pole forest characterized by canopy closure of dense tree regeneration, with tree diameters typically smaller than 10 inches. It then proceeds through stratification of over-, mid-, and understory layers. Late successional forests, from 50 to 100 years in age and older, include old growth conditions. This stage contains the largest trees and often has well-developed canopy layers and scattered openings caused by tree mortality. Of particular importance as habitat are forest conditions that exist at both extremes of the forest successional continuum-early successional and late successional forests.

Another important type of forest that combines elements of both early and mid – to late successional forest is open woodlands. Created and maintained largely by periodic fire disturbance regimes, open woodlands are characterized by an overstory of trees that are spaced far enough apart tto allow sunlight to reach the forest floor. This structural condition allows the development of a grassy/shrubby/herbaceous/woody understory more typical of early successional forest and grassland/shrublands. Many high priority species depend on the juxtaposition of both overstory mature and a well-developed grassy/shrubby/herbaceous understory for their life cycle needs. Northern bobwhite quail, red-headed woodpecker, brown-headed nuthatch, northern flicker, Appalachian yellow-bellied sapsucker, eastern wood-pewee, golden-winged warbler, Indiana bat, pine snake, grizzled skipper, box huckleberry, shale-barren rockcress, small-spreading pogonia, sword-leaf phlox, variable sedge, and smooth coneflower are just a few high priority species dependent upon open woodland habitat.

Early successional forests are important because they are highly productive in terms of forage, diversity of food sources, insect production, nesting and escape cover, and soft mast. Early successional forests have the shortest lifespan (usually about 10 years) of any of the forest successional stages, and are typically in short supply and declining on national forests in the Southern Appalachians (SAMAB 1996:28), and in the eastern United States (Thompson 2001). Early successional forests are also not distributed regularly or randomly across the landscape (Lorimer 2001). These habitats are essential for some birds (ruffed grouse, chestnut-sided warbler, golden-winged warbler, prairie warbler, yellow-breasted chat, blue-winged warbler, Swainson's warbler); key to deer, turkey, and bear in the South; and sought by hunters, berry pickers, crafters, and herb gatherers for the wealth of opportunities they provide (Gobster 2001). Many species commonly associated with late successional forest conditions also use early successional forests periodically, or depend upon it during some portion of their life cycle (Hunter et al. 2001).
The need for seedling/sapling conditions to provide habitat for birds associated with early successional habitats is a current topic of concern. Old fields can provide conditions required by many early seral species, but this habitat type itself is very uncommon on the National Forest. The minimal area that is required by each species varies and is not fully understood. Kirpez and

Stauffer (1994) documented local research findings that harvest groups of approximately 0.5 to 2 acres in size provide suitable habitat for such early seral dependent birds as the indigo bunting and rufous-sided towhee. In addition, local U.S. Forest Service bird monitoring efforts have identified the chestnut-sided warbler, an early seral species, inhabiting group harvest areas of less than 1 acre in size. In a discussion of management of early-successional habitats, Thompson and Dessecker (1997) identified group selection areas of less than 0.5 acres as inadequate for a variety of forest songbirds. Thus, there is a group of forest songbirds, such as the prairie and golden-winged warblers, which require disturbance patches that are less than 10 years of age and greater than 2 acres is size. Thus, the early successional forest habitat that will be created in patches greater than 2 acres, will result from even-aged timber harvest.

In addition to structure and patch size, the elevation at which early seral habitats exist plays a role in providing habitat for some species. The chestnut-sided warbler typically occurs at higher elevations on the GWNF. Thus, provision of seedling/sapling habitat needs to be considered at both high and lower elevations.

Eastern hardwood stands begin to produce significant amounts of hard mast at about age 40. Hard mast is a very important component for many wildlife species such as bear, squirrel, and turkey. Therefore, the age at which hardwood stands begin to produce adequate amounts of hard mast, especially upland hardwood stands dominated by oak species, is an important stage in stand development. Hard mast production is highly variable between species as well as individuals of the same species. Hard mast production in any given year is dependent upon many factors including climate and weather, insects and disease, stand density, size of trees, stand composition, and stand age. Many of these factors are either beyond control (e.g. weather) or more appropriately considered at site specific levels (e.g. stand density). For the purposes of effects analysis and disclosure at the Forest Plan level, stand age and stand composition are excellent indicators of a stand's hard mast production capability.

The five major oak species (Quercus alba, Q. prinus, Q. velutina, Q. rubra, and Q. coccinea) all begin hard mast production at ages from 20 to 25 years old. Maximum acorn production is achieved at 40 to 50 years old. Carya glabra, C. tomentosa, and Fagus grandifolia produce hard mast in quantity at ages of 30 to 40 years. Finally, Tilia americana can begin producing adequate amounts of hard mast as early as 15 years old. (Burns and Honkala 1990.) Goodrum and others found that acorn yields tended to be largest in the classes from 40 to 49 years old up to 90 to 99 years old, but declined thereafter (Goodrum et al. 1971). Shaw arrived at a similar conclusion when he found that stands in his study area ranging from 40 to 80 years old comprised 50% of the management unit, but produced 90 percent of the acorn crop. (Shaw 1971.) Thus, the age of 40 years old as the beginning of significant hard mast production in eastern hardwood forests is widely accepted.

Like early successional forests, late successional forests provide habitats and food supplies for a suite of habitat specialists as well as habitat generalists. These habitats are important providers of high canopy nesting, roosting, and foraging habitat, suitable tree diameters for cavity development and excavation, and relatively large volumes of seed and hard mast. Although it takes many decades for late successional forest conditions to develop, these habitats are more common and contiguous across the national forest and are dominant features in the SAA area (SAMAB 1996:28).

At the time of the SAA, National Forest System lands had only 3% of forest habitats in the early successional stage, while 89% was in the mid- and late successional classes; 45% of this was late successional forest (SAMAB 1996:168). Other public lands were similar to the National Forest. Conversely, private industrial lands had 22% in early successional forest and only 4% in late successional forest; private non-industrial had 8% in early successional forest and 9% in late successional forest (SAMAB 1996:168-169). The 20-year trends (SAMAB 1996:28) show early successional forest on National Forests decreasing by 4%, with late successional forest increasing by 34%. Trends for private forests are mixed, with increases in both early- and late successional forest percentages. These results likely reflect the mixed objectives of private landowners, with some focusing on commodity production and others on amenity values. In general, on National Forest System lands forest conditions are weighted heavily toward total acres of older forests, while private forests are providing a more balanced distribution of forest successional conditions from young to old (Trani-Griep 1999).

Quality of forest successional habitats may also vary between private and national forest system lands. Objectives on national forests to provide for wildlife habitat needs, recreational activities, scenic integrity objectives, and water quality often result in greater vegetation structure retained in early successional forests than in similar habitats on private lands. On private lands, more intensive management may simplify structure and composition, reducing habitat quality. Similarly, effort to restore and maintain desired ecological conditions and processes in mid- and late successional forests also often enhances habitat quality over that found on private lands. For these reasons, conclusions regarding cumulative habitat availability from both private and national forest system lands must be made with caution.

Hurricanes (Foster 1992), lightning frequency (Delcourt 1998), fire frequency (Whitney 1986), and pre-settlement cultural activities (Delcourt 1987) were probably the major sources of disturbance events that created early successional forests prior to European occupation. Less drastic perturbations such as mortality events from tornadoes, insect or disease outbreaks, or defoliation (passenger pigeon roosts) were typically less extensive and cyclic but nonetheless provided a source of early successional forest conditions. Natural disturbances, however, are unpredictable, episodic, and heterogeneous (Lorimer 2001); influential at a landscape scale; and are neither uniform nor random in distribution. Anthropogenic disturbances occurred more frequently in floodplains along major rivers and in “hunting grounds.” In a recent review paper by disturbance ecologist Craig Lorimer (Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. Wildlife Society Bulletin 2001, 29(2):425-439), Lorimer states that predicting frequency of more severe natural disturbances (the kind that would created desired early-successional forest patches) is difficult because they are highly episodic and spatially heterogeneous. Lorimer goes on to state: “…the episodic nature of large natural disturbances creates a sort of ‘feast or famine’ environment that may subject early successional animal populations to erratic fluctuations…” Such feasts and famines may be especially extreme when looking at the smaller natural landscapes represented by national forests, surrounded by private lands that may be converted to nonforest. Successional forest objectives are designed to reduce the feast and famine swings for early-successional forest species, while providing ample habitat for mature forest species.

Overall, landscape patterns more consistently contain a component of early successional forests in places more “likely” to be susceptible to disturbances, i.e., south and west facing slopes, sandy or well drained soils, or in fire adapted plant communities. Fire suppression, intensive agriculture resulting in massive soil losses, land use changes, and urban sprawl have drastically altered the variables that would perpetuate a landscape with a significant component of early- successional forests. With many species associated with early successional forests in the southeast in decline (Hunter et al. 2001), it is imperative that management actions include some provision for perpetuating early successional forest conditions. At the same time, many of these same factors, especially land use conversion, have reduced the distribution and abundance of quality late successional forests across the larger landscape. Maintenance of these on public lands is equally imperative.

Permanent grass/forb and seedling/sapling/shrub habitats are important elements of early successional habitat. Permanent openings typically are maintained for wildlife habitat on an annual or semi-annual basis with the use of cultivation, mowing, or other vegetation management treatments. These openings may contain native grasses and forbs or may be planted to non-native agricultural species such as clover, orchard grass, wheat, or small grains. Old fields are sites that are no longer maintained, are maintained on a less frequent basis (5-10 year intervals, usually with burning and mowing) or are succeeding to forest. They are largely influenced by past cultural activities and may be dense sod or a rapidly changing field of annual and perennial herbs, grasses, woody shrubs and tree seedlings.

Permanent openings are used by a variety of wildlife, both game and non-game species. Parker and others (1992) reported use of agricultural openings by 54 species of birds and 14 species of mammals in a study on the Chattahoochee National Forest. Bird species observed included wild turkey, several species of raptors and woodpeckers, and numerous songbirds including a number of neotropical migrants such as pine warbler, ovenbird, and black-throated green warbler. The greatest number of avian species and highest bird species diversity was found within the edge zone of the openings. Mammals observed included species such as white-tailed deer, striped skunk, woodchuck, bobcat, black bear, red bat, eastern cottontail, opossum, and several other small mammals.

The benefits of permanent openings to white-tailed deer are well documented. Permanent openings, especially those containing grass-clover mixtures, are used most intensively in early spring, but also are an important source of nutritious forage in winter, especially when acorns are in short supply (Wentworth et al. 1990, Kammermeyer et al. 1993). Kammermeyer and Moser (1990) found a significant relationship between openings and deer harvest with only 0.13% of the land area in high quality openings. Forest openings also are a key habitat component for wild turkeys throughout the year (Thackston et al. 1991, Brenneman et al. 1991). Maintained openings provide nutritious green forage in the winter and early spring and seeds during late summer and fall. Because of the abundance of insects and herbaceous plants produced in these openings, they are especially important as brood rearing habitat for young turkeys (Nenno and Lindzey 1979, Healy and Nenno 1983). Linear openings, especially those associated with young regenerating forests, provide optimal brood habitat conditions for ruffed grouse (Dimmick et al. 1996).

There also are numerous wildlife benefits from openings maintained in native species. Native warm season grasses provide nesting, brood-rearing, and roosting habitat for northern bobwhite and other grassland species of wildlife (Dimmick et al. 2001). Native species are well adapted to local environments and generally require less intensive maintenance following establishment.

Old fields provide food and cover for a variety of wildlife species. A number of disturbance-dependant birds, such as northern bobwhite, grasshopper sparrow, golden-winged warbler, and blue winged warbler, are associated with old field habitat (Hunter et al. 2001). Recently abandoned fields are important for rabbits and many small mammals (Livaitis 2001). Woodcock use old fields as courtship, feeding, and roosting sites (Straw et al. 1994, Krementz and Jackson 1999). Although managed less intensively than other types of permanent openings, some degree of periodic management is necessary to maintain these habitats.

Fire Regime

The presence of fire begins long before humans arrived in North America. Evidence of lightning fires exists as fusain in coal layers and as lightning scars on petrified trees (Pyne, 1982). Even today, lightning and thunderstorms are abundant, and Pyne surmised, "A phenomenon of such magnitude and longevity has unquestionably kindled profound evolutionary consequences". This great and persistent selecting force has influenced ecosystem traits and characteristics since fuels and lightning first interacted. The result is a forest with diversity and flexibility that is well adapted to fire occurrence. Fire has no doubt been a major selection force in our forest ecosystems, both lightning and anthropogenic. Many communities and species require fire to sustain populations. Oak and southern yellow pine communities have been major components of these forests for thousands of years. These communities promote and require fire. Recurring fire has been a part of the ecosystem for thousands of years. Burning is the oldest sustained land management force on these forests. No other practice can be said to have such a track record with known results.

A clearer picture of change over time is gained when we focus on the period since the last ice age. Dramatic changes in plant and animal communities have occurred during this post-glacial period. Importantly, humans made their way onto the North American scene during this period. The ecosystems developed within the influences of both climatic and human forces. The question often debated is whether human ignition, for those thousands of years, should be considered when determining the “natural” state of ecosystems. Several points seem clear. The forests have been continually changing. The diversity and flexibility of these natural systems are necessary to react to change. Fire is an important mechanism to retain that diversity and flexibility.

Early human occupation of Virginia dates back to approximately 11,500 BP during the Paleoindian period (Barber, 1996). European contact was relatively early in the region of the George Washington and Jefferson National Forests, Barber (1996) notes European contact did not occur in the Ridge and Valley area until the 1670's, and the written historical record of fire is rich with accounts from travelers and explorers. The obvious conclusion, common to each account, was the extensive use of fire by Native Americans. The effect, likewise, was extensive. Early observations describe vast areas of grassy savannas, commonplace smoke and fire, clearings and fields and apparent utilization of fire-managed vegetation (Maxwell, 1910; Day, 1953; Pyne, 1982; Hammett, 1992; Brown, 2000). Maxwell contains a great number of accounts,

but his perspective certainly reflects the bias and prejudices of the opponents to light burning. From all accounts, regardless of their perspective, burning by the Native Americans was a commonplace practice, serving many needs.

Methods of constructing fire histories in the east for pre-European settlement times have relied largely on sediment records (Craig, 1969; Watts, 1979; Patterson and Backman, 1988; Patterson and Sassaman, 1988; Wilkins et al., 1991; Kneller and Peteet, 1993; Patterson and Stevens, 1995; Delcourt and Delcourt, 1996). These studies typically extract a core of sediment from a pond or bog, and that core is then sampled for pollen, plant macrofossils, and/ or charcoal. Though a scarcity of suitable sites has limited the number of such investigations, ponds and bogs have provided a number of valuable sites in the Central Appalachians. Sites within or near the Forests are: Potts Pond (Watts, 1979) in Alleghany County; Hack (Spring) Pond and Quarles Pond (Craig, 1969), in Augusta County; Brown's Pond (Kneller and Peteet, 1993) in Bath County; and another study that includes Brown's Pond and also Green Pond, in Augusta County, near Sherando Lake (Patterson and Stevens, 1995).

Common to each study is the dynamic nature of the composition of plant communities. Climate is the determinant mechanism that propels this continuum of change along a geologic time scale (Patterson and Backman, 1988). Fire acts within this continuum on a shorter scale, to provide an important catalyst that selects one plant over another. Watts (1979) agrees that this "migration of single species is an opportunistic response to changes in climate and environmental circumstances independent of other species". From 7,880 BP to the present, oak has been the dominant genus, comprising more than 50% of the pollen record. Pine is also present, increasing within this time period from 3% to 22%, with both white pine and yellow pines being represented. Chestnut stays below 1% until the upper, later half of the profile. The continued dominance of oak corresponds with relatively greater amounts of charcoal deposits. Blackgum was also found on Potts Mountain (Watts, 1979) during this period. Watts had also noted an earlier rise in American chestnut at Potts Mountain.

Patterson and Stevens (1995) correlated charcoal surface area to pollen abundance, signifying the relative importance of fire for sampled time periods. Brown's Pond (Bath County) and Green Pond (Augusta County) were examined. Similar to other studies, they agree that the vegetation around Brown's Pond has changed little over the past 1,000 to as much as 4,000 years, with oak, hickory and chestnut representing important taxa. Also, ragweed was consistently present during this period, an indicator of agricultural activity.

Green Pond, on the other hand, showed a marked increase in total pine pollen, from <20% before the chestnut decline to over 40% more recently. Diploxylon pines (hard pines; i.e. pitch, table mountain, shortleaf, and Virginia) are more important than at Brown's Pond. Also of significance is the recent reduction in oak pollen since the chestnut decline, from > 40% to less than 30%, suggesting local vegetative changes.

They then looked at the amount of charcoal surface area found, relative to the pollen samples. At Green Pond, evidence suggests fire presence both before and after European settlement. They determined that fire had a significant impact on vegetation around the time of European settlement. Those high charcoal values are followed by a sharp increase in pine pollen. This charcoal peak was between the increase in agricultural pollen and before the chestnut decline.

The data suggests that fire in early post-European settlement resulted in a dramatic change in vegetation.

At Brown's Pond, high charcoal to pollen ratios appear at 650 years BP, ~2,000 BP, and 4,210 years BP. The average ratio prior to European settlement is slightly higher than post-settlement, with two fires clearly evident since Euro-settlement. The higher pre-euro-settlement values indicate the long historical role fire has played in the hardwoods. The authors suggest that long interval fire regimes have been important in maintaining the vegetative composition typical of the central Appalachians.

Patterson and Sassaman (1988) compared amounts of sedimentary charcoal to archaeological sites and found that fires were common near larger Native American populations and where their land-use practices were greatest. Charcoal records prior to European settlement and post-settlement show little difference, except during the slash fires associated with the logging boom at the turn of the century.

These records clearly suggest that fires have been important in that area for the past 4,000 years, during a period of low lightning incidence. Human use of fire has been important in determining plant community composition (see also Sutherland, and others, 1993).

Delcourt and Delcourt conclude by stating, "If management goals of the U.S. Forest Service include maintaining populations of fire-adapted pines and certain oak species that are currently declining because of active fire suppression, then future management tools clearly must include prescribed burning. The lesson from the Horse Cove example of prehistoric human use of fire is that fires of limited extent, focused on particular portions of the landscape, and excluded from others, can promote a heterogeneous mosaic of different vegetation types, some of which include clearly fire-adapted species, and others of which include fire-intolerant species. In order to maintain both old growth mesic hardwoods and fire-adapted pines within the same forest district, an optimal management plan would be based upon an understanding of the effects of different frequencies and intensities of fire applied to varying portions of the topographic-edaphic gradient and different areal extents of impact. Work of vegetation ecologists such as Runkle (1982, 1985) and Barden (1980, 1981) indicates that equilibrium, old growth mixed mesophytic forests will regenerate only under a disturbance regime that includes infrequent windthrow to open canopy gaps but which explicitly excludes fire (see also Clark and Royall, 1996). Promotion of Appalachian oak forests, including relatively widely spaced oak groves or "oak orchards" with sparse understory of grass and bracken fern (Stephenson et al. 1993), on the other hand requires use of frequent ground fires such as may have been used by prehistoric Native Americans to maintain their hunting and gathering grounds. Furthermore, periodic crown fires along exposed ridge crests may be necessary for regeneration of fire-adapted endemic pine species".

The George Washington National Forest was established in 1918 and the national direction regarding fire was quite clear in the early days of the Forest Service (Pyne, 1982)..."Forest fires have no place in any forest but as a result of ignorance, carelessness, and indifference (Anonymous, 1936)". The practitioners of "controlled burning" battled against an enormous campaign set at the national level to stop all fire. With that new direction of suppressing all fires, that major force of selection that had been present since the ice age was suddenly altered. The consequences of that well-intentioned but misguided policy would not be obvious for several

decades. The selection process that influenced plant and animal communities now changed with the absence of fire.

Perhaps, though, in defense of the dedicated firefighters during these times, this is the way it had to happen. The use of fire-fighting equipment, intelligence, weather forecasts, budgets and fire behavior prediction have only recently enabled prescribed burning on a substantial level. Recent scientific literature regarding plant and animal reactions and effects are now better known. We have better data on pre-Euro-American settlement conditions. And now we are beginning to understand some of the more dramatic long-term impacts of fire exclusion, as plant and animal populations and conditions of forest ecosystems are altered.

Several other studies have approached the issue of fire occurrence, what it has been in the past and the implications of fire exclusion. Dendropyrochronology studies provide valuable information such as the season of fire occurrence since trees lay down early season and late season wood in each tree ring per year; the number of fire scars on an individual tree provides data on fire frequency; and, by cross dating fire scars on different trees that occurred in the same year one is able to approximate the spatial extent of a fire.

Sutherland et al., 1993, sought to "reconstruct the historical relationship between fire and community structure using both the age and species composition approach in combination with tree-ring fire history analysis". Their study was one of the first in the Central Appalachians to use fire scars on pines to examine fire history. The study site on Brush Mountain in southwest Virginia west of Blacksburg, noted the loss of table mountain pine (Pinus pungens) recruitment since fire suppression in the late 1930's. Major recruitment of P. pungens occurred twice during the 1800's, probably due to exceptionally hot fires. The fire scar chronology indicated that fire occurred frequently (every 9-11 years) throughout the 19th century and early 20th century. Most of those fires occurred during the dormant season, most likely in early spring. The hot recruitment fires may have been during the growing season. They stated, "Fire suppression is most likely the cause of a dramatic change in the composition of the Brush Mountain communities during the last 60 years (Williams and Johnson, 1990). In the past, fire clearly promoted integrity of the Pinus pungens community on Brush Mountain".

Subsequent fire history studies using dendrochronology at multiple sites and a larger sample size of scarred trees on both the GWNF and Jefferson National Forest found that the fire interval from the early 1700's to the 1930's ranged from 2 to 9 years (Aldrich, et.al. 2010; DeWeese, 2007; Lafon and Grissino-Mayer, 2005). Additional unpublished work by Aldrich has pushed this timeframe back to the mid-1600's which pre-dates European settlement in western Virginia. Work by Lafon in the southern Blue Ridge has found similar intervals for the same timeframe.

To examine fire history further back in time recent studies have examined and dated charcoal found in soil layers. A study on southwestern North Carolina found that fires burned regularly across the studied landscape for at least the past 4,000 years. These fires were not confined to the dry oak-pine dominated ridges but extended downslope into areas that are today dominated by mesic hardwood forests (Fesenmyer and Christensen, 2010).

Habitat Fragmentation

Habitat fragmentation is a key issue for viability of local populations of breeding birds and other species like salamanders in some mature mesic deciduous forest settings. Birds in this group avoid forest edges during nesting and are adapted to forest interior conditions. Most are neotropical migrants that primarily nest and raise young in the temperate Americas. These species are grouped for effects analysis due to their sensitivity to forest fragmentation and edge effects (Hamel 1992).

Studies conducted in the mid-western U.S. have documented that forest interior species may not successfully breed in small patches of otherwise suitable habitat. Quality of their forest interior habitat is measured in part by proportion of edge, an artifact of juxtaposing forested and non-forested habitats. Edges fragment forest interior habitats and are associated with increased predation and brood parasitism by the brown-headed cowbird in agricultural settings (Primack 1993; Yahner 1998). However, characteristics of the surrounding landscape, such as percent forest cover, determine the magnitude of local edge effects. Findings of Robinson and others (1995) indicate that large landscapes with at least 70-80% forest cover offer high potential as quality habitat for forest interior species, where adverse effects of edge are reduced to levels compatible with productive populations.

Donovan and others (1997) found that abundance of the brown-headed cowbird in a midwestern U.S. setting was significantly greater in highly fragmented landscapes (< 15% forested) than in moderately fragmented (45-55% forested) or unfragmented (>90% forested) landscapes, but abundance in moderate and unfragmented landscapes did not differ. Landscape-scale habitat patterns significantly influenced overall nest predation patterns and cowbird abundance. However, local effects of livestock grazing and horse corrals caused high variation between landscape units with similar percent forest characteristics. The specific types of non-forested habitats present may be important.

As a general rule, parasitism levels of 25% or less and daily nest predation rates of 4% or less should give most forest interior species "at least a chance" (Robinson 1995) of having self-sustaining local populations (also May and Robinson 1985; Donovan et al. 1995). Based on the work of Robinson and others (1995), these parasitism rates are associated with a minimum of 70-80% forest cover at a landscape (75,000 acre) scale for a midwestern U.S. setting.

Duguay and others (2001) found that in a forested setting in West Virginia (Monongahela National Forest, >88% forest cover), “fifteen years after harvest, cuts placed within otherwise extensively forested areas do not result in the type of edge effects (population sinks) observed in areas fragmented by agriculture in the midwestern U.S.” They also concluded that implementing relatively small cuts that create edge on a small proportion of the landscape may not result in increased nest failure, provided that other factors such as proximity to cowbird feeding sites are not prominent. The study involved tracking 556 nests of 46 species over a four-year period and calculation of daily nest survival rates.

Other habitat factors are known to influence productivity of this species group. Presence of young forest patches within a forested landscape is likely to have positive benefits for immature birds. Vega Rivera (1998) and Anders and others (1998) found that after fledging, juvenile wood thrushes disperse from mature forest habitats and enter early successional forests where they fed

on invertebrates and fruit. Use of these habitats was very high relative to their availability. Later in the season, they shifted back into mature forest habitats. Fledglings preferred areas with dense understory and ground cover with species such as blackberry, sumac, and grape. Such areas may be provided by relatively small even-aged regeneration areas or by smaller dispersed canopy gaps. Scattered canopy gaps and associated dense understories likely were characteristic of old growth mesic deciduous forests. Open habitats such as pastures, old fields, and managed wildlife openings were rarely used.

The significance of National Forest System lands to this species group was analyzed at both regional and forest scales in the Southern Appalachian Assessment (SAMAB 1996b: 69-73). This analysis of forest interior habitat focused primarily on patterns of land use (forested vs. non-forested) and measures of edge effects at a landscape scale. Based on this analysis, there are approximately 9 to 10.5 million acres of suitable habitat in the Southern Appalachian Assessment (SAA) Area with about 4.7 to 5.4 million acres (52%) located within tracts greater than 5,000 acres.

Approximately 70% of suitable habitat and 51% of the largest tracts are privately owned, while 23% of suitable habitat and 39% of the largest tracts are on national forest land. A notable difference is found within the Blue Ridge Mountains, where approximately 40% of suitable habitat and half of the largest tracts occur on national forest land. Within the SAA area, the majority of forest interior habitat occurs within the Blue Ridge Mountains, followed by the Northern Ridge and Valley/Cumberland Mountains. The Southern Ridge and Valley and Southern Cumberland Plateau have the smallest relative amount (SAMAB, 1996b:73).

To determine the landscape context of the GWNF, a shifting window analysis was conducted using 1990 National Land Cover Data (U.S. EPA 2002). Percent forest cover within a surrounding landscape of 75,000 acres (per Donovan et al. 1997) was calculated for each 90-meter grid cell located on the national forest and nearby private land. For this analysis, Deciduous, Evergreen, and Mixed Forest, and Woody Wetlands were classified as forested lands. All other land cover types, including recent clearcuts (transitional cover type), were classed as non-forest cover. This analysis indicates the great majority of the GWNF occurs within a landscape that is more than 70 to 90% forested. A similar analysis was recently completed by the Nature Conservancy for the Central Appalachians. Termed landscape integrity analysis, TNC incorporated publicly available spatial data to analylise distance of forested habitat with known landscape disturbing features such as roads, residential and urban development, transportation corridors, and mining and other industries (Dougerty and Byers 2008). This analysis for the GWNF showed similar forested landscape patterns to the shifting window analysis.

There are several areas within the GWNF that have settings that are less than 70% forested, where edge effects could adversely affect productivity of forest interior birds and other species. In all cases, either urban and/or agricultural influences create a landscape that is less than 70% forested. The major river valleys of the Potomac and Shenandoah are largely privately owned and dominated by either residential and urban development, or agricultural activities.

Non-native Invasive Species (NNIS)

Non-native invasive plant and animal species can have severe detrimental effects on native species and natural communities, and are problematic across the GWNF. They currently occur on every district. NNIS degrade biological diversity by displacing native species, altering natural community structure and processes, and changing food webs. The desired condition for non-native invasive plants (NNIP) is to reduce or eliminate percent coverage across the GWNF. Because of their contribution to biological diversity, threatened, endangered, and sensitive (TES) species habitat and rare communities, including Special Biological Areas, are a high priority for NNIP control efforts. This key characteristic is addressed in the revised Forest Plan by forest-wide desired conditions, objectives for eradication and treatment of NNIP, and standards to help control NNIP at the project level. Although we do not have a complete inventory of all occurrences of NNIP, preliminary data indicate that they are widespread on all units. Based upon current and projected program levels NNIP will be treated more aggressively under the revised Forest Plan. Some NNIP will be more easily controlled than others. While we may have good results in some cases, NNIP will remain a difficult challenge and it is likely that species new to the Forest will appear during the life of the Forest Plan.

Non-native invasive insects such as hemlock woolly adelgid and gypsy moth are also a significant deterrent to ecological sustainability on the GWNF.

5.2 Ecosystem Diversity Indicators by Alternative

The following tables display the current condition of each indicator identified for each ecological system. It also displays the estimated condition of the indicator after 10 years (Table 8), or 50 years (Table 9), of implementation of each alternative. Please note that some of the indicators overlap each other (acres of late successional are included in the acres of mid to late successinal stages and acres of open canopy are included in the acres of mid to late successional stages). Table 10 identifies a description (poor, fair, or good) for the indicator based on the indicator values.

Table 8. —Condition of Indicators of Ecosystem Characteristics after Ten Years of Implementation

Ecosystem	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933	933	933	933	933	933	933	933
Acres Burned at Desired Frequency	0	176	360	0	187	360	360	360
Compliance with Invasive Species Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open Canopy	0	176	360	0	187	360	360	360
Caves and Karstlands	119,000							

Ecosystem	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Total Occurrences at Desired Condition	100%	100%	100%	100%	100%	100%	100%	100%
Compliance with cave, karst guidelines	No	No	Yes	Yes	Yes	Yes	Yes	
Cliff, Talus and Shale Barrens	23,401	23,401	23,401	23,401	23,401	23,401	23,401	23,401
Compliance with Invasive Species Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open and Open Canopy	1,022	2,112	5,758		2,996	5,758	5,758	5,758
Cove Forest	60,296	60,296	60,296	60,296	60,296	60,296	60,296	60,296
Acres in mid to late successional stages	59,309	58,928	58,928	60,296	58,737	59,876	59,027	58,928
Acres of Late Successional	27,788	32,856	32,856	33,478	32,715	33,255	32,652	32,856
Acres of Regenerating Forest	987	1,368	1,368	0	1,559	420	1,269	1,368
Acres of open canopy in mid to late successional stages	1,001	1,001	1,001	1,001	1,001	1,001	1,001	1,001
Northern Hardwood Forest	10,723	10,723	10,723	10,723	10,723	10,723	10,723	10,723
Acres in mid to late successional stages	10,542	10,568	10,568	10,557	10,557	10,547	10,545	10,568
Acres of Late Successional	10,016	10,066	10,066	9,855	10,088	10,083	10,049	10,066
Acres of Regenerating Forest	141	155	155	166	166	176	178	155
Acres of open canopy in mid to late successional stages	411	518	518	518	518	518	518	518
Oak Forests and Woodlands	756,267	756,267	756,267	756,267	756,267	756,267	756,267	756,267
Acres Burned at Desired Frequency	14,421	27,874	74,583		49,894	74,583	74,583	74,583
Acres in mid to late successional stages	725,441	709,701	709,701	735,505	696,279	720,716	732,379	709,701
Acres of Mature Forest	652,219	626,690	626,690	652,236	613,267	637,705	632,362	626,690
Acres of Regenerating Forest	25,433	40,929	40,929	15,125	54,351	29,914	18,251	40,929

Ecosystem	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Acres of open canopy in mid to late successional stages	14,652	42,999	89,708	15,125	65,019	89,708	89,708	89,708
Acres of open grasslands or forbs	4,861	5,697	7,098	4,861	6,358	7,098	7,098	7,098
Pine Forests and Woodlands	159,660	159,660	159,660	159,660	159,660	159,660	159,660	159,660
Acres Burned at Desired Frequency	2,933	5,693	18,328		11,422	18,328	18,328	18,328
Acres in mid to late successional stages	155,536	155,181	155,181	157,961	156,726	155,180	152,427	155,181
Acres of Regenerating Forest	3,978	4,377	4,377	1,597	2,832	4,378	7,131	4,377
Acres of open canopy in mid to late successional stages	3,136	7,290	19,925	1,597	13,019	19,925	19,925	19,925
Floodplains, Wetlands and Riparian Areas	53,560	53,560	53,560	53,560	53,560	53,560	53,560	53,560
Compliance with Riparian Guidelines	Yes	Yes - 1993	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	526	526	526	526	526	526	526	526
Total System Acres at Desired Condition	526	526	526	526	526	526	526	526

Table 9. —Condition of Indicators of Ecosystem Characteristics after Fifty Years of Implementation

Ecosystem	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933	933	933	933	933	933	933	933
Acres Burned at Desired Frequency	0	313	885	0	408	885	885	885
Compliance with Invasive Species Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open Canopy	0	313	885	0	408	885	885	885
Caves and Karstlands	119,000							
Total Occurrences at Desired Condition	100%	100%	100%	100%	100%	100%	100%	100%
Compliance with cave, karst guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Cliff, Talus and Shale Barrens	23,401	23,401	23,401	23,401	23,401	23,401	23,401	23,401

Ecosystem	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Compliance with Invasive Species Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open and Open Canopy	1,022	3,760	11,500		6,530	11,500	11,500	11,500
Cove Forest	60,296	60,296	60,296	60,296	60,296	60,296	60,296	60,296
Acres in mid to late successional stages	59,309	58,990	58,990	60,296	57,892	59,876	58,261	58,990
Acres of Late Successional	27,788	46,806	46,806	49,672	43,273	47,935	47,028	46,806
Acres of Regenerating Forest	987	1,306	1,306	0	2,404	420	2,035	1,306
Acres of open canopy in mid to late successional stages	1,001	1,001	1,001	1,001	1,001	1,001	1,001	1,001
Northern Hardwood Forest	10,723	10,723	9,882	10,723	9,882	9,882	10,723	9,882
Acres in mid to late successional stages	10,542	10,542	9,709	10,616	7,956	9,783	10,592	9,709
Acres of Late Successional	10,016	10,313	9,480	10,529	7,379	9,688	10,446	9,480
Acres of Regenerating Forest	141	181	173	107	1,926	99	131	173
Acres of open canopy in mid to late successional stages	411	518	510	518	510	510	518	510
Oak Forests and Woodlands	756,267	756,267	756,267	756,267	756,267	756,267	756,267	756,267
Acres Burned at Desired Frequency	14,421	31,581	125,739		81,484	125,739	125,739	125,739
Acres in mid to late successional stages	725,441	710,049	710,049	735,505	695,332	720,706	728,843	710,049
Acres of Mature Forest	652,219	625,470	625,470	723,901	558,694	654,172	694,015	625,470
Acres of Regenerating Forest	25,433	40,581	40,581	15,125	55,298	29,924	21,787	40,581
Acres of open canopy in mid to late successional stages	14,652	46,706	140,864	15,125	96,609	140,864	140,864	140,864
Acres of open grasslands or forbs	4,861	5,808	8,633	4,861	7,306	8,633	8,633	8,633
Pine Forests and Woodlands	159,660	159,660	159,660	159,660	159,660	159,660	159,660	159,660
Acres Burned at Desired Frequency	2,933	7,066	32,684		20,258	32,684	32,684	32,684
Acres in mid to late successional stages	155,536	155,181	155,181	157,961	151,285	155,180	156,682	155,181
Acres of Regenerating Forest	3,978	4,377	4,377	1,597	8,273	4,378	2,876	4,377
Acres of open canopy in mid to late successional stages	3,136	8,663	34,281	1,597	21,855	34,281	34,281	34,281
Floodplains, Wetlands and Riparian Areas	53,560	53,560	53,560	53,560	53,560	53,560	53,560	53,560
Compliance with Riparian Guidelines	Yes	Yes-1993	Yes	Yes	Yes	Yes	Yes	Yes

Ecosystem	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Spruce Forest	526	526	1,367	526	1,367	1,367	526	1,367
Total System Acres at Desired Condition	526	526	1,367	526	1,367	1,367	526	1,367

Table 10. — Description of Indicator Condition

Ecosystem	Current			
Indicator	Condition	Poor	Fair	Good
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933			
Acres Burned at Desired Frequency	0	<33% (<308 acres)	33-80%	> 80% (>746 acres)
Compliance with Invasive Species Guidelines	No	No		Yes
Acres of Open Canopy	0	<33% (<308 acres)	33-80%	> 80% (>746 acres)
Caves and Karstlands				
Total Occurrences at Desired Condition	100%	<70%	70-90%	>90%
Compliance with cave, karst guidelines	No	No		Yes
Cliff, Talus and Shale Barrens	23,401			
Compliance with Invasive Species Guidelines	No	No		Yes
Acres of Open and Open Canopy	1,022	<33% (<7,722 acres)	33-80%	> 80% (>18,721 acres)
Cove Forest	60,296			
Acres in mid to late successional stages	59,309	0-60% (<36,177 acres)or >99% (59,693 acres)	61-91 % (36,177 - 54,869 acres) or 97-99% (58,487 - 59693 acres)	92-96% (54,869 - 58,487 acres)
Acres of Late Successional	27,788	<40% (24,118 acres) or greater than 80% (48,236 acres)	40-54% (24,118 - 32,559 acres) or 60-80% (36,177 - 48,236 acres)	55-59% (32,559 - 36,177 acres)
Acres of Regenerating Forest	987	0-1% (603 acres) or > 20% (12,059 acres)	1-3% (602 - 1,808 acres) or 9-20% (5,426- 12,059 acres)	4-8% (1,808 - 5,426 acres)
Acres of open canopy in mid to late successional stages	1,001	0-2 % (1,205 acres) or >25% (15,074 acres)	3 -5 % (1,205 - 3,014 acres) or 13-24 % (7,838. - 15,074 acres)	6 - 12 % (3,014 - 7,838 acres)
Northern Hardwood Forest	10,723			
Acres in mid to late successional stages	10,542	99-100 % (10,615 acres) or <60% (6,433 acres)	61 - 87 % (6,433 - 9,329 acres) or 93 to 98 % (9,972 - 10,615 acres)	88 - 92% (9,329 - 9,972 acres)
Acres of Late Successional	10,016	<40% (4,289 acres) or >90% (9,650 acres)	40-69% (4,289 - 7,398 acres) or 75-90% (8,042 - 9,650 acres)	70-74% (7,398 - 8,042 acres)
Acres of Regenerating Forest	141	0-2 %(214 acres) or >25% (2,680 acres)	3-5% (214 - 643 acres) or 13-24% (1,393 - 2,680 acres)	7-12% (643 - 1,393 acres)

Ecosystem	Current			
Indicator	Condition	Poor	Fair	Good
Acres of open canopy in mid to late successional stages	411	0-3 % (312acres) or >25% (2,680 acres)	4-7% (321 - 750 acres) or 13-24% (1,393 - 2,680 acres)	8-12% (750 - 1,393 acres)
Oak Forests and Woodlands	756,267			
Acres Burned at Desired Frequency	14,421	<33% (249,568 acres)	33-80%	>80% (605,013 acres)
Acres in mid to late successional stages	725,441	>94% (710,890 acres) or <50 % (378,133 acres)	89-93% (673,077 - 710,890 acres) or 51-83% (378,133 - 627,701 acres)	84-88% (627,701 - 673,077 acres)
Acres of Mature Forest	652,219	<30% (226,880 acres) or >89% (673,077 acres)	30-39% (226,880 - 294,944 acres) or 61-89% (461,322 - 673,077 acres)	40-60% (294,944 - 461,322 acres)
Acres of Regenerating Forest	25,433	0-3% (22,688 acres) or >30% (226,880 acres)	4-8% (22,688 - 60,501 acres) or 12 - 29% (90,752 - 226,880 acres)	9-11% (60,501 - 90,752 acres)
Acres of open canopy in mid to late successional stages	14,652	0-20 % (151,253 acres) or >80% (605,013 acres)	21-54% (151,253 - 408,384 acres) or 66-80% (499,136 - 605,013 acres)	55-65% (408,384 - 499,136 acres)
Acres of open grasslands or forbs	4,861	0-1% (7,562 acres)	1 - 3 %	3-5% (22,688 - 37,813 acres)
Pine Forests and Woodlands	159,660			
Acres Burned at Desired Frequency	2,933	<33% (52,687 acrs)	33-80%	>80% (127,728 acres)
Acres in mid to late successional stages	155,536	>96% (153,273 acres) or <60% (95,796 acres)	60-84% (95,796 - 134,114 acres) or 91-95% (145,290 - 153,273 acres)	85-90% (134,114 - 145,290 acres)
Acres of Regenerating Forest	3,978	0-4% (6,386 acres) or >35% (55,881 acres)	5-9% (6,386 - 14,369 acres) or 16 -35% (25,545 - 55,881 acres)	10-15% (14,369 - 25,545 acres)
Acres of open canopy in mid to late successional stages	3,136	<30 % (47,898 acres) or >90% (143,694 acres)	81-90% (47,898 - 110,165 acres) or 31 to 69% (129,324 - 143,694 acres)	70-80 % (110,165 - 129,324 acres)
Floodplains, Wetlands and Riparian Areas	53,560			
Compliance with Riparian Guidelines	Yes	No		Yes
Spruce Forest	526	473.4		526
Total System Acres at Desired Condition	526	<90% (473 acres) of current acres	90-99% of current acres	current (523 acres)

6.0 Forest Plan Desired Ecological Conditions

6.1 Plan Components for Ecosystem Diversity

Forest Plan components that provide for ecosystem diversity include desired conditions, objectives, and standards. Desired conditions and objectives for ecosystem diversity are integrated throughout the Plan and addressed not only under Ecosystem Diversity but also in plan components for species diversity, healthy watersheds, and healthy forests. The following sections describe recommendations for desired conditions, objectives and standards to address ecological diversity needs.

6.2 Extent of Ecological Systems

Table 11. —Current and desired percent of ecological systems by unit on the George Washington National Forest

Ecological System	Approximate Existing Acres	Desired Acres
Spruce Forest	526	1,367
Northern Hardwood Forest	10,723	9,984
Cove Forest	60,296	60,296
Oak Forests and Woodlands	756,267	763,726
Pine Forests and Woodlands	159,660	152,099
Mafic Glade and Barrens and Alkaline Glades and Woodlands	933	933
Cliff, Talus and Shale Barrens	23,401	23,401
Floodplains, Wetlands, and Riparian Areas	53,560	53,560
Total Acres	1,065,366	1,065,366
Caves and Karstlands (included in above acres)	54,379	54,379

6.3 Forest-wide Desired Conditions

Forest-wide desired conditions would be found in the following sections and should include the following concepts:

Ecosystem diversity

Native ecological systems occupy appropriate sites and sustain strong, resilient populations of associated terrestrial and aquatic species.

There is a mix of closed canopy forest, intermittent canopy, and open canopy conditions. Forest and woodland ecological systems support a diversity of tree ages, from regeneration to old

growth, providing a relatively stable mix of ecological conditions across the landscape over time. Ecological systems are intact and as resilient as possible to absorb negative effects associated with various natural and human-caused stresses.

Species Diversity

Natural ecological communities exist in amounts, arrangements, and conditions capable of supporting native and desired non-native species within the planning area.

Natural disturbances, such as fire, wind, insects and diseases, ice storms, and floods, modify the landscape, providing habitat for disturbance dependent species.

Threatened and endangered species are recovered or moving towards recovery. Risks and threats are reduced or eliminated, especially during critical life stages such as nesting or raising offspring. The potential for sensitive species to become listed as threatened or endangered is reduced.

Watersheds

Watersheds within the Forest are resilient, have intact hydrologic function, and support the quality and quantity of water necessary for channel maintenance, aquatic habitats, riparian habitats and beneficial water uses, including public water supplies.

Soils

Forest soils have adequate physical, biological, and chemical properties to maintain or improve vegetative growth, hydrologic function, nutrient cycling and slope stability.

Geology

Groundwater is protected. Management activities in karst areas are not adversely affecting groundwater. Groundwater-dependent ecosystems are protected and sustained. Caves, sinkholes and other karst features function to maintain groundwater quality and provide habitat for species that depend on these features.

Fire

Fire regimes across the GWNF are within historical ranges (Fire Condition Class 1). Low-intensity fires periodically burn through forests removing surface fuels and maintaining an open understory. Native vegetation patterns, species composition, and structure are intact and functioning within natural limits. The risk of losing key ecosystems is low. Fire is allowed to operate in its historic ecological role as close as possible.

6.4 Standards

Standards convey information and guidance that supplements agency policies and are applied to projects or activities aimed at achieving desired conditions. Many of the forestwide and Management Prescription Area standards are designed to assure projects are completed to best restore and maintain ecological systems.

6.5 Forest-wide Management Strategies

Program emphasis for managing for ecosystem and species diversity should be placed on restoring composition, structure, and relative abundance of all native ecological systems. Restoration efforts should be implemented utilizing the vegetation management program practices to achieve desired conditions. Forest Plan strategies for wildlife and vegetation management programs should emphasize the need for using an integrated fire management program to restore and maintain all fire-dependent ecological systems. Future project work should examine needs for rare and wetland community restoration, T&E species sustainability, and restoring relative abundance of appropriate sites across the landscape. Program and project work should incorporate key ecological characteristics and work toward achieving desired conditions to support associated species. Based on current budgetary constraints, ecological restoration progress is expected to occur at a slow pace; therefore project work should explore alternative means such as stewardship projects and partnerships to restore ecological systems on the GWNF.

6.6 Ecological System Specific Direction

The following information is derived from the ESE database and describes the 20 ecological systems identified for the GWNF. Each description includes recommended desired ecological conditions, management strategies and objectives. The ages of the various structural condition classes may need to be adjusted in the Forest Plan to better correlate with ten-year age classes traditionally used for management descriptions.

6.6.1 Spruce Forest

Desired Ecological Condition

Found only in the higher elevations near West Virginia this system is a predominately mature or old-growth forest with a diversity of vertical and age structure on sites to which this species is appropriate and of historical occurrence. Overstories are typically dominated by red spruce, but this system grades into northern hardwoods. Often other tree species found with red spruce include American beech, yellow birch, and sugar maple. The herbaceous layer is most typically dominated by mosses, ferns, sedges, and forbs, The Spruce Forest system supports populations of associated rare species, including the West Virginia northern flying squirrel. Regenerating forests (0-35 years old) comprise less than 18% percent of system acreage and is generally in small canopy gaps. **Mature forest** (66 years old or older) comprise approximately 57 percent of system acreage. Fire is rare in this system and the canopy is predominantly closed.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Mid-Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	18	14	11	57
Age	0-35	36-65	36-65	66+

Management Strategy

The Spruce Forest system is limited to the Laurel Fork area. Strategies for restoring and maintaining the Spruce Forest system should emphasize restoring spruce to those sites where Norway spruce and red pine have been planted and maintaining conditions favorable to continued growth of existing stands. The Laurel Fork area should continue to be managed to restore and maintain the Spruce Forest including active planting of red spruce seedlings and releasing red spruce seedlings that are suppressed by hardwoods.

Objectives

Objectives should focus on the extent of this system and on restoration needs.

6.6.2 Northern Hardwood Forest

Desired Ecological Condition

Usually found in the highest elevations on the Forest this forest is dominated by overstories that include American beech, sugar maple and yellow birch with some eastern hemlock. Midstories and understories are usually well developed. The understory varies quite a bit, in some places dominated by evergreen shrubs and in others by herbs. Regenerating forests occupy around 10% of the area. Late successional forests make up around 72 percent of the area. Since these sites are predominantly at high elevation and are mesic, fire is not a major disturbance mechanism. Weather events such as high wind, ice, heavy wet snow, and the combinations of these account for most disturbances where open canopies exist in about 10 percent of the area.

Structural conditions are patterned after the Southern Appalachian Northern Hardwood Forest System since it has a greater emphasis on closed canopy conditions which are more like the situation on the GWNF. They are as follows:

Structure	Early Successional	Mid-Successional Closed Canopy	Late Successional Closed Canopy	Late Successional Open Canopy
% of ecological system	10	18	62	10
Age	0-24	25-74	75-374	75-149

Management Strategy

Forest strategies for restoring, maintaining, and enhancing the Northern Hardwood Forest ecological system should emphasize maintaining this system on the lands where it occurs. Some regeneration could take place, but it would not be a high priority.

Objectives

Objectives should focus on the extent of this system on the landscape.

6.6.3 Cove Forest

Desired Ecological Condition

These closed-canopy forests are found on concave landforms and often associated with riparian areas. Overstories are typically dominated by yellow poplar, hemlock, birch, magnolia, basswood, and red maple. Midstories are well developed and fairly diverse in acidic coves rhododendron is often abundant. Understories have a well-developed herb layer, often very dense and usually high in species richness, and it is present in all but the acid coves. Well-developed and fairly diverse subcanopy and shrub layers are often also present in all but the acid coves.

This system supports populations of associated rare species, such as ginseng. Regenerating forests (0-10 years old) comprise around 4 percent of system acreage. Late successional forests (100 years old or older) comprise around 57 percent of system acreage. Fire is not a major disturbance in this system and typically occurs only in driest of conditions.Open canopy structure is present on only about 9 percent of the area. On the Forest this type is interspersed with the oak dominated systems. Cove Forest often occupies land along riparian areas and adjacent to upland areas.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Late Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	4	39	9	48
Age	0-9	10-100	100-119	100+

Management Strategy

The management strategy for the Cove Forest is to utilize timber harvest to approach the early successional habitat objective since fire is not a common disturbance in this system.

Objectives

Objectives should focus on the structural conditions for early and late successional stages.

6.6.4 Oak Forests and Woodlands

Desired Ecological Condition

This is the most common ecological system on the Forest and can be viewed as the matrix forest in which the other types exist. Overstories are typically dominated by red oak, white oak, chestnut oak, black oak and scarlet oak. Heath shrubs such as blueberry, huckleberry and mountain laurel are common in the understory and often form a dense shrub layer. Regenerating forests (3-19 years old) comprise around 22 percent of system acreage. Fire is a very important

component of this system and results in open canopy structure on about 50 percent of the area. In many of the woodland areas native grasses are common.

Structural conditions are as follows:

Structure	Open	Early Successional Open Canopy	Mid-Late Successional Open Canopy	Late Successional Closed Canopy	Mid -Late Successional Closed Canopy
% of ecological system	4	22	50	17	7
Age	0-2	3-19	20-299	50+	20+

These categories are slightly different for this ecological type as compared to the others. It contains an open condition. These open areas (age 0-2yrs) are grassland historically maintained by frequently recurring fire (1-2yrs). These areas would typically be less than 100ac, but may have been up to 500 ac. The mid-late successional open canopy represents most of the system where fire maintains open canopy conditions. The late successional stages represent areas where fire is not a major component. The Mid to Late Successional Closed Canopy condition occurs where fire has been excluded long enough to develop a composition of mixed mesophytic species that then make opportunities for fire even more uncommon.

Management Strategy

Forest strategies for maintaining, and enhancing the oak systems rely heavily on utilizing fire to restore and maintain the open canopy conditions and the openings. Openings will also be maintained through direct creation and maintenance activities. Timber harvest will be another frequent technique of creating regenerating forests and creating desired open canopy conditions. Given its importance as a food source for many wildlife species, maintaining a high percentage of oak in ages that produce mast is also important.

Objectives

Objectives should focus on structural conditions for early succession, mature forest and open canopy conditions through restoration of the fire regime. Objectives should also include the need for open conditions and restoration of American chestnut.

6.6.5 Pine Forests and Woodlands

Desired Ecological Condition

Next to Oak Forest and Woodlands this ecological system is the most common on the Forest and occupies the upper slopes and south to west exposures. Overstories are typically dominated by table mountain pine, pitch pine, and some Virginia pine along with dry site oaks such as chestnut oak, scarlet oak, and bear oak. A dense heath shrub layer is almost always present. Mountian laurel is the most typical and dominant, but species of blueberry and huckleberry along with fetterbush may also be dominant. Native grasses and sedges are common along with dry site herbs and forbs. Their density varies depending on shrub cover. Regenerating forests (0-

13 years old) comprise about 13 percent of system acreage. Mid to late successional forests comprise approximately 87 percent of system acreage. Frequent fire occurring about every 3-9 years is a very important component of this system and result in open canopy structure on about 80 percent of the area.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Mid-Successional Open Canopy	Late Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	13	3	25	54	5
Age	0-15	16-70	16-70	71+	71+

Management Strategy

Fire will be the prime strategy for maintaining and enhancing the pine forests. Timber harvest will also be used to a lesser extent for regeneration.

Objectives

Objectives should focus on structural conditions, particularly the need for open canopy conditions and restoration of the fire regime.

6.6.6 Mafic Glade and Barrens and Alkaline Glades and Woodlands

Desired Ecological Condition

The alkaline systems consist of woodlands and open glades on thin soils over limestone, dolostone or similar calcareous rock. In some cases, the woodlands grade into closed-canopy forests. Eastern red cedar is often a common tree, and along with chinkapin oak is indicative of the limestone substrate. Warm season grasses such as big and little bluestem are often the dominant herbs; forb richness is often high. The mafic systems found in the Blue Ridge consist of vegetation associated with shallow soils over predominantly mafic bedrock (which is rich in iron and magnesium), usually with significant areas of rock outcrops. These areas support a patchy mosaic of open woodland and grassy herbaceous vegetation sometimes with a predominant woody short-shrub community present. The canopy species are species tolerant of dry, shallow soils, most commonly chestnut oak, pines and eastern red cedar. Shrubs may be dense, with species determined by soil chemistry. The herb layer is usually fairly dense and dominated by grasses, both in treeless areas and beneath open canopy. The forbs include species characteristic of other rock outcrops and grassland species, with a smaller number of forest species present.

Edaphic features largely control these areas, but the open nature of the glades, woodlands and barrens continue to be maintained through fire which is operating in its natural regime. Non-native invasive plants are not significant influence on vegetation in these areas. Recreation use

is managed so that it does not adversely affect the native vegetation. This system supports populations of associated rare species, including the marsh muhly, stiff goldenrod, drooping bluegrass, tall cinquefoil, and Rand's goldenrod.

Management Strategy

Forest strategies for maintaining, and enhancing this system include prescribed fire and managing wildfire, control of non-native invasive plants and monitoring and managing recreation use in the areas.

Objectives

Objectives should focus on the extent of the ecological system and the need for retaining open canopy conditions.

6.6.7 Cliff, Talus and Shale Barrens

Desired Ecological Condition

Vegetation on and near shale barrens is mostly classified as woodland, overall, but may include large open areas of sparse vegetation. Dominant trees are primarily chestnut oak, pitch pine, and Virginia pine, although on higher-pH substrates the common trees include eastern red cedar and white ash. Shale barren endemic plants are diagnostic in the herb layer. The substrate includes areas of solid rock as well as unstable areas of shale scree, usually steeply sloped.

The cliff and talus systems comprise sparsely vegetated to partially wooded cliffs and talus slopes. It consists of vertical or near-vertical cliffs and the talus slopes below. In some cases, this system may take the form of upper-slope boulderfields without adjacent cliffs, where talus forms from freeze/thaw action cracking the bedrock. Most of the substrate is dry and exposed, but areas of seepage are often present. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places.

Edaphic features largely control these areas, but the open nature of the talus and edges of shale barrens continue to be maintained through fire which is occurring in its natural regime. Non-native invasive plants are not a significant influence on vegetation in these areas. Deer browsing is not impacting native vegetation. Recreation use is managed so that it does not adversely affect the native vegetation. This system supports populations of associated rare species, including the shale barren rockcress, Millboro leatherflower, shale -barren blazing star, shale-barren evening primrose, Appalachian grizzled skipper, bristly sarsaparilla, chestnut lipfern, mountain sandwort, and three-toothed cinquefoil.

Management Strategy

Forest strategies for maintaining, and enhancing these systems include prescribed fire and managing wildfire, control of non-native invasive plants, managing deer browsing, and monitoring and managing recreation use in the areas.

Objectives

Appalachian Shale Barrens - At the end of the first decade of the Plan:

Objectives should focus on the extent of the ecological system and the need for retaining open canopy conditions.

6.6.8 Floodplains, Wetlands, and Riparian Areas

Desired Ecological Condition

Overstories are typically dominated by the same trees occupying the oak and cove forest types. Midstories and Understories are often well developed and diverse. This system supports populations of many associated rare species. Regenerating forests (0-10 years old) are uncommon, though small openings are present and are important for key species. Open wetlands and open beaver meadows and ponds provide much of the open habitat conditions. Late successional forest is common and makes up most of the canopy. Fire is rare.

Riparian corridors reflect the physical structure, biological components, and ecological processes that sustain aquatic, riparian, and associated upland functions and values. The preferred management for riparian corridors is one that maintains, or moves toward, the restoration of processes that regulate the environmental and ecological components of riparian areas. However, due to the high value that these areas have for many uses, evidence of human activity (developed recreation areas, roads and trails, dams and reservoirs, and pastoral areas) may be present.

Riparian corridors are managed to emphasize the maintenance, restoration, and enhancement of habitat for species that depend on riparian resources for at least a part of their life-cycle. Management may also occur to maintain, restore, or enhance habitat for other species that benefit from riparian resources as long as the needs of species that depend on riparian resources for at least a part of their life-cycle are met.

The soils of riparian corridors have an organic layer (including litter, duff, and/or humus) of sufficient depth and composition to maintain the natural infiltration capacity, moisture regime, and productivity of the soil (recognizing that floods may periodically sweep some areas within the floodplain of soil and vegetation). Exposed mineral soil and soil compaction from human activity may be present but are dispersed and do not impair the productivity and fertility of the soil. Any human-caused disturbances or modifications that cause environmental degradation through concentrated runoff, soil erosion, or sediment transport to the channel or water body are promptly rehabilitated or mitigated to reduce or eliminate impacts.

Trees within the corridors are managed to provide sufficient amounts and sizes of woody debris to maintain habitat complexity and diversity for aquatic and riparian wildlife species. Recruitment of woody debris typically occurs naturally; however, woody debris may be purposefully introduced to enhance aquatic and terrestrial habitat. Both in-stream and terrestrial woody debris are regarded as essential and generally left undisturbed.

The riparian corridor functions as a travel-way for aquatic and terrestrial organisms. The corridor serves as a connector of habitats and populations allowing gene flow to occur, thus keeping populations genetically viable. Stream structures -- such as bridges, culverts, and aquatic habitat improvement structures -- may be evident in some streams and water bodies. With the exception of some dams, most structures do not decrease in-stream connectivity.

Suitable habitat is provided in the riparian corridor for riparian flora and fauna; especially threatened, endangered, sensitive (TES) and locally rare species. Vegetation (dead and alive) reflects the potential natural diversity of plant communities with appropriate horizontal and vertical structure needed to provide the shade, food, shelter, and microclimate characteristics for aquatic and terrestrial species. Rehabilitation of past and future impacts (both natural and human-caused) may be necessary to protect resource values and facilitate recovery of riparian structure and functions.

Vegetative communities within the riparian corridor are diverse and productive, providing for a rich variety of organisms and habitat types. The vegetative community within the riparian corridor is predominately forested; however, some native non-forested communities such as wet meadows and grass or shrub dominated plant communities may occur. The desired vegetative condition of non-forested communities is determined by site-specific analysis.

The forest contains multiple canopy layers, which provide diverse habitat structure, and thermal and protective cover for wildlife. Snags used by birds, bats, and other small animals are abundant. Dying and down trees are common, often in naturally occurring patches. Wet meadows, non-forest communities, and open forest canopies, created by flooding, wind damage, wildland fire, insect infestations, disease, restoration, and vegetation management may be seen.

Streams are in dynamic equilibrium; that is, stream systems normally function within natural ranges of flow, sediment movement, temperature, and other variables. The geomorphic condition of some channels may reflect the process of long-term adjustment from historic watershed disturbances (e.g., past intensive farming or logging practices). The combination of geomorphic and hydrologic processes creates a diverse physical environment, which, in turn, fosters biological diversity. The physical integrity of aquatic systems, stream banks and substrate, including shorelines and other components of habitat is intact and stable. Where channel shape is modified (e.g., road crossings), the modification preserves channel stability and function.

The range of in-stream flows is maintained to support channel function, aquatic biota and wildlife habitat, floodplain function, and aesthetic values. Water uses and other modifications of flow regimes are evaluated in accordance with the national Forest Service in-stream flow strategy and site-specific analysis.

Water quality remains within a range that ensures survival, growth, reproduction, and migration of aquatic and riparian wildlife species; and contributes to the biological, physical, and chemical integrity of aquatic ecosystems. Water quality meets or exceeds State and Federal standards. Water quality (e.g.: water temperature, sediment level, dissolved oxygen, and pH) will be improved where necessary to benefit aquatic communities.

Floodplains properly function as detention/retention storage areas for floodwaters, sources of organic matter to the water column, and habitat for aquatic and riparian species. Modification of the floodplain is infrequent but may be undertaken to protect human life and property or to meet other appropriate management goals (e.g., restoration). There may be evidence of some roads, trails, and recreation developments. Some wetland habitats may show signs of restoration.

The biological integrity of aquatic communities is maintained, restored, or enhanced. Aquatic species distributions are maintained or are expanded into previously occupied habitat. The amount, distribution, and characteristics of aquatic habitats for all life stages are present to maintain populations of indigenous and desired non-native species. Habitat conditions

contribute to the recovery of species under the Endangered Species Act. Species composition, distribution, and relative abundance of organisms in managed habitats is comparable to reference streams of the same region. Some streams and lakes, however, may be stocked with non-native fish by the respective State natural resource agency.

Beavers are recognized as a keystone species that increase landscape heterogeneity and species diversity. Beaver ponds beneficially modify water flow rates, enhance groundwater recharge rates, raise water tables, sequester sediment, increase aquatic productivity, and modify water chemistry. Over time, beavers create a mosaic of habitats that are utilized by plants, amphibians, fish, insects, birds, and mammals that would not otherwise occur.

Management Strategy

Forest strategies for maintaining, and enhancing these systems rely on implementation of the standards originally developed to protect threatened and endangered fish and mussels on the Jefferson National Forest. Beaver populations are allowed to provide a variety of benefits.

Objectives

Objectives should focus on retaining the extent and the character of the areas.

Standards

Standards for the riparian corridor are established in the guidance for the Riparian Management Prescription Area. These should be the same as the standards developed for the the Fish and Mussell Conservation Plan that were incorporated into the Jefferson Forest Plan.

6.6.9 Caves and Karstlands

Desired Ecological Condition

This important ecological system is found to a limited degree on the Forest where it is associated with carbonate bedrock (limestone and dolostone) and often characterized by internal drainage. This bedrock type is typically found in valleys where it is dissolved by groundwater creating surface depressions (sinkholes) and underground caves and tunnels. These features are protected both from recreational damage and from polluted water, which, in turn, protects the species that depend on them.

Standards

Compliance with Cave and Karstland Guidelines should be met through use of standards like:

- FW-63: A minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer. Wider buffers are identified through site-specific analysis when necessary to protect caves from potential subterranean and surface impacts. Perennial, intermittent, channeled ephemeral stream standards will apply beyond the first 200 feet.
- FW-64: The use of caves for disposal sites or the alteration of cave entrances is prohibited except for the construction of cave gates or similar structures to ensure closure.

- FW-65: Management activities within any area draining into a cave are limited if they may affect the cave ecosystem through sedimentation, soil sterilization, the addition of nutrients or other chemicals (including pesticides and fertilizers), or if they change the cave's natural hydrology or micro-climate.
- FW-66: Post and enforce seasonal closure orders around entrances of caves and abandoned mines occupied by significant populations of bats, to reduce the frequency and degree of human intrusion. Prohibit camping and campfires at the entrance to caves, mines, and rock shelters used by bats.
- FW-67: If such closure orders are found to be ineffective, construct and maintain gates or other structures that allow for entrance and egress by bats. If necessary to further discourage human disturbance to caves occupied by significant populations of bats, close non-essential public access routes controlled by the Forest Service within ¼ mile of cave entrances during periods of use by bats.
- FW-68: Human access to caves for educational and recreation use may be allowed during periods when bats are not present. If damage to a cave occurs as a result of such use, close the cave. Allow human access (i.e. scientific study) on a case-by-case basis when bats are present.
- FW-69: The specific location of a Significant cave cannot be made available to the public unless it is determined that disclosure of this information would not create a substantial risk of harm, theft, or destruction of the cave. Significant and potentially significant caves on the Forest are managed in accordance with the Cave Resources Protection Act of 1988 (16 U.S.C. 4301-4309) to protect them through regulating their use, requiring permits for removal of their resources, and prohibiting destructive acts.
- FW-215: Identify, using the appropriate type and scale of geologic mapping, the geologic components (processes, structures, materials, and landforms), such as groundwater and karst, relevant to proposed projects, and integrate the components into: 1) siting and design of the project; 2) restoration; 3) ecological sustainability; and 4) environmental analysis.
- FW-215a: Locate and design projects to minimize potential adverse effects on groundwater and groundwater dependent ecosystems. In karst areas, integrate geologic assessment in project design and monitoring.
- FW-145: Identify caves or abandoned mines that contain significant populations of bats as smoke-sensitive targets. Avoid smoke entering these caves or mines when bats are hibernating (generally this is Nov 1 to April 1).
- Indiana bat Standards

Management Strategy

Forest strategies for maintaining and enhancing caves and karstlands include management to maintain the hydrology and not affect water quality in area draining into cave systems or in karst terrain. Monitoring of cave use and gating caves when needed to protect cave features and the biota are also components.

6.6.10 Special BiologicAreas

Desired Ecological Condition

Botanical-Zoological areas are managed for the following: (1) protection of threatened, endangered, sensitive, or locally rare species from human taking or human-caused detrimental habitat changes; (2) stable or increasing populations of threatened, endangered, sensitive, or locally rare species; and (3) functioning ecosystems.

Specific management activities necessary to maintain, restore, or enhance threatened, endangered, sensitive, and locally rare species for each special biological area are described in the Virginia Department of Conservation and Recreation, Division of Natural Heritage, Reports of Special Biological Areas (1991, 2000) and other pertinent biological reference material.

These management activities will result in a forest successional stage appropriate for maintaining the threatened, endangered, sensitive, and locally rare species. All areas are protected from human-caused detrimental habitat change, the taking of threatened or endangered species, and the collection of living plants or animals unless such collections are used for achieving the stated management goals. Access to these areas may be limited.

Management Strategy

The 108 Special Biological Areas on the GWNF all support ecosystem diversity and rare natural communities and assemblages of rare plant and animal species are represented there. These conditions of these communities are maintained or enhanced from their current condition. Management strategies are developed for each the Special Biological Areas that include needed management actions and monitoring needs.

6.6.11 Additional Guidance

Indicators for two of the ecological systems include compliance with Non-Native Invasive Species Guidelines. These guidelines include management strategy and standards such as:

- Management of non-native invasive species will focus on four components: 1) prevention of new infestations; 2) elimination of new infestations before they become established; 3) containment or reduction of established infestations; and 4) reclamation of native habitats and ecosystems.
- Post and maintain signs at trailheads and use other opportunities to inform OHV and ATV users to thoroughly wash their OHVs and ATVs to remove all soil, seeds, and other attached material prior to coming on the Forest.
- Utilize public notification such as posting signs in campgrounds to control the movement of firewood into Forest campgrounds and other dispersed campsites.
- NNIP parts capable of starting new plants (seeds, rhizomes, etc.) need proper disposal. Options include piling and burning on site, or bagging-and moving off site. Bagged plants should either be incinerated or should receive standard garbage disposal. For large woody bushed that are difficult to move, treatments should be scheduled prior to seed set, as practical.
- Use of mowing as a NNIP control method should be timed to avoid spreading seeds (e.g., before seed set).

- Retain native vegetation and limit soil disturbance as much as possible.
- Following NNIP treatments, exposed soils will be promptly revegetated to avoid recolonization by NNIP or potential soil erosion. Only approved seed mixtures and weed seed-free mulch should be used.
- FW-86: The use of Category 1 Species is prohibited.
- FW-87: The establishment or encouragement of Category 2 Species is prohibited in areas where ecological conditions would favor invasiveness and is discouraged elsewhere. Projects that use Category 2 Species should document why no other (non-invasive) species will serve the purpose and need.
- FW-88: Favor use of native grasses and wildflowers beneficial as wildlife foods when seeding temporary roads, skid roads, log landings and other temporary openings when slopes are less than 5%. On slopes greater than 5%, favor use of vegetation that best controls erosion.
- FW-88a: Planning for management activities includes consideration of existing and potential non-native invasive plant (NNIP) threats. Site-specific plans should include control/eradication treatments and follow up monitoring of those treatments for effectiveness. Examples include inventory and treatment of log landing and haul road sites for timber sales, control lines (particularly those with soil disturbance) and areas near existing seed sources for prescribed burns, and trail corridors for trail construction.
- FW-88b: A contractor's sources of fill, soil, shale, and related materials will be pre-approved. Contractors will submit a description of the source. The project inspector or a qualified designee will inspect the supply source. Use of the source will be prohibited if contaminated by transferable agents of invasive species.
- FW-88c: Forest sources of fill, borrow or road surfacing material will be examined for NNIP and treated as necessary to prevent transfer of invasive plants to other parts of the Forest.
- FW-88d: Mechanical equipment, such as that used for logging, mowing, fire fighting and earth moving (including road graders), should be free of soil, seeds, and other attached material prior to coming on the Forest or being moved from areas on the Forest with NNIP infestations to areas free from noticeable infestations. Such equipment should be examined by qualified Forest Service personnel before allowed on the Forest.
- FW-88e: Personnel treating NNIP infestation will take appropriate measures to prevent transporting seeds or other propagules to other sites. Such measures may include cleaning equipment at the treatment site after treatment, bagging the equipment until such time that it can be cleaned (e.g. hand sprayers), removing and bagging outer garments after treatment, brushing clothing and boots thoroughly before departing the treatment site.
- FW-88f: Fueling of oiling of mechanical equipment will occur away from aquatic habitat.
- FW-88g: When work is conducted in areas containing TESLR plant species, those plants will be flagged, marked or identified for applicators to avoid spraying. A physical barrier will be used to protect non-target species when they occur immediately adjacent to the treatment area.

- 1A-008 Forest insect and disease outbreaks are controlled only if necessary to prevent unacceptable damage to resources on adjacent land, prevent an unacceptable loss to the wilderness resource due to non-native pests, or protect threatened, endangered, and sensitive species.
- 1A-011 Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied chemicals, with Regional Forester approval, when necessary.
- 2C2-010 Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied chemicals, with Forest Supervisor approval, when necessary.
- 2C3-007 Aggressively control insect and disease outbreaks when threatening the outstandingly remarkable values of the river corridor or when needed for safety or legal reasons. Consider eradication of recently established non-native pests. Favor the most effective control method.
- 4B-001 Native forest insect and disease outbreaks are controlled only to protect threatened, endangered, and sensitive species or to prevent unacceptable damage to resources on adjacent land. Non-native invasive insects and diseases may be eradicated or suppressed. Favor biological control methods.
- 4B-002 Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary.
- 4C1-003 Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, and sensitive species. Non-native invasive insects and diseases may be eradicated or suppressed. Favor biological control methods.
- 4C1-004 Eradicate non-native invasive vegetation when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary
- 4D-004 Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, sensitive, or locally rare species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the special biological community. Favor biological control methods.
- 4D-005 Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary.
- 4D-006a Control non-native invasive species (plants, animals, insects, and diseases) where they are causing negative effects to rare communities. Do not introduce non-native species in or near rare communities, unless it is a natural enemy of an non-native pest.
- 4E-006 Control insect and disease outbreaks when necessary to protect the cultural/historic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- 5A-001 Aggressively control forest insects, diseases, and non-native invasive plants using the most effective control method. Salvage is allowed.
- 5B-003 Aggressively control non-native, invasive plant species within these areas.
- 5C-001 Aggressively control non-native, invasive plant species within these corridors.
- 7A1-003 Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.

- 7B-006 Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- 7C-012 The forest health strategy is to diminish the occurrence of pest problems by managing host-type conditions at low hazard. Use appropriate and practical suppression of pests, both non-native and native, with all available tools as the normal practice.
- 7D-004 The forest health strategy is to prevent the occurrence of pest problems by managing host-type conditions at low hazard. Aggressive suppression of pests, both non-native and native, with all available integrated pest management tools is normal practice. Favor the most effective control method. Salvage, cut and leave, and pruning are rapid and complete to protect the health and safety of visitors and facilities.
- 7E-003 Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, and sensitive species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the old growth community. Favor biological control methods.
- 7E-004 Eradicate non-native invasive plants when the infestations are isolated. Use approved hand-applied pesticides, when necessary.
- 7F-009 Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- 7G-002 Eradicate non-native invasive plants.
- 8E7-006 Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, sensitive, or locally rare species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the special biological community. Favor biological control methods.
- 8E7-007 Control or eradicate non-native invasive plants using hand-applied herbicides, with Forest Supervisor approval, when necessary.
- 8E7-008 Control non-native invasive animals, insects, and diseases where they are causing negative effects to rare communities. Do not introduce non-native species in or near rare communities, unless it is a natural enemy of a non-native pest.
- 12D-004 Suppression and eradication of non-native pests are allowed.
- 13-006 The forest health strategy is to minimize the occurrence of pest problems by managing host-type conditions. Suppression of pests, both non-native and native, is accomplished with all available integrated pest management tools.
- 13-007 Proactively manage species composition and tree vigor in stands at a level that reduces susceptibility to damage from insect and disease infestations and other forest health problems like oak decline. Suppress native and non-native insects and diseases using an integrated pest management approach.

6.7 Forest Plan Strategies for Addressing Ecological Stresses and Threats

Appendix 1 contains a summary of some of the strategies considered in alternatives to address the identified stresses and threats to the ecological systems.

Appendix 1 Ecological Systems Stresses, Threats and Strategies

Target Name	Stress	Threat	Strategy
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	6.1 Recreational activities	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	6.1 Recreational activities	Objective to maintain or increase acres of spruce forest
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.3.1 Limited existing distribution of system/habitat	0 None or Unknown	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Caves and Karstlands	1 Terrestrial System/Habitat Stresses	6 Human intrusions and disturbance	Establish guidelines for caves and karstlands
Caves and Karstlands	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Caves and Karstlands	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Cliff, Talus and Shale Barrens	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	8.2 Problematic native species	Establish desired condition for shale barrens

Target Name	Stress	Threat	Strategy
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	8.2 Problematic native species	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Cliff, Talus and Shale Barrens	1.3 Limited distribution of the system/habitat	0.1 None	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.3 Limited distribution of the system/habitat	0.1 None	Establish guidelines for cliff and talus and shale barren areas
Cove Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish desired condition for cove forests
Cove Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish Invasive Species Control Guidelines
Northern Hardwood Forest	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Northern Hardwood Forest	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Establish management strategy for climate change incl land allocation, obj and desired conditons
Northern Hardwood Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish Invasive Species Control Guidelines
Northern Hardwood Forest	1.3 Limited distribution of the system/habitat	11.1 Geographic shifts in climate	Establish management strategy for climate change incl land allocation, obj and desired conditons
Oak Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Oak Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Oak Forests and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Oak Forests and Woodlands	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pine Forests and Woodlands	1.2 Modification of vegetation	11.3 Temperature extremes	Establish objective for mature pine forests
Pine Forests and Woodlands	1.2 Modification of vegetation	11.3 Temperature extremes	Establish objective for pine open woodlands
Pine Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year

Target Name	Stress	Threat	Strategy
Pine Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Pine Forests and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Pine Forests and Woodlands	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pine Forests and Woodlands	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	
Floodplains, Wetlands and Riparian Areas	1.1 Conversion and fragmentation	7.32 Off Road Vehicles	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Floodplains, Wetlands and Riparian Areas	1.2 Modification of vegetation	8.1 Non-native invasive species	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3 Limited distribution of the system/habitat	0.1 None	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3.1 Limited existing distribution of system/habitat	7.33 Lack of disturbance; succession	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3.2 Limited potential distribution of system/habitat	7.34 Loss of beaver activitiy	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	6 Human intrusions and disturbance	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.1 Stream flow modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.1 Stream flow modification	7.2 Dams and water management	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.4 Water chemistry modification	9.5.1 Acid deposition	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.5 Aquatic/Riparian system modification	11.2 Droughts	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.5 Aquatic/Riparian system modification	8 Invasive & problematic species	Utilize Jefferson riparian standards
Spruce Forest	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Spruce Forest	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Objective to maintain or increase acres of spruce forest
Spruce Forest	1.2 Modification of vegetation	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition

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U.S. Department of Agriculture

Forest Service

Southern Region

Species Diversity Report

George Washington National Forest

April 2011

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1.0 Introduction

Planning for ecological sustainability is an iterative two-stage process that involves first providing for a diversity of ecosystems and then by developing additional direction to meet the biological needs of specific species or species groups. Most plant and animal species will be sustained by managing for a diversity of ecosystems in the Plan area. However, additional provisions may be needed to help provide ecological conditions for specific species such as federally listed threatened and endangered (T&E) species, sensitive species and locally rare species.

This Species Diversity Report is a supplement to the Ecosystem Diversity Report, which described how the ecological characteristics for ecosystems on the George Washington National Forest (GWNF) were identified. Ecosystem characteristics were evaluated through development of an Ecological Sustainability Evaluation (ESE) database or tool, best available science, consideration of data and trends documented in the Evaluation of the Need for Change Report/Analysis of the Management Situation (AMS), annual monitoring evaluations, and internal reviews. A similar analysis process was also used to assess species diversity. This report describes the species evaluation process and uses the understanding gained from analysis of ecosystem diversity to develop additional plan components for species diversity.

2.0 Species Diversity

2.1 Ecosystem Context for Species

Nineteen native ecosystems were identified for the GWNF. A system was added to cover caves and karstlands. Current acreage of each system was calculated using Forest Service GIS data. All identified terrestrial ecological systems were documented in a relational database, the ESE tool, which was based on the structure of The Nature Conservancy (TNC) planning tool. The ESE tool served as the primary process record for ecological sustainability analysis. It included documentation of scientific and other sources consulted, uncertainties encountered, and strategic choices made during development of the database.

Ecological conditions that provide for ecosystem diversity are described in detail in the Ecosystem Diversity Report. These ecological conditions were further analyzed to understand the environmental context and ability for National Forest System (NFS) lands to contribute to the diversity of plant and animal species. The following analysis process was used to determine whether, in addition to plan components for maintaining ecosystem diversity, further species-specific plan components were necessary to sustain species diversity.

As we developed the ecosystem diversity analysis, we identified that many of the ecological systems had similar key attributes, indicators, species associates and resulting forest plan components. For purposes of analysis we combined the systems into the following Ecological System Groups for the ESE Tool:

Table 1. Ecological Systems

Ecological System Groups	Ecological System
Spruce Forest	Central and Southern Appalachian Spruce-Fir Forest
Northern Hardwood Forest	Appalachian (Hemlock)-Northern Hardwood Forest
Cove Forest	Southern and Central Appalachian Cove Forest
Oak Forests and Woodlands	Northeastern Interior Dry-Mesic Oak Forest
	Central and Southern Appalachian Montane Oak Forest
	Central Appalachian Dry Oak-Pine Forest
Pine Forests and Woodlands	Southern Appalachian Montane Pine Forest and Woodland
	Central Appalachian Pine-Oak Rocky Woodland
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Southern and Central Appalachian Mafic Glade and Barrens
	Central Appalachian Alkaline Glade and Woodland
Cliff, Talus and Shale Barrens	North-Central Appalachian Circumneutral Cliff and Talus
	North-Central Appalachian Acidic Cliff and Talus
	Appalachian Shale Barrens
Floodplains Wetlands and Riparian Areas	Central Appalachian Floodplain
	Central Appalachian Riparian
	Central Interior Highlands and Appalachian Sinkhole and Depression Pond
	Southern and Central Appalachian Bog and Fen
	North-Central Appalachian Acidic Swamp
	North-Central Appalachian Seepage Fen
Caves and Karstlands	Caves and Karstlands

Key attributes and indicators were identified for each of these systems to determine if the systems are performing to their desired conditions.

2.2 Identification and Screening of Species

The GWNF started with statewide species lists compiled from a variety of sources including the Birds of Conservation Concern list, Virginia and West Virginia State Heritage Programs tracked plant and animal lists, Virginia and West Virginia State Comprehensive Wildlife Strategy species of greatest conservation need list, Regional Forester's Sensitive Species list, federally listed Threatened and Endangered Species, and demand species. The original list consisted of about 474 plant and animal species with ranges occurring throughout the states.

Appendix 1 lists the 97 species which were removed from the list because they did not occur or have potential to occur on NFS-administered land based upon suitable habitat, range, or expert taxonomic consensus. If these species are found to occur on the GWNF, they will be re-evaluated. Of the remaining species an additional 82 species were not analyzed further because: a) the species is unaffected by management; b) the Forest is of marginal importance to conservation of the species; c) knowledge of species' ecology is insufficient to support conservation strategy; d) species' taxonomy is too uncertain to develop conservation strategy; or d) species is common and demonstrably secure on the Forest.

The remaining 295 species are addressed in this analysis. Eighty-four of these species have not been found on the Forest, but could possibly be present and nine are only historical records of species that have not been recently found.

3.0 Threatened and Endangered Species

This section covers threatened and endangered (T&E) species, which are those species listed by the Department of the Interior, U.S. Fish and Wildlife Service, or the National Oceanic and Atmospheric Administration, National Marine Fisheries Service as threatened or endangered. The U.S. Fish and Wildlife Service (USFWS) is the agency responsible for listing T&E species on lands managed by the GWNF. The Forest Service cooperates with USFWS efforts in conserving T&E species through protection and habitat management. The Forest Service conducts activities and programs to assist in the identification, conservation, and protection of threatened and endangered species and their habitats. Site specific evaluations are conducted for any proposed activity that may take place within habitat for these species or near known populations. The GWNF program priorities for T&E species include:

- Implement Forest Service actions as recommended in recovery plans for federally listed species. In the absence of an approved recovery plan, implement and, if necessary develop interim Forest Service conservation measures. Update interim conservation measures as needed when new science becomes available.
- Work with USFWS and other conservation partners to develop recovery plans for federally listed species and candidate conservation agreements for species proposed for listing.
- Coordinate with partners to implement measures to resolve conflicts with threatened and endangered species and their habitats.
- Monitor trends in population and/or habitat of federally listed species.

3.1 Threatened and Endangered Species List

The GWNF worked cooperatively with the USFWS to develop the list of federally threatened or endangered species to be considered in the ESE process. Eight T&E species were evaluated in the ESE process (Table 1). These 8 species are further described below.

Table 2. Federally listed T&E species included in Forest Plan revision process

Taxa	Species	Status
Mammal	Indiana Bat (*Myotis sodalis*)	Endangered
Mammal	Virginia Big-Eared Bat (*Corynorhinus townsendii virginianus*)	Endangered
Mussel	James Spinymussel (*Pleurobema collina*)	Endangered
Vascular Plant	Shale Barren Rock Cress (*Arabis serotinai*)	Endangered

Taxa	Species	Status
Vascular Plant	Smooth Cone Flower (*Echinacea laevigata*)	Endangered
Vascular Plant	Virginia Sneezeweed (*Helenium virginicum*)	Threatened
Vascular Plant	Swamp Pink (*Helonius bullata*)	Threatened
Vascular Plant	Northeastern Bulrush (*Scirpus ancistrochaetus*)	Endangered

3.2 Threatened and Endangered Species Descriptions and Plan Components

3.2.1 Indiana Bat

Background

A Biological Assessment was written in April 1997 to analyze effects to the Indiana bat resulting from continued implementation of the George Washington and Jefferson National Forest Plans. Formal Consultation with the Annapolis Field Office of the U.S. Fish and Wildlife Service was requested on May 12, 1997 which included a request for incidental take. On September 16, 1997 a Biological Opinion was issued that included incidental take provisions along with Terms and Conditions and Conservation Recommendations. The George Washington Forest Plan was amended (Amendment #6) to include provisions resulting from that formal consultation. Information presented in the 1997 Biological Assessment and Biological Opinion is still pertinent to the current revised George Washington Forest Plan and is therefore incorporated by reference.

On March 11, 1967, the Indiana bat was listed as a federal endangered species under the Endangered Species Preservation Act (ESPA) of 1966. Species listed under ESPA carried over and became listed by the Endangered Species Act when it became law in 1973. A recovery plan for the species was completed on October 14, 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision has never been completed.

Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and Hellhole Cave in Pendleton County, West Virginia. No critical habitat is on or near the GWNF. The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Bats are often readily found and easily counted at this time. Census of hibernating Indiana bats is the most reliable method of tracking population trends rangewide. As such, winter distribution of

the Indiana bat is well documented. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn period, bats roost under sloughing bark and in cracks of dead, partially dead and live trees.

The U.S. Fish and Wildlife Service in 2007 reported the total population of Indiana bats at a recent historic high of approximately 468,181 individuals. This total is still less than half the estimated population in 1960. The 2009 population of Indiana bats was estimated to be 387,835 individuals. Reasons for the decline from 2007 are unknown, but some speculation is that the decline was caused by White Nose Syndrome (WNS) which is causing severe bat mortality in the eastern U.S. Indiana bats hibernate in approximately 336 hibernacula (USFWS, 2010). Indiana has 49% of hibernating individuals followed by Kentucky 15%, Illinois 14%, New York 8%, West Virginia 4%, Missouri 4%, Tennessee 3%, Ohio 2% and the remaining eight states with hibernacula (including Virginia) <1%. The eight largest "Priority One" hibernacula (recorded population >30,000 since 1960) contain 199,000 Indiana bats, or 52 percent of the total known population. The 69 hibernacula classified as "Priority Two" (recorded population >500 but <30,000 bats since 1960) contain 174,000 Indiana bats, or 45 percent of the total known population. The remaining 259 caves known to have been occupied by Indiana bats contain only 15,000 bats, less than 4 percent of the total population (the four hibernacula on or near the Forest – Starr Chapel, Mountain Grove, Clarks, and Hupman's Saltpetre Caves - are in this category). Although the winter range is large, the known population of the species has been found in only 336 hibernacula in an area with tens of thousands of caves (and mines). Within 5 miles of the George Washington & Jefferson National Forests, eleven hibernacula for Indiana bats are known from 7 counties in Virginia (Bath, Bland, Craig, Highland, Lee, Tazewell, and Wise) and 1 county in West Virginia (Monroe). The Virginia Fish and Wildlife Information Service has additional historic records of Indiana bats wintering in Dickenson, Giles, Montgomery, and Shenandoah counties. Critical habitat for the Indiana bat has not been designated in Virginia. Currently all 12 caves have been gated to reduce or eliminate human disturbance. All 12 caves continue to support varying numbers of Indiana bats.

The Indiana bat has been documented in Virginia since the mid-1960's. In the early 1960's, the state's Indiana bat population was estimated at over 5,000. Dalton (1987) found 2,500 Indiana bats hibernating in eight caves during a 10-year survey of 170 caves in 22 counties. In 1997 the state's population was estimated to be 1,840 bats. The following table illustrates population numbers in VA and WV since 2001:

Table 3. Indiana bat population levels

	2001	**2003**	**2005**	**2007**	**2009**
Virginia	969	1,158	769	723	730
West Virginia	9,714	11,444	13,417	14,745	14,855

All four caves that occur on or near the Forest that support hibernating Indiana bats are gated to control human access. The following table displays numbers of bats seen during winter survey counts conducted over the past 40 years in four caves in or near the Forest (Table 3a). Numbers fluctuate from count-to-count but those caves that have lower numbers of bats seem to maintain low numbers while those with higher numbers maintain relative higher numbers of bats. Steps have been taken by the GWNF to protect these caves for the Indiana bat. Since 1995, bat gates have been installed on all significant caves used by T&E bats on the Forest. Starr Chapel Cave and Mountain Grove Cave on the Warm Springs Ranger District, are the only caves on National Forest land which serve as hibernacula for Indiana bats. Clarks Cave and Hupman's Saltpeter Cave are on private land, but within 2-miles of Forest land. Therefore portions of the primary and/or secondary cave protection areas extend onto the Forest. Over the past 15-years Rick Reynolds of the Virginia Department of Game and Inland Fisheries has assisted the Forest in monitoring bats during winter surveys and assisting with other studies.

Table 3a. Indiana Bats in Hibernacula On or Near the GWNF

(Caves with Primary and Secondary Cave Protection Areas on land managed by GWNF)
(Number of Bats Counted per Rick Reynolds - VDGIF)

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
1960	600			
1962	600			
1970				
1972	35			
1974	30			
1978	2			
1979	1			
1980	0			
1981		0		
1982	16	0		
1983	29			
1984				
1985	30			
1986		0	21	
1987	5		52	
1988			31	0
1989	36			
1990	37	5	22	26
1991	23			0
1992	38	23	0	220
1993	31	0		
1994	42	1	20	300
1995	60			
1996			0	225
1997	54			
1998		2		
1999	55		1	

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
2000				
2001		2		5
2002				
2003	67		47	4
2004				
2005	57		50	0
2006				
2007	68		49	
2008				
2009	61		48	
2010				
2011	*	*	*	*

Blank cells = no survey done that winter.
* Survey for 2011 still ongoing as of 2-15-2011

It is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional, or local level due to the variability of known roost sites and lack of knowledge about landscape scale habitat characteristics. Forest management practices that affect occupied roost trees may have local impacts on Indiana bat populations. However, the bats live in highly altered landscapes, depend on an ephemeral resource (dead and dying trees) and appear to be very adaptable. Anecdotal evidence suggests that these bats may respond positively to some degree of habitat disturbance (USDI Fish and Wildlife Service 1999). General standards that would help ensure adequate roost habitat include retention of snags and suitable roost trees whenever possible, prescribed burning to restore and maintain open midstory foraging conditions (using only cool season backing fires in karst areas), and ensuring a continuous supply of oaks, hickories, and ash as well as other trees with exfoliating bark (Menzel et al. 2001).

During summer, reproductive females form maternity colonies in trees. Maternity colonies may be formed hundreds of miles from the hibernacula, and females from a maternity colony may come from more than one hibernaculum. In contrast, males often use wooded areas near the hibernaculum, occasionally visiting the hibernaculum throughout the summer. Males sometime migrate long distances to summer habitat, although they tend to be less migratory than females, and often, though not always, remain geographically close to the hibernacula. During this time, males often roost individually, and likely use trees similar in character to those used near hibernacula in autumn and spring. Wooded lands closer to hibernacula are more likely to support males in summer than areas farther away, but essentially all of the George Washington National Forest may provide suitable summer habitat. Although most of the lands within the Forest provide suitable summer habitat for the Indiana bat, based on observations and field surveys, no juveniles or lactating females have been found. There is no evidence to date that maternity colonies occur in Virginia or within the GWNF. The core summer range of the Indiana bat is southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio. West Virginia is within the eastern maternity range, but not within the core range. Maternity colonies are known to occur in some eastern states, such as Kentucky and North Carolina. In the summer of 1995, six male Indiana bats were captured in Tucker County, West

Virginia. These captures represent the first documented summer use in West Virginia by Indiana bats and suggest that males in West Virginia use areas near the hibernacula during summer. Until 2004 the best evidence of maternity activity in West Virginia was the discovery of a juvenile male on August 5, 1999 (Kiser et al. 1999b). This is outside the defined maternity period and likely represents a juvenile migrating to a nearby hibernaculum. Then during the summer of 2004 surveys found a maternity colony estimated at 25 Indiana bats in Tucker County, West Virginia within two-miles of a known hibernaculum (USFS, 2009). That same summer three male Indiana bats were captured on the Monongahela National Forest in Pendleton County and tracked to a roost tree where 23 other bats were subsequently counted (USFS 2009). To date no maternity colonies or reproductive female Indiana bats have been captured in Virginia during the summer reproductive season. In summer 1993, Chris Hobson of the Virginia Division of Natural Heritage surveyed areas of Bath, Bland, Highland, Lee, Tazewell, and Wise counties in proximity to known hibernacula. No female Indiana bats were captured and seven males were captured at five sites. One of the males, captured on July 28, 1993 in Cumberland Gap National Historic Park, Lee County, was a juvenile, suggesting that a maternity colony may be located in the Cumberland Gap area of Virginia, Kentucky, or Tennessee. These captures are the only documented summer Indiana bat occurrences in Virginia and suggest that males, at the least, use areas near the hibernacula during summer in western Virginia (Hobson, 1993). Brack and others analyzed summer netting efforts 1995 to 2000 to identify summer reproductive populations in Virginia, West Virginia, and portions of Pennsylvania considered within the summer range of the Indiana bat. Over 3,000 net nights of effort failed to produce evidence of any maternity colonies.

Autumn swarming and spring staging typically occur in woodlands near the hibernacula with use of the hibernacula increasing as autumn progresses towards winter and decreasing as spring progresses towards summer. Little is known about the habitat used by either sex during migration, although it is generally presumed to include a variety of wooded habitats. The following is an excerpt from the USDI Fish and Wildlife Service (1999) Revised Draft Indiana Bat Recovery Plan: “Although certain migration patterns may be inferred from limited band returns, they should be interpreted with caution. The sparse band recovery records, all of which are from the Midwest, indicate that females and some males migrate north in the spring upon emergence from hibernation (Hall 1962; Barbour and Davis 1969; LaVal and LaVal 1980), although there is also evidence that movements may occur in other directions. However, summer habitats in the eastern and southern United States have not been well investigated; it is possible that both sexes of Indiana bats occur throughout these regions. Very little is known about Indiana bat summer habitat use in the southern and eastern United States, or how many Indiana bats may migrate to form maternity colonies there. Most summer captures of reproductively active Indiana bats (pregnant or lactating females or juveniles) have been made between April 15 and August 15 in areas generally north of the major cave areas. While these observations suggest that many or most female Indiana bats in the Midwest migrate north in the spring and south in the fall, potentially significant numbers also migrate in other directions.” When Indiana bats are captured in spring or autumn, especially when caught near a cave or mine, there is generally no way to determine why the bat was in the area. Indiana bats may use caves and mines during the non-maternity season (autumn through spring) for one or more reasons: 1) winter hibernation (and “preparation” for hibernation); 2) autumn swarming; 3) spring staging; and 4) vagrant or migratory use. Hibernacula tend to have higher use in spring and autumn, and larger winter concentrations typically produce greater spring and autumn use. In West Virginia, a male juvenile caught on August 5, 1999 (Kiser et al. 1999b) was likely migrating to a nearby

hibernaculum. As noted above, Indiana bats hibernating in mountainous regions of West Virginia may travel to warmer areas in the western part of the state or states to the west to raise their young. Brack and others indicated that nursery colonies were less likely in higher elevations and areas of cooler temperatures. During a survey of coal mining operations in Wise County Virginia, a consulting firm documented use of an abandoned coalmine by a female Indiana bat on April 14, 2001 which may have been a migratory individual. During autumn swarming and spring staging, Indiana bats use the cave hibernacula and nearby wooded habitats. In autumn, use of woodlands decreases over time as bats enter hibernation. The converse is true in spring. Two recent telemetry studies documented use of a variety of habitats within 2 miles of two caves on the Jefferson National Forest. In late September 1999 four Indiana bats (3 males, 1 female) were trapped and fitted with radio transmitters at the entrance of Rocky Hollow Cave in Wise County. From September 23rd to October 13th (21 days) three roost trees were located (all on private land) that were used by two of the bats (one male and one female). The female used two different trees in open woodlands approximately 1.5 miles southwest of the cave near the Lonesome Pine Country Club. One was a shagbark hickory 19" DBH (diameter breast height) and the other was a yellow poplar with peeling bark next to a skid-road that had been damaged during a logging operation. The tree occupied by the male bat was used as a roost on multiple days and was a pignut hickory 27.9" DBH located 0.15 miles north of the cave. Other observations made during the course of the study included extensive foraging activity over hayfields and along edges of forests and fields. During September and October of 2000 an extensive survey was made of fall swarming activity near Newberry-Bane Cave in Bland County, Virginia as part of the proposed American Electric Power (AEP) 765 kV Wyoming (WV) to Jacksons Ferry (VA) powerline project. This work was conducted by Virgil Brack of Environmental Solutions and Innovations, Cincinnati, Ohio and is documented in the Appendix to the Biological Assessment for the EIS associated with that project. Of 27 Indiana bats captured (24 males and 3 females) at the mouth of Newberry-Bane Cave, 17 (14 males and 3 females) were fitted with transmitters. Radio-tagged bats were monitored between September 9th and October 21st within 2-miles of the cave entrance.

Information gathered on foraging ecology found that Indiana bats most frequently used agricultural land (44.7%), intermediate deciduous forests (22.6%), and open deciduous forests (19.0%) habitats types, comprising 86.3% of all habitat types used for foraging during the survey. The bats' activity areas included proportionally more agricultural lands and open forests than was available in the study area. Closed canopy woodlands were not used by foraging bats to the extent they were available. The study concluded that Indiana bats more frequently used rights-of-way, pasture edges, savannah-like woods, and other openings rather than large, continuous tracts of closed canopy forests. These findings are consistent with the interpretation of telemetry data in similar studies.

For roosting ecology the study found a total of 26 roost trees for 8 of 17 bats fitted with transmitters. Of the 26 roost trees, 39% were shagbark hickories (*Carya ovata*) and 12 % northern red oak (*Quercus rubra*), for a total of 51%. Other tree species used as roosts included white oak (*Quercus alba*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), American basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*). Five (19%) of the roost trees were dead snags. All roost trees were located in close proximity to the cave entrance ranging from 0.16 to 0.86 miles, with an average distance of 3,280 feet (0.6 miles). All roost trees were located near

forest canopy openings such as open woodlands of pastures, scattered trees of recently logged areas, old logging roads, utility line corridors, and natural drainages. Five of the eight bats used the same roost tree for two to three consecutive days. Roosts were located in all types of deciduous forests, but exhibited a disproportionately small use of mixed evergreen and deciduous forests. Roosts trees were very exposed with little or no canopy. It is likely that in doing so the bats were taking advantage of exposure to solar radiation in order to better regulate body temperature. Many open-canopy areas existed due to recent logging activity that left scattered trees within the harvested areas. Roosts in closed canopy deciduous forests were often in small openings near open corridor flyways.

While much of the activity observed during the study was close to the cave (within approximately 0.6 mile) bats also left the 2-mile study area all together. Males more so than females tended to range further from the cave. Perhaps they would leave to forage where there was less competition for prey (the caves in the area serve as hibernacula for over 8,000 individual bats of at least five different species) and return to the cave area periodically to mate. It's therefore likely roosting and foraging activity also occurred outside this 2-mile area but all documented roost trees and foraging behavior observed were within two miles of the Newberry-Bane cave. Work in Missouri (Romme et al. 2002) and Kentucky (Kiser and Elliott 1996; and Gumbert 1996) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods. Based on terrain and landscape characteristics of these areas (generally rolling without great vertical relief) when compared to the Ridge and Valley terrain of Virginia (mountainous with vertical relief 1,300 to 2,500 feet) it is likely Indiana bat activity in this portion of the Appalachians is confined to the valley in which the hibernaculum occurs and may extend into adjacent valleys via gaps in the surrounding ridges or mountains. It is unlikely many bats will fly up more than a 1,000 vertical feet and over a mountain to forage in an adjacent valley, especially when these mountains are densely forested without many open corridors to serve as flyways.

The timing of spring and autumn migration has been generally inferred as the time between when bats leave the hibernacula and when they are found in maternity areas (spring), and vice-versa (autumn). In most portions of the range, this is generally considered to be from 15 April to 15 May in spring, and 15 August to 15 November in autumn, although these dates are sometimes adjusted regionally to accommodate latitudinal differences in season. Essentially all acres within the George Washington National Forest could serve as potential migratory habitat for the Indiana bat.

Threats

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves contaminated in 2009-2010. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

Forest Plan Components

Effects to the federally endangered Indiana bat (*Myotis sodalis*) were considered because it is assumed the entire Forest is potential habitat for this species. See USDI Fish and Wildlife Service's Biological Opinion (BO) of September 16, 1997 and the Forest's Environmental Assessment/Decision Notice of March 12, 1998 for the "Proposed Forest Plan Amendment for Management of the Federally Endangered Indiana Bat." Potential habitat (mature forests with trees having exfoliating bark) exists across the entire Forest and contains tree species of the size and type known to be used by the Indiana bat. The retention of some snags, shagbark hickory, and hollow trees (as available) will allow for potential Indiana bat roost sites. Decreasing canopy closure as occurs with timbering and prescribed fire activities will increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young during a wide range of weather conditions. Pond/waterhole construction will increase the number of upland water sources available for Indiana bats. Persistence of early successional habitats and forests with an open understory and patchy overstory would create insect-rich foraging areas and flight corridors leading to any potential roost trees. Harvesting would produce a mosaic of regeneration areas intermixed with mature and late successional forests. Likewise prescribed fire would also create a mosaic of forest successional stages from early to late resulting from varying fire intensities associated with topographic features, vegetative types, and fuel accumulations. This will indirectly provide feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early successional vegetation, and even along the borders of croplands, or wooded strips (fencerows), and over ponds. In contrast, negative impacts to the Indiana bat will be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts. Although the likelihood is very low, tree cutting activities could result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats via removal of some large-diameter hardwood trees occupied by bats during the period from approximately April 1 to October 15. Occupied and potential roost trees could be directly affected by vegetation management, firewood and salvage sales, routine maintenance/permitting of small clearings including easements, rights-of-way and access to privately-owned lands, and road construction. Plan implementation will result in vegetation disturbance and possible impact to currently occupied and potentially occupied roost trees. There is potential for adverse effects to a maternity roost tree if one occurs on the Forest and in an area where trees are being felled. However, forest-wide standards would minimize, if not eliminate, the chance of adverse effects under all alternatives. Any Indiana bat roosts that are discovered would be protected from

cutting and modification until they were no longer suitable (unless treatments were needed for public or employee safety) under all alternatives.

The National Forest fuelwood program allows the public to purchase and collect wood, often recently downed or standing/leaning dead trees, for personal use. The program is regulated by issuance of an area-specific permit and collection occurs primarily along roadsides and other specified sites with easy access. Vehicles must remain on open roads are not allowed to travel through the forest in order to find, cut, and load firewood. This therefore restricts the distance at which most people are willing to cut and haul firewood and results in firewood being cut within 150 feet (about two tree lengths) of an open road, and limited almost exclusively to level terrain or the uphill side. Volume of firewood cut on the GWNF during 2008 was 4,488 CCF (hundred cubic feet) and during 2009 5,256 CCF, for an average of 4,872 CCF over the two-year period. A 14" DBH tree contains approximately 0.5 CCF of firewood, therefore approximately 9,744 dead trees were cut for firewood each year. The number of standing dead trees on the GW can be calculated based on analysis of data collected during the 2002-2007 Forest Inventory and Analysis conducted by the Southern Forest Research Station, Asheville, NC and published in 2009. The number of dead standing trees at that time was 14.9 per acre for all trees larger than 5" DBH and 6.1 per acre for trees larger than 9" DBH. Given that the Forest is approximately 1,065,389 acres, this equates to at least 6,498,873 dead standing trees >9" DBH. All portions of the Forest continue to be infested with gypsy moths and infestations are forest-wide with cycles of defoliation and mortality resulting from population fluctuations of gypsy moths. The result of these infestations is extensive areas of hardwood (especially oak) mortality in the overstory. Therefore, if 9,744 standing dead trees are cut each year for firewood, this equals to 0.15% of the total available standing dead trees. Since most of these dead trees are not close to roads or are in Management Prescriptions where firewood cutting is not allowed, the possibility of harming an Indiana bat is extremely remote. Also it is not just standing dead trees or snags that Indiana bats roost in, but also live trees. Brack and Brown (2002) reported 81% of roost sites used by radio-tagged Indiana bats were live trees and 19% were snags. The odds of encountering a roosting bat are even further reduced since only dead trees are available for cutting as firewood and these dead trees represent perhaps 20% of the trees where they roost. Assuming this trend represented Indiana bat roost selection throughout the GWNF, personal use firewood collection could affect 0.0003% of the potential Indiana bat roost sites. Although risk of "take" resulting from firewood cutting cannot be completely eliminated, the risk of direct effects to roosts in the vicinity of hibernacula is further minimized since the collection of firewood in primary and secondary cave protection areas is not allowed by prescription standard. Some minimal risk of taking a bat roosting in a standing dead tree cut for firewood elsewhere on the Forest would continue to exist. However, given the relatively low number of Indiana bats on the Forest when compared to the number of acres, plus standing trees and snags, and that the use of any individual dead tree as a roost is very brief, the likelihood of take from firewood cutting is extremely small, if not non-existent under all alternatives. Most types of timber harvest (salvage, even-aged, uneven-aged, etc.) activities would require some snag and potential roost tree retention plus specific retention of leave trees such as shagbark hickories. Forestwide standards in all alternatives require stand regeneration treatments greater than ten acres in size, a minimum average basal area of 15 square feet per acre of live trees is retained throughout the rotation, and priority is given to retaining the largest available trees that exhibit characteristics favored by roosting Indiana bats (sloughing bark, cracks and crevices).

Over the past several years the Forest has steadily increased its prescribed burn program. Alternative E would have the highest acres with 20,000 acres estimated to be prescribed burned each year. Most of these burns will occur during the spring and early summer with some during the late winter and early fall. Control lines will consist of existing roads, trails, and streams wherever possible. In areas where control lines will need to be constructed they will be done with handtools and/or bulldozer. Lines will consist of a two to five foot wide strip dug to mineral soil. Some trees will need to be felled during line construction but in most cases larger trees will be avoided with the line going around and between the largest trees. Some standing trees and snags near the line will be felled which pose a hazard to personnel or may burn and fall across the line thereby spreading fire across the line and into areas not scheduled for burning. Purposes for the use of prescribed fire include ecosystem restoration, wildlife and rare species management, site preparation, and oak/pine regeneration. The 1997 Biological Opinion stated as a Conservation Recommendation that the Forest increase prescribed burning on lands unsuitable for timber harvest to maintain flight and foraging corridors in upland and riparian areas.

Two Indiana bats were found to have WNS during an April 21, 2010 cave survey conducted by Rick Reynolds (VDGIF) and Wil Orndorf (VDCR) in Starr Chapel Cave. This represents the first time Indiana bats have been documented with WNS on the Forest. They are also known to occur in other caves which are infested with WNS and where other bat species have been found that are infected but individual Indiana bats in those caves have not shown signs of WNS infection. Time will tell the extent to which WNS will affect the Indiana bat. Caves with significant bat populations on Forest land will continue to be gated and locked. Currently a Regional Forester closure order is in effect that closes all caves and mines on National Forest lands to human intrusion. If and when access is needed WNS protocols will be followed that eliminate contamination from caving activity.

Plan Alternatives A, C, and E do not allow for commercial wind power development. Alternatives B, D, F and G allow for consideration of wind power development. Alternatives B, F and G assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently, there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

Cumulatively, with implementation of any alternative, the Forest will maintain a supply of snags, live potential roost trees, upland water sources, and other habitat features across the landscape to allow for the maintenance, and promote the recovery, of Indiana bat populations. At the same time, activities can still continue to meet other multiple-use objectives. For example, timber harvesting can still occur to accomplish sufficient forest regeneration to provide diverse insect productions and provide for the continuation of diverse forest conditions across the GWNF. Overall, there will be both benefits and impacts to the Indiana bat from management activities on the Forest. From a beneficial standpoint, the retention of some snags, shagbark hickory, and hollow trees in sale areas would allow potential Indiana bat roost sites to be conserved; the opening up of the canopy in sale areas and their margins would increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young; pond construction would increase the number of upland water sources available for Indiana bat. Slightly positive benefits for Indiana bat would result as harvested units create insect-rich foraging areas and flight corridors leading to any tree roosts that might be

present there. Positive benefits would result from prescribed burning by decreasing understory vegetation density. Positive benefits will also be realized from the application of prescriptions and associated standards focused on protecting caves and managing vegetation structure and condition within 2-miles of hibernacula.

Contrastingly, negative impacts to the Indiana bat would be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bat which would be incurred on regeneration cuts. Although these bats will use small forest openings and edges as foraging habitat, they would be unlikely to utilize the central portions of harvested units during the early years of regeneration unless the residual basal area were unusually high. It is possible that the increased rate of insect production in the regeneration areas would make up for any loss of foraging habitat acreage, but such a determination would be difficult to make without extensive long-term research on the subject. The level of estimated timber harvest ranges from 1,000 to 5,000 acres depending on Alternative. Specific acreage by type of silvicultural system for each alternative is discussed in the Social/Economic Environment, Timber Management section of the EIS. See specifically Table x-xxx.

Although the likelihood is very low, implementation of any alternative may result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats, via removal of some large-diameter hardwood trees occupied by bats during the period April 1 through October 15. This risk would be greatest in those alternatives with the highest acres of timber harvest. Alternative D has the highest acres estimated, followed by Alternatives A, B, E, G and F in order. Alternative C has no timber harvest allowed.

Under all alternatives, Forestwide and management prescription standards will provide adequate protection for summering and transitory Indiana bat individuals. These standards and prescriptions provide for maintenance of extensive forest areas that would remain undisturbed by most human processes that result from tree cutting. These areas are characterized by disturbance events where net losses and gains of potential roost trees would be dependent on ecological processes including tree mortality due to aging, insect and disease, lightning caused fires, and weather events.

In addition, all alternatives allocate areas surrounding known Indiana bat hibernacula to Management Prescription 8E4a and 8E4b. In the future, newly discovered hibernacula will be added through the Forest Plan amendment process. In the 1997 Biological Opinion for the GWNF, and the 2004 BO for the Jefferson NF, the Service determined that the level of anticipated take (4,500 acres not including prescribed burning on the GW and 16,800 acres including prescribed burning on the JNF) is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of any critical habitat. Finally, this agency feels that there will be overall cumulative positive benefits for the Indiana bat. The agency believes that some level of harvesting on the GWNF is necessary in order to manage, retain and perpetuate the existing forest types. It is within this diversity of these forest types that the Indiana bat has been able to survive over long periods of time, and has been able to maintain its numbers on the Forest

in recent years. Although the loss of a few individuals from time to time during timber harvest is remotely possible, the overall large amount of improving roosting and foraging habitat for the Indiana bat, coupled with management activities taking bat life requirements into account, coupled with an increasing number of upland drinking water sources, and gating of hibernacula, suggests that these potential losses would be offset by overall future net gains in the population under all alternatives.

Effects of WNS are unknown at this time. It's likely that Indiana bats will be further affected by WNS and those cumulative effects will exceed any action Forest Plan implementation will cause under any alternative.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

3.2.2 Virginia Big-Eared Bat

Background

Formerly included in the genus *Plecotus*, the Virginia big-eared bat is a subspecies of the more common and widespread Western (or Townsend's) big-eared bat that occurs throughout the western U.S., southwest Canada, and most of Mexico. The subspecies, *virginianus*, occupies a very limited geographic range in the Central Appalachians. The species was listed under provisions of the Endangered Species Act as Endangered in December 1979. The Recovery Plan was issued in May 1984 and a draft revised recovery plan was submitted for review in 1996, but was never completed. The first substantive 5-year review of the species was released by the USFWS, Elkins Office in Summer 2008. Generally, population numbers have shown moderate to strong increases range-wide over the past 15 years. In the late 1980's it was estimated the total population of the subspecies in West Virginia, Virginia, Kentucky, and North Carolina to be approximately 10,000 bats (Dalton 1987). By 1997 the range-wide population of *C.t. virginianus* was estimated to have almost doubled at less than 20,000 individuals (Pupek 1997). In West Virginia some cave populations grew as much as 350% from 1983 to 1995 (Pupek 1997). Survey data from 2006-2007 indicate a population of 10,900 hibernating bats and 7,169 maternity colony bats. These surveys did not include bachelor colonies nor several caves with significant bat use due to access or safety concerns. In Virginia this bat is known from eight caves in five counties in two separate geographic areas. One is in the upper headwaters of the James River (Cowpasture River) and the other is in the New River watershed. According to the Virginia Fish and Wildlife Information Service, it is known from three caves in Tazewell County and one in Highland County during the summer and five caves during the winter in Tazewell, Bland, and Highland Counties. Previous observations of single or a few individuals in caves found in Rockingham, Bath, and Pulaski Counties have not been seen in recent years. The Virginia big-eared bat occupies caves year-round. These bats are not migratory and their longest recorded movement is only 64 kilometers (almost 40 miles) (Dalton & Handley 1991). Males and females hibernate singly or in mixed clusters in a few caves then move in the spring to other cave(s) with females forming smaller summer maternity / nursery colonies and males being solitary or in bachelor groups during that season. Mating begins in late summer/early autumn and continues into early winter. Ovulation and fertilization are delayed until late winter/early spring. Maternity colonies form as early as March or as late as June depending on when the roost

site reaches a suitably warm temperature. Gestation lasts 2-3.5 months. A litter of one is born in late spring/early summer. Young can fly at about 2.5-3 weeks of age, weaned by 6-8 weeks, and leave the cave to forage on their own by the end of July or August. Most individuals leave the nursery cave by mid to late September. Females are sexually mature their first summer. Males may not be sexually active until their second year. Nearly all adult females breed every year (NatureServe 2010).

The Virginia big-eared bat is primarily a feeder on moths. Food habits of the maternity colony in Tazewell County, Virginia found that moths formed over 90% of the diet with beetles a distant second followed by lesser quantities of other flying insects. Foraging activity typically occurs within 4-6 miles of summer roost caves. Bats have been observed foraging over corn and alfalfa fields as well as mature upland forests, wherever moths occur in abundance (Dalton et al. 1986). Limiting factors for the Virginia big-eared bat include caves with suitable temperature regimes (cold in winter and warm in summer). This bat tolerates lower cave temperatures during hibernation than other bats and often occupies areas in caves that receive cold-air flow near entrances. Maternity colonies are typically warmer than those used for hibernation.

Threats

Declines appear to be primarily related to human disturbance and loss of cave habitat quality. The Virginia big-eared bat is extremely intolerant of any human disturbance. The growing popularity of spelunking is a tremendous threat to these bats. Former decline is likely attributable to human intrusion into caves, which depletes energy reserves of aroused bats and may lead to cave abandonment if disturbance is frequent, (NatureServe 2010). The recovery plan (USDI Fish and Wildlife Service 1984) recommends recovery actions focused on cave acquisition and gating of entrances to control human access. On the George Washington National Forest there are no caves occupied by the Virginia big-eared bat at any time of the year. All occupied caves in Virginia, during both summer and winter, are on private land. Cave occurrences of the Virginia big-eared bat closest to the Forest are located in Highland County, Virginia and Pendleton County, West Virginia where the distance from occupied caves to Forest managed land is approximately 9-miles. It's therefore possible, but unlikely, that the species may forage over some portions of the North River Ranger District from the Brandywine area of Pendleton County, WV south to the McDowell area of Highland County, VA.

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves contaminated in 2009-2010. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly

into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

Forest Plan Components

Under all alternatives, Forestwide standards relevant to the Virginia big-eared bat and associated cave habitat would protect all caves that are potentially discovered or purchased which support Virginia big-eared bats. Although no hibernacula or summer roost caves have been identified on the Forest, Forest-wide standards maintain vegetation and require installation of gates or other protective structures at entrances of all caves occupied by populations of any threatened or endangered bats. Until a newly discovered cave has been surveyed for bats, it is assumed that federally listed bats are present and the cave and surrounding habitat are maintained for them until surveyed. Potential foraging habitat will be maintained as vegetated and any changes will result from forest succession and limited management activities such as timber sales and prescribed burning.

Currently no VBEB have been found with WNS. They are known to occur in caves which are infected with WNS and where other bat species have been found that are infected. Time will tell if WNS will affect the VBEB. Caves with significant bat populations on Forest land will continue to be gated and locked. Currently a Regional Forester closure order is in effect that closes all caves and mines on National Forest lands to human intrusion. If and when access is needed WNS protocols will be followed that eliminate contamination from caving activity.

Plan Alternatives A, C, and E do not allow for commercial wind power development. Alternatives B, D, F and G allow for consideration of wind power development. Alternatives B, F and G assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

There are expected to be no cumulative effects to the Virginia big-eared bat resulting from implementation of any alternative. As stated above, the caves where this species occurs are on private land near the Forest. Landowners of these caves are aware of the bats presence and the caves are either gated or protected to limit human entrance and disturbance. Individual Virginia big-eared bats may occasionally forage or fly over National Forest land, but vegetated conditions will be maintained based on standards associated with prescription allocations under all alternatives. Insect populations (especially moths) will continue and be maintained so foraging will not be effected. In the northern portion of the Virginia big-eared bats range there have been concerns about the effect gypsy moth (*Lymantria dispar*) defoliation and suppression efforts may have on Virginia big-eared bats. Defoliation and the subsequent short-term loss of forest cover may suppress insect populations and thus food sources for the bats. Likewise the use of certain pesticides suppresses or eliminates insect populations to varying degrees and lengths of time depending on the type of insecticide used (USDA 1995). Gypsy moths are well established across the GWNF. Suppression of gypsy moth outbreaks have not been done on the GW since Spring of 2003 when 1,311 acres in six areas were treated with Btk and none of those areas were

within 50-miles of known Virginia big-eared bat occurrences. If and when necessary, decisions on gypsy moth management will be made at that time and further analysis handled at a project level.

Effects of WNS are unknown at this time. It's likely that VBEB will be affected by WNS and those cumulative effects will exceed any action Forest Plan implementation will cause under any alternative.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

3.2.3 James Spinymussel

Background

The James spinymussel was federally listed as endangered in 1988 (USDI Fish and Wildlife Service 1990). Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960's, but now appears extirpated from 90% of the historic range. Since 1990, James spinymussel populations have been found in three tributaries to the Dan River in Virginia and North Carolina, which is outside of the species range known at the time of listing.

Threats

This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking organic detritus, diatoms, phytoplankton, and zooplankton from the water column. The following excerpt from Hove and Neves (1994) states the current thinking on threats:

"There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994).

Forest Plan Components

Occurrences of the James spinymussel near the Forest include Potts Creek, Craig Creek, Pedlar River, Cowpasture River, Bullpasture River, Mill Creek, and there are historic records from the James and Calfpasture Rivers. In the Craig Creek watershed, the species is stable due to population(s) in Johns, Dicks, and Little Oregon creeks (near the Jefferson National Forest). The species appears to be extirpated in Potts Creek or at low numbers that detection is extremely difficult. In the Cowpasture River watershed, population status in the Cowpasture and Bullpasture is uncertain with the population in Mill Creek stable (see Table 4, Watson 2010).

Table 4. Location and Status of James spinymussel populations in the James River Watershed.

Watershed	Tributary	County/State	Status
James River	Bullpasture River	Highland/VA	Unknown
	Calfpasture River	Rockbridge/VA	Extirpated?
	Catawba Creek	Botetourt/VA	Extirpated?
	Cowpasture River	Bath & Alleghany/VA	Stable?
	Mill Creek	Bath/VA	Stable
	Craig Creek	Craig/VA	Declining
	Dicks Creek	Craig/VA	Stable to increasing
	James River mainstem	Various	Extirpated
	Johns Creek	Craig/VA	Stable
	Little Oregon Creek	Craig/VA	Stable to increasing
	Patterson Creek	Botetourt/VA	Extirpated?
	Pedlar River	Amherst/VA	Stable
	Potts Creek	Monroe/WV	Stable
	Potts Creek	Craig & Alleghany/VA	Extirpated?
	Upper Potts Creek	Monroe/WV	Stable?

Despite extensive searches, no occurrences of the spinymussel have been located on the GWNF (Watson 2010). The 14 miles of potential habitat modeled for this species in the Ecological Sustainability Analysis assumes all of the river mileage is suitable substrate, which is not probable; in all of the watersheds with spinymussels near the GWNF, the occurrences are all on private land. The James spinymussel does occur both upstream and downstream from the Forest. Current Forest management provides for water quantity and quality that contributes to the persistence of mussel populations. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. Several isolated reaches of habitat on the Forest could provide sites for augmentation if the substrate were suitable. Working cooperatively with State biologists, university experts, and the US Fish and Wildlife Service, the Forest developed a pro-active conservation plan for federally listed fish and mussels in 2004. The standards and guidelines in the plan are implemented in 6th level HUC watersheds that contain listed fish or mussel species. The following watersheds on the GWNF are covered by the Federally Listed Mussel and Fish Conservation Plan.

Table 5. Sixth Level HUC watersheds on the George Washington National Forest included in the Federally Listed Mussel and Fish Conservation Plan.

6th Level HUC	Watershed Name
020802010403	Mill Branch-Potts Creek
020802010404	Cast Steel Run-Potts Creek
020802010405	Hays Creek-Potts Creek
020802010601	Wolfe Draft-Cowpasture River*

6th Level HUC	Watershed Name
020802010602	Shaws Fork*
020802010603	Benson Run-Cowpasture River*
020802010701	Scotchtown Draft-Cowpasture River
020802010702	Dry Run*
020802010703	Thompson Creek-Cowpasture River*
020802010801	Mill Creek-Cowpasture River*
020802010803	Simpson Creek-Cowpasture River
020802011201	Rolands Run Branch-Craig Creek
020802011202	Barbours Creek*
020802011205	Roaring Run-Craig Creek
020802011302	Town Branch-Catawba Creek
020802020104	Hamilton Branch*
020802020105	Fridley Branch-Calfpasture River*
020802020106	Cabin Creek-Mill Creek
020802020108	Guys Run-Calfpasture River*
020802020506	Poague Run-Maury River*
020802030201	Lynchburg Reservoir-Pedlar River
020802030202	Browns Creek-Pedlar River
020802030203	Horsley Creek-Pedlar River

* No spinymussel occurrence in this watershed, but is found in downstream HUC(s)

The decline and extirpation of most populations of the James spinymussel may be attributed to habitat modification, sedimentation, eutrophication, and other forms of water quality degradation. Restricted movement of host fish may also be a factor in the decline of this species. For populations of the James spinymussel on or near the Forest potential management influences include: sedimentation, altered flow, and blockage of host fish passage associated with roads and crossings. Forest-wide and riparian standards will protect the James spinymussel and its habitat from sediment released during management activities. Instream flow needs will be quantified and maintained to protect aquatic organisms when new water use authorizations are proposed. Prior to the stocking of any non-native species, the national forest coordinates with the appropriate State agencies to ensure populations and habitats of native species are maintained.

The Forest will manage and protect extant populations and historical habitats of the James spinymussel. Protection and active management will be implemented where the species is physically on or historically occurred on Forest lands. Protection, monitoring, and augmentation will be the primary recovery objectives. Actions will be taken in order to identify additional suitable habitat and restore fish hosts and mussels to areas on Forest lands.

Recovery objectives will include annual or bi-annual monitoring within Virginia of representative populations by qualified biologists for populations trend and habitat quality. Monitoring will include either search indices or transects depending on local conditions and mussel densities. Inventories of additional potential habitat will also be conducted.

3.2.4 Shale Barren Rock Cress

Background

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Shale barren rockcress was listed as endangered under the Endangered Species Act on August 8, 1989.

A narrow endemic known only from shale barren regions of Virginia and West Virginia; one of the most restricted shale barren endemics. According to NatureServe, approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia, of these most are made up of fewer than 50 individuals; there are, perhaps, fewer than 4,000 plants altogether. Most occurrences are on public lands, predominantly National Forests. Depending on the definition of an occurrence, there appear to be more occurrences than indicated in NatureServe. The following is from the Forest's Monitoring and Evaluation Report 2004:

> *"In 1993 there were 17 known occurrences of shale barren rockcress on the Forest. The Forest's focus since this species was listed has been to attempt to locate additional populations and further define its range on the Forest. From 1994 to 1998 agency personnel worked cooperatively with the Virginia Division of Natural Heritage and the USFWS to inventory shale barrens on the Forest (Belden, Ludwig, and Van Alstine 1999). The Virginia Division of Natural Heritage identified 809 potential shale barrens from aerial photographs. Of these, 188 were examined for rare species. The inventory resulted in 27 new occurrences of shale barren rockcress, bringing the total known sites on the Forest (in Virginia) to 37. This number does not include two sites where shale barren rockcress was known to occur recently, but could not be found in 1994. In 2004 the West Virginia Department of Natural Resources discovered a new population of shale barren rockcress at the Little Fork North Shale Barren bringing the total occurrences on the Forest from the 77 reported by the West Virginia Natural Heritage Program in 2000 to 78. This includes both Virginia and West Virginia information. Of the 78 occurrences, 17 were known in 1993 when the GWNF Plan took effect, so there has been an increase of 61 occurrences."*

Because of the highly stressful nature of shale barrens environments, this species is not believed to be capable of tolerating much additional disturbance. Threats include road/trail construction and maintenance, erosion, inundation resulting from flood control measures, deer browsing, competition from exotic plants, and declines of its pollinators due to the spraying of Dimilin and BT insecticides for gypsy moth control.

An endemic of shale deposits, this species occurs only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations from 400 to 600 meters. Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. All extant

occurrences are on shales of Devonian age (Ludwig pers. comm.); a single occurrence was known from the Martinsburg shale of Ordovician age, but it is no longer extant.

The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (Dix 1990). These barrens support sparse, scrubby growth; frequently-observed species include Quercus ilicifolia, Q. prinus, Q. rubra, Pinus virginiana, Juniperus virginiana, Prunus alleghaniensis, Rhus aromatica, Celtis tenuifolia, Kalmia latifolia, Bouteloua curtipendula, Andropogon scoparius, Phlox subulata var. brittonii, Silene caroliniana ssp. pensylvanica, Sedum telephoides, Antennaria spp., Aster spp., and Solidago spp. (Dix 1990). Local variations in associated flora may be considerable (Braunschweig et al 1999, Jarrett et al 1996, Keener 1970, Keener 1983, Wieboldt 1987).

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Recovery tasks for the Forest identified in the shale barren rockcress Recovery Plan include:

1. Implement and evaluate the monitoring program.

Threats

Threats include:

(1) Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.

(2) Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).

(3) Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm.).

(4) Moderately xeric sites may be subject to encroachment of exotic plant species such as Centauria biebersteinii and numerous grasses (Dix 1990). Such encroachment is a particular concern for Arabis serotina since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.

(5) A significant threat to the insect pollinators of A. serotina is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale-barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the fauna.

(6) Finally, the very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.

Forest Plan Components

All known locations of shale barren rockcress on the Forest in WV and VA are on land allocated to management prescription 4D, Special Biological Area. Habitat for this species is stable on the Forest. There are possible threats to shale barren communities from invasive native and exotic species. Populations appear stable, but since they naturally tend to fluctuate greatly from year to year this is uncertain. Potential habitat is being inventoried and continues to reveal new populations that will be protected. Management activities are having no effect on the habitat that contains the shale barren rockcress and thus are having no effect on the rockcress.

Overall, viability is being maintained through identification and protection of occurrences, however, viability is still of concern due to the naturally limited distribution of this species. Shale barren rockcress populations are expected to remain relatively stable in the near future.

The Forest encompasses several populations of the endemic shale barren rockcress that are in the core of its limited distribution in the Northern Ridge and Valley Section of the mid-Appalachians. This species is inherently rare and not well distributed across the Forest. Current management provides for ecological conditions capable to maintain the shale barren rockcress populations considering its limited distribution and abundance. Overall, ecological conditions are sufficient on the Forest to maintain viability (persistence over time) of populations on national forest land.

3.2.5 Smooth Cone Flower

Background

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Smooth coneflower was listed as endangered under the Endangered Species Act on September 8, 1992.

This species is known from about 100 occurrences, a majority of which are of fair to poor viability in several southeastern states. Most historically known populations were destroyed by

development and habitat alteration, especially the suppression of fire, and a number of remaining populations are primarily in marginal locations, where they are vulnerable to urbanization, the use of herbicides, repeated mowing, and potentially, collection for the medicinal trade. Small remote populations may suffer from loss of habitat due to succession.

The Recovery Plan for smooth coneflower does not have any recovery tasks specific to the Forest.

Threats

Habitat loss and degradation due to habitat alteration affected 19 of 21 populations known in 1992 (USFWS 1992). Conversion of habitat to agriculture and/or silviculture, residential and industrial development, and highway maintenance (e.g., herbicides) havs threatened this species in the past and may continue. Habitat loss and degradation as a result of prolonged fire suppression is also considered a major threat to the species' habitat. Commercial digging was not thought to be a problem as this practice is generally confined to *Echinacea* populations west of the Mississippi River. However, the Southern Appalachian Species Viability Project (2002) reported that this showy species with medicinal uses is occasionally harvested. Remaining populations appear to be small in numbers which may result in low genetic diversity.

Formerly, a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires as well as large herbivores (such as bison), it now, primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. Usually found in areas with magnesium and calcium-rich soils. It requires full or partial sun. Associated species include: *Juniperus virginiana* and *Eryngium yuccifolium*. Fire or some other suitable form of disturbance, such as well-timed mowing or the careful clearing of trees, is essential to maintaining the glade remnants upon which this species depends. Without such periodic disturbance, the habitat is overtaken by shrubs and trees [Endangered Spp. Tech. Bull. 17(1-2): 9-10].

Forest Plan Components

All known locations of smooth coneflower on the Forest are on lands allocated to management prescription 4D, Special Biological Area. There are currently two known populations of this species on the Forest. Both are in Alleghany County. One is a roadside occurrence that continues to be difficult to manage due to the steepness of the site and encroaching woody vegetation. This population is very small and may not be viable over the long term. The second population is more robust and occurs in an open woodland area. The site needs prescribed fire to maintain the open conditions this species requires, however, no prescribed fires have occurred or are planned.

3.2.6 Virginia Sneezeweed

Background

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Virginia sneezeweed was listed as threatened under the Endangered Species Act on November 3, 1998.

A limited amount of habitat in two Virginia counties and six Missouri counties make up this species' entire global range. There are currently 61 documented occurrences, although 4 or fewer may not be extant, with the majority in Missouri as of 2006. The Virginia occurrences are restricted to small, discrete areas around sinkholes, and occupying, in total, less than 20 acres (8 ha). Missouri occurrences occupy ca. 11 acres within both discrete and less discrete wetland habitat. Six Virginia occurrences are currently protected by being on National Forest land or within state preserves. Only 9 Missouri occurrences have some protection although not complete. Sites in both states are threatened by drainage and residential development.

The number of Virginia documented occurrences has been revised downward to 17 by using a 1 km separation distance between occurrences (J. Townsend, VA Dept. of Conservation and Recreation 2006 pers. comm.) These 17 occurrences had previously been recognized as 30 occurrences, with an occurrence at that time being equal to the plants within a discrete pond or wet meadow. It is expected that additional survey work will find more occurrences within the 21-80 range; some of these may be within the more disturbed farm pond type of habitat. As most of the sites in Virginia have not been visited since 1995, it is not known how many are currently extant. Based on what was known at the time the draft Recovery Plan was written in 2000 there were 4 sites where plants had not been seen over several years of surveys (U.S. Fish and Wildlife Service 2000). The Virginia occurrences were located during extensive survey work from 1985 to 1995 in over 100 limestone sinkhole ponds along the western edge of the Blue Ridge Mountains in the Shenandoah Valley of Virginia (FWS 1998).

The Draft Recovery Plan includes the Forest in the following recovery tasks:

1. Seek permanent protection for known populations.
2. Identify essential habitat.
3. Identify sinkhole habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisitions by the GWJNF.
4. Conduct studies to characterize environmental parameters of the sinkhole ponds.
5. Conduct studies to characterize the hydrologic regime at selected sinkhole ponds.
6. Alleviate site specific threats as the need and opportunity arise.
7. Develop a monitoring plan including standard monitoring methodologies.
8. Implement the monitoring plan.
9. Conduct surveys for additional populations in Virginia.
10. Develop guidelines as to what constitutes a self-sustaining population.
11. Maintain seed sources for the species.

On the Forest all known populations of Virginia sneezeweed are located in Augusta County except for a very small population that was located in 2009 between Glasgow and Buena Vista in Rockbridge County.

Threats

In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.).

Exotic organisms may pose threats to *H. virginicum* populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *Lymantria dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded.

The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000):
The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. In contrast, actions have been taken at some of the Virginia sites to stop or lessen the periodic inundation. Significant ditches have been dug at two sites, with smaller ditching at three sites. Ditching and plowing occurred at one site in the past, and some evidence of the ditch remains, but does not significantly affect the hydrologic regime. Portions of the sites at 2 sites have been filled in. It is safe to assume that the pressure to control seasonal flooding will only increase, as the area of the Shenandoah Valley where the Virginia populations of *H. virginicum* are found is experiencing rapid growth, particularly in the building and expansion of residential subdivisions.

In addition to obvious hydrological alterations made directly to the sinkhole ponds, off-site actions may affect the hydrology of the ponds. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. Little is known about the relative importance of groundwater vs. surface flow to the hydrological regime of the sinkhole ponds, but preliminary research suggests that the relative importance of these water sources is unique for each pond (E. Knapp, Washington and Lee University pers. comm.).

A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. The Virginia Department of Conservation and Recreation's Division of Natural Heritage reviewed the

proposal for this project in 1991 and recommended against any road widening to the east in the area of the pond and further recommended that VDOT consult with the U.S. Fish and Wildlife Service before any construction began. While the long range plans still include widening Rt. 340 to 4 lanes in this section, this project is not active; VDOT will coordinate with USFWS whenever the project becomes active (S. Stannard, VDOT pers. comm.)

Another *H. virginicum* population is near the site of silos built in the early 1990's that are used to store septic waste. This waste is eventually dumped on the ground elsewhere on this landowners' ridge-top property and not near the *H. virginicum* site. However, in a 1995 site visit by DCR-DNH a large pile of soil was present on the north side of the shallow basin that supports the *H. virginicum* population. The landowner was considering pushing the soil into the seasonally wet basin to level it out, but was agreeable to not do that. In a 1997 site visit the pile was still present and was larger than in 1995. In 1995 and 1997, it was noted that sediment from the pile had washed into the edge of the pond site, creating different soil conditions in that area and making it more favorable for weedy species (DCR-DNH database).

Mowing occurs in at least 3 of the Virginia sites. Continued mowing may provide beneficial effects to the species; a site that is one of the largest if not the largest and densest population, has been periodically mowed and bush-hogged by the landowner for an extended period of time. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted.

Herbivory does not appear to be a problem; however, the threat *to H. virginicum* from cattle grazing needs evaluation. Large populations of *H. virginicum* co-exist in three sites with cattle grazing. This suggests that the species may respond favorably to limited amounts of disturbance. Knox et al. (1999) tested the hypothesis that *H. virginicum* is unpalatable to generalist herbivores in a common garden study; none of the *H. virginicum* plants were grazed by either vertebrate or invertebrate herbivores. Knox notes that this is consistent with reports of toxicity in other *Helenium* species associated with the presence of sesquiterpene lactones (Hesker 1982, Anderson et al. 1983, Anderson et al. 1986, Arnason et al 1987). *Helenium virginicum* has been shown to contain a sesquiterpene lactone, virginolide (Herz and Santhanam 1967). According to J.S. Knox (pers. comm.), the leaves of *H. virginicum* are bitter-tasting; selective grazing by cattle of more palatable associated species therefore may eliminate plant competitors. However, other effects on *H. virginicum* from cattle grazing such as the increased nutrient loads, soil compaction, and trampling of plants are unknown. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species.

With federally listed wetland species, the federal permitting process carried out by the US Army Corps of Engineers (USACOE) under authority of the Clean Water Act of 1977, is often the point at which proposed actions can be reviewed in light of their effect on a federally listed species and protection actions can be recommended. The isolated and often small seasonally wet habitat of *Helenium virginicum*, however, does not currently have direct federal protection. United States vs. Wilson 133 F. 3d 251(4th Cir. 1997) ruled that the USACOE has no jurisdiction over isolated water bodies that have no surface connection with any tributary stream that flows into traditional navigable waters or interstate waters. Nationwide Permit 26, under federal wetlands regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program), which has applied to headwater areas and isolated wetlands, is currently being revised including

a lower minimum acreage (1/10 acre); the Norfolk District of the USACOE is proposing a regional minimum threshold of 1/4 acre (E. Gilinsky, DEQ, pers. comm.). These lower minimum acreages, however, will not apply to the *Helenium virginicum* habitat if the ruling in U.S. vs. Wilson stands.

Currently, so-called Tulloch ditching, draining by ditching in which excavation occurs by mechanical means that do not require placing excavated material into a wetland and in which the material is lifted and hauled to an upland disposal site, does not require that USACOE be notified or a permit obtained. Major ditching has been used at three of the *H. virginicum* sites to control the seasonal flooding with more minor ditching used at another three sites.

As most of the populations of *H. virginicum* are on private lands, the current legal protections in place for this species will not be adequate to insure the long-term survival of *H. virginicum*. The effects of future regulation changes are not known.

Extremes in the fluctuating hydroperiod of the sinkhole ponds could, when preceded by low investment in the seed bank, result in the local extinction of populations. Extended drought at a site could make a site more favorable for colonization by other plants previously hampered by the periodic inundation of the site. This would include tree species, which could result in increased shading within the site and so reduce the areas favorable for *H. virginicum*. An extended period of inundation, coupled with development of a floating vegetation mat, such as occurred at one site (Knox 1997), could lead to local extinction if an insufficient seed bank existed to recover from the death of the vegetative plants. Either of these extremes in hydroperiod could result from normal variability in weather patterns or from larger scale climate changes, of either natural or human origin.

If found to hold true for other populations of *H. virginicum*, the self-incompatible breeding system of *H. virginicum* found in one of the populations may eventually lead to local extinction at sites with low population numbers as the chance of successful pollination decreases (Messmore and Knox 1997).

In Missouri threats include grazing and/or trampling of plants in the pasture sites and haying of the plants during the growing season. Herbicide or plant growth hormones used on roadside pose a threat to the roadside populations.

Forest Plan Components

All known locations of Virginia sneezeweed on the Forest are on land allocated to 4D Special Biological Area. There are still threats from illegal ATV use

3.2.7 Swamp Pink

Background

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Swamp pink was listed as a threatened species under the Endangered Species Act on September 9, 1988. *Helonias bullata* is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia. Restricted to forested wetlands that are perennially water-saturated with a low frequency of inundation, habitat specificity appears to be a critical factor in this species' rarity. Approximately 225 occurrences are believed extant, over half of which are in New Jersey; 80 additional occurrences are considered historical and 15 are extirpated. The species is locally abundant at several sites in New Jersey, Delaware, Virginia, and North Carolina; some have 10,000+ clumps of plants. In addition to sites known to have been extirpated, significant habitat has been lost throughout the range due to factors such as drainage for agriculture. A number of local population declines have also been documented in the past 20 years. Degradation of this species' sensitive habitat via changes to the hydrologic regime is the primary threat. Such changes can be direct (ditching, damming, draining) or indirect (from development in the watershed); indirect impacts are particularly difficult to address. Other threats include poor water quality, invasive species, trash, all terrain vehicles, deer herbivory, trampling, and collection. Given this species' very specific hydrological requirements, climate change could also be an issue. *H. bullata* has limited ability to colonize new sites (low incidence of flowering, limited seed dispersal, and poor seedling establishment) and low genetic variation, limiting its ability to adapt to changing conditions and recover when sites are destroyed.

Overall trends of local population declines and extirpations are beginning to emerge (USFWS 2007). The number of occurrences considered historic has increased from 79 to 97 since 1991, a loss of 18 sites (8 in NJ, 8 in DE, and 2 in NC) (USFWS 2007). More than 20 occurrences in New Jersey and Delaware alone have documented declines in population size or condition since the early 1990s (USFWS 2007). In New Jersey, the number of occurences ranked A or B has decreased by 7 since 1991; comparing occurrence ranks from 1997 and 2004, 6 occurrences were upgraded while 20 were downgraded (USFWS 2007). Of the 27 occurrences discovered in Delaware between 1983 and 1999, 16 showed substantial declines in plant numbers during the most recent site visits (USFWS 2007).

Habitat specificity appears to be the critical factor in defining *H. bullata* as a rare species (USFWS 2007). Adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007). Habitat availability may be a limiting factor across much of the range; Coastal Plain forested headwater wetlands have been significantly reduced by development, and mountain bogs are both historically uncommon and impacted by agricultural conversion (USFWS 2007). Nevertheless, the New Jersey Pine Barrens contain some apparently suitable but unoccupied sites, suggesting that this species' habitat requirements are not fully understood and/or that low dispersal limits colonization of these areas (USFWS 2007). Efforts to create or restore *H. bullata* habitat have had limited success (USFWS 2007).

Recovery tasks for Federal agencies in the swamp pink Recovery Plan include:

1. Monitor threats to extant sites.
2. Develop and maintain site-specific conservation plans.

3. Enforce regulations protecting the species and its wetland habitat.
4. Investigate population dynamics, using a standard method.
5. Identify and, as needed, implement management techniques.

Threats

Habitat degradation is the primary range wide threat. This degradation is difficult to address through either land protection or regulatory mechanisms because it is often brought about by off-site land uses, particularly development. Evidence of detrimental effects of development on *H. bullata* habitat and population quality continues to accumulate; such impacts are anticipated to worsen as development continues (USFWS 2007). A major component of habitat degradation is changes to the hydrologic regime. Such changes can be direct (e.g., ditching, damming, draining) or indirect (i.e, from development in the watershed). Indirect impacts often result from increased impervious surface in the watershed, which reduces infiltration and increases overland flow of stormwater, leading to increased stream erosion, wetland sedimentation, flood volumes and velocities, water level fluctuations, and hydrologic drought (USFWS 2007). Other components of degradation associated with adjacent development include poor water quality, invasive exotic species, trash, all terrain vehicles, herbivory by overabundant deer populations, trampling, and collection (USFWS 2007). Direct habitat losses have slowed, but historical losses were substantial (USFWS 2007). Because this species requires a very specific hydrology in order to thrive, climate change, which has the potential to either increase or decrease water levels at established sites, is an anticipated threat. For example, increased drought in southern Appalachians mountain bogs may already be having detrimental impacts. Also, about 10% of known occurrences are in areas with increased vulnerability to coastal flooding due to sea level rise (USFWS 2007).

The specific wetland habitat required by this species is easily degraded through both direct and secondary disturbances; among the wetland types it inhabits, some such as sphagnum bogs and Atlantic white cedar swamps are particularly fragile. A low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make colonization of new sites via reproduction from seed rare for this species (Godt et al. 1995, USFWS 2007). Finally, Godt et al. (1995) found low overall genetic diversity both within the species and within populations, even relative to the means found for other endemic and narrowly distributed species. This suggests that *H. bullata* may have limited capacity to adapt to future environmental change.

Habitat specificity appears to be the critical factor in defining *H. bullata* as a rare species (USFWS 2007). Adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007). Habitat availability may be a limiting factor across much of the range; Coastal Plain forested headwater wetlands have been significantly reduced by development, and mountain bogs are both historically uncommon and impacted by agricultural conversion (USFWS 2007). Nevertheless, the New Jersey Pine Barrens contain some apparently suitable but unoccupied sites, suggesting that this species' habitat requirements are not fully understood and/or that low dispersal limits colonization of these areas (USFWS 2007). Efforts to create or restore *H. bullata* habitat have had limited success (USFWS 2007).

At one site in St. Marys Wilderness trail maintenance by a volunteer group altered swamp pink habitat and a log footbridge was placed on 6 swamp pink plants. Fortuitous and prompt action by the Forest Botanist resulted in the removal of the logs and monitoring a year later indicated the plants had survived and were doing well. The Mills Creek Dam restoration project has the potential to affect swamp pink, however, the US Fish and Wildlife Service has described mitigation measures that would reduce or eliminate the impact of this project.

Forest Plan Components

All known occurrences of swamp pink are on land that will be allocated to 4D, Special Biological Area, and/or 1A Designated Wilderness. Herbivory and shading may continue to be threats. Use of prescribed fire or wildland fire may be a tool to reduce shading in some areas.

3.2.8 Northeastern Bulrush

Background

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Northeastern bulrush was listed as endangered under the Endangered Species Act in 1991. Populations are known from MA, MD, NH, NY (presumed extirpated), PA, VA, VT, and WV. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. When this species was listed as endangered there were 33 known populations. As of 2007, there were about 113 extant occurrences known in the Appalachians from southern Vermont and New Hampshire to western Virginia, with most occurrences in Pennsylvania.

Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). There are about ten historical occurrences: New York (1), Pennsylvania (7), Virginia (1), Quebec (1). The plants are restricted to fairly specific wetland habitats that are infrequent, especially in the southern part of the range. Various threats are associated with the habitat, including drainage and development, agricultural runoff, and any developments that could alter the local hydrology. Additional, unsurveyed habitat does exist, and more populations of this species may be found in the future if the potential habitats remain intact.

Long-term monitoring of known sites is needed before any conclusions can be drawn about the habitat needs of the plant, or about the stability of its populations in changing environments.

The implementation schedule for the northeastern bulrush recovery plan (USDI Fish and Wildlife Service 1993) includes five items that directly relate to Forest Service management:

1. Secure permanent protection for known populations;
2. Resurvey sites thought to have suitable habitat;

3. Verify, monitor, and protect any additional populations;
4. Identify potentially suitable habitat for additional surveys; and
5. Survey potential sites.

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. At least one site (in Massachusetts) is in a sand plain, where water level fluctuates as well. Two sites in Vermont are influenced to some extent by beaver activity as well as other hydrological factors.

With the information available it is difficult to compare sites throughout the plant's range. For example, lists of associated species may represent an entire wetland or the immediate vicinity of the plant, but this is not always possible to determine from available information. Nevertheless, examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis, and Triadenum virginicum.

Virginia. There are seven extant northeastern bulrush sites in Virginia, with two ranked as A/AB, two ranked B/BC, and one ranked E. The status of most of these sites is unknown because they have not been surveyed since the 1980s or 1990s. Habitat includes emergent ridgetop shallow ponds, shallow sinkhole depressions and mountainside bench ponds. Four sites are located on private land, three are on public land, and ownership of one site is undetermined. In Virginia, the northeastern bulrush is listed as State endangered; however, no additional protection (e.g., buffers) is afforded to wetlands supporting the species. No upland buffers are regulated or protected around any wetlands in the State. The northeastern bulrush is protected under the Endangered Plant and Insect Species Act of 1979, which prohibits take without a permit, but individual landowners are exempt from these permitting requirements.

West Virginia. There are three northeastern bulrush populations in West Virginia, two of which are ranked B, and one of which is ranked D. These occurrences were surveyed and last observed in 2005. Habitat includes sinkhole ponds atop a low, flat sandstone ridge, and small seasonal ponds. Two of these sites are located on private lands, and one is located on National Forest land managed by the U.S. Forest Service (USFWS 2008).

The northeastern bulrush has no official status in West Virginia, and this State does not have an endangered species law. No upland buffers are regulated or protected around any wetlands in the State.

Threats

Among the potential human threats are agricultural runoff, construction of logging and fire roads, development, all-terrain vehicle use, collection, and dredging. In addition to human activity, there may be natural threats to the species as well, although more information about the biology and ecology of the species is needed before these influences can be clearly implicated in the decline of the species. Among possible natural threats are deer, beaver (one Vermont

population has suffered alarming fluctuations, apparently as a result of beaver activity), natural water level fluctuations, fire (this may have damaged a population in Pennsylvania), and succession (it has been suggested that this may adversely affect populations in West Virginia and Maryland). Fluctuations in population size have been observed at several localities for the species. It is very likely that botanists visiting the known sites for the species do not identify vegetative plants, and it is postulated that the fluctuations are in number of flowering/ fruiting culms rather than actual number of plants.

The 5-year review of northeastern bulrush by the US Fish and Wildlife Service stated that new information indicates that shading may be a threat, "Therefore, in some cases, it may be helpful to manage the habitat surrounding these sites by selectively removing larger trees to reduce canopy cover increase light exposure" (USFWS 2008). The 5-year review also noted that alterations of the hydrology of wetlands supporting northeastern bulrush could have negative effects.

On the Forest, northeastern bulrush is known to occur at three sites:

Cast Steel Run Pond – Allegheny County, VA

The population occupies most of the area of about a 15,000 square foot peat-filled mountain pond situated on a mountain side bench. Appears to be natural, situated over Devonian Silurian boundary formations. 1994: 1000+ culms, many fruiting,. Plants growing on saturated peat in oligotrophic semipermanently flooded wetland.

Pond Run Pond – Hardy County, WV

Small seasonal pond that is often dry at time of monitoring (late summer). Population has remained stable and with same distribution since 2000. Pond Run Pond is monitored by the West Virginia Department of Natural Resources. Their 2002 report to the Forest indicated concern about increasing canopy closure over the pond that may negatively affect the Northeastern bulrush. They also noted the possible hydrologic connection between Pond Run Pond and a bog uphill. A trail runs between the pond and the bog and may be interfering with the normal movement of water between the two areas. A field review by U.S. Forest Service, WV Division of Natural Resources, and U.S. Fish and Wildlife Service personnel was conducted on May 25, 2004. The decision was made to try daylighting the pond to slowly increase sunlight reaching the pond. A 6 inch diameter red maple on the south side of the pond was girdled. No evidence of damage from horses was seen. On September 24, 2004 WVDNR returned and noted that the girdled red maple was alive and the wound had healed over. They suggest repeating the girdling and cutting deeper.

Potts Mountain Pond – Allegheny and Craig Counties, VA Basin marsh; water about 30 cm deep; probably rarely, if ever, goes dry. 1990: 3 clumps with 10, 20 & 100 fruiting culms respectively. 1989: 44 fertile culms counted; about half of pond edge individuals vegetative; other half produced fertile culms. Toward pond center, 4 aggregated clumps produced 17 fertile culms. In 1987, the total population covered an area of about ten square meters and consisted of several hundred plants (Virginia Department of Conservation and Recreation 1996). 1990: 3 clumps with 10, 20 & 100 fruiting culms respectively. 1989: 44 fertile culms counted; about half

of pond edge individuals vegetative; other half produced fertile culms. Toward pond center, 4 aggregated clumps produced 17 fertile culms.

The Potts Mountain population has been qualitatively monitored annually since 1990. A designated off-highway vehicle (OHV) trail/road runs near the pond. There has been concern that users of such vehicles might drive them through the pond as they have at other locations. The monitoring found that in June of 2001 at least one OHV had driven toward the pond. The tire tracks followed the drainage path from Potts Pond. The OHV did not enter the pond and there was no damage to the northeastern bulrush. In response to this activity large rocks were placed in the area where the OHV left the designated OHV road to prevent further incursions. In August of 2003 more damage in the same area was seen. Some of the rocks had been moved and, as in 2001, an OHV drove toward the pond following the pond drainage. In January of 2004 the OHV road was closed by the installation of a gate at the FDR 176 entrance. A sign was put up informing the public of the reason for the road closure. Before the road was opened for OHV use, 90 additional large rocks were put in place. In addition, the wilderness boundary has been remarked and there is a Forest Supervisor's order prohibiting vehicles from entering the Special Biological Community that supports the northeastern bulrush. This order includes signs placed along the road and around the Special Biological Community. The habitat is still intact and undisturbed and the bulrush is present in the pond. Area occupied by the bulrush has not changed since the Forest Service acquired the site.

At this site the greatest threats are alteration of hydrology, either through draining the pond or changes in the inputs of surface and groundwater, and off highway vehicles (OHV's). The Potts Mountain Trail, an OHV trail, passes near the pond. Under all alternatives, except A (the 1993 Revised Forest Plan), this site will be allocated as management prescription 4D, Special Biological Area. Special Biological Areas are assemblages of plants and animals that occupy a small portion of the landscape, but contribute significantly to plant and animal diversity. They are managed under this prescription to ensure their contribution to meeting goals for community diversity, endangered and threatened species recovery and habitat for sensitive and locally rare species. These lands serve as core areas for conservation of the most significant elements of biological diversity identified to date on the Forest. Recreational access may be limited by signs and barriers, where necessary, to protect community integrity. Interpretive signs or other information may be available where it is likely to promote public knowledge of rare communities and improve community protection. In addition, Forest-wide standards in all alternatives that provide protection to this species are those standards that protect individuals and sites of federally listed species and those that control non-native invasive species where they are adversely affecting federally listed species.

Maple Springs – Rockingham County VA. Northeastern bulrush has been reported from this site, but subsequent surveys have failed to find it. It does not appear that this species occupies this site, however, this pond is protected as part of the Shenandoah Mountain Crest Special Biological Area.

Forest Plan Components

The known occurrences of this species on the Forest are protected under all alternatives, except A (the 1993 Revised Forest Plan), as management prescription 4D, Special Biological Area. The

cumulative impacts of the OHV trail that passes near the pond on Potts Mountain have the potential to negatively affect the pond and the northeastern bulrush through illegal OHV use (driving through the pond or creating deep ruts that affect hydrology) or through maintenance of the OHV road affecting the hydrology of the area. Standards in management prescription 4D allow OHV use to be managed to protect this plant. The Pond Run Pond site is very near the intersection of two trails that are used by hikers and horses. In the past there has been evidence of hoof prints in the pond basin. A wire fence has been constructed to discourage watering horses in the pond. Shading has also been a concern at this site and over the past several years a slow process of girdling trees has been occurring.

3.3 Threatened and Endangered Species Summary of Plan Components

Table 6. T&E species, associated ecological systems, and plan component

Species	Ecosystem	Forest Plan Component
Indiana bat	Caves and Karstlands	Management Prescription Areas: designation of the primary and secondary Indiana bat cave areas Standards/Guidelines: standards for activities within the primary and secondary Indiana bat cave areas; standards for activities throughout the Forest in regard to leave trees during timber harvest activities Objectives: improvement of habitat through increased open woodlands
Virginia Big-Eared Bat	Caves and Karstlands	Standards: Forestwide cave standards
James Spinymussel	Floodplains, Wetlands and Riparian Areas	Standards: Riparian standards
Shale Barrens Rock Cress	Appalachian Shale Barrens	Management Prescription Areas: All known locations are in Special Biologic Areas
Smooth Cone Flower		Management Prescription Areas: All known locations are in Special Biologic Areas
Virginia Sneezeweed	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biologic Areas Standards: Riparian standards
Swamp Pink	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biologic Areas Standards: Riparian standards
Northeastern Bulrush	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas All known locations are in Special Biologic Areas Standards: Riparian standards

4.0 Other Species Addressed

4.1 Species list

Criteria for identifying other species to be addressed include the following:

- Species identified as proposed and candidate species under ESA.
- Species ranked G-1, G-2 and G-3 on the NatureServe ranking system.
- Subspecific taxa ranked T-1, T-2 and T-3 on the NatureServe ranking system.
- Species that have been petitioned for federal listing and for which a positive "90-day finding" has been made.
- Species that have been recently delisted, including those delisted within the past five years and other delisted species for which regulatory agency monitoring is still considered necessary.
- Species with ranks of S-1, S-2, N-1, or N-2 on the NatureServe ranking system[1]
- State-listed threatened and endangered species that do not meet other criteria
- Species identified as species of conservation concern in state comprehensive wildlife strategies for which habitat on the Forest is important.
- Bird species on the U.S. Fish and Wildlife Service Birds of Conservation Concern National Bird Priority List
- Additional species that valid existing information indicates are of regional or local conservation concern due to factors that may include:
    - Significant threats to populations or habitat
    - Declining trends in populations or habitat
    - Rarity
    - Restricted ranges
    - Southern Region regional forester's sensitive species
- Species that are hunted or fished
- Other species of public interest
- Invasive species may also be considered

The 282 species remaining for further consideration were screened to determine whether ecosystem diversity plan components fully covered their sustainability needs. If species habitat needs were not met solely through meeting the desired conditions of the ecological systems, additional direction was developed.

4.2 Species Groups

The GWNF used species groups as an evaluation and analysis tool to improve planning efficiency and for development of management strategies. Species were grouped according to their habitat needs, limiting factors, threats, and specific habitat elements (snags, den trees, woody debris, etc). Many species occurred in multiple groups.

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[1] The NatureServe ranking system is available at http://www.natureserve.org/.

Where possible, species groups were associated with ecological systems. Some groups are directly related to specific systems. Other groups may be more closely related to some ecological systems than others, but may be associated with multiple systems. Some groups may occur in any of the systems. The list of species groups and the ecosystem(s) with which they are associated are listed in Table 7. Where multiple ecological systems are listed, the predominant system is listed first.

Table 7. Species group and associated ecological system(s)

Species Group	Associated Ecological System(s)
Alkaline glades and barrens	Alkaline Glade and Woodlands and Mafic Glades and Barrens
Area Sensitive Grassland and Shrubland and Open Woodlands	Pine Forest and Woodlands, Oak Forests and Woodlands
Area Sensitive Grasslands.	Oak Forests and Woodlands Floodplains, Wetlands and Riparian Areas
Area Sensitive Shrubland and Open Woodlands	Pine Forest and Woodlands, Oak Forests and Woodlands
Area Sensitive Late Successional Coniferous, Deciduous and/or Mixed Forests	Spruce Forest, Northern Hardwood Forest, Cove Forest, Oak Forests and Woodlands, Pine Forests and Woodlands, Floodplains Wetlands and Riparian Areas.
Calciphiles	Caves and Karstlands Alkaline Glade and Woodlands and Mafic Glades and Barrens All
Caves	Caves and Karstlands
Cavity Trees, Den Trees and Snags	Oak Forests and Woodlands All
Cliff and Talus and large rock outcrops	Cliff, Talus and Shale Barrens
Cove forests	Cove Forests
Fire Dependent and Fire Enhanced	Pine Forests and Woodlands, Alkaline Glade and Woodlands and Mafic Glades and Barrens Oak Forests and Woodlands
Grasslands	Oak Forests and Woodlands All
Hard and Soft Mast Dependent	Pine Forests and Woodlands, Oak Forests and Woodlands
High Elevation Coniferous, Deciduous and/or Mixed Forests	Northern Hardwood Forests Cove Forests Spruce Forests Pine Forests and Woodlands Oak Forests and Woodlands
High Elevation Openings, grassy or shrubby or open woodlands	Oak Forests and Woodlands Northern Hardwood Forests Cove Forests Spruce Forests Pine Forests and Woodlands
Late Successional Hardwood Dominated Forest	Oak Forests and Woodlands Cove Forests

Species Group	Associated Ecological System(s)
	Floodplains, Wetlands and Riparian Areas Northern Hardwood Forests
Lepidopterans	Oak Forests and Woodlands All
Mafic rocks	Alkaline Glade and Woodlands and Mafic Glades and Barrens
Occurrence Protection	Oak Forests and Woodlands All
Open Woodlands	Oak Forests and Woodlands Alkaline Glade and Woodlands and Mafic Glades and Barrens Cliff, Talus and Shale Barrens Pine Forests and Woodlands
Regenerating Forests	Oak Forests and Woodlands All
Riparian	Floodplains, Wetlands and Riparian Areas
Ruderal	Any
Sandstone Glades and Barrens	Any
Sensitive to Over-Collection	All
Sensitive to Recreation Traffic	Any
Shale barrens	Cliff, Talus and Shale Barrens
Shrublands	Oak Forests and Woodlands All
Species in a Special Biologic Area	All

Since species may be associated with many species groups a description of the level of association is included in each of the following tables that list the species in each group. The levels are defined as follows:

Group Weight	Group Weight Description
Very High	All or nearly all of the species' needs are covered by needs of this group.
High	A high proportion of the species' needs are covered by the needs of this group.
Moderate	A moderate proportion of the species' needs are covered by the needs of this group.
Low	A low proportion of the species' needs are covered by the needs of this group.

4.2.1 Alkaline Glade and Barren Associates

These species are associated with alkaline glades and barrens. Their habitat needs are tied directly to the Mafic Glade and Barrens and Alkaline Glades and Woodlands ecological system. Maintaining those ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight

Houstonia canadensis	Canada bluets	High
Ruellia purshiana	Pursh's wild petunia	High

4.2.2 Calciphile Associates

These species generally require basic soils (pH greater than seven) in areas underlain by carbonate bedrock. They are often associated with the Cave and Kartland ecological systems, but can be found in other areas where the bedrock geology and soil conditions present the appropriate conditions. Additional measures beyond those identified for the ecological system are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Campanula rotundifolia	American harebell	High
Delphinium exaltatum	tall larkspur	High
Desmodium cuspidatum	toothed tick-trefoil	High
Echinacea laevigata	smooth coneflower	High
Euphorbia purpurea	glade spurge	Moderate
Glyphyalinia raderi	Maryland glyph	High
Helicodiscus diadema	Shaggy coil	High
Helicodiscus triodus	Talus coil	High
Houstonia canadensis	Canada bluets	High
Juniperus communis var depressa	ground juniper	Moderate
Linum lewisii	prairie flax	High
Linum sulcatum	grooved yellow flax	High
Melica nitens	Three-flowered melic grass	High
Nampabius turbator	Cave centipede	High
Oligoneuron rigidum	stiff goldenrod	High
Onosmodium virginianum	Virginia false-gromwell	High
Paronychia virginica	yellow nailwort	High
Paxistima canbyi	Canby's mountain lover	High
Phlox amplifolia	Broadleaf phlox	High
Pseudanophthalmus avernus	Avernus cave beetle	High
Pseudanophthalmus intersectus	Crossroads cave beetle	High
Pseudanophthalmus nelsoni	Nelson's cave beetle	High
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	High
Pseudotremia princeps	South Branch Valley cave millipede	High
Pycnanthemum torreyi	Torrey's mountain-mint	High
Pygmarrhopalites carolynae	Cave springtail	High

Species Name	Common Name	Group Weight
Pygmarrhopalites sacer	Cave springtail	High
Rosa setigera	prairie rose	Moderate
Ruellia purshiana	Pursh's wild petunia	High
Scutellaria parvula var. parvula	small skullcap	High
Sporobolus neglectus	small dropseed	High
Stygobromus gracilipes	Shenandoah Valley cave amphipod	High
Stygobromus hoffmani	Alleghany County cave amphipod	High
Stygobromus morrisoni	Morrison's cave amphipod	High
Stygobromus mundus	Bath County cave amphipod	High
Stygobromus sp. 7	Sherando spinosid amphipod	High
Stygobromus sp. nov.	Massanutten Spring Amphipod	High
Symphoricarpos albus	snowberry	High
Thuja occidentalis	bristly sarsaparilla	High
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	Moderate
Zygonopus weyeriensis	Grand Caverns blind cave millipede	High
Zygonopus whitei	Luray Caverns blind cave millipede	High

4.2.3 Cave Associates

These species live in caves. Temperature, humidity, water flow, water quality and level of human disturbance are all important components of the cave habitat. The habitat needs of the species in this group are tied directly to the Cave and Karstland ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Apochthonius holsingeri	A cave pseudoscorpion	Very High
Corynorhinus townsendii virginianus	Virginia big-eared bat	Very High
Kleptochthonius anophthalmus	A cave pseudoscorpion	Very High
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	Very High
Myotis leibii	eastern small-footed bat	Very High
Myotis sodalis	Indiana bat	Very High
Nampabius turbator	Cave centipede	Very High
Neotoma magister	Alleghany woodrat	Moderate
Pseudanophthalmus avernus	Avernus cave beetle	Very High
Pseudanophthalmus intersectus	Crossroads cave beetle	Very High
Pseudanophthalmus nelsoni	Nelson's cave beetle	Very High

Species Name	Common Name	Group Weight
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	Very High
Pseudognaphalium macounii	Winged cudweed	Very High
Pseudotremia princeps	South Branch Valley cave millipede	Very High
Pygmarrhopalites carolynae	Cave springtail	Very High
Pygmarrhopalites sacer	Cave springtail	Very High
Pygmarrhopalites caedus	A cave springtail	Very High
Stygobromus gracilipes	Shenandoah Valley cave amphipod	Very High
Stygobromus hoffmani	Alleghany County cave amphipod	Very High
Stygobromus morrisoni	Morrison's cave amphipod	Very High
Stygobromus mundus	Bath County cave amphipod	Very High
Stygobromus sp. 7	Sherando spinosid amphipod	Very High
Stygobromus sp. nov.	Massanutten Spring Amphipod	Very High
Zygonopus weyeriensis	Grand Caverns blind cave millipede	Very High
Zygonopus whitei	Luray Caverns blind cave millipede	Very High

4.2.4 Cavity Tree, Den Tree and Snag Associates

Cavity and den trees are live or dead trees with openings or broken out tops that provide habitat for reproduction, shelter, and/or hibernation. Snags are dead trees or live trees with dead limbs or tops that provide sloughing bark, perches, and food sources for a variety of animals. This habitat and these species can be found throughout the GWNF. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Aegolius acadicus	northern saw-whet owl	High
Certhia americana	brown creeper	Very High
Contopus borealis	olive-sided flycatcher	High
Myotis sodalis	Indiana bat	High
Sciurus carolinensis	gray squirrel	High
Sciurus niger	Eastern fox squirrel	High
Sitta canadensis	red-breasted nuthatch	High
Sphyrapicus varius	yellow-bellied sapsucker	High
Thryomanes bewickii altus	Appalachian Bewick's wren	High
Troglodytes troglodytes	winter wren	Moderate
Tyto alba	barn owl	High
Ursus americanus	black bear	High

4.2.5 Cliff, Talus and Large Rock Outcrop Associates

These species are dependent on cliffs, the talus slopes below cliffs, other talus slopes and large rock outcrops. The rock substrate is the key component and type of rock can be important to some species. The habitat needs of the species in this group are tied directly to the Cliff, Talus and Shale Barrens ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need. There are smaller cliffs and talus areas that are not readily recognized and large rock outcrops can be found throughout many other ecological systems. Therefore, additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Aralia hispida	Northern white cedar	High
Betula cordifolia	mountain paper birch	Very High
Campanula rotundifolia	American harebell	High
Cheilanthes eatonii	chestnut lipfern	Very High
Crotalus horridus	Timber rattlesnake	Very High
Cuscuta coryli	hazel dodder	Very High
Cystopteris fragilis	fragile fern	Very High
Falco peregrinus	peregrine falcon	Very High
Geranium robertianum	herb-robert	High
Helianthemum bicknellii	plains frostweed	High
Linum lewisii	prairie flax	High
Linum sulcatum	grooved yellow flax	High
Minuartia groenlandica	mountain sandwort	Very High
Myotis leibii	eastern small-footed bat	Very High
Neotoma magister	Alleghany woodrat	High
Paronychia virginica	yellow nailwort	High
Paxistima canbyi	Canby's mountain lover	High
Plethodon punctatus	Cow Knob salamander	Moderate
Plethodon virginia	Shenandoah Mt. salamander	Moderate
Scutellaria parvula var. parvula	small skullcap	High
Scutellaria saxatilis	Rock skullcap	Moderate
Sibbaldiopsis tridentata	three-toothed cinquefoil	Very High
Spilogale putorius	Spotted Skunk	High
Sporobolus neglectus	small dropseed	High
Symphoricarpos albus	snowberry	High
Thuja occidentalis	bristly sarsaparilla	High
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	High

4.2.6 Cove Forest Associates

These species are known to be associated with cove forests. The habitat needs of the species in this group are tied directly to the Cove Forest ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Leucothoe fontanesiana	highland dog-hobble	High
Panax quinquefolius	Ginseng	High
Panax trifolius	Dwarf ginseng	High

4.2.7 Fire Dependent and Fire Enhanced Associates

These species are generally associated with open woodland conditions that require frequent fires.

These species range from those generally dependent upon fire (weighted very high) to those that are not dependent upon fire, but whose habitat is enhanced through frequent fires. This habitat type is found in the ecological systems where fire is an active component of the disturbance regime. The habitat needs of the species in this group are tied directly to the Pine Forests and Woodlands, Alkaline Glade and Woodlands, Mafic Glades and Barrens, and Oak Forests and Woodlands ecological systems. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Anaphalis margaritacea	pearly everlasting	High
Arabis serotina	shale barren rockcress	High
Aralia hispida	Northern white cedar	Very High
Arnoglossom muehlenbergii	great Indian-plantain	Moderate
Bartramia longicauda	upland sandpiper	Moderate
Betula cordifolia	mountain paper birch	High
Bonasa umbellus	ruffed grouse	Moderate
Bromus kalmii	wild chess	High
Buckleya distichophylla	Piratebush	Very High
Callophrys irus	Frosted elfin	High
Caprimulgus carolinensis	chuck-will's widow	High
Caprimulgus vociferus	whip-poor-will	Moderate
Carex polymorpha	variable sedge	Very High
Colinus virginianus	northern bobwhite	Moderate
Crataegus pruinosa	prunose hawthorn	Moderate

Species Name	Common Name	Group Weight
Delphinium exaltatum	tall larkspur	High
Dendroica discolor	prairie warbler	Moderate
Echinacea laevigata	smooth coneflower	High
Elymus trachycaulus	slender wheatgrass	High
Erynnis martialis	Mottled duskywing	High
Gaylussacia brachycera	box huckleberry	Very High
Liochlorophis vernalis	Smooth green snake	High
Meleagris gallopavo	wild turkey	Moderate
Odocoileus virginianus	white-tailed deer	Moderate
Onosmodium virginianum	Virginia false-gromwell	Moderate
Oporornis philadelphia	mourning warbler	High
Phlox buckleyi	sword-leaved phlox	High
Pituophis melanoleucus	northern pinesnake	High
Prunus alleghaniensis	Alleghany sloe	High
Pyrgus wyandot	Appalachian grizzled skipper	High
Ruellia purshiana	Pursh's wild petunia	Moderate
Sciurus niger	Eastern fox squirrel	Moderate
Vermivora chrysoptera	golden winged warbler	High

4.2.8 Hard and Soft Mast Associates

These species need a mixture of both hard and soft mast as food. The habitat associated with these species can be found in other ecological systems, but is most common in the oak forests and woodlands. Maintaining the Oak Forest and Woodland ecological systems and moving them towards their desired condition will satisfy most of the needs of the species in this group related to this habitat need. The one additional need is to maintain existing shrubland areas.

Species in Group

Species Name	Common Name	Group Weight
Bonasa umbellus	ruffed grouse	High
Meleagris gallopavo	wild turkey	High
Odocoileus virginianus	white-tailed deer	High
Sciurus carolinensis	gray squirrel	High
Sciurus niger	Eastern fox squirrel	High
Ursus americanus	black bear	High

4.2.9 High Elevation Coniferous, Deciduous and/or Mixed Forest Associates

These species are generally found at high elevation (>3,000 feet) in forested environments. The habitat associated with these species can be found throughout the ecological systems, but is confined to the high elevations. The habitat needs of the species in this group are tied directly to the Spruce Forest and Northern Hardwood ecological systems. Additional measures are needed

to assure that the high elevation Oak Forests and Woodlands and the Pine Forests and Woodlands that are at high elevation will also be maintained. Maintaining these ecological systems, implementing additional measures, and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Aegolius acadicus	northern saw-whet owl	High
Carpodacus purpureus	purple finch	High
Catharus guttatus	hermit thrush	High
Certhia americana	brown creeper	High
Coccyzus erythropthalmus	black-billed cuckoo	High
Contopus borealis	olive-sided flycatcher	High
Cornus canadensis	bunchberry	High
Dendroica fusca	blackburnian warbler	High
Dendroica magnolia	magnolia warbler	High
Empidonax alnorum	alder flycatcher	High
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Very High
Gymnocarpium appalachianum	Appalachian oak fern	Very High
Heuchera alba	white alumroot	Very High
Huperzia appalachiana	Appalachian fir clubmoss	High
Hypericum mitchellianum	Blue Ridge St. John's-wort	High
Lepus americanus	snowshoe hare	High
Lonicera canadensis	American fly-honeysuckle	Very High
Loxia curvirostra	red crossbill	Very High
Martes pennanti	fisher	Very High
Microtus chrotorrhinus carolinensis	Southern rock vole	High
Oporornis philadelphia	mourning warbler	High
Plethodon punctatus	Cow Knob salamander	Very High
Plethodon virginia	Shenandoah Mt. salamander	High
Pyrola elliptica	shinleaf	High
Regulus satrapa	golden-crowned kinglet	Very High
Schizachne purpurascens	purple oat-grass	High
Seiurus noveboracensis	northern waterthrush	High
Sitta canadensis	red-breasted nuthatch	High
Sorex palustris punctulatus	southern water shrew	High
Sphyrapicus varius	yellow-bellied sapsucker	High
Sylvilagus obscurus	Appalachian Cottontail	Very High
Trillium pusillum var. virginianum	mountain least trillium	High

Species Name	Common Name	Group Weight
Troglodytes troglodytes	winter wren	Very High

4.2.10 Late Successional Hardwood Dominated Forest Associates

These species are associated with late successional systems usually dominated by hardwoods. These areas have developing or well-developed canopy gap dynamics, large woody material on the ground, and den and cavity trees. The habitat needs of the species in this group are tied directly to the Northern Hardwood, Cove Forest, and Oak Forest and Woodlands ecological systems. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Ambystoma tigrinum	Eastern tiger salamander	High
Bonasa umbellus	ruffed grouse	High
Dendroica cerulea	cerulean warbler	High
Glyptemys insculpta	wood turtle	Moderate
Meleagris gallopavo	wild turkey	High
Neotoma magister	Alleghany woodrat	Moderate
Odocoileus virginianus	white-tailed deer	High
Plethodon punctatus	Cow Knob salamander	Moderate
Plethodon virginia	Shenandoah Mt. salamander	Moderate
Sciurus carolinensis	gray squirrel	High
Semionellus placidus	Millipede	High
Spilogale putorius	Spotted Skunk	Moderate
Ursus americanus	black bear	High

4.2. 11 Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates

These are species requiring large blocks (generally 500 acres or greater) of mature successional forest systems. These areas have developing or well-developed canopy structural dynamics, large woody material on the ground, and den and cavity trees. The habitat needs of the species in this group are tied directly to the Spruce, Northern Hardwood, Pine Forests and Woodlands, Oak Forest and Woodlands, Cover Forest, and Wetlands and Riparian ecological systems. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Aegolius acadicus	northern saw-whet owl	High
Aquila chrysaetos	golden eagle	Very High

Catharus guttatus	hermit thrush	High
Certhia americana	brown creeper	High
Corynorhinus townsendii virginianus	Virginia big-eared bat	High
Dendroica cerulea	cerulean warbler	High
Dendroica fusca	blackburnian warbler	Moderate
Empidonax virescens	acadian flycatcher	Moderate
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	High
Loxia curvirostra	red crossbill	Moderate
Martes pennanti	fisher	Very High
Myotis sodalis	Indiana bat	Very High
Plethodon punctatus	Cow Knob salamander	High
Plethodon virginia	Shenandoah Mt. salamander	High
Seiurus noveboracensis	northern waterthrush	High
Ursus americanus	black bear	Very High

4.2.12 Lepidopterans

These are lepidopterans that are either sensitive to fire injury (due to their limited distribution) or to treatment of gypsy moths with insecticides like Bt or dimilin. Many of these species rely on host plants that occur in open conditions, so fire is an important aspect of maintaining their habitat. However, since at least one of their life stages is always present in the area, care must be taken in planning prescribed burns. These species and habitats could be found in many ecological systems. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Autochton cellus	Golden-banded skipper	High
Boloria selene	Silver-bordered fritillary	Very High
Callophrys irus	Frosted elfin	Very High
Catocala herodias gerhardi	Herodias underwing	Very High
Catocala marmorata	Marbled underwing	Very High
Colias interior	Pink-edged sulphur	Very High
Erora laeta	Early hairstreak	Very High
Erynnis martialis	Mottled duskywing	Very High
Erynnis persius	Persius duskywing	Very High
Euchloe olympia	Olympia marble	Very High
Incisalia polia	Hoary elfin	Very High
Phyciodes batesii	Tawny crescent	Very High
Phyciodes cocyta	Northern crescent	Very High
Polygonia progne	Gray comma	Very High
Pyrgus wyandot	Appalachian grizzled skipper	Very High

Species Name	Common Name	Group Weight
Satyrium favonius ontario	Northern Hairstreak	Very High
Speyeria atlantis	Atlantis fritillary	Very High
Speyeria diana	Diana fritillary	Very High
Speyeria idalia	Regal fritillary	Very High

4.2.13 Mafic Rock Associates

These species are associated with mafic rock substrates and often with seepage areas. The habitat needs of the species in this group are tied directly to the Mafic Glades and Barrens ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Clematis occidentalis	purple clematis	High
Muhlenbergia glomerata	marsh muhly	High
Poa saltuensis	drooping bluegrass	High
Potentilla arguta	tall cinquefoil	Very High
Pycnanthemum torreyi	Torrey's mountain-mint	High
Ruellia purshiana	Pursh's wild petunia	High
Solidago randii = S. simplex var. randii	Rand's goldenrod	Very High

4.2.14 Species Needing Occurrence Protection

Species in this group are rare in occurrence on the GWNF although habitat is widespread. Habitat assessments can not accurately predict the presence of these species. Most of these species occur in less than 5 populations on the Forest and are sensitive to management actions. Those species which have more than 5 known occurrences represent populations which are critical to the survival of the species and have limited occurrence outside of GWNF. T&E species are not included in this group because they require species-specific protection and have specific guidance described in Section 2. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Adlumia fungosa	Climbing fumatory	High
Ammodramus henslowii	Henslow's sparrow	High
Arnoglossom muehlenbergii	great Indian-plantain	High
Bartramia longicauda	upland sandpiper	High
Buckleya distichophylla	Piratebush	High

Species Name	Common Name	Group Weight
Callophrys irus	Frosted elfin	High
Carex polymorpha	variable sedge	High
Carex roanensis	Roan Mountain sedge	High
Catocala herodias gerhardi	Herodias underwing	High
Catocala marmorata	Marbled underwing	High
Circus cyaneus	northern harrier	High
Corallorhiza bentleyi	Bentley's coalroot	High
Cornus canadensis	bunchberry	High
Cornus rugosa	roundleaf dogwood	High
Corynorhinus townsendii virginianus	Virginia big-eared bat	High
Crataegus calpodendron	pear hawthorn	Moderate
Crataegus pruinosa	prunose hawthorn	Moderate
Cuscuta coryli	hazel dodder	High
Cuscuta rostrata	beaked dodder	High
Cypripedium reginae	showy lady's-slipper	Moderate
Desmodium cuspidatum	toothed tick-trefoil	High
Erora laeta	Early hairstreak	High
Erynnis martialis	Mottled duskywing	High
Eumeces anthracinus	coal skink	High
Falco peregrinus	peregrine falcon	High
Gaylussacia brachycera	box huckleberry	High
Glyphyalinia raderi	Maryland glyph	Low
Goodyera repens	dwarf rattlesnake plantain	High
Gymnocarpium appalachianum	Appalachian oak fern	High
Haliaeetus leucocephalus	bald eagle	High
Helicodiscus diadema	Shaggy coil	High
Helicodiscus triodus	Talus coil	High
Heuchera alba	white alumroot	High
Hypericum mitchellianum	Blue Ridge St. John's-wort	High
Juglans cinerea	butternut	High
Leucothoe fontanesiana	highland dog-hobble	High
Monotropsis odorata	sweet pinesap	High
Myotis leibii	eastern small-footed bat	High
Myotis sodalis	Indiana bat	High
Nannaria shenandoah	Shenandoah Mountain xystodesmid	High
Phlox amplifolia	Broadleaf phlox	Moderate
Phlox buckleyi	sword-leaved phlox	High
Phyciodes batesii	Tawny crescent	High
Pituophis melanoleucus	northern pinesnake	Low

Species Name	Common Name	Group Weight
Pygmarrhopalites caedus	A cave springtail	High
Pyrola elliptica	shinleaf	High
Satyrium favonius ontario	Northern Hairstreak	High
Semionellus placidus	Millipede	High
Triodopsis picea	Spruce Knob threetooth	High
Triphora trianthophora	nodding pogonia	High

4.2.15 Open Area Associates

Many species require open areas for at least some part of their life history. Openings allow sunlight to reach the ground and that often allows for more herbaceous vegetation and shrubby vegetation to become established. Herbaceous vegetation also allows for development of a richer insect population which can provide food which is often important for the early portion of several species lives. Open areas can take many forms. A stand of trees that is harvested, blown down, or burned creates an opening while the new stand regenerates. The opening for the first ten years is referred to as early successional habitat and is important for many species as a temporary opening. As the stand continues to grow, the dense stand of saplings in the range of 11 to 20 years provides habitat important to ruffed grouse. Openings can be as small as the opening created by a tree falling (canopy gaps) or as large as grasslands greater than 100 acres in size which are desired by Henslow's sparrows. If disturbance of an area occurs on a regular basis, trees will not be reestablished on the site. It may stay as a grassland with very frequent disturbance or as a shrubland with less frequent disturbance. Open woodlands are created when fire is frequent in a mature stand of trees. The few mature trees will maintain an open canopy, but the understory will be open enough for a grassy or herbaceous understory will develop that can be maintained with frequent fire. These openings are sometimes hard to distinguish from each other and they may move from one type to another depending upon the type and frequency of disturbance.

4.2.15a Area Sensitive Grassland and Shrubland and Open Woodlands Associates

These species require the presence of large blocks (from 40 to 100+ acres) of a combination of grasslands and shrublands and/or open woodlands. It is important to have complexes of all these habitat components. It is important to retain existing sites. While many of these habitats would be found in the Oak Forest and Woodland ecological system, these could be found in other systems as well. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Caprimulgus carolinensis	chuck-will's widow	High
Caprimulgus vociferus	whip-poor-will	High
Colinus virginianus	northern bobwhite	High
Dendroica discolor	prairie warbler	High
Sciurus niger	Eastern fox squirrel	High

Vermivora chrysoptera	golden winged warbler	High

4.2.15.b Area Sensitive GrasslandsAssociates

These species require the presence of large blocks (40 to 100 acres or greater) of open grassland habitat. It is important to retain existing sites and expand them where possible. Most of these species prefer areas at the larger end of this size range. While many of these habitats would be found in the Oak Forest and Woodland ecological system, these couldbe found in other systems as well. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Ammodramus henslowii	Henslow's sparrow	Very High
Bartramia longicauda	upland sandpiper	Very High
Circus cyaneus	northern harrier	Very High
Lanius ludovicianus	loggerhead shrike	Very High
Speyeria idalia	Regal fritillary	Very High
Tyto alba	barn owl	High

4.2.15.c Area Sensitive Shrubland and Open Woodland Associates

These species require the presence of large blocks (100 acres or greater) of a mix of open shrubland and open woodland habitat. It is important to retain existing sites and expand them where possible. While many of these habitats would be found in the Oak Forest and Woodland ecological system, these could be found in other systems as well. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Erynnis martialis	Mottled duskywing	High

4.2.15.d Grassland Associates

These species are associated with open areas of any size with grass or forb dominated vegetation. These areas may be permanent openings or temporary openings that will eventually become shrublands or forests. While many of these habitats would be found in the Oak Forest and Woodland ecological system, these could be found in other systems as well. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Anaphalis margaritacea	pearly everlasting	High
Arnoglossom muehlenbergii	great Indian-plantain	Moderate
Bonasa umbellus	ruffed grouse	Moderate
Colinus virginianus	northern bobwhite	High
Erynnis persius	Persius duskywing	High
Glyptemys insculpta	wood turtle	Moderate
Incisalia polia	Hoary elfin	High
Lanius ludovicianus	loggerhead shrike	High
Liochlorophis vernalis	Smooth green snake	High
Meleagris gallopavo	wild turkey	High
Mustela nivalis	least weasel	High
Odocoileus virginianus	white-tailed deer	High
Polygonia progne	Gray comma	Moderate
Scolopax minor	American woodcock	High
Thryomanes bewickii altus	Appalachian Bewick's wren	High
Tyto alba	barn owl	High
Ursus americanus	black bear	High
Vermivora chrysoptera	golden winged warbler	High
Virginia valeriae pulchra	mountain earth snake	High

4.2.15.e High Elevation Opening (Grassy Or Shrubby) or Open Woodland Associates

These species are associated with openings or open woodlands at elevations greater than 3,000 feet. The habitat needs of the species in this group are tied directly to the Northern Hardwood, Oak Forest and Woodlands and Pine Forest and Woodlands ecological systems. Additional measures will need to assure that the high elevation grasslands and shrublands are also maintained. Maintaining these ecological systems and these additional measures and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Carpodacus purpureus	purple finch	High
Catharus guttatus	hermit thrush	Moderate
Coccyzus erythropthalmus	black-billed cuckoo	High
Contopus borealis	olive-sided flycatcher	High
Cuscuta rostrata	beaked dodder	Very High
Gnaphalium uliginosum	low cudweed	High
Hypericum mitchellianum	Blue Ridge St. John's-wort	High

Species Name	Common Name	Group Weight
Juniperus communis var depressa	ground juniper	High
Lepus americanus	snowshoe hare	Moderate
Liochlorophis vernalis	Smooth green snake	Very High
Melospiza georgiana	swamp sparrow	High
Oporornis philadelphia	mourning warbler	High
Rubus idaeus ssp. strigosus	American red raspberry	Very High
Sphyrapicus varius	yellow-bellied sapsucker	High
Sylvilagus obscurus	Appalachian Cottontail	Very High
Thryomanes bewickii altus	Appalachian Bewick's wren	High
Vermivora chrysoptera	golden winged warbler	Very High

4.2.15.f Shrubland Associates

These species are associated with shrub dominated vegetation. The habitat needs of the species in this group are tied directly to the Cove Forest, Northern Hardwood, Pine Forest and Woodland, Oak Forest and Woodlands, and Mafic Glade and Barrens and Alkaline Glades and Woodlands ecological systems. Additional measures will need to assure that the existing shrublands are also maintained. Maintaining these ecological systems and these additional measures and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Anaphalis margaritacea	pearly everlasting	Moderate
Bonasa umbellus	ruffed grouse	High
Colinus virginianus	northern bobwhite	High
Erynnis persius	Persius duskywing	Moderate
Eumeces anthracinus	coal skink	Low
Glyptemys insculpta	wood turtle	High
Incisalia polia	Hoary elfin	High
Lanius ludovicianus	loggerhead shrike	High
Meleagris gallopavo	wild turkey	High
Mustela nivalis	least weasel	High
Odocoileus virginianus	white-tailed deer	High
Oryzopsis asperifolia	white-grained mtn-ricegrass	High
Polygonia progne	Gray comma	Moderate
Prunus nigra	Canada plum	Moderate
Spilogale putorius	Spotted Skunk	Moderate
Thryomanes bewickii altus	Appalachian Bewick's wren	High
Ursus americanus	black bear	High

Vermivora chrysoptera	golden winged warbler	High
Virginia valeriae pulchra	mountain earth snake	Moderate

4.2.15.g Regenerating Forest Associates

These species utilize regenerating even-aged forests of pole-size timber (typically in the 10-30 year old age class group). The habitat needs of the species in this group are tied directly to the Cove Forest, Pine Forest and Woodland, and Oak Forest and Woodlands ecological systems. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Bonasa umbellus	ruffed grouse	High
Caprimulgus carolinensis	chuck-will's widow	High
Caprimulgus vociferus	whip-poor-will	High
Dendroica discolor	prairie warbler	High
Dendroica magnolia	magnolia warbler	High
Lepus americanus	snowshoe hare	Very High
Odocoileus virginianus	white-tailed deer	High
Oporornis philadelphia	mourning warbler	High
Ursus americanus	black bear	High

4.2.15.h Open Woodland Associates

These species are associated with mature stands of trees with open (26-60% open) canopies and well developed grassy or shrubby understories. The habitat needs of the species in this group are tied directly to the Cove Forest, Northern Hardwood, Pine Forest and Woodland, Oak Forest and Woodlands, and Mafic Glade and Barrens and Alkaline Glades and Woodlands ecological systems. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Bonasa umbellus	ruffed grouse	High
Callophrys irus	Frosted elfin	High
Caprimulgus carolinensis	chuck-will's widow	High
Caprimulgus vociferus	whip-poor-will	High
Catocala herodias gerhardi	Herodias underwing	High
Colinus virginianus	northern bobwhite	High
Delphinium exaltatum	tall larkspur	Moderate
Desmodium sessilifolium	sessile-leaf tick-trefoil	Moderate

Species Name	Common Name	Group Weight
Echinacea laevigata	smooth coneflower	High
Erysimum capitatum	western wallflower	High
Euchloe olympia	Olympia marble	High
Eumeces anthracinus	coal skink	High
Falco peregrinus	peregrine falcon	High
Glyptemys insculpta	wood turtle	High
Helianthemum bicknellii	plains frostweed	High
Helianthemum propinquum	low frostweed	High
Linum lewisii	prairie flax	High
Linum sulcatum	grooved yellow flax	High
Liochlorophis vernalis	Smooth green snake	High
Meleagris gallopavo	wild turkey	High
Melica nitens	Three-flowered melic grass	High
Myotis sodalis	Indiana bat	Very High
Odocoileus virginianus	white-tailed deer	High
Oligoneuron rigidum	stiff goldenrod	High
Onosmodium virginianum	Virginia false-gromwell	High
Oryzopsis asperifolia	white-grained mtn-ricegrass	High
Pituophis melanoleucus	northern pinesnake	High
Plethodon sherando	Big levels salamander	High
Poa saltuensis	drooping bluegrass	High
Polygonia progne	Gray comma	Moderate
Prunus alleghaniensis	Alleghany sloe	High
Pycnanthemum torreyi	Torrey's mountain-mint	High
Pyrgus wyandot	Appalachian grizzled skipper	High
Rosa setigera	prairie rose	High
Satyrium favonius ontario	Northern Hairstreak	High
Scutellaria parvula var. parvula	small skullcap	High
Scutellaria saxatilis	Rock skullcap	Moderate
Speyeria diana	Diana fritillary	High
Spiranthes ochroleuca	yellow nodding ladies'-tresses	High
Trichostema setaceum	narrow-leaved blue curls	High
Ursus americanus	black bear	High
Vermivora chrysoptera	golden winged warbler	Very High
Virginia valeriae pulchra	mountain earth snake	High
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	High

4.2.16 Riparian Area Associates

Species occurring in this group require wetlands, aquatic systems (streams, lakes, or ponds), springs, seeps or areas adjacent to these systems. The habitat needs of the species in this group are tied directly to the Floodplain, Wetland and Riparian Area ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need. There are also a number of the species in this group that benefit from open canopies. These include wetland plants and many of the birds. Flood events, canopy gaps, edaphic conditions and beaver activity are expected to meet most of the needs of these species.

Species in Group

Species Name	Common Name	Group Weight
Aegolius acadicus	northern saw-whet owl	High
Alnus incana ssp. rugosa	speckled alder	Very High
Ambystoma tigrinum	Eastern tiger salamander	High
Anas rubripes	American black duck	Very High
Arnoglossom muehlenbergii	great Indian-plantain	
Aster radula	rough-leaved aster	Very High
Autochton cellus	Golden-banded skipper	Very High
Boloria selene	Silver-bordered fritillary	Very High
Boltonia montana	no common name	Very High
Bonasa umbellus	ruffed grouse	High
Bromus ciliatus	fringed brome grass	Very High
Calopogon tuberosus	Grass pink	Very High
Carex aquatilis	water sedge	Very High
Carex arctata	black sedge	Very High
Carex barrattii	Barratt's sedge	Very High
Carex buxbaumii	Buxbaum's sedge	Very High
Carex lasiocarpa var. americana	slender sedge	Very High
Carex schweinitzii	Schweinitz's sedge	High
Carex vesicaria		Very High
Castor canadensis	Beaver	Very High
Catocala marmorata	Marbled underwing	High
Certhia americana	brown creeper	High
Cicindela ancocisconensis	a tiger beetle	Very High
Clemmys guttata	spotted turtle	Very High
Coccyzus erythropthalmus	black-billed cuckoo	High
Colias interior	Pink-edged sulphur	Very High
Contopus borealis	olive-sided flycatcher	High
Cyperus dentatus	toothed flatsedge	High
Cypripedium reginae	showy lady's-slipper	Very High

Species Name	Common Name	Group Weight
Dendroica cerulea	cerulean warbler	High
Dendroica magnolia	magnolia warbler	High
Desmodium canadense	showy tick-trefoil	High
Desmodium sessilifolium	sessile-leaf tick-trefoil	High
Echinodorus tenellus	dwarf burhead	Very High
Eleocharis compressa	flat-stemmed spikerush	Very High
Eleocharis melanocarpa	black-fruited spikerush	Very High
Eleocharis robbinsii	Robbins spikerush	Very High
Elymus canadensis	nodding wild rye	High
Empidonax alnorum	alder flycatcher	High
Empidonax virescens	acadian flycatcher	Very High
Epilobium ciliatum	Hair willow-herb	High
Epilobium leptophyllum	linear-leaved willow-herb	Very High
Equisetum sylvaticum	woodland horsetail	Very High
Eriocaulon aquaticum	white buttons	Very High
Erynnis persius	Persius duskywing	High
Eupatorium maculatum	spotted joe-pye weed	High
Euphorbia purpurea	glade spurge	High
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Moderate
Glyceria acutiflora	sharp-scaled manna-grass	Very High
Glyceria grandis	American manna-grass	Very High
Glyptemys insculpta	wood turtle	High
Gnaphalium uliginosum	low cudweed	High
Goodyera repens	dwarf rattlesnake plantain	Moderate
Haliaeetus leucocephalus	bald eagle	Very High
Hansonoperla appalachia	Appalachian stonefly	Very High
Helenium virginicum	Virginia sneezeweed	Very High
Helonias bullata	swamp-pink	Very High
Huperzia appalachiana	Appalachian fir clubmoss	Very High
Hydraena maureenae	Maureen's shale stream beetle	Very High
Hypericum boreale	northern St. John's-wort	Very High
Iliamna remota	Kankakee globe-mallow	Moderate
Isoetes lacustris	lake quillwort	Very High
Isonychia tusculanensis	a mayfly	Very High
Juncus brachycephalus	small-head rush	Very High
Juncus brevicaudatus	narrow-panicled rush	Very High
Leuctra mitchellensis	Mitchell needlefly	Very High
Leuctra monticola	montane needlefly	Very High
Liparis loeselii	Loesel's twayblade	Very High
Lonicera canadensis	American fly-honeysuckle	High

Species Name	Common Name	Group Weight
Lontra canadensis	river otter	Very High
Lycopodiella inundata	northern bog clubmoss	High
Lythrum alatum	winged loosestrife	Very High
Maianthemum stellatum	stary false Solomon's-seal	High
Megaleuctra flinti	Shenandoah needlefly	Very High
Melospiza georgiana	swamp sparrow	High
Microtus chrotorrhinus carolinensis	Southern rock vole	High
Muhlenbergia glomerata	marsh muhly	High
Myotis sodalis	Indiana bat	High
Nemotaulius hostilis	a limnephilid caddisfly	Very High
Nyctanassa violacea	yellow-crowned night-heron	Very High
Nycticorax nycticorax	black-crowned night-heron	Very High
Osmunda cinnamomea var. glandulosa	glandular cinnamon fern	Very High
Panicum hemitomon	maidencane	Very High
Paragnetina ishusa	widecollar stonefly	Very High
Paraleptophlebia jeanae	a mayfly	Very High
Parnassia grandifolia	Large-leaved grass-of-parnassus	Very High
Peltigera hydrothyria	Waterfan	Very High
Perlesta frisoni	Blue Ridge stonefly	Very High
Platanthera grandiflora	large purple fringed orchid	Very High
Platanthera peramoena	purple fringeless orchid	Very High
Poa paludigena	bog bluegrass	Very High
Poa palustris	fowl bluegrass	Very High
Polanisia dodecandra	common clammy-weed	Very High
Polygonia progne	Gray comma	Moderate
Potamogeton amplifolius		Very High
Potamogeton hillii	Hill's pondweed	Very High
Potamogeton oakesianus	Oakes pondweed	Very High
Potamogeton tennesseensis	Tennessee pondweed	Very High
Ribes americanum	wild black currant	Very High
Sabatia campanulata	slender marsh rose-pink	Very High
Sagittaria calycina var calycina	long-lobed arrowhead	Very High
Sagittaria rigida	sessile-fruited arrowhead	Very High
Saxifraga pensylvanica	swamp saxifrage	High
Schizachne purpurascens	purple oat-grass	High
Schoenoplectus subterminalis	water bulrush	Very High
Scirpus ancistrochaetus	northeastern bulrush	Very High

Species Name	Common Name	Group Weight
Scirpus torreyi		Very High
Sciurus carolinensis	gray squirrel	High
Scolopax minor	American woodcock	Very High
Seiurus noveboracensis	northern waterthrush	High
Sida hermaphrodita	Virginia mallow	Very High
Solidago rupestris	riverbank goldenrod	Very High
Solidago uliginosa	bog goldenrod	Very High
Sorex palustris punctulatus	southern water shrew	High
Sparganium chlorocarpum = S. emersum	narrow-leaf burreed	Very High
Spartina pectinata	freshwater cordgrass	Very High
Speyeria atlantis	Atlantis fritillary	Very High
Sphagnum russowii	Russow's peatmoss	Very High
Sphyrapicus varius	yellow-bellied sapsucker	Very High
Spiranthes lucida	shining ladies'-tresses	Very High
Spiranthes ochroleuca	yellow nodding ladies'-tresses	High
Sylvilagus obscurus	Appalachian Cottontail	Moderate
Triadenum fraseri	Fraser's marsh St. John's-wort	Very High
Triantha racemosa	coastal false-asphodel	Very High
Troglodytes troglodytes	winter wren	High
Vaccinium macrocarpon	large cranberry	Very High
Verbena scabra	sandpaper vervain	Very High
Vermivora chrysoptera	golden winged warbler	Very High
Veronica scutellata	marsh speedwell	Very High
Viburnum lentago	nannyberry	Very High
Vicia americana	American purple vetch	Very High
Vitis rupestris	sand grape	Very High
Woodwardia virginica	Virginia chainfern	Very High

4.2.17 Ruderal Associates

These species are associated with previously disturbed habitats like old fields, old homesites and roadsides. These species are not associated with any particular ecological system so additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Arnoglossom muehlenbergii	great Indian-plantain	High
Cicindela patruela	Barrens tiger beetle	High

Cirsium altissimum	tall thistle	Very High
Desmodium cuspidatum	toothed tick-trefoil	Moderate
Eumeces anthracinus	coal skink	High
Gnaphalium uliginosum	low cudweed	Moderate
Phlox buckleyi	sword-leaved phlox	Very High
Polygonia progne	Gray comma	High
Prunus nigra	Canada plum	Moderate
Vicia americana	American purple vetch	High

4.2.18 Sandstone Glades and Barrens Associates

These species inhabit sandstone glades and barrens. Additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Cicindela patruela	Barrens tiger beetle	High
Helianthemum bicknellii	plains frostweed	High
Incisalia polia	Hoary elfin	High

4.2.19 Species Sensitive to Over-Collection

Species in this group are sensitive to excessive collection which could lead to sharp population declines. These species are collected commercially and used for a variety of purposes including food, medicinal, decorative, gardening / landscaping, pet trade, and trophy hunting (rattlesnake rattle collection). These species are not associated with any particular ecological system so additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Crotalus horridus	Timber rattlesnake	Very High
Cypripedium reginae	showy lady's-slipper	Very High
Glyptemys insculpta	wood turtle	Very High
Panax quinquefolius	Ginseng	Very High
Panax trifolius	Dwarf ginseng	High
Platanthera grandiflora	large purple fringed orchid	Moderate
Platanthera peramoena	purple fringeless orchid	Moderate
Pyrgus wyandot	Appalachian grizzled skipper	High

Species Name	Common Name	Group Weight
Speyeria diana	Diana fritillary	High
Speyeria idalia	Regal fritillary	High

4.2.20 Species Sensitive to Recreational Traffic

Species in this group are sensitive to excessive human disturbance such as trampling, harassment, vehicular mortality, and direct mortality. Reptile species are especially sensitive to being harmed, harassed, and killed by humans. This interaction with humans can have long-term negative effects on population sizes and sustainability. Plant species on this list are especially sensitive to trampling by off-road vehicles, heavy equipment, horses, and human traffic. These species are not associated with any particular ecological system so additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Minuartia groenlandica	mountain sandwort	High
Sibbaldiopsis tridentata	three-toothed cinquefoil	Moderate

4.2.21 Shale Barren Associates

Species occurring in this group require shale barrens. The habitat needs of the species in this group are tied directly to the Cliff, Talus and Shale Barrens ecological system. Maintaining these ecological systems and moving them towards their desired condition will satisfy the needs of the species in this group related to this habitat need.

Species in Group

Species Name	Common Name	Group Weight
Arabis patens	Spreading rockcress	Very High
Arabis serotina	shale barren rockcress	Very High
Astragalus distortus	bent milkvetch	Very High
Bromus kalmii	wild chess	Very High
Cheilanthes eatonii	chestnut lipfern	High
Clematis albicoma	White-haired Leatherflower	Very High
Clematis coactilis	Virginia white-haired leatherflower	Very High
Clematis viticaulis	Millboro leatherflower	Very High
Elymus trachycaulus	slender wheatgrass	Very High
Eriogonum allenii	Yellow Buckwheat	Very High
Erysimum capitatum	western wallflower	High

Euchloe olympia	Olympia marble	High
Liatris helleri	shale -barren blazing star	Very High
Melica nitens	Three-flowered melic grass	Moderate
Oenothera argillicola	Shale-barren evening primrose	Very High
Paronychia argyrocoma	Silver Nail-wort	Very High
Paronychia virginica	yellow nailwort	Very High
Prunus alleghaniensis	Alleghany sloe	Moderate
Pyrgus wyandot	Appalachian grizzled skipper	High
Rosa setigera	prairie rose	Moderate
Solidago arguta var. harrisii	Shale Barren Goldenrod	Very High
Sporobolus neglectus	small dropseed	Moderate
Taenidia montana	Virginia mountain pimpernel	Very High
Trichostema setaceum	narrow-leaved blue curls	High
Trifolium virginicum	Kate's mountain clover	Very High
Viola pedatifida	prairie violet	Very High

4.2.22 Species with Habitat in Special Biologic Areas

These are species that occupy habitat that has been designated as special biologic areas. These areas are established with the goal to manage the area for the particular rare communities or species at the site. These species are not associated with any particular ecological system so additional measures beyond those identified for the ecological systems are needed to assure that the habitat needs for these species are addressed.

Species in Group

Species Name	Common Name	Group Weight
Aegolius acadicus	northern saw-whet owl	Moderate
Ambystoma tigrinum	Eastern tiger salamander	Very High
Anaphalis margaritacea	pearly everlasting	Moderate
Arabis serotina	shale barren rockcress	Very High
Aralia hispida	Northern white cedar	Moderate
Betula cordifolia	mountain paper birch	Very High
Boloria selene	Silver-bordered fritillary	Very High
Boltonia montana	no common name	Very High
Bromus kalmii	wild chess	Very High
Campanula rotundifolia	American harebell	Very High
Carex aquatilis	water sedge	High
Carex arctata	black sedge	High
Carex barrattii	Barratt's sedge	Very High
Carex buxbaumii	Buxbaum's sedge	Very High
Carex lasiocarpa var. americana	slender sedge	High
Carex polymorpha	variable sedge	Moderate

Species Name	Common Name	Group Weight
Carex roanensis	Roan Mountain sedge	High
Carex vesicaria		High
Carpodacus purpureus	purple finch	Very High
Castor canadensis	Beaver	Low
Catharus guttatus	hermit thrush	Moderate
Certhia americana	brown creeper	Moderate
Cheilanthes eatonii	chestnut lipfern	High
Cicindela patruela	Barrens tiger beetle	Moderate
Cirsium altissimum	tall thistle	Very High
Clematis viticaulis	Millboro leatherflower	Very High
Clemmys guttata	spotted turtle	Very High
Colias interior	Pink-edged sulphur	Very High
Contopus borealis	olive-sided flycatcher	Moderate
Cornus canadensis	bunchberry	Very High
Cornus rugosa	roundleaf dogwood	Very High
Crataegus pruinosa	prunose hawthorn	Very High
Cuscuta rostrata	beaked dodder	High
Cypripedium reginae	showy lady's-slipper	Very High
Cystopteris fragilis	fragile fern	Very High
Dendroica fusca	blackburnian warbler	Moderate
Dendroica magnolia	magnolia warbler	Moderate
Desmodium cuspidatum	toothed tick-trefoil	High
Echinacea laevigata	smooth coneflower	Very High
Echinodorus tenellus	dwarf burhead	Very High
Eleocharis melanocarpa	black-fruited spikerush	High
Eleocharis robbinsii	Robbins spikerush	Very High
Elymus trachycaulus	slender wheatgrass	High
Empidonax alnorum	alder flycatcher	Moderate
Epilobium leptophyllum	linear-leaved willow-herb	Very High
Equisetum sylvaticum	woodland horsetail	Very High
Eriocaulon aquaticum	white buttons	Very High
Erynnis martialis	Mottled duskywing	High
Erysimum capitatum	western wallflower	High
Gaylussacia brachycera	box huckleberry	Very High
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Very High
Glyceria grandis	American manna-grass	Very High
Gnaphalium uliginosum	low cudweed	Moderate
Gymnocarpium appalachianum	Appalachian oak fern	High
Helenium virginicum	Virginia sneezeweed	Very High
Helianthemum bicknellii	plains frostweed	High
Helonias bullata	swamp-pink	Very High

Species Name	Common Name	Group Weight
Heuchera alba	white alumroot	Very High
Houstonia canadensis	Canada bluets	Very High
Hypericum mitchellianum	Blue Ridge St. John's-wort	Moderate
Isoetes lacustris	lake quillwort	Very High
Juncus brachycephalus	small-head rush	High
Juncus brevicaudatus	narrow-panicled rush	High
Juniperus communis var depressa	ground juniper	Very High
Lepus americanus	snowshoe hare	Very High
Leucothoe fontanesiana	highland dog-hobble	Very High
Liparis loeselii	Loesel's twayblade	Very High
Loxia curvirostra	red crossbill	High
Martes pennanti	fisher	High
Minuartia groenlandica	mountain sandwort	Low
Monotropsis odorata	sweet pinesap	Moderate
Muhlenbergia glomerata	marsh muhly	Very High
Oligoneuron rigidum	stiff goldenrod	Very High
Oryzopsis asperifolia	white-grained mtn-ricegrass	High
Osmunda cinnamomea var. glandulosa	glandular cinnamon fern	Very High
Panicum hemitomon	maidencane	Very High
Phlox buckleyi	sword-leaved phlox	Moderate
Platanthera grandiflora	large purple fringed orchid	Very High
Plethodon punctatus	Cow Knob salamander	Very High
Plethodon sherando	Big levels salamander	Very High
Plethodon virginia	Shenandoah Mt. salamander	Very High
Poa palustris	fowl bluegrass	Very High
Poa saltuensis	drooping bluegrass	Very High
Polygonia progne	Gray comma	Moderate
Potamogeton oakesianus	Oakes pondweed	Very High
Potentilla arguta	tall cinquefoil	Very High
Pyrgus wyandot	Appalachian grizzled skipper	High
Pyrola elliptica	shinleaf	Moderate
Regulus satrapa	golden-crowned kinglet	High
Ribes americanum	wild black currant	High
Rubus idaeus ssp. strigosus	American red raspberry	Very High
Sabatia campanulata	slender marsh rose-pink	Very High
Sagittaria calycina var calycina	long-lobed arrowhead	Very High
Schizachne purpurascens	purple oat-grass	High
Schoenoplectus subterminalis	water bulrush	Very High
Scirpus ancistrochaetus	northeastern bulrush	Very High

Species Name	Common Name	Group Weight
Seiurus noveboracensis	northern waterthrush	High
Sibbaldiopsis tridentata	three-toothed cinquefoil	Moderate
Sitta canadensis	red-breasted nuthatch	High
Solidago randii = S. simplex var. randii	Rand's goldenrod	Very High
Solidago rupestris	riverbank goldenrod	High
Solidago uliginosa	bog goldenrod	Very High
Sorex palustris punctulatus	southern water shrew	Moderate
Sparganium chlorocarpum = S. emersum	narrow-leaf burreed	High
Speyeria atlantis	Atlantis fritillary	Very High
Sphagnum russowii	Russow's peatmoss	High
Spiranthes ochroleuca	yellow nodding ladies'-tresses	Moderate
Symphoricarpos albus	snowberry	High
Thuja occidentalis	bristly sarsaparilla	High
Triadenum fraseri	Fraser's marsh St. John's-wort	Very High
Triantha racemosa	coastal false-asphodel	Very High
Trichostema setaceum	narrow-leaved blue curls	High
Trifolium virginicum	Kate's mountain clover	Very High
Trillium pusillum var. virginianum	mountain least trillium	Very High
Triphora trianthophora	nodding pogonia	Moderate
Troglodytes troglodytes	winter wren	High
Vaccinium macrocarpon	large cranberry	Very High
Viola pedatifida	prairie violet	Very High
Vitis rupestris	sand grape	High
Woodwardia virginica	Virginia chainfern	Moderate

A summary of all of the groups with which individual species are associated is in Appendix 2.

5.0 Effects of Alternatives on Species

For species and species groups whose needs are addressed by the condition of the ecological systems, the effects by alternative are described in the Ecological Systems Report.

For the species and species groups that require additional direction, their key attributes and indicators are described as follows.

Attributes and Indicators

The following key attributes were identified for each species group.

Table 8. Key Attributes and Indicators for Species Groups

Species Group	Key Attribute	Indicator Name
Area Sensitive Grassland and Shrubland and Open Woodlands	Habitat Type Abundance	Total acres of area sensitive grasslands, shrublands or open woodlands
Area Sensitive Grasslands.	Habitat Type Abundance	Area sensitive open Habitat grasslands greater than 100 ac
Area Sensitive Grasslands.	Habitat Type Abundance	Area sensitive open habitat grasslands greater than 40 ac
Area Sensitive Shrubland and Open Woodlands	Habitat Type Abundance	Area sensitive open habitat shrubland and open woodland greater than 100 ac
Grasslands	Existing grasslands	Existing grasslands in open conditions
Grasslands	Habitat Type Abundance	Total grasslands acres
High Elevation Openings, grassy or shrubby or open woodlands	Habitat Type Abundance	Total High Elevation Grassland acres
High Elevation Openings, grassy or shrubby or open woodlands	Habitat Type Abundance	Total high elevation shrubland acres
Shrublands	Habitat Type Abundance	Total shrubland acres
Cavity Trees, Den Trees and Snags	Habitat Element Abundance	Compliance with den/cavity tree and snag guidelines
Lepidopterans - sensitive to fire injury and sensitive to some insecticides (Bt, dimilin)	Fire Regime	Compliance with lepidopteran guidelines
Lepidopterans - sensitive to fire injury and sensitive to some insecticides (Bt, dimilin)	Sensitivity to invasive species treatments	Compliance with guidelines for lepidopterans
Sensitive to Over-Collection	Persistence of Species Occurrences	Compliance with guidelines for over collection
Sensitive to Recreation Traffic	Persistence of Species Occurrences	Compliance with recreation traffice guidelines
Cliff and Talus and large rock outcrops	Habitat Element Abundance	Compliance with cliff, talus and large rock outcrop guidelines
Calciphiles	Habitat Type Abundance	Acres of habitat that supports calciphiles
Calciphiles	Habitat Type Abundance	Total High-Quality Habitat Type Acres
Occurrence Protection	Persistence of Species Occurrences	Compliance with Species Occurrence Guidelines

The following tables display the current condition of each indicator identified for the species groups. It also displays the estimated condition of the indicator after 10 years (Table 9), or 50 years (Table 10), of implementation of each alternative. Table 11 identifies a description (poor, fair, or good) for the indicator based on the indicator values.

The effects by alternative are summarized in the following table:

Table 9. Current Condition and Expected Condition of Indicators at End of First Decade

Species Group	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Alkaline glades and barrens		See mafic and alkaline grades ecological system						
Area Sensitive Grassland and Shrubland and Open Woodlands								
Total acres of area sensitive grasslands, shrublands or open woodlands	24,341	58,215	121,389	22,360	86,859	121,389	121,389	121,389
Shrublands > 40 acres	367	367	367	367	367	367	367	367
Area Sensitive Grasslands.								
Area sensitive open Habitat grasslands greater than 100 ac	2,358	2,358	2,358	2,358	2,358	2,358	2,358	2,358
Area Sensitive Grasslands.								
Area sensitive open habitat grasslands greater than 40 ac	2,744	2,744	2,744	2,744	2,744	2,744	2,744	2,744
Area Sensitive Shrubland and Open Woodlands								
Area sensitive open habitat shrubland and open woodland greater than 100 ac	21,339	55,213	118,387	19,358	83,857	118,387	118,387	118,387
Shrublands > 100 acres	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates								
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	899,645	878,879	878,879	907,616	866,882	890,309	881,576	890,309
Calciphiles								
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves		See caves and karstlands ecological system						
Cavity Trees, Den Trees and Snags								
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and large rock outcrops								
Compliance with cliff, talus and large rock outcrop guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests		See cove forests ecological system						
Fire Dependent and Fire Enhanced								
Acres burned at desired frequency in all systems	18,376	35,855	99,029	0	64,499	99,029	99,029	99,029
Grasslands								
Existing grasslands in open conditions	4,861	4,861	4,861	2,431	4,861	4,861	4,861	4,861
Total grasslands acres	4,861	5,963	7,227	2,815	6,536	7,227	7,227	7,227

Species Group	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Hard and Soft Mast Dependent								
Total shrubland acres	15,213	31,503	31,503	1,562	43,582	19,562	11,503	31,503
Regenerating forest, pine + oak	29,411	45,306	45,306	16,722	57,183	34,292	25,382	45,306
Mature Oak	652,219	626,690	626,690	652,236	613,267	637,705	632,362	626,690
Open canopy pine + oak	17,788	50,289	109,633	16,722	78,038	109,633	109,633	109,633
High Elevation Coniferous, Deciduous and/or Mixed Forests								
Total acres of oak, cove or pine ecosystems in mid-late succession at elvevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312
High Elevation Openings, grassy or shrubby or open woodlands								
Total High Elevation Grassland acres	891	891	891	891	891	891	891	891
Total high elevation shrubland acres	151	151	151	151	151	151	151	151
Regeneration at high elevation	1,018	1,561	1,561	563	1,964	1,163	894	1,561
Late Successional Hardwood Dominated Forest								
Mature and late successional oak, cove and northern hardwoods	690,022	669,611	669,611	695,568	656,069	681,042	675,062	669,611
Lepidopterans -								
Compliance with lepidopteran guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks		See mafic and alkaline grades ecological system						
Occurrence Protection								
Compliance with Species Occurrence Guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands								
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	21,230	55,104	118,278	19,249	83,748	118,278	118,278	118,278
Regenerating Forests								
Regenerating forest, pine, oak, cove, northern hardwood systems	30,539	46,829	46,829	16,888	58,908	34,888	26,829	46,829
Riparian		See riparian ecological system						
Ruderal								
Compliance with ruderal species guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sandstone Glades and Barrens								
Compliance with sandstone glades species guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection								

Species Group	Current	Condition of Indicator at end of 10 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Compliance with guidelines for over collection	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic								
Compliance with recreation traffice guidelines	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens		See cliff, talus and shale barrens ecological system						
Shrublands								
Total shrubland acres	15,213	31,503	31,503	1,562	43,582	19,562	11,503	31,503
Total maintained Shrubland acres	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503
Species in a Special Biologic Area								
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10. Current Condition and Expected Condition of Indicators at End of Fifth Decade

Species Group	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Alkaline glades and barrens	See mafic and alkaline grades ecological system							
Area Sensitive Grassland and Shrubland and Open Woodlands								
Total acres of area sensitive grasslands, shrublands or open woodlands	24,341	65,080	193,160	22,360	131,032	193,160	193,168	193,160
Shrublands > 40 acres	367	367	367	367	367	367	367	367
Area Sensitive Grasslands.								
Area sensitive open Habitat grasslands greater than 100 ac	2,358	2,358	2,358	2,358	2,358	2,358	2,358	2,358
Area Sensitive Grasslands.								
Area sensitive open habitat grasslands greater than 40 ac	2,744	2,744	2,744	2,744	2,744	2,744	2,744	2,744
Area Sensitive Shrubland and Open Woodlands								
Area sensitive open habitat shrubland and open woodland greater than 100 ac	21,339	62,078	190,158	19,358	128,030	190,158	190,166	190,158
Shrublands > 100 acres	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates								

Species Group	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	899,645	891,856	891,864	996,149	815,558	922,743	962,257	921,827
Calciphiles								
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves	See caves and karstlands ecological system							
Cavity Trees, Den Trees and Snags								
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and large rock outcrops								
Compliance with cliff, talus and large rock outcrop guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests	See cove forests ecological system							
Fire Dependent and Fire Enhanced								
Acres burned at desired frequency in all systems	18,376	42,720	170,808	0	108,680	170,808	170,808	170,808
Grasslands								
Existing grasslands in open conditions	4,861	4,861	4,861	2,431	4,861	4,861	4,861	4,861
Total grasslands acres	4,861	6,100	8,662	2,815	7,419	8,662	8,662	8,662
Hard and Soft Mast Dependent								
Total shrubland acres	15,213	31,119	31,119	1,503	52,583	19,503	11,503	31,119
Regenerating forest, pine + oak	29,411	44,958	44,958	16,722	63,571	34,302	24,663	44,958
Mature Oak	652,219	625,470	625,470	723,901	558,694	654,172	694,015	625,470
Open canopy pine + oak	17,788	55,369	175,145	16,722	118,464	175,145	175,145	175,145
High Elevation Coniferous, Deciduous and/or Mixed Forests								
Total acres of oak, cove or pine ecosystems in mid-late succession at elvevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312
High Elevation Openings, grassy or shrubby or open woodlands								
Total High Elevation Grassland acres	891	891	891	891	891	891	891	891
Total high elevation shrubland acres	151	151	151	151	151	151	151	151
Regeneration at high elevation	1,018	1,548	1,548	561	2,263	1,161	894	1,548
Late Successional Hardwood Dominated Forest								

Species Group	Current	Condition of Indicator at end of 50 years						
Indicator	Condition	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G
Mature and late successional oak, cove and northern hardwoods	690,022	682,588	681,756	784,101	609,346	711,795	751,488	681,756
Lepidopterans -								
Compliance with lepidopteran guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks	See mafic and alkaline grades ecological system							
Occurrence Protection								
Compliance with Species Occurrence Guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands								
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	21,230	61,969	190,049	19,249	127,921	190,049	190,057	190,049
Regenerating Forests								
Regenerating forest, pine, oak, cove, northern hardwood systems	30,539	46,445	46,437	16,829	67,901	34,821	26,829	46,437
Riparian	See riparian ecological system							
Ruderal								
Compliance with ruderal species guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sandstone Glades and Barrens								
Compliance with sandstone glades species guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection								
Compliance with guidelines for over collection	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic								
Compliance with recreation traffice guidelines	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens	See cliff, talus and shale barrens ecological system							
Shrublands								
Total shrubland acres	15,213	31,119	31,119	1,503	52,583	19,503	11,503	31,119
Total maintained Shrubland acres	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503
Species in a Special Biologic Area								
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 11. Description of Indicator Condition

Species Group	Current			
Indicator	Condition	Poor	Fair	Good
Area Sensitive Grassland and Shrubland and Open Woodlands				

Species Group	Current			
Indicator	Condition	Poor	Fair	Good
Total acres of area sensitive grasslands, shrublands or open woodlands	24,341	<202,262 acres, >751,819 acres	202,262 - 521,661 acres or 631,572 - 751,819 acres	521,661 - 631,572 acres
Shrublands > 40 acres	367	<90% (330 acres) of existing blocks are maintained	90-99 % of existing blocks are maintained	100 % (367 acres) exisiting blocks are maintained
Area Sensitive Grasslands.				
Area sensitive open Habitat grasslands greater than 100 ac	2,358	<90% (2,122 acres) of existing blocks are maintained	90-99 % of existing blocks are maintained	100 % (2,358 acres) exisiting blocks are maintained
Area Sensitive Grasslands.				
Area sensitive open habitat grasslands greater than 40 ac	2,744	<90 % (2,469 acres) of existing blocks retained	90-99% of existing blocks retained	100 % (2,744 acres) exisiting blocks are maintained
Area Sensitive Shrubland and Open Woodlands				
Area sensitive open habitat shrubland and open woodland greater than 100 ac	21,339	<199,260 acres, >748,817 acres	199,260 - 518,659 or 628,570 - 748,817	518,659 - 628,570
Shrublands > 100 acres	109	<90% (90 acres) of existing blocks are maintained	90-99 % of existing blocks are maintained	100 % (109 acres) exisiting blocks are maintained
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates				
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	899,645	<405,170 acres, >938,325 acres	405,170 - 523,103 acres or 704,919 - 938,325 acres	523,103 - 704,919 acres
Calciphiles				
Total High-Quality Habitat Type Acres	6,823	0-25% (1,705 acres) of locations in SBA	26-49% of locations in SBA	50-74% (3,41 - 5,116 acres) of locations in SBA
Cavity Trees, Den Trees and Snags				
Compliance with den/cavity tree and snag guidelines	Yes	No		Yes
Cliff and Talus and large rock outcrops				
Compliance with cliff, talus and large rock outcrop guidelines	No	No		Yes
Fire Dependent and Fire Enhanced				
Acres burned at desired frequency in all systems	18,376	<199,151 acres, >748,708 acres	199,151 - 518,551 acres or 628,461 - 748,708 acres	518,551 - 628,461 acres
Grasslands				

Species Group	Current			
Indicator	Condition	Poor	Fair	Good
Existing grasslands in open conditions	4,861	<80% (3,888 acres) of existing grasslands	80 -100% of existing grasslands, many dominated by native grasses	all (4,861 acres) existing grasslands in native grasses
Total grasslands acres	4,861	<1% (7,562 acres) of oak ecosystem acres	1-3% of oak ecosystem acres	3-5% (22,688 - 37,813 acres) of Oak ecosystem acres
High Elevation Coniferous, Deciduous and/or Mixed Forests				
Total acres of oak, cove or pine ecosystems in mid-late succession at elvevations >3000 feet	156,312	=<70% (109,418 acres)of current forested area >3000 feet	70-90% of current forested area >3000 feet	>90% (140,680 acres) of current forested area >3000 feet
High Elevation Openings, grassy or shrubby or open woodlands				
Total High Elevation Grassland acres	891	<80% (712 acres) of existing high elevation grasslands maintained	80 -100% of existing high elevation grasslands maintained, many dominated by native grasses	all exsiting (891 acres) high elevation grasslands maintained in native grasses
Total high elevation shrubland acres	151	<80% (120 acres) of existing high elevation shrublands maintained	80 -100% of existing high elevation shrublands maintained	all exsiting (151 acres) high elevation shrublands maintained in native grasses
Late Successional Hardwood Dominated Forest				
Mature and late successional oak, cove and northern hardwoods	690,022	<255,287 acres, >730,965 acres	255,287 - 334,902 acres or 505,542 - 730,965 acres	334,902 acres - 505,542 acres
Lepidopterans -				
Compliance with lepidopteran guidelines	No	No		Yes
Occurrence Protection				
Compliance with Species Occurrence Guidelines	No	No		Yes
Open Woodlands				
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	21,230	<199,151 acres, >748,708 acres	199,151 - 518,551 acres or 628,461 - 748,708 acres	518,551 - 628,461 acres
Regenerating Forests				
Regenerating forest, pine, oak, cove, northern hardwood systems	30,539	<29,677 acres, >294,820 acres	29,677 - 76,679 acres or 121,724 - 294,820 acre	76,679 - 121,724 acres
Ruderal				
Compliance with ruderal species guidelines	No			Yes
Sandstone Glades and Barrens				

Species Group	Current			
Indicator	Condition	Poor	Fair	Good
Compliance with sandstone glades species guidelines	No			Yes
Sensitive to Over-Collection				
Compliance with guidelines for over collection	No	No		Yes
Sensitive to Recreation Traffic				
Compliance with recreation traffice guidelines	No	No		Yes
Shrublands				
Total shrubland acres	15,213	<31,394 acres, >299,004 acres	31,394 - 78,826 acres or 124,621 - 299,004 acres	78826 - 124,621 acres
Total maintained Shrubland acres	1,503	<751 acres		1,503 acres
Species in a Special Biologic Area				
Special Biological Area Managed for the habitat needed by the species	Yes	No		Yes

The complete summary of stresses and threats for each species and how it is addressed in the Forest Plan is in Appendix 3.

6.0 Plan Components for Species Diversity

6.1 Introduction

A wide array of species occurs on the GWNF, with many species sharing common habitat requirements that are associated with particular ecological systems. In the revised Forest Plan, the plan components developed for ecosystem diversity are fundamental to providing appropriate ecological conditions for sustaining species diversity. Most species' requirements would be met in whole through ecosystem diversity plan components, meaning that provisions in the Plan to restore, maintain, and protect ecological systems are sufficient to sustain plant and animal species on the forest. The first portion of this section describes how species with similar habitat needs are grouped and addressed through plan components for ecosystem diversity.

Although most species on NFS lands would be conserved through the management of healthy and productive ecosystems, even under the best conditions some species require additional attention in the Plan. In the second portion of this section, those species that require further provisions in the Plan are grouped by similar species needs and additional recommended plan components (typically standards) are identified for each species group. With the addition of these plan components, sustainability needs for all species would be addressed in the Plan.

6.2 Species Groups Covered by Ecosystem Diversity Plan Components

Those species groups whose habitat needs would be met in whole, or in part, through achieving the desired conditions for the ecological systems are identified in the following table.

Table 12. Relationship of Species Groups to Ecological Systems

Species Group	Associated Ecological System(s)	Needs Met in Whole
Alkaline glades and barrens	Alkaline Glade and Woodlands and Mafic Glades and Barrens	X
Area Sensitive Late Successional Coniferous, Deciduous and/or Mixed Forests	Spruce Forest, Northern Hardwood Forest, Cove Forest, Oak Forests and Woodlands, Pine Forests and Woodlands, Floodplains Wetlands and Riparian Areas.	X
Calciphiles	Caves and Karstlands	
Caves	Caves and Karstlands	X
Cliff and Talus and large rock outcrops	Cliff, Talus and Shale Barrens	
Cove forests	Cove Forests	X
Fire Dependent and Fire Enhanced	Pine Forests and Woodlands, Alkaline Glade and Woodlands and Mafic Glades and Barrens Oak Forests and Woodlands	X
Hard and Soft Mast Dependent	Oak Forests and Woodlands	
High Elevation Coniferous, Deciduous and/or Mixed Forests	Northern Hardwood Forests Spruce Forests Pine Forests and Woodlands Oak Forests and Woodlands	
Late Successional Hardwood Dominated Forest	Oak Forests and Woodlands Cove Forests Northern Hardwood Forests	X
Mafic rocks	Alkaline Glade and Woodlands and Mafic Glades and Barrens	X
High Elevation Openings, grassy or shrubby or open woodlands	Oak Forests and Woodlands Northern Hardwood Forests Pine Forests and Woodlands	X
Shale barrens	Cliff, Talus and Shale Barrens	
Regenerating Forests	Oak Forests and Woodlands Cove Forest Pine Forests and Woodlands	X
Shrublands	Oak Forests and Woodlands Cove Forest Pine Forests and Woodlands Alkaline Glade and Woodlands and Mafic Glades and Barrens Northern Hardwood Forests	
Open Woodlands	Oak Forests and Woodlands Cove Forest Pine Forests and Woodlands Alkaline Glade and Woodlands and Mafic Glades and Barrens Northern Hardwood Forests	X

Species Group	Associated Ecological System(s)	Needs Met in Whole
Shale Barrens	Cliff, Talus and Shale Barrens	X
Riparian	Floodplains, Wetlands and Riparian Areas	X

6.3 Species Groups Requiring Additional Plan Components

This section provides details on groups of species that will require further plan components in addition to those already provided by ecological diversity. Management strategies and appropriate plan components are recommended for each group. These groups represent small spatial scales and groups of species associated with localized conditions and features that cross ecosystem boundaries.

6.3.1 Calciphile Associates

Plan Components

Ecosystem diversity plan components include desired conditions and objectives for the Cave and Karstland Ecological System and standards for caves and karstlands. Special Biological Areas should be established for the most representative calciphile sites.

Management Strategies

The communities that are most representative of the calciphile associates should be established as Special Biological Areas. These include all the areas recommended by the Virginia Natural Heritage Program. As additional significant areas are identified they should be added as special biological areas.

6.3.2 Cavity Tree, Den Tree and Snag Associates

Plan Components

Ecosystem diversity plan components include desired conditions for managed forest to provide habitat for denning and cavity nesting species. Rock falls, caves, uprooted trees, and cavity trees of all sizes serve as suitable nesting and denning sites.

The following make up the den/cavity tree and snag guidelines. Compliance with these guidelines should be met through use of standards that will address the needs of the cavity and den tree associates like:

- FW-33: Favor the retention of large (>20" d.b.h.) standing snags and den trees when implementing silvicultural treatments. Active bear den trees are retained in harvest areas along with an unharvested buffer of at least 100 feet wide on all sides of the den..
- FW-102: When applying herbicide, protect non-target vegetation, especially threatened, endangered, proposed, or sensitive plants by employing a physical barrier between them and the area being treated. The physical barrier must be sufficient to protect the non-target vegetation from herbicide drift and flow.
- 7C-011 Favor the retention of large (>20" d.b.h.[2]) standing snags and den trees when implementing silvicultural treatments.
- Desired Condition for Management Prescription 13: Rockfalls, caves, road culverts, uprooted trees, and trees larger than 22 inches in diameter serve as potential dens. Known

den trees are retained in harvest areas and future den trees will be recruited over the long term on the many acres in older age classes.

- Indiana-bat standards

  FW-46: In order to promote potential summer roost trees and maternity sites for the Indiana bat throughout the Forest, planned silvicultural practices in hardwood-dominated forest types will leave all shagbark hickory trees greater than 6 inches d.b.h.3 and larger, except when they pose a safety hazard. In addition:

  · Clearcut openings 10 to 25 acres in size will also retain a minimum average of 6 snags or cavity trees per acre, 9 inches d.b.h. or larger, scattered or clumped.

  · Group selection openings and clearcuts less than 10 acres in size have no provision for retention of a minimum number of snags, cavity trees, or residual basal area due the small opening size and safety concerns.

  · All other harvesting methods (and clearcut openings 26-40 acres in size) will retain a minimum residual 15 square feet of basal area per acre (including 6 snags or cavity trees) scattered or clumped. Residual trees are greater than 6 inches d.b.h. with priority given to the largest available trees, which exhibit characteristics favored as roost trees by Indiana bats.

- 8E4-023 In order to promote fall foraging and swarming areas, timber activities will leave all shagbark hickory trees and retain a minimum average of 6 snags or cavity trees (greater than or equal to 9 inches d.b.h.) per acre as potential roost sites (except where they pose a safety hazard). For group selection harvest method, all shagbark hickories are maintained (except where they pose a safety hazard) with no provision for minimum number of snags or cavity trees due to the small opening size.

Management Strategies

Cavity and den trees are generally not limiting and with the increasing age of most of the trees in most of the ecological systems, cavity and den trees will become even more common. The key characteristics for this group are recruitment of new den/cavity trees and retention of existing trees, particularly in areas where management activities are planned. This should be done through the use of den/cavity tree and snag guidelines.

6.3.3 Cliff, Talus and Rock Outcrop Associates

Plan Components

Ecosystem diversity plan components include desired conditions and objectives for the Cliff and Talus and Shale Barrens ecological systems. In addition is the Cliff, Talus and Large Rock Outcrop guideline, described in the following standard:

When land disturbing projects are proposed in these areas:
-identified species associated with this group will be searched for; and
- effects of the proposed project on the species will be evaluated

Management Strategies

Manage these areas to enhance habitat for TESLR species that may occur there. Follow the Cliff, Talus and Large Rock Outcrop guidelines for managing these areas.

6.3.4 Hard and Soft Mast Associates

Plan Components

Ecosystem diversity plan components include desired conditions and objectives for open canopy, regenerating forests and mature trees (oak) in the Oak and Pine Forest and Woodlands ecological systems. In addition, an objective is needed to maintain existing shrubland areas on the GWNF.

Management Strategies

Manage to restore and maintain the open woodlands, regenerating forests and existing shrublands that produce a mixture of hard and soft mast.

6.3.5 High Elevation Coniferous, Deciduous and/or Mixed Forest Associates

Plan Components

Desired conditions and objectives that maintain the Spruce, Northern Hardwood Forest, Cove Forest, Oak Forest and Woodland, and Pine Forest and Woodland ecological systems will support this group.

Management Strategies

Manage to maintain the forested environment at high elevations (>3,000 feet). This would include all successional stages of the forests. Spruce restoration may include planting red spruce seedlings, removing exotic tree plantations, and releasing red spruce from hardwood overstory.

6.3.6 Lepidopterans

Plan Components

Lepidopteran guidelines should be incorporated with the following standard:

When projects are proposed in areas where these species occur:

-the area where the species occurs and adjacent habitat will not be treated with dimilin, BT or other insecticides that kill lepidopterans other than gypsy moth; and

- the entire area where the species occurs will not be part of a single prescribed burn; burning will be done only in patches of the occupied habitat.

Management Strategies

Species in this group are especially sensitive to the direct effects of fire, and care should be taken whenever fire is used in areas where they are known to occur. There are no direct key characteristics for this group, however project monitoring can determine if damage is occurring to species. These species are limited in occurrence on the GWNF, therefore implementation of special provisions at the project level are unlikely to interfere with completion of work.

When developing burn plans, the following should be considered at a minimum for all species in this group:

- Is any species from this group present or have potential to be present in project area?
- Is species habitat present in project area?
- What are the negative effects of fire to species?
- What mitigation can be performed to reduce impacts to species, i.e.. burning during specific part of life-cycle (hibernation, non-breeding, dormancy, etc); protecting individuals from direct effects of fire; protecting duff layer in mesic areas; etc.?
- Are there sufficient populations of this species adjacent to the project area to re-populate after the project?
- Are there any additional techniques that can be used to reduce impacts?
- Consideration of and mitigation for these questions should provide for species in this group.

6.3.7 Species Needing Occurrence Protection

Plan Components

Because these species are low in occurrence across the GWNF and can not be accurately predicted by availability of habitat, ecosystem and species diversity plan components should provide some protection for these species, but additional provisions are needed due to their rarity and sensitivity to management. The following standard should be created to implement the Species Occurrence Guidelines:

When projects are proposed in areas where species in this group are likely to occur (known county, proximity to known populations, suitable habitat):

-identified species associated with this group will be searched for; and

- effects of the proposed project on the species will be evaluated

Management Strategies

These species are rare in occurrence across the forest and known populations should be protected. Implement the Species Occurrence Guidelines to protect these species.

6.3.8 Open Area Associates

Plan Components

Because these openings blend into one another, the objectives to meet the needs for these species groups could include:

- Maintain and enhance old fields, short/medium/tall grasslands at old farm tracts
- Maintain grassland habitat. Maintain all current areas that are greater than 40 acres in size in patches at least that size, or greater. Maintain all current areas that are greater than 100 acres in size in patches at least that size.
- Maintain shrubland habitat.
- Areas of forest will be in the 0-10 –year age class from regeneration harvest.
- Restore and maintain areas in open woodland conditions through the use of fire on an annual basis.
- Create or maintain grasslands, shrublands or regenerating forests on high elevation (>3,000 feet) land.
- Maintain or create old fields or clusters of maintained openings (1-5 acres in size) on sites greater than 2,000 feet elevation.

Management Strategies

All of these types of opening are important. Manage to maintain existing grasslands and shrublands of all sizes. For some species it is important to maintain openings of a given size (greater than 40 acres or greater than 100 acres). Moving towards the desired open woodland component of the Oak Forest and Woodland and Pine Forest and Woodland ecological systems will produce open woodlands of a variety of sizes, including those greater than 100 acres in size. Meeting the regenerating forest objectives of the ecological systems is also important for this group. Objectives for openings at high elevations also need to be included.

It is important that these open conditions be incorporated within a forested environment. Many species need a combination of closed canopy and open canopy conditions during various parts of their life cycle. This is particularly important for many bird species.

6.3.9 Ruderal Associates

Plan Components

Add a standard to manage the old home sites, roadsides, old fields where members of the ruderal species group are found in conditions that maintain their open character.

Management Strategies

Manage the old home sites, roadsides, old fields where these species are found in conditions that maintain their open character.

6.3.10 Sandstone Glades and Barrens Associates

Plan Components

Establish Special Biological Areas for areas that represent high quality examples of this habitat.

Management Strategies

Sandstone glades and barrens may transition with other systems like cliff, talus and shale barrens. Where good examples of the sandstone glade and barren habitat are present, they are identified as Special Biological Areas. As more are identified they will be added as Special Biological Areas.

6.3.11 Species Sensitive to Over-Collection

Plan Components

Plan components include species diversity desired conditions and the following standards to limit collection of species occurring within rare communities to approved scientific purposes only:

- Limit permission to collect these species;
- Limit sharing of location information of these species;
- Avoid improving access to these locations;
- Evaluate seasonal closure of access to these locations
- Evaluate relocation of access to these locations.

Management Strategies

The strategy for these species is to continue to educate the public on species needs, restrict access to known populations, and limit approval of collections of these species to scientific purposes only.

6.3.12 Species Sensitive to Recreational Traffic

Plan Components

The following standard applies to this species group:

- Provide education regarding the recreational impacts to these species;
- Alert recreation users of the concerns in the area;
- Avoid improving access to these locations;
- Evaluate seasonal closure of access to these locations

- Evaluate relocation of access to these locations.

Management Strategies

All species on this list occur outside of rare and wetland communities. There are no ecosystem diversity plan components which cover these species. The strategy for these species is to continue to educate the public on species needs, restrict access to rare or sensitive populations, increase road ecopassage, and implement standards to protect these species where they occur during projects that involve heavy equipment or ground disturbance. New roads and trails should be located to avoid populations of these species and existing roads and trails should be evaluated for closure if they are causing declines to populations. Many roads on the Forest are not under our control, so partnerships and collaborative efforts may be required to help sustain species in this group.

6.3.13 Species with Habitat in Special Biologic Areas

These species are addressed in the Ecological Diversity Report

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Appendix F-1. Species Not Carried Forward into the Ecological Sustainability Analysis

Taxon	Scientific Name	Common Name	Rationale
Amphibian	Plethodon shenandoah	Shenandoah salamander	1
Amphibian	Pseudacris brachyphona	Mountain chorus frog	5
Arachnid	Anthrobia mammouthia	Mammoth cave spider	4a
Arachnid	Apochthonius coecus	A cave pseudoscorpion	4a
Arachnid	Chitrella superba	A cave pseudoscorpion	4a
Arachnid	Mundochthonius holsingeri	A cave pseudoscorpion	1
Bird	Dendroica caerulescens	black-throated blue warbler	5
Bird	Ixobrychus exilis exilis	least bittern	1
Bird	Melanerpes erythrocephalus	red-headed woodpecker	3
Bird	Oporornis formosus	Kentucky warbler	3
Bird	Rallus elegans	King rail	1
Insect	Euphyes bimacula	Two-spotted skipper	4a
Insect	Properigea costa	A noctuid moth	4a
Insect	Pseudanophthalmus fuscus	A cave beetle	1
Insect	Pseudanophthalmus hubbardi	Hubbard's cave beetle	1
Insect	Pseudanophthalmus hypertrichosis	A cave beetle	1
Insect	Pseudanophthalmus pontis	Natural Bridge cave beetle	1
Insect	Pseudanophthalmus potomaca	South Branch Valley cave beetle	4a
Insect	Pseudanopthalmus parvicollis	Thin-necked cave beetle	4a
Insect	Pseudosinella granda	A cave springtail	4a
Insect	Pygmarrhopalites lacuna	A cave springtail	1
Insect	Pygmarrhopalites pavo	A cave springtail	1
Insect	Pygmarrhopalites silvus	A cave springtail	1
Insect	Remenus kirchneri	Blue Ridge springfly	1
Insect	Schaefferia hubbardi	A cave springtail	4a
Insect	Strophopteryx limata	Newfound willowfly	1
Insect	Sweltsa voshelli	Virginia sallfly	1
Invertebrate	Amaurobius borealis	Spider	4a
Invertebrate	Anaplectoides brunneomedia	Brown-lined dart moth	4a
Invertebrate	Antrolana lira	Madison Cave isopod	1
Invertebrate	Caecidotea bowmani	Natural Bridge cave isopod	4a
Invertebrate	Caecidotea vandeli	Vandel's cave isopod	4a
Invertebrate	Cleidogona fidelitor	Faithful millipede	4a
Invertebrate	Clubiona spiralis	Two-clawed hunting spider	4a
Invertebrate	Euchlaena milnei	Looper moth	4a
Invertebrate	Lytrosis permagnaria	Geometrid moth	4a
Invertebrate	Melanoplus acrophilus acrophilus	Short-winged melanoplus	1

Taxon	Scientific Name	Common Name	Rationale
Invertebrate	Melanoplus cherokee	Cherokee melanoplus	1
Invertebrate	Melanoplus divergens	Divergent melanoplus	1
Invertebrate	Melanoplus serrulatus	Serrulate melanoplus	1
Invertebrate	Paravitrea reesei	Round supercoil	1
Invertebrate	Procotyla typhlops	A groundwater planarian	1
Invertebrate	Pseudanophthalmus limicola	Mud-dwelling cave beetle	1
Invertebrate	Pseudotremia alecto	Millipede	4a
Invertebrate	Scudderia septentrionalis	Northern bush katydid	1
Invertebrate	Sphaeroderus schaumii	Schaum's ground beetle	4a
Invertebrate	Sphalloplana virginiana	Rockbridge County cave planarian	1
Invertebrate	Stygobromus baroodyi	Rockbridge County cave amphipod	4a
Invertebrate	Stygobromus biggersi	Bigger's cave amphipod	1
Invertebrate	Stygobromus estesi	Craig County cave amphipod	1
Invertebrate	Stygobromus fergusoni	Montgomery County cave amphipod	1
Invertebrate	Stygobromus pseudospinosus	Luray Caverns amphipod	4a
Invertebrate	Stygobromus spinosus	Blue Ridge spring amphipod	4a
Invertebrate	Stylodrilus beattiei	A cave lumbriculid worm	4a
Invertebrate	Synanthedon castaneae	Chestnut clearwing moth	1
Invertebrate	Trimerotropis saxatalis	Rock-loving grasshopper	1
Mammal	Juncus articulatus	jointed rush	4a
Mammal	Stygobromus stegerorum	Madison Cave amphipod	4a
Nonvascular Plant	Anastrophyllum saxicola	Liverwort	1
Nonvascular Plant	Anzia americana	Foliose lichen	1
Nonvascular Plant	Brachydontium trichodes	Peak moss	1
Nonvascular Plant	Bryoerythrophyllum ferruginascens	Moss	1
Nonvascular Plant	Buxbaumia minakatae	Bug-on-a-stick moss	4a
Nonvascular Plant	Cephaloziella massalongi	Liverwort	1
Nonvascular Plant	Cephaloziella spinicaulis	Liverwort	1
Nonvascular Plant	Diplophyllum obtusatum	Liverwort	1
Nonvascular Plant	Drepanolejeunea appalachiana	Liverwort	1
Nonvascular Plant	Entodon sullivantii	Sullivant's entodon	1
Nonvascular Plant	Ephebe solida	Fructicose lichen	1
Nonvascular	Fissidens appalachensis	Appalachian pocket moss	1

Taxon	Scientific Name	Common Name	Rationale
Plant			
Nonvascular Plant	Heterodermia appalachensis	Foliose lichen	1
Nonvascular Plant	Homaliadelphus sharpii	Sharp's homaliadelphus	1
Nonvascular Plant	Hygrohypnum closteri	Closter's brook-hypnum	1
Nonvascular Plant	Hypotrachyna virginica	Foliose Lichen	1
Nonvascular Plant	Lejeunea blomquistii	Liverwort	1
Nonvascular Plant	Leptodontium excelsum	Grandfather Mountain excelsum	1
Nonvascular Plant	Lophocolea appalachiana	Liverwort	1
Nonvascular Plant	Macrocoma sullivantii	Sullivant's manned-moss	1
Nonvascular Plant	Melanelia stygia	Foliose lichen	1
Nonvascular Plant	Metzgeria fruticulosa (=M. temperata)	Liverwort	1
Nonvascular Plant	Metzgeria uncigera	Liverwort	1
Nonvascular Plant	Palamocladium leskeoides	Palamocladium	1
Nonvascular Plant	Pannaria conoplea	Foliose lichen	1
Nonvascular Plant	Pellia appalachiana (= Pelia X appalachiana)	Liverwort	1
Nonvascular Plant	Physcia pseudospeciosa	Rosette lichen	1
Nonvascular Plant	Plagiochila austinii	Liverwort	1
Nonvascular Plant	Plagiochila caduciloba	Liverwort	1
Nonvascular Plant	Plagiochila sullivantii var. sullivantii	Sullivant's leafy liverwort	1
Nonvascular Plant	Plagiochila virginica var virginica	Liverwort	1
Nonvascular Plant	Polytrichum appalachianum	Appalachian haircap moss	1
Nonvascular Plant	Riccardia jugata	Liverwort	1
Nonvascular Plant	Sphagnum fallax	Pretty peatmoss	3
Nonvascular	Sphagnum flavicomans	Peatmoss	1

Taxon	Scientific Name	Common Name	Rationale
Plant			
Nonvascular Plant	Sphagnum girgensohnii	Girgensohn's peatmoss	1
Nonvascular Plant	Sphagnum quinquefarium	Five-rowed peatmoss	1
Nonvascular Plant	Tetrodontium brownianum	Little Georgia moss	1
Nonvascular Plant	Tortula ammonsiana = Syntrichia ammonsiana	Ammon's tortula	1
Nonvascular Plant	Xanthoparmelia monticola	Xanthoparmelia lichen	1
Reptile	Terrapene carolina	eastern box turtle	5
Snail	Fontigens tartarea	Organ cavesnail	4a
Snail	Glyphyalinia picea	Rust glyph	4a
Snail	Helicodiscus lirellus	Rubble coil	4a
Vascular Plant	Aconitum reclinatum	white monkshood	1
Vascular Plant	Agastache scrophulariifolia	Giant purple hyssop	5
Vascular Plant	Allium oxyphilum	Nodding onion	1
Vascular Plant	Anemone canadensis	Canada anemone	1
Vascular Plant	Arabis hirsuta var. adpressipilis	hairy rockcress	1
Vascular Plant	Arethusa bulbosa	Dragon's mouth	1
Vascular Plant	Aster laevis var. concinnus	Smooth purple aster	5
Vascular Plant	Baptisia australis	blue wild-indigo	5
Vascular Plant	Berberis canadensis	American barberry	1
Vascular Plant	Botrychium matricariifolium = Sceptridium oneidense	Chamomile grape fern	4a
Vascular Plant	Botrychium oneidense	Blunt-lobed grape fern	4b
Vascular Plant	Bouteloua curtipendula	Side-oats grama	5
Vascular Plant	Calamagrostis canadensis	Canada reedgrass	5
Vascular Plant	Camassia scilloides	wild hyacinth	1
Vascular Plant	Campanula aparinoides	Marsh bellflower	5
Vascular Plant	Carex conoidea	field sedge	1
Vascular Plant	Carex cristatella	crested sedge	1
Vascular Plant	Carex hitchcockiana	Hitchcock's sedge	5
Vascular Plant	Carex interior	inland sedge	1
Vascular Plant	Carex ormostachya	necklace spike sedge	1
Vascular Plant	Carex pedunculata	longstalk sedge	1
Vascular Plant	Carex plantaginea	Plantain-leaved sedge	3
Vascular Plant	Carex tetanica	rigid sedge	5
Vascular Plant	Carex trisperma	Three-seeded sedge	5
Vascular Plant	Carex verrucosa	Warty sedge	1
Vascular Plant	Chenopodium simplex	Giant-seed goosefoot	3

Taxon	Scientific Name	Common Name	Rationale
Vascular Plant	Cymophyllus fraserianus	Fraser's sedge	5
Vascular Plant	Diarrhena americana	Eastern beakgrass	5
Vascular Plant	Dicentra eximia	Bleeding heart	5
Vascular Plant	Dirca palustris	Leatherwood	3
Vascular Plant	Eriophorum virginicum	Tawny cotton-grass	3
Vascular Plant	Eupatorium godfreyanum	Godfrey's thoroughwort	5
Vascular Plant	Geum aleppicum	yellow avens	1
Vascular Plant	Hasteola suaveolens	False Indian-plantain	1
Vascular Plant	Helianthus atrorubens	Savanna hairy sunflower	5
Vascular Plant	Helianthus laevigatus	smooth sunflower	5
Vascular Plant	Heuchera parviflora	Little-leaved alumroot	1
Vascular Plant	Hexalectris spicata	crested coralroot	5
Vascular Plant	Hydrocotyle americana	American pennywort	3
Vascular Plant	Hypericum ellipticum	pale St. John's-wort	1
Vascular Plant	Isoetes virginica	Virginia quillwort	1
Vascular Plant	Isotria medeoloides	small whorled pogonia	1
Vascular Plant	Juncus subcaudatus	Woods rush	5
Vascular Plant	Lachnanthes caroliniana	Carolina redroot	1
Vascular Plant	Listera smallii	Kidney-leaf twayblade	5
Vascular Plant	Lithospermum latifolium	American gromwell	5
Vascular Plant	Lycopodiella margueritae	Marguerite's clubmoss	1
Vascular Plant	Lycopodium annotinum	Stiff clubmoss	5
Vascular Plant	Lysimachia radicans	trailing loosestrife	1
Vascular Plant	Malaxis bayardii	Appalachian adder's-mouth	1
Vascular Plant	Milium effusum	Millet grass	5
Vascular Plant	Monarda didyma	Oswego Tea	5
Vascular Plant	Orontium aquaticum	Golden club	3
Vascular Plant	Penstemon hirsutus	hairy beardtoungue	5
Vascular Plant	Platanthera flava var. herbiola	Turbercled rein-orchid	5
Vascular Plant	Polygonum arifolium = arifolia	Halberdleaf tearthumb	5
Vascular Plant	Polygonum cilinode = Fallopia cilinodis	Fringed black bindweed	4b
Vascular Plant	Pycnanthemum virginianum	Virginia mountain mint	5
Vascular Plant	Ranunculus trichophyllus	white water crowfoot	1
Vascular Plant	Ribes lacustre	bristly black currant	4b
Vascular Plant	Robinia hispida var kelseyi	Kelsey's locust	4b
Vascular Plant	Robinia viscosa	Clammy locust	4b
Vascular Plant	Sanicula trifoliata	Large-fruited snakeroot	5
Vascular Plant	Saxifraga careyana	Golden-eye saxifrage	1
Vascular Plant	Saxifraga caroliniana	Carolina saxifrage	1
Vascular Plant	Solidago squarrosa	Squarrose goldenrod	5

Taxon	Scientific Name	Common Name	Rationale
Vascular Plant	Sphenopholis pensylvanica	Swamp wedgescale	3
Vascular Plant	Stellaria longifolia	Longleaf stitchwort	5
Vascular Plant	Talinum teretifolium	Roundleaf flame-flower	1
Vascular Plant	Taxus canadensis	Canada yew	5
Vascular Plant	Thermopsis mollis (= T. m. var. mollis)	Appalachian golden-banner	1
Vascular Plant	Torreyochloa pallida	Pale mannagrass	5
Vascular Plant	Triosteum aurantiacum	Horse gentian	5
Vascular Plant	Vaccinium hirsutum	Hairy blueberry	1
Vascular Plant	Viola appalachiensis	Appalachian blue violet	1
Vascular Plant	Viola conspersa	American dog violet	5
Vascular Plant	Woodwardia areolata	Netted chain fern	5

Key to Rationale

1 No occurrences or habitat known on the Unit.

2 Species is unaffected by Management

3 Unit is of marginal importance to conservation of the species.

4a Knowledge of species' ecology is insufficient to support conservation strategy.

4b Species' taxonomy is too uncertain to develop conservation strategy.

5 Species is common and demonstrably secure on the Unit.

O Other (describe in comments)

Appendix F-2. Species Groups by Individual Species

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Adlumia fungosa	Climbing fumatory	Occurrence Protection						
Aegolius acadicus	northern saw-whet owl	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Cavity Trees, Den Trees and Snags	Riparian	Species in a Special Biologic Area		
Alnus incana ssp. rugosa	speckled alder	Riparian						
Ambystoma tigrinum	Eastern tiger salamander	Late Successional Hardwood Dominated Forest	Riparian	Species in a Special Biologic Area				
Ammodramus henslowii	Henslow's sparrow	Area Sensitive Grasslands.	Occurrence Protection					
Anaphalis margaritacea	pearly everlasting	Fire Dependent and Fire Enhanced	Grasslands	Shrublands	Species in a Special Biologic Area			
Anas rubripes	American black duck	Riparian						
Apochthonius holsingeri	A cave pseudoscorpion	Caves						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Aquila chrysaetos	golden eagle	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates						
Arabis patens	Spreading rockcress	Shale barrens						
Arabis serotina	shale barren rockcress	Fire Dependent and Fire Enhanced	Shale barrens	Species in a Special Biologic Area				
Aralia hispida	Northern white cedar	Cliff and Talus and large rock outcrops	Fire Dependent and Fire Enhanced	Species in a Special Biologic Area				
Arnoglossom muehlenbergii	great Indian-plantain	Fire Dependent and Fire Enhanced	Grasslands	Occurrence Protection	Riparian	Ruderal		
Aster radula	rough-leaved aster	Riparian						
Astragalus distortus	bent milkvetch	Shale barrens						
Autochton cellus	Golden-banded skipper	Lepidopterans	Riparian					
Bartramia longicauda	upland sandpiper	Area Sensitive Grasslands.	Fire Dependent and Fire Enhanced	Occurrence Protection				
Betula cordifolia	mountain paper birch	Cliff and Talus and large rock outcrops	Fire Dependent and Fire Enhanced	Species in a Special Biologic Area				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Boloria selene	Silver-bordered fritillary	Lepidopterans	Riparian	Species in a Special Biologic Area				
Boltonia montana	no common name	Riparian	Species in a Special Biologic Area					
Bonasa umbellus	ruffed grouse	Fire Dependent and Fire Enhanced	Grasslands	Hard and Soft Mast Dependent	Late Successional Hardwood Dominated Forest	Riparian	Open Woodlands	Regenerating Forests & Shrublands
Bromus ciliatus	fringed brome grass	Riparian						
Bromus kalmii	wild chess	Fire Dependent and Fire Enhanced	Shale barrens	Species in a Special Biologic Area				
Buckleya distichophylla	Piratebush	Fire Dependent and Fire Enhanced	Occurrence Protection					
Callophrys irus	Frosted elfin	Fire Dependent and Fire Enhanced	Lepidopterans	Occurrence Protection	Open Woodlands			
Calopogon tuberosus	Grass pink	Riparian						
Campanula rotundifolia	American harebell	Calciphiles	Cliff and Talus and large rock outcrops	Species in a Special Biologic Area				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Caprimulgus carolinensis	chuck-will's widow	Area Sensitive Grassland and Shrubland and Open Woodlands	Fire Dependent and Fire Enhanced	Open Woodlands	Regenerating Forests			
Caprimulgus vociferus	whip-poor-will	Area Sensitive Grassland and Shrubland and Open Woodlands	Fire Dependent and Fire Enhanced	Open Woodlands	Regenerating Forests			
Carex aquatilis	water sedge	Riparian	Species in a Special Biologic Area					
Carex arctata	black sedge	Riparian	Species in a Special Biologic Area					
Carex barrattii	Barratt's sedge	Riparian	Species in a Special Biologic Area					
Carex buxbaumii	Buxbaum's sedge	Riparian	Species in a Special Biologic Area					
Carex lasiocarpa var. americana	slender sedge	Riparian	Species in a Special Biologic Area					
Carex polymorpha	variable sedge	Fire Dependent and Fire Enhanced	Occurrence Protection	Species in a Special Biologic Area				
Carex roanensis	Roan Mountain sedge	Occurrence Protection	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Carex schweinitzii	Schweinitz's sedge	Riparian						
Carex vesicaria		Riparian	Species in a Special Biologic Area					
Carpodacus purpureus	purple finch	High Elevation Openings, grassy or shrubby or open woodlands	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area				
Castor canadensis	Beaver	Riparian	Species in a Special Biologic Area					
Catharus guttatus	hermit thrush	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Species in a Special Biologic Area			
Catocala herodias gerhardi	Herodias underwing	Lepidopterans	Occurrence Protection	Open Woodlands				
Catocala marmorata	Marbled underwing	Lepidopterans	Occurrence Protection	Riparian				
Certhia americana	brown creeper	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed	High Elevation Coniferous, Deciduous and/or Mixed Forests	Cavity Trees, Den Trees and Snags	Riparian	Species in a Special Biologic Area		

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Forest Associates						
Cheilanthes eatonii	chestnut lipfern	Cliff and Talus and large rock outcrops	Shale barrens	Species in a Special Biologic Area				
Cicindela ancocisconensis	a tiger beetle	Riparian						
Cicindela patruela	Barrens tiger beetle	Ruderal	Sandstone glades and barrens	Species in a Special Biologic Area				
Circus cyaneus	northern harrier	Area Sensitive Grasslands.	Occurrence Protection					
Cirsium altissimum	tall thistle	Ruderal	Species in a Special Biologic Area					
Clematis albicoma	White-haired Leatherflower	Shale barrens						
Clematis coactilis	Virginia white-haired leatherflower	Shale barrens						
Clematis occidentalis	purple clematis	Mafic rocks						
Clematis viticaulis	Millboro leatherflower	Shale barrens	Species in a Special Biologic Area					
Clemmys guttata	spotted turtle	Riparian	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Coccyzus erythropthalmus	black-billed cuckoo	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Riparian				
Colias interior	Pink-edged sulphur	Lepidopterans	Riparian	Species in a Special Biologic Area				
Colinus virginianus	northern bobwhite	Area Sensitive Grassland and Shrubland and Open Woodlands	Fire Dependent and Fire Enhanced	Grasslands	Open Woodlands	Shrublands		
Contopus borealis	olive-sided flycatcher	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Riparian	Species in a Special Biologic Area	Cavity Trees, Den Trees and Snags		
Corallorhiza bentleyi	Bentley's coalroot	Occurrence Protection						
Cornus canadensis	bunchberry	High Elevation Coniferous, Deciduous and/or Mixed Forests	Occurrence Protection	Species in a Special Biologic Area				
Cornus rugosa	roundleaf dogwood	Occurrence Protection	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Corynorhinus townsendii virginianus	Virginia big-eared bat	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	Caves	Occurrence Protection				
Crataegus calpodendron	pear hawthorn	Occurrence Protection						
Crataegus pruinosa	prunose hawthorn	Fire Dependent and Fire Enhanced	Occurrence Protection	Species in a Special Biologic Area				
Crotalus horridus	Timber rattlesnake	Cliff and Talus and large rock outcrops	Sensitive to Over-Collection					
Cuscuta coryli	hazel dodder	Cliff and Talus and large rock outcrops	Occurrence Protection					
Cuscuta rostrata	beaked dodder	High Elevation Openings, grassy or shrubby or open woodlands	Occurrence Protection	Species in a Special Biologic Area				
Cyperus dentatus	toothed flatsedge	Riparian						
Cypripedium reginae	showy lady's-slipper	Occurrence Protection	Riparian	Sensitive to Over-Collection	Species in a Special Biologic Area			
Cystopteris fragilis	fragile fern	Cliff and Talus and large rock outcrops	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Delphinium exaltatum	tall larkspur	Calciphiles	Fire Dependent and Fire Enhanced	Open Woodlands				
Dendroica cerulea	cerulean warbler	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	Late Successional Hardwood Dominated Forest	Riparian				
Dendroica discolor	prairie warbler	Area Sensitive Grassland and Shrubland and Open Woodlands	Fire Dependent and Fire Enhanced	Regenerating Forests				
Dendroica fusca	blackburnian warbler	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area				
Dendroica magnolia	magnolia warbler	High Elevation Coniferous, Deciduous and/or Mixed Forests	Regenerating Forests	Species in a Special Biologic Area	Riparian			
Desmodium canadense	showy tick-trefoil	Riparian						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Desmodium cuspidatum	toothed tick-trefoil	Calciphiles	Occurrence Protection	Ruderal	Species in a Special Biologic Area			
Desmodium sessilifolium	sessile-leaf tick-trefoil	Open Woodlands	Riparian					
Echinacea laevigata	smooth coneflower	Calciphiles	Fire Dependent and Fire Enhanced	Open Woodlands	Species in a Special Biologic Area			
Echinodorus tenellus	dwarf burhead	Riparian	Species in a Special Biologic Area	Riparian				
Eleocharis compressa	flat-stemmed spikerush	Riparian						
Eleocharis melanocarpa	black-fruited spikerush	Riparian	Species in a Special Biologic Area					
Eleocharis robbinsii	Robbins spikerush	Riparian	Species in a Special Biologic Area					
Elymus canadensis	nodding wild rye	Riparian						
Elymus trachycaulus	slender wheatgrass	Fire Dependent and Fire Enhanced	Shale barrens	Species in a Special Biologic Area				
Empidonax alnorum	alder flycatcher	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian	Species in a Special Biologic Area	Riparian			

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Empidonax virescens	acadian flycatcher	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	Riparian					
Epilobium ciliatum	Hair willow-herb	Riparian						
Epilobium leptophyllum	linear-leaved willow-herb	Riparian	Species in a Special Biologic Area					
Equisetum sylvaticum	woodland horsetail	Species in a Special Biologic Area	Riparian					
Eriocaulon aquaticum	white buttons	Riparian	Species in a Special Biologic Area					
Eriogonum allenii	Yellow Buckwheat	Shale barrens						
Erora laeta	Early hairstreak	Lepidopterans	Occurrence Protection					
Erynnis martialis	Mottled duskywing	Area Sensitive Shrubland and Open Woodlands	Fire Dependent and Fire Enhanced	Lepidopterans	Occurrence Protection	Species in a Special Biologic Area		
Erynnis persius	Persius duskywing	Grasslands	Lepidopterans	Riparian	Shrublands			
Erysimum capitatum	western wallflower	Open Woodlands	Shale barrens	Species in a Special Biologic Area				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Euchloe olympia	Olympia marble	Lepidopterans	Open Woodlands	Shale barrens				
Eumeces anthracinus	coal skink	Occurrence Protection	Open Woodlands	Ruderal	Shrublands			
Eupatorium maculatum	spotted joe-pye weed	Riparian						
Euphorbia purpurea	glade spurge	Calciphiles	Riparian					
Falco peregrinus	peregrine falcon	Cliff and Talus and large rock outcrops	Occurrence Protection	Open Woodlands				
Gaylussacia brachycera	box huckleberry	Fire Dependent and Fire Enhanced	Occurrence Protection	Species in a Special Biologic Area				
Geranium robertianum	herb-robert	Cliff and Talus and large rock outcrops						
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian	Species in a Special Biologic Area			
Glyceria acutiflora	sharp-scaled manna-grass	Riparian						
Glyceria grandis	American manna-grass	Riparian	Species in a Special Biologic Area					
Glyphyalinia raderi	Maryland glyph	Calciphiles	Occurrence Protection					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Glyptemys insculpta	wood turtle	Late Successional Hardwood Dominated Forest	Riparian	Open Woodlands	Sensitive to Over-Collection	Shrublands	Grasslands	
Gnaphalium uliginosum	low cudweed	High Elevation Openings, grassy or shrubby or open woodlands	Riparian	Ruderal	Species in a Special Biologic Area			
Goodyera repens	dwarf rattlesnake plantain	Occurrence Protection	Riparian					
Gymnocarpium appalachianum	Appalachian oak fern	High Elevation Coniferous, Deciduous and/or Mixed Forests	Occurrence Protection	Species in a Special Biologic Area				
Haliaeetus leucocephalus	bald eagle	Occurrence Protection	Riparian					
Hansonoperla appalachia	Appalachian stonefly	Riparian						
Helenium virginicum	Virginia sneezeweed	Riparian	Species in a Special Biologic Area					
Helianthemum bicknellii	plains frostweed	Cliff and Talus and large rock outcrops	Open Woodlands	Sandstone glades and barrens	Species in a Special Biologic Area			

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Helianthemum propinquum	low frostweed	Open Woodlands						
Helicodiscus diadema	Shaggy coil	Calciphiles	Occurrence Protection					
Helicodiscus triodus	Talus coil	Calciphiles	Occurrence Protection					
Helonias bullata	swamp-pink	Species in a Special Biologic Area	Riparian					
Heuchera alba	white alumroot	High Elevation Coniferous, Deciduous and/or Mixed Forests	Occurrence Protection	Species in a Special Biologic Area				
Houstonia canadensis	Canada bluets	Alkaline glades and barrens	Calciphiles	Species in a Special Biologic Area				
Huperzia appalachiana	Appalachian fir clubmoss	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian					
Hydraena maureenae	Maureen's shale stream beetle	Riparian						
Hypericum boreale	northern St. John's-wort	Riparian						
Hypericum mitchellianum	Blue Ridge St. John's-wort	High Elevation Coniferous, Deciduous and/or Mixed	High Elevation Openings, grassy or shrubby or open	Occurrence Protection	Species in a Special Biologic Area			

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Forests	woodlands					
Iliamna remota	Kankakee globe-mallow	Riparian						
Incisalia polia	Hoary elfin	Grasslands	Lepidopterans	Sandstone glades and barrens	Shrublands			
Isoetes lacustris	lake quillwort	Riparian	Species in a Special Biologic Area					
Isonychia tusculanensis	a mayfly	Riparian						
Juglans cinerea	butternut	Occurrence Protection						
Juncus brachycephalus	small-head rush	Species in a Special Biologic Area	Riparian					
Juncus brevicaudatus	narrow-panicled rush	Species in a Special Biologic Area	Riparian					
Juniperus communis var depressa	ground juniper	High Elevation Openings, grassy or shrubby or open woodlands	Species in a Special Biologic Area	Calciphiles				
Kleptochthonius anophthalmus	A cave pseudoscorpion	Caves						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Lanius ludovicianus	loggerhead shrike	Area Sensitive Grasslands.	Grasslands	Shrublands				
Lepus americanus	snowshoe hare	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Regenerating Forests	Species in a Special Biologic Area			
Leucothoe fontanesiana	highland dog-hobble	Cove forests	Occurrence Protection	Species in a Special Biologic Area				
Leuctra mitchellensis	Mitchell needlefly	Riparian						
Leuctra monticola	montane needlefly	Riparian						
Liatris helleri	shale -barren blazing star	Shale barrens						
Linum lewisii	prairie flax	Calciphiles	Cliff and Talus and large rock outcrops	Open Woodlands				
Linum sulcatum	grooved yellow flax	Calciphiles	Cliff and Talus and large rock outcrops	Open Woodlands				
Liochlorophis vernalis	Smooth green snake	Fire Dependent and Fire Enhanced						
Liochlorophis vernalis	Smooth green snake	High Elevation Openings, grassy or shrubby or open woodlands	Open Woodlands	Grasslands				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Liparis loeselii	Loesel's twayblade	Riparian	Species in a Special Biologic Area					
Lonicera canadensis	American fly-honeysuckle	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian					
Loxia curvirostra	red crossbill	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area				
Lycopodiella inundata	northern bog clubmoss	Riparian						
Lythrum alatum	winged loosestrife	Riparian						
Maianthemum stellatum	stary false Solomon's-seal	Riparian						
Martes pennanti	fisher	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area				
Megaleuctra flinti	Shenandoah needlefly	Riparian						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Meleagris gallopavo	wild turkey	Fire Dependent and Fire Enhanced	Grasslands	Hard and Soft Mast Dependent	Late Successional Hardwood Dominated Forest	Open Woodlands	Shrublands	
Melica nitens	Three-flowered melic grass	Calciphiles	Open Woodlands	Shale barrens				
Melospiza georgiana	swamp sparrow	High Elevation Openings, grassy or shrubby or open woodlands	Riparian					
Microtus chrotorrhinus carolinensis	Southern rock vole	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian					
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	Caves						
Minuartia groenlandica	mountain sandwort	Cliff and Talus and large rock outcrops	Sensitive to Recreation Traffic	Species in a Special Biologic Area				
Monotropsis odorata	sweet pinesap	Occurrence Protection	Species in a Special Biologic Area					
Muhlenbergia glomerata	marsh muhly	Mafic rocks	Species in a Special Biologic Area	Riparian				
Mustela nivalis	least weasel	Grasslands	Shrublands					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Myotis leibii	eastern small-footed bat	Caves	Cliff and Talus and large rock outcrops	Occurrence Protection				
Myotis sodalis	Indiana bat	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	Caves	Cavity Trees, Den Trees and Snags	Occurrence Protection	Open Woodlands	Riparian	
Nampabius turbator	Cave centipede	Calciphiles	Caves					
Nannaria shenandoah	Shenandoah Mountain xystodesmid	Occurrence Protection						
Nemotaulius hostilis	a limnephilid caddisfly	Riparian						
Neotoma magister	Alleghany woodrat	Caves	Cliff and Talus and large rock outcrops	Late Successional Hardwood Dominated Forest				
Nyctanassa violacea	yellow-crowned night-heron	Riparian						
Nycticorax nycticorax	black-crowned night-heron	Riparian						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Odocoileus virginianus	white-tailed deer	Fire Dependent and Fire Enhanced	Grasslands	Hard and Soft Mast Dependent	Late Successional Hardwood Dominated Forest	Open Woodlands	Regenerating Forests	Shrublands
Oenothera argillicola	Shale-barren evening primrose	Shale barrens						
Oligoneuron rigidum	stiff goldenrod	Calciphiles	Open Woodlands	Species in a Special Biologic Area				
Onosmodium virginianum	Virginia false-gromwell	Fire Dependent and Fire Enhanced	Open Woodlands	Calciphiles				
Oporornis philadelphia	mourning warbler	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Regenerating Forests	Fire Dependent and Fire Enhanced			
Oryzopsis asperifolia	white-grained mtn-ricegrass	Open Woodlands	Shrublands	Species in a Special Biologic Area				
Osmunda cinnamomea var. glandulosa	glandular cinnamon fern	Species in a Special Biologic Area	Riparian					
Panax quinquefolius	Ginseng	Cove forests	Sensitive to Over-Collection					
Panax trifolius	Dwarf ginseng	Cove forests	Sensitive to Over-Collection					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Panicum hemitomon	maidencane	Riparian	Species in a Special Biologic Area					
Paragnetina ishusa	widecollar stonefly	Riparian						
Paraleptophlebia jeanae	a mayfly	Riparian						
Parnassia grandifolia	Large-leaved grass-of-parnassus	Riparian						
Paronychia argyrocoma	Silver Nail-wort	Shale barrens						
Paronychia virginica	yellow nailwort	Calciphiles	Cliff and Talus and large rock outcrops	Shale barrens				
Paxistima canbyi	Canby's mountain lover	Calciphiles	Cliff and Talus and large rock outcrops					
Peltigera hydrothyria	Waterfan	Riparian						
Perlesta frisoni	Blue Ridge stonefly	Riparian						
Phlox amplifolia	Broadleaf phlox	Calciphiles	Occurrence Protection					
Phlox buckleyi	sword-leaved phlox	Fire Dependent and Fire Enhanced	Occurrence Protection	Ruderal	Species in a Special Biologic Area			
Phyciodes batesii	Tawny crescent	Lepidopterans	Occurrence Protection					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Phyciodes cocyta	Northern crescent	Lepidopterans						
Pituophis melanoleucus	northern pinesnake	Fire Dependent and Fire Enhanced	Occurrence Protection	Open Woodlands				
Platanthera grandiflora	large purple fringed orchid	Riparian	Sensitive to Over-Collection	Species in a Special Biologic Area				
Platanthera peramoena	purple fringeless orchid	Riparian	Sensitive to Over-Collection					
Plethodon punctatus	Cow Knob salamander	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Late Successional Hardwood Dominated Forest	Species in a Special Biologic Area	Cliff and Talus and large rock outcrops		
Plethodon sherando	Big levels salamander	Open Woodlands	Species in a Special Biologic Area					
Plethodon virginia	Shenandoah Mt. salamander	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Late Successional Hardwood Dominated Forest	Species in a Special Biologic Area	Cliff and Talus and large rock outcrops		
Poa paludigena	bog bluegrass	Riparian						
Poa palustris	fowl bluegrass	Riparian	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Poa saltuensis	drooping bluegrass	Mafic rocks	Open Woodlands	Species in a Special Biologic Area				
Polanisia dodecandra	common clammy-weed	Riparian						
Polygonia progne	Gray comma	Grasslands	Lepidopterans	Riparian	Open Woodlands	Ruderal	Shrublands	Species in a Special Biologic Area
Potamogeton amplifolius		Riparian						
Potamogeton hillii	Hill's pondweed	Riparian						
Potamogeton oakesianus	Oakes pondweed	Riparian	Species in a Special Biologic Area					
Potamogeton tennesseensis	Tennessee pondweed	Riparian						
Potentilla arguta	tall cinquefoil	Mafic rocks	Species in a Special Biologic Area					
Prunus alleghaniensis	Alleghany sloe	Fire Dependent and Fire Enhanced	Open Woodlands	Shale barrens				
Prunus nigra	Canada plum	Ruderal	Shrublands					
Pseudanophthalmus avernus	Avernus cave beetle	Calciphiles	Caves					
Pseudanophthalmus intersectus	Crossroads cave beetle	Calciphiles	Caves					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Pseudanophthalmus nelsoni	Nelson's cave beetle	Calciphiles	Caves					
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	Calciphiles	Caves					
Pseudognaphalium macounii	Winged cudweed	Caves						
Pseudotremia princeps	South Branch Valley cave millipede	Calciphiles	Caves					
Pycnanthemum torreyi	Torrey's mountain-mint	Calciphiles	Mafic rocks	Open Woodlands				
Pygmarrhopalites carolynae	Cave springtail	Calciphiles	Caves					
Pygmarrhopalites sacer	Cave springtail	Calciphiles	Caves					
Pygmarrhopalites caedus	A cave springtail	Caves	Occurrence Protection					
Pyrgus wyandot	Appalachian grizzled skipper	Fire Dependent and Fire Enhanced	Lepidopterans	Open Woodlands	Sensitive to Over-Collection	Shale barrens	Species in a Special Biologic Area	
Pyrola elliptica	shinleaf	High Elevation Coniferous, Deciduous and/or Mixed Forests	Occurrence Protection	Species in a Special Biologic Area				
Regulus satrapa	golden-crowned kinglet	High Elevation Coniferous, Deciduous and/or Mixed	Species in a Special Biologic Area					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Forests						
Ribes americanum	wild black currant	Species in a Special Biologic Area	Riparian					
Rosa setigera	prairie rose	Calciphiles	Open Woodlands	Shale barrens				
Rubus idaeus ssp. strigosus	American red raspberry	High Elevation Openings, grassy or shrubby or open woodlands	Species in a Special Biologic Area					
Ruellia purshiana	Pursh's wild petunia	Alkaline glades and barrens	Calciphiles	Fire Dependent and Fire Enhanced	Mafic rocks			
Sabatia campanulata	slender marsh rose-pink	Species in a Special Biologic Area	Riparian					
Sagittaria calycina var calycina	long-lobed arrowhead	Species in a Special Biologic Area	Riparian					
Sagittaria rigida	sessile-fruited arrowhead	Riparian						
Satyrium favonius ontario	Northern Hairstreak	Lepidopterans	Occurrence Protection	Open Woodlands				
Saxifraga pensylvanica	swamp saxifrage	Riparian						

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Schizachne purpurascens	purple oat-grass	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area	Riparian				
Schoenoplectus subterminalis	water bulrush	Riparian	Species in a Special Biologic Area					
Scirpus ancistrochaetus	northeastern bulrush	Riparian	Species in a Special Biologic Area					
Scirpus torreyi		Riparian						
Sciurus carolinensis	gray squirrel	Late Successional Hardwood Dominated Forest	Hard and Soft Mast Dependent	Cavity Trees, Den Trees and Snags	Riparian			
Sciurus niger	Eastern fox squirrel	Area Sensitive Grassland and Shrubland and Open Woodlands	Cavity Trees, Den Trees and Snags	Fire Dependent and Fire Enhanced	Hard and Soft Mast Dependent			
Scolopax minor	American woodcock	Grasslands	Riparian					
Scutellaria parvula var. parvula	small skullcap	Calciphiles	Cliff and Talus and large rock outcrops	Open Woodlands				
Scutellaria saxatilis	Rock skullcap	Cliff and Talus and large rock outcrops	Open Woodlands					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Seiurus noveboracensis	northern waterthrush	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area	Riparian			
Semionellus placidus	Millipede	Late Successional Hardwood Dominated Forest	Occurrence Protection					
Sibbaldiopsis tridentata	three-toothed cinquefoil	Cliff and Talus and large rock outcrops	Sensitive to Recreation Traffic	Species in a Special Biologic Area				
Sida hermaphrodita	Virginia mallow	Riparian						
Sitta canadensis	red-breasted nuthatch	Cavity Trees, Den Trees and Snags	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area				
Solidago arguta var. harrisii	Shale Barren Goldenrod	Shale barrens						
Solidago randii = S. simplex var. randii	Rand's goldenrod	Species in a Special Biologic Area	Mafic rocks					
Solidago rupestris	riverbank goldenrod	Species in a Special Biologic Area	Riparian					
Solidago uliginosa	bog goldenrod	Species in a Special	Riparian					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Biologic Area						
Sorex palustris punctulatus	southern water shrew	High Elevation Coniferous, Deciduous and/or Mixed Forests	Riparian	Species in a Special Biologic Area				
Sparganium chlorocarpum = S. emersum	narrow-leaf burreed	Species in a Special Biologic Area	Riparian					
Spartina pectinata	freshwater cordgrass	Riparian						
Speyeria atlantis	Atlantis fritillary	Lepidopterans	Species in a Special Biologic Area	Riparian				
Speyeria diana	Diana fritillary	Lepidopterans	Open Woodlands	Sensitive to Over-Collection				
Speyeria idalia	Regal fritillary	Area Sensitive Grasslands.	Lepidopterans	Sensitive to Over-Collection				
Sphagnum russowii	Russow's peatmoss	Species in a Special Biologic Area	Riparian					
Sphyrapicus varius	yellow-bellied sapsucker	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands	Riparian	Cavity Trees, Den Trees and Snags			
Spilogale putorius	Spotted Skunk	Late Successional Hardwood	Shrublands	Cliff and Talus and large rock outcrops				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Dominated Forest						
Spiranthes lucida	shining ladies'-tresses	Riparian						
Spiranthes ochroleuca	yellow nodding ladies'-tresses	Riparian	Open Woodlands	Species in a Special Biologic Area				
Sporobolus neglectus	small dropseed	Cliff and Talus and large rock outcrops	Shale barrens	Calciphiles				
Stygobromus gracilipes	Shenandoah Valley cave amphipod	Calciphiles	Caves					
Stygobromus hoffmani	Alleghany County cave amphipod	Calciphiles	Caves					
Stygobromus morrisoni	Morrison's cave amphipod	Calciphiles	Caves					
Stygobromus mundus	Bath County cave amphipod	Calciphiles	Caves					
Stygobromus sp. 7	Sherando spinosid amphipod	Calciphiles	Caves					
Stygobromus sp. nov.	Massanutten Spring Amphipod	Calciphiles	Caves					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Sylvilagus obscurus	Appalachian Cottontail	High Elevation Coniferous, Deciduous and/or Mixed Forests	High Elevation Openings, grassy or shrubby or open woodlands					
Sylvilagus obscurus	Appalachian Cottontail	Riparian						
Symphoricarpos albus	snowberry	Calciphiles	Cliff and Talus and large rock outcrops	Species in a Special Biologic Area				
Taenidia montana	Virginia mountain pimpernel	Shale barrens						
Thryomanes bewickii altus	Appalachian Bewick's wren	High Elevation Openings, grassy or shrubby or open woodlands	Cavity Trees, Den Trees and Snags	Grasslands	Shrublands			
Thuja occidentalis	bristly sarsaparilla	Cliff and Talus and large rock outcrops	Species in a Special Biologic Area	Calciphiles				
Triadenum fraseri	Fraser's marsh St. John's-wort	Riparian	Species in a Special Biologic Area					
Triantha racemosa	coastal false-asphodel	Riparian	Species in a Special Biologic Area					
Trichostema setaceum	narrow-leaved blue curls	Open Woodlands	Shale barrens	Species in a Special Biologic Area				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Trifolium virginicum	Kate's mountain clover	Species in a Special Biologic Area	Shale barrens					
Trillium pusillum var. virginianum	mountain least trillium	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area					
Triodopsis picea	Spruce Knob threetooth	Occurrence Protection						
Triphora trianthophora	nodding pogonia	Species in a Special Biologic Area	Occurrence Protection					
Troglodytes troglodytes	winter wren	High Elevation Coniferous, Deciduous and/or Mixed Forests	Species in a Special Biologic Area	Riparian	Cavity Trees, Den Trees and Snags			
Tyto alba	barn owl	Area Sensitive Grasslands.	Cavity Trees, Den Trees and Snags	Grasslands				
Ursus americanus	black bear	Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates	Late Successional Hardwood Dominated Forest	Cavity Trees, Den Trees and Snags	Grasslands	Hard and Soft Mast Dependent	Open Woodlands	Regenerating Forests & Shrublands
Vaccinium macrocarpon	large cranberry	Species in a Special	Riparian					

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
		Biologic Area						
Verbena scabra	sandpaper vervain	Riparian						
Vermivora chrysoptera	golden winged warbler	Area Sensitive Grassland and Shrubland and Open Woodlands	High Elevation Openings, grassy or shrubby or open woodlands	Fire Dependent and Fire Enhanced	Grasslands	Riparian	Open Woodlands	Shrublands
Veronica scutellata	marsh speedwell	Riparian						
Viburnum lentago	nannyberry	Riparian						
Vicia americana	American purple vetch	Riparian	Ruderal					
Viola pedatifida	prairie violet	Species in a Special Biologic Area	Shale barrens					
Virginia valeriae pulchra	mountain earth snake	Grasslands	Open Woodlands	Shrublands				
Vitis rupestris	sand grape	Species in a Special Biologic Area	Riparian					
Woodwardia virginica	Virginia chainfern	Species in a Special Biologic Area	Riparian					
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	Cliff and Talus and large rock outcrops	Open Woodlands	Calciphiles				

Species Scientific Name	Common Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name	Species Group Name
Zygonopus weyeriensis	Grand Caverns blind cave millipede	Calciphiles	Caves					
Zygonopus whitei	Luray Caverns blind cave millipede	Calciphiles	Caves					

Appendix 3. Species Stresses and Threats and Forest Plan Strategies

Species Name	Stress	Threat	Management Strategies
Adlumia fungosa	0 None or Unknown	0 None or Unknown	
Aegolius acadicus	1 Terrestrial System/Habitat Stresses	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Aegolius acadicus	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Aegolius acadicus	1.3.1 Limited existing distribution of system/habitat	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Aegolius acadicus	1.3.1 Limited existing distribution of system/habitat	11 Climate Change and Weather	Utilize Jefferson riparian standards
Aegolius acadicus	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Aegolius acadicus	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Utilize Jefferson riparian standards
Aegolius acadicus	2 Aquatic System/Habitat Stresses	7.33 Lack of disturbance; succession	Utilize Jefferson riparian standards
Alnus incana ssp. rugosa	2.5 Aquatic/Riparian system modification	8.1 Non-native invasive species	Utilize Jefferson riparian standards
Ambystoma tigrinum	1.2 Modification of vegetation	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Ammodramus henslowii	1.1 Conversion and fragmentation	7 Modification of natural systems	Establish objective for grasslands of various sizes
Ammodramus henslowii	2 Aquatic System/Habitat Stresses	7.33 Lack of disturbance; succession	Utilize Jefferson riparian standards
Anaphalis margaritacea	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Apochthonius holsingeri	0.3 Unknown	0.2 Unknown	
Aquila chrysaetos	1.1 Conversion and fragmentation	A Highly modified land uses	
Aquila chrysaetos	3.1.1 Accidental mortality	A Highly modified land uses	
Aquila chrysaetos	3.1.2 Persecution mortality	5.1.1 Hunting and/or poaching of terrestrial animals	Enforce laws on off road use, illeagal hunting
Arabis patens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Arabis patens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Arabis patens	1.3 Limited distribution of the system/habitat	8.2 Problematic native species	
Arabis serotina	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	

Species Name	Stress	Threat	Management Strategies
Arabis serotina	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Arabis serotina	3.3.2 Predation	8.2 Problematic native species	
Aralia hispida	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Arnoglossom muehlenbergii	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Aster radula	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Astragalus distortus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Autochton cellus	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish Lepidopteran guidelines
Autochton cellus	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Bartramia longicauda	1.1 Conversion and fragmentation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Bartramia longicauda	1.1 Conversion and fragmentation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Bartramia longicauda	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Betula cordifolia	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Boloria selene	1.1 Conversion and fragmentation	7.33 Lack of disturbance; succession	Establish desired condtion for riparian areas
Boloria selene	1.1 Conversion and fragmentation	7.34 Loss of beaver activitiy	Establish desired condtion for riparian areas
Boloria selene	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Boltonia montana	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Bonasa umbellus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Bonasa umbellus	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Bonasa umbellus	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Bromus ciliatus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Bromus kalmii	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Buckleya distichophylla	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Callophrys irus	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Callophrys irus	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Callophrys irus	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year

Species Name	Stress	Threat	Management Strategies
Callophrys irus	1.2.2 Modification of vegetation composition	7 Modification of natural systems	Establish fire objective of 12,000 to 20,000 acres per year
Callophrys irus	1.2.2 Modification of vegetation composition	7 Modification of natural systems	Establish Lepidopteran guidelines
Callophrys irus	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Calopogon tuberosus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Campanula rotundifolia	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Caprimulgus carolinensis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Caprimulgus carolinensis	1.2.2 Modification of vegetation composition	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Caprimulgus carolinensis	1.2.2 Modification of vegetation composition	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Caprimulgus vociferus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Caprimulgus vociferus	1.2.2 Modification of vegetation composition	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Caprimulgus vociferus	1.2.2 Modification of vegetation composition	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Carex aquatilis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carex arctata	0 None or Unknown	0 None or Unknown	
Carex barrattii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carex buxbaumii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carex lasiocarpa var. americana	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carex polymorpha	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Carex polymorpha	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	
Carex roanensis	1.2 Modification of vegetation	7 Modification of natural systems	Establish guidelines for species occurrence
Carex schweinitzii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carex vesicaria	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Carpodacus purpureus	1.2.2 Modification of vegetation composition	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Carpodacus purpureus	1.3.1 Limited existing distribution of system/habitat	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Carpodacus purpureus	1.3.1 Limited existing distribution of system/habitat	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year

Species Name	Stress	Threat	Management Strategies
Carpodacus purpureus	1.3.1 Limited existing distribution of system/habitat	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Carpodacus purpureus	2.5 Aquatic/Riparian system modification	7.33 Lack of disturbance; succession	Utilize Jefferson riparian standards
Castor canadensis	1.3.1 Limited existing distribution of system/habitat	5.1.1 Hunting and/or poaching of terrestrial animals	Establish desired condtion for riparian areas
Castor canadensis	3.1.2 Persecution mortality	6 Human intrusions and disturbance	Establish desired condtion for riparian areas
Catharus guttatus	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Catocala herodias gerhardi	1 Terrestrial System/Habitat Stresses	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Catocala herodias gerhardi	1 Terrestrial System/Habitat Stresses	8.1 Non-native invasive species	Establish Lepidopteran guidelines
Catocala marmorata	0.3 Unknown	0.2 Unknown	
Certhia americana	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Certhia americana	1.3 Limited distribution of the system/habitat	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Certhia americana	1.3 Limited distribution of the system/habitat	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Certhia americana	1.3 Limited distribution of the system/habitat	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Certhia americana	2 Aquatic System/Habitat Stresses	9.5.1 Acid deposition	Utilize Jefferson riparian standards
Cheilanthes eatonii	1 Terrestrial System/Habitat Stresses	6 Human intrusions and disturbance	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Cicindela ancocisconensis	2 Aquatic System/Habitat Stresses	7.2 Dams and water management	Utilize Jefferson riparian standards
Cicindela ancocisconensis	2 Aquatic System/Habitat Stresses	7.32 Off Road Vehicles	Enforce laws on off road use, illeagal hunting
Cicindela ancocisconensis	2 Aquatic System/Habitat Stresses	A.3.2 Mining and quarrying	
Cicindela patruela	1 Terrestrial System/Habitat Stresses	6 Human intrusions and disturbance	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Cicindela patruela	1 Terrestrial System/Habitat Stresses	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Cicindela patruela	1 Terrestrial System/Habitat Stresses	7.32 Off Road Vehicles	Enforce laws on off road use, illeagal hunting
Cirsium altissimum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Clematis albicoma	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	

Species Name	Stress	Threat	Management Strategies
Clematis occidentalis	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Clematis occidentalis	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Utilize Jefferson riparian standards
Clematis viticaulis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Clemmys guttata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Coccyzus erythropthalmus	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Colias interior	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish Lepidopteran guidelines
Colias interior	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Contopus borealis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Corallorhiza bentleyi	0.2 Lack of knowledge	0 None or Unknown	
Corallorhiza bentleyi	0.2 Lack of knowledge	0.2 Unknown	
Cornus canadensis	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for species occurrence
Cornus canadensis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Cornus rugosa	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Corynorhinus townsendii virginianus	3.2 Disrupted activity/energy budgets	6 Human intrusions and disturbance	Establish guidelines for caves and karstlands
Corynorhinus townsendii virginianus	3.3.5 Disease	8.1 Non-native invasive species	Establish guidelines for caves and karstlands
Crataegus calpodendron	3.5 Limited population size	7 Modification of natural systems	Establish guidelines for species occurrence
Crataegus pruinosa	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Crotalus horridus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Crotalus horridus	3.1.2 Persecution mortality	5.1.1 Hunting and/or poaching of terrestrial animals	Enforce laws on off road use, illeagal hunting
Cuscuta coryli	0.3 Unknown	0.2 Unknown	
Cuscuta rostrata	0.3 Unknown	0.2 Unknown	
Cyperus dentatus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Cypripedium reginae	1.2.1 Modification of vegetation structure	7 Modification of natural systems	Establish guidelines for species occurrence
Cypripedium reginae	3.1.2 Persecution mortality	5.2 Collection of plants	Establish guidelines for overcollection

Species Name	Stress	Threat	Management Strategies
Cypripedium reginae	3.3.2 Predation	8.2 Problematic native species	
Cystopteris fragilis	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Delphinium exaltatum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Dendroica fusca	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Dendroica magnolia	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Desmodium canadense	0.3 Unknown	0.2 Unknown	
Desmodium cuspidatum	0.3 Unknown	0.2 Unknown	
Desmodium sessilifolium	0.3 Unknown	0.2 Unknown	
Echinacea laevigata	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Echinodorus tenellus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Eleocharis compressa	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Eleocharis melanocarpa	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Eleocharis robbinsii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Elymus canadensis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Elymus trachycaulus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Empidonax alnorum	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Epilobium ciliatum	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Epilobium leptophyllum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Equisetum sylvaticum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Eriocaulon aquaticum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Eriogonum allenii	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Eriogonum allenii	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Eriogonum allenii	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines

Species Name	Stress	Threat	Management Strategies
Erora laeta	1 Terrestrial System/Habitat Stresses	8 Invasive & problematic species	Establish Lepidopteran guidelines
Erora laeta	1.2 Modification of vegetation	7 Modification of natural systems	Establish guidelines for species occurrence
Erora laeta	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Erynnis martialis	1 Terrestrial System/Habitat Stresses	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Erynnis martialis	1 Terrestrial System/Habitat Stresses	8.1 Non-native invasive species	Establish Lepidopteran guidelines
Erynnis martialis	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Erynnis martialis	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Erynnis martialis	1.2 Modification of vegetation	8.2 Problematic native species	
Erynnis martialis	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Erynnis persius	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Erynnis persius	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Erynnis persius	1.1 Conversion and fragmentation	8.1 Non-native invasive species	Establish Lepidopteran guidelines
Erynnis persius	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Erysimum capitatum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Euchloe olympia	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish Lepidopteran guidelines
Euchloe olympia	3 Species Population Stresses	8.1 Non-native invasive species	Establish Lepidopteran guidelines
Euchloe olympia	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Eumeces anthracinus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Eupatorium maculatum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Euphorbia purpurea	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Gaylussacia brachycera	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Gaylussacia brachycera	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	
Geranium robertianum	1.3 Limited distribution of the system/habitat	5.3 Timber harvest	Establish guidelines for cliff and talus and shale barren areas
Glaucomys sabrinus fuscus	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons

Species Name	Stress	Threat	Management Strategies
Glyceria acutiflora	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Glyceria grandis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Glyphyalinia raderi	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for species occurrence
Glyphyalinia raderi	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for species occurrence
Glyphyalinia raderi	3 Species Population Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Glyphyalinia raderi	3.1.1 Accidental mortality	6.1 Recreational activities	Establish guidelines for species occurrence
Glyphyalinia raderi	3.3 Interspecific interactions	8.1 Non-native invasive species	
Glyptemys insculpta	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Establish management strategy for managing wood turtle habitat
Glyptemys insculpta	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	
Glyptemys insculpta	3.1.2 Persecution mortality	5.1.1 Hunting and/or poaching of terrestrial animals	Enforce laws on off road use, illeagal hunting
Glyptemys insculpta	3.1.2 Persecution mortality	5.1.1 Hunting and/or poaching of terrestrial animals	Establish guidelines for overcollection
Gnaphalium uliginosum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Goodyera repens	1.2 Modification of vegetation	5.3 Timber harvest	Establish guidelines for species occurrence
Gymnocarpium appalachianum	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Gymnocarpium appalachianum	1.2 Modification of vegetation	5.3 Timber harvest	Establish guidelines for species occurrence
Hansonoperla appalachia	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Helenium virginicum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Helenium virginicum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Helianthemum bicknellii	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Helianthemum propinquum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Helicodiscus diadema	1 Terrestrial System/Habitat Stresses	7.32 Off Road Vehicles	Enforce laws on off road use, illeagal hunting
Helicodiscus diadema	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for species occurrence
Helicodiscus diadema	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for species occurrence
Helicodiscus diadema	3 Species Population Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition

Species Name	Stress	Threat	Management Strategies
Helicodiscus diadema	3.1.1 Accidental mortality	6.1 Recreational activities	Establish guidelines for species occurrence
Helicodiscus diadema	3.3 Interspecific interactions	8.1 Non-native invasive species	
Helicodiscus triodus	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for species occurrence
Helicodiscus triodus	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for species occurrence
Helicodiscus triodus	3 Species Population Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Helicodiscus triodus	3.1.1 Accidental mortality	6.1 Recreational activities	Establish guidelines for species occurrence
Helicodiscus triodus	3.3 Interspecific interactions	8.1 Non-native invasive species	
Helonias bullata	1.3.2 Limited potential distribution of system/habitat	7 Modification of natural systems	
Helonias bullata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Helonias bullata	3.3.2 Predation	8.2 Problematic native species	
Heuchera alba	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Heuchera alba	3.5 Limited population size	7 Modification of natural systems	Establish guidelines for species occurrence
Houstonia canadensis	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Huperzia appalachiana	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Huperzia appalachiana	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Utilize Jefferson riparian standards
Hydraena maureenae	2 Aquatic System/Habitat Stresses	11.2 Droughts	Utilize Jefferson riparian standards
Hypericum boreale	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Hypericum mitchellianum	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Hypericum mitchellianum	1.2 Modification of vegetation	5.3 Timber harvest	Establish guidelines for species occurrence
Iliamna remota	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Incisalia polia	1.2.2 Modification of vegetation composition	7 Modification of natural systems	Establish Lepidopteran guidelines
Isoetes lacustris	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Isonychia tusculanensis	0.3 Unknown	0.2 Unknown	

Species Name	Stress	Threat	Management Strategies
Isonychia tusculanensis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Juglans cinerea	3.3.5 Disease	8 Invasive & problematic species	
Juncus brachycephalus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Juncus brevicaudatus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Juniperus communis var depressa	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Kleptochthonius anophthalmus	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for caves and karstlands
Lepus americanus	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Lepus americanus	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Lepus americanus	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Leucothoe fontanesiana	1.3 Limited distribution of the system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Leuctra mitchellensis	0.3 Unknown	0.2 Unknown	
Leuctra mitchellensis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Leuctra monticola	0.3 Unknown	0.2 Unknown	
Leuctra monticola	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Liatris helleri	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Linum lewisii	1.3.2 Limited potential distribution of system/habitat	7 Modification of natural systems	
Linum sulcatum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Liochlorophis vernalis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Liparis loeselii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Lonicera canadensis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Lonicera canadensis	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Loxia curvirostra	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Lycopodiella inundata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards

Species Name	Stress	Threat	Management Strategies
Lythrum alatum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Maianthemum stellatum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Martes pennanti	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Megaleuctra flinti	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Megaleuctra flinti	2 Aquatic System/Habitat Stresses	7.2 Dams and water management	Utilize Jefferson riparian standards
Megaleuctra flinti	2.3 Water temperature modification	11.3 Temperature extremes	Utilize Jefferson riparian standards
Megaleuctra flinti	2.4 Water chemistry modification	9.5.1 Acid deposition	Utilize Jefferson riparian standards
Melica nitens	1.3.2 Limited potential distribution of system/habitat	7 Modification of natural systems	
Microtus chrotorrhinus carolinensis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Miktoniscus racovitzai	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for caves and karstlands
Minuartia groenlandica	3.1.1 Accidental mortality	6.1 Recreational activities	Establish guidelines for recreation traffic
Monotropsis odorata	0 None or Unknown	0 None or Unknown	
Muhlenbergia glomerata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Myotis sodalis	1.3 Limited distribution of the system/habitat	0.1 None	
Myotis sodalis	3.2 Disrupted activity/energy budgets	6 Human intrusions and disturbance	Establish guidelines for caves and karstlands
Myotis sodalis	3.3.5 Disease	8 Invasive & problematic species	Establish guidelines for caves and karstlands
Nampabius turbator	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Nannaria shenandoah	0.3 Unknown	0.2 Unknown	
Nannaria shenandoah	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for species occurrence
Nemotaulius hostilis	0.3 Unknown	0.2 Unknown	
Nemotaulius hostilis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Oenothera argillicola	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Oligoneuron rigidum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Onosmodium virginianum	1.3.2 Limited potential distribution of system/habitat	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year

Species Name	Stress	Threat	Management Strategies
Oporornis philadelphia	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Oryzopsis asperifolia	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Osmunda cinnamomea var. glandulosa	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Panax quinquefolius	3.1 Direct mortality	5.2 Collection of plants	
Panax quinquefolius	3.1.2 Persecution mortality	5.2 Collection of plants	Establish guidelines for overcollection
Panax trifolius	3.1.2 Persecution mortality	5.2 Collection of plants	Establish guidelines for overcollection
Panicum hemitomon	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Paragnetina ishusa	0.3 Unknown	0.2 Unknown	
Paragnetina ishusa	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Paraleptophlebia jeanae	0.3 Unknown	0.2 Unknown	
Paraleptophlebia jeanae	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Parnassia grandifolia	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Paronychia argyrocoma	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Paronychia argyrocoma	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Paronychia argyrocoma	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Paronychia virginica	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	
Paronychia virginica	1.3.2 Limited potential distribution of system/habitat	7 Modification of natural systems	Establish fire objective of 12,000 to 20,000 acres per year
Paxistima canbyi	1.3.2 Limited potential distribution of system/habitat	7 Modification of natural systems	
Peltigera hydrothyria	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Peltigera hydrothyria	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Utilize Jefferson riparian standards
Peltigera hydrothyria	2.1 Stream flow modification	7.2 Dams and water management	Utilize Jefferson riparian standards
Peltigera hydrothyria	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	
Peltigera hydrothyria	3.5 Limited population size	0.2 Unknown	
Perlesta frisoni	0.3 Unknown	0.2 Unknown	
Phlox amplifolia	0 None or Unknown	0 None or Unknown	
Phlox buckleyi	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year

Species Name	Stress	Threat	Management Strategies
Phyciodes batesii	1.2.2 Modification of vegetation composition	7 Modification of natural systems	Establish Lepidopteran guidelines
Phyciodes cocyta	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish Lepidopteran guidelines
Phyciodes cocyta	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Pituophis melanoleucus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Platanthera grandiflora	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Platanthera peramoena	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Plethodon punctatus	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Plethodon punctatus	1.2.1 Modification of vegetation structure	5.3 Timber harvest	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Plethodon punctatus	1.2.1 Modification of vegetation structure	7 Modification of natural systems	
Plethodon sherando	0 None or Unknown	0 None or Unknown	
Plethodon sherando	1.2.1 Modification of vegetation structure	5.3 Timber harvest	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Plethodon virginia	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Plethodon virginia	1.2.1 Modification of vegetation structure	5.3 Timber harvest	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Plethodon virginia	1.2.1 Modification of vegetation structure	7 Modification of natural systems	
Poa paludigena	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Poa palustris	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Poa saltuensis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Polanisia dodecandra	2.1 Stream flow modification	7.2 Dams and water management	Utilize Jefferson riparian standards
Polanisia dodecandra	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Polygonia progne	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish objective for grasslands of various sizes
Polygonia progne	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish objective for oak open woodlands
Polygonia progne	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Potamogeton amplifolius	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards

Species Name	Stress	Threat	Management Strategies
Potamogeton hillii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Potamogeton oakesianus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Potamogeton tennesseensis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Potentilla arguta	1.2.1 Modification of vegetation structure	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Prunus alleghaniensis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Prunus nigra	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pseudanophthalmus avernus	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Pseudanophthalmus avernus	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Pseudanophthalmus intersectus	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Pseudanophthalmus intersectus	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Pseudanophthalmus nelsoni	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Pseudanophthalmus nelsoni	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Pseudanophthalmus petrunkevitchi	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Pseudanophthalmus petrunkevitchi	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Pseudognaphalium macounii	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pseudognaphalium macounii	3.3.1 Competition	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Pseudotremia princeps	0.3 Unknown	0.2 Unknown	
Pseudotremia princeps	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Pseudotremia princeps	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Pycnanthemum torreyi	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pygmarrhopalites carolynae	0.3 Unknown	0.2 Unknown	
Pygmarrhopalites sacer	0.3 Unknown	0.2 Unknown	
Pygmarrhopalites caedus	0.3 Unknown	0.2 Unknown	
Pyrgus wyandot	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Pyrgus wyandot	1 Terrestrial System/Habitat Stresses	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Pyrgus wyandot	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year

Species Name	Stress	Threat	Management Strategies
Pyrgus wyandot	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Pyrgus wyandot	1.2.2 Modification of vegetation composition	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pyrgus wyandot	1.2.2 Modification of vegetation composition	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Pyrgus wyandot	1.3.1 Limited existing distribution of system/habitat	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Pyrgus wyandot	3 Species Population Stresses	8.1 Non-native invasive species	Establish Lepidopteran guidelines
Pyrgus wyandot	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Pyrola elliptica	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Pyrola elliptica	1.2 Modification of vegetation	5.3 Timber harvest	
Pyrola elliptica	1.3.1 Limited existing distribution of system/habitat	0 None or Unknown	
Regulus satrapa	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Ribes americanum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Rosa setigera	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Rubus idaeus ssp. strigosus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Ruellia purshiana	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Sabatia campanulata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sagittaria calycina var calycina	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sagittaria rigida	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Satyrium favonius ontario	1 Terrestrial System/Habitat Stresses	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Satyrium favonius ontario	1.2.2 Modification of vegetation composition	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Satyrium favonius ontario	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Satyrium favonius ontario	3.5 Limited population size	0.2 Unknown	
Saxifraga pensylvanica	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Schizachne purpurascens	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons

Species Name	Stress	Threat	Management Strategies
Schizachne purpurascens	1.2 Modification of vegetation	7 Modification of natural systems	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Schoenoplectus subterminalis	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Scirpus ancistrochaetus	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Scirpus torreyi	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Scutellaria parvula var. parvula	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Scutellaria saxatilis	0 None or Unknown	0 None or Unknown	
Seiurus noveboracensis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Semionellus placidus	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for species occurrence
Sibbaldiopsis tridentata	3.1.1 Accidental mortality	6 Human intrusions and disturbance	Establish guidelines for recreation traffic
Sida hermaphrodita	2.1 Stream flow modification	7.2 Dams and water management	Utilize Jefferson riparian standards
Sida hermaphrodita	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sitta canadensis	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Solidago arguta var. harrisii	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Solidago arguta var. harrisii	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Solidago arguta var. harrisii	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Solidago randii = S. simplex var. randii	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Solidago rupestris	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Solidago uliginosa	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sorex palustris punctulatus	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Sparganium chlorocarpum = S. emersum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Spartina pectinata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Speyeria atlantis	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish Lepidopteran guidelines

Species Name	Stress	Threat	Management Strategies
Speyeria atlantis	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Speyeria diana	1 Terrestrial System/Habitat Stresses	A.3.2 Mining and quarrying	Establish Lepidopteran guidelines
Speyeria diana	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Speyeria diana	1.2 Modification of vegetation	8.2 Problematic native species	
Speyeria diana	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Speyeria idalia	1.1 Conversion and fragmentation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Speyeria idalia	1.1 Conversion and fragmentation	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Speyeria idalia	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Speyeria idalia	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish Lepidopteran guidelines
Speyeria idalia	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Speyeria idalia	3.1.2 Persecution mortality	5.1.2 Collection of terrestrial animals	Establish guidelines for overcollection
Speyeria idalia	3.6 Isolation of metapopulations	7 Modification of natural systems	
Sphagnum russowii	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sphyrapicus varius	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Spilogale putorius	3.3.2 Predation	8.2 Problematic native species	
Spiranthes lucida	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Spiranthes ochroleuca	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Sporobolus neglectus	1.3.1 Limited existing distribution of system/habitat	7 Modification of natural systems	
Stygobromus gracilipes	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Stygobromus gracilipes	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Stygobromus hoffmani	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Stygobromus hoffmani	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Stygobromus morrisoni	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Stygobromus morrisoni	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Stygobromus mundus	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Stygobromus mundus	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands

Species Name	Stress	Threat	Management Strategies
Stygobromus sp. 7	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Stygobromus sp. 7	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Stygobromus sp. 7	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Stygobromus sp. nov.	0.3 Unknown	0.2 Unknown	
Stygobromus sp. nov.	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Sylvilagus obscurus	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Sylvilagus obscurus	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Utilze timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Sylvilagus obscurus	1.2.1 Modification of vegetation structure	A.2 Agriculture	
Sylvilagus obscurus	3.3.1 Competition	7 Modification of natural systems	
Symphoricarpos albus	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Taenidia montana	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Thuja occidentalis	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Triadenum fraseri	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Triantha racemosa	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Trichostema setaceum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Trifolium virginicum	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Trillium pusillum var. virginianum	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Trillium pusillum var. virginianum	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Triodopsis picea	1 Terrestrial System/Habitat Stresses	A Highly modified land uses	Establish guidelines for species occurrence
Triodopsis picea	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for species occurrence
Triodopsis picea	3 Species Population Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Triodopsis picea	3.1.1 Accidental mortality	6.1 Recreational activities	Establish guidelines for recreation traffic
Triodopsis picea	3.3 Interspecific interactions	8.1 Non-native invasive species	
Triphora trianthophora	0 None or Unknown	0 None or Unknown	

Species Name	Stress	Threat	Management Strategies
Troglodytes troglodytes	1.2 Modification of vegetation	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditons
Vaccinium macrocarpon	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Verbena scabra	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Veronica scutellata	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Viburnum lentago	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Vicia americana	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Viola pedatifida	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Virginia valeriae pulchra	0 None or Unknown	0 None or Unknown	
Vitis rupestris	2.5 Aquatic/Riparian system modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Woodwardia virginica	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Zigadenus elegans ssp. glaucus = Anticlea glauca	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Zygonopus weyeriensis	0.3 Unknown	0.2 Unknown	
Zygonopus weyeriensis	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Zygonopus weyeriensis	1 Terrestrial System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Zygonopus whitei	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for caves and karstlands
Zygonopus whitei	1 Terrestrial System/Habitat Stresses	8.1 Non-native invasive species	Establish guidelines for caves and karstlands

Aquatic Ecological Sustainability Analysis

George Washington National Forest
April 2011

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1. Introduction

National Forest Management Act (NFMA) regulation, adopted in 1982, requires that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). For planning purposes, a viable population is one that has numbers and distribution of reproductive individuals to insure its continued existence and is well distributed in the planning area. USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in persistence of the species over time.

Aquatic habitats are unique in that they are found in and adjacent to streams and lakes. The mobility of aquatic species is usually limited to these habitats. Habitat alteration is probably the major cause of decline of aquatic diversity in the South. Channelization, impoundment sedimentation, and flow alterations are the most common physical habitat alterations associated with the decline of aquatic species (Walsh et al 1995; Etnier 1997; Burkhead et al. 1997). Other human-induced impacts to aquatic species include pollutions, introduced species, and over-harvesting (Miller 1989).

The initial focus of this aquatic ecological sustainability analysis is on ecosystem diversity of aquatic habitats within the GWNF, and the key factors within those habitats for maintaining aquatic ecological integrity. This approach is supplemented with a complementary species-specific approach that focuses on quantifying the habitats where individual species are found within the GWNF.

The goals of this analysis are:

1) Develop plan components for a framework that provides characteristics of ecosystem diversity and contributes to the diversity of native plant and animal species.
2) Evaluate if additional provisions are needed for specific federally listed species, FS sensitive species, and locally rare species consistent with the limits of agency authorities, the capability of the plan area, and overall multiple use objectives.

2. – Ecosystem Diversity

Ecosystem diversity is defined as the variety and relative extent of ecosystem types including their composition, structure, and processes.

The GWNF developed an aquatic habitat classification to facilitate the Aquatic Ecological Sustainability Analysis (see Appendix 1). The methods used in this classification follow the basic structure of The Nature Conservancy (TNC) aquatic community classification, and the Virginia and West Virginia Comprehensive Wildlife Action Plans, yet habitat classifications were focused on land managed by the GWNF.

As described in Appendix 1, this habitat classification is hierarchical and is based on an understanding of how habitat influences the composition and distribution of aquatic biological communities. It is based on four assumptions (Higgins et al. 1998):

1. Physiographic and climatic patterns influence the distribution of organisms, and can be used to predict the expected range of biological community types (Jackson and Harvey 1989; Tonn 1990; Maxwell et al. 1995; Angermeier and Winston 1998; Burnett et al. 1998).
2. The physical structure of aquatic habitats (or ecosystems) can be used to predict the distribution of aquatic communities (Gorman and Karr 1978; Schlosser 1982).
3. Aquatic habitats are continuous; however, generalizations about discrete patterns in habitat use can be made (Vannote et al. 1980; Schlosser 1982).
4. Using a nested classification system, (i.e. stream reach habitat types within species ranges), we can account for community diversity that is difficult to observe or to measure (taxonomic, genetic, or ecological) (Frissell et al 1986; Angermeier and Schollsser 1995).

2.1 – Spatial Scales for Ecosystem Diversity

Physiographic Provinces

The GWNF lies in two physiographic provinces or ecoregions, the Blue Ridge and Ridge and Valley. Both of these ecoregions have their own unique geology and landtype characteristics. The following descriptions are summarized from Jenkins and Burkhead (1993).

Blue Ridge
This montane-upland province extends northeast-southwest from southern Pennsylvania to northern Georgia. The GWNF is in the narrow Northern Blue Ridge province (north of the Roanoke River) which is an irregular chain of mountains one to a few peaks wide, about 2-12 miles wide overall; its maximum elevation is about 4,000 feet. It is effectively the frontal mountain range of the adjacent Valley and Ridge Province. Together they apparently represent an erosional system that had been uplifted.

The rocks of the Blue Ridge are largely resistant types; thus Blue Ridge streams tend to be the softwater type. A chief feature of small Blue Ridge streams is high gradient, reflected by a high frequency of rapids, by cascades and falls in many headwaters, and by bottoms chiefly of large gravel, rubble boulder, and bedrock. Small streams are cool or cold during summer; rain-caused turbidity clears quickly.

Ridge and Valley
This province consists of parallel, northeast-southwest lines of mountains and valleys adjoining the northwest boarder of the Blue Ridge. It is marked by long narrow parallel ridges oriented with the long axis of the province. Consequently

its streams form a rectilinear trellis drainage pattern of parallel-flowing stream in the valleys that are connected by right-angle valleys through the ridges. Mountain ridges are capped by protruding edges of resistant sandstone and quartzite formations; the tops of many are 3,200-4,100 feet in elevation. Intermontane valleys are floored by easily erodible carbonate (limestone and dolomite) and shale rocks; in transecting the province, carbonate valleys often alternate with shale valleys.

Small montane streams of the Valley and Ridge closely resemble the tumbling streams at similar elevations in the Blue Ridge. Streams in the valleys are of moderate gradient; shoals, runs and riffles usually compose one-third to one-sixth or less of the length. In valley streams, gravel rubble, and boulder bottoms are characteristic of both pools and riffles; bedrock is a common substrate. Substrates in calm pools of most valley streams often are quite silted; notable patches of sand are rare throughout the province. Montane streams of the province tend to carry soft water, whereas valley streams typically are the hard-water type. Almost all streams generally are clear but become heavily turbid from moderate or heavy rain. The Valley and Ridge is noted for watered caves and high-volume spring streams.

River Drainages

Within the GWNF, the two physiographic provinces are drained by two major river drainages, the James and Potomac. Both of these drainages are Atlantic slope, and drain into the Chesapeake Bay. Geological history has shaped the evolution and distribution of modern aquatic fauna. Former climates have strongly influenced this fauna as well. The following descriptions of the drainages are summarized from Jenkins and Burkhead (1993).

James Drainage

This drainage is nearly wholly within Virginia; only a short segment of each of two streams originates in West Virginia. The watershed encompasses 10,102 sq. miles. The main channel of 432 miles is the longest in the state. The James River takes its name at the confluence of the Cowpasture and Jackson rivers near Clifton Forge; 94 miles of the Jackson are included in the total length. Major portions of the drainage are in the Coastal Plain, Piedmont, and Valley and Ridge; many tributaries drop from the Blue Ridge.

The James drainage fish assemblage is fairly specious for an Atlantic slope drainage, with 109 total taxa; 73 native (3 endemic), 26 introduced, and 10 estuarine or diadromous taxa. Many range terminations fall in and adjacent to the James. Three fish are endemic to the drainage: roughhead shiner (*Notropis semperasper*), longfin darter (*Etheostoma longimanum*), and a stripeback darter subspecies (*Percina notogramma montuosa*).

Potomac Drainage
The portion of the Potomac watershed in Virginia is 5,706 sq. miles in surface area, 39% of the whole Potomac watershed; the remainder is in Pennsylvania, Maryland, and West Virginia. The Shenandoah system is the largest division of the Potomac in Virginia. The Shenandoah system is partitioned into the large North Fork and South Fork subsystems and the smaller lower Shenandoah subsystem. The Shenandoah system meanders through the Valley and Ridge for 205 miles.

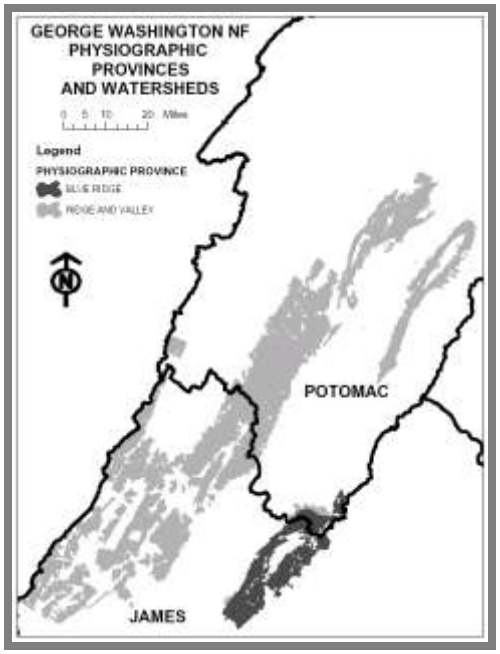
Two Valley and Ridge portions of the upper Potomac system proper (above the Shenandoah mouth) drain Virginia and cross into West Virginia. The portion in the small northern area just west of the lower Shenandoah River flows directly to the Potomac River. The few short, cool or cold streams heading in Highland County go to the South Branch Potomac River.

The Potomac drainage has 61 native, 30 introduced, and 11 diadromous or estuarine taxa – 102 in all. Its endemic taxon is an undescribed sculpin, either a subspecies of *Cottus cognatus* (slimy sculpin) or a closely related species. The Shenandoah River system has a montane and upland fauna that basically is typical of other western Chesapeake basin fauna; however, several species unexpectedly are localized or missing. No consistent basis was discerned for any of the odd Shenandoah patterns; long-standing deforestation of the broad divisions of the fertile valley may be involved. The system may have suffered higher silt levels earlier than most others in Virginia. European settlers found the valley to be a huge, partly cultivated prairie the Indians had maintained through burning. Siltation associated with extensive tilling by the settlers certainly worsened stream conditions.

George Washington National Forest

Within this framework of physiographic provinces and river drainages, the GWNF manages 1,065,389 acres of land (see Figure 1). The characteristics of the aquatic habitats (streams, rivers, lakes, and wetlands) managed by the GWNF are described in the next section.

Figure 1. GWNF Land within the Potomac and James watersheds and the Blue Ridge and Ridge and Valley Provinces.



2.2 – Characteristics of Ecosystem Diversity

Stream Reach Classification

Streams display continuous changes in physical and chemical characteristics from headwaters to mouth, which may influence the structure and function of biological communities along this continuum (Vannote et al. 1980). Factors of watershed size, elevation, and geology are interrelated along the continuum. These are the factors that were used to classify the lotic (stream) habitat on the GWNF. See Appendix 1 for a detailed description of the factors and classification process. Springs and seeps were not included in this classification because of modeling constraints. The importance of springs and seeps is recognized and they should be treated as an aquatic component of the riparian area during project planning and implementation.

Based on five categories for size, two categories for elevation, and five categories for geology (see Table 1), there were 38 different stream habitat types (within 1,178.7 miles of perennial water) identified within GWNF ownership (see Table 2). However, over 82% are characterized by only 10 different stream habitat types, with only three habitat types comprising almost 50% of the Forest streams. These include 20% in the headwater, higher elevation, sandstone/quartzite classification (121); and another 28% in the headwater, lower elevation, shale and sandstone/quartzite classifications (113 and 111).

Table 1. Aquatic Habitat Classification Categories Used For Continuous Variables

Category	Range of Values	Assigned Number
Stream Size:	Watershed area (sq. miles)	Class
Headwater	<2	100
Stream	2-10	200
Large stream	10-20	300
Small River	20-70	400
Large River	>70	500
Elevation (temperature regime):	Elevation (ft):	Class
Lower elevation (warm/cool water)	≤2000	10
Higher elevation (cold water)	>2000	20
Geology:	Rock Types:	Class
Sandstone/quartzite	Sandstone & quartzite	1
Limestone	limestone	2
Shale	shale	3
Granite	granite, metabasalt, proxene, gneiss	4
Charnokite/mylonite	charnikite & mylonite	5

Table 2. Lotic Habitat Classification

Stream Type	Sum of Miles	Percent of Miles	Description	Example
121	240.60	20.41%	Headwater, higher elevation, sandstone/quartzite	Locust Spring Run, Highland Co.
113	181.61	15.41%	Headwater, lower elevation, shale	Downy Branch, Allegheny Co.
111	153.41	13.02%	Headwater, lower elevation, sandstone/quartzite	Buck Lick Run, Rockingham Co.
211	100.01	8.49%	Stream, lower elevation, sandstone/quartzite	Slate Lick Branch, Rockingham Co.
213	74.76	6.34%	Stream, lower elevation, shale	Little Fork, Pendleton Co.
221	61.43	5.21%	Stream, higher elevation, sandstone/quartzite	Little Back Creek, Bath Co.
112	50.38	4.27%	Headwater, lower elevation, limestone	Upper Kelly Run, Bath Co.
123	47.98	4.07%	Headwater, higher elevation, shale	Upper Pitt Spring Run, Page Co.
212	36.46	3.09%	Stream, lower elevation, limestone	Cub Run, Page Co.
122	24.93	2.11%	Headwater, higher elevation, limestone	Jordan Run, Bath Co.
411	21.21	1.80%	Small river, lower elevation, sandstone/quartzite	North River, Augusta Co.
513	20.62	1.75%	Large river, lower elevation, shale	Cowpasture River, Bath Co.
114	18.44	1.56%	Headwater, lower elevation, granite	King Creek, Amherst Co.
313	16.88	1.43%	Large stream, lower elevation, shale	Wilson Creek, Bath Co.
512	13.91	1.18%	Large river, lower elevation, limestone	Jackson River, Bath Co.
124	12.93	1.10%	Headwater, higher elevation, granite	Crabtree Creek, Nelson Co.
311	12.52	1.06%	Large stream, lower elevation, sandstone/quartzite	Lower Cove Run, Hardy Co.
321	11.27	0.96%	Large stream, higher elevation, sandstone/quartzite	Skidmore Fork, Rockingham Co.
214	10.45	0.89%	Stream, lower elevation, granite	Shoe Creek, Nelson Co.
223	9.06	0.77%	Stream, higher elevation, shale	Little Mill Creek, Bath Co.
115	8.08	0.69%	Headwater, lower elevation, charnokite/mylonite	Cedar Creek, Amherst Co.
413	8.07	0.68%	Small river, lower elevation, shale	Dunlap Creek, Allegheny Co.
222	5.59	0.47%	Stream, higher elevation, limestone	Muddy Run, Bath Co.
224	5.39	0.46%	Stream, higher elevation, granite	S.F. Piney River, Amherst Co.
314	5.38	0.46%	Large stream, lower elevation, granite	Pedlar River, Amherst Co.
312	4.14	0.35%	Large stream, lower elevation, limestone	Smith Creek, Allegheny Co.
421	3.86	0.33%	Small river, higher elevation, sandstone/quartzite	Laurel Fork, Highland Co.

Stream Type	Sum of Miles	Percent of Miles	Description	Example
125	3.85	0.33%	Headwater, higher elevation, charnokite/mylonite	Upp. N.F. Piney R., Nelson/Amherst
414	3.84	0.33%	Small river, lower elevation, granite	Pedlar River, Amherst Co.
215	3.61	0.31%	Stream, lower elevation, charkonite/mylonite	Browns Creek, Amherst Co.
415	2.30	0.19%	Small river, lower elevation, charnokite/mylonite	Tye River, Nelson Co.
511	2.09	0.18%	Large river, lower elevation, sandstone/quartzite	Passage Creek, Shenandoah Co.
412	2.04	0.17%	Small river, lower elevation, limestone	Trout Run, Hardy Co.
315	1.08	0.09%	Large stream, lower elevation, charnokite/mylonite	Piney River, Nelson/Amherst Co.
322	0.28	0.02%	Large stream, higher elevation, limestone	Dry Run, Bath Co.
423	0.14	0.01%	Small river, higher elevation, shale	Back Creek, Highland Co.
225	0.06	0.00%	Stream, higher elevation, charkonite/mylonite	Lower N.F. Piney R., Nelson/Amherst
323	0.03	0.00%	Large stream, higher elevation, shale	Shaws Fork, Highland Co.
	1178.66	100.00%		

The Ecosystem Diversity Report for the George Washington National Forest identified two aquatic-related ecological systems that cross-walk with the stream reach classification.

Ecological System from Ecosytem Diversity Report	Lotic Habitat Classification
Central Appalachian Floodplain	Stream size classes of: Small River and Large River
Central Appalachian Riparian	Stream size classes of: Headwater, Stream and Large Stream

Lake, Pond, and Wetland Classification

Lentic aquatic habitat has standing water and includes lakes, ponds, and swamps. It is primarily determined by slope (or gradient) and substrate or storage capacity.

Lakes and ponds were classified by size and connectivity to a stream. A waterbody greater than five acres was called a lake; a waterbody equal to or less than five acres was called a pond. Wetlands were classified according to the type of vegetation within the wetland. Six habitat types were identified (see Table 3). The category of "Lake Connected To A Stream" covered the greatest amount of acres on the Forest because this category included the 2,530 acre Lake Moomaw.

Table 3. Lentic Habitat Classification

Category	Abbreviation	Number	Acres on GWNF	Percent
Lake Connected To A Stream	LCS	34	2830.6	87.7%
Woody Wetland	WW	189	185.7	5.8%
Emergent Herbaceous Wetland	EHW	139	85.0	2.6%
Pond Not Connected To A Stream	PNCS	81	70.5	2.2%
Pond Connected To A Stream	PCS	29	36.0	1.1%
Lake Not Connected To A Stream	LNCS	2	20.9	0.6%
TOTALS		474	3228.7	100.0%

The Ecosystem Diversity Report for the George Washington National Forest identified four aquatic-related ecological systems that cross-walk with the lake, pond and wetland classification.

Ecological System from Ecosystem Diversity Report	Lentic Habitat Classification
Central Interior Highlands and Appalachian Sinkhole and Depression Pond	Pond not connected to a stream, Woody wetland, Emergent Herbaceous Wetland
Southern and Central Appalachian Bog and Fen	Woody wetland, Emergent Herbaceous Wetland
North-Central Appalachian Acidic Swamp	Woody wetland
North-Central Appalachian Seepage Fen	Emergent Herbaceous Wetland

2.3 – Key Factors

Aquatic ecological integrity must include physical, chemical, and biological integrity. Furthermore, biological integrity is dependent on physical and chemical integrity. Key factors related to physical, chemical, and biological integrity have been identified that are important for maintaining aquatic ecological sustainability.

Aquatic Ecological Integrity	Key Factors
Physical Integrity	Riparian Areas, Instream Habitat, Lake and Wetland Habitat, Thermal Regime
Chemical Integrity	Dissolved Oxygen, pH and Alkalinity, Other Elements
Biological Integrity	Species Occurrence, Watershed Health

Physical Integrity

Riparian Areas

Riparian areas sustain the aquatic environment by influencing water temperature, light, habitat diversity, channel morphology, food webs and productivity, and the species diversity of stream and lake systems. Intact riparian areas are important in all aquatic habitats.

Maintenance of consistent daily and seasonal fluctuations in water temperature and ambient light levels is crucial to the viability of plant and animal populations. Riparian forests dampen fluctuations in stream water temperature; blocking out heat to keep water cooler during the day and summertime, and capturing heat as it radiates from the soil and water to keep the stream environment warmer during the night and wintertime. The net effect is an environment more conducive to life with fewer tendencies for wide fluctuations in stream temperature. Light levels are regulated in similar fashion.

Litterfall and algal production are the two primary sources of food energy inputs to streams. Both are intimately tied to the presence of riparian forest. Litterfall (leaves, twigs, fruit seeds, and other organic debris), is most abundant when riparian forests are present. Because large pieces of litter do not travel very far away from their origin, a streamside forest is often desirable along the entire length of a stream to

provide the necessary balance of food inputs appropriate to the food chain of native species. In addition, terrestrial insects falling into the water from riparian vegetation can comprise a major portion of the summer diet of fish in headwater streams (LaRoche 2008).

In stream macroinvertebrate populations are affected by changes in litter inputs, as well. The metabolic activity of some of these organisms may increase as streamside plants are removed. This allows woody material to be decomposed more quickly, making nutrients in this material less available to fish and other aquatic species.

The type and amount of algae produced in a stream is affected by the amount of light striking the water surface. Studies show that the algal community of a stream well shaded by older trees is dominated by single celled algae (diatoms) throughout the year. Streams in deforested areas often contain many threadlike (filamentous) green algae, and few diatoms. While some macroinvertebrates such as crayfish and waterboatmen insects readily consume filamentous green algae, most herbivorous species of stream macroinvertebrates have evolved mouth parts specialized for scraping diatoms from the surface of rocks and wood. They cannot eat filamentous algae. Macroinvertebrate diversity tends to decline if a streamside zone is deforested (Austin 2005).

In addition, riparian forests remove, sequester, or transform nutrients, sediments and other pollutants. Pollution removal depends on (1) the capability to intercept surface water and groundwater borne pollutants, and (2) the activity levels of certain pollutant removal processes. Rain and sediment that runs off the land in sheet flow can be slowed and filtered in the forest, settling out sediment, nutrients, and other potential pollutants before they reach the water. Some potential pollutants, such as fertilizers or pesticides, which originate on land, are taken up by plant roots. Nutrients are stored in leaves, limbs, and roots instead of reaching the stream or lake.

Riparian areas will be discussed in section 2.5 in terms of the current condition and trend on the Forest for stable and complex riparian vegetation community and recreation impacts.

Instream Habitat

The substrate is the bottom of, or bottom material in, the stream. The substrate is directly determined by the underlying geologic material. Many aquatic species require specific substrates for their different feeding, hiding, and reproductive strategies. Loose coarse substrate has abundant spaces between and under stones to support the invertebrate foods of many fishes and to serve as egg deposition sites and cover from predators. Freshwater mussels generally need a mixture of loose gravel and sand in which to burrow. Siltation occurs when suspended solids settle from the water column. This fine sediment tends to smother gravel and rubble and fill interstices around boulders, and thus reduces benthic biota and buries breeding sites.

Generally, the more complex the stream habitat, the more complex the stream community. Habitat complexity can come from substrate, gradient, and outside influences such as large woody debris (LWD). In streams with steep gradient and large substrate, boulders often are the dominant structure in the channel (ex. stream type 221, Stream, higher elevation, sandstone/quartzite). In high gradient streams, there is a large range of particle sizes. In contrast, lower gradient streams have primarily smaller particle sizes. Where substrate sizes are small, LWD is an important feature in channel morphology. Lower elevation small streams with smaller particle sizes where LWD could be an important feature include stream types 212 (Stream, lower elevation, limestone) and 213 (Stream, lower elevation, shale). In addition to habitat formation, LWD retains organic and inorganic matter, provides food for invertebrates, and serves as habitat for both invertebrates and fish

Instream habitat will be discussed in section 2.5in terms of the current condition and trend on the Forest for LWD and stream habitat complexity.

Lake and Wetland Habitat

There are only two natural lakes in Virginia, Lake Drummond in the Dismal Swamp, and Mountain Lake near the top of a mountain in Giles County. Neither of which is on the GWNF. One natural lake/pond, Trout Pond, exists in West Virginia on the GWNF. However, there are numerous smaller natural ponds and wetlands, in addition to human-built impoundments (reservoirs). Because they vary in size, depth, chemistry, hydro-period, and vegetation, there are often unique flora and fauna associated with these habitats. Beaver ponds, especially, offer a unique habitat that stores water, traps sediment, reduces erosion, and enhances riparian vegetation. Because of their location on gentle terrain, and easy access, natural ponds and wetlands are often vulnerable to human exploitation and alteration; while man-made reservoirs are usually a center for water-based recreation.

Thermal Regime

Water temperature is a characteristic that can vary widely and is influenced by a number of variables including latitude, altitude, season, weather, shade, and proximity to springs.

Geology directly affects water temperature through elevation changes, and the influence of springs and groundwater. Groundwater influence is a function of watershed storage capacity. The greater the storage, the higher the percent of flow from groundwater, and the cooler the stream water temperature. Watersheds with a large amount of limestone geology generally have a greater amount of groundwater influence because of the presence of large underground aquifers, springs and seeps (ex. stream types 112 (Headwater, lower elevation, limestone) and 222 (Stream, higher elevation, limestone)).

Temperature has a great influence in determining what organisms can survive in a water body. Temperature directly affects the amount of oxygen that can be dissolved

in water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites and diseases. Fish such as trout depend upon cool, oxygen-rich waters.

Human activities influence water temperature. Thermal pollution and streamside clearing can create changes in water temperature. Soil erosion and sedimentation raises water temperature by increasing the amount of suspended solids in the water. Suspended solids make water cloudy. Cloudy water absorbs more radiation (and warmth) from the sun than clear water does.

Chemical Integrity

Dissolved Oxygen

Dissolved oxygen (DO) comes from a variety of sources. The action of waves and water tumbling over rocks helps mix oxygen in the atmosphere with moving water. Geology directly affects DO by controlling not only elevation, but also stream gradient. Rock with higher mass strength produces larger stream particle sizes (for example, granitic formation), and thus steeper gradients.

Plants release oxygen into the water as a byproduct of photosynthesis during daylight hours, but plants and animals also use oxygen during respiration and produce carbon dioxide. Both oxygen and carbon dioxide are more soluble in water at low temperatures than at high ones. Large amounts of carbon dioxide are a sign of accumulating organic material and low dissolved oxygen.

Human activities have great potential to influence dissolved oxygen levels because they are so closely linked to temperature and nutrient levels. Increased nutrients (like phosphorus and nitrogen) stimulate algal growth. Eventually the algae die and accumulate. Animal waste, sewage and other industry discharges, agricultural and urban runoff, in addition to the dead algae, create a large amount of organic material.

Bacteria and fungi use oxygen to break down this organic material and cause the biochemical oxygen demand within the system to increase. Biochemical oxygen demand refers to the amount of oxygen required by microorganisms to oxidize an amount of organic materials. A high demand lowers the availability of dissolved oxygen in the water.

When oxygen is consumed by aerobic bacteria, there is less available for other aquatic organisms. Only organisms, such as carp, midge flies and leeches that are tolerant of low dissolved oxygen levels will survive. This reduces the diversity within the system, creating a system that is less stable ecologically.

pH and Alkalinity

The pH of a water body is affected by its age, geology and the chemicals discharged into it by communities and industries. Alkalinity refers to the ability of a solution to resist changes in pH. Alkalinity buffers waters against dramatic changes in pH.

Geology directly affects pH because the main sources of natural alkalinity are rocks that contain carbonate, bicarbonate and hydroxide compounds. Borates, silicates and phosphates also may contribute to alkalinity. Waters flowing through limestone typically have good buffering capacity (ex. stream classifications 222, 512, 312). Waters flowing through granite and quartzite areas, typically have low alkalinity and poor buffering capacity (ex. stream classifications 111, 211).

Since buffering capacity ultimately depends on the weathering of acid-neutralizing material from the bedrock, hard bedrock types produce less buffering capacity for streams than soft bedrock types. Mountains by their very nature are more resistant to weathering than surrounding lowlands, so mountain streams and lakes are usually the most sensitive to acidification. In contrast, large valley streams and lakes are the recipients of upstream weathering products and are often less sensitive to acidification.

Human activities also affect the pH of water bodies. Acid precipitation is the result of nitrogen oxide gases and sulfur dioxide combining with water in the atmosphere to produce nitric and sulfuric acids. These gases are produced and released into the atmosphere during the burning of fossil fuels such as gas, oil and coal. Acid precipitation falls into water bodies and makes some of them acidic. Runoff from acidic Soils also contributes to acid waters. Water bodies that have limestone geology are less susceptible because the alkaline carbonates of limestone help neutralize the effects of acid precipitation.

Unpolluted rain has a pH of around 5.6 (slightly acid). Currently, the average rain and snowfall in most states east of the Mississippi River measures between 4 and 5 on the pH scale. Some individual storms go as low as 3.0.

Most aquatic organisms survive best within a limited pH range. Even small changes in pH are harmful to acid sensitive species. Most fish can tolerate pH values of about 5.0 to 9.0. pH values outside that range can create problems for reproduction and survival. Alkalinity helps fish and aquatic life because it protects against pH changes and makes water less vulnerable to acid precipitation. When alkalinity falls below 2 mg/l the pH of waters can change easily. During the spring alkalinity is especially important for protecting aquatic organisms in their early life stages from large amounts of acidic snowmelt and runoff.

Other Elements

Magnesium, calcium, sodium, potassium, chloride, aluminum, iron, manganese, copper, and zinc are just a few of the elements that can occur in stream water. The level of these elements in stream water is directly related to the underlying bedrock

material. Often these elements are in excess in stream water as a result of human activity (such as mining).

A note about aluminum is warranted because it is extremely toxic to aquatic life, and it has a unique relationship to pH. Aluminum is the most abundant metal on the earth's surface, and the third most abundant element. It is non-toxic and insoluble under acid-neutral conditions, but very toxic to fish and other aquatic species under acidic conditions. Unfortunately, the solubility of aluminum increases exponentially as pH falls below 5.6; its maximum toxicity occurs at about pH 5.0. Acid deposition results in the release of aluminum from Soils and its transport in solution to streams and lakes.

Biological Integrity

Species Occurrence

Aquatic species are not found uniformly distributed across all habitat types; many are tied to specific habitat needs or preferences. The specific habitat associations for Threatened and Endangered, FS sensitive species and locally rare species are found later in this report. In general, aquatic species distributions are determined by major river drainage, size of the water body, and local characteristics (substrate, light, velocity, temperature, energy sources, and chemistry).

Biogeography

Geography directly influences the distribution of aquatic organisms at a large scale through the division of major river drainages. For example, some species are naturally found in the James River watershed, and not the Tennessee River watershed, or vice versa. Those species that are native and restricted to a given area or watershed are called "endemic". Species richness, as well as degree of endemism varies greatly by major river drainage.

Longitudinal Zonation

As previously stated in this report, most species occupy streams or stream reaches of particular size ranges, thus their distributions are longitudinally zoned. Species richness in stream reaches is related to longitudinal zonation. Headwaters nearly universally have fewer species than do medium and large streams in the same system.

The River Continuum Concept (paraphrased from Cushing 1995).

This concept explains how geology, light, current velocity, temperature, and energy sources interact to produce the changing mosaic of aquatic insects from headwaters to river mouth.

- In the headwaters, the stream is narrow and generally well-shaded by the riparian canopy. Primary producer energy for the stream comes from riparian vegetation. The stream is dominated by insects that are shredders and collectors.
- The stream's mid-reaches have a wider bed, warmer temperatures, more light, and nutrients. Algae is abundant on the stream bottom, and the stream is dominated by insects that are grazers and collectors.

- The lower reaches of a river are slow-flowing and deeper. Increased turbidity prevents sunlight from supporting algal growth on the bottom. In-stream primary production takes place within the water column where suspended algae and macrophytes are abundant. The insect community is largely made up of collectors, both filterers and gatherers.

Species occurrence will be discussed in section 2.5 in terms of Management Indicator Species in the current GW Forest Plan and barriers to aquatic organism passage. It also will be discussed in terms of habitat on the Forest for FS sensitive species or locally rare species in section 3.2.

Watershed Health

The living systems of a water body are the product of millennia of adapting to climatic, geological, chemical, and biological factors. Their very existence integrates everything that has happened where they live, as well as what has happened upstream and upland. When something alters the landscape around a river's headwaters, life in lowland reaches feels the effects (Karr and Chu 1999).

Recent research comparing stream segments having 30 meter wide buffers to stream segments with 15 meter wide buffers, found that those with 15 meter buffers have: 1) higher peak temperatures, and 2) more fine sediments (Jones et al. 2006). In addition, trout populations were shown to respond markedly to these habitat changes. Streams with 15 meter buffers would not be able to maintain the temperatures necessary to sustain young trout. Furthermore, studies in deforested watersheds (e.g., intensive agriculture and urban systems) have shown that wide land-use alterations can overwhelm the capacity of riparian buffers to support high-quality instream habitats and associated biotic communities (Roth et al. 1996, Wang et al. 2003, Roy et al. 2005).

Terrestrial and aquatic invasive species can alter habitat and biologic interactions. Examples of forest-altering species include the gypsy moth and hemlock woolly adelgid. Examples of non-native invasive aquatic species are didymo algae and Asian clams.

Watershed health will be discussed in section 2.5 in terms of benthic macroinvertebrate monitoring on the Forest, and invasive species examples.

2.4 – Range of Variation

The physical and biological characteristics of ecosystems do not remain constant over time, as plant and animal communities are continually altered in response to changes in physiographic and climatic conditions. In many cases, periodic disturbance is required to foster ecological processes (e.g., flooding promotes nutrient cycling in riparian soils), or to complete the life cycles of various organisms (e.g., pond drying/filling to facilitate marbled salamander reproduction). A certain amount of change is therefore unavoidable and essential in watershed ecosystems. For this reason, a key element in maintaining aquatic ecological integrity is the ecosystem's ability to evolve over time and to self-regulate following disturbance (Helfield et al. 1998).

Floods and Droughts

The watersheds of the GWNF periodically experience extreme flow events. Virginia lies in the path of cyclone storms that originate in the Gulf of Mexico and the Atlantic Ocean and carry large amounts of moisture. Flooding is common in the state, especially in the western mountain regions, where high precipitation and steep topography produce rapid runoff. The lands of the GWNF have been touched by floods of magnitude greater than 50-year recurrence interval in 1940, 1969, 1972, 1977, and 1985, as well as 1996 (van der Leeden, 1993). Most of these were produced by hurricanes. The potential for flooding is greatest when Soils are near saturation as they are in the spring or at any time of year following several days of rain. The presence of a forest canopy in a watershed can reduce flood peaks from small-to-moderate storms during the growing season because the growing trees utilize soil moisture and transpire it to the atmosphere. However, this soil moisture difference becomes negligible during large-storm events. A small mountain watershed on the GWNF can produce flood peaks approaching 1,000-cubic feet per second, per square mile. In contrast, a larger river basin like the James River at Holcomb Rock will have a maximum peak discharge of only 50-cubic feet per second, per square mile.

Historically, the great floods in western Virginia have been associated with hurricanes, which form part of the ecological disturbance regime for aquatic ecosystems. The way that a watershed responds to a hurricane event is strongly influenced by watershed condition and also by natural factors of sensitivity. A healthy watershed is resilient and can rapidly recover from the effects of a large flood. A watershed under stress from historic or ongoing land uses may show disproportionately more watershed damage and channel impacts, and will take much longer to recover. The watersheds of the Appalachians are in the process of seeking a new equilibrium partly, in response to the loss of American chestnut from the forests. Because of its resistance to rot, large woody debris produced from downed chestnuts would persist for decades and add stability to headwaters streams. In addition to increased longevity in the aquatic system, the mature chestnut trees were much larger than the trees of the second growth forests of today. When compared to streams in virgin forests in the Appalachian Mountains, the streams in second growth forests have significantly less large woody debris.

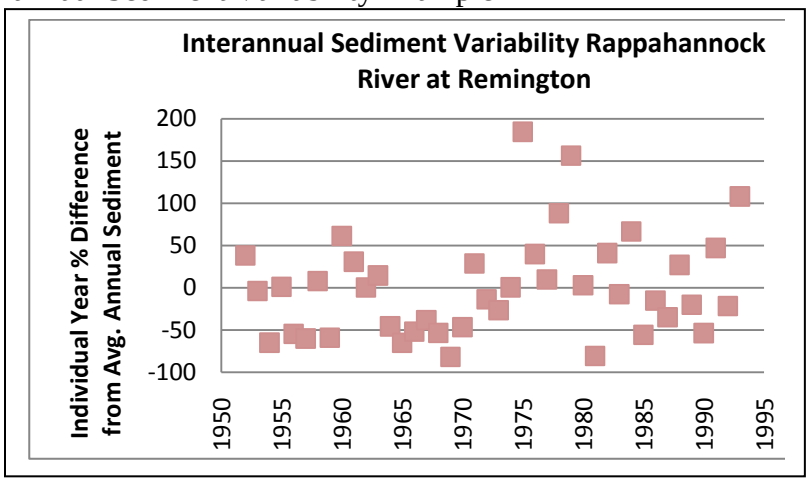
Low flows typically occur during late summer and early autumn when precipitation is low and soil moisture is utilized by growing vegetation. Water in the stream represents the release of water from groundwater and soil storage. Because of the wide range in topography, rock types, and soils, there is a wide variation of low flows in the streams of the GWNF. Where soils are deep, slopes are gentle, and drainage density is low, precipitation can be stored within the watershed and released slowly. Thus, peak flows are moderated and low flows are sustained. As greater flow contributions are from groundwater, water temperature is usually lower and less variable. Based on years of data from U.S. Geological Survey (USGS) stream gages across the Forest, for the same low flow recurrence interval, streams in the Ridge and Valley have one half of the flow rates of Blue Ridge streams.

Sediment

There is a great deal of variability in the sediment yield from year to year, which is termed "interannual variability." In part, this is because sediment yield is much greater during high runoff years with more stormflow to erode and transport sediment. Conversely, sediment yield is much less during drought years when high flows may be less than bankfull. However, interannual variability is a function of much more than the weather.

Data from the USGS gage on the Rappahannock River at Remington provides an expression of the variability of annual sediment yield. For the 42 years with flow and sediment data, each year's percent difference from the long-term mean ranges from plus 184 percent to minus 82 percent. A change of annual sediment yield of plus or minus 60 percent represents one standard deviation from the long-term mean. This value is also termed the coefficient of variation. According to Bunte and MacDonald (1999), "very few records of annual sediment yield have a coefficient of variation of less than 50%, and most values are closer to 100%." Therefore, the data from the Rappahannock provide a good but conservative estimate of the coefficient of variation for watershed systems on the George Washington National Forest. Figure 2 displays the interannual sediment variability for the Rappahannock River at Remington.

Figure 2. Interannual Sediment Variability Example



2.4a – Disturbance Processes

Natural Change Processes

Natural disturbance processes are typically characterized according to the frequencies at which they occur, and the intensity of their effects. Intensity of disturbance is typically defined according to the magnitude of effects on biotic communities. Frequency and intensity are generally inversely proportional to one another, as plant and animal communities associated with frequently disturbed habitats tend to develop adaptations that allow them to persist or even thrive under those conditions.

Within the watershed, upper reaches (low order streams or headwaters) are affected primarily by infrequent, high-intensity events (e.g., landsides, debris flows), whereas lower reaches (high order streams or rivers) tend to be affected by frequent, low-intensity events (e.g., flood scour/deposistion) (Helfield et al. 1998). A description of these streams follows:

- Low Order Streams (Headwaters)

The channel morphology of a low order stream is characterized by high gradient step-pools formed by large substrate particles (boulders) and large wood. The floodplain is narrow and constrained. Disturbance is infrequent, but often extreme, in the form of landslides and debris flows. The effects of the disturbance are severe hillslope and channel erosion, and channel aggradation and degradation.

- Mid-Order Streams (Streams to Large Streams)

The channel morphology of a mid order stream is characterized by a moderate gradient assemblage of pools, riffles, and runs. Particle sizes are mixed, but predominantly cobble size, with some exposed bedrock. The floodplain ranges from unconstrained to constrained. Disturbance is more frequent, and in the form of debris flows, landslide/dam break floods (torrents), and bank erosion. The effects are cycles of aggradation and degradation, mass transfer and deposition of LWD, and alteration of riparian zone.

- High Order Streams (Small to Large Rivers)

The channel morphology of a high order stream is characterized by low gradient pools, riffles and runs. Particle sizes are smaller, dominated by sand and gravel. The floodplain is wide to accommodate the sinuous channel. Disturbance is frequent, but of lower intensity, in the form of floods, and treefall. The effects of disturbance are bank erosion, evulsions, and alteration of the riparian zone.

Wetlands and natural lakes and ponds are likewise affected and maintained by natural change processes. As described by Euliss et al. (2008), these habitats "occur at positions in the landscape where the underlying geology creates hydrologic conditions suitable for their development". The fundamental ecological processes at work in these lentic systems are a balance of hydrodynamics (including flooding and drought), erosional properties, and nutrient cycling (Euliss et al. 2008, Pearson 1994). An example of a natural disturbance process in these systems is the never ending cycle of beaver ponds filling with debris and being abandoned to the forces of erosion and terrestrial recolonization. Hackney and Adams (1992) state that beavers have probably created more aquatic and wetland habitats than human efforts have ever done.

Anthropogenic Change Processes

A biota can sustain itself- it is very resilient- when faced with normal environmental variation, even when that variation is large (e.g., variation in river flow). But the same biota may not be able to withstand even the smallest disturbance outside the range of its evolutionary experience (Karr and Chu 1999). Habitat alteration is the major cause of decline of aquatic diversity in the South (Clingenpeel and Leftwich 2008). Channelization, impoundment, sedimentation, and flow alterations are the most common physical habitat alterations associated with the decline of aquatic species (Walsh et al. 1995; Etnier 1997; Burkhead et al. 1997). Other human-induced impacts to aquatic species include pollution, introduced species, and over-harvesting (Miller 1989). Euliss et al. (2008) likewise note that human stressors on lake and wetland habitat include: shoreline alteration, altered sediment supply and transport, altered hydrology, land-use

change, development on uplands, invasive species, introduction of non-native organisms, and disruption of fire regimes.

Habitat quality within a freshwater ecosystem is determined by activities within the watershed (Abell et al. 2000; Scott and Helfman 2002). A resource assessment was conducted using information from the Eastern Watershed Assessment Protocol (EWAP 2002) and is documented in Appendix 5. Fifth code HUC watersheds were evaluated in a GIS environment to characterize the watersheds based on the following conditions, or human-caused disturbances that can affect aquatic biota outside their normal range of variation.

Disturbance or Condition	Watershed Parameter	Data Management from EWAP 2002*
Characterization	National Forest ownership	Percent of national forest within the watershed
Characterization	Land Use (forested)	Percent of forest cover within the watershed
Deforestation/channelization/grazing streambanks	Forested riparian	Length of streams flowing through forested land cover divided by total length of streams in watershed
Sediment and impacts from roads	Road Density	Length of highway divided by watershed area expressed as a percentage
Sediment and impacts from roads	Road – riparian interaction	Percent of total stream length in each HUC that has road within 30 meters.
Point and non-point source pollution	Point sources of pollution	Sum of ricris, cercla, pcs, and ifd sites
Dams/impoundment construction	Dams / Diversions	Number of dams found in the watershed
Point and non-point source pollution	State Impaired Waters	Total length of impaired streams divided by total stream length expressed as a percentage.
Acid deposition	Acid deposition sensitivity	Percent of watershed with high acid deposition sensitivity
Characterization	Public water supply sources	Number of drinking water sources found in the watershed
Characterization	Drainage Density	Length of streams divided by watershed area expressed as a percentage.
Characterization	Number of aquatic TE/S/LR	Number of aquatic TE/S/LR not counting birds and non-TE plants

*** Except for Number of aquatic TE/S/LR, these are from 2009 analysis.**

The analysis in Appendix 5 is a description of the major resource components within the watersheds that contain the GWNF; it is a coarse evaluation of the interactions among the physical, biological and human aspects of the watersheds and the processes influencing them (Regional Ecosystem Office 1995). As seen in Chart 1, the percent forested land use in a watershed generally mirrors the percent National Forest in that watershed, with the exception of the east side of the Blue Ridge Mountains on the Pedlar District where there are large tracts of private forested land (HUC codes 0208020301-0208020306). HUCs 0207000102 and 0208020108 are Laurel Fork and Craig Creek, respectively, where a large part of the watersheds are on other National Forests (the Monongahela (41% NF) and Jefferson (62%NF)). This watershed analysis is a snapshot in time,

incorporating many human disturbances outside the control of, and area managed by, the Forest Service. For example, the percent of impaired streams in a watershed is generally the inverse of the percent National Forest in that watershed (see Chart 2). The analysis shows the relative condition of the watersheds, and the relative importance of Forest lands to aquatic TE/S/LR species and their habitat (see Charts 3 and 4). As outlined by Kershner (1997), this characterization step is followed by the identification of current conditions related to issues and current plan management (Section 2.5), and finally, development of recommended goals and guidelines to maintain the key factors of ecological integrity (Section 2.6).

Chart 1. Percent National Forest land and forested land use within a 5th level watershed.

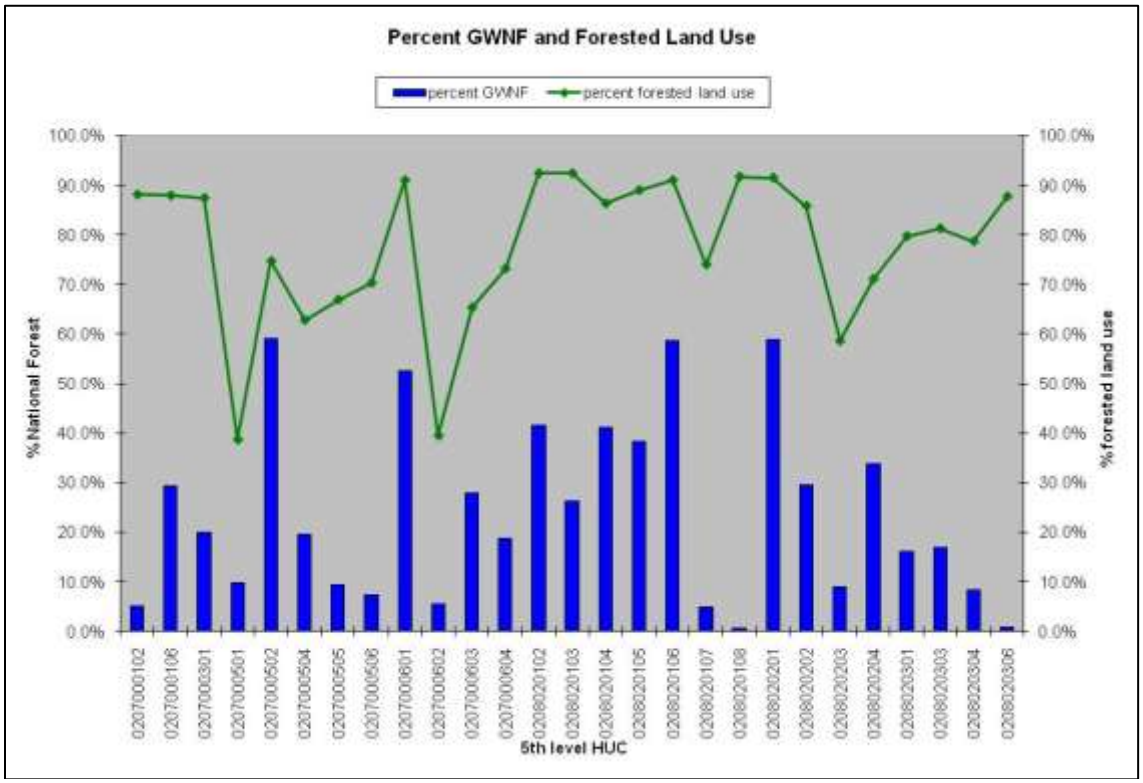


Chart 2. Percent National Forest land and impaired streams within a 5th level watershed

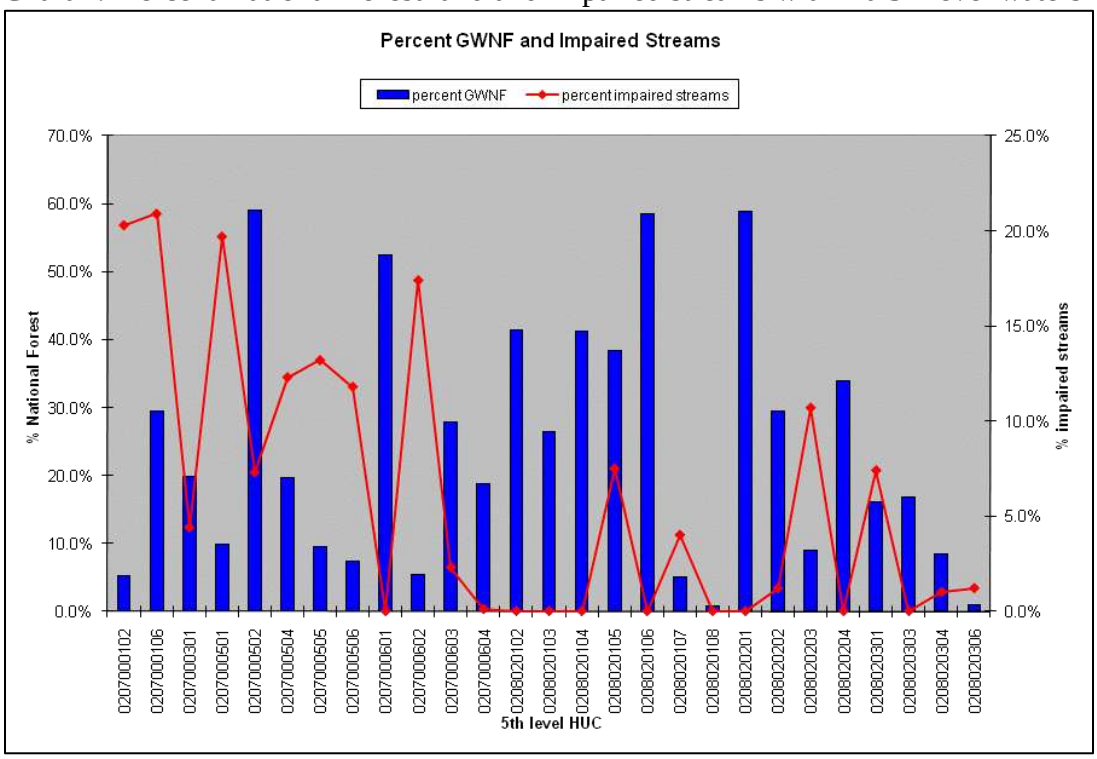


Chart 3. Percent National Forest land and total number of aquatic TE/S/LR species within a 5th level watershed.

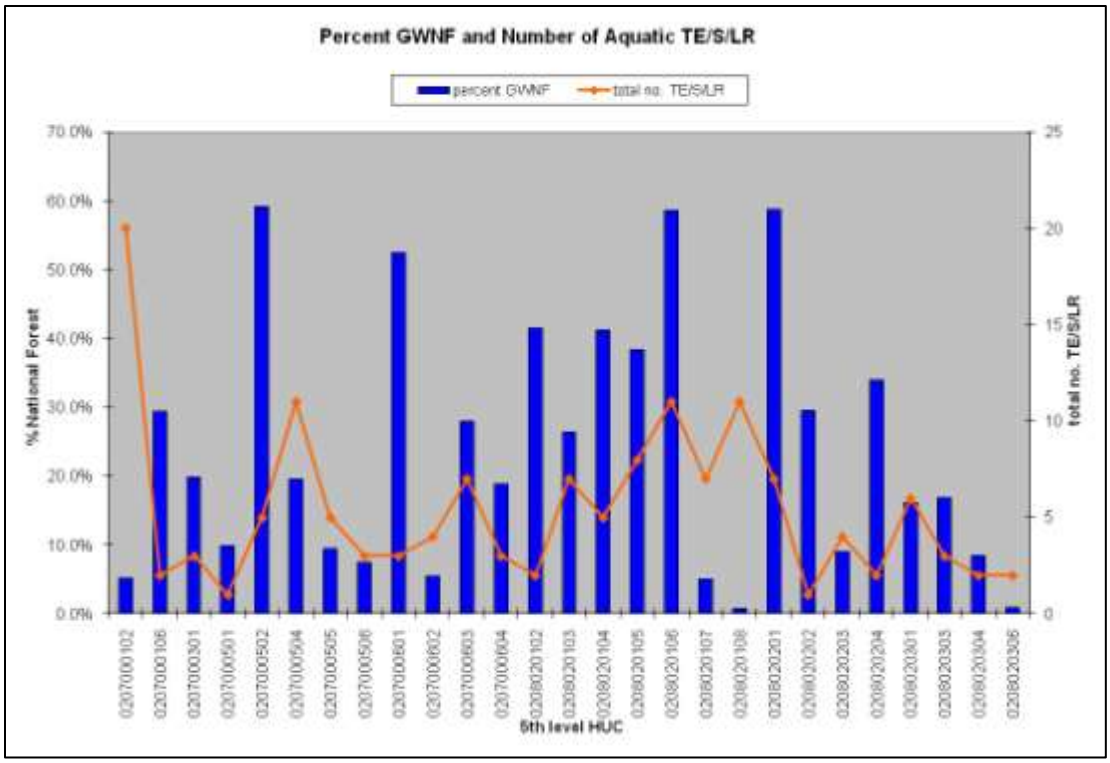
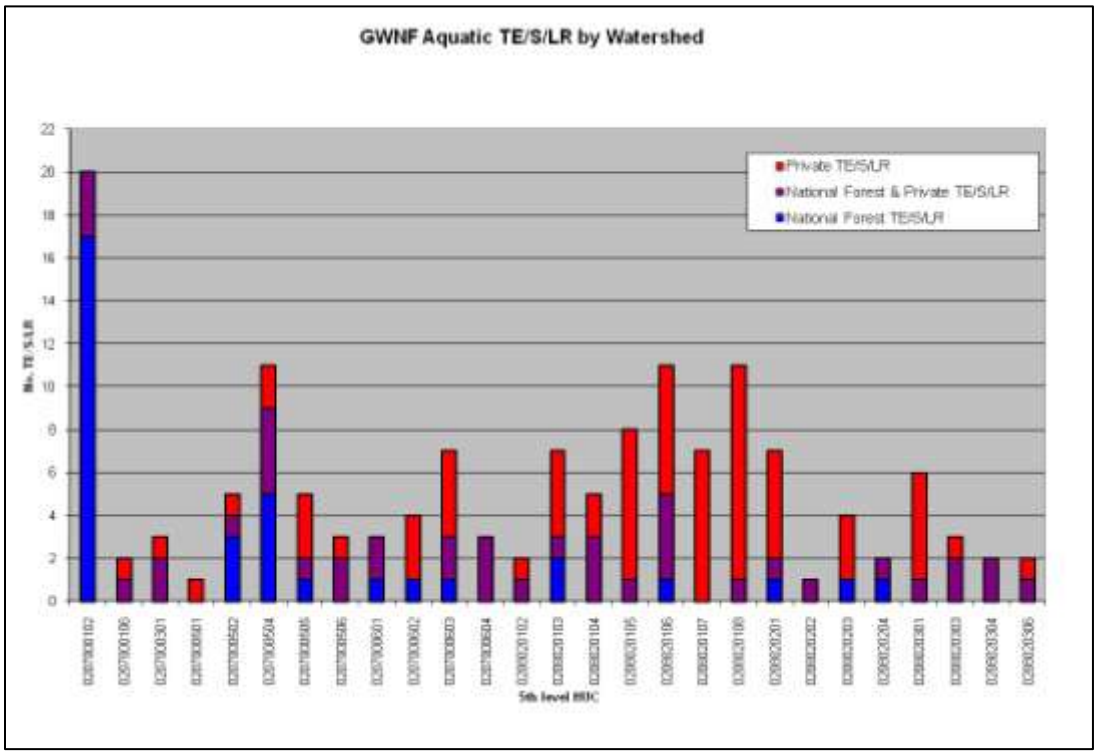


Chart 4. Number of Aquatic TE/S/LR species on National Forest, National Forest and Private land, and Private land within a 5th level watershed.



2.5 – Current Condition and Trend of Ecosystem Characteristics and Status of Ecosystem Diversity

Physical Integrity

Riparian Areas

Stable and complex vegetation community

Current Condition: The 1993 Forest Plan allows up to 20% basal area removal of trees along perennial non-native trout streams and 50% basal area removal along intermittent streams. There is no regulation of vegetation management along ephemeral streams. One timber sale was designed to specifically address the issue of removing non-native pine plantations along the North River. Otherwise, no projects were known to have removed any vegetation within riparian areas of the GWNF.

See discussion under *invasive species*, about the hemlock woolly adelgid and riparian vegetation.

Trend: Riparian vegetation across most of the Forest is undisturbed and growing older, except in areas where hemlock woolly adelgid and gypsy moth have caused mortality, and in developed or dispersed recreation areas.

Dispersed Recreation opportunities and impacts

Current Condition: Projects that were done to improve riparian conditions included closing or moving roads and trails, improving stream crossings, and planting a forested riparian buffer. This is not an all-inclusive list, and it is recognized that many more projects have occurred to improve watershed conditions. It is also recognized that many more dispersed recreation opportunities and problems exist across the Forest, and have yet to be addressed.

Trend: Mitigation of recreation impacts to riparian areas is an on-going process; as some areas are rehabilitated; other user-created areas are degraded.

Instream Habitat

Large Woody Debris (LWD) and instream habitat surveys

Current Condition: Forest personnel surveyed stream habitat to measure desired future condition (DFC) parameters identified in the 1993 Revised GWNF Forest Plan. Surveys were conducted on portions of the Pedlar Ranger District in 1995 and 2005, Lee District in 2001, Dry River District in 2002, 2003, 2004 and 2005, and the Warm Springs in 2005. Overall, 631 km (392 miles) of streams were surveyed using a modified Basinwide Visual Estimation Technique (BVET [Dolloff et al. 1993]) to estimate woody debris loading, percentage of pool and riffle area, and the width of the riparian area of streams. The distribution of woody debris was also mapped. See Table 4 for a summary of LWD and % pool area.

Table 4. Miles of Stream Habitat Surveyed In 1995-2005
George Washington National Forest

Year Surveyed	# of Stream Miles Surveyed	% of Streams Below Minimum Pool Area DFC	% of Streams Below Minimum LWD DFC
1995	113	48	44
2001	75	75	35
2002	57	62	33
2003	55	70	19
2004	35	71	78
2005	57	96	83

A comparison of individual streams surveyed in 1995 and again in 2005 on the Pedlar District showed a decrease in the median number of pools, number of riffles, and total LWD per km, while the median pool and riffle surface area increased. This report suggests that in 1995 only 25% of streams met the DFC for stream area in pools and less than half of streams met the DFC for total LWD. By 2005 no streams met the DFC for pool area and 75% of streams did not meet the DFC for total LWD. The

changes in pool/riffle ratio, number of pools and riffles per km, and pool and riffle surface area are all consistent with decrease in total LWD. The largest decrease of LWD was in the smallest size class. These pieces most often form pool habitat by combining with other small woody debris to form debris jams. In general the smallest size classes are the most easily dislodged and transported downstream or out of the active stream channel during high flows (Hilderbrand et al. 1998, Montgomery et al. 2003). Loss of debris accumulations from long riffle areas following flood events could result in the changes in stream habitat observed. The median amount of the largest size classes of LWD either remained the same or increased in the reaches between 1995 and 2005.

Following Plan approval, across all Ranger Districts, large woody debris was deliberately added to many streams that did not meet the DFC. In addition, efforts were made in the North River to return a highly modified stream channel to a more natural condition. Past hydrological modifications of the North River include bank armoring with rock gabions and channelization to protect the road from frequent floods. These modifications resulted in a wide, shallow channel that lacks fisheries habitat complexity. Under a recent project, rock veins and weirs, and other structures made of natural materials were placed in the stream channel to consolidate streamflow and increase sinuosity. Non-functional rock gabions blocking the natural floodplain were removed.

Trend: Management actions such as adding large woody debris and other types of in-stream structures moved particular streams toward meeting the DFC. However, the vast majority of the Forest's streams received no direct management action. Although comparisons of 1995 and 2005 stream surveys showed a decrease in streams meeting the desired future conditions for pool/riffle ratio and total LWD, the median amount of the largest size classes of LWD either remained the same or increased during that time period. The largest size classes (size 3: > 5 m long, 10-50 cm diameter; size 4: >5 m long, >50 cm diameter) are most stable and can easily have residence times of greater than 10 years in Appalachian streams with relatively little movement (Andy Dolloff, unpublished data). Continued supply of these size classes to the stream may result in increases in total pool habitat in the future.

Such differences highlight the fact that LWD dynamics are governed by a wide array of chronic and acute events, both natural and anthropogenic, including flooding, fires, stand maturation, riparian composition, and timber harvest (Dolloff and Warren 2003, Benda et al. 2003). For example, insect infestations such as gypsy moth or hemlock woolly adelgid can result in the relatively rapid death of many trees. Smaller size classes of LWD are added to the stream as dead trees standing in the riparian area begin to shed branches, and larger size classes are added as these trees continue to decompose and eventually fall across the stream channel. Natural additions of LWD can come through slow attrition or in large pulses if stands are impacted by events such as hurricanes. It is expected that streams will move toward the DFC through natural process if riparian forests are allowed to mature and more trees are left in the

vicinity for recruitment of future LWD (Benda et al. 2003, Boyer and Berg 2003, Dolloff and Warren 2003, Morris et al 2007, Reich et al. 2003).

Lake and Wetland Habitat

Current Condition: National Forest lakes and reservoirs have been managed to support balanced, productive self-sustaining recreational fisheries, in addition to other water-based recreation (swimming and boating). Fisheries Management was practiced in cooperation with State agencies to provide fishing opportunities to the public. Management practices included angler access improvement, liming and fertilization, aquatic weed control, fish habitat improvement, and fish stocking.

Wetlands and natural ponds have been managed to support self-sustaining populations of native species associated with permanent pond, wetland, and vernal pool habitat. The benefit of fishless ponds and vernal pools to many amphibians and insects is recognized and stocking fish has been discouraged. In several cases, fish have been removed from these ponds.

Trend: Many of the reservoirs on the Forest were built in the 1950's for flood control or water supply. They are becoming increasingly filled with sediment, and many are in need of dredging. Wetlands and natural ponds are protected on the Forest, and beaver ponds and meadows are increasing in number with the expanding beaver population in Virginia (Feis 2009).

Thermal Regime

Current Condition: Water temperatures have not been systematically tracked across the Forest. The Virginia Department of Environmental Quality has listed six streams in the 2008 303d report as being impaired for temperature within the GW proclamation boundary. In addition, Switzer Lake was listed as impaired for temperature. These impairments are attributed to natural conditions, drought-related impacts, or unknown sources; they are not attributed to any Forest management activities.

Trend: It is expected that with the warming climate over the past several decades and into the future, stream temperatures will likely increase (Flebbe et al. 2006). A multi-agency cooperative project is being planned to look at short and long term temperature changes in headwater streams throughout western Virginia. Protecting and restoring riparian forests will help moderate these changes. See section 3.4, temperature change species group for additional discussion.

Chemical Integrity

Dissolved Oxygen

Current Condition: The 2008 303d reports for Virginia and West Virginia list 49 streams that run through the Forest as being impaired, none for DO. The sources of these impairments are off-Forest (acid deposition, fecal coliform, E. coli, agriculture), or are described as "natural." Of the five reservoirs listed, none are impaired for DO. Their impairments are pH and temperature.

Trend: Two streams and two reservoirs that are within the National Forest have been removed from the impaired waters list since the 2006 report.

pH and Alkalinity

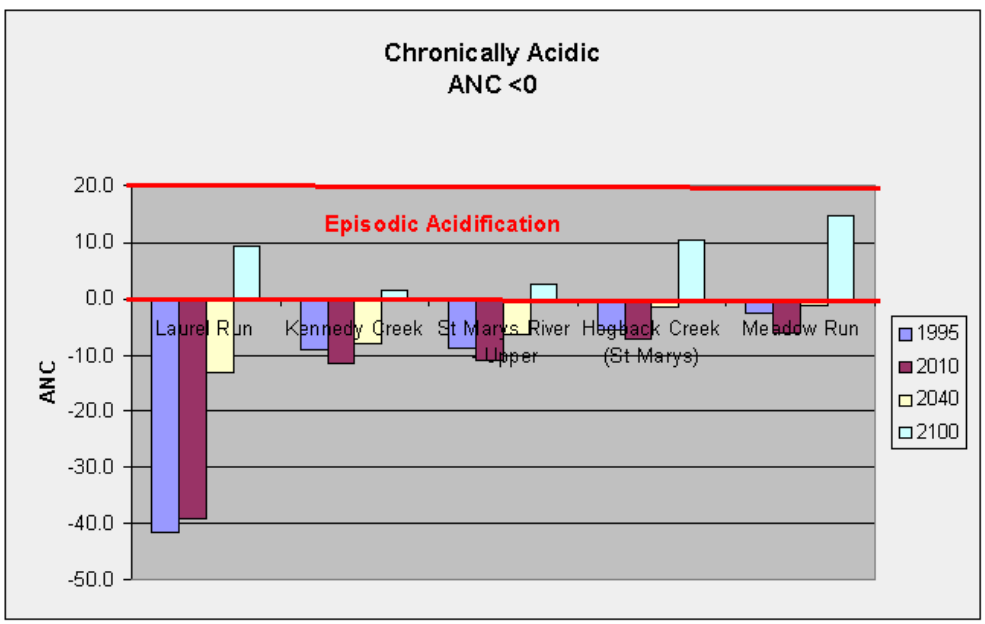
Current Condition: Water quality has been systematically monitored on Forest streams since 1987. As expected, the general water quality of any given stream is strongly tied to the underlying geology coupled with prevailing air quality. The collected data has been used to determine trends and changes in stream water composition, and to project the future chemical status of native trout streams. A 1998 report (Bulger et al. 1998) found that of the study streams in non-limestone geology, 50 percent are "non-acidic." An estimated 20 percent are extremely sensitive to further acidification; another 24 percent experience regular episodic acidification at levels harmful to brook trout and other aquatic species. The remaining 6 percent of streams are "chronically acidic" and cannot host populations of brook trout or any other fish species.

Atmospheric deposition is listed as the cause of impairment for 21 of the 49 impaired streams running through the Forest, and 4 of the 5 reservoirs, in the 2008 303d reports.

Trend: Modeling conducted by the Southern Appalachian Mountain Initiative (SAMI) and reported in their 2002 publication on acid deposition showed that even with the sulfate deposition declining considerably, as new air regulations are implemented, stream recovery will be slow or non-existent over the next 100 years. Chronically acidic streams may improve slightly and be only episodically acidic by 2100, but they will still be marginal for brook trout (see Figure 3).

Due to the lengthy recovery time anticipated for acidified streams on the Forest, selective liming to improve water chemistry should continue to be considered.

Figure 3. SAMI Modeling Results for Selected Streams on the GWNF.



The following streams have been limed on the GW Forest since 1989:

Table 5. Streams Limed on GWNF.

George Washington National Forest Stream Liming		
Date	**Stream**	**County**
1990, 1997	Cedar Creek	Shenandoah
1993, 1994, 1997, 2006	Laurel Run	Shenandoah
1997, 2000, 2003, 2006, 2009	Little Passage Creek	Shenandoah
1989, 1990,1991, 1998, 2001, 2004, 2007, 2010	Little Stony Creek	Shenandoah
1990, 1998, 2001, 2007	Mill Creek	Shenandoah
1993,1997, 1999, 2002, 2005, 2008	Mountain Run	Rockingham
1999	St. Mary's River & 5 tribs	Augusta
2005	St. Mary's River & 6 tribs	Augusta
1995, 1996, 1997, 1998, 1999	Trout Pond Run	Hampshire, WV

Trends in pH for several of the limed streams are shown in Figures 4 and 6.

Figure 4. St. Mary's River pH following liming.

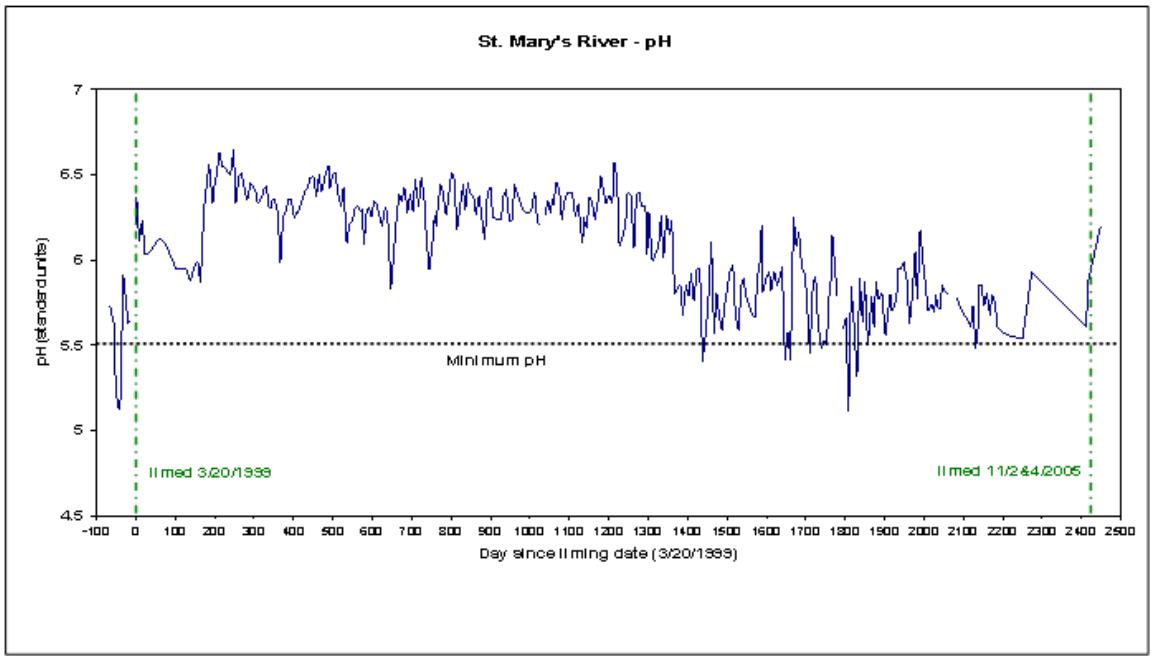
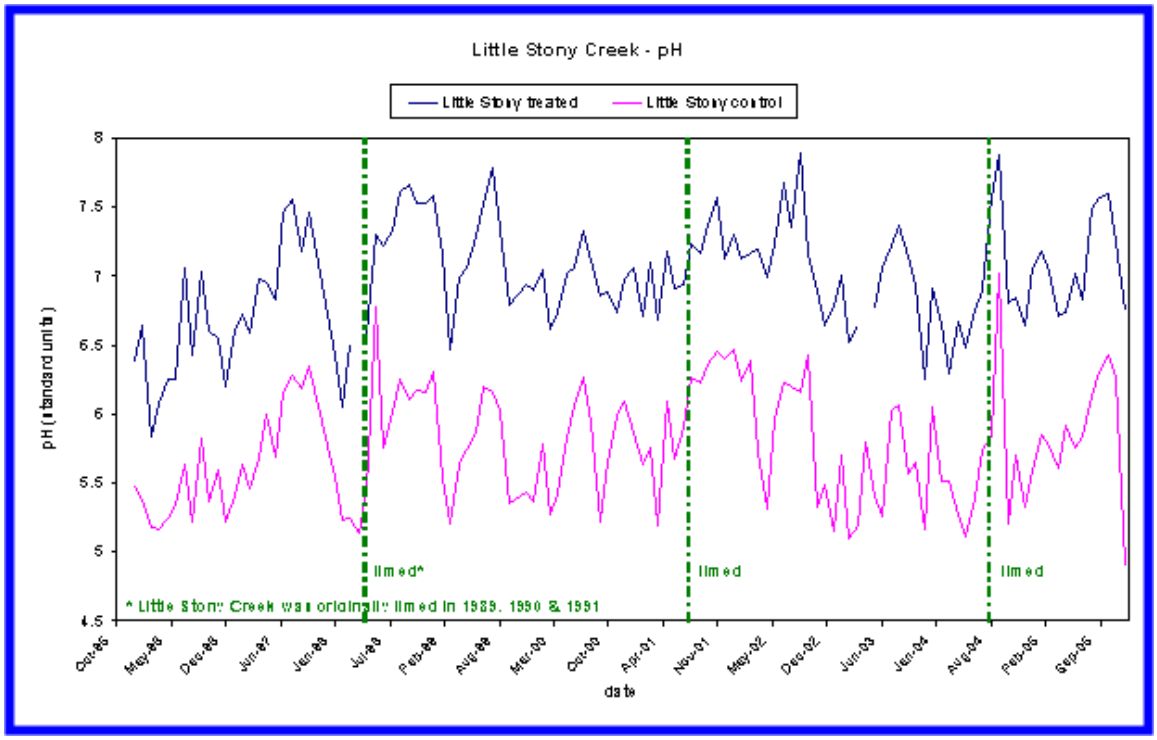


Figure 6. Little Stony Creek pH following liming.



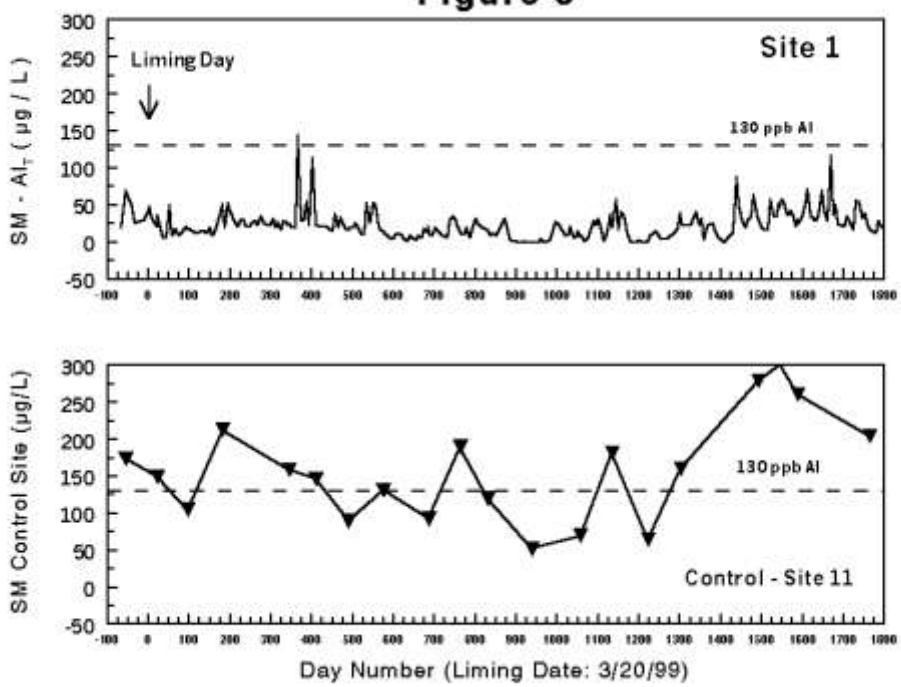
Additional trend information on the effects of acidification and liming is documented in Appendix G, Brook Trout and Wild Trout section, of the annual M&E reports since the 1997-1998 report.

Other Elements

Current Condition: Aluminum is soluble and toxic to aquatic organisms under acidic conditions as described in section 2.3, and warrants further discussion.

Trend: Aluminum levels were monitored in stream water following a liming treatment at St. Mary's River. Total aluminum concentration levels above 130 g / L are considered hazardous for aquatic life and thus was chosen as the maximum acceptable amount for this study. Figure 5 below shows the total aluminum concentration for the St. Mary's River in the weekly samples taken at the gauging location (site 1) on the top graph and the quarterly aluminum values taken at the control site (site 11) upstream of the limestone treatment. The graphs show that aluminum was mobilized during high flow periods due to low pH and flushing in the untreated reach of the stream. Episodic short-term spikes in aluminum concentrations as well as the base flow concentrations were less than the target value downstream of limestone treatment. Aluminum concentration at site 1 averaged 39.3 + 16.9 ppb prior to liming and 21.3 + 18.0 ppb since the liming.

Figure 5



Biological Integrity

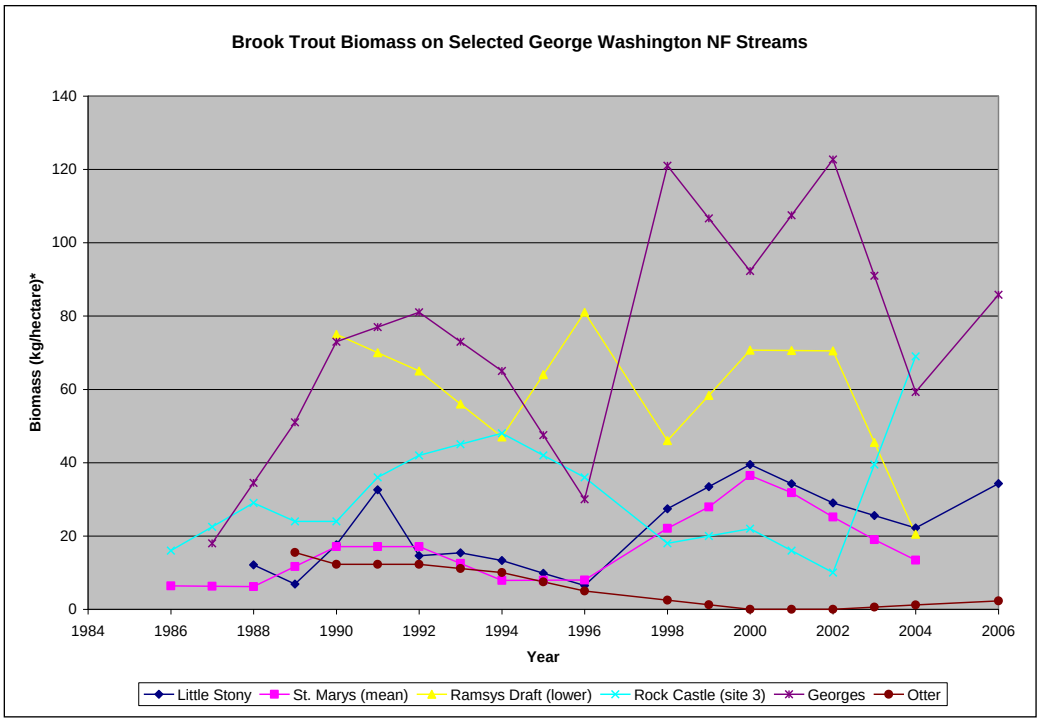
Species Occurrence

Management Indicator species

Current Condition: The 1993 GWNF included brook trout as a Management Indicator Species (MIS) for cold water stream habitat, the centrarchid family for warmwater/lake habitat, and the James spinymussel as a T&E species. The trends for these aquatic species on the Forest are discussed below. Occurrences of other FS sensitive species or locally rare species are discussed elsewhere in this report.

Trend: *Brook Trout* - As shown in Figure 7 below, populations of brook trout tend to fluctuate greatly over time. These findings do not necessarily suggest negative impacts to those streams from management activities, but rather that trout numbers are often highly variable due to natural occurrences (drought, floods, high temperatures, etc). As documented in Appendix G of the annual M&E reports, timber harvesting and other management activities did not significantly decrease habitat or populations of brook trout. Furthermore, some management activities, such as stream liming and habitat restoration, were specifically designed to improve brook trout habitat and increase their populations. Because of ecological and recreational interest in this species, we recommend wild brook trout as a MIS in the revised Forest Plan. Additional discussion of brook trout is in Section 3.4 under Temperature Change Species group.

Figure 7. Brook Trout Biomass on Selected GWNF streams.



*Not all streams were surveyed every year. For those years without a survey, an average was added to the data table in order to draw a continuous trend line.

Centrarchid (Sunfish) Family - As documented in Appendix G of the annual M&E reports, Forest Service activities, such as the creation of structures in reservoirs, are beneficial to members of the sunfish family. However, even though the addition and maintenance of underwater structures in Forest reservoirs is necessary for healthy self-sustaining warm water fish populations, these populations are heavily manipulated through fishing regulations and harvest pressure (Noble 2002; Quinn 2002; Spotte 2007; Swennson 2002; Wilson and Dicenzo 2002). Reservoirs are not a natural system, supporting native fish communities. Because of this, we recommend that the Forest continue to work with State agencies to monitor warm water fish and enhance habitat on the Forest land, but not include the sunfish family as a MIS in the revised Forest Plan.

James spinymussel - As documented in Appendix G of the annual M&E reports, several new occurrences of the James spinymussel were located from surveys conducted on streams in Bath County in 2000-2004. The James spinymussel does occur in watersheds that contain NFS land and occurs both upstream and downstream from the Forest. Current Forest management provides for water quantity and quality that contributes to the persistence of mussel populations.

Overall, viability remains a concern for the James spinymussel on the GWNF, yet management has little ability to affect its overall viability. Factors outside the authority of this agency affect the viability of the James spinymussel.

The Forest is currently working with the US Fish and Wildlife Service and VDGIF to locate James spinymussel populations on National Forest and habitat suitable for augmentation. This Federally endangered species should be considered in the revised Plan.

Aquatic Organism Passage (AOP)

Current Condition: Recent National and Regional attention has focused on the issue of aquatic organism passage. Land managers recognized that instream barriers can prevent migration, dispersal, and colonization, leading to genetic isolation and possible extirpation. Specifically, culverts, where roads cross streams, can be barriers to fish or other aquatic organisms (Gibson et al. 2005, Verry 2000).

Forest Service researchers used the 'National Inventory and Assessment Procedure for Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings' developed by the USFS San Dimas Technology and Development Center to assess road stream crossings on the Forest. On the GWNF, over 500 stream-road crossing surveys were conducted between 2003 and 2006. The majority of crossings (i.e. culverts or low-water fords) were not passable for all fish types (strong, moderate, or weak swimmers and leapers). This inventory can be used to identify barriers to aquatic passage and prioritize them for replacement/repair based on maximum benefit to aquatic organisms or habitat.

Streams where bottomless arch culverts were installed at road crossings to improve aquatic organism passage on the GWNF include:

- Laurel Run and Hunkerson Gap on the Lee District
- Pitts Spring Run and Roaring Run on the Lee District
- Middle River and Slatelick on the North River District
- Mill Creek on the Pedlar District
- Little Irish Creek on the Pedlar District.

Trend: Culverts are being replaced/repaired with designs that allow for AOP where appropriate. Likewise, new road crossings are designed to allow for AOP when it is desirable (does not provide a pathway for invasive species). AOP is increasing across the Forest.

Watershed Health

Benthic macroinvertebrates

Current Condition: Benthic macroinvertebrates are organisms that live in or on the bottom substrates of rivers, streams, or other waterbodies. These organisms are primarily insect larvae, but also include worms, crustaceans and mollusks. The use of macroinvertebrates has proven to be a reliable monitoring tool, as they are sensitive to changes in aquatic habitat and water quality, which in turn reflects the overall health of the watershed. Benthic macroinvertebrates are included as a monitoring item in the current GW Forest Plan, and have been monitored on the GWNF since 1993.

Sample sites were selected downstream of management activity areas to monitor the impacts on stream health of projects including but not limited to timber sales and prescribed burns. Other samples were collected to create a baseline of stream conditions within the forest. Across the Forest, 728 samples were collected, analyzed and assigned an overall MAIS (Macroinvertebrate Aggregated Index for Streams) score. The MAIS incorporates nine metrics to evaluate the current condition of a stream relative to others within the ecological unit. It ranges from 0 to 18. Less than 6 is very poor, between 7 and 12 is poor/fair, between 13 and 16 is good, and between 17 and 18 is very good.

Of these samples, 84% were in the “good” and “very good” categories.

Trend: Trends for aquatic macroinvertebrates have been fully documented in Chapter 2 (Management Area 18) of the annual M&E reports since the 1997-1998 report.

A paired t-test was used to compare the MAIS scores of 18 streams before and after timber harvests that occurred at various locations across the Forest. Only samples collected from March through the first week in June were compared to minimize seasonal variability in structure of macroinvertebrate communities. There was no significant difference between the pre and post timber harvest MAIS scores; both the pre and post mean scores were in the “Good” category (See Table 6 below).

Table 6. Paired samples t-test on pre and post MAIS scores from 18 different timber sales

Mean MAIS pre	16
Mean MAIS post	15
95% CI	-0.365 to 2.365
P value	0.140

A paired t-test was used to compare the MAIS scores of 7 streams before and after prescribed burn that occurred at various locations across the Forest. There was no significant difference between the pre and post prescribed burn MAIS scores; both the pre and post mean scores were in the "Good" category (see Table 7 below).

Table 7. Paired samples t-test on pre and post MAIS scores from 7 different prescribed burns

Mean MAIS pre	16
Mean MAIS post	16
95% CI	-1.098 to 1.669
P value	0.631

Invasive Species – several examples

Current Condition: *Adelges tsugae* (Hemlock woolly adelgid) - The Hemlock woolly adelgid, is native to Asia and was first introduced to North America in British Columbia in the 1920's and was later discovered in the Shenandoah Mountains of Virginia in the 1950's. Adelgids feed by sucking sap from hemlock twigs and when they reach very high densities they can cause dieback and mortality of their hosts. In the eastern US, the adelgid's principal host is eastern hemlock, *Tsuga Canadensis*, a tree typically associated with streams and riparian areas. Heavy infestations have killed trees in as little as four years, but some trees have survived infestations for more than 10 years.

Currently, hemlock woolly adelgid has only invaded part of the range of eastern hemlock in the United States and Canada. On average, the insect has spread about 15-20 miles per year. Wind, birds, animals, and accidental movement by people cause this rapid spread. In Asia, the insect is found in very cold climates. Thus, it is likely to colonize most or all of the range of the eastern hemlock species. Eastern hemlocks contribute to stream habitat by providing dense shade in the summer and thermal control in the winter. The wood of the hemlock decays relatively slowly and can contribute long-lasting LWD and to the stream's overall stability.

Forest inventories list 1,092 acres of hemlock stands on the GWNF. Another 5,584 acres are listed as hemlock-hardwood, meaning that they are greater than 70% hemlock. The GWNF sprays individual trees or injects the soil with a systemic insecticide within recreation areas to protect them from the adelgid. At this time it is not economically or technically feasible to treat large stands of hemlock within the forest.

Trend: It is expected that there will be a large increase in LWD to streams with hemlocks in their riparian corridor. In addition, for those streams with a significant

portion of the riparian forest in hemlock, summer temperatures may increase with the loss of streamside shading.

Current Condition: *Didymosphenia geminata* (Didymo) – Didymo is a freshwater diatom (type of alga) that historically was only found in pristine lakes and streams of northern latitudes. Its range is now expanding in North America to include lower elevation clear, cool streams. It can form massive blooms on the bottoms of streams and rivers where it attaches itself to the streambed by stalks. These stalks can form a thick brown mat that smothers rocks, submerged plants and other materials. Established mats form flowing streamers that can turn white at their ends and look similar to tissue paper. Although the alga appears slimy, it feels like wet cotton wool. Didymo was found in the Jackson River and Smith River tailwaters in Virginia in spring of 2006, the Pound River tailwater in 2007, and Dan River in 2008. Information sheets were posted at Forest Service angler access points along the Jackson River to inform anglers and instruct them on how to prevent the spread of this invasive species. The Smith and Dan Rivers are not on or near National Forest land.

Trend: Didymo colonization was monitored monthly over a 12 month period at a single transect in the Jackson River downstream of Gathright Dam to observe its growth over time. In 2008, didymo density steadily increased from February – April, peaked in May - June, then rapidly declined in the period from July – October. Transect scores were plotted against discharge, water temperature, and depth to evaluate relationships between alga density and non-biological factors. Positive, but weak, relationships were determined with all three criteria, but the strongest was between transect score and discharge. Biological response to didymo infestation was also examined by electrofishing and benthic macroivertebrate monitoring before and after 2006. Post-infestation catch rates for wild rainbow trout (*Onchorhynchus mykiss*) in the Gathright Dam area were not significantly different than historic values ($t_{0.05, 5} = 0.949$). Stream metrics calculated for macroinvertebrates from the Gathright Dam area in 2007-08 showed a decline in ecological health from 1992-93 samples. Results from this preliminary investigation indicated that didymo infestation has had a variable impact on aquatic fauna in one reach of the Jackson River Tailwater.

2.6 – Plan Components for Ecosystem Diversity

The 1993 GWNF Plan went a long way in providing sound direction for managing aquatic resources. Aquatic and riparian Desired Future Conditions (DFCs) were allocated to riparian ecosystems associated with ponds, lakes, and perennial streams. These areas were managed to restore, maintain, and/or enhance the inherent ecological processes and functions of the associated aquatic and riparian communities as described by the DFC for Management Area 18. Management did focus on providing habitat for species that depend on riparian resources for at least a part of their life-cycle. Yet, some more can be done. The GWNF Plan revision effort should recognize and address the following:

1. Recognize riparian values other than, and in addition to, aquatic resources and buffering streams from other management practices;
2. Recognize the important role of intermittent and channeled ephemeral headwater streams in maintaining water quality and quantity, recycling nutrients, and providing habitat for plants and animals. It is appropriate to provide management direction for the areas around not only perennial stream channels, but also intermittent and channeled ephemeral streams;
3. The Forest also developed a Federally Listed Fish and Mussel Conservation Plan cooperatively with the USFWS and state partners. The intent was to provide pro-active and consistent management direction for watersheds that contained T&E fish and mussels. The USFWS Fish and Mussel Conservation Strategy needs to be incorporated into the revised plan as guidelines for site-specific projects;
4. Address a new issue over aquatic organism passage; and
5. Address whether grazing should continue within riparian areas as a suitable use.

Aquatic and riparian Desired Future Conditions (DFCs) should be allocated to all riparian areas across the George Washington National Forest. Riparian corridors should be managed to restore, maintain, and/or enhance the inherent ecological processes and functions of the associated aquatic and riparian communities as described by the DFC. Management should focus on providing habitat for species that depend on riparian resources for at least a part of their life-cycle. The following Plan Components should be carried forward from the 1993 Plan or developed to address either a Key Factor in maintaining Aquatic Ecological integrity, or a disturbance process. These plan components were developed from previous Forest Plans, state Best Management Practices, and current research. They are building on the approach that was used in the 1993 Plan, an approach that was successful in maintaining aquatic integrity as documented by the monitoring and evaluation reports.

PHYSICAL INTEGRITY

Goal 1 Watershed

Manage watersheds to maintain or restore resilient and stable conditions to support the quality and quantity of water necessary to protect ecological functions and support beneficial water uses. Channeled ephemeral streams maintain the ability of the land to filter sediment from upslope disturbances and to provide forest material as nutrient input while achieving the Desired Conditions of the adjacent management prescription area. (Corresponding standards: 002, 007, 008, 013, 014, 015, 016, 019, 020, 021, 022, 029, 030, 031)

Goal 2 Sediment Regime

Restore and maintain the sediment regime under which the aquatic system evolved. Sediment regime elements include the timing, volume, rate, and character of sediment input, storage, and transport. Maintain sedimentation

rates that are in dynamic equilibrium with the watershed, and stabilize or improve the biological condition of the stream. (Corresponding standards: 001, 002, 005, 006, 012, 013, 014, 015, 017, 018, 019, 020, 021, 022, 023, 024, 025, 026, 028, 029, 030, 031, 032, 033, 034, 035, 036, 037, 038, 043)

Objective 2.01 Streams are managed in a manner that results in sedimentation rates that stabilize or improve the biological condition category of the stream as monitored using aquatic macroinvertebrates.

Goal 3 Instream Flow

Instream flows (or lake levels) provide the amounts necessary to: 1) maintain the capacity of the channels to transport water and sediment; 2) protect aquatic organisms and provide habitat for all life history stages and migration; 3) transport nutrients; and 4) sustain or restore riparian habitats and communities. (Corresponding standards: 008, 023, 024, 025, 027, 042)

Goal 4 Connectivity

Maintain and restore spatial and temporal connectivity within and among stream segments and watersheds. Maintain physically unobstructed routes to areas that fulfill critical life history requirements of aquatic and riparian-dependent species; and prevent further human caused fragmentation of aquatic habitats. (Corresponding standards: 023, 027, 043, 044)

Goal 5 Riparian - Aquatics

Restore and maintain native species composition and the structural diversity of plant communities in riparian zones and wetlands to provide adequate thermal regulation, nutrient filtering, appropriate rate of surface and bank erosion, and sufficient amount and distributions of large wood to sustain physical habitat complexity and stability. Riparian areas will contain a minimum amount of exposed mineral Soil and effective mitigation measures will be taken where surface disturbances or modifications concentrate runoff, accelerate Soil erosion, or transport sediment to stream channels. Management will focus on restoring and/or maintaining riparian-dependent plant and animal species. (Corresponding standards: 003, 004, 009, 010, 011, 043)

Objective 5.01 Streamsides are managed in a manner that restores and maintains amounts of large woody debris (LWD) sufficient to maintain habitat diversity for aquatic and riparian species (approximately 200 pieces per stream mile).

Goal 6 Riparian - Terrestrial

Restore and maintain taxonomically diverse vegetation (both living and dead) with both horizontal and vertical structural diversity consisting of distinct

vegetation layers from the water surface to the canopy top. Riparian diversity can be enhanced by habitat differences along the length of the ecosystem. Rehabilitation of past and future impacts (both natural and human-caused) may be necessary to protect resource value and facilitate recovery of riparian structure and functions. Geomorphic and Soil bioengineering, vegetation management, and other rehabilitation techniques should follow ecological principals and emphasize recovery of the diversity and complexity of native vegetative communities. (Corresponding standards: 005, 009, 010, 011)

CHEMICAL INTEGRITY

Goal 7 Water Quality

Maintain or exceed State water quality standards for aquatic biodiversity and beneficial downstream uses. Maintain and restore water quality necessary to support healthy riparian, aquatic and wetland ecosystems. (Corresponding standards: 018, 035, 039, 040, 045, 046, 047, 048)

Objective 7.01 Streams are managed in a manner that ensures water quality remains in the range that ensures survival, growth, reproduction, and migration of individual aquatic and riparian-dependent species and individual organisms.

BIOLOGICAL INTEGRITY

Goal 8 Aquatic Biodiversity

Manage aquatic habitats to maintain or restore native aquatic biodiversity. Streams and other aquatic habitats should foster the species composition, diversity, and functional organization that is common and comparable to natural habitat. Exceptions can be made for desired, non-native sport fish species, especially in modified habitats such as reservoirs. (Corresponding standards: 041, 043, 044, 045, 046, 047, 048)

STANDARDS (The Goals that are addressed by that guideline are listed in parentheses at the end.) The Plan should adopt the Jefferson Forest Plan Riparian Corridor and Forest-wide Channeled Ephemeral standards (consistent with the Federally Listed Fish and Mussel Conservation Plan).

001 Any human caused disturbances or modifications that may concentrate runoff, erode the Soil, or transport sediment to the channel or water body are rehabilitated or mitigated to reduce or eliminate impacts. Channel stability of streams is protected during management activities. (Goal 2)

002 Motorized vehicles are restricted to designated crossings. Motorized vehicles may be allowed on a case-by-case basis, after site-specific analysis, outside of designated crossings where it can be shown to benefit riparian resources. (Goal 1, Goal 2)

003 The removal of large woody debris (pieces greater than 4 feet long and 4 inches in diameter on the small end) is allowed if it poses a risk to water

quality, degrades habitat for aquatic or riparian wildlife species, impedes water recreation (e.g. rafting) or when it poses a threat to private property or Forest Service infrastructure (e.g., bridges). The need for removal must be determined on a case-by-case basis. (Goal 5)

004 The addition of large woody debris for stream habitat diversity will generally favor stream reaches with an average bank full width of less than 30 feet in Rosgen B channel types. Log length will generally be 50% greater than bank full width. In stream reaches where there may be potential debris impacts to downstream private or public infrastructure (e.g., bridges) or to water-based recreation (e.g. rafting), the active recruitment (placement) of large woody debris will be limited in quantity and scope. (Goal 5)

005 Existing permanent wildlife openings may be maintained within the riparian corridor. However, permanent wildlife openings identified as causing environmental degradation through concentrated runoff, Soil erosion, sediment transport to the channel or water body are mitigated or closed and restored. New permanent wildlife openings within the riparian corridor are permitted where needed to provide habitat for riparian species, or threatened, endangered, sensitive, and locally rare species. (Goal 2, Goal 6)

006 Use no-till mechanical cultivation methods for maintenance of wildlife openings. (Goal 2)

007 Management actions that may negatively alter the hydrologic conditions of wetland rare communities are prohibited. Such actions may include livestock grazing and construction of roads, plowed or bladed firelines, and impoundments in or near these communities. (Goal 1)

008 Allow beaver pond complexes to develop naturally where not impacting developed recreation sites or open system roads. (Goal 1, Goal 3)

009 Insect and disease control measures will be determined on the basis of risk to adjacent resources, long-term sustainability, and appropriate needs for the function and condition of the riparian area. Cut and leave is the preferred method for control and suppression of insects and disease in the core of the riparian corridor. Cut and remove is permitted in the extended area beyond the core. Other control measures may be used when a condition poses a risk to stream stability, degrades water quality, adversely affects habitat for aquatic or riparian species, poses a threat to public safety or facilities, or when “cut and leave” is not effective. (Goal 5, Goal 6)

010 Tree removals from the core of the riparian corridor may only take place if needed to:

- Enhance the recovery of the diversity and complexity of vegetation native to the site;
- Rehabilitate both natural and human-caused disturbances;
- Provide habitat improvements for aquatic or riparian species, or threatened, endangered, sensitive, and locally rare species;

- Reduce fuel buildup;
- Provide for public safety;
- For approved facility construction/renovation (Goal 5, Goal 6)

011 Permitted firewood cutting within the riparian corridor must take into consideration large woody debris needs. Ranger Districts will identify areas where firewood cutting is not permitted due to large woody debris concerns. (Goal 5, Goal 6)

012 Construction of firelines with heavy mechanized equipment (e.g. bulldozers) in riparian corridors is prohibited. Hand lines, wet lines, or black lines are used to create firelines within the riparian corridor to minimize Soil disturbance. Water diversions are used to keep sediment out of streams. Firelines are not constructed in stream channels, but streams may be used as firelines. (Goal 2)

013 New trails will normally be located outside of the riparian corridor except at designated crossings or where the trail location requires some encroachment (e.g. to accommodate stream crossings in steep terrain, etc.), or to manage access to water bodies. (Goal 1, Goal 2)

014 New motorized trails are prohibited within the riparian corridor except at designated crossings or where the trail location requires some encroachment; for example, to accommodate steep terrain. When existing OHV trails within riparian corridor are causing unacceptable resource damage, appropriate mitigation measures (which may include OHV trail closure) will be implemented. (Goal 1, Goal 2)

015 Proposed recreation facilities will be located outside of the riparian corridor or 100-year floodplain (Executive Order 11988) and wetlands (Executive Order 11990) unless no practicable alternative location exists. Where future facilities cannot be located out of the 100-year floodplain, structural mitigation and best management practices will be used. Trails, campsites, and other recreational developments are located, constructed, and maintained to minimize impacts to channel banks and other resources. When existing facilities are causing unacceptable resource damage appropriate mitigation measures will be implemented. Soils are stabilized on eroding trails and recreational sites. (Goal 1, Goal 2)

016 Where grazing is currently allowed and under a permit, grazing is controlled and mitigated to restore, maintain or enhance the integrity of stream channels and banks and prevent unacceptable resource damage. Reauthorizing grazing in riparian corridors within these existing allotments may occur if continued grazing would have no unacceptable resource damage on riparian resources. New grazing allotments or new permits for inactive allotments will exclude the riparian corridor. (Goal 1)

017 Where authorized by permit, livestock watering areas, stream crossings, and stream banks are managed to maintain bank stability. Designated entry

points, crossings, and watering points are located, sized, and maintained to minimize the impact to riparian vegetation and function. (Goal 2)

018 Feeding troughs and salt and mineral blocks are not allowed inside the riparian corridor unless the entire pasture is within the riparian corridor, in which case they are located as far away from streams as possible. Watering troughs are appropriately located to protect the streams. (Goal 2, Goal 7)

019 New roads are located outside the riparian corridor except at designated crossings or where the road location requires some encroachment; for example to accommodate steep terrain, or are allowed within the corridor if the road will cause more resource damage if it were located outside the corridor. When existing roads within riparian corridor are causing unacceptable resource damage, appropriate mitigation measures will be implemented. (Goal 1, Goal 2)

020 In-stream use of heavy equipment or other in-stream disturbance activities is limited to the amount of time necessary for completion of the project. Construction of crossings is completed on all streams as soon as possible after work has started on the crossing. Permanent and temporary roads on either side of stream crossings within the riparian corridor are graveled. (Goal 1, Goal 2)

021 When constructing roads, each road segment will be stabilized prior to starting another segment. Stream crossings will be stabilized before road construction proceeds beyond the crossing. (Goal 1, Goal 2)

022 To minimize the length of streamside disturbance, ensure that approach sections are aligned with the stream channel at as near a right angle as possible. Locate riparian corridor crossings to minimize the amount of fill material needed and minimize channel impacts. Generally, permanent structures or temporary bridges on permanent abutments are provided when developing new crossings on perennial streams. Permanent structures, temporary bridges or hardened fords are used when crossing intermittent streams. (Goal 1, Goal 2)

023 Design structures (culverts, bridges, etc.) to accommodate storm flows expected to occur while the structures will be in place. Use scientifically accepted methods for calculating expected storm flows. (Goal 2, Goal 3, Goal 4)

024 Design crossings so stream flow does not pond above the structure during normal flows in order to reduce sediment deposition immediately above the crossing and maintain the channel's ability to safely pass high flows. (Goal 2, Goal 3)

025 Design the crossing so that stream flow will not be diverted along the road if the structure fails, plugs with debris, or is over-topped. (Goal 2, Goal 3)

026 Fords associated with new road construction are not used in perennial streams without site-specific environmental analysis. Establish fords only under conditions that will not cause significant streambank erosion. Erosion stone

or larger rock is used to increase load bearing strength at the water/land interface. (Goal 2)

027 Riparian corridors are generally unsuitable for new human created stream channel impoundments, but may be considered on a project specific basis, consistent with appropriate Federal and state regulations. Impoundments will generally be designed to allow complete draining, with minimum flows, cold-water releases, and re-aeration in trout waters and other specific waters when needed. Downstream catch basins and fish ladders are constructed for fish salvage/passage, if necessary. New human-constructed impoundments are unsuitable on streams where federally listed species will be negatively affected. (Goal 3, Goal 4)

028 For activities not already covered in the above standards, ground disturbing activities are allowed within the corridor if the activity will cause more resource damage if it were located outside the corridor, on a case-by-case basis following site-specific analysis. Any activity allowed under these conditions is minimized and effective sediment trapping structures such as silt fences, brush barriers, hay bale barriers, gravelling, etc., are required. Sediment control, prior to, or simultaneous with, the ground disturbing activities, is provided. (Goal 2)

029 Within the channeled ephemeral zone, up to 50% of the basal area may be removed down to a minimum basal area of 50 square feet per acre. Removal of additional basal area is allowed on a case-by-case basis when needed to benefit riparian dependant resources. (Goal 1, Goal 2)

030 At least partial suspension is required when yarding logs over channeled ephemeral streams. (Goal 1, Goal 2)

031 The addition of large woody debris in channeled ephemeral reaches will primary be through passive recruitment rather than active placement. (Goal 1, Goal 2)

032 When crossing channeled ephemeral streams, culverts, temporary bridges, hardened fords, or corduroy are used where needed to protect channel or bank stability. (Goal 2)

033 New motorized trails are prohibited within the channeled ephemeral zone except at designated crossings or where the trail location requires some encroachment; for example, to accommodate steep terrain. (Goal 2)

034 Where grazing is currently allowed and under a permit, control and mitigate to restore, enhance, or maintain the integrity of channels and banks. Grazing permit reauthorization is allowed, provided progress towards mitigation of negative impacts on the channeled ephemeral zones has occurred. New grazing permits will be designed to prevent negative impacts to the channeled ephemeral zone. Livestock will be excluded from channeled ephemeral zones whenever the zone cannot be maintained or restored otherwise. (Goal 2)

035 Feeding troughs, watering troughs, and salt and mineral blocks are not allowed inside the channeled ephemeral zone. Watering troughs are appropriately located to protect the streams. (Goal 2, Goal 7)

036 During prescribed fire operations in the channeled ephemeral zone, use the least ground disturbing method of fireline construction, favor blacklines and handtools. (Goal 2)

037 Do not disk, blade, or plow fireline within the ephemeral stream channels, use them as natural firebreaks (This applies to the actual stream channel, not the entire 25 foot zone). (Goal 2)

038 Revegetate and water bar firelines as quickly as possible, where necessary to prevent erosion. Use water diversions to keep sediment out of channels. (Goal 2)

039 Restoration of chemical integrity of aquatic ecosystems (from impacts such as acid deposition and acid mine drainage) is allowed on a site-specific basis for protection or for restoration of aquatic species. (Goal 7)

040 Fire retardants should not be applied directly over open water. (Goal 7)

041 Stocking of new non-native species and stocking of previously unstocked areas is not allowed where it will negatively impact native aquatic species or communities. Prior to any stocking, national forests coordinate with the appropriate State and Federal agencies to ensure that populations and habitats of native species are maintained. (Goal 8)

042 Instances where the flow regime is modified for other purposes (such as reservoir releases for recreational sports or hydroelectric demand), evaluate instream flow needs in accordance with the national strategy for water rights and instream flows. (Goal 3)

043 In-stream habitat improvements and stream-connected disturbance will be designed and implemented after consideration of the life-cycle requirements of aquatic species. (Goal 2, Goal 4, Goal 5, Goal 8)

044 All new stream crossings will be constructed to allow the passage of aquatic organisms, and maintain natural flow regime. Exceptions may be allowed in order to prevent the upstream migration of undesired species. (Goal 4, Goal 8)

045 Insecticides known to have adverse impact on aquatic ecosystems are not applied within 200 feet of perennial or intermittent streams, or open bodies of water. (Goal 7, Goal 8)

046 No herbicide is broadcast on rock outcrops or sinkholes. No Soil-active herbicide with a half-life longer than 3 months is broadcast on slopes over 45 percent, erodible Soils, or aquifer recharge zones. Such areas are clearly marked before treatment so applicators can easily see and avoid them. (Goal 7, Goal 8)

047 No herbicide is aerially applied within 200 horizontal feet, nor ground-applied within 30 horizontal feet of lake, wetlands, perennial or intermittent springs and streams. No herbicide is applied within 100 horizontal feet of any public or domestic water source. Selective treatments (which require added site-specific analysis and use of aquatic-labeled pesticides may occur within these buffers only to prevent significant environmental damage such as noxious week infestations. Buffers are clearly marked before treatment, so applicators can easily see and avoid them. (Goal 7, Goal 8)

048 Pesticide mixing, loading, or cleaning areas in the field are not located within 200 feet of open water or wells, or other sensitive areas. (Goal 7, Goal 8)

3. – Species Diversity

3.1 – Ecosystem Context for Species

The second purpose of this sustainability analysis was to provide a dataset that can be used to describe species-habitat associations for specific federally listed species, other locally rare species, and species of management concern. All aquatic species are contained in the habitats described above, and the Forest Plan components are to be designed to maintain the key characteristics that are necessary to sustain aquatic habitat.

A determination was made regarding how much of a particular habitat is on the GWNF, and whether or not it currently supports the associated species. This level of classification does not capture finer scale habitat attributes (i.e. pool/riffle composition depth, specific substrate composition, etc.) that may be important to refine the predictive habitat maps. However, it is useful in determining general patterns in species distributions, and may indicate areas to survey for a species, or areas in which to promote habitat restoration and private land conservation measures. In addition, since each species is associated with a particular habitat, the Forest Plan components designed to maintain key characteristics of that particular habitat can be tracked. From this documented review, recommendations may be forthcoming to the Forest Supervisor on whether additional aquatic species-specific plan components may be necessary.

3.2 – Identification and Screening of Species

Three categories of species were identified for consideration in planning:

- Species that are federally listed as T&E under the Endangered Species Act (ESA).
- Species for which management actions may be necessary to prevent listing under the ESA.
- Species for which management actions may be necessary to achieve ecological or other multiple-use objectives. They may be species for which there are local concerns resulting from declines in habitat, population, and/or distribution, species that are of high public interest, or species such as invasives for which control measures may be desirable.

Only species whose ranges overlap the GWNF proclamation boundary were considered.

A comprehensive list of species of potential viability concern was compiled for the GWNF that include those species found, or potentially found, on the GWNF that are (a) listed as proposed, threatened, or endangered under the federal Endangered Species Act, (b) listed on the regional Forester's Sensitive Species list, (c) identified as locally rare on the National Forest within the ecoregion by Forest Service biologists, or (d) included in either the Virginia or West Virginia Wildlife Action Plans. Each species was assessed according to the criteria below and then placed into the appropriate category, or dropped from further consideration (see Appendix 6 for a list of species dropped from further consideration).

3.2a – Federally Listed Species

The Forest worked cooperatively with the U.S. Fish and Wildlife Service to determine the list of threatened or endangered species appropriate to address in this Forest Plan Revision.

There are four aquatic species listed by the Department of Interior, U.S. Fish and Wildlife Service as threatened or endangered that have been documented on GWNF (see Table 8 for a summary of habitat on the GWNF). A more detailed habitat description for these species is found in Appendix 2.

Table 8. Federally Threatened or Endangered Aquatic Species on the GWNF.

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
mussel	*Pleurobema collina*	James spinymussel	G1	S1	S1	FE	312, 313, 415, 513		14.3 mi
plant	*Helenium virginicum*	Virginia sneezeweed	G3	S2		FT		EHW, PNCS, WW	4.0 ac
plant	*Helonias bullata*	swamp pink	G3	S2S3		FT	111, 121, 123, 211, 221		7.3 mi
plant	*Scirpus ancistrochaetus*	northeastern bulrush	G3	S2	S1	FE		WW, PNCS	1.1 ac

Despite extensive searches, no occurrences of the spinymussel have been located on the GWNF (Watson 2010). The 14 miles of potential habitat modeled for this species (Table 8) assumes all of the river mileage is suitable substrate, which is not probable; in all of the watersheds with spinymussels near the GWNF, the occurrences are all on private land (Appendix 5, Table 3). The direct importance of Forest lands to spinymussel habitat from a global and eco-regional perspective is very limited. However, the Forest contributes indirectly by providing good water quality to downstream spinymussel habitat. In addition, the several isolated reaches of habitat on the Forest could provide sites for augmentation if the substrate was suitable, and thus become locally important.

The Virginia sneezeweed is found only in Virginia and Missouri. Although there is only approximately four acres of habitat on the GWNF (Table 8), one of the two 5th level HUC watersheds in Virginia where this plant is found includes occurrences on the GWNF (Appendix 5, Table 3). The Forest is important to this species at a global, eco-regional, and local level.

Both swamp pink and northeastern bulrush are found in a total of 8 states, thus, the GWNF is moderately important at a global scale. There are occurrences on both private and Forest land (Appendix 5, Table 3). For swamp pink, much of the in-tact habitat in Virginia is on the GWNF, therefore, at the eco-regional and local level, the Forest is very important. For the bulrush, there are only a few acres of habitat on the GWNF, but the Forest is still important at the eco-regional and local level. More information on the threats and importance of Forest land to these plant species can be found in the Terrestrial Ecological Sustainability Analysis.

3.2b – Other at Risk Species and Species of Management Concern

Criteria for identifying other species to be addressed are as follows:

- Species identified as proposed and candidate species under ESA.
- Species ranked G-1, G-2 and G-3 by NatureServe.
- Subspecific taxa ranked T-1, T-2 and T-3 by NatureServe.
- Species that have been petitioned for federal listing and for which a positive "90-day finding" has been made.
- Species that have been recently delisted including those delisted within the past five years and other delisted species for which regulatory agency monitoring is still considered necessary.
- Species with ranks of S-1, S-2, N-1 or N-2 on the NatureServe ranking system.
- State listed threatened and endangered species.
- Species identified as species of conservation concern in State Comprehensive Wildlife Strategies.
- Species on the U.S. Fish & Wildlife Service Birds of Conservation Concern National Priority List.
- Additional species that may be of regional or local conservation concern due to:
    - Significant threats to populations or habitat
    - Declining trends in populations or habitat
    - Rarity
    - Restricted ranges (e.g., narrow endemics, disjunct populations, species at the edge of their ranges)
- Species hunted or fished.
- Other species of public interest.
- Invasive or other species for which control measures are needed.

One hundred thirty-two aquatic species that occur on the GWNF have been identified for further consideration in the planning process (see Tables 9 & 10 for a summary of these species by habitat on the GWNF). A more detailed habitat description for most of the faunal species is found in Appendix 2.

Table 9. Aquatic At-Risk Species Addressed on the GWNF.

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
fish	*Notropis semperasper*	Roughhead shiner	G2G3	S2S3	_	S	413, 423, 512, 513, 123		73.7 mi
fish	*Noturus gilberti*	Orangefin madtom	G2	S2	_	S	512, 513		6.5 mi
insect	*Hydraena maureenae*	Maureen's shale stream beetle	G1G3	S1S3	_	S	113		150.9 mi
insect	*Cicindela ancocisconensis*	Appalachian tiger beetle	G3	S2	S3	S	513		6.20 mi
mammal	*Sorex palustris punctulatus*	southern water shrew	G5T3	S1S2	S1	S	121, 221, 321, 411, 421		13.5 mi
mussel	*Alasmidonta varicosa*	Brook floater	G3	S1	S1	S	513		1.3 mi
mussel	*Elliptio lanceolata*	Yellow lance	G2G3	S2S3	_	S	512, 513		30.8 mi
mussel	*Fusconaia masoni*	Atlantic pigtoe	G2	S2	_	S	313		0.2 mi
mussel	*Lasmigona subviridis*	Green floater	G3	S2	S2	S	415, 513		21.9 mi
bird	*Haliaeetus leucocephalus*	Bald eagle	G5	S23B/S3N	S2B/S3N	S			Riparian
plant	*Boltonia montana*	Doll's daisy	G1G2	S1	_	S			Riparian
plant	*Iliamna remota*	Kankakee globe-mallow	G1Q	S1	_	S			Riparian
plant	*Isoetes virginica*	Virginia quillwort	G1Q	S1?	_	S			Riparian
plant	*Peltigera hydrothyria*	waterfan	G3G5	S1	_	S	113, 114, 121, 124, 221		515.0 mi
plant	*Poa paludigena*	bog bluegrass	G3	S2	S1	S			Riparian
plant	*Potamogeton hillii*	Hill's pondweed	G3	S1	_	S			Riparian
plant	*Potamogeton tennesseensis*	Tennessee pondweed	G2	S1	S2	S			Riparian
plant	*Sida hermaphrodita*	Virginia mallow	G3	S1	S2	S			Riparian
plant	*Vitis rupestris*	sand grape	G3	S1?	S2	S			Riparian

Both the roughhead shiner and Maureen's shale stream beetle are endemic to Virginia. They are found both on Forest land and private land (Appendix 5, Table 3). The GWNF not only provides some habitat directly, but indirectly contributes by providing good water quality to downstream habitat. The Forest is important to these species at the global, eco-regional, and local level.

The orangefin madtom is known only from Virginia and North Carolina. There are no documented occurrences of orangefin madtoms on the GWNF (Appendix 5, Table 3), and only 6.5 miles of potential habitat (Table 9). Therefore, the direct importance of Forest lands to orangefin madtom habitat from a global and eco-regional perspective is very

limited. However, the Forest contributes indirectly by providing good water quality to the downstream madtom habitat, and thus could be locally important.

The Appalachian tiger beetle is known from 15 states and Quebec. It is found on both Forest and private land (Appendix 5, Table 3) in Virginia, but there are only 6.2 miles of potential habitat on the GWNF (Table 9). The direct importance of Forest lands to Appalachian tiger beetle habitat from a global and eco-regional perspective is very limited. However, the Forest contributes indirectly by providing good water quality to the downstream tiger beetle habitat, and thus could be locally important.

The southern water shrew is found in six states; in Virginia it is found in two watersheds, on both Forest and private land (Appendix 5, Table 3). With only about 13 miles of potential habitat on the Forest (Table 9), the direct importance of Forest lands to southern water shrew habitat from a global and eco-regional perspective is moderate. However, the Forest is very important to this species at a local level.

There are no documented occurrences of the four FS Sensitive mussel species on the GWNF (Appendix 5, Table 3), with potential habitat ranging from less than a mile for the Atlantic pigtoe to approximately 31 miles for the yellow lance (Table 9). Therefore, the direct importance of Forest lands to these mussel species from a global and eco-regional perspective is very limited. However, the Forest contributes indirectly by providing good water quality to the downstream mussel habitat, and thus could be locally important.

Information on the importance of Forest land to FS Sensitive plant and bird species can be found in the Terrestrial Ecological Sustainability Analysis.

Table 10. Aquatic Species of Management Concern Addressed on the GWNF. Under Status, LR= locally rare, SMC=species of management concern, and MIS=Management Indicator Species.

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
amphib	*Ambystoma tigrinum*	eastern tiger salamander	G5	S1		LR		WW, PNCS, EHW	39.1 ac
bird	*Anas rubripes*	Amer. black duck	G5	S4	S2B/S4N	LR	511,512,513	WW	36.6 mi & 185.7 ac
bird	*Empidonax alnorum*	alder flycatcher	G5	S1B	S3B/S4N	LR		WW	185.7 ac
bird	*Emidonax virescens*	Acadian flycatcher	G5	S5	S5B	MIS			Riparian
bird	*Melospiza georgiana*	swamp sparrow	G5	S1B/S4S5N	S3B/S4N	LR		EHW	85.0 ac
bird	*Nycticorax nycticorax*	black-crowned night-heron	G5	S3B/S4N	SHB	LR	511,512,513	WW	36.6 mi & 185.7 ac
bird	*Nyctanassa violacea*	yellow-crowned night-heron	G5	S2S3B/S3N	S1N	LR	511,512,513	WW	36.6 mi & 185.7 ac
bird	*Seiurus noveboracensis*	northern waterthrush	G5	S1B	S2B	LR		WW, EHW	270.7 ac
crayfish	*Cambarus monongalensis*	A Crayfish	G5	S1?	S3	LR	121, 221, 321, 411, 421		17.6 mi
fish	*Anguilla rostrata*	American eel	G4	S5	S2	SMC	114, 115, 211, 212, 214, 215, 314, 411, 413, 415, 513		145.6 mi

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
fish	*Cottus cf. cognatus*	Checkered sculpin	G4Q	_	_	LR			Riparian
fish	*Salvelinus fontinalus*	Brook trout	G5	S4	S5	MIS	111, 112, 113, 114, 115, 121, 122, 123, 124, 211, 212, 213, 214, 215, 221, 223, 224, 311, 312, 321, 411, 413, 421, 512		1,119.9 mi
insect/ odonate	*Aeshna canadensis*	Canada darner	G5	S1	S1	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Aeshna tuberculifera*	black-tipped darner	G4	S2S3	S2	LR		WW, EHW, PCS, PNCS	89.4 ac
insect/ odonate	*Aeshna verticalis*	green-striped darner	G5	S1	S2	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Anax longipes*	comet darner	G5	S3	S1	LR		WW, EHW, PCS, PNCS	49.4 ac
insect/ odonate	*Calopteryx amata*	Superb jewelwing	G4	S1	-	LR	121, 221, 321, 411, 421		17.6 mi
insect/ odonate	*Calopteryx angustipennis*	Appalachian jewelwing	G4	S2	S2	LR	513		.09 mi
insect/ odonate	*Celithemis martha*	Martha's penant	G4	S2	_	LR		WW, EHW, PCS, PNCS, LCS	54.7 ac
insect/ odonate	*Cordulegaster diastatops*	delta-spotted spiketail	G5	S1	S2	LR	121		10.23 mi
insect/ odonate	*Enallagma annexum (AKA cyathigerum)*	northern bluet	G5	S1	S2	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Epitheca canis*	beaverpond baskettail	G5	S1	S1S2	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Gomphus adelphus*	mustached clubtail	G4	S1	S2	LR	413, 513		23.9 mi
insect/ odonate	*Gomphus quadricolor*	rapids clubtail	G3/G4	S2	S2S3	LR	413, 513		23.9 mi
insect/ odonate	*Ladona julia (AKA Libellula julia)*	chalk-fronted corporal skimmer	G5	S1	S2	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Lanthus parvulus*	double-striped clubtail	G4	S2	S2	LR	111, 112, 121, 122, 123		13.2 mi
insect/ odonate	*Lestes disjunctus*	northern spreadwing	G5	S2	S2S3	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Leucorrhinia hudsonica*	Hudsonian whiteface	G5	S1	S1	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Nehalennia irene*	sedge sprite	G5	S1	S3	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Neurocordulia yamaskanensis*	stygian shadowdragon	G5	S2	S2	LR	512, 513		34.5 mi
insect/ odonate	*Rhionaeschna mutata (AKA Aeshna mutata)*	spatterdock darner	G3G4	S2	S1	LR		WW, EHW, PCS, PNCS	49.4 ac
insect/ odonate	*Somatochlora elongata*	Ski-tipped emerald	G5	S1S2	S2	LR		EHW, PCS, PNCS	34.7 ac
insect/ odonate	*Sympetrum obtrusum*	white-faced meadowhawk	G5	S1	S2	LR		EHW, PCS, PNCS	34.7 ac
insect	*Autochton cellus*	Golden banded skipper	G5	S3	S1S2	LR			Riparian

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
insect	*Boloria selene*	Silver-bordered fritillary	G5	S2	S3	LR			Riparian
insect	*Colias interior*	Pink-edged sulphur	G5	S1S2	S2	LR			Riparian
insect	*Isonychia hoffmani*	Hoffman's Isonychia mayfly	G1/G3	S1	-	LR	121, 221, 321, 411, 421		17.6 mi
insect	*Nemotaulius hostilis*	a limnephilid caddisfly	G5	S1	SNR	LR		EHW, PCS, PNCS	34.7 ac
insect	*Speyeria atlantis*	Atlantis fritillary	G5	S2	S3	LR			Riparian
mammal	*Castor canadensis*	beaver	G5	S5	S5	SMC			Riparian
mammal	*Lontra canadensis*	River otter	G5	S4	S1	LR			Riparian
mussel	*Villosa constricta*	Notched Rainbow	G3	S3	_	LR	415, 512, 513		33.1 mi
reptile	*Clemmys guttata*	spotted turtle	G5	S4	S1	LR		EHW, PNCS	6.45 ac
reptile	*Glyptemys insculpta*	wood turtle	G4	S2	S2	LR	111, 112, 113, 123, 211, 212, 213, 221, 313, 311, 312, 411, 413, 412, 513		217.6 mi
plant	*Alnus incana ssp. rugosa*	speckled alder	G5T5	S2		LR			Riparian
plant	*Arethusa bulbosa*	Dragon's mouth	G4	S1		LR			Riparian
plant	*Aster radula*	rough-leaved aster	G5	S1		LR			Riparian
plant	*Bromus ciliatus*	fringed brome grass	G5	S1	S4	LR			Riparian
plant	*Calopogon tuberosus*	Grass pink	G5	S1	S2	LR			Riparian
plant	*Carex aquatilis*	water sedge	G5	S1	S1	LR			Riparian
plant	*Carex arctata*	Black sedge	G5	S1	S1	LR			Riparian
plant	*Carex barrattii*	Barratt's sedge	G4	S2	_	LR			Riparian
plant	*Carex buxbaumii*	Buxbaum's sedge	G5	S2	S2	LR			Riparian
plant	*Carex conoidea*	field sedge	G5	S1S2	S1	LR			Riparian
plant	*Carex cristatella*	crested sedge	G5	S2	S4	LR			Riparian
plant	*Carex interior*	inland sedge	G5	S1	S1	LR			Riparian
plant	*Carex lasiocarpa var. americana*	slender sedge	G5T5	S1	?	LR			Riparian
plant	*Carex schweinitzii*	Schweinitz's sedge	G3G4	S1	_	LR			Riparian
plant	*Carex vesicaria*	inflated sedge	G5	S1S2	S2	LR			Riparian
plant	*Cyperus dentatus*	toothed flatsedge	G4	S1	SNR	LR			Riparian
plant	*Cypripedium reginae*	showy lady's-slipper	G4	S1	S1	LR			Riparian
plant	*Echinodorus tenellus*	dwarf burhead	G5?	S1	_	LR			Riparian
plant	*Eleocharis compressa*	flattened spikerush	G4	S2	S2	LR			Riparian
plant	*Eleocharis melanocarpa*	black-fruited spikerush	G4	S2	_	LR			Riparian
plant	*Eleocharis robbinsii*	Robbins spikerush	G4G5	S1	_	LR			Riparian
plant	*Elymus canadensis*	nodding wild rye	G5	S2?	S5	LR			Riparian

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
plant	*Epilobium leptophyllum*	linear-leaved willow-herb	G5	S2	S3	LR			Riparian
plant	*Equisetum sylvaticum*	Woodland horsetail	G5	S1	S1	LR			Riparian
plant	*Eriocaulon aquaticum*	white buttons	G5	S1	_	LR			Riparian
plant	*Eupatorium maculatum*	spotted joe-pye weed	G5	S2	S1	LR			Riparian
plant	*Glyceria acutiflora*	sharp-scaled manna-grass	G5	S3	S2	LR			Riparian
plant	*Glyceria grandis*	American manna-grass	G5T?	S1	S1	LR			Riparian
plant	*Huperzia appalachiana*	Appalachian fir clubmoss	G4/G5	S2	_	LR			Riparian
plant	*Hypericum boreale*	northern St. John's-wort	G5	S2	SH	LR			Riparian
plant	*Hypericum ellipticum*	pale St. John's-wort	G5	SH	S4	LR			Riparian
plant	*Isoetes lacustris*	lake quillwort	G5	S1?	_	LR			Riparian
plant	*Juncus brachycephalus*	small-head rush	G5	S2	_	LR			Riparian
plant	*Juncus brevicaudatus*	narrow-panicled rush	G5	S2	S4	LR			Riparian
plant	*Lachnanthes caroliniana*	Carolina redroot	G4	SH	_	LR			Riparian
plant	*Liparis loeselii*	Loesel's twayblade	G5	S2	S2	LR			Riparian
plant	*Lycopodiella inundata*	northern bog clubmoss	G5	S1	S2?	LR			Riparian
plant	*Lythrum alatum*	winged loosestrife	G5	S2	S1	LR			Riparian
plant	*Muhlenbergia glomerata*	marsh muhly	G5	S2	SNR	LR			Riparian
plant	*Osmunda cinnamomea var. glandulosa*	glandular cinnamon fern	G5TNR	S1	SNR	LR			Riparian
plant	*Panicum hemitomon*	maidencane	G5?	S2	_	LR			Riparian
plant	*Parnassia grandiflora*	Large-leaved grass of parnassus	G3	S2	S1	LR			Riparian
plant	*Platanthera grandiflora*	large purple fringed orchid	G5	S1	S4	LR			Riparian
plant	*Platanthera peramoena*	purple fringeless orchis	G5	S2	S4	LR			Riparian
plant	*Poa palustris*	fowl bluegrass	G5	S1S2	S4	LR			Riparian
plant	*Polanisia dodecandra*	common clammy-weed	G5QT?	S2		LR			Riparian
plant	*Potamogeton amplifolius*	Large leaf pondweed	G5	S1S2	S4	LR			Riparian
plant	*Potamogeton oakesianus*	Oakes pondweed	G4	S2	SH	LR			Riparian
plant	*Ribes americanum*	Wild black currant	G5	S1?	S2	LR			Riparian
plant	*Sabatia campanulata*	slender marsh rose-pink	G5	S2	_	LR			Riparian
plant	*Sagittaria calycina var calycina*	long-lobed arrowhead	G5T5?	S1	SH	LR			Riparian
plant	*Sagittaria rigida*	sessile-fruited arrowhead	G5	S1	SNA	LR			Riparian
plant	*Schoenoplectus subterminalis*	water bulrush	G4G5	S1S2	_	LR			Riparian

Group	SCIENTIFIC NAME	COMMON NAME	G-RANK	S-RANK VA	S-RANK WV	STATUS	STREAM HABITAT	LAKE HABITAT	POTENTIAL HABITAT
plant	*Scirpus torreyi*	Torrey's bulrush	G5?	S1	S1	LR			Riparian
plant	*Solidago rupestris*	riverbank goldenrod	G4?	S1	_	LR			Riparian
plant	*Solidago uliginosa*	bog goldenrod	G4G5 T?	S2		LR			Riparian
plant	*Sparganium chlorocarpum*	narrow-leaf burreed	G5	S1		LR			Riparian
plant	*Spartina pectinata*	freshwater cordgrass	G5	S2	S4	LR			Riparian
plant	*Sphagnum russowii*	Russow's peatmoss	G5	S1S2		LR			Riparian
plant	*Spiranthes lucida*	shining ladies'-tresses	G5	S1	S1S2	LR			Riparian
plant	*Spiranthes ochroleuca*	yellow nodding ladies'-tresses	G4	S1	S5	LR			Riparian
plant	*Triadenum fraseri (Hypericum v.)*	Fraser's marsh St. John's-wort	G5	S1	S4	LR			Riparian
plant	*Triantha racemosa*	coastal false-asphodel	G5	S1	_	LR			Riparian
plant	*Vaccinium macrocarpon*	large cranberry	G4	S2	S2	LR			Riparian
plant	*Verbena scabra*	sandpaper vervain	G5	S2	S1	LR			Riparian
plant	*Veronica scutellata*	marsh speedwell	G5	S1	S2	LR			Riparian
plant	*Viburnum lentago*	nannyberry	G5	S1	S1S2	LR			Riparian
plant	*Vicia americana*	American purple vetch	G5	S1S2	S4	LR			Riparian
plant	*Woodwardia virginica*	Virginia chainfern	G5	S5	SNR	LR			Riparian

3.3 – Information Collection

Species collection records were compiled from the Virginia Department of Game and Inland Fisheries (VDGIF) collections database, Virginia Department of Conservation and Recreation's Division of Natural Heritage (VDNH) records, West Virginia Department of Natural Resources (WVDNR) records, and USFS records. Using ArcMap®, records of selected species were connected to the attributed stream reaches or lakes/wetlands, allowing for characterization of the species' habitats as noted in the above tables.

3.4 – Species Groups

All of the above federally listed species, sensitive species and species of management concern are tied to the specified aquatic habitats. The following groups address threats that could affect habitat for a number of species.

ACID SENSITIVE STREAM SPECIES

Acid deposition rates and the underlying geology were used to analyze Forest watersheds for their sensitivity to acidification. They were put into three categories; high, moderate, and low sensitivity. When cross-walked with stream habitat types, 793 miles (67%) of perennial streams on the GWNF were within the highly sensitive watersheds. See Table

11 for a list of stream habitats by watershed sensitivity. Of those, the smallest streams at the highest elevations are most susceptible. As discussed in the pH and alkalinity section, even if acid emissions are reduced, streams will continue to acidify for a number of years. It should be expected that species living in those streams will be negatively affected by acidification. Table 12 is a list of those species found in the stream habitat types that occur in watersheds that are highly sensitive to acidification. Management strategies in the acid sensitive watersheds should address this issue and maximize nutrient replacement when planning vegetation management and/or look for alternative solutions (such as stream or watershed liming or fertilization), if negative effects to biota are to be avoided.

Table 11. GWNF Stream Habitat Type by Watershed Acid Sensitivity

Watershed Sensitivity to Acidification	Stream Habitat Type	Miles	Percent of Miles
HIGH	111, 113, 114, 115, 121, 123, 125, 211, 213, 215, 221, 223, 225, 311, 313, 315, 321, 323, 411, 413, 415, 421, 423, 511, 513	792.9	67%
MODERATE	124, 214, 224, 314, 414	232.0	20%
LOW	112, 122, 212, 222, 312, 322, 412, 512	153.8	13%

Table 12. Species Found in Watersheds with a High Sensitivity to Acidification

SCIENTIFIC NAME	COMMON NAME
Alasmidonta undulata	triangle floater
Alasmidonta varicosa	brook floater
Anas rubripes	northern black duck
Anguilla rostrata	American eel
Calopteryx angustipennis	Appalachian jewelwing
Cambarus monongalensis	a crayfish
Clemmys insculpta	wood turtle
Cordulegaster diastatops	delta-spotted spiketail
Elliptio lanceolata	yellow lance
Fusconaia masoni	Atlantic pigtoe
Gomphus viridifrons	green-faced clubtail
Helonias bullata	swamp pink
Hydraena maureenae	Maureen's shale stream beetle
Lanthus parvulus	double-striped clubtail
Lasmigona subviridis	green floater
Notropis semperasper	roughhead shiner
Noturus gilberti	orangefin madtom
Nyctanassa violacea	yellow-crowned night-heron
Pleurobema collina	James spinymussel
Salvelinus fontinalus	brook trout
Sorex palustris punctulatus	southern water shrew
Villosa constricta	notched rainbow

TEMPERATURE CHANGE SPECIES

It is recognized that climate change will impact the ability of the Nation's forest to provide water and other critical watershed services (Knapp et al. 2008). Warming over the past several decades has fundamentally altered the hydrologic cycle, and these changes are percolating through our watersheds. Projected climate changes to the hydrologic cycle through warmer water temperatures, more intense storms, and greater inter-annual variability in precipitation, indicate the importance of maintaining and protecting healthy watersheds. Bakke (2008) describes three key components relating climate change processes to management and conservation of aquatic resources; resilient habitat, refugia, and restoration.

Resiliency refers to the ability of a system to return to its original condition after being disturbed. In ecology, resiliency carries the additional meaning of how much disturbance a system can "absorb" without crossing a threshold and entering an entirely different state of equilibrium. This requires that certain key habitat characteristics or processes will change little; with respect to stream aquatic habitat, these key elements are temperature and disturbance regime. Rivers and streams most resilient to temperature change include those dominated by groundwater input. Aspect, riparian shading, and valley shape also play a role in thermoregulation. A resilient disturbance regime would be one where peak flows and available sediment sources do not become altered. Likewise, streams most resilient to changes in disturbance regime would include those with flow dominated by groundwater. Resiliency can only function if the landscape offers a redundancy of habitat opportunities; there must be enough habitat and connectivity so that a disturbance to one area allows populations to recover and recolonize from another area.

Refugia are places in the landscape where organism can go to escape extreme conditions, be it short term or long term. Protecting these areas, and maintaining or improving connectivity will be increasingly important.

Restoration should include activities which reestablish the structures and function of the stream ecosystem in a manner that the ecosystem will become self-maintaining. High priority actions would be protection of good habitat, improving connectivity and access to existing habitat. If active restoration, such as enhancement of instream habitat with large wood, is to be performed in potentially unstable settings, it will be important to design these projects with the appropriate level of redundancy to accommodate greater rates of channel migration and flood magnitudes. Passive restoration techniques, such as establishment of wider riparian buffers, may be a more sustainable alternative in light of increased geomorphic instability.

Species that are non-tolerant of warmer water will find their habitat reduced (see brook trout discussion, below). As streams and lakes change, species that are unable to adapt will need to move to suitable habitat; this emphasizes the need for maintaining connectivity between habitat units. Management and land use decisions should be designed to maintain and protect healthy watersheds, and support watershed resilience. Specific management strategies the George Washington National Forest can adopt to

address the management and conservation of aquatic resources in light of predicted effects from climate change are:

- Protect and restore beaver meadows, wetlands, and floodplains to improve natural storage, reduce flood hazards, and prolong seasonal flows. Beaver ponds and wetlands recharge groundwater, raise the water table, retain sediment and organic matter, store water during floods and release it slowly, mitigate low flows and drought, reduce carbon turnover rate, raise pH and ANC, while reducing SO^2, Al, and NO^3 .
- Protect and restore riparian forests to moderate changes in stream temperature, maintain stream bank stability, and provide instream habitat.
- Remove migration barriers and re-establish habitat connectivity so that species can more to more suitable habitat, or move to or from refugia.
- Reduce flood and wildfire risks in vulnerable watersheds to prevent increased surface erosion and mass wasting leading to aggradation of river channels.
- Improve or decommission roads to reduce adverse impacts during large storms to prevent surface erosion and fill slope failure and landslides. Construct stream crossings and bridges to withstand major storm and runoff events.

Brook trout are not only a MIS, but a coldwater species that depend on relatively low stream temperatures to survive. A recent study (Flebbe et al. 2006) projects that rising temperature changes from climate change (and the loss of hemlock along streams) will shrink natural trout habitat. Using the Hadley Centre and the Canadian Centre climate change models, Flebbe found that between 53 and 97 percent of wild trout populations in the Southern Appalachians could die out as streams become warmer by the year 2100.

Currently, Virginia has one of the strongest native brook trout resources in the Southeast. Of the 2,350 miles of wild trout resource identified by the State, approximately 80% remains brook trout. Wild brook trout populations are generally limited to higher elevations in the western mountains of the state. However, brook trout were once found throughout the limestone spring creeks in the Great Valley region located between the Blue Ridge and Allegheny mountain ranges and along some of the smaller tributaries of the Potomac at least as far east as Fairfax County. Most of the valley limestone stream populations were likely extirpated a century or more ago with the agricultural development of the valley but some persisted as late as the mid-1960s. The populations within Potomac River tributaries were known to be strong through the 1950s and still persisted as late as the early 1980s. These populations were eliminated with residential development of the region. Recent research supports the relationship between forested watersheds and presence of brook trout; conversely, watersheds with extensive development (with as little as 4% impervious cover) were unable to support brook trout in their streams (Stranko et al. 2008). It is estimated that at least 38% of the original brook trout populations have been extirpated from Virginia.

Most of the remaining populations are well protected from land use changes due to public ownership by land management agencies such as the George Washington and Jefferson National Forest, the Shenandoah National Park and scattered holdings of the Virginia Department of Game and Inland Fisheries. However, they will not be immune to thermal and hydrologic effects resulting from climate change. Impacts to trout and other cold-water species can hopefully be reduced by implementing the management strategies outlined above that are designed to maintain and protect healthy watersheds, and support watershed resilience.

3.5 – Plan Components for Species Diversity & Evaluation of Plan Components on Species Diversity

Plan components for ecosystem diversity identified in section 2.6 and 3.4 should satisfy most aquatic species diversity objectives on the GWNF. In addition, many of the species listed above are within existing or proposed Special Biological Areas (SBA). With an SBA designation, management is focused on the unique species or biological communities that occur in the area. See Appendix 3 for a crosswalk of the aquatic species found in SBAs and Appendix 4 for those found in proposed SBAs.

Managing watersheds, riparian areas, and perennial, intermittent, and channeled ephemeral streams to maintain or restore resilient and stable conditions to support the quality and quantity of water necessary to protect ecological functions and support beneficial water uses will improve and maintain habitat conditions and habitat connections for aquatic species habitat groups and will maintain suitable habitat that is not currently occupied but has a likelihood of being occupied in the future by species identified in this analysis.

However, this analysis does recommend additional plan components specifically for two aquatic/riparian species on the GWNF: tiger salamander, and wood turtle. Each is discussed next along with the rationale as to why additional Plan components are necessary.

TIGER SALAMANDER

The 1993 Plan created the Maple Flats SBA in part to protect the Easter tiger salamander. Appendix G of the 2004 M&E report states “Delineation of the Maple Flats Special Biological Area containing the eastern tiger salamander appears to have encompassed much, if not all, habitat used by this species on the GWNF. Observations made since this species was discovered on the Forest indicate that this species is still present at all locations where previously found. Population size and trend studies are ongoing, as are inventories of potential habitat. As new information on population trends and habitat use surface, management activities will be adjusted to protect the eastern tiger salamander where they occur on the Forest. Forest Service management activities are having no effect on the eastern tiger salamander since all sinkhole ponds in the Maple Flats area are avoided and buffered from management activities.” In 2005-2007 eastern tiger salamander egg masses and adults were found at 6 sinkhole ponds outside, and 4-5 miles west, of the Maple Flats Sinkhole Complex. It is recognized that local amphibian

population persistence requites sufficient terrestrial habitat, the maintenance of habitat quality, and connectivity among local populations (Harper et al. 2008). New Special Biological Areas should be created to protect the newly found eastern tiger salamander populations. This should include habitat management between all the ponds to allow for long-range dispersal, including mature forest and low stem densities.

WOOD TURTLE

Based on the assessment information, the agencies have identified strategies with the highest likelihood of improving wood turtle habitat and with the highest likelihood of mitigating the impacts of other activities on the Forest. It is recognized that the primary limiting factors affecting the viability of the wood turtle in the region are, illegal collection, habitat loss and fragmentation, and vehicular mortality (Buhlmann. et al., 2008). Habitat maintenance and improvement is where the forest can make the biggest gains on conserving the wood turtle.

The assessment information on habitat indicates that wood turtles have both aquatic and terrestrial habitat needs. They benefit from high quality streams with some level of stream disturbance (beaver ponds, cut banks, large woody debris, alluvial depositions). Their terrestrial habitat needs for nesting and foraging appear to be best met by a variety of settings, including openings, shrub habitat and forested habitat. Aside from habitat needs, the main threats on the National Forest appear to be collection and mortality from vehicles.

Wood turtle conservation on the Forest will consist of goals and strategies designed to enhance habitat and reduce potential threats. Forest Plan riparian standards or guidelines will be followed if they are more restrictive than those in the wood turtle conservation strategy.

12.1 Goals and Conservation Measures (CM)

The following goals and strategies apply to perennial streams, seeps, riparian areas, and adjacent upland areas on the Forest (GW) within the range of the wood turtle. Currently, this range includes the North Fork Shenandoah and the South Fork of the South Branch of the Potomac River and the Cacapon River watersheds on the Lee and North River Ranger Districts.

Goal 1 Watersheds are managed to maintain or enhance the terrestrial summer foraging habitat of wood turtles.

CM 1.01 Maintain or create openings in riparian areas for turtle foraging and thermoregulation.

Goal 2 Watersheds are managed to maintain or enhance the nesting habitat of wood turtles.

CM 2.01 Manage and protect known existing nest sites.

CM 2.02 Create additional suitable nest sites where appropriate.

Goal 3 Watersheds are managed to maintain or enhance the overwintering aquatic habitat of wood turtles.

CM 3.01 Maintain or create in stream woody debris.

CM 3.02 Minimize sediment, pollutant, and pesticide loading to stream channels.

CM 3.03 Avoid stream channelization, artificial impoundments (i.e. dams), and bank stabilization that would decrease potential overwintering habitat.

CM 3.04 Allow beaver activities that create suitable habitat.

Goal 4 Human interactions, such as motorized vehicle use and recreation, are managed to minimize impacts to wood turtles.

CM 4.01 The Forest Service, working cooperatively with the Virginia Department of Game and Inland Fisheries and the West Virginia Division of Natural Resources, will identify hibernacula with significant turtle concentrations and/or other areas where there is a high potential for human interaction with wood turtles. They will evaluate the need for seasonal restrictions on road use or other activities to protect the turtle. The time that turtles are nesting or foraging away from the stream and most subject to terrestrial impact would be from April through October. In stream activities would be of greatest concern during the period of November through March.

CM 4.02 When mowing within 1000 feet (300 m) of a perennial stream, mowing decks will be raised a minimum of 8 inches (20 cm) above the ground between April 1 and November 15.

CM 4.03 Work with law enforcement to help identify law enforcement activities to curtail illegal collection activities (e.g. encourage wildlife road checks, increased law enforcement surveillance).

Goal 5 Manage riparian and aquatic habitats to protect water quality and enhance conditions for riparian dependent species.

CM 5.01 Riparian and aquatic habitat will be managed using the standards and guidelines in the Forest Plan.

Goal 6 Recognize the Paddy Run watershed on the Lee District as an emphasis area for wood turtle management; “Because of its relatively intact forest, remote location, position within the Cedar Creek watershed, connection to the Capon River watershed, and relatively protected status inside of the George Washington National Forest, Vance’s Cove probably represents

the best potential for long-term protection of a viable metapopulation of wood turtles" (Akre and Ernst, 2006).

The Paddy Run emphasis area includes National Forest land within the Paddy Run watershed, including Vance's Cove, starting at the National Forest boundary at Paddy Gap (see attached map). Long term desired future management direction for this area comes from the George Washington Forest Revised Land and Resource Management Plan. (Forest Plan). Project desired future conditions will be derived from management area designations 4, 9, 15, 18, 21, all of which are located within the emphasis area.

Within this emphasis area the following activities will be implemented:

CM 6.01 No logging activities allowed within 100 feet (30 m) of the edge of perennial streams and seeps, except to enhance habitat for wood turtles. No logging activities (including those for wood turtle enhancement) allowed within 300 feet (100 m) of the edge of perennial streams and seeps from April 1 to November 15. In coordination with VDGIF and Forest Service biologists, logging activity restrictions in the 300 ft buffer zone may be modified on a case-by-case basis. Regeneration harvest will be limited to no more than 6% of the watershed in a 10 year period.

CM 6.02 Forest Road 93 will be closed to the public at the end of spring gobbler season, established by VDGIF, until July 1 to reduce vehicular traffic during times of the year when the turtles are most active, especially nesting season.

CM 6.03 Create and/or maintaining openings with a mixture of grass, forbs and shrubs in the riparian corridor for turtle foraging areas.

CM 6.04 Create and/or maintain nest sites away from roads and trails as appropriate.

CM 6.05 Place LWD and root wads into the stream channel to provide over-wintering habitat as appropriate.

CM 6.06 Look for opportunities to reduce human-turtle interactions such as moving existing trails and roads away from riparian areas, and eliminating stocking from the upper reaches of Paddy Run.

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Appendix 1. Aquatic Habitat Classification Process Paper

George Washington National Forest

Dawn Kirk, Forest Fisheries Biologist
Gary Kappesser, Forest Hydrologist
January 16, 2007

A. Introduction

The George Washington National Forest (GWNF) developed an aquatic habitat classification to facilitate the Aquatic Ecological Sustainability Analysis. The methods used in this classification follow the basic structure of The Nature Conservancy (TNC) aquatic community classification, and the Virginia and West Virginia Wildlife Action Plans, yet habitat classifications were focused on land managed by the GWNF.

There were multiple goals in this effort. One was to provide a means to describe and catalog the diversity of aquatic habitats in the GWNF (coarse filter). The second was to provide a dataset that can be used to describe species-habitat associations for specific federally listed species, FS sensitive species, and locally rare species (fine filter). A determination could then be made regarding how much of a particular habitat is on National Forest, and whether or not it currently supports the associated species. This level of classification does not capture finer scale habitat attributes (i.e. pool/riffle composition depth, specific substrate composition, etc.) that may be important to refine the predictive habitat maps. However, it is useful in determining general patterns in species distributions, and may indicate areas to survey for a species, or areas in which to promote habitat restoration and private land conservation measures.

This habitat classification is hierarchical and is based on an understanding of how habitat influences the composition and distribution of biological communities. It is based on four assumptions (Higgins et al. 1998):

1. Physiographic and climatic patterns influence the distribution of organisms, and can be used to predict the expected range of biological community types (Jackson and Harvey 1989; Tonn 1990; Maxwell et al. 1995; Angermeier and Winston 1998; Burnett et al. 1998).
2. The physical structure of aquatic habitats (or ecosystems) can be used to predict the distribution of aquatic communities (Gorman and Karr 1978; Schlosser 1982).
3. Aquatic habitats are continuous; however, generalizations about discrete patterns in habitat use can be made (Vannote et al. 1980; Schlosser 1982).
4. Using a nested classification system, (i.e. stream reach habitat types within species ranges), we can account for community diversity that is difficult to observe or to measure (taxonomic, genetic, or ecological) (Frissell et al 1986; Angermeier and Schollsser 1995).

B. Watersheds and Species Ranges

The Forest stratified GWNF habitat by an individual species known range on or near the Forest using hydrologic units or watersheds. Hydrologic units have been consistently developed across both Virginia and West Virginia, and cover the extent of the Forest land. Specifically, habitat was identified as potential habitat for a species only if it was within a watershed that was within the known range of the species. For example, potential habitat for the roughhead shiner was limited to the James River Drainage, since it is not known from the Potomac Drainage. This captured both the geographic and physiographic aspects of species distribution.

Angermeier and Winston (1999) found that physiography and drainage together described 27% of the variance in fish species composition. In addition, they found that fish community types described by the drainage-physiography combination were more distinct than those described by drainage or physiography alone. The Ecoregional Drainage Unit (EDU) is a spatial representation of this variable. The EDU concept was incorporated by TNC. They developed aggregations of 8-digit hydrologic units based on similarities in several variable including geology, flow characteristics, and topography (Smith et al. 2002). The TNC dataset included size-1 Aquatic Ecological Systems that were extensively explored by the Forest for use in this process. Above the Forest Service boundary, aquatic ecosystems were smaller that what was defined by TNC as a size-1 Aquatic Ecological System, and a portion of Forest land was not classified; therefore, the TNC classification was not used.

Virginia's Wildlife Action Plan defined a total of 34 EDUs in Virginia, compiling 14 drainages and six ecoregions. Since Virginia's dataset did not include the land that the GWNF manages in WV, and since a WV stream classification system has not been completed, the GWNF decided to use hydrologic units stratified by species range.

C. Stream Reach Classification

Streams and rivers display continuous changes in physical and chemical characteristics from headwaters to mouth, which may influence the structure and function of biological communities along this continuum (Vannote et al. 1980). Factors of elevation, watershed size, and geology are interrelated along the continuum. These factors in turn influence the distribution, abundance, and productivity of stream flora and fauna.

The lotic (stream and river) aquatic ecosystems of the George Washington National Forest were characterized in a GIS environment using combinations of watershed size, elevation, and geology.

Table 1. Habitat attributes assigned to each stream reach.

Attribute	Description	Data Source
Stream Size	Determined by watershed area	DEM, NHD
Elevation	Stream segments above or below 610 meters (2000 feet)	DEM

Geology	The geological class intersection of the stream segment	GIS coverage of USGS geologic maps

Stream Size
Most species occupy streams or stream reaches of particular size ranges, thus their distributions are longitudinally zoned. Species richness in stream reaches is related to longitudinal zonation. Headwaters nearly universally have fewer species than do medium and large streams in the same system.

Stream size is directly related to watershed area, and was determined using the watershed area. Stream size classes were assigned that are consistent with what was used in Virginia's Wildlife Action Plan.

Watershed area was derived in GIS from a 10 meter digital elevation model (DEM). The DEM was downloaded from:

http://fsweb.clearinghouse.fs.fed.us/

Individual quads were merged in ArcMap to create a mosaic covering the GWNF. Watershed information was then extracted from the DEM using an ArcMap extension called HydroTools available from the following web site:

http://www.crwr.utexas.edu/gis/archydrobook/ArcHydroTools/Tools.htm

The first step that ArcHydro Tools does is called "DEM Reconditioning". This step is unique to this extension and forces the DEM generated streams to coincide with the blue line stream locations. The extension creates a folder called "Layers" and generates a new DEM called AgreeDEM. Subsequent steps in Preprocessing that need to be done include Fill Sinks, Flow Direction, and Flow Accumulation. The Flow Accumulation grid is the useful product. The value in each grid expresses the number of grids that flow into it. In a 10 meter DEM each grid represents an area of 100 square meters (10m X 10m). Area in grids can be later translated into area in square miles or acres. The stream network can be extracted with the next ArcHydro Tools step of Stream Definition. This identifies flow accumulation cells greater than a specified number and gives each a value of one. A flow accumulation value of 500 represents 12.4 acres and approximates the drainage needed to support a channeled ephemeral stream in the Southeast. The resulting grid is labeled STR. Using the Map Calculator in Spatial Analyst, the STR grid can be multiplied by the Flow Accumulation grid to create a gridded stream network with watershed area in grids at intervals equal to the size of the grid (10 meters). Spatial Analyst was used to convert the grid (raster) to features as a polyline shapefile with a field called GRIDCODE that represents the watershed area upstream from each line segment in number of grids. Fields were then added to the attribute table of the shapefile. Use the calculate function to populate the fields with area in square miles (for a 10 meter grid, multiply "gridcode" by 0.00003861022). This value converts 10 meter – square

grids into square miles. Thus, each segment of the stream polyline will have an attribute of watershed area attached to it.

Elevation
Stream temperature has been identified as an important factor to predict species distributions. However, it is difficult to predict in a landscape scale classification. Since stream temperature decreases predictably with increasing elevation in mountains, largely due to the temperature lapse rate of the atmosphere, we have included reach elevation (in feet) as a surrogate attribute for temperature (Flebbe et al. 2006). A reach elevation of 2000 ft was used as the break point between cold water and cool/warm water habitat. This corresponds with findings by Meisner (1990), and was validated by reviewing the aquatic community in selected reaches. In addition, recent research by Owen (2006) found that the threshold for year-round temperatures sufficient to sustain trout in the Monongahela National Forest of West Virginia was at 2000 ft elevation.

The DEM was used to select stream segments as being above or below 610 meters (2000 feet) and attributed accordingly.

Geology
Geologic structure and rock type influence local substrate, slope, and longitudinal profiles of the streambed, as well as influencing water chemistry. These factors in turn influence the distribution, abundance, and productivity of stream flora and fauna.

The topographical features of the GWNF are the result of differential erosion of rocks of different resistance. Ridges are made up of more resistant quartzites and granties, and valleys are composed of less resistant shales and limestones (Hack 1957). Thus, the smaller headwater streams are associated with higher elevations and more resistant geology. Conversely, the larger river systems are more commonly found in the valleys at lower elevations and on less resistant shales and limestones. The size of the stream bed material (substrate) is determined by rock type and drainage area. Resistant quartzites and granites produce stream channels with boulders and large cobbles. Shales produce stream bed material dominated by gravel and small cobble. The size of the stream bed material and the drainage area of the watershed determine stream channel gradient (slope). Stream channels dominated by boulders are commonly found to have steeper gradients than those dominated by gravels.

Bedrock and surficial geology, including Soils, also strongly influence the flow regime and water quality of a stream.

The flow of a stream or river varies over time in response to precipitation events over its watershed. Different rocks and Soils have different water infiltration and storage capacities. Watersheds underlain by rocks and Soils with large storage capacity will have smaller flood peaks and higher low flows than will watersheds whose rocks and Soils lack storage capacity. Differences in storage capacity are reflected in differences in the watershed's drainage density, expressed as the miles of stream channel per square mile or

watershed. As storage capacity decreases, drainage density increases. As drainage density increase, flood peaks increase and low flows decrease.

Geology influences physical water quality of a stream because rock types decompose at different rates, and have different rates of denuation. Estimates of denudation rates for ridge-forming sandstones, and valley-forming shale for the Appalachians in Virginia are:

Sandstone	0.000078 inches per year	15 tons/sq. mile/year
Shale	0.00039 inches per year	75 tons/sq. mile/year

These translate into very different sediment yields. The annual sediment yield from shale is five times that of the sandstone. Similarly, turbidity (amount of solid particles suspended in water) differs by geology. Rock types that weather to produce colloidal size particles of silt and clay (ex. shales and impure limestone) will result in streams with greater potential turbidity. In contrast, sand and larger size particles will show little to no turbidity for the same or grater sediment concentrations.

Geology influences water chemistry as rocks are weathered and dissolved in water. The chemistry of the water can determine the heath or distribution of biota. For example, dissolved calcium can be a limiting factor in the distribution of many aquatic organisms, mollusks and crayfish in particular. Calcium levels would be highest in streams that flow through rocks that contain carbonate, such as limestone. Waters flowing through limestone also typically have high alkalinity and would be better able to buffer against dramatic changes in pH (such as from acid deposition). Waters flowing through granite and quartzite, typically have low alkalinity and poor buffering capacity.

Geology was obtained from the GWNF polygon GIS coverage created by manually digitizing available USGS geologic maps at scales of 1:24000 and 1:100,000.

Stream Types

Once the reaches were attributed, we divided the continuous variables into meaningful categories after some literature review and preliminary analyses of the data. We decided upon five categories for size, two categories for elevation, and five categories for geology (see Table 2).

Table 2. Aquatic habitat classification categories used for continuous variables

Stream Size:	**Watershed area (sq. miles)**	**Class**
Headwater	<2	100
Stream	2-10	200
Large stream	10-20	300
Small River	20-70	400
Large River	>70	500
Elevation (temperature regime):	Elevation (ft):	Class
Lower elevation (warm/cool water)	≤2000	10
Higher elevation (cold water)	>2000	20
Geology:	Rock Types:	Class

Sandstone/quartzite	Sandstone & quartzite	1
Limestone	limestone	2
Shale	shale	3
Granite	granite, metabasalt, proxene, gneiss	4
Charnokite/mylonite	charnikite & mylonite	5

The categories were concatenated by their assigned number to come up with a stream type for each reach that described the size, elevation, and geology (see Table 3).

Table 3. Miles of Lotic Habitat on GWNF by Stream Type.

Stream Type	Sum of Miles	Percent of Miles	Description	Example
111	153.41	13.02%	Headwater, lower elevation, sandstone/quartzite	Buck Lick Run, Rockingham Co.
112	50.38	4.27%	Headwater, lower elevation, limestone	Upper Kelly Run, Bath Co.
113	181.61	15.41%	Headwater, lower elevation, shale	Downy Branch, Allegheny Co.
114	18.44	1.56%	Headwater, lower elevation, granite	King Creek, Amherst Co.
115	8.08	0.69%	Headwater, lower elevation, charnokite/mylonite	Cedar Creek, Amherst Co.
121	240.60	20.41%	Headwater, higher elevation, sandstone/quartzite	Locust Spring Run, Highland Co.
122	24.93	2.11%	Headwater, higher elevation, limestone	Jordan Run, Bath Co.
123	47.98	4.07%	Headwater, higher elevation, shale	Upper Pitt Spring Run, Page Co.
124	12.93	1.10%	Headwater, higher elevation, granite	Crabtree Creek, Nelson Co.
125	3.85	0.33%	Headwater, higher elevation, charnokite/mylonite	Upp. N.F. Piney R., Nelson/Amherst
211	100.01	8.49%	Stream, lower elevation, sandstone/quartzite	Slate Lick Branch, Rockingham Co.
212	36.46	3.09%	Stream, lower elevation, limestone	Cub Run, Page Co.
213	74.76	6.34%	Stream, lower elevation, shale	Little Fork, Pendleton Co.
214	10.45	0.89%	Stream, lower elevation, granite	Shoe Creek, Nelson Co.
215	3.61	0.31%	Stream, lower elevation, charkonite/mylonite	Browns Creek, Amherst Co.
221	61.43	5.21%	Stream, higher elevation, sandstone/quartzite	Little Back Creek, Bath Co.
222	5.59	0.47%	Stream, higher elevation, limestone	Muddy Run, Bath Co.
223	9.06	0.77%	Stream, higher elevation, shale	Little Mill Creek, Bath Co.
224	5.39	0.46%	Stream, higher elevation, granite	S.F. Piney River, Amherst Co.
225	0.06	0.00%	Stream, higher elevation, charkonite/mylonite	Lower N.F. Piney R., Nelson/Amherst
311	12.52	1.06%	Large stream, lower elevation, sandstone/quartzite	Lower Cove Run, Hardy Co.
312	4.14	0.35%	Large stream, lower elevation, limestone	Smith Creek, Allegheny Co.
313	16.88	1.43%	Large stream, lower elevation, shale	Wilson Creek, Bath Co.
314	5.38	0.46%	Large stream, lower elevation, granite	Pedlar River, Amherst Co.
315	1.08	0.09%	Large stream, lower elevation, charnokite/mylonite	Piney River, Nelson/Amherst Co.
321	11.27	0.96%	Large stream, higher elevation, sandstone/quartzite	Skidmore Fork, Rockingham Co.
322	0.28	0.02%	Large stream, higher elevation, limestone	Dry Run, Bath Co.
323	0.03	0.00%	Large stream, higher elevation, shale	Shaws Fork, Highland Co.
411	21.21	1.80%	Small river, lower elevation, sandstone/quartzite	North River, Augusta Co.
412	2.04	0.17%	Small river, lower elevation, limestone	Trout Run, Hardy Co.
413	8.07	0.68%	Small river, lower elevation, shale	Dunlap Creek, Allegheny Co.
414	3.84	0.33%	Small river, lower elevation, granite	Pedlar River, Amherst Co.
415	2.30	0.19%	Small river, lower elevation, charnokite/mylonite	Tye River, Nelson Co.
421	3.86	0.33%	Small river, higher elevation, sandstone/quartzite	Laurel Fork, Highland Co.
423	0.14	0.01%	Small river, higher elevation, shale	Back Creek, Highland Co.
511	2.09	0.18%	Large river, lower elevation, sandstone/quartzite	Passage Creek, Shenandoah Co.

Stream Type	Sum of Miles	Percent of Miles	Description	Example
512	13.91	1.18%	Large river, lower elevation, limestone	Jackson River, Bath Co.
513	20.62	1.75%	Large river, lower elevation, shale	Cowpasture River, Bath Co.
	1178.66	100.00%		

D. Lake, Pond, and Wetland Classification

Lentic aquatic habitat has standing water and includes lakes, ponds, and swamps. It is primarily determined by slope (or gradient) and substrate or storage capacity. On the GWNF there are numerous small natural ponds and wetlands, in addition to human-built impoundments (reservoirs). Because they vary in size, depth, chemistry, hydro-period, and vegetation, there are often unique flora and fauna associatedwith these habitats.

Lentic habitat was identified on the George Washington National Forest using the National Land Cover Database (NLCD) for Virginia and West Virginia produced by the U.S. Geological Survey. This portion of the NLCD was created as part of land cover mapping activities for Federal Region III that includes the States of Maryland, Delaware, Pennsylvania, Virginia, West Virginia, and the District of Columbia. The NLCD classification contains 21 different land cover categories with a spatial resolution of 30 meters.

Citation_Information:
Originator: U.S. Geological Survey (USGS)
Publication_Date: 19990527
Title: Virginia Land Cover Data Set
Edition: 1
Geospatial_Data_Presentation_Form: raster digital data
Publication_Information:
Publication_Place: Sioux Falls, SD USA
Publisher: U.S. Geological Survey
http://erg.usgs.gov/isb/pubs/factsheets/fs10800.html

The NLCD layer has three lentic water cover classes, their definitions are below:

- Open water (NLCD 11) – All areas of open water: typically 25% or greater cover of water (per pixel).
- Woody Wetlands (NLCD 91) – Areas where forest or shrubland vegetation accounts for 25-100% of the cover and the Soil or substrate is periodically saturated with or covered with water.
- Emergent Herbaceous Wetlands (NLCD 92) – Areas where perennial herbaceous vegetation accounts for 75-100% of the cover and the Soil or substrate is periodically saturated with or covered with water.

Open water was further stratified by size and connectivity to lotic ecosystems (flowing water). Waterbodies greater than 5 acres were classified as lakes. Waterbodies smaller than 5 acres were classified as ponds. Lakes and ponds that intersected the NHD streams layer in GIS were classified as "connected to stream". Those that did not intersect were classified as "not connected to stream".

Thus, six unique lentic aquatic habitats were differentiated. The number of features, acres, and percent of each and total acres of lentic aquatic habitat are summarized in Table 4.

Table 4. Acres of Lentic Habitat on GWNF by Category.

Category	Abbreviation	Number	Acres on GWNF	Percent
Lake connected to a stream	LCS	34	2830.6	87.7%
Lake not connected to a stream	LNCS	2	20.9	0.6%
Pond connected to a stream	PCS	29	36.0	1.1%
Pond not connected to a stream	PNCS	81	70.5	2.2%
Emergent herbaceous wetland	EHW	139	85.0	2.6%
Woody wetland	WW	189	185.7	5.8%
TOTALS		474	3228.7	100.0%

The category of "Lake connected to a stream" covered the greatest amount of acres on the Forest because this category included the 2,530 acre Lake Moomaw.

E. Species-Habitat Relationships

Species collection records were compiled from the Virginia Department of Game and Inland Fisheries (VDGIF) collections database, Virginia Department of Conservation and Recreation's Division of Natural Heritage (VDNH) records, West Virginia Department of Natural Resources (WVDNR) records, and USFS records. Using ArcMap®, records of selected species were connected to the attributed stream reaches or lakes/wetlands, allowing for remote characterization of the species' habitats.

Once the connections were complete, we exported the data to a Microsoft Excel® spreadsheet and compiled a list of habitat classifications for each species. A query was run using ArcMap® to identify all the associated habitat types on the GWNF for each species, within their known range. The habitat types were identified first, and then clipped to the size HUC watershed appropriate to their known distribution near the Forest. For example, based on known occurrences, the James River spinymussel was associated with habitat types 312, 313, 415, and 513 within the upper and middle James River watersheds.

F. References

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Appendix 2. Detailed Habitat of Aquatic Species on the GWNF.

		Pleurobema collina	*Scirpus ancistrochaetus*	*Helenium virginicum*	*Helonias bullata*	*Notropis semperasper*	*Noturus gilberti*	*Hydraena maureenae*
Habitat Code	Stream (miles) or Lake (acres) Habitat	James spinymussel	northeastern bulrush	Virginia sneezeweed	swamp pink	Roughhead shiner	Orangefin madtom	Maureen's shale stream beetle
111	Headwater, lower elevation, sandstone/quarzite				1.5			
112	Headwater, lower elevation, limestone							
113	Headwater, lower elevation, shale							150.9
114	Headwater, lower elevation, granitic							
115	Headwater, lower elevation, charnokite/mylonite							
121	Headwater, higher elevation, sandstone/quarzite				2.4			
122	Headwater, higher elevation, limestone							
123	Headwater, higher elevation, shale				0.1	37.6		
124	Headwater, higher elevation, granitic							
125	Headwater, higher elevation, charnokite/mylonite							
211	Stream, lower elevation, sandstone/quarzite				3.2			
212	Stream, lower elevation, limestone							
213	Stream, lower elevation, shale							
214	Stream, lower elevation, granitic							
215	Stream, lower elevation, charkonite/mylonite							
221	Stream, higher elevation, sandstone/quarzite				0.0			
222	Stream, higher elevation, limestone							
223	Stream, higher elevation, shale							
224	Stream, higher elevation, granitic							
225	Stream, higher elevation, charkonite/mylonite							
311	Large stream, lower elevation, sandstone/quarzite							
312	Large stream, lower elevation, limestone	0.2						
313	Large stream, lower elevation, shale	5.9						
314	Large stream, lower elevation, granitic							
315	Large stream, lower elevation, charnokite/mylonite							
321	Large stream, higher elevation, sandstone/quarzite							
322	Large stream, higher elevation, limestone							
323	Large stream, higher elevation, shale							
411	Small river, lower elevation, sandstone/quarzite							
412	Small river, lower elevation, limestone							
413	Small river, lower elevation, shale					5.1		
414	Small river, lower elevation, granitic							
415	Small river, lower elevation, charnokite/mylonite	1.6						
421	Small river, higher elevation, sandstone/quarzite							
423	Small river, higher elevation, shale					0.1		
511	Large river, lower elevation, sandstone/quarzite							
512	Large river, lower elevation, limestone					12.0	0.4	
513	Large river, lower elevation, shale	6.6				18.8	6.1	
TOTALS	Miles of stream habitat	14.3			7.3	73.7	6.5	150.9
WW	Woody wetland		1.1	0.22				
EHW	Emergent herbaceous wetland			1.56				
PNCS	Pond not connected to a stream			2.22				
PCS	Pond connected to a stream							
LNCS	Lake not connected to a stream							
LCS	Lake connected to a stream							
TOTALS	Acres of lake habitat		1.1	4				

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Cicindela ancocisconensis	*Alasmidonta varicosa*	*Elliptio lanceolata*	*Fusconaia masoni*	*Lasmigona subviridis*	*Villosa constricta*	*Ambystoma tigrinum*
Habitat Code	Stream (miles) or Lake (acres) Habitat	Tiger beetle	Brook floater	Yellow lance	Atlantic pigtoe	Green floater	Notched Rainbow	eastern tiger salamander
111	Headwater, lower elevation, sandstone/quarzite							
112	Headwater, lower elevation, limestone							
113	Headwater, lower elevation, shale							
114	Headwater, lower elevation, granitic							
115	Headwater, lower elevation, charnokite/mylonite							
121	Headwater, higher elevation, sandstone/quarzite							
122	Headwater, higher elevation, limestone							
123	Headwater, higher elevation, shale							
124	Headwater, higher elevation, granitic							
125	Headwater, higher elevation, charnokite/mylonite							
211	Stream, lower elevation, sandstone/quarzite							
212	Stream, lower elevation, limestone							
213	Stream, lower elevation, shale							
214	Stream, lower elevation, granitic							
215	Stream, lower elevation, charkonite/mylonite							
221	Stream, higher elevation, sandstone/quarzite							
222	Stream, higher elevation, limestone							
223	Stream, higher elevation, shale							
224	Stream, higher elevation, granitic							
225	Stream, higher elevation, charkonite/mylonite							
311	Large stream, lower elevation, sandstone/quarzite							
312	Large stream, lower elevation, limestone							
313	Large stream, lower elevation, shale				0.2			
314	Large stream, lower elevation, granitic							
315	Large stream, lower elevation, charnokite/mylonite							
321	Large stream, higher elevation, sandstone/quarzite							
322	Large stream, higher elevation, limestone							
323	Large stream, higher elevation, shale							
411	Small river, lower elevation, sandstone/quarzite							
412	Small river, lower elevation, limestone							
413	Small river, lower elevation, shale							
414	Small river, lower elevation, granitic							
415	Small river, lower elevation, charnokite/mylonite					2.3	2.3	
421	Small river, higher elevation, sandstone/quarzite							
423	Small river, higher elevation, shale							
511	Large river, lower elevation, sandstone/quarzite							
512	Large river, lower elevation, limestone			12.0			12.0	
513	Large river, lower elevation, shale	6.2	1.3	18.8		19.6	18.8	
TOTALS	Miles of stream habitat	6.2	1.3	30.8	0.2	21.9	33.1	
WW	Woody wetland							8
EHW	Emergent herbaceous wetland							26.02
PNCS	Pond not connected to a stream							5.12
PCS	Pond connected to a stream							
LNCS	Lake not connected to a stream							
LCS	Lake connected to a stream							
TOTALS	Acres of lake habitat							39.14

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Empidonax alnorum	*Melospiza georgiana*	*Seiurus noveboracensis*	*Cambarus monongalensis*	*Salvelinus fontinalus*	*Aeshna canadensis*	*Aeshna tuberculifera*	*Aeshna verticalis*
Habitat Code	Stream (miles) or Lake (acres) Habitat	alder flycatcher	swamp sparrow	northern waterthrush	A Crayfish	Brook trout	Canada darner	black-tipped darner	green-striped darner
111	Headwater, lower elevation, sandstone/quarzite					153.4			
112	Headwater, lower elevation, limestone					50.4			
113	Headwater, lower elevation, shale					181.6			
114	Headwater, lower elevation, granitic					18.4			
115	Headwater, lower elevation, charnokite/mylonite					8.1			
121	Headwater, higher elevation, sandstone/quarzite				10.2	240.6			
122	Headwater, higher elevation, limestone					24.9			
123	Headwater, higher elevation, shale					48.0			
124	Headwater, higher elevation, granitic					12.9			
125	Headwater, higher elevation, charnokite/mylonite								
211	Stream, lower elevation, sandstone/quarzite					100.0			
212	Stream, lower elevation, limestone					36.5			
213	Stream, lower elevation, shale					74.8			
214	Stream, lower elevation, granitic					10.4			
215	Stream, lower elevation, charkonite/mylonite					3.6			
221	Stream, higher elevation, sandstone/quarzite				0.6	61.4			
222	Stream, higher elevation, limestone								
223	Stream, higher elevation, shale					9.1			
224	Stream, higher elevation, granitic					5.4			
225	Stream, higher elevation, charkonite/mylonite								
311	Large stream, lower elevation, sandstone/quarzite					12.5			
312	Large stream, lower elevation, limestone					4.1			
313	Large stream, lower elevation, shale								
314	Large stream, lower elevation, granitic					5.4			
315	Large stream, lower elevation, charnokite/mylonite								
321	Large stream, higher elevation, sandstone/quarzite				3.5	11.3			
322	Large stream, higher elevation, limestone								
323	Large stream, higher elevation, shale								
411	Small river, lower elevation, sandstone/quarzite				0.1	21.2			
412	Small river, lower elevation, limestone								
413	Small river, lower elevation, shale					8.1			
414	Small river, lower elevation, granitic								
415	Small river, lower elevation, charnokite/mylonite								
421	Small river, higher elevation, sandstone/quarzite				3.2	3.9			
423	Small river, higher elevation, shale								
511	Large river, lower elevation, sandstone/quarzite								
512	Large river, lower elevation, limestone					13.9			
513	Large river, lower elevation, shale								
TOTALS	Miles of stream habitat				17.6	1119.9			
WW	Woody wetland	185.7		185.7				26.47	
EHW	Emergent herbaceous wetland		84.95	84.95			26.47	35.81	26.47
PNCS	Pond not connected to a stream						3.56	9.12	3.56
PCS	Pond connected to a stream						4.67	12.68	4.67
LNCS	Lake not connected to a stream								
LCS	Lake connected to a stream							5.34	
TOTALS	Acres of lake habitat	185.7	84.95	270.65			34.7	89.42	34.7

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Calopteryx amata	*Calopteryx angustipennis*	*Celithemis martha*	*Cordulegaster diastatops*	*Enallagma annexum*	*Epitheca canis*	*Leucorrhinia hudsonica*
Habitat Code	Stream (miles) or Lake (acres) Habitat	Superb jewelwing	Appalachian jewelwing	Martha's penant	delta-spotted spiketail	northern bluet	beaverpond baskettail	Hudsonian whiteface
111	Headwater, lower elevation, sandstone/quarzite							
112	Headwater, lower elevation, limestone							
113	Headwater, lower elevation, shale							
114	Headwater, lower elevation, granitic							
115	Headwater, lower elevation, charnokite/mylonite							
121	Headwater, higher elevation, sandstone/quarzite	10.2			10.23			
122	Headwater, higher elevation, limestone							
123	Headwater, higher elevation, shale							
124	Headwater, higher elevation, granitic							
125	Headwater, higher elevation, charnokite/mylonite							
211	Stream, lower elevation, sandstone/quarzite							
212	Stream, lower elevation, limestone							
213	Stream, lower elevation, shale							
214	Stream, lower elevation, granitic							
215	Stream, lower elevation, charkonite/mylonite							
221	Stream, higher elevation, sandstone/quarzite	0.6						
222	Stream, higher elevation, limestone							
223	Stream, higher elevation, shale							
224	Stream, higher elevation, granitic							
225	Stream, higher elevation, charkonite/mylonite							
311	Large stream, lower elevation, sandstone/quarzite							
312	Large stream, lower elevation, limestone							
313	Large stream, lower elevation, shale							
314	Large stream, lower elevation, granitic							
315	Large stream, lower elevation, charnokite/mylonite							
321	Large stream, higher elevation, sandstone/quarzite	3.5						
322	Large stream, higher elevation, limestone							
323	Large stream, higher elevation, shale							
411	Small river, lower elevation, sandstone/quarzite	0.1						
412	Small river, lower elevation, limestone							
413	Small river, lower elevation, shale							
414	Small river, lower elevation, granitic							
415	Small river, lower elevation, charnokite/mylonite							
421	Small river, higher elevation, sandstone/quarzite	3.2						
423	Small river, higher elevation, shale							
511	Large river, lower elevation, sandstone/quarzite							
512	Large river, lower elevation, limestone							
513	Large river, lower elevation, shale		0.087					
TOTALS	Miles of stream habitat	17.6	0.1		10.2			
WW	Woody wetland			26.47				
EHW	Emergent herbaceous wetland			9.34		26.47	26.47	26.47
PNCS	Pond not connected to a stream			5.56		3.56	3.56	3.56
PCS	Pond connected to a stream			8.01		4.67	4.67	4.67
LNCS	Lake not connected to a stream							
LCS	Lake connected to a stream			5.34				
TOTALS	Acres of lake habitat			54.72		34.7	34.7	34.7

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Gomphus adelphus	*Gomphus quadricolor*	*Ladona julia*	*Lanthus parvulus*	*Lestes disjunctus*	*Nycticorax nyciticorax*	*Nyctanassa violacea*
Habitat Code	Stream (miles) or Lake (acres) Habitat	mustached clubtail	rapids clubtail	chalk-fronted corporal skimmer	double-striped clubtail	Northern spreadwing	Black-crowned night heron	Yellow-crowned night heron
111	Headwater, lower elevation, sandstone/quarzite				0.31			
112	Headwater, lower elevation, limestone				1.51			
113	Headwater, lower elevation, shale							
114	Headwater, lower elevation, granitic							
115	Headwater, lower elevation, charnokite/mylonite							
121	Headwater, higher elevation, sandstone/quarzite				10.84			
122	Headwater, higher elevation, limestone				0.11			
123	Headwater, higher elevation, shale				0.39			
124	Headwater, higher elevation, granitic							
125	Headwater, higher elevation, charnokite/mylonite							
211	Stream, lower elevation, sandstone/quarzite							
212	Stream, lower elevation, limestone							
213	Stream, lower elevation, shale							
214	Stream, lower elevation, granitic							
215	Stream, lower elevation, charkonite/mylonite							
221	Stream, higher elevation, sandstone/quarzite							
222	Stream, higher elevation, limestone							
223	Stream, higher elevation, shale							
224	Stream, higher elevation, granitic							
225	Stream, higher elevation, charkonite/mylonite							
311	Large stream, lower elevation, sandstone/quarzite							
312	Large stream, lower elevation, limestone							
313	Large stream, lower elevation, shale							
314	Large stream, lower elevation, granitic							
315	Large stream, lower elevation, charnokite/mylonite							
321	Large stream, higher elevation, sandstone/quarzite							
322	Large stream, higher elevation, limestone							
323	Large stream, higher elevation, shale							
411	Small river, lower elevation, sandstone/quarzite							
412	Small river, lower elevation, limestone							
413	Small river, lower elevation, shale	5.1	5.1					
414	Small river, lower elevation, granitic							
415	Small river, lower elevation, charnokite/mylonite							
421	Small river, higher elevation, sandstone/quarzite							
423	Small river, higher elevation, shale							
511	Large river, lower elevation, sandstone/quarzite						2.09	2.09
512	Large river, lower elevation, limestone						13.91	13.91
513	Large river, lower elevation, shale	18.8	18.8				20.62	20.62
TOTALS	Miles of stream habitat	23.9	23.9		13.2		36.6	36.6
WW	Woody wetland						185.7	185.7
EHW	Emergent herbaceous wetland			26.47		26.47		
PNCS	Pond not connected to a stream			3.56		3.56		
PCS	Pond connected to a stream			4.67		4.67		
LNCS	Lake not connected to a stream							
LCS	Lake connected to a stream							
TOTALS	Acres of lake habitat			34.7		34.7	185.7	185.7

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Nehalennia irene	*Neurocordulia yamaskanensis*	*Rhionaeschna mutata*	*Somatochlora elongata*	*Sympetrum obtrusum*	*Anas rubripes*
Habitat Code	Stream (miles) or Lake (acres) Habitat	sedge sprite	stygian shadowdragon	spatterdock darner	Ski-tipped emerald	white-faced meadowhawk	Amer. Black duck
111	Headwater, lower elevation, sandstone/quarzite						
112	Headwater, lower elevation, limestone						
113	Headwater, lower elevation, shale						
114	Headwater, lower elevation, granitic						
115	Headwater, lower elevation, charnokite/mylonite						
121	Headwater, higher elevation, sandstone/quarzite						
122	Headwater, higher elevation, limestone						
123	Headwater, higher elevation, shale						
124	Headwater, higher elevation, granitic						
125	Headwater, higher elevation, charnokite/mylonite						
211	Stream, lower elevation, sandstone/quarzite						
212	Stream, lower elevation, limestone						
213	Stream, lower elevation, shale						
214	Stream, lower elevation, granitic						
215	Stream, lower elevation, charkonite/mylonite						
221	Stream, higher elevation, sandstone/quarzite						
222	Stream, higher elevation, limestone						
223	Stream, higher elevation, shale						
224	Stream, higher elevation, granitic						
225	Stream, higher elevation, charkonite/mylonite						
311	Large stream, lower elevation, sandstone/quarzite						
312	Large stream, lower elevation, limestone						
313	Large stream, lower elevation, shale						
314	Large stream, lower elevation, granitic						
315	Large stream, lower elevation, charnokite/mylonite						
321	Large stream, higher elevation, sandstone/quarzite						
322	Large stream, higher elevation, limestone						
323	Large stream, higher elevation, shale						
411	Small river, lower elevation, sandstone/quarzite						
412	Small river, lower elevation, limestone						
413	Small river, lower elevation, shale						
414	Small river, lower elevation, granitic						
415	Small river, lower elevation, charnokite/mylonite						
421	Small river, higher elevation, sandstone/quarzite						
423	Small river, higher elevation, shale						
511	Large river, lower elevation, sandstone/quarzite						2.09
512	Large river, lower elevation, limestone		13.9				13.91
513	Large river, lower elevation, shale		20.6				20.62
TOTALS	Miles of stream habitat		34.5				36.6
WW	Woody wetland			26.47			185.7
EHW	Emergent herbaceous wetland	26.47		9.34	26.47	26.47	
PNCS	Pond not connected to a stream	3.56		5.56	3.56	3.56	
PCS	Pond connected to a stream	4.67		8.01	4.67	4.67	
LNCS	Lake not connected to a stream						
LCS	Lake connected to a stream						
TOTALS	Acres of lake habitat	34.7		49.38	34.7	34.7	185.7

Appendix 2. Detailed Habitat of Aquatic Species on the GWNF con't.

		Isonychia hoffmani	*Nemotaulius hostilis*	*Sorex palustris punctulatus*	*Clemmys guttata*	*Glyptemys insculpta*	*Anguilla rostrata*	*Anax longipes*
Habitat Code	Stream (miles) or Lake (acres) Habitat	Hoffman's Isonychia mayfly	limnephilid caddisfly	southern water shrew	spotted turtle	wood turtle	American eel	comet darner
111	Headwater, lower elevation, sandstone/quarzite					60.9		
112	Headwater, lower elevation, limestone					25.4		
113	Headwater, lower elevation, shale					29.0		
114	Headwater, lower elevation, granitic						15.5	
115	Headwater, lower elevation, charnokite/mylonite						8.1	
121	Headwater, higher elevation, sandstone/quarzite	10.2		6.8				
122	Headwater, higher elevation, limestone							
123	Headwater, higher elevation, shale					6.4		
124	Headwater, higher elevation, granitic							
125	Headwater, higher elevation, charnokite/mylonite							
211	Stream, lower elevation, sandstone/quarzite					38.3	64.8	
212	Stream, lower elevation, limestone					13.8	17.3	
213	Stream, lower elevation, shale					23.0		
214	Stream, lower elevation, granitic						9.7	
215	Stream, lower elevation, charkonite/mylonite						3.5	
221	Stream, higher elevation, sandstone/quarzite	0.6		0.6		6.3		
222	Stream, higher elevation, limestone							
223	Stream, higher elevation, shale							
224	Stream, higher elevation, granitic							
225	Stream, higher elevation, charkonite/mylonite							
311	Large stream, lower elevation, sandstone/quarzite					2.0		
312	Large stream, lower elevation, limestone					1.7		
313	Large stream, lower elevation, shale					4.0		
314	Large stream, lower elevation, granitic						4.0	
315	Large stream, lower elevation, charnokite/mylonite							
321	Large stream, higher elevation, sandstone/quarzite	3.5		2.7				
322	Large stream, higher elevation, limestone							
323	Large stream, higher elevation, shale							
411	Small river, lower elevation, sandstone/quarzite	0.1		0.1		2.5	15.7	
412	Small river, lower elevation, limestone					0.2		
413	Small river, lower elevation, shale					3.0	3.0	
414	Small river, lower elevation, granitic							
415	Small river, lower elevation, charnokite/mylonite						2.3	
421	Small river, higher elevation, sandstone/quarzite	3.2		3.3				
423	Small river, higher elevation, shale							
511	Large river, lower elevation, sandstone/quarzite							
512	Large river, lower elevation, limestone							
513	Large river, lower elevation, shale					1.3	1.8	
TOTALS	Miles of stream habitat	17.6		13.5		217.6	145.6	
WW	Woody wetland							26.47
EHW	Emergent herbaceous wetland		26.47		1.11			9.34
PNCS	Pond not connected to a stream		3.56		5.34			5.56
PCS	Pond connected to a stream		4.67					8.01
LNCS	Lake not connected to a stream							
LCS	Lake connected to a stream							
TOTALS	Acres of lake habitat		34.7		6.45			49.4

Appendix 3. Aquatic Species within GWNF Special Biological Areas

Group	SCIENTIFIC NAME	COMMON NAME	Big Levels	Browns Pond	Coal Road	Dabney Lancaster Shale Barren	Loves Run Ponds	Maple Flats	Maple Springs	Peters Mill Run	Pines Chapel Pond	Potts Pond	Powells Fort Camp
amphib	*Ambystoma tigrinum*	eastern tiger salamander	X				X	X			X		
insect/ odonate	*Aeshna tuberculifera*	black-tipped darner						X				X	
insect/ odonate	*Celithemis martha*	Martha's penant						X					
plant	*Boltonia montana*	no common name						X					
plant	*Carex aquatilis*	water sedge	X										
plant	*Carex barrattii*	Barratt's sedge						X					
plant	*Carex buxbaumii*	Buxbaum's sedge						X					
plant	*Carex vesicaria*	inflated sedge		X									
plant	*Cypripedium reginae*	showy lady's-slipper								X			X
plant	*Eleocharis melanocarpa*	black-fruited spikerush					X	X					
plant	*Eleocharis robbinsii*	Robbins spikerush						X					

Aquatic Species on the GWNF within Special Biological Areas, con't.

Group	SCIENTIFIC NAME	COMMON NAME	Big Levels	Browns Pond	Coal Road	Dabney Lancaster Shale Barren	Loves Run Ponds	Maple Flats	Maple Springs	Peters Mill Run	Pines Chapel Pond	Potts Pond	Powells Fort Camp
plant	*Eriocaulon aquaticum*	white buttons						X					
plant	*Helenium virginicum*	Virginia sneezeweed	X		X		X	X			X		
plant	*Helonias bullata*	swamp pink	X					X					
plant	*Hypericum boreale*	northern St. John's-wort					X	X					
plant	*Isoetes virginica*	Virginia quillwort						X					
plant	*Juncus brachycephalus*	small-head rush										X	
plant	*Liparis loeselii*	Loesel's twayblade								X			
plant	*Lycopodiella inundata*	northern bog clubmoss						X					
plant	*Panicum hemitomon*	maidencane						X					
plant	*Potamogeton oakesianus*	Oakes pondweed					X	X					
plant	*Sabatia campanulata*	slender marsh rose-pink						X					
plant	*Schoenoplectus subterminalis*	water bulrush						X					

Aquatic Species on the GWNF within Special Biological Areas, con't.

Group	SCIENTIFIC NAME	COMMON NAME	Big Levels	Browns Pond	Coal Road	Dabney Lancaster Shale Barren	Loves Run Ponds	Maple Flats	Maple Springs	Peters Mill Run	Pines Chapel Pond	Potts Pond	Powells Fort Camp
plant	*Scirpus ancistrochaetus*	northeastern bulrush							X			X	
plant	*Vaccinium macrocarpon*	large cranberry	X					X					
plant	*Vitis rupestris*	sand grape				X							
plant	*Woodwardia virginica*	Virginia chainfern					X						
reptile	*Clemmys guttata*	spotted turtle						X					

Appendix 4. Aquatic Species within Proposed Special Biological Areas

Group	SCIENTIFIC NAME	COMMON NAME	Cast Steel Pond	Cellar Mtn	Cold Springs Branch	Grassy Pond	Hidden Valley	Humpback Mtn	Indian Grave Ridge	James River Gorge	Laurel Fork	Mtn View Church	Overall Riverside	Pond Run Pond	Upper Crabtree	Upper St. Marys	Waterfall Mtn
amphib	*Ambystoma tigrinum*	eastern tiger salamander				X											
fish	*Notropis semperasper*	Roughhead shiner					X										
insect/ odonate	*Aeshna canadensis*	Canada darner									X						
insect/ odonate	*Aeshna tuberculifera*	black-tipped darner									X						
insect/ odonate	*Aeshna verticalis*	green-striped darner									X						
insect/ odonate	*Calopteryx amata*	Superb jewelwing									X						
insect/ odonate	*Cordulegaster diastatops*	delta-spotted spiketail									X						
insect/ odonate	*Enallagma annexum (AKA cyathigerum)*	northern bluet									X						

Aquatic Species on the GWNF within Proposed Special Biological Areas, con't.

Group	SCIENTIFIC NAME	COMMON NAME	Cast Steel Pond	Cellar Mtn	Cold Springs Branch	Grassy Pond	Hidden Valley	Humpback Mtn	Indian Grave Ridge	James River Gorge	Laurel Fork	Mtn View Church	Overall Riverside	Pond Run Pond	Upper Crabtree	Upper St. Marys	Waterfall Mtn
insect/ odonate	*Epitheca canis*	beaverpond baskettail									X						
insect/ odonate	*Ladona julia (AKA Libellula julia)*	chalk-fronted corporal skimmer									X						
insect/ odonate	*Lanthus parvulus*	double-striped clubtail									X						
insect/ odonate	*Lestes disjunctus*	northern spreadwing									X						
insect/ odonate	*Leucorrhinia hudsonica*	Hudsonian whiteface									X						
insect/ odonate	*Nehalennia irene*	sedge sprite									X						

Group	SCIENTIFIC NAME	COMMON NAME	Cast Steel Pond	Cellar Mtn	Cold Springs Branch	Grassy Pond	Hidden Valley	Humpback Mtn	Indian Grave Ridge	James River Gorge	Laurel Fork	Mtn View Church	Overall Riverside	Pond Run Pond	Upper Crabtree	Upper St. Marys	Waterfall Mtn
insect/ odonate	*Rhionaeschna mutata (AKA Aeshna mutata)*	spatterdock darner				X					X						
insect/ odonate	*Somatochlora elongata*	Ski-tipped emerald									X						
insect/ odonate	*Sympetrum obtrusum*	white-faced meadowhawk									X						
insect	*Isonychia hoffmani*	Hoffman's Isonychia mayfly									X						
mammal	*Sorex palustris punctulatus*	southern water shrew									X						
plant	*Eleocharis compressa*	flattened spikerush							X								
plant	*Epilobium leptophyllum*	linear-leaved willow-herb									X				X		
plant	*Glyceria grandis*	American manna-grass									X						
plant	*Helenium virginicum*	Virginia sneezeweed				X											

Aquatic Species on the GWNF within Proposed Special Biological Areas, con't.

Group	SCIENTIFIC NAME	COMMON NAME	Cast Steel Pond	Cellar Mtn	Cold Springs Branch	Grassy Pond	Hidden Valley	Humpback Mtn	Indian Grave Ridge	James River Gorge	Laurel Fork	Mtn View Church	Overall Riverside	Pond Run Pond	Upper Crabtree	Upper St. Marys	Waterfall Mtn
plant	*Helonias bullata*	swamp pink		X	X							X				X	
plant	*Juncus brevicaudatus*	narrow-panicled rush									X						
plant	*Liparis loeselii*	Loesel's twayblade															X
plant	*Muhlenbergia glomerata*	marsh muhly						X									
plant	*Polanisia dodecandra*	common clammy-weed								X							
plant	*Sagittaria calycina var calycina*	long-lobed arrowhead					X										
plant	*Scirpus ancistrochaetus*	northeastern bulrush	X											X			
plant	*Solidago rupestris*	riverbank goldenrod							X				X				
plant	*Solidago uliginosa*	bog goldenrod									X						
plant	*Sparganium chlorocarpum*	narrow-leaf burreed									X						
plant	*Spartina pectinata*	freshwater cordgrass								X							
plant	*Sphagnum russowii*	Russow's peatmoss									X						

Aquatic Species on the GWNF within Proposed Special Biological Areas, con't.

Group	SCIENTIFIC NAME	COMMON NAME	Cast Steel Pond	Cellar Mtn	Cold Springs Branch	Grassy Pond	Hidden Valley	Humpback Mtn	Indian Grave Ridge	James River Gorge	Laurel Fork	Mtn View Church	Overall Riverside	Pond Run Pond	Upper Crabtree	Upper St. Marys	Waterfall Mtn
plant	*Spiranthes ochroleuca*	yellow nodding ladies'-tresses									X						

Appendix 5. Watershed Analysis for GWNF Plan Revision.

The introduction, purpose and need, objectives, methods, and watershed parameters in the following analysis (except for the species information) are derived from A Watershed Analysis For Forest Planning on the George Washington & Jefferson National Forests, January 17, 2002, George Washington and Jefferson National Forests, Roanoke, Virginia.

INTRODUCTION

At the direction of the Regional Forester, a team was assembled to develop a watershed analysis process that would pertain directly to the forests under revision in the Southern Region. Watershed analysis at this scale is a relatively new concept and few examples exist to emulate. The team relied on the publication, Ecosystem Analysis at the Watershed Scale: Federal Guide for Watershed Analysis (1995 Version 2.2, Regional Interagency Executive Committee, Portland, Oregon), Inland West Watershed Reconnaissance efforts, White River National Forest Watershed Analysis, Chattoga River Ecosystem Demonstration Project and procedures used in the Ozark-Ouachita Highland Assessment.

PURPOSE AND NEED

The Federal Guide for Watershed Analysis (1995) defines Watershed Analysis as:

> A procedure to characterize the human, aquatic, riparian and terrestrial features, conditions, processes, and interactions within a watershed. It provides a systematic way to understand and organize ecosystem information. In doing so, watershed analysis enhances our ability to estimate direct, indirect and cumulative effects of our activities and guide the general type, location and sequence of appropriate management activities within a watershed.

The Forest Service has routinely debated and struggled to understand watershed condition, cumulative effects, and how management activities and human interactions impact aquatic resources. By approaching these issues spatially on a watershed scale it will add to our understanding of these processes and human interactions. Once we clearly understand the watershed processes and disturbances over time that creates the existing condition, we can then determine Sial needs and make better informed and science based management decisions for the future.

The Region 8 "Watershed Analysis Procedure" is a starting point for determining and ranking watershed health. The procedure follows a rapid characterization of 5th level Hydrologic Units, also referred to as watersheds in this document. Descriptive indicators of watershed condition and watershed vulnerability are used that are indicative of the relative health of a watershed. Watershed analysis must include complete watershed areas at the 5th field level. There the data represent private as well as public lands.

OBJECTIVES

The objective of the watershed analysis procedure is to provide an assessment of watershed health for 5th level watersheds containing portions of the George Washington and Jefferson National Forests. This assessment produces a comparison of watershed condition and

watershed vulnerability among these watersheds. From this assessment the Forest Planning Team should be able to:

- Incorporate watershed analysis into the Forest Plan revision process
- Discuss desired future conditions at the watershed scale,
- Facilitate discussion of effects of forest management activities at the watershed level,
- Prioritize watershed restoration needs,
- Determine riparian prescriptions based on watershed condition and vulnerability,
- Recommend alternative management emphases based on watershed health and
- Prioritize where subsequent finer detailed watershed assessments should occur. At the next lower scale.

A goal for watershed management in the East is to "save the best and restore the rest" where feasible. This assessment provides a basis for establishing management strategies that will help achieve this goal.

Overview of the Process

The EWAP is a rapid characterization of 5th level Hydrologic Units that are termed watersheds in this document. The assessment process follows a logical sequence that provides the basis for describing the existing conditions within a watershed in an objective and credible format:

A. Develop set of watershed parameters based on core set and any supplemental parameters;
B. Assemble pertinent data (appropriate GIS coverages, aquatic information, etc.);
C. Build database of information for each watershed based on a set of parameters already developed;
D. Rank the parameter values among watersheds;
E. Summarize ranks to derive condition and vulnerability scores per watershed; and
F. Compile results (graphics, data, ranks) into an assessment report.

METHODS

Recognizing time constraints within the revision process, the proposed watershed analysis relies only on existing or readily derived data sets. The following guidelines were adopted for the development of the watershed analysis process to insure consistency between each forest:

1. The resolution of data would be at Forest Planning scale (usually 1:100,000). Finer resolution could be used if the data were available for all the watersheds within the area of interest.
2. The watershed boundaries would follow 5th level Hydrologic Units as defined by NRCS / Multi-agency Maps. The Forest may choose to redefine some Hydrologic Unit boundaries as long as the watershed retained the 5th level size (40,000 - 250,000 acres). Watersheds (5th level Hydrologic Units) where National Forest land was inconsequential (less than 1 percent of the watershed) were dropped from analysis.
3. The data for the analysis (excluding watershed boundaries) would already exist or be

readily derived. The data would include non-Forest Service lands within the watershed.

4. Stream coverages would be represented by EPA RF3 stream reach streams.

The *Federal Guide* (referenced above) describes a six-step process for watershed analysis that sets the stage for subsequent decision-making. The information, organized by watershed, is to be used as a prelude to NEPA analysis and help prioritize ecological needs. Since the Southern Appalachian Forest Plan revision process is already well past issue identification and alternative development, the team decided to adapt the portions of the *Federal Guide* that would best fit the revision process. In brief, the watershed analysis process was based on parameters that described the existing physical and ecological conditions within a watershed as well as the parameters that are susceptible to change as a result of Forest Service management activities. Other parameters were used that reflected trends. These parameters formed the basis for ranking watersheds.

WATERSHED PARAMETERS

Core watershed parameters were identified (Table 1) that would be applicable on all forests. Further examination of the parameters revealed that the parameters grouped into two broad categories: condition and vulnerability. Condition parameters reflected natural and human factors that potentially affected watershed health. Vulnerability parameters denoted characteristics that could be changed (positive or negative) as a result of Forest Service management activities. The core parameters were grouped as shown in Table 1.

Road density and drainage density were derived data and the accuracy of information was recognized as being marginal at the 1; 100,000 scale. Both of these parameters were selected as core parameters since their information is very useful in comparison between watersheds and, together, they serve as an indirect measure of the density of road-stream crossings.

TABLE 1. Core Parameters for Watershed Analysis.

Category	Watershed Parameter	Data Managment	Data Source
Condition	National Forest ownership	Percent of national forest within the watershed	Forest Derived
	Road Density	Length of highway divided by watershed area expressed as a percentage	MAIA Data
	Forested Land Use	Percent of forest cover within the watershed	MAIA Data
	Mines	Number of mines found in the watershed	MAIA Data
	Agricultural land slopes > 3%	Spatial query of MAIA cropland or pasture land use and DEM slope coverage.	MAIA Derived
	Forested Riparian	Length of streams flowing through forested land cover divided by total length of streams in watershed	MAIA Data
	Road – riparian interaction	Percent of total stream length in each HUC that has road within 30 meters.	MAIA Derived

Category	Watershed Parameter	Data Managment	Data Source
	Point sources of pollution	Sum of ricris, cercla, pcs, and ifd sites	EPA - Basins data
	Recreation pressure	A ranking by the forest recreation staff of recreation pressure.	Forest Derived
	Impoundments	Number of dams found in the watershed	EPA - Basins data
	Native Fish	Number of native fish species divided by total number of fish species expressed as a percentage.	Forest Derived
Vulnerability	Erodible Soils	Percent of area with (Soil erodibility factor X sq. root of max slope range) greater than 1.20	NRCS STATSGO
	State Impaired Waters	Total length of impaired streams divided by total stream length expressed as a percentage.	Forest Derived
	Acid Deposition Sensitivity	Percent of watershed with high acid deposition sensitivity	Forest Derived
	Number Aquatic TES Species	Number of species found in watershed	Forest Derived
	Occurrences of TES species	Number of occurrences of TES species by watershed	Forest Derived
	Endemic Fish	Number of species found in watershed	Forest Derived
	Public Water Supply Sources	Number of drinking water sources found in the watershed	EPA - Basins data
	Drainage Density	Length of streams divided by watershed area expressed as a percentage.	MAIA Data

ANALYSIS FOR AQUATIC ECOLOGICAL SUSTAINABILITY 2010

A subset of the above parameters was used to characterize the GWNF watersheds for the 2010 aquatic ecological sustainability analysis. In addition, the number of aquatic TE, S, and LR within each watershed was tabulated (see Table 2). Birds and non-TE plants were not included in this analysis because species occurrence locations were not readily available in GIS format. In order to assess the importance of Forest lands to the species from an eco-regional and planning area perspective, it was noted whether the species occurrence was only on National Forest, on both National Forest and private land, or only on private land within each watershed (see Table 3). The potential habitat on the GWNF for individual species is detailed in Appendix 2, and can be used to assess the importance of Forest lands to species habitat from a unit perspective.

Table 2. Characterization of the 5th level watersheds containing GWNF land.

5th level HUC watersheds (2002)	percent GWNF	percent forested land use	percent riparian area in forested land use	road density	road-riparian interaction	point sources of pollution	no. dams	drainage density	public water supply sources	percent impaired streams	acid deposition sensitivity	total no. TE/S/LR	National Forest TE/S/LR	National Forest & Private TE/S/LR	Private TE/S/LR
0207000102	5.2%	88.1%	82.1%	1.22	3.920	7	0	1.15	2	20.3%	0.80	20	17	3	0
0207000106	29.4%	87.9%	81.7%	1.37	4.762	11	23	1.53	2	20.9%	1.00	2	0	1	1
0207000301	19.9%	87.4%	83.4%	1.44	5.030	20	6	1.41	0	4.4%	1.00	3	0	2	1
0207000501	9.8%	38.7%	40.2%	2.72	5.296	60	4	1.40	2	19.7%	0.36	1	0	0	1
0207000502	59.1%	74.7%	71.0%	1.59	4.600	15	10	1.42	2	7.3%	0.71	5	3	1	1
0207000504	19.6%	62.8%	63.3%	2.57	3.356	53	15	1.44	2	12.3%	0.41	11	5	4	2
0207000505	9.5%	66.9%	64.1%	2.08	3.501	24	4	1.71	2	13.2%	0.45	5	1	1	3
0207000506	7.4%	70.3%	66.9%	2.52	4.249	59	4	1.61	6	11.8%	0.35	3	0	2	1
0207000601	52.5%	91.0%	86.4%	1.50	5.019	0	4	1.52	0	0.0%	1.00	3	1	2	0
0207000602	5.5%	39.5%	44.1%	2.62	3.946	41	1	1.54	12	17.4%	0.22	4	1	0	3
0207000603	27.9%	65.3%	65.6%	2.47	4.307	70	9	1.62	7	2.3%	0.73	7	1	2	4
0207000604	18.8%	73.2%	78.3%	1.77	3.154	16	4	1.48	0	0.1%	0.69	3	0	3	0
0208020102	41.5%	92.4%	86.0%	1.10	4.088	2	1	1.47	1	0.0%	1.00	2	0	1	1
0208020103	26.4%	92.4%	87.2%	1.16	3.236	1	1	1.73	3	0.0%	1.00	7	2	1	4
0208020104	41.2%	86.3%	73.7%	1.32	3.360	13	5	1.48	0	0.0%	0.98	5	0	3	2
0208020105	38.3%	89.0%	82.6%	1.90	2.573	34	4	1.52	7	7.5%	1.00	8	0	1	7
0208020106	58.6%	91.0%	85.5%	1.32	2.480	3	3	1.59	0	0.0%	1.00	11	1	4	6
0208020107	5.0%	74.0%	66.7%	1.81	3.057	7	0	1.76	2	4.0%	0.59	7	0	0	7
0208020108	0.8%	91.7%	87.5%	1.16	2.624	5	4	1.69	0	0.0%	1.00	11	0	1	10
0208020201	58.8%	91.5%	87.5%	1.32	3.094	2	2	1.65	0	0.0%	1.00	7	1	1	5
0208020202	29.5%	85.8%	80.6%	2.03	4.672	0	1	1.85	0	1.2%	1.00	1	0	1	0
0208020203	9.0%	58.6%	54.0%	2.32	3.971	26	2	1.49	4	10.7%	0.30	4	1	0	3
0208020204	33.9%	71.1%	72.2%	1.60	3.039	0	3	1.30	0	0.0%	0.41	2	1	1	0
0208020301	16.2%	79.7%	79.2%	2.98	2.775	130	30	1.73	15	7.4%	0.16	6	0	1	5
0208020303	16.9%	81.3%	76.7%	1.86	2.995	5	4	1.52	0	0.0%	0.13	3	0	2	1
0208020304	8.4%	78.7%	76.3%	2.08	2.442	5	8	1.59	5	1.0%	0.22	2	0	2	0
0208020306	0.9%	87.7%	80.3%	1.71	4.452	4	9	1.63	2	1.2%	0.21	2	0	1	1

Table 3. Species occurrence by watershed and land ownership (NF = on National Forest only, NFP = on both National Forest and private land, P = on private land only).

SCIENTIFIC NAME	COMMON NAME	0207000102	0207000106	0207000301	0207000501	0207000502	0207000504	0207000505	0207000506	207000601	0207000602	0207000603	0207000604	0208020102	0208020103	0208020104	0208020105	0208020106	0208020107	0208020108	0208020201	0208020202	0208020203	0208020204	0208020301	0208020303	0208020304	0208020306
Pleurobema collina	James spinymussel														P			P	P	P	P				P			
Helenium virginicum	Virginia sneezeweed						NFP	P																				
Helonias bullata	swamp pink						NFP																	NF				
Scirpus ancistrochaetus	northeastern bulrush					NF	P	P							NF	P												
Notropis semperasper	Roughhead shiner													P	P	NFP	P	NFP	P	P	P							
Noturus gilberti	Orangefin madtom																	P		P								
Hydraena maureenae	Maureen's shale stream beetle									NF							P	NFP		P	NF							
Cicindela ancocisconensis	a tiger beetle																P	NFP										
Sorex palustris punctulatus	southern water shrew	NFP														NFP												
Alasmidonta varicosa	Brook floater								P		P	P																
Elliptio lanceolata	Yellow lance																P	P	P	P			P		P			
Fusconaia masoni	Atlantic pigtoe																		P	P	P							
Lasmigona subviridis	Green floater											P													P	P		
Villosa constricta	Notched Rainbow														P			P	P	P			P		P			
Ambystoma tigrinum	eastern tiger salamander						NFP																					
Cambarus monongalensis	A Crayfish	NF																										
Anguilla rostrata	American eel				P	P	P	P	NFP		P	P	NFP							P					P	NFP	NFP	P
Salvelinus fontinalus	Brook trout	NFP	NFP	NFP		NFP	NFP	NFP	NFP	NFP	NF	NFP	NFP	NFP	NFP	NFP	NFP	NFP	P	NFP	NFP	NFP	NF	NFP	NFP	NFP	NFP	NFP
Aeshna canadensis	Canada darner	NF																										
Cottus cf. cognatus	Checkered sculpin			P																								
Aeshna tuberculifera	black-tipped darner	NF				NF	NF	NF							NF		P		P									
Aeshna verticalis	green-striped darner	NF																										
Anax longipes	comet						NF																					

SCIENTIFIC NAME	COMMON NAME	0207000102	0207000106	0207000301	0207000501	0207000502	0207000504	0207000505	0207000506	207000601	0207000602	0207000603	0207000604	0208020102	0208020103	0208020104	0208020105	0208020106	0208020107	0208020108	0208020201	0208020202	0208020203	0208020204	0208020301	0208020303	0208020304	0208020306
	darner																											
Calopteryx amata	Superb jewelwing	NF																										
Calopteryx angustipennis	Appalachian jewelwing											NF						NF		P			P					
Celithemis martha	Martha's penant						NF																					
Cordulegaster diastatops	delta-spotted spiketail	NF																										
Enallagma annexum (AKA cyathigerum)	northern bluet	NF																										
Epitheca canis	beaverpond baskettail	NF																										
Gomphus adelphus	mustached clubtail																	P			P							
Gomphus quadricolor	rapids clubtail																	P		P	P							
Ladona julia (AKA Libellula julia)	chalk-fronted corporal skimmer	NF																										
Lanthus parvulus	double-striped clubtail	NF P																										
Lestes disjunctus	northern spreadwing	NF														P	P											
Leucorrhinia hudsonica	Hudsonian whiteface	NF																										
Nehalennia irene	sedge sprite	NF																										
Neurocordulia yamaskanensis	stygian shadowdragon											P					P											
Rhionaeschna mutata (AKA Aeshna mutata)	spatterdock darner	NF													P													
Somatochlora elongata	Ski-tipped emerald	NF																										
Sympetrum obtrusum	white-faced meadowhawk	NF																										
Isonychia hoffmani	Hoffman's Isonychia mayfly	NF																										
Nemotaulius hostilis	a limnephilid caddisfly	NF																										
Clemmys guttata	spotted turtle						NF																					
Glyptemys insculpta	wood turtle		P	NF P						NF P	P	NF P	NF P															

Appendix 6. Aquatic species dropped from further consideration.

Species Name	Common Name	Taxa	Forest	NatureServe Global Rank	Virginia DNH Rank	West Virginia NHP Rank	Va State Con Concern Plan (WAP)	West Va State Con Concern Plan (WAP)	Hunted or Public Interest (Y or N)	Known occurrences on Forest?	Final Plan Species Categories	Rationale
Ixobrychus exilis exilis	least bittern	Bird	?	G5	S2B/S3N	S1B	Y		N	?	DROP	not known from FS
Rallus elegans	King rail	Bird	GWJ	G4	S2B/S3N	S1B	Y	Y	N	?	DROP	not known from FS
Cottus cognatus	slimy sculpin	Fish	GW	G5	S2	S1	Y	Y	N	N	DROP	LR, Not on FS. In Virginia known from cold, alkaline spring-fed brooks with strong flows. These are found mainly in valley bottoms. (from Jenkins' Fishes of Virginia). South Branch Potomac, South Fork Shenandoah.
Cottus girardi	Potomac sculpin	Fish	GW	G4	S3	S3	N	Y	N	Y	DROP	LR, Not S1 or S2, or VASOC
Margariscus margarita	pearl dace	Fish	GW	G5	S3S4	S3S4	Y	Y	N	N	DROP	LR, not on FS, not S1 or S2
Percina rex	Roanoke logperch	Fish	J	G1G2	S1S2		Y	N	N	N	DROP	NOT ON THE GWNF (only on the Jeff)!
Hansonoperla appalachia	Appalachian stonefly	Insect	GWJ	G3	S1S3	S2	Y	Y	N	N	DROP	LR not known from FS, not a lot of info
Isonychia tusculanensis	a mayfly	Insect	J	G4	S2		Y	N	N	N	DROP	Not on GW
Leuctra mitchellensis	Mitchell needlefly	Insect	?	G3	S1S2		Y	N	N	N	DROP	LR not known from FS, not a lot of info
Leuctra monticola	montane needlefly	Insect	J	G1Q	S1		Y	N	N	N	DROP	Not on GW
Megaleuctra flinti	Shenandoah needlefly	Insect	GW	G2	S2	S1	Y	Y	N	N	DROP	LR not known from FS, not a lot of info
Paragnetina ishusa	widecollar stonefly	Insect	GW	G3G4	S1S3		Y	N	N	N	DROP	LR not known from FS, not a lot of info
Paraleptophlebia jeanae	a mayfly	Insect	?	G3G4	S1S3		Y	N	N	N	DROP	LR not known from FS, not a lot of info
Perlesta frisoni	Blue Ridge stonefly	Insect	GWJ	G3G4	S1S2		Y	N	N	N	DROP	LR not known from FS, not a lot of info
Alasmidonta undulata	triangle floater	Mollusk	GW	G4	S3S4	S1	Y	Y	N	N	DROP	LR, not on FS

Species Name	Common Name	Taxa	Forest	NatureServe Global Rank	Virginia DNH Rank	West Virginia NHP Rank	Va State Con Concern Plan (WAP)	West Va State Con Concern Plan (WAP)	Hunted or Public Interest (Y or N)	Known occurrences on Forest?	Final Plan Species Categories	Rationale
Lampsilis cariosa	yellow lampmussel	Mollusk	GW	G3	S2	S1	Y	Y	N	N	DROP	LR, not on FS
Arigomphus furcifer	lilypad clubtail	Odonata	GW	G5	SH		Y	N	N	N	DROP	LR, possibly extirpated
Gomphus borealis	beaverpond clubtail	Odonata	GW	G4	SH		Y	N	N	N	DROP	LR, possibly extirpated
Gomphus descriptus	harpoon clubtail	Odonata	GW	G4	S1	S3	Y	Y	N	N	DROP	LR, not on FS
Leucorrhinia frigida	frosted whiteface	Odonata	GW	G5	SH		Y	N	N	N	DROP	LR, possibly extirpated
Somatochlora williamsoni	Williamson's emerald	Odonata	GW	G5	SH		Y	N	N	N	DROP	LR, possibly extirpated
Gomphus viridifrons	green-faced clubtail	Odonata	GW	G3	S2	S3	Y	Y	N	N	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comments that it is not on the GWNF
Cordulia shurtleffi	American emerald	Odonata	GW	G5	S3	S3	N	N	N	Y	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comments that it is S3 and should be deleted from LR list
Enallagma hageni	Hagen's bluet	Odonata	GW	G5	S3	S3S4	N	N	N	Y	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comments that it is S3 and should be deleted from LR list
Leucorrhinia intacta	dot-tailed whiteface	Odonata	GW	G5	S3	S3	N	N	N	Y	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comments that it is S3 and should be deleted from LR list
Nehalennia integricollis	southern sprite	Odonata	GW	G5	S3	-	N	N	N	Y	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comments that it is S3 and should be deleted from LR list
Tramea onusta	red-mantled glider	Odonata	GW	G5	S1	-	Y	N	N	Y	DROP	Dropped on 2/3/2009 as per 12/2/2008 Roble comment that this spp. Is probably just a casual visitor to VA, and should be deleted from list.

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Appendix H Terrestrial and Aquatic Species Viability Tables

Table H-1. Terrestrial Species Priority and Species Groups.

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Apochthonius holsingeri	A cave pseudoscorpion	G1	U1	Caves					
Boltonia montana	no common name	G1	U1	Riparian	Special Biologic Area				
Corallorhiza bentleyi	Bentley's coalroot	G1	U1	Occurrence Protection					
Helicodiscus diadema	Shaggy coil	G1	U1	Calciphiles	Occurrence Protection				
Kleptochthonius anophthalmus	A cave pseudoscorpion	G1	U1	Caves					
Nampabius turbator	Cave centipede	G1	U1	Calciphiles	Caves				
Nannaria shenandoah	Shenandoah Mountain xystodesmid	G1	U1	Occurrence Protection					
Pygmarrhopalites sacer	Cave springtail	G1	U1	Calciphiles	Caves				
Pygmarrhopalites caedus	A cave springtail	G1	U1	Caves	Occurrence Protection				
Pyrgus wyandot	Appalachian grizzled skipper	G1	U1	Fire Dependent/ Enhanced	Lepidopterans	Open Woodlands	Sensitive to Over-Collection	Shale barrens	Special Biologic Area
Iliamna remota	Kankakee globe-mallow	G1	UP	Riparian					
Leuctra monticola	montane needlefly	G1	UP	Riparian					
Pseudanophthalmus avernus	Avernus cave beetle	G1	UP	Calciphiles	Caves				
Pseudanophthalmus intersectus	Crossroads cave beetle	G1	UP	Calciphiles	Caves				
Pseudanophthalmus nelsoni	Nelson's cave beetle	G1	UP	Calciphiles	Caves				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	G1	UP	Calciphiles	Caves				
Pseudotremia princeps	South Branch Valley cave millipede	G1	UP	Calciphiles	Caves				
Stygobromus hoffmani	Alleghany County cave amphipod	G1	UP	Calciphiles	Caves				
Buckleya distichophylla	Piratebush	G2	U1	Fire Dependent/ Enhanced	Occurrence Protection				
Carex roanensis	Roan Mountain sedge	G2	U1	Occurrence Protection	Special Biologic Area				
Echinacea laevigata	smooth coneflower	G2	U1	Calciphiles	Fire Dependent/ Enhanced	Open Woodlands	Special Biologic Area		
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	G2	U1	Area Sensitive Mature Forest	High Elevation Forests	Riparian	Special Biologic Area		
Glyphyalinia raderi	Maryland glyph	G2	U1	Calciphiles	Occurrence Protection				
Helicodiscus triodus	Talus coil	G2	U1	Calciphiles	Occurrence Protection				
Myotis sodalis	Indiana bat	G2	U1	Area Sensitive Mature Forest	Caves	Cavity, Den, Snags	Occurrence Protection	Open Woodlands	Riparian
Plethodon sherando	Big levels salamander	G2	U1	Open Woodlands	Special Biologic Area				
Potamogeton tennesseensis	Tennessee pondweed	G2	U1	Riparian					
Pycnanthemum torreyi	Torrey's mountain-mint	G2	U1	Calciphiles	Mafic rocks	Open Woodlands			
Pygmarrhopalites carolynae	Cave springtail	G2	U1	Calciphiles	Caves				
Stygobromus mundus	Bath County cave amphipod	G2	U1	Calciphiles	Caves				
Trillium pusillum var. virginianum	mountain least trillium	G2	U1	High Elevation Forests	Special Biologic Area				
Arabis serotina	shale barren rockcress	G2	U2	Fire Dependent/ Enhanced	Shale barrens	Special Biologic Area			
Clematis viticaulis	Millboro leatherflower	G2	U2	Shale barrens	Special Biologic Area				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Heuchera alba	white alumroot	G2	U2	High Elevation Forests	Occurrence Protection	Special Biologic Area			
Hydraena maureenae	Maureen's shale stream beetle	G2	U2	Riparian					
Phlox buckleyi	sword-leaved phlox	G2	U2	Fire Dependent/ Enhanced	Occurrence Protection	Ruderal	Special Biologic Area		
Plethodon virginia	Shenandoah Mt. salamander	G2	U2	Area Sensitive Mature Forest	High Elevation Forests	Late Successional Hardwood	Special Biologic Area	Cliff, Talus, outcrops	
Stygobromus sp. 7	Sherando spinosid amphipod	G2	U2	Calciphiles	Caves				
Stygobromus sp. nov.	Massanutten Spring Amphipod	G2	U2	Calciphiles	Caves				
Thryomanes bewickii altus	Appalachian Bewick's wren	G2	UH	High Elevation Openings	Cavity, Den, Snags	Grasslands	Shrublands		
Megaleuctra flinti	Shenandoah needlefly	G2	UP	Riparian					
Paxistima canbyi	Canby's mountain lover	G2	UP	Calciphiles	Cliff, Talus, outcrops				
Stygobromus morrisoni	Morrison's cave amphipod	G2	UP	Calciphiles	Caves				
Erora laeta	Early hairstreak	GU	U1	Lepidopterans	Occurrence Protection				
Callophrys irus	Frosted elfin	G3	U1	Fire Dependent/ Enhanced	Lepidopterans	Occurrence Protection	Open Woodlands		
Cicindela ancocisconensis	a tiger beetle	G3	U1	Riparian					
Cicindela patruela	Barrens tiger beetle	G3	U1	Ruderal	Sandstone glades and barrens	Special Biologic Area			
Clematis coactilis	Virginia white-haired leatherflower	G3	U1	Shale barrens					
Hypericum mitchellianum	Blue Ridge St. John's-wort	G3	U1	High Elevation Forests	High Elevation Openings	Occurrence Protection	Special Biologic Area		
Microtus chrotorrhinus carolinensis	Southern rock vole	G3	U1	High Elevation Forests	Riparian				
Myotis leibii	eastern small-footed bat	G3	U1	Caves	Cliff, Talus, outcrops	Occurrence Protection			
Poa paludigena	bog bluegrass	G3	U1	Riparian					

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Scirpus ancistrochaetus	northeastern bulrush	G3	U1	Riparian	Special Biologic Area				
Sorex palustris punctulatus	southern water shrew	G3	U1	High Elevation Forests	Riparian	Special Biologic Area			
Stygobromus gracilipes	Shenandoah Valley cave amphipod	G3	U1	Calciphiles	Caves				
Vitis rupestris	sand grape	G3	U1	Special Biologic Area	Riparian				
Arabis patens	Spreading rockcress	G3	U2	Shale barrens					
Carex polymorpha	variable sedge	G3	U2	Fire Dependent/ Enhanced	Occurrence Protection	Special Biologic Area			
Gaylussacia brachycera	box huckleberry	G3	U2	Fire Dependent/ Enhanced	Occurrence Protection	Special Biologic Area			
Gymnocarpium appalachianum	Appalachian oak fern	G3	U2	High Elevation Forests	Occurrence Protection	Special Biologic Area			
Helenium virginicum	Virginia sneezeweed	G3	U2	Riparian	Special Biologic Area				
Helonias bullata	swamp-pink	G3	U2	Special Biologic Area	Riparian				
Plethodon punctatus	Cow Knob salamander	G3	U2	Area Sensitive Mature Forest	High Elevation Forests	Late Successional Hardwood	Special Biologic Area	Cliff, Talus, outcrops	
Speyeria diana	Diana fritillary	G3	U2	Lepidopterans	Open Woodlands	Sensitive to Over-Collection			
Triphora trianthophora	nodding pogonia	G3	U2	Special Biologic Area	Occurrence Protection				
Zygonopus weyeriensis	Grand Caverns blind cave millipede	G3	U2	Calciphiles	Caves				
Juglans cinerea	butternut	G3	U3	Occurrence Protection					
Liatris helleri	shale -barren blazing star	G3	U3	Shale barrens					
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	G3	U3	Caves					
Monotropsis odorata	sweet pinesap	G3	U3	Occurrence Protection	Special Biologic Area				
Neotoma magister	Alleghany woodrat	G3	U3	Caves	Cliff, Talus, outcrops	Late Successional Hardwood			
Oenothera argillicola	Shale-barren evening primrose	G3	U3	Shale barrens					

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Panax quinquefolius	Ginseng	G3	U3	Cove forests	Sensitive to Over-Collection				
Ruellia purshiana	Pursh's wild petunia	G3	U3	Alkaline glades and barrens	Calciphiles	Fire Dependent/ Enhanced	Mafic rocks		
Scutellaria saxatilis	Rock skullcap	G3	U3	Cliff, Talus, outcrops	Open Woodlands				
Taenidia montana	Virginia mountain pimpernel	G3	U3	Shale barrens					
Trifolium virginicum	Kate's mountain clover	G3	U3	Special Biologic Area	Shale barrens				
Peltigera hydrothyria	Waterfan	G3	U4	Riparian					
Erynnis martialis	Mottled duskywing	G3	UH	Area Sensitive Shrubland and Open Woodlands	Fire Dependent/ Enhanced	Lepidopterans	Occurrence Protection	Special Biologic Area	
Speyeria idalia	Regal fritillary	G3	UH	Area Sensitive Grasslands.	Lepidopterans	Sensitive to Over-Collection			
Virginia valeriae pulchra	mountain earth snake	G3	UH	Grasslands	Open Woodlands	Shrublands			
Carex schweinitzii	Schweinitz's sedge	G3	UP	Riparian					
Catocala herodias gerhardi	Herodias underwing	G3	UP	Lepidopterans	Occurrence Protection	Open Woodlands			
Catocala marmorata	Marbled underwing	G3	UP	Lepidopterans	Occurrence Protection	Riparian			
Delphinium exaltatum	tall larkspur	G3	UP	Calciphiles	Fire Dependent/ Enhanced	Open Woodlands			
Euphorbia purpurea	glade spurge	G3	UP	Calciphiles	Riparian				
Hansonoperla appalachia	Appalachian stonefly	G3	UP	Riparian					
Leuctra mitchellensis	Mitchell needlefly	G3	UP	Riparian					
Paragnetina ishusa	widecollar stonefly	G3	UP	Riparian					
Paraleptophlebia jeanae	a mayfly	G3	UP	Riparian					

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Parnassia grandifolia	Large-leaved grass-of-parnassus	G3	UP	Riparian					
Perlesta frisoni	Blue Ridge stonefly	G3	UP	Riparian					
Phlox amplifolia	Broadleaf phlox	G3	UP	Calciphiles	Occurrence Protection				
Semionellus placidus	Millipede	G3	UP	Late Successional Hardwood	Occurrence Protection				
Sida hermaphrodita	Virginia mallow	G3	UP	Riparian					
Triodopsis picea	Spruce Knob threetooth	G3	UP	Occurrence Protection					
Zygonopus whitei	Luray Caverns blind cave millipede	G3	UP	Calciphiles	Caves				
Adlumia fungosa	Climbing fumatory	G4	U1	Occurrence Protection					
Arnoglossom muehlenbergii	great Indian-plantain	G4	U1	Fire Dependent/ Enhanced	Grasslands	Occurrence Protection	Riparian	Ruderal	
Carex barrattii	Barratt's sedge	G4	U1	Riparian	Special Biologic Area				
Corynorhinus townsendii virginianus	Virginia big-eared bat	G4	U1	Area Sensitive Mature Forest	Caves	Occurrence Protection			
Cuscuta rostrata	beaked dodder	G4	U1	High Elevation Openings	Occurrence Protection	Special Biologic Area			
Cypripedium reginae	showy lady's-slipper	G4	U1	Occurrence Protection	Riparian	Sensitive to Over-Collection	Special Biologic Area		
Eleocharis compressa	flat-stemmed spikerush	G4	U1	Riparian					
Eleocharis melanocarpa	black-fruited spikerush	G4	U1	Riparian	Special Biologic Area				
Eleocharis robbinsii	Robbins spikerush	G4	U1	Riparian	Special Biologic Area				
Euchloe olympia	Olympia marble	G4	U1	Lepidopterans	Open Woodlands	Shale barrens			
Lanius ludovicianus	loggerhead shrike	G4	U1	Area Sensitive Grasslands.	Grasslands	Shrublands			
Paronychia argyrocoma	Silver Nail-wort	G4	U1	Shale barrens					
Potamogeton oakesianus	Oakes pondweed	G4	U1	Riparian	Special Biologic Area				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Schoenoplectus subterminalis	water bulrush	G4	U1	Riparian	Special Biologic Area				
Scutellaria parvula var. parvula	small skullcap	G4	U1	Calciphiles	Cliff, Talus, outcrops	Open Woodlands			
Solidago randii = S. simplex var. randii	Rand's goldenrod	G4	U1	Special Biologic Area	Mafic rocks				
Solidago rupestris	riverbank goldenrod	G4	U1	Special Biologic Area	Riparian				
Solidago uliginosa	bog goldenrod	G4	U1	Special Biologic Area	Riparian				
Spiranthes ochroleuca	yellow nodding ladies'-tresses	G4	U1	Riparian	Open Woodlands	Special Biologic Area			
Vaccinium macrocarpon	large cranberry	G4	U1	Special Biologic Area	Riparian				
Autochton cellus	Golden-banded skipper	G4	U2	Lepidopterans	Riparian				
Clematis albicoma	White-haired Leatherflower	G4	U2	Shale barrens					
Polygonia progne	Gray comma	G4	U2	Grasslands & Shrublands	Lepidopterans	Riparian	Open Woodlands	Ruderal	Special Biologic Area
Prunus alleghaniensis	Alleghany sloe	G4	U2	Fire Dependent/ Enhanced	Open Woodlands	Shale barrens			
Satyrium favonius ontario	Northern Hairstreak	G4	U2	Lepidopterans	Occurrence Protection	Open Woodlands			
Sylvilagus obscurus	Appalachian Cottontail	G4	U2	High Elevation Forests	High Elevation Openings	Riparian			
Vermivora chrysoptera	golden winged warbler	G4	U2	Area Sensitive Grassland, Shrubland, Open Woodlands	High Elevation Openings	Fire Dependent/ Enhanced	Grasslands & Shrublands	Riparian	Open Woodlands
Crotalus horridus	Timber rattlesnake	G4	U3	Cliff, Talus, outcrops	Sensitive to Over-Collection				
Dendroica cerulea	cerulean warbler	G4	U3	Area Sensitive Mature Forest	Late Successional Hardwood	Riparian			
Eriogonum allenii	Yellow Buckwheat	G4	U3	Shale barrens					
Glyptemys insculpta	wood turtle	G4	U3	Late Successional Hardwood	Riparian	Open Woodlands	Sensitive to Over-Collection	Shrublands	Grasslands

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Solidago arguta var. harrisii	Shale Barren Goldenrod	G4	U3	Shale barrens					
Contopus borealis	olive-sided flycatcher	G4	UH	High Elevation Forests	High Elevation Openings	Riparian	Special Biologic Area	Cavity, Den, Snags	
Falco peregrinus	peregrine falcon	G4	UH	Cliff, Talus, outcrops	Occurrence Protection	Open Woodlands			
Phyciodes batesii	Tawny crescent	G4	UH	Lepidopterans	Occurrence Protection				
Pituophis melanoleucus	northern pinesnake	G4	UH	Fire Dependent/ Enhanced	Occurrence Protection	Open Woodlands			
Houstonia canadensis	Canada bluets	G4	UNP	Alkaline glades and barrens	Calciphiles	Special Biologic Area			
Ammodramus henslowii	Henslow's sparrow	G4	UP	Area Sensitive Grasslands.	Occurrence Protection				
Cyperus dentatus	toothed flatsedge	G4	UP	Riparian					
Helianthemum propinquum	low frostweed	G4	UP	Open Woodlands					
Huperzia appalachiana	Appalachian fir clubmoss	G4	UP	High Elevation Forests	Riparian				
Isonychia tusculanensis	a mayfly	G4	UP	Riparian					
Linum lewisii	prairie flax	G4	UP	Calciphiles	Cliff, Talus, outcrops	Open Woodlands			
Onosmodium virginianum	Virginia false-gromwell	G4	UP	Fire Dependent/ Enhanced	Open Woodlands	Calciphiles			
Paronychia virginica	yellow nailwort	G4	UP	Calciphiles	Cliff, Talus, outcrops	Shale barrens			
Prunus nigra	Canada plum	G4	UP	Ruderal	Shrublands				
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	G4	UP	Cliff, Talus, outcrops	Open Woodlands	Calciphiles			
Aegolius acadicus	northern saw-whet owl	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	Cavity, Den, Snags	Riparian	Special Biologic Area	
Alnus incana ssp. rugosa	speckled alder	G5	U1	Riparian					

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Ambystoma tigrinum	Eastern tiger salamander	G5	U1	Late Successional Hardwood	Riparian	Special Biologic Area			
Anaphalis margaritacea	pearly everlasting	G5	U1	Fire Dependent/ Enhanced	Grasslands	Shrublands	Special Biologic Area		
Bromus kalmii	wild chess	G5	U1	Fire Dependent/ Enhanced	Shale barrens	Special Biologic Area			
Campanula rotundifolia	American harebell	G5	U1	Calciphiles	Cliff, Talus, outcrops	Special Biologic Area			
Caprimulgus carolinensis	chuck-will's widow	G5	U1	Area Sensitive Grassland, Shrubland, Open Woodlands	Fire Dependent/ Enhanced	Open Woodlands	Regenerating Forests		
Carex aquatilis	water sedge	G5	U1	Riparian	Special Biologic Area				
Carex arctata	black sedge	G5	U1	Riparian	Special Biologic Area				
Carex buxbaumii	Buxbaum's sedge	G5	U1	Riparian	Special Biologic Area				
Carex lasiocarpa var. americana	slender sedge	G5	U1	Riparian	Special Biologic Area				
Carex vesicaria		G5	U1	Riparian	Special Biologic Area				
Carpodacus purpureus	purple finch	G5	U1	High Elevation Openings	High Elevation Forests	Special Biologic Area			
Catharus guttatus	hermit thrush	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	High Elevation Openings	Special Biologic Area		
Cheilanthes eatonii	chestnut lipfern	G5	U1	Cliff, Talus, outcrops	Shale barrens	Special Biologic Area			
Cirsium altissimum	tall thistle	G5	U1	Ruderal	Special Biologic Area				
Clemmys guttata	spotted turtle	G5	U1	Riparian	Special Biologic Area				
Colias interior	Pink-edged sulphur	G5	U1	Lepidopterans	Riparian	Special Biologic Area			
Colinus virginianus	northern bobwhite	G5	U1	Area Sensitive Grassland, Shrubland, Open Woodlands	Fire Dependent/ Enhanced	Grasslands	Open Woodlands	Shrublands	
Cornus canadensis	bunchberry	G5	U1	High Elevation Forests	Occurrence Protection	Special Biologic Area			
Cornus rugosa	roundleaf dogwood	G5	U1	Occurrence Protection	Special Biologic Area				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Crataegus pruinosa	prunose hawthorn	G5	U1	Fire Dependent/ Enhanced	Occurrence Protection	Special Biologic Area			
Cuscuta coryli	hazel dodder	G5	U1	Cliff, Talus, outcrops	Occurrence Protection				
Cystopteris fragilis	fragile fern	G5	U1	Cliff, Talus, outcrops	Special Biologic Area				
Dendroica fusca	blackburnian warbler	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	Special Biologic Area			
Dendroica magnolia	magnolia warbler	G5	U1	High Elevation Forests	Regenerating Forests	Special Biologic Area	Riparian		
Elymus trachycaulus	slender wheatgrass	G5	U1	Fire Dependent/ Enhanced	Shale barrens	Special Biologic Area			
Epilobium leptophyllum	linear-leaved willow-herb	G5	U1	Riparian	Special Biologic Area				
Equisetum sylvaticum	woodland horsetail	G5	U1	Special Biologic Area	Riparian				
Eriocaulon aquaticum	white buttons	G5	U1	Riparian	Special Biologic Area				
Erynnis persius	Persius duskywing	G5	U1	Grasslands	Lepidopterans	Riparian	Shrublands		
Erysimum capitatum	western wallflower	G5	U1	Open Woodlands	Shale barrens	Special Biologic Area			
Glyceria grandis	American manna-grass	G5	U1	Riparian	Special Biologic Area				
Gnaphalium uliginosum	low cudweed	G5	U1	High Elevation Openings	Riparian	Ruderal	Special Biologic Area		
Haliaeetus leucocephalus	bald eagle	G5	U1	Occurrence Protection	Riparian				
Helianthemum bicknellii	plains frostweed	G5	U1	Cliff, Talus, outcrops	Open Woodlands	Sandstone glades and barrens	Special Biologic Area		
Hypericum boreale	northern St. John's-wort	G5	U1	Riparian					
Incisalia polia	Hoary elfin	G5	U1	Grasslands	Lepidopterans	Sandstone glades and barrens	Shrublands		
Isoetes lacustris	lake quillwort	G5	U1	Riparian	Special Biologic Area				
Juncus brachycephalus	small-head rush	G5	U1	Special Biologic Area	Riparian				
Juncus brevicaudatus	narrow-panicled rush	G5	U1	Special Biologic Area	Riparian				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Juniperus communis var depressa	ground juniper	G5	U1	High Elevation Openings	Special Biologic Area	Calciphiles			
Lepus americanus	snowshoe hare	G5	U1	High Elevation Forests	High Elevation Openings	Regenerating Forests	Special Biologic Area		
Leucothoe fontanesiana	highland dog-hobble	G5	U1	Cove forests	Occurrence Protection	Special Biologic Area			
Liparis loeselii	Loesel's twayblade	G5	U1	Riparian	Special Biologic Area				
Lonicera canadensis	American fly-honeysuckle	G5	U1	High Elevation Forests	Riparian				
Loxia curvirostra	red crossbill	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	Special Biologic Area			
Martes pennanti	fisher	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	Special Biologic Area			
Melospiza georgiana	swamp sparrow	G5	U1	High Elevation Openings	Riparian				
Minuartia groenlandica	mountain sandwort	G5	U1	Cliff, Talus, outcrops	Sensitive to Recreation Traffic	Special Biologic Area			
Muhlenbergia glomerata	marsh muhly	G5	U1	Mafic rocks	Special Biologic Area	Riparian			
Oligoneuron rigidum	stiff goldenrod	G5	U1	Calciphiles	Open Woodlands	Special Biologic Area			
Oporornis philadelphia	mourning warbler	G5	U1	High Elevation Forests	High Elevation Openings	Regenerating Forests	Fire Dependent/ Enhanced		
Oryzopsis asperifolia	white-grained mtn-ricegrass	G5	U1	Open Woodlands	Shrublands	Special Biologic Area			
Osmunda cinnamomea var. glandulosa	glandular cinnamon fern	G5	U1	Special Biologic Area	Riparian				
Panax trifolius	Dwarf ginseng	G5	U1	Cove forests	Sensitive to Over-Collection				
Panicum hemitomon	maidencane	G5	U1	Riparian	Special Biologic Area				
Platanthera grandiflora	large purple fringed orchid	G5	U1	Riparian	Sensitive to Over-Collection	Special Biologic Area			
Platanthera peramoena	purple fringeless orchid	G5	U1	Riparian	Sensitive to Over-Collection				

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Poa palustris	fowl bluegrass	G5	U1	Riparian	Special Biologic Area				
Potentilla arguta	tall cinquefoil	G5	U1	Mafic rocks	Special Biologic Area				
Pyrola elliptica	shinleaf	G5	U1	High Elevation Forests	Occurrence Protection	Special Biologic Area			
Regulus satrapa	golden-crowned kinglet	G5	U1	High Elevation Forests	Special Biologic Area				
Ribes americanum	wild black currant	G5	U1	Special Biologic Area	Riparian				
Rubus idaeus ssp. strigosus	American red raspberry	G5	U1	High Elevation Openings	Special Biologic Area				
Sabatia campanulata	slender marsh rose-pink	G5	U1	Special Biologic Area	Riparian				
Sagittaria calycina var calycina	long-lobed arrowhead	G5	U1	Special Biologic Area	Riparian				
Schizachne purpurascens	purple oat-grass	G5	U1	High Elevation Forests	Special Biologic Area	Riparian			
Seiurus noveboracensis	northern waterthrush	G5	U1	Area Sensitive Mature Forest	High Elevation Forests	Special Biologic Area	Riparian		
Sibbaldiopsis tridentata	three-toothed cinquefoil	G5	U1	Cliff, Talus, outcrops	Sensitive to Recreation Traffic	Special Biologic Area			
Sitta canadensis	red-breasted nuthatch	G5	U1	Cavity, Den, Snags	High Elevation Forests	Special Biologic Area			
Speyeria atlantis	Atlantis fritillary	G5	U1	Lepidopterans	Special Biologic Area	Riparian			
Sphagnum russowii	Russow's peatmoss	G5	U1	Special Biologic Area	Riparian				
Symphoricarpos albus	snowberry	G5	U1	Calciphiles	Cliff, Talus, outcrops	Special Biologic Area			
Thuja occidentalis	bristly sarsaparilla	G5	U1	Cliff, Talus, outcrops	Special Biologic Area	Calciphiles			
Triantha racemosa	coastal false-asphodel	G5	U1	Riparian	Special Biologic Area				
Trichostema setaceum	narrow-leaved blue curls	G5	U1	Open Woodlands	Shale barrens	Special Biologic Area			
Troglodytes troglodytes	winter wren	G5	U1	High Elevation Forests	Special Biologic Area	Riparian	Cavity, Den, Snags		

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Viola pedatifida	prairie violet	G5	U1	Special Biologic Area	Shale barrens				
Woodwardia virginica	Virginia chainfern	G5	U1	Special Biologic Area	Riparian				
Aralia hispida	Northern white cedar	G5	U2	Cliff, Talus, outcrops	Fire Dependent/ Enhanced	Special Biologic Area			
Betula cordifolia	mountain paper birch	G5	U2	Cliff, Talus, outcrops	Fire Dependent/ Enhanced	Special Biologic Area			
Boloria selene	Silver-bordered fritillary	G5	U2	Lepidopterans	Riparian	Special Biologic Area			
Certhia americana	brown creeper	G5	U2	Area Sensitive Mature Forest	High Elevation Forests	Cavity, Den, Snags	Riparian	Special Biologic Area	
Coccyzus erythropthalmus	black-billed cuckoo	G5	U2	High Elevation Forests	High Elevation Openings	Riparian			
Empidonax alnorum	alder flycatcher	G5	U2	High Elevation Forests	Riparian	Special Biologic Area	Riparian		
Eumeces anthracinus	coal skink	G5	U2	Occurrence Protection	Open Woodlands	Ruderal	Shrublands		
Glyceria acutiflora	sharp-scaled manna-grass	G5	U2	Riparian					
Liochlorophis vernalis	Smooth green snake	G5	U2	High Elevation Openings	Open Woodlands	Grasslands	Fire Dependent/ Enhanced		
Mustela nivalis	least weasel	G5	U2	Grasslands	Shrublands				
Phyciodes cocyta	Northern crescent	G5	U2	Lepidopterans					
Poa saltuensis	drooping bluegrass	G5	U2	Mafic rocks	Open Woodlands	Special Biologic Area			
Saxifraga pensylvanica	swamp saxifrage	G5	U2	Riparian					
Scolopax minor	American woodcock	G5	U2	Grasslands	Riparian				
Sparganium chlorocarpum = S. emersum	narrow-leaf burreed	G5	U2	Special Biologic Area	Riparian				
Sphyrapicus varius	yellow-bellied sapsucker	G5	U2	High Elevation Forests	High Elevation Openings	Riparian	Cavity, Den, Snags		
Spilogale putorius	Spotted Skunk	G5	U2	Late Successional Hardwood	Shrublands	Cliff, Talus, outcrops			

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Tyto alba	barn owl	G5	U2	Area Sensitive Grasslands.	Cavity, Den, Snags	Grasslands			
Caprimulgus vociferus	whip-poor-will	G5	U3	Area Sensitive Grassland, Shrubland, Open Woodlands	Fire Dependent/ Enhanced	Open Woodlands	Regenerating Forests		
Castor canadensis	Beaver	G5	U3	Riparian	Special Biologic Area				
Lontra canadensis		G5	U3	Riparian					
Aquila chrysaetos	golden eagle	G5	U4	Area Sensitive Mature Forest					
Dendroica discolor	prairie warbler	G5	U4	Area Sensitive Grassland, Shrubland, Open Woodlands	Fire Dependent/ Enhanced	Regenerating Forests			
Empidonax virescens	acadian flycatcher	G5	U4	Area Sensitive Mature Forest	Riparian				
Echinodorus tenellus	dwarf burhead	G5	UH	Riparian	Special Biologic Area	Riparian			
Aster radula	rough-leaved aster	G5	UP	Riparian					
Astragalus distortus	bent milkvetch	G5	UP	Shale barrens					
Bartramia longicauda	upland sandpiper	G5	UP	Area Sensitive Grasslands.	Fire Dependent/ Enhanced	Occurrence Protection			
Bromus ciliatus	fringed brome grass	G5	UP	Riparian					
Calopogon tuberosus	Grass pink	G5	UP	Riparian					
Circus cyaneus	northern harrier	G5	UP	Area Sensitive Grasslands.	Occurrence Protection				
Clematis occidentalis	purple clematis	G5	UP	Mafic rocks					
Crataegus calpodendron	pear hawthorn	G5	UP	Occurrence Protection					
Desmodium canadense	showy tick-trefoil	G5	UP	Riparian					
Desmodium cuspidatum	toothed tick-trefoil	G5	UP	Calciphiles	Occurrence Protection	Ruderal	Special Biologic Area		

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Desmodium sessilifolium	sessile-leaf tick-trefoil	G5	UP	Open Woodlands	Riparian				
Elymus canadensis	nodding wild rye	G5	UP	Riparian					
Epilobium ciliatum	Hair willow-herb	G5	UP	Riparian					
Eupatorium maculatum	spotted joe-pye weed	G5	UP	Riparian					
Geranium robertianum	herb-robert	G5	UP	Cliff, Talus, outcrops					
Goodyera repens	dwarf rattlesnake plantain	G5	UP	Occurrence Protection	Riparian				
Linum sulcatum	grooved yellow flax	G5	UP	Calciphiles	Cliff, Talus, outcrops	Open Woodlands			
Lycopodiella inundata	northern bog clubmoss	G5	UP	Riparian					
Lythrum alatum	winged loosestrife	G5	UP	Riparian					
Maianthemum stellatum	stary false Solomon's-seal	G5	UP	Riparian					
Melica nitens	Three-flowered melic grass	G5	UP	Calciphiles	Open Woodlands	Shale barrens			
Nemotaulius hostilis	a limnephilid caddisfly	G5	UP	Riparian					
Polanisia dodecandra	common clammy-weed	G5	UP	Riparian					
Pseudognaphalium macounii	Winged cudweed	G5	UP	Caves					
Rosa setigera	prairie rose	G5	UP	Calciphiles	Open Woodlands	Shale barrens			
Sagittaria rigida	sessile-fruited arrowhead	G5	UP	Riparian					
Scirpus torreyi		G5	UP	Riparian					
Spartina pectinata	freshwater cordgrass	G5	UP	Riparian					
Spiranthes lucida	shining ladies'-tresses	G5	UP	Riparian					
Sporobolus neglectus	small dropseed	G5	UP	Cliff, Talus, outcrops	Shale barrens	Calciphiles			
Triadenum fraseri	Fraser's marsh St. John's-wort	G5	UP	Riparian	Special Biologic Area				
Verbena scabra	sandpaper vervain	G5	UP	Riparian					

Element Name	Common Name	G Rank	Unit Rank	Species Group 1	Species Group 2	Species Group 3	Species Group 4	Species Group 5	Species Group 6
Veronica scutellata	marsh speedwell	G5	UP	Riparian					
Viburnum lentago	nannyberry	G5	UP	Riparian					
Vicia americana	American purple vetch	G5	UP	Riparian	Ruderal				
Bonasa umbellus	ruffed grouse	G5	UNA	Fire Dependent/ Enhanced	Grasslands & Shrublands	Regenerating Forests & Hard and Soft Mast Dependent	Late Successional Hardwood	Riparian	Open Woodlands
Meleagris gallopavo	wild turkey	G5	UNA	Fire Dependent/ Enhanced	Grasslands	Hard and Soft Mast Dependent	Late Successional Hardwood	Open Woodlands	Shrublands
Odocoileus virginianus	white-tailed deer	G5	UNA	Fire Dependent/ Enhanced	Grasslands & Shrublands	Hard and Soft Mast Dependent	Late Successional Hardwood	Open Woodlands	Regenerating Forests
Sciurus carolinensis	gray squirrel	G5	UNA	Late Successional Hardwood	Hard and Soft Mast Dependent	Cavity, Den, Snags	Riparian		
Sciurus niger	Eastern fox squirrel	G5	UNA	Area Sensitive Grassland, Shrubland, Open Woodlands	Cavity, Den, Snags	Fire Dependent/ Enhanced	Hard and Soft Mast Dependent		
Ursus americanus	black bear	G5	UNA	Regenerating Forests & Hard and Soft Mast Dependent	Late Successional Hardwood	Area Sensitive Mature Forest	Grasslands & Shrublands	Cavity, Den, Snags	Open Woodlands

Shaded Cells are species groups affected by direction requiring additional protection

Unshaded cells are species groups affected be levels of habitat management activities

G-Rank is the Global Conservation Rank

G1 – Critically Imperiled

G2- Imperiled

G3- Vulnerable

G4- Apparently Secure

G5 – Secure

Unit Rank	Unit Rank Description
U1	Critically Imperiled—Critically imperiled on the unit because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the unit.
U2	Imperiled—Imperiled on the unit because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the unit.
U3	Vulnerable—Vulnerable on the unit due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation on the unit.
U4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
U5	Secure—Common, widespread, and abundant on the unit.
UH	Possibly Extirpated (Historical)—Species or system occurred historically in unit, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or system could become UH without such
UP	Possibly Present--There are no known current or historical occurrences, but the unit is within the range of the species or system and there is some chance it may occur.
UNA	Not Applicable—A unit rank is not applicable because rarity or vulnerability is not the conservation issue for the species or system (e.g., cowbirds or invasive species).

Table H.2 Priority Species and Comparison of Alternative Effects on Habitat Management for the Species

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Apochthonius holsingeri	A cave pseudoscorpion	G1	U1								+
Boltonia montana	no common name	G1	U1								+
Corallorhiza bentleyi	Bentley's coalroot	G1	U1								+
Helicodiscus diadema	Shaggy coil	G1	U1								+
Kleptochthonius anophthalmus	A cave pseudoscorpion	G1	U1								+
Nampabius turbator	Cave centipede	G1	U1								+
Nannaria shenandoah	Shenandoah Mountain xystodesmid	G1	U1								+
Pygmarrhopalites sacer	Cave springtail	G1	U1								+
Pygmarrhopalites caedus	A cave springtail	G1	U1								+
Pyrgus wyandot	Appalachian grizzled skipper	G1	U1		++	-	+	++	++	++	+
Iliamna remota	Kankakee globe-mallow	G1	UP								+
Leuctra monticola	montane needlefly	G1	UP								+
Pseudanophthalmus avernus	Avernus cave beetle	G1	UP								+
Pseudanophthalmus intersectus	Crossroads cave beetle	G1	UP								+
Pseudanophthalmus nelsoni	Nelson's cave beetle	G1	UP								+
Pseudanophthalmus petrunkevitchi	Petrunkevitch's cave beetle	G1	UP								+
Pseudotremia princeps	South Branch Valley cave millipede	G1	UP								+
Stygobromus hoffmani	Alleghany County cave amphipod	G1	UP								+
Buckleya distichophylla	Piratebush	G2	U1		++	-	+	++	++	++	+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Carex roanensis	Roan Mountain sedge	G2	U1								+
Echinacea laevigata	smooth coneflower	G2	U1		++	-	+	++	++	++	+
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	G2	U1		=	-	=	=	=	=	+
Glyphyalinia raderi	Maryland glyph	G2	U1								+
Helicodiscus triodus	Talus coil	G2	U1								+
Myotis sodalis	Indiana bat	G2	U1		+	-	+	+	+	+	+
Plethodon sherando	Big levels salamander	G2	U1		++	-	+	++	++	++	+
Potamogeton tennesseensis	Tennessee pondweed	G2	U1								+
Pycnanthemum torreyi	Torrey's mountain-mint	G2	U1		++	-	+	++	++	++	+
Pygmarrhopalites carolynae	Cave springtail	G2	U1								+
Stygobromus mundus	Bath County cave amphipod	G2	U1								+
Trillium pusillum var. virginianum	mountain least trillium	G2	U1								+
Arabis serotina	shale barren rockcress	G2	U2		++	-	+	++	++	++	+
Clematis viticaulis	Millboro leatherflower	G2	U2								+
Heuchera alba	white alumroot	G2	U2								+
Hydraena maureenae	Maureen's shale stream beetle	G2	U2								+
Phlox buckleyi	sword-leaved phlox	G2	U2		++	-	+	++	++	++	+
Plethodon virginia	Shenandoah Mt. salamander	G2	U2		=	=	=	=	=	=	+
Stygobromus sp. 7	Sherando spinosid amphipod	G2	U2								+
Stygobromus sp. nov.	Massanutten Spring Amphipod	G2	U2								+
Thryomanes bewickii altus	Appalachian Bewick's wren	G2	UH		+	-	+	=	-	+	+
Megaleuctra flinti	Shenandoah needlefly	G2	UP								+
Paxistima canbyi	Canby's mountain lover	G2	UP								+
Stygobromus morrisoni	Morrison's cave amphipod	G2	UP								+
Erora laeta	Early hairstreak	GU	U1								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Callophrys irus	Frosted elfin	G3	U1		++	-	+	++	++	++	+
Cicindela ancocisconensis	a tiger beetle	G3	U1								+
Cicindela patruela	Barrens tiger beetle	G3	U1								+
Clematis coactilis	Virginia white-haired leatherflower	G3	U1								+
Hypericum mitchellianum	Blue Ridge St. John's-wort	G3	U1		+	-	+	=	-	+	+
Microtus chrotorrhinus carolinensis	Southern rock vole	G3	U1								+
Myotis leibii	eastern small-footed bat	G3	U1								+
Poa paludigena	bog bluegrass	G3	U1								+
Scirpus ancistrochaetus	northeastern bulrush	G3	U1								+
Sorex palustris punctulatus	southern water shrew	G3	U1								+
Stygobromus gracilipes	Shenandoah Valley cave amphipod	G3	U1								+
Vitis rupestris	sand grape	G3	U1								+
Arabis patens	Spreading rockcress	G3	U2								+
Carex polymorpha	variable sedge	G3	U2		++	-	+	++	++	++	+
Gaylussacia brachycera	box huckleberry	G3	U2		++	-	+	++	++	++	+
Gymnocarpium appalachianum	Appalachian oak fern	G3	U2								+
Helenium virginicum	Virginia sneezeweed	G3	U2								+
Helonias bullata	swamp-pink	G3	U2								+
Plethodon punctatus	Cow Knob salamander	G3	U2		=	=	=	=	=	=	+
Speyeria diana	Diana fritillary	G3	U2		++	-	+	++	++	++	+
Triphora trianthophora	nodding pogonia	G3	U2								+
Zygonopus weyeriensis	Grand Caverns blind cave millipede	G3	U2								+
Juglans cinerea	butternut	G3	U3								+
Liatris helleri	shale -barren blazing star	G3	U3								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	G3	U3								+
Monotropsis odorata	sweet pinesap	G3	U3								+
Neotoma magister	Alleghany woodrat	G3	U3		-	+	-	-	-	-	+
Oenothera argillicola	Shale-barren evening primrose	G3	U3								+
Panax quinquefolius	Ginseng	G3	U3		+	-	+	=	+	+	+
Ruellia purshiana	Pursh's wild petunia	G3	U3		++	-	+	++	++	++	+
Scutellaria saxatilis	Rock skullcap	G3	U3		++	-	+	++	++	++	+
Taenidia montana	Virginia mountain pimpernel	G3	U3								+
Trifolium virginicum	Kate's mountain clover	G3	U3								+
Peltigera hydrothyria	Waterfan	G3	U4								+
Erynnis martialis	Mottled duskywing	G3	UH		++	-	+	++	++	++	+
Speyeria idalia	Regal fritillary	G3	UH		=	=	=	=	=	=	+
Virginia valeriae pulchra	mountain earth snake	G3	UH		++	-	+	++	++	++	
Carex schweinitzii	Schweinitz's sedge	G3	UP								+
Catocala herodias gerhardi	Herodias underwing	G3	UP		++	-	+	++	++	++	+
Catocala marmorata	Marbled underwing	G3	UP								+
Delphinium exaltatum	tall larkspur	G3	UP		++	-	+	++	++	++	+
Euphorbia purpurea	glade spurge	G3	UP								+
Hansonoperla appalachia	Appalachian stonefly	G3	UP								+
Leuctra mitchellensis	Mitchell needlefly	G3	UP								+
Paragnetina ishusa	widecollar stonefly	G3	UP								+
Paraleptophlebia jeanae	a mayfly	G3	UP								+
Parnassia grandifolia	Large-leaved grass-of-parnassus	G3	UP								+
Perlesta frisoni	Blue Ridge stonefly	G3	UP								+
Phlox amplifolia	Broadleaf phlox	G3	UP								+
Semionellus placidus	Millipede	G3	UP		-	+	-	-	-	-	+
Sida hermaphrodita	Virginia mallow	G3	UP								+
Triodopsis picea	Spruce Knob threetooth	G3	UP								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Zygonopus whitei	Luray Caverns blind cave millipede	G3	UP								+
Adlumia fungosa	Climbing fumatory	G4	U1								+
Arnoglossom muehlenbergii	great Indian-plantain	G4	U1		++	-	+	++	++	++	+
Carex barrattii	Barratt's sedge	G4	U1								+
Corynorhinus townsendii virginianus	Virginia big-eared bat	G4	U1		=	=	=	=	=	=	+
Cuscuta rostrata	beaked dodder	G4	U1		+	-	+	=	-	+	+
Cypripedium reginae	showy lady's-slipper	G4	U1								+
Eleocharis compressa	flat-stemmed spikerush	G4	U1								+
Eleocharis melanocarpa	black-fruited spikerush	G4	U1								+
Eleocharis robbinsii	Robbins spikerush	G4	U1								+
Euchloe olympia	Olympia marble	G4	U1		++	-	+	++	++	++	+
Lanius ludovicianus	loggerhead shrike	G4	U1		+	-	+	+	+	+	
Paronychia argyrocoma	Silver Nail-wort	G4	U1								+
Potamogeton oakesianus	Oakes pondweed	G4	U1								+
Schoenoplectus subterminalis	water bulrush	G4	U1								+
Scutellaria parvula var. parvula	small skullcap	G4	U1		++	-	+	++	++	++	+
Solidago randii = S. simplex var. randii	Rand's goldenrod	G4	U1								+
Solidago rupestris	riverbank goldenrod	G4	U1								+
Solidago uliginosa	bog goldenrod	G4	U1								+
Spiranthes ochroleuca	yellow nodding ladies'-tresses	G4	U1		++	-	+	++	++	++	+
Vaccinium macrocarpon	large cranberry	G4	U1								+
Autochton cellus	Golden-banded skipper	G4	U2								+
Clematis albicoma	White-haired Leatherflower	G4	U2								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Polygonia progne	Gray comma	G4	U2		++	-	+	++	++	++	+
Prunus alleghaniensis	Alleghany sloe	G4	U2		++	-	+	++	++	++	+
Satyrium favonius ontario	Northern Hairstreak	G4	U2		++	-	+	++	++	++	+
Sylvilagus obscurus	Appalachian Cottontail	G4	U2		+	-	+	=	-	+	+
Vermivora chrysoptera	golden winged warbler	G4	U2		++	-	+	++	+	++	+
Crotalus horridus	Timber rattlesnake	G4	U3								+
Dendroica cerulea	cerulean warbler	G4	U3		=	=	=	=	=	=	+
Eriogonum allenii	Yellow Buckwheat	G4	U3								+
Glyptemys insculpta	wood turtle	G4	U3		+	-	+	+	+	+	+
Solidago arguta var. harrisii	Shale Barren Goldenrod	G4	U3								+
Contopus borealis	olive-sided flycatcher	G4	UH		+	-	+	=	-	+	+
Falco peregrinus	peregrine falcon	G4	UH		++	-	+	++	++	++	+
Phyciodes batesii	Tawny crescent	G4	UH								+
Pituophis melanoleucus	northern pinesnake	G4	UH		++	-	+	++	++	++	+
Houstonia canadensis	Canada bluets	G4	UNP								+
Ammodramus henslowii	Henslow's sparrow	G4	UP		=	=	=	=	=	=	+
Cyperus dentatus	toothed flatsedge	G4	UP								+
Helianthemum propinquum	low frostweed	G4	UP		++	-	+	++	++	++	
Huperzia appalachiana	Appalachian fir clubmoss	G4	UP								+
Isonychia tusculanensis	a mayfly	G4	UP								+
Linum lewisii	prairie flax	G4	UP		++	-	+	++	++	++	+
Onosmodium virginianum	Virginia false-gromwell	G4	UP		++	-	+	++	++	++	+
Paronychia virginica	yellow nailwort	G4	UP								+
Prunus nigra	Canada plum	G4	UP		+	-	+	+	=	+	+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Zigadenus elegans ssp. glaucus = Anticlea glauca	white camas	G4	UP		++	-	+	++	++	++	+
Aegolius acadicus	northern saw-whet owl	G5	U1		=	=	=	=	=	=	+
Alnus incana ssp. rugosa	speckled alder	G5	U1								+
Ambystoma tigrinum	Eastern tiger salamander	G5	U1		-	+	-	-	-	-	+
Anaphalis margaritacea	pearly everlasting	G5	U1		++	-	+	++	++	++	+
Bromus kalmii	wild chess	G5	U1		++	-	+	++	++	++	+
Campanula rotundifolia	American harebell	G5	U1								+
Caprimulgus carolinensis	chuck-will's widow	G5	U1		++	-	+	++	++	++	
Carex aquatilis	water sedge	G5	U1								+
Carex arctata	black sedge	G5	U1								+
Carex buxbaumii	Buxbaum's sedge	G5	U1								+
Carex lasiocarpa var. americana	slender sedge	G5	U1								+
Carex vesicaria		G5	U1								+
Carpodacus purpureus	purple finch	G5	U1		+	-	+	=	-	+	+
Catharus guttatus	hermit thrush	G5	U1		+	-	+	+	+	+	+
Cheilanthes eatonii	chestnut lipfern	G5	U1								+
Cirsium altissimum	tall thistle	G5	U1								+
Clemmys guttata	spotted turtle	G5	U1								+
Colias interior	Pink-edged sulphur	G5	U1								+
Colinus virginianus	northern bobwhite	G5	U1		++	-	+	++	+	++	
Cornus canadensis	bunchberry	G5	U1								+
Cornus rugosa	roundleaf dogwood	G5	U1								+
Crataegus pruinosa	prunose hawthorn	G5	U1		++	-	+	++	++	++	+
Cuscuta coryli	hazel dodder	G5	U1								+
Cystopteris fragilis	fragile fern	G5	U1								+
Dendroica fusca	blackburnian warbler	G5	U1		=	=	=	=	=	=	+
Dendroica magnolia	magnolia warbler	G5	U1		+	-	++	+	=	+	+
Elymus trachycaulus	slender wheatgrass	G5	U1		++	-	+	++	++	++	+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Epilobium leptophyllum	linear-leaved willow-herb	G5	U1								+
Equisetum sylvaticum	woodland horsetail	G5	U1								+
Eriocaulon aquaticum	white buttons	G5	U1								+
Erynnis persius	Persius duskywing	G5	U1		+	-	+	+	+	+	+
Erysimum capitatum	western wallflower	G5	U1		++	-	+	++	++	++	+
Glyceria grandis	American manna-grass	G5	U1								+
Gnaphalium uliginosum	low cudweed	G5	U1		+	-	+	=	-	+	+
Haliaeetus leucocephalus	bald eagle	G5	U1								+
Helianthemum bicknellii	plains frostweed	G5	U1		++	-	+	++	++	++	+
Hypericum boreale	northern St. John's-wort	G5	U1								+
Incisalia polia	Hoary elfin	G5	U1		+	-	+	+	+	+	+
Isoetes lacustris	lake quillwort	G5	U1								+
Juncus brachycephalus	small-head rush	G5	U1								+
Juncus brevicaudatus	narrow-panicled rush	G5	U1								+
Juniperus communis var depressa	ground juniper	G5	U1		+	-	+	=	-	+	+
Lepus americanus	snowshoe hare	G5	U1		+	-	++	+	=	+	+
Leucothoe fontanesiana	highland dog-hobble	G5	U1		+	-	+	=	+	+	+
Liparis loeselii	Loesel's twayblade	G5	U1								+
Lonicera canadensis	American fly-honeysuckle	G5	U1								+
Loxia curvirostra	red crossbill	G5	U1		=	=	=	=	=	=	+
Martes pennanti	fisher	G5	U1		=	=	=	=	=	=	+
Melospiza georgiana	swamp sparrow	G5	U1		+	-	+	=	-	+	+
Minuartia groenlandica	mountain sandwort	G5	U1								+
Muhlenbergia glomerata	marsh muhly	G5	U1								+
Oligoneuron rigidum	stiff goldenrod	G5	U1		++	-	+	++	++	++	+
Oporornis philadelphia	mourning warbler	G5	U1		++	-	+	++	++	++	+
Oryzopsis asperifolia	white-grained mtn-	G5	U1		++	-	+	++	++	++	+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
	ricegrass										
Osmunda cinnamomea var. glandulosa	glandular cinnamon fern	G5	U1								+
Panax trifolius	Dwarf ginseng	G5	U1		+	-	+	=	+	+	+
Panicum hemitomon	maidencane	G5	U1								+
Platanthera grandiflora	large purple fringed orchid	G5	U1								+
Platanthera peramoena	purple fringeless orchid	G5	U1								+
Poa palustris	fowl bluegrass	G5	U1								+
Potentilla arguta	tall cinquefoil	G5	U1								+
Pyrola elliptica	shinleaf	G5	U1								+
Regulus satrapa	golden-crowned kinglet	G5	U1								+
Ribes americanum	wild black currant	G5	U1								+
Rubus idaeus ssp. strigosus	American red raspberry	G5	U1		+	-	+	=	-	+	+
Sabatia campanulata	slender marsh rose-pink	G5	U1								+
Sagittaria calycina var calycina	long-lobed arrowhead	G5	U1								+
Schizachne purpurascens	purple oat-grass	G5	U1								+
Seiurus noveboracensis	northern waterthrush	G5	U1		=	=	=	=	=	=	+
Sibbaldiopsis tridentata	three-toothed cinquefoil	G5	U1								+
Sitta canadensis	red-breasted nuthatch	G5	U1								+
Speyeria atlantis	Atlantis fritillary	G5	U1								+
Sphagnum russowii	Russow's peatmoss	G5	U1								+
Symphoricarpos albus	snowberry	G5	U1								+
Thuja occidentalis	bristly sarsaparilla	G5	U1								+
Triantha racemosa	coastal false-asphodel	G5	U1								+
Trichostema setaceum	narrow-leaved blue curls	G5	U1		++	-	+	++	++	++	+
Troglodytes troglodytes	winter wren	G5	U1								+
Viola pedatifida	prairie violet	G5	U1								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Woodwardia virginica	Virginia chainfern	G5	U1								+
Aralia hispida	Northern white cedar	G5	U2		++	-	+	++	++	++	+
Betula cordifolia	mountain paper birch	G5	U2		++	-	+	++	++	++	+
Boloria selene	Silver-bordered fritillary	G5	U2								+
Certhia americana	brown creeper	G5	U2		=	=	=	=	=	=	+
Coccyzus erythropthalmus	black-billed cuckoo	G5	U2		+	-	+	=	-	+	+
Empidonax alnorum	alder flycatcher	G5	U2								+
Eumeces anthracinus	coal skink	G5	U2		++	-	+	++	++	++	+
Glyceria acutiflora	sharp-scaled manna-grass	G5	U2								+
Liochlorophis vernalis	Smooth green snake	G5	U2		++	-	+	++	++	++	
Mustela nivalis	least weasel	G5	U2		+	-	+	+	+	+	
Phyciodes cocyta	Northern crescent	G5	U2								+
Poa saltuensis	drooping bluegrass	G5	U2		++	-	+	++	++	++	+
Saxifraga pensylvanica	swamp saxifrage	G5	U2								+
Scolopax minor	American woodcock	G5	U2		+	-	+	+	+	+	+
Sparganium chlorocarpum = S. emersum	narrow-leaf burreed	G5	U2								+
Sphyrapicus varius	yellow-bellied sapsucker	G5	U2		+	-	+	=	-	+	+
Spilogale putorius	Spotted Skunk	G5	U2		+	-	+	+	+	+	+
Tyto alba	barn owl	G5	U2		+	-	+	+	+	+	+
Caprimulgus vociferus	whip-poor-will	G5	U3		++	-	+	++	++	++	
Castor canadensis	Beaver	G5	U3								+
Lontra canadensis		G5	U3								+
Aquila chrysaetos	golden eagle	G5	U4		=	=	=	=	=	=	
Dendroica discolor	prairie warbler	G5	U4		++	-	+	++	++	++	
Empidonax virescens	acadian flycatcher	G5	U4		=	=	=	=	=	=	+
Echinodorus tenellus	dwarf burhead	G5	UH								+
Aster radula	rough-leaved aster	G5	UP								+
Astragalus distortus	bent milkvetch	G5	UP								+
Bartramia longicauda	upland sandpiper	G5	UP		++	-	+	++	++	++	+
Bromus ciliatus	fringed brome grass	G5	UP								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Calopogon tuberosus	Grass pink	G5	UP								+
Circus cyaneus	northern harrier	G5	UP		=	=	=	=	=	=	+
Clematis occidentalis	purple clematis	G5	UP								+
Crataegus calpodendron	pear hawthorn	G5	UP								+
Desmodium canadense	showy tick-trefoil	G5	UP								+
Desmodium cuspidatum	toothed tick-trefoil	G5	UP								+
Desmodium sessilifolium	sessile-leaf tick-trefoil	G5	UP		++	-	+	++	++	++	+
Elymus canadensis	nodding wild rye	G5	UP								+
Epilobium ciliatum	Hair willow-herb	G5	UP								+
Eupatorium maculatum	spotted joe-pye weed	G5	UP								+
Geranium robertianum	herb-robert	G5	UP								+
Goodyera repens	dwarf rattlesnake plantain	G5	UP								+
Linum sulcatum	grooved yellow flax	G5	UP		++	-	+	++	++	++	+
Lycopodiella inundata	northern bog clubmoss	G5	UP								+
Lythrum alatum	winged loosestrife	G5	UP								+
Maianthemum stellatum	stary false Solomon's-seal	G5	UP								+
Melica nitens	Three-flowered melic grass	G5	UP		++	-	+	++	++	++	+
Nemotaulius hostilis	a limnephilid caddisfly	G5	UP								+
Polanisia dodecandra	common clammy-weed	G5	UP								+
Pseudognaphalium macounii	Winged cudweed	G5	UP								+
Rosa setigera	prairie rose	G5	UP		++	-	+	++	++	++	+
Sagittaria rigida	sessile-fruited arrowhead	G5	UP								+
Scirpus torreyi		G5	UP								+
Spartina pectinata	freshwater cordgrass	G5	UP								+
Spiranthes lucida	shining ladies'-tresses	G5	UP								+
Sporobolus neglectus	small dropseed	G5	UP								+
Triadenum fraseri	Fraser's marsh St. John's-wort	G5	UP								+

				Habitat Management Effects Compared to Current Condition							Species Protection Plan Direction
Element Name	Common Name	G Rank	Unit Rank	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts B - G
Verbena scabra	sandpaper vervain	G5	UP								+
Veronica scutellata	marsh speedwell	G5	UP								+
Viburnum lentago	nannyberry	G5	UP								+
Vicia americana	American purple vetch	G5	UP								+
Bonasa umbellus	ruffed grouse	G5	UNA		++	-	+	++	+	++	+
Meleagris gallopavo	wild turkey	G5	UNA		++	-	+	++	+	++	
Odocoileus virginianus	white-tailed deer	G5	UNA		++	-	+	++	+	++	
Sciurus carolinensis	gray squirrel	G5	UNA		+	-	+	+	=	+	+
Sciurus niger	Eastern fox squirrel	G5	UNA		+	-	+	+	=	+	+
Ursus americanus	black bear	G5	UNA		++	-	+	++	+	++	+

+ means small improvement in habitat
++ means improvement in habitat
= means habitat remains the same
- means small decrease in habitat
Blank means no difference in habitat among the alternatives

Table H-3. Current /Existing Situation Viability Outcomes* by Species and Watershed. Shaded columns indicate species sensitivity.**

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
Pleurobema collina	James spinymussel	Potts Creek	P	26%	71%	87%	100%	1.16	C
		Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	E
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Calfpasture River	P	59%	78%	88%	100%	1.32	C
		Pedlar River-James River	P	16%	25%	79%	16%	2.98	C
Helenium virginicum	Virginia sneezeweed	Back Creek-South River	NFP	20%	36%	63%	41%	2.57	B
		Naked Creek-South Fork Shenandoah River	P	10%	58%	64%	45%	2.08	C
Helonias bullata	swamp pink	Back Creek-South River	NFP	20%	36%	63%	41%	2.57	B
		Irish Creek-South River	NF	34%	53%	72%	41%	1.60	B
Scirpus ancistrochaetus	northeastern bulrush	Dry River-North River	NF	59%	66%	71%	71%	1.59	D
		Back Creek-South River	P	20%	36%	63%	41%	2.57	E
		Naked Creek-South Fork Shenandoah River	P	10%	58%	64%	45%	2.08	E
		Potts Creek	NF	26%	71%	87%	100%	1.16	D
		Back Creek-Jackson River	P	41%	84%	74%	98%	1.32	E
Notropis semperasper	Roughhead shiner	Dunlap Creek	P	42%	83%	86%	100%	1.10	C
		Potts Creek	P	26%	71%	87%	100%	1.16	C
		Back Creek-Jackson River	NFP	41%	84%	74%	98%	1.32	B
		Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	C
		Cowpasture River	NFP	59%	85%	86%	100%	1.32	B
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	C
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Calfpasture River	P	59%	78%	88%	100%	1.32	C

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
Noturus gilberti	Orangefin madtom	Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
Hydraena maureenae	Maureen's shale stream beetle	Shoemaker River-North Fork Shenandoah River	NF	53%	88%	86%	100%	1.50	D
		Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	E
		Cowpasture River	NFP	59%	85%	86%	100%	1.32	B
		Craig Creek	P	<1%	76%	88%	100%	1.16	E
		Calfpasture River	NF	59%	78%	88%	100%	1.32	D
Cicindela ancocisconensis	Appalachian tiger beetle	Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	E
		Cowpasture River	NFP	59%	85%	86%	100%	1.32	D
Sorex palustris punctulatus	southern water shrew	North Fork South Branch Potomac River	NFP	5%	92%	82%	80%	1.22	D
		Back Creek-Jackson River	NFP	41%	84%	74%	98%	1.32	D
Alasmidonta varicosa	Brook floater	Gooney Run-South Fork Shenandoah River	P	7%	60%	67%	35%	2.52	E
		Smith Creek-North Fork Shenandoah River	P	6%	46%	44%	22%	2.62	E
		Stony Creek-North Fork Shenandoah River	P	28%	61%	66%	73%	2.47	E
Elliptio lanceolata	Yellow lance	Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	C
		Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	E
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Maury River	P	9%	32%	54%	30%	2.32	C
		Pedlar River-James River	P	16%	25%	79%	16%	2.98	C
Fusconaia masoni	Atlantic pigtoe	Catawba Creek-James River	P	5%	53%	67%	59%	1.81	E
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Calfpasture River	P	59%	78%	88%	100%	1.32	E
Lasmigona subviridis	Green floater	Stony Creek-North Fork Shenandoah River	P	28%	61%	66%	73%	2.47	C

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
		Pedlar River-James River	P	16%	25%	79%	16%	2.98	C
		Tye River	P	17%	33%	77%	13%	1.86	C
Villosa constricta	Notched Rainbow	Potts Creek	P	26%	71%	87%	100%	1.16	C
		Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	C
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Maury River	P	9%	32%	54%	30%	2.32	C
		Pedlar River-James River	P	16%	25%	79%	16%	2.98	C
Peltigera hydrothyria	waterfan	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	B
		Middle River	NF	10%	37%	40%	36%	2.72	B
		Stony Creek-North Fork Shenandoah River	NF	28%	61%	66%	73%	2.47	B
		Cowpasture River	NF	59%	85%	86%	100%	1.32	B
		Irish Creek-South River	NFP	34%	53%	72%	41%	1.60	A
		Tye River	NFP	17%	33%	77%	13%	1.86	A
		Buffalo River	NFP	8%	28%	76%	22%	2.08	A
Ambystoma tigrinum	eastern tiger salamander	Back Creek-South River	NFP	20%	36%	63%	41%	2.57	B
Cambarus monongalensis	A Crayfish	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	B
Anguilla rostrata	American eel	Middle River	P	10%	37%	40%	36%	2.72	C
		Dry River-North River	P	59%	66%	71%	71%	1.59	C
		Back Creek-South River	P	20%	36%	63%	41%	2.57	C
		Naked Creek-South Fork Shenandoah River	P	10%	58%	64%	45%	2.08	C
		Gooney Run-south Fork Shenandoah River	NFP	7%	60%	67%	35%	2.52	B
		Smith Creek-North Fork Shenandoah River	P	6%	46%	44%	22%	2.62	C
		Stony Creek-North Fork Shenandoah River	P	28%	61%	66%	73%	2.47	C
		Cedar Creek	NFP	19%	34%	78%	69%	1.77	A
		Craig Creek	P	<1%	76%	88%	100%	1.16	E
		Pedlar River-James River	P	16%	25%	79%	16%	2.98	C
		Tye River	NFP	17%	33%	77%	13%	1.86	A
		Buffalo River	NFP	8%	28%	76%	22%	2.08	A
		Rockfish River	P	1%	21%	80%	21%	1.71	C

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
Salvelinus fontinalus	Brook trout	North Fork South Branch Potomac River	NFP	5%	92%	82%	80%	1.22	B
		South Fork South Branch Potomac River	NFP	29%	86%	82%	100%	1.37	B
		Cacapon River	NFP	20%	79%	83%	100%	1.44	B
		Dry River-North River	NFP	59%	66%	71%	71%	1.59	A
		Back Creek-South River	NFP	20%	36%	63%	41%	2.57	B
		Naked Creek-South Fork Shenandoah River	NFP	10%	58%	64%	45%	2.08	B
		Gooney Run-south Fork Shenandoah River	NFP	7%	60%	67%	35%	2.52	B
		Shoemaker River-North Fork Shenandoah River	NFP	53%	88%	86%	100%	1.50	B
		Smith Creek-North Fork Shenandoah River	NF	6%	46%	44%	22%	2.62	B
		Stony Creek-North Fork Shenandoah River	NFP	28%	61%	66%	73%	2.47	A
		Cedar Creek	NFP	19%	34%	78%	69%	1.77	B
		Dunlap Creek	NFP	42%	83%	86%	100%	1.10	B
		Potts Creek	NFP	26%	71%	87%	100%	1.16	B
		Back Creek-Jackson River	NFP	41%	84%	74%	98%	1.32	A
		Wilson Creek-Jackson River	NFP	38%	86%	83%	100%	1.90	A
		Cowpasture River	NFP	59%	85%	86%	100%	1.32	A
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	C
		Craig Creek	NFP	<1%	76%	88%	100%	1.16	B
		Calfpasture River	NFP	59%	78%	88%	100%	1.32	A
		Little Calfpasture River	NFP	30%	75%	81%	100%	2.03	B
		Maury River	NF	9%	32%	54%	30%	2.32	B
		Irish Creek-South River	NFP	34%	53%	72%	41%	1.60	A
		Pedlar River-James River	NFP	16%	25%	79%	16%	2.98	B
		Tye River	NFP	17%	33%	77%	13%	1.86	A
		Buffalo River	NFP	8%	28%	76%	22%	2.08	B
		Rockfish River	NFP	1%	21%	80%	21%	1.71	B
Cottus cf. cognatus	Checkered sculpin	Cacapon River	P	20%	79%	83%	100%	1.44	C
Aeshna canadensis	Canada darner	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Aeshna tuberculifera	black-tipped darner	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
		Dry River-North River	NF	59%	66%	71%	71%	1.59	B
		Back Creek-South River	NF	20%	36%	63%	41%	2.57	B
		Naked Creek-South Fork Shenandoah River	NF	10%	58%	64%	45%	2.08	D
		Potts Creek	NF	26%	71%	87%	100%	1.16	B
		Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	C
		Catawba Creek-James River	P	5%	53%	67%	59%	1.81	E
Aeshna verticalis	green-striped darner	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Anax longipes	comet darner	Back Creek-South River	NF	20%	36%	63%	41%	2.57	B
Calopteryx amata	Superb jewelwing	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Calopteryx angustipennis	Appalachian jewelwing	Stony Creek-North Fork Shenandoah River	NF	28%	61%	66%	73%	2.47	B
		Cowpasture River	NF	59%	85%	86%	100%	1.32	B
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Maury River	P	9%	32%	54%	30%	2.32	C
Celithemis martha	Martha's penant	Back Creek-South River	NF	20%	36%	63%	41%	2.57	B
Cordulegaster diastatops	delta-spotted spiketail	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	B
Enallagma annexum (AKA cyathigerum)	northern bluet	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Epitheca canis	beaverpond baskettail	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Gomphus adelphus	mustached clubtail	Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Calfpasture River	P	59%	78%	88%	100%	1.32	C
Gomphus quadricolor	rapids clubtail	Cowpasture River	P	59%	85%	86%	100%	1.32	C
		Craig Creek	P	<1%	76%	88%	100%	1.16	C
		Calfpasture River	P	59%	78%	88%	100%	1.32	C

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
Ladona julia (AKA Libellula julia)	chalk-fronted corporal skimmer	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Lanthus parvulus	double-striped clubtail	North Fork South Branch Potomac River	NFP	5%	92%	82%	80%	1.22	B
Lestes disjunctus	northern spreadwing	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
		Back Creek-Jackson River	P	41%	84%	74%	98%	1.32	C
		Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	C
Leucorrhinia hudsonica	Hudsonian whiteface	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Nehalennia irene	sedge sprite	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Neurocordulia yamaskanensis	stygian shadowdragon	Stony Creek-North Fork Shenandoah River	P	28%	61%	66%	73%	2.47	C
		Wilson Creek-Jackson River	P	38%	86%	83%	100%	1.90	C
Rhionaeschna mutata (AKA Aeshna mutata)	spatterdock darner	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
		Potts Creek	P	26%	71%	87%	100%	1.16	C
Somatochlora elongata	Ski-tipped emerald	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Sympetrum obtrusum	white-faced meadowhawk	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Isonychia hoffmani	Hoffman's Isonychia mayfly	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	B
Nemotaulius hostilis	a limnephilid caddisfly	North Fork South Branch Potomac River	NF	5%	92%	82%	80%	1.22	D
Clemmys guttata	spotted turtle	Back Creek-South River	NF	20%	36%	63%	41%	2.57	D
Glyptemys insculpta	wood turtle	South Fork South Branch Potomac River	P	29%	86%	82%	100%	1.37	C
		Cacapon River	NFP	20%	79%	83%	100%	1.44	B
		Shoemaker River-North Fork Shenandoah	NFP	53%	88%	86%	100%	1.50	B

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	% High Erosion Potential	% Forested Riparian	% High Acid Sensitivity	Road Density (miles/sq.mi.)	Viability outcome
		River							
		Smith Creek-North Fork Shenandoah River	P	6%	46%	44%	22%	2.62	C
		Stony Creek-North Fork Shenandoah River	NFP	28%	61%	66%	73%	2.47	B
		Cedar Creek	NFP	19%	34%	78%	69%	1.77	B

***Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.**

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to influence the species is limited. Therefore species viability in the watershed may be at risk.

****Birds and non-TE plants and mammals were not included in this analysis because species occurrence locations were not readily available in GIS format. See Terrestrial Ecological Analysis.**

Table H-4. Species Habitat on NF, Rank*, and Sensitivity Factor**

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
mussel	*Pleurobema collina*	James spinymussel	G1	S1	S1	FE	14.3 mi	U1	4	3	x	x		x	
plant	*Helenium virginicum*	Virginia sneezeweed	G3	S2		FT	4.0 ac	U2	1	1		x			
plant	*Helonias bullata*	swamp pink	G3	S2S3		FT	7.3 mi	U2	1	1	x			x	
plant	*Scirpus ancistrochaetus*	northeastern bulrush	G3	S2	S1	FE	1.1 ac	U1	2	2		x			
fish	*Notropis semperasper*	Roughhead shiner	G2G3	S2S3	_	S	73.7 mi	U3	3	2	x	x		x	
fish	*Noturus gilberti*	Orangefin madtom	G2	S2	_	S	6.5 mi	UP	4	4	x	x		x	
insect	*Hydraena maureenae*	Maureen's shale stream beetle	G1G3	S1S3	_	S	150.9 mi	U2	1	3	x			x	
insect	*Cicindela ancocisconensis*	Appalachian tiger beetle	G3	S2	S3	S	6.20 mi	U1	3	2	x				
mammal	*Sorex palustris punctulatus*	southern water shrew	G5T3	S1S2	S1	S	13.5 mi	U1	2	2		x	x	x	
mussel	*Alasmidonta varicosa*	Brook floater	G3	S1	S1	S	1.3 mi	UP	4	4	x	x		x	
mussel	*Elliptio lanceolata*	Yellow lance	G2G3	S2S3	_	S	30.8 mi	UP	4	3	x	x		x	
mussel	*Fusconaia masoni*	Atlantic pigtoe	G2	S2	_	S	0.2 mi	UP	4	4	x	x		x	
mussel	*Lasmigona subviridis*	Green floater	G3	S2	S2	S	21.9 mi	UP	4	3	x	x		x	
bird	*Haliaeetus leucocephalus*	Bald eagle	G5	S23B /S3N	S2B/ S3N	S	Riparian	U1	4	3					
plant	*Boltonia montana*	Doll's daisy	G1G2	S1	_	S	Riparian	U1	1	1					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
plant	*Iliamna remota*	Kankakee globe-mallow	G1Q	S1	_	S	Riparian	UP	4	4					
plant	*Isoetes virginica*	Virginia quillwort	G1Q	S1?	_	S	Riparian	UP	5	5					
plant	*Peltigera hydrothyria*	waterfan	G3G5	S1	_	S	515.0 mi	U4	3	2	x		x	x	
plant	*Poa paludigena*	bog bluegrass	G3	S2	S1	S	Riparian	U1	3	2					
plant	*Potamogeton hillii*	Hill's pondweed	G3	S1	_	S	Riparian	UP	5	5					
plant	*Potamogeton tennesseensis*	Tennessee pondweed	G2	S1	S2	S	Riparian	U1	3	3					
plant	*Sida hermaphrodita*	Virginia mallow	G3	S1	S2	S	Riparian	UP	4	4					
plant	*Vitis rupestris*	sand grape	G3	S1?	S2	S	Riparian	U1	4	3					
amphib	*Ambystoma tigrinum*	eastern tiger salamander	G5	S1		LR	39.1 ac	U1	4	2				x	
bird	*Anas rubripes*	Amer. black duck	G5	S4	S2B/ S4N	LR	36.6 mi & 3,228.7 ac	UP	4	3					
bird	*Empidonax alnorum*	alder flycatcher	G5	S1B	S3B/ S4N	LR	185.7 ac	U2	4	2					
bird	*Empidonax virescens*	Acadian flycatcher	G5	S5	S5B	MIS	Riparian	U4	4	3					
bird	*Melospiza georgiana*	swamp sparrow	G5	S1B/ S4S5 N	S3B/ S4N	LR	85.0 ac	U1	4	3					
bird	*Nycticorax nycticorax*	black-crowned night-heron	G5	S3B/ S4N	SHB	LR	36.6 mi & 3,228.7 ac	UP	4	3					
bird	*Nyctanassa violacea*	yellow-crowned night-heron	G5	S2S3 B/S3 N	S1N	LR	36.6 mi & 3,228.7 ac	UP	4	3				x	
bird	*Seiurus noveboracensis*	northern waterthrush	G5	S1B	S2B	LR	270.7 ac	U1	4	2					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
crayfish	*Cambarus monongalensis*	A Crayfish	G5	S1?	S3	LR	17.6 mi	U1	4	3	x	x	x	x	
fish	*Anguilla rostrata*	American eel	G4	S5	S2	SMC	145.6 mi	U4	4	3	x	x		x	x
fish	*Cottus cf. cognatus*	Checkered sculpin	G4Q	-	-	LR	Riparian	U3	4	4	x	X	x	x	x
fish	*Salvelinus fontinalus*	Brook trout	G5	S4	S5	MIS	1,119.9 mi	U5	3	1	x	x	x	x	x
insect/	*Aeshna canadensis*	Canada darner	G5	S1	S1	LR	34.7 ac	U1	4	2			x		
insect/	*Aeshna tuberculifera*	black-tipped darner	G4	S2S3	S2	LR	89.4 ac	U2	4	2			x		
insect/	*Aeshna verticalis*	green-striped darner	G5	S1	S2	LR	34.7 ac	U1	4	2			x		
insect/	*Anax longipes*	comet darner	G5	S3	S1	LR	49.4 ac	U1	4	2			x		
insect/	*Calopteryx amata*	Superb jewelwing	G4	S1	-	LR	17.6 mi	U1	4	2	x	x	x		
insect/	*Calopteryx angustipennis*	Appalachian jewelwing	G4	S2	S2	LR	.09 mi	U1	4	3	x	x	x	x	
insect/	*Celithemis martha*	Martha's penant	G4	S2	_	LR	54.7 ac	U1	4	2			x		
insect/	*Cordulegaster diastatops*	delta-spotted spiketail	G5	S1	S2	LR	10.23 mi	U1	4	2	x	x	x	x	
insect/	*Enallagma annexum (AKA cyathigerum)*	northern bluet	G5	S1	S2	LR	34.7 ac	U1	4	2			x		
insect/	*Epitheca canis*	beaverpond baskettail	G5	S1	S1S2	LR	34.7 ac	U1	4	2			x		
insect/	*Gomphus adelphus*	mustached clubtail	G4	S1	S2	LR	23.9 mi	UP	4	4	x	x			
insect/	*Gomphus quadricolor*	rapids clubtail	G3/G4	S2	S2S3	LR	23.9 mi	UP	4	4	x	x			
insect/	*Ladona julia (AKA Libellula julia)*	chalk-fronted corporal skimmer	G5	S1	S2	LR	34.7 ac	U1	4	2			x		
insect/	*Lanthus parvulus*	double-striped clubtail	G4	S2	S2	LR	13.2 mi	U1	4	2	x	x	x	x	

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
insect/	*Lestes disjunctus*	northern spreadwing	G5	S2	S2S3	LR	34.7 ac	U1	4	3			x		
insect/	*Leucorrhinia ihudsonica*	Hudsonian whiteface	G5	S1	S1	LR	34.7 ac	U1	4	2			x		
insect/	*Nehalennia irene*	sedge sprite	G5	S1	S3	LR	34.7 ac	U1	4	2			x		
insect/	*Neurocordulia yamaskanensis*	stygian shadowdragon	G5	S2	S2	LR	34.5 mi	UP	4	4	x	x	x		
insect/	*Rhionaeschna mutata (AKA Aeshna mutata)*	spatterdock darner	G3G4	S2	S1	LR	49.4 ac	U1	4	3			x		
insect/	*Somatochlora elongata*	Ski-tipped emerald	G5	S1S2	S2	LR	34.7 ac	U1	4	2			x		
insect/	*Sympetrum obtrusum*	white-faced meadowhawk	G5	S1	S2	LR	34.7 ac	U1	4	2			x		
insect	*Autochton cellus*	Golden banded skipper	G5	S3	S1S2	LR	Riparian	U2	3	2					
insect	*Boloria selene*	Silver-bordered fritillary	G5	S2	S3	LR	Riparian	U2	2	1					
insect	*Colias interior*	Pink-edged sulphur	G5	S1S2	S2	LR	Riparian	U1	4	3					
insect	*Isonychia hoffmani*	Hoffman's Isonychia mayfly	G1/G3	S1	-	LR	17.6 mi	U1	2	1	x	x	x	x	
insect	*Nemotaulius hostilis*	a limnephilid caddisfly	G5	S1	SNR	LR	34.7 ac	U1	4	2			x		
insect	*Speyeria atlantis*	Atlantis fritillary	G5	S2	S3	LR	Riparian	U1	3	2					
mammal	*Castor canandensis*	beaver	G5	S5	S5	SMC	Riparian	U3	4	4					
mammal	*Lontra canadensis*	river otter	G5	S4	S1	LR	Riparian	U3	4	3					
mussel	*Villosa constricta*	Notched Rainbow	G3	S3	_	LR	33.1 mi	UP	4	3	x	x		x	
reptile	*Clemmys guttata*	spotted turtle	G5	S4	S1	LR	6.45 ac	U1	4	4					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
reptile	*Glyptemys insculpta*	wood turtle	G4	S2	S2	LR	217.6 mi	U2	4	2	x	x	x	x	
plant	*Alnus incana ssp. rugosa*	speckled alder	G5T5	S2		LR	Riparian	U1	4	4					
plant	*Arethusa bulbosa*	Dragon's mouth	G4	S1		LR	Riparian	UH	5	5					
plant	*Aster radula*	rough-leaved aster	G5	S1		LR	Riparian	UP	4	4					
plant	*Bromus ciliatus*	fringed brome grass	G5	S1	S4	LR	Riparian	UP	4	4					
plant	*Calopogon tuberosus*	Grass pink	G5	S1	S2	LR	Riparian	UP	4	3					
plant	*Carex aquatilis*	water sedge	G5	S1	S1	LR	Riparian	U1	4	2					
plant	*Carex arctata*	*Black sedge*	*G5*	*S1*	*S1*	*LR*	Riparian	U1	4	2					
plant	*Carex barrattii*	Barratt's sedge	G4	S2	_	LR	Riparian	U1	3	2					
plant	*Carex buxbaumii*	Buxbaum's sedge	G5	S2	S2	LR	Riparian	U1	4	3					
plant	*Carex conoidea*	field sedge	G5	S1S2	S1	LR	Riparian	UP	4	2					
plant	*Carex cristatella*	crested sedge	G5	S2	S4	LR	Riparian	UP	4	3					
plant	*Carex interior*	inland sedge	G5	S1	S1	LR	Riparian	UP	4	4					
plant	*Carex lasiocarpa var. americana*	slender sedge	G5T5	S1	?	LR	Riparian	U1	4	3					
plant	*Carex schweinitzii*	Schweinitz's sedge	G3G4	S1	_	LR	Riparian	UP	4	4					
plant	*Carex vesicaria*	inflated sedge	G5	S1S2	S2	LR	Riparian	U1	4	3					
plant	*Cyperus dentatus*	toothed flatsedge	G4	S1	SNR	LR	Riparian	UP	4	4					
plant	*Cypripedium reginae*	showy lady's-slipper	G4	S1	S1	LR	Riparian	U1	4	3					
plant	*Echinodorus tenellus*	dwarf burhead	G5?	S1	_	LR	Riparian	UH	4	4					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
plant	*Eleocharis compressa*	flattened spikerush	G4	S2	S2	LR	Riparian	U1	4	2					
plant	*Eleocharis melanocarpa*	black-fruited spikerush	G4	S2	_	LR	Riparian	U1	3	2					
plant	*Eleocharis robbinsii*	Robbins spikerush	G4G5	S1	_	LR	Riparian	U1	4	3					
plant	*Elymus canadensis*	nodding wild rye	G5	S2?	S5	LR	Riparian	UP	4	4					
plant	*Epilobium leptophyllum*	linear-leaved willow-herb	G5	S2	S3	LR	Riparian	U1	4	3					
plant	*Equisetum sylvaticum*	Woodland horsetail	G5	S1	S1	LR	Riparian	U1	4	4					
plant	*Eriocaulon aquaticum*	white buttons	G5	S1	_	LR	Riparian	U1	4	3					
plant	*Eupatorium maculatum*	spotted joe-pye weed	G5	S2	S1	LR	Riparian	UP	4	4					
plant	*Glyceria acutiflora*	sharp-scaled manna-grass	G5	S3	S2	LR	Riparian	U2	4	3					
plant	*Glyceria grandis*	American manna-grass	G5T?	S1	S1	LR	Riparian	U1	4	3					
plant	*Huperzia appalachiana*	Appalachian fir clubmoss	G4/G5	S2	_	LR	Riparian	UP	4	4					
plant	*Hypericum boreale*	northern St. John's-wort	G5	S2	SH	LR	Riparian	U1	4	4					
plant	*Hypericum ellipticum*	pale St. John's-wort	G5	SH	S4	LR	Riparian	UNP	5	5					
plant	*Isoetes lacustris*	lake quillwort	G5	S1?	_	LR	Riparian	U1	4	4					
plant	*Juncus brachycephalus*	small-head rush	G5	S2	_	LR	Riparian	U1	4	3					
plant	*Juncus brevicaudatus*	narrow-panicled rush	G5	S2	S4	LR	Riparian	U1	4	4					
plant	*Lachnanthes caroliniana*	Carolina redroot	G4	SH	_	LR	Riparian	UH	5	5					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
plant	*Liparis loeselii*	Loesel's twayblade	G5	S2	S2	LR	Riparian	U1	4	3					
plant	*Lycopodiella inundata*	northern bog clubmoss	G5	S1	S2?	LR	Riparian	UP	4	4					
plant	*Lythrum alatum*	winged loosestrife	G5	S2	S1	LR	Riparian	UP	4	4					
plant	*Muhlenbergia glomerata*	marsh muhly	G5	S2	SNR	LR	Riparian	U1	4	4					
plant	*Osmunda cinnamomea var. glandulosa*	glandular cinnamon fern	G5TNR	S1	SNR	LR	Riparian	U1	3	2					
plant	*Panicum hemitomon*	maidencane	G5?	S2	_	LR	Riparian	U1	4	3					
plant	*Parnassia grandiflora*	Large-leaved grass of parnassus	G3	S2	S1	LR	Riparian	UP	4	4					
plant	*Platanthera grandiflora*	large purple fringed orchid	G5	S1	S4	LR	Riparian	U1	4	4					
plant	*Platanthera peramoena*	purple fringeless orchis	G5	S2	S4	LR	Riparian	U1	4	3					
plant	*Poa palustris*	fowl bluegrass	G5	S1S2	S4	LR	Riparian	U1	4	4					
plant	*Polanisia dodecandra*	common clammy-weed	G5QT?	S2		LR	Riparian	UP	4	4					
plant	*Potamogeton amplifolius*	Large leaf pondweed	G5	S1S2	S4	LR	Riparian	U2	4	4					
plant	*Potamogeton oakesianus*	Oakes pondweed	G4	S2	SH	LR	Riparian	U1	4	3					
plant	*Ribes americanum*	Wild black currant	G5	S1?	S2	LR	Riparian	U1	4	4					
plant	*Sabatia campanulata*	slender marsh rose-pink	G5	S2	_	LR	Riparian	U1	3	3					
plant	*Sagittaria calycina var calycina*	long-lobed arrowhead	G5T5?	S1	SH	LR	Riparian	U1	4	2					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
plant	*Sagittaria rigida*	sessile-fruited arrowhead	G5	S1	SNA	LR	Riparian	UP	4	3					
plant	*Schoenoplectus subterminalis*	water bulrush	G4G5	S1S2	_	LR	Riparian	U1	4	4					
plant	*Scirpus torreyi*	Torrey's bulrush	G5?	S1	S1	LR	Riparian	UP	4	3					
plant	*Solidago rupestris*	riverbank goldenrod	G4?	S1	_	LR	Riparian	U1	4	2					
plant	*Solidago uliginosa*	bog goldenrod	G4G5 T?	S2		LR	Riparian	U1	4	3					
plant	*Sparganium chlorocarpum*	narrow-leaf burreed	G5	S1		LR	Riparian	U2	4	3					
plant	*Spartina pectinata*	freshwater cordgrass	G5	S2	S4	LR	Riparian	UP	4	4					
plant	*Sphagnum russowii*	Russow's peatmoss	G5	S1S2		LR	Riparian	U2	4	3					
plant	*Spiranthes lucida*	shining ladies'-tresses	G5	S1	S1S2	LR	Riparian	UP	4	4					
plant	*Spiranthes ochroleuca*	yellow nodding ladies'-tresses	G4	S1	S5	LR	Riparian	U1	3	3					
plant	*Triadenum fraseri (Hypericum v.)*	Fraser's marsh St. John's-wort	G5	S1	S4	LR	Riparian	UP	4	4					
plant	*Triantha racemosa*	coastal false-asphodel	G5	S1	_	LR	Riparian	U1	4	4					
plant	*Vaccinium macrocarpon*	large cranberry	G4	S2	S2	LR	Riparian	U1	4	3					
plant	*Verbena scabra*	sandpaper vervain	G5	S2	S1	LR	Riparian	UP	4	4					
plant	*Veronica scutellata*	marsh speedwell	G5	S1	S2	LR	Riparian	UP	4	4					
plant	*Viburnum lentago*	nannyberry	G5	S1	S1S2	LR	Riparian	UP	4	4					
plant	*Vicia americana*	American purple vetch	G5	S1S2	S4	LR	Riparian	UP	4	4					

Species			Habitat and Ranking								Species Sensitivity Factor				
Group	Scientific Name	Common Name	G-Rank	S-Rank VA	S-Rank WV	Status	Potential Habitat on FS	Unit Rank	Global Conservation Importance Rating	Regional Conservation Importance Rating	sediment	habitat complexity	Temp.	Acid Deposition	Passage
plant	*Woodwardia virginica*	Virginia chainfern	G5	S5	SNR	LR	Riparian	U1	4	4					

***G-Rank = global rank; S-Rank VA= State rank in Virginia; S-Rank WV=State rank in West Virginian; Unit Rank=Rank of rarity on the GWNF (U1=critically imperiled, U2=imperiled, U3=vulnerable, U4=apparently secure, U5=secure, UU=unrankable, UH=historical, UX=presumed extirpated, UP=possibly present, UNP=not present, UNR=not ranked, UNA=not applicable)**

****Sensitivity factors were not assigned to those species with "riparian" as potential habitat.**

Table H-5. Changes* to Viability by Forest Plan Alternative**

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
Pleurobema collina	James spinymussel	Potts Creek	C	o	+	+	+	+	+	+
		Cowpasture River	C	o	+	+	+	+	+	+
		Catawba Creek-James River	E	o	+	+	+	+	+	+
		Craig Creek	C	o	+	+	+	+	+	+
		Calfpasture River	C	o	+	+	+	+	+	+
		Pedlar River-James River	C	o	+	+	+	+	+	+
Helenium virginicum	Virginia sneezeweed	Back Creek-South River	B	o	+	+	o	+	+	+
		Naked Creek-South Fork Shenandoah River	C	o	+	+	o	+	+	+
Helonias bullata	swamp pink	Back Creek-South River	B	o	+	+	o	+	+	+
		Irish Creek-South River	B	o	+	+	o	+	+	+
Scirpus ancistrochaetus	northeastern bulrush	Dry River-North River	D	o	+	+	o	+	+	+
		Back Creek-South River	E	o	+	+	o	+	+	+
		Naked Creek-South Fork Shenandoah River	E	o	+	+	o	+	+	+
		Potts Creek	D	o	+	+	o	+	+	+
		Back Creek-Jackson River	E	o	+	+	o	+	+	+
Notropis semperasper	Roughhead shiner	Dunlap Creek	C	o	+	+	o	+	+	+
		Potts Creek	C	o	+	+	o	+	+	+
		Back Creek-Jackson River	B	o	+	+	o	+	+	+
		Wilson Creek-Jackson River	C	o	+	+	o	+	+	+
		Cowpasture River	B	o	+	+	o	+	+	+
		Catawba Creek-James River	C	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
		Calfpasture River	C	o	+	+	o	+	+	+
Noturus gilberti	Orangefin madtom	Cowpasture River	C	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
Hydraena maureenae	Maureen's shale stream beetle	Shoemaker River-North Fork Shenandoah River	D	o	+	+	o	+	+	+
		Wilson Creek-Jackson River	E	o	+	+	o	+	+	+

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
		Cowpasture River	B	o	+	+	o	+	+	+
		Craig Creek	E	o	+	+	o	+	+	+
		Calfpasture River	D	o	+	+	o	+	+	+
Cicindela ancocisconensis	Appalachian tiger beetle	Wilson Creek-Jackson River	E	o	+	+	o	+	+	+
		Cowpasture River	D	o	+	+	o	+	+	+
Sorex palustris punctulatus	southern water shrew	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
		Back Creek-Jackson River	D	o	+	+	o	+	+	+
Alasmidonta varicosa	Brook floater	Gooney Run-South Fork Shenandoah River	E	o	+	+	o	+	+	+
		Smith Creek-North Fork Shenandoah River	E	o	+	+	o	+	+	+
		Stony Creek-North Fork Shenandoah River	E	o	+	+	o	+	+	+
Elliptio lanceolata	Yellow lance	Wilson Creek-Jackson River	C	o	+	+	o	+	+	+
		Cowpasture River	C	o	+	+	o	+	+	+
		Catawba Creek-James River	E	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
		Maury River	C	o	+	+	o	+	+	+
		Pedlar River-James River	C	o	+	+	o	+	+	+
Fusconaia masoni	Atlantic pigtoe	Catawba Creek-James River	E	o	+	+	+	+	+	+
		Craig Creek	C	o	+	+	+	+	+	+
		Calfpasture River	E	o	+	+	+	+	+	+
Lasmigona subviridis	Green floater	Stony Creek-North Fork Shenandoah River	C	o	+	+	o	+	+	+
		Pedlar River-James River	C	o	+	+	o	+	+	+
		Tye River	C	o	+	+	o	+	+	+
Villosa constricta	Notched Rainbow	Potts Creek	C	o	+	+	o	+	+	+
		Cowpasture River	C	o	+	+	o	+	+	+
		Catawba Creek-James River	C	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
		Maury River	C	o	+	+	o	+	+	+

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
		Pedlar River-James River	C	o	+	+	o	+	+	+
Peltigera hydrothyria	waterfan	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
		Middle River	B	o	+	+	o	+	+	+
		Stony Creek-North Fork Shenandoah River	B	o	+	+	o	+	+	+
		Cowpasture River	B	o	+	+	o	+	+	+
		Irish Creek-South River	A	o	+	+	o	+	+	+
		Tye River	A	o	+	+	o	+	+	+
		Buffalo River	A	o	+	+	o	+	+	+
Ambystoma tigrinum	eastern tiger salamander	Back Creek-South River	B	o	+	+	o	+	+	+
Cambarus monongalensis	A Crayfish	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
Anguilla rostrata	American eel	Middle River	C	o	+	+	o	+	+	+
		Dry River-North River	C	o	+	+	o	+	+	+
		Back Creek-South River	C	o	+	+	o	+	+	+
		Naked Creek-South Fork Shenandoah River	C	o	+	+	o	+	+	+
		Gooney Run-south Fork Shenandoah River	B	o	+	+	o	+	+	+
		Smith Creek-North Fork Shenandoah River	C	o	+	+	o	+	+	+
		Stony Creek-North Fork Shenandoah River	C	o	+	+	o	+	+	+
		Cedar Creek	A	o	+	+	o	+	+	+
		Craig Creek	E	o	+	+	o	+	+	+
		Pedlar River-James River	C	o	+	+	o	+	+	+
		Tye River	A	o	+	+	o	+	+	+
		Buffalo River	A	o	+	+	o	+	+	+
		Rockfish River	C	o	+	+	o	+	+	+
Salvelinus fontinalus	Brook trout	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
		South Fork South Branch Potomac River	B	o	+	-	o	+	+	+
		Cacapon River	B	o	+	-	o	+	+	+
		Dry River-North River	A	o	+	-	o	+	+	+
		Back Creek-South River	B	o	+	-	o	+	+	+
		Naked Creek-South Fork Shenandoah River	B	o	+	+	o	+	+	+
		Gooney Run-south Fork Shenandoah River	B	o	+	+	o	+	+	+
		Shoemaker River-North Fork Shenandoah River	B	o	+	-	o	+	+	+

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
		Smith Creek-North Fork Shenandoah River	B	o	+	-	o	+	+	+
		Stony Creek-North Fork Shenandoah River	A	o	+	-	o	+	+	+
		Cedar Creek	B	o	+	-	o	+	+	+
		Dunlap Creek	B	o	+	-	o	+	+	+
		Potts Creek	B	o	+	-	o	+	+	+
		Back Creek-Jackson River	A	o	+	-	o	+	+	+
		Wilson Creek-Jackson River	A	o	+	-	o	+	+	+
		Cowpasture River	A	o	+	-	o	+	+	+
		Catawba Creek-James River	C	o	+	-	o	+	+	+
		Craig Creek	B	o	+	-	o	+	+	+
		Calfpasture River	A	o	+	-	o	+	+	+
		Little Calfpasture River	B	o	+	-	o	+	+	+
		Maury River	B	o	+	+	o	+	+	+
		Irish Creek-South River	A	o	+	-	o	+	+	+
		Pedlar River-James River	B	o	+	+	o	+	+	+
		Tye River	A	o	+	+	o	+	+	+
		Buffalo River	B	o	+	+	o	+	+	+
		Rockfish River	B	o	+	+	o	+	+	+
Cottus cf. cognatus	Checkered sculpin	Cacapon River	C	o	+	-	o	+	+	+
Aeshna canadensis	Canada darner	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Aeshna tuberculifera	black-tipped darner	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
		Dry River-North River	B	o	+	+	o	+	+	+
		Back Creek-South River	B	o	+	+	o	+	+	+
		Naked Creek-South Fork Shenandoah River	D	o	+	+	o	+	+	+
		Potts Creek	B	o	+	+	o	+	+	+
		Wilson Creek-Jackson River	C	o	+	+	o	+	+	+
		Catawba Creek-James River	E	o	+	+	o	+	+	+
Aeshna verticalis	green-striped darner	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Anax longipes	comet darner	Back Creek-South River	B	o	+	+	o	+	+	+
Calopteryx amata	Superb jewelwing	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
Calopteryx angustipennis	Appalachian jewelwing	Stony Creek-North Fork Shenandoah River	B	o	+	+	o	+	+	+
		Cowpasture River	B	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
		Maury River	C	o	+	+	o	+	+	+
Celithemis martha	Martha's penant	Back Creek-South River	B	o	+	+	o	+	+	+
Cordulegaster diastatops	delta-spotted spiketail	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
Enallagma annexum (AKA cyathigerum)	northern bluet	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Epitheca canis	beaverpond baskettail	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Gomphus adelphus	mustached clubtail	Cowpasture River	C	o	+	+	o	+	+	+
		Calfpasture River	C	o	+	+	o	+	+	+
Gomphus quadricolor	rapids clubtail	Cowpasture River	C	o	+	+	o	+	+	+
		Craig Creek	C	o	+	+	o	+	+	+
		Calfpasture River	C	o	+	+	o	+	+	+
Ladona julia (AKA Libellula julia)	chalk-fronted corporal skimmer	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Lanthus parvulus	double-striped clubtail	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
Lestes disjunctus	northern spreadwing	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
		Back Creek-Jackson River	C	o	+	+	o	+	+	+
		Wilson Creek-Jackson River	C	o	+	+	o	+	+	+
Leucorrhinia hudsonica	Hudsonian whiteface	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Nehalennia irene	sedge sprite	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+

Scientific Name	Common Name	Watershed	Viability outcome from Table H-3	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G
Neurocordulia yamaskanensis	stygian shadowdragon	Stony Creek-North Fork Shenandoah River	C	o	+	+	o	+	+	+
		Wilson Creek-Jackson River	C	o	+	+	o	+	+	+
Rhionaeschna mutata (AKA Aeshna mutata)	spatterdock darner	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
		Potts Creek	C	o	+	+	o	+	+	+
Somatochlora elongata	Ski-tipped emerald	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Sympetrum obtrusum	white-faced meadowhawk	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Isonychia hoffmani	Hoffman's Isonychia mayfly	North Fork South Branch Potomac River	B	o	+	+	o	+	+	+
Nemotaulius hostilis	a limnephilid caddisfly	North Fork South Branch Potomac River	D	o	+	+	o	+	+	+
Clemmys guttata	spotted turtle	Back Creek-South River	D	o	+	+	o	+	+	+
Glyptemys insculpta	wood turtle	South Fork South Branch Potomac River	C	o	+	+	o	+	+	+
		Cacapon River	B	o	+	+	o	+	+	+
		Shoemaker River-North Fork Shenandoah River	B	o	+	+	o	+	+	+
		Smith Creek-North Fork Shenandoah River	C	o	+	+	o	+	+	+
		Stony Creek-North Fork Shenandoah River	B	o	+	+	o	+	+	+
		Cedar Creek	B	o	+	+	o	+	+	+

*** +, increased protection for aquatic and riparian habitat from current plan over the planning period**

-, decreased protection for aquatic and riparian habitat from current plan over the planning period

o, no change in protection for aquatic and riparian habitat from current plan over the planning period

****Birds and non-TE plants and mammals were not included in this analysis because species occurrence locations were not readily available in GIS format. See Terrestrial Ecological Analysis.**

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APPENDIX I - FEDERAL OIL AND GAS LEASING AVAILABILITY - STIPULATIONS

1. HORIZONTAL DRILLING MORATORIUM STIPULATION

The surface management agency (USDA-Forest Service) has a moratorium on processing Surface Use Plan of Operations of an Application for Permit to Drill for any horizontal well and associated hydraulic fracturing. The moratorium will end on May 1, 2013. The moratorium applies on the lands described below (legal subdivision or other description).

For the purpose of: Considering additional information, such as information developed by U.S. Environmental Protection Agency, for use in processing Application for Permit to Drill for horizontal wells with multi-stage hydraulic fracturing.

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

2. HORIZONTAL DRILLING OPERATIONS CONTROL STIPULATION

Horizontal drilling operations are subject to the following special operating constraints. The surface management agency (USDA-Forest Service) will be lead agency for conducting environmental analysis of Application for Permit to Drill (APD) for any horizontal well and associated hydraulic fracturing. In cooperation with BLM, the USDA-Forest Service will scrutinize proposed operations in regard to use and disposal of surface water and groundwater, and the type and amounts of materials used in hydraulic fracturing. Applicants for Surface Use Plan of Operations of APD shall supply a list of the quantity and chemical composition of all materials proposed for use in drilling and hydraulic fracturing, including any associated Material Safety Data Sheets.

The Drilling Plans must be in sufficient detail to permit a complete appraisal of the technical adequacy of the ground water protection components of the proposed drilling. The proposed casing and cementing programs shall be designed to protect and/or isolate all usable water zones, lost circulation zones, and abnormally pressured zones. The operator shall submit the proposed casing program, including size, grade, weight, type of thread and coupling, the setting depth of each string, and its condition. The operator must include the minimum design criteria, including casing loading assumptions and corresponding safety factors for burst, collapse, and tensions (body yield and joint strength).

Based on an the environmental analysis, the USDA-Forest Service will determine whether use of surface water and/or groundwater on National Forest System (NFS) lands will be authorized. Use of surface water and/or groundwater may be severely limited or prohibited.

Prior to conducting hydraulic fracturing operation, the operator shall submit as-built wellbore construction information so that the APD administrators (BLM and Forest Service) can assess:
Adequacy of surface casing to protect fresh water and to isolate potable fresh water supplies from deeper gas-bearing zones,

Adequacy of cement in the annular space around the surface casing,

Adequacy of cement on production (and intermediate) casing to prevent upward migration of fluids during all reservoir conditions,

Use of centralizers to ensure that the cement sheath surrounds the casing strings.

No hydraulic fracturing operation shall commence until the APD administrators provide authorization for the operation after a review of the as-built wellbore construction information. After authorization is granted, the operator shall provide the APD administrators with at least three days notice before commencing hydraulic fracturing operation.

Flowback operations shall use above ground storage tanks rather than surface impoundments. The fluid disposal plan must demonstrate that flowback water pipelines and conveyances will be constructed of suitable materials, maintained in a leak-free condition, regularly inspected

and operated using all appropriate spill control and storm water pollution prevention practices.

Surface disposal of hydraulic fracturing materials on NFS lands will not be authorized. Based on an environmental analysis, the USDA-Forest Service will determine whether subsurface disposal of hydraulic fracturing materials in an EPA-approved underground injection well on NFS lands will be authorized or prohibited.

On the lands described below:

For the purpose of (reasons): Protecting surface water and ground water.

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

3. NO HORIZONTAL DRILLING STIPULATION

No horizontal drilling is allowed on the lands described below (legal subdivision or other description).

For the purpose of (reasons): Protecting surface water and ground water.

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

4. NO SURFACE OCCUPANCY STIPULATION

No surface occupancy or use is allowed on the lands described below (legal subdivision or other description).

For the purpose of:

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

5. CONTROLLED SURFACE USE STIPULATION

Surface occupancy or use is subject to the following special operating constraints.

On the lands described below:

For the purpose of (reasons):

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

6. TIMING LIMITATION STIPULATION

No surface use is allowed during the following time period(s). This stipulation does not apply to operation and maintenance of production facilities

On the lands described below:

For the purpose of (reasons):

Based on the Revised Land and Resource Management Plan for the George Washington National Forest (Forest Plan).

Any changes to this stipulation will be made in accordance with the land use plan and/or the regulatory provisions for such changes.

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APPENDIX J - FEDERAL OIL AND GAS LEASING AVAILABILITY– Aquatic Resources

Table J1. Marcellus Shale by Aquatic Species and Watershed

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
Pleurobema collina	James spinymussel	Potts Creek	P	26%	12,529	11.3%	47.8%		
		Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
		Calfpasture River	P	59%	69,850	46.3%	72.5%		
Helenium virginicum	Virginia sneezeweed	Naked Creek-South Fork Shenandoah River	P	10%	1,331	0.6%	0.9%		
Scirpus ancistrochaetus	northeastern bulrush	Dry River-North River	NF	59%	110,980	58.9%	67.8%	Y	FED
		Naked Creek-South Fork Shenandoah River	P	10%	1,331	0.6%	0.9%		
		Potts Creek	NF	26%	12,529	11.3%	47.8%	N	
		Back Creek-Jackson River	P	41%	55,586	25.2%	45.0%		
Notropis semperasper	Roughhead shiner	Dunlap Creek	P	42%	37,679	34.8%	73.6%		
		Potts Creek	P	26%	12,529	11.3%	47.8%		
		Back Creek-Jackson River	NFP	41%	55,586	25.2%	45.0%	Y	PVT
		Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
		Cowpasture River	NFP	59%	95,086	42.0%	71.9%	Y	FED
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
		Calfpasture River	P	59%	69,850	46.3%	72.5%		

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
Noturus gilberti	Orangefin madtom	Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
Hydraena maureenae	Maureen's shale stream beetle	Shoemaker River-North Fork Shenandoah River	NF	53%	61,945	46.5%	87.8%	Y	FED
		Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
		Cowpasture River	NFP	59%	95,086	42.0%	71.9%	Y	PVT
		Craig Creek	P	1%	1,259	0.5%	62.1%		
		Calfpasture River	NF	59%	69,850	46.3%	72.5%	Y	FED
Cicindela ancocisconensis	Appalachian tiger beetle	Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
		Cowpasture River	NFP	59%	95,086	42.0%	71.9%	Y	FED
Sorex palustris punctulatus	southern water shrew	North Fork South Branch Potomac River	NFP	5%	10,384	5.1%	71.3%	Y	FED
		Back Creek-Jackson River	NFP	41%	55,586	25.2%	45.0%	Y	FED
Alasmidonta varicosa	Brook floater	Smith Creek-North Fork Shenandoah River	P	6%	333	0.2%	5.4%		
		Stony Creek-North Fork Shenandoah River	P	28%	4,906	2.2%	20.2%		
Elliptio lanceolata	Yellow lance	Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
		Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
Fusconaia masoni	Atlantic pigtoe	Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
		Calfpasture River	P	59%	69,850	46.3%	72.5%		
Lasmigona subviridis	Green floater	Stony Creek-North Fork Shenandoah River	P	28%	4,906	2.2%	20.2%		

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
Villosa constricta	Notched Rainbow	Potts Creek	P	26%	12,529	11.3%	47.8%		
		Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
Peltigera hydrothyria	waterfan	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
		Middle River	NF	10%	22,543	9.4%	11.0%	Y	FED
		Stony Creek-North Fork Shenandoah River	NF	28%	4,906	2.2%	20.2%	N	PVT
		Cowpasture River	NF	59%	95,086	42.0%	71.9%	Y	FED
Cambarus monongalensis	A Crayfish	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Anguilla rostrata	American eel	Middle River	P	10%	22,543	9.4%	11.0%		
		Dry River-North River	P	59%	110,980	58.9%	67.8%		
		Naked Creek-South Fork Shenandoah River	P	10%	1,331	0.6%	0.9%		
		Smith Creek-North Fork Shenandoah River	P	6%	333	0.2%	5.4%		
		Stony Creek-North Fork Shenandoah River	P	28%	4,906	2.2%	20.2%		
		Cedar Creek	NFP	19%	422	0.4%	32.7%	N	FED
		Craig Creek	P	1%	1,259	0.5%	62.1%		
Salvelinus fontinalus	Brook trout	North Fork South Branch Potomac River	NFP	5%	10,384	5.1%	71.3%	Y	FED
		South Fork South Branch Potomac River	NFP	29%	55,525	30.1%	90.5%	Y	BOTH
		Cacapon River	NFP	20%	5,484	2.1%	66.9%	N	PVT
		Dry River-North River	NFP	59%	110,980	58.9%	67.8%	Y	BOTH
		Naked Creek-South Fork Shenandoah River	NFP	10%	1,331	0.6%	0.9%	N	PVT
		Shoemaker River-North Fork Shenandoah River	NFP	53%	61,945	46.5%	87.8%	Y	PVT

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
		Smith Creek-North Fork Shenandoah River	NF	6%	333	0.2%	5.4%	N	PVT
		Stony Creek-North Fork Shenandoah River	NFP	28%	4,906	2.2%	20.2%	Y	PVT
		Cedar Creek	NFP	19%	422	0.4%	32.7%	Y	FED
		Dunlap Creek	NFP	42%	37,679	34.8%	73.6%	Y	FED
		Potts Creek	NFP	26%	12,529	11.3%	47.8%	Y	FED
		Back Creek-Jackson River	NFP	41%	55,586	25.2%	45.0%	Y	FED
		Wilson Creek-Jackson River	NFP	38%	22,436	16.2%	44.7%	Y	FED
		Cowpasture River	NFP	59%	95,086	42.0%	71.9%	Y	BOTH
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
		Craig Creek	NFP	1%	1,259	0.5%	62.1%	Y	FED
		Calfpasture River	NFP	59%	69,850	46.3%	72.5%	Y	FED
		Little Calfpasture River	NFP	30%	14,974	28.0%	65.2%	Y	FED
Cottus cf. cognatus	Checkered sculpin	Cacapon River	P	20%	5,484	2.1%	66.9%		
Aeshna canadensis	Canada darner	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%		
Aeshna tuberculifera	black-tipped darner	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
		Dry River-North River	NF	59%	110,980	58.9%	67.8%	Y	PVT
		Naked Creek-South Fork Shenandoah River	NF	10%	1,331	0.6%	0.9%	N	FED
		Potts Creek	NF	26%	12,529	11.3%	47.8%	Y	FED
		Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
		Catawba Creek-James River	P	5%	6,955	3.3%	22.1%		
Aeshna verticalis	green-striped darner	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Calopteryx amata	Superb jewelwing	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Calopteryx angustipennis	Appalachian jewelwing	Stony Creek-North Fork Shenandoah River	NF	28%	4,906	2.2%	20.2%	Y	FED

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
		Cowpasture River	NF	59%	95,086	42.0%	71.9%	Y	FED
		Craig Creek	P	1%	1,259	0.5%	62.1%		
Cordulegaster diastatops	delta-spotted spiketail	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Enallagma annexum (AKA cyathigerum)	northern bluet	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Epitheca canis	beaverpond baskettail	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Gomphus adelphus	mustached clubtail	Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Calfpasture River	P	59%	69,850	46.3%	72.5%		
Gomphus quadricolor	rapids clubtail	Cowpasture River	P	59%	95,086	42.0%	71.9%		
		Craig Creek	P	1%	1,259	0.5%	62.1%		
		Calfpasture River	P	59%	69,850	46.3%	72.5%		
Ladona julia (AKA Libellula julia)	chalk-fronted corporal skimmer	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Lanthus parvulus	double-striped clubtail	North Fork South Branch Potomac River	NFP	5%	10,384	5.1%	71.3%	Y	FED
Lestes disjunctus	northern spreadwing	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
		Back Creek-Jackson River	P	41%	55,586	25.2%	45.0%		
		Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		
Leucorrhinia hudsonica	Hudsonian whiteface	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Nehalennia irene	sedge sprite	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Neurocordulia yamaskanensis	stygian shadowdragon	Stony Creek-North Fork Shenandoah River	P	28%	4,906	2.2%	20.2%		
		Wilson Creek-Jackson River	P	38%	22,436	16.2%	44.7%		

Scientific Name	Common Name	Watershed	National Forest (NF) or Private (P) occurrence	% GWNF	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Marcellus shale on FS at occurrence	fed or pvt mineral ownership at occurrence
Rhionaeschna mutata (AKA Aeshna mutata)	spatterdock darner	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
		Potts Creek	P	26%	12,529	11.3%	47.8%		
Somatochlora elongata	Ski-tipped emerald	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Sympetrum obtrusum	white-faced meadowhawk	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Isonychia hoffmani	Hoffman's Isonychia mayfly	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Nemotaulius hostilis	a limnephilid caddisfly	North Fork South Branch Potomac River	NF	5%	10,384	5.1%	71.3%	Y	FED
Glyptemys insculpta	wood turtle	South Fork South Branch Potomac River	P	29%	55,525	30.1%	90.5%		
		Cacapon River	NFP	20%	5,484	2.1%	66.9%	Y	PVT
		Shoemaker River-North Fork Shenandoah River	NFP	53%	61,945	46.5%	87.8%	Y	PVT
		Smith Creek-North Fork Shenandoah River	P	6%	333	0.2%	5.4%		
		Stony Creek-North Fork Shenandoah River	NFP	28%	4,906	2.2%	20.2%	N	PVT
		Cedar Creek	NFP	19%	422	0.4%	32.7%	Y	FED

Table J2. Aquatic Species Viability Changes due to Marcellus Shale in Watershed by Forest Plan Alternative *

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
Pleurobema collina	James spinymussel	Potts Creek	C	C	C	C	C	C	C	C
		Cowpasture River	C	C	C	C	C	C	C	C
		Catawba Creek-James River	E	E	E	E	E	E	E	E
		Craig Creek	C	C	C	C	C	C	C	C
		Calfpasture River	C	C	C	C	C	C	C	C
Helenium virginicum	Virginia sneezeweed	Naked Creek-South Fork Shenandoah River	C	C	C	C	C	C	C	C
Scirpus ancistrochaetus	northeastern bulrush	Dry River-North River	D	E	E	D	E	D	E	D
		Naked Creek-South Fork Shenandoah River	E	E	E	E	E	E	E	E
		Potts Creek	D	D	D	D	D	D	D	D
		Back Creek-Jackson River	E	E	E	E	E	E	E	E
Notropis semperasper	Roughhead shiner	Dunlap Creek	C	C	C	C	C	C	C	C
		Potts Creek	C	C	C	C	C	C	C	C
		Back Creek-Jackson River	B	C	C	C	C	C	C	C
		Wilson Creek-Jackson River	C	C	C	C	C	C	C	C
		Cowpasture River	B	C	C	C	C	C	C	C
		Catawba Creek-James River	C	C	C	C	C	C	C	C
		Craig Creek	C	C	C	C	C	C	C	C
		Calfpasture River	C	C	C	C	C	C	C	C
Noturus gilberti	Orangefin madtom	Cowpasture River	C	C	C	C	C	C	C	C
		Craig Creek	C	C	C	C	C	C	C	C
Hydraena maureenae	Maureen's shale stream beetle	Shoemaker River-North Fork Shenandoah River	D	E	E	E	E	E	E	E
		Wilson Creek-Jackson River	E	E	E	E	E	E	E	E

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
		Cowpasture River	B	C	C	C	C	C	C	C
		Craig Creek	E	E	E	E	E	E	E	E
		Calfpasture River	D	E	E	D	E	D	E	D
Cicindela ancocisconensis	Appalachian tiger beetle	Wilson Creek-Jackson River	E	E	E	E	E	E	E	E
		Cowpasture River	D	E	E	D	E	D	E	D
Sorex palustris punctulatus	southern water shrew	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
		Back Creek-Jackson River	D	E	E	D	E	D	E	D
Alasmidonta varicosa	Brook floater	Smith Creek-North Fork Shenandoah River	E	E	E	E	E	E	E	E
		Stony Creek-North Fork Shenandoah River	E	E	E	E	E	E	E	E
Elliptio lanceolata	Yellow lance	Wilson Creek-Jackson River	C	C	C	C	C	C	C	C
		Cowpasture River	C	C	C	C	C	C	C	C
		Catawba Creek-James River	E	E	E	E	E	E	E	E
		Craig Creek	C	C	C	C	C	C	C	C
Fusconaia masoni	Atlantic pigtoe	Catawba Creek-James River	E	E	E	E	E	E	E	E
		Craig Creek	C	C	C	C	C	C	C	C
		Calfpasture River	E	E	E	E	E	E	E	E
Lasmigona subviridis	Green floater	Stony Creek-North Fork Shenandoah River	C	C	C	C	C	C	C	C
Villosa constricta	Notched Rainbow	Potts Creek	C	C	C	C	C	C	C	C
		Cowpasture River	C	C	C	C	C	C	C	C
		Catawba Creek-James River	C	C	C	C	C	C	C	C
		Craig Creek	C	C	C	C	C	C	C	C
Peltigera hydrothyria	waterfan	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
		Middle River	B	C	C	B	C	B	C	B
		Stony Creek-North Fork Shenandoah River	B	B	B	B	B	B	B	B
		Cowpasture River	B	C	C	B	C	B	C	B
Cambarus monongalensis	A Crayfish	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B
Anguilla rostrata	American eel	Middle River	C	C	C	C	C	C	C	C
		Dry River-North River	C	C	C	C	C	C	C	C
		Naked Creek-South Fork Shenandoah River	C	C	C	C	C	C	C	C
		Smith Creek-North Fork Shenandoah River	C	C	C	C	C	C	C	C
		Stony Creek-North Fork Shenandoah River	C	C	C	C	C	C	C	C
		Cedar Creek	A	A	A	A	A	A	A	A
		Craig Creek	E	E	E	E	E	E	E	E
Salvelinus fontinalus	Brook trout	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B
		South Fork South Branch Potomac River	B	C	C	C	C	C	C	C
		Cacapon River	B	B	B	B	B	B	B	B
		Dry River-North River	A	C	C	C	C	C	C	C
		Naked Creek-South Fork Shenandoah River	B	B	B	B	B	B	B	B
		Shoemaker River-North Fork Shenandoah River	B	C	C	C	C	C	C	C
		Smith Creek-North Fork Shenandoah River	B	B	B	B	B	B	B	B
		Stony Creek-North Fork Shenandoah River	A	C	C	C	C	C	C	C
		Cedar Creek	B	C	C	B	C	B	C	B
		Dunlap Creek	B	C	C	B	C	B	C	B
		Potts Creek	B	C	C	B	C	B	C	B
		Back Creek-Jackson River	A	C	C	A	C	A	C	A

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
		Wilson Creek-Jackson River	A	C	C	A	C	A	C	A
		Cowpasture River	A	C	C	C	C	C	C	C
		Catawba Creek-James River	C	C	C	C	C	C	C	C
		Craig Creek	B	C	C	B	C	B	C	B
		Calfpasture River	A	C	C	A	C	A	C	A
		Little Calfpasture River	B	C	C	B	C	B	C	B
Cottus cf. cognatus	Checkered sculpin	Cacapon River	C	C	C	C	C	C	C	C
Aeshna canadensis	Canada darner	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Aeshna tuberculifera	black-tipped darner	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
		Dry River-North River	B	C	C	C	C	C	C	C
		Naked Creek-South Fork Shenandoah River	D	D	D	D	D	D	D	D
		Potts Creek	B	C	C	B	C	B	C	B
		Wilson Creek-Jackson River	C	C	C	C	C	C	C	C
		Catawba Creek-James River	E	E	E	E	E	E	E	E
Aeshna verticalis	green-striped darner	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Calopteryx amata	Superb jewelwing	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Calopteryx angustipennis	Appalachian jewelwing	Stony Creek-North Fork Shenandoah River	B	C	C	B	C	B	C	B
		Cowpasture River	B	C	C	B	C	B	C	B
		Craig Creek	C	C	C	C	C	C	C	C
Cordulegaster diastatops	delta-spotted spiketail	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B
Enallagma annexum (AKA cyathigerum)	northern bluet	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
Epitheca canis	beaverpond baskettail	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Gomphus adelphus	mustached clubtail	Cowpasture River	C	C	C	C	C	C	C	C
		Calfpasture River	C	C	C	C	C	C	C	C
Gomphus quadricolor	rapids clubtail	Cowpasture River	C	C	C	C	C	C	C	C
		Craig Creek	C	C	C	C	C	C	C	C
		Calfpasture River	C	C	C	C	C	C	C	C
Ladona julia (AKA Libellula julia)	chalk-fronted corporal skimmer	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Lanthus parvulus	double-striped clubtail	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B
Lestes disjunctus	northern spreadwing	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
		Back Creek-Jackson River	C	C	C	C	C	C	C	C
		Wilson Creek-Jackson River	C	C	C	C	C	C	C	C
Leucorrhinia hudsonica	Hudsonian whiteface	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Nehalennia irene	sedge sprite	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Neurocordulia yamaskanensis	stygian shadowdragon	Stony Creek-North Fork Shenandoah River	C	C	C	C	C	C	C	C
		Wilson Creek-Jackson River	C	C	C	C	C	C	C	C
Rhionaeschna mutata (AKA Aeshna mutata)	spatterdock darner	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
		Potts Creek	C	C	C	C	C	C	C	C
Somatochlora elongata	Ski-tipped emerald	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Sympetrum obtrusum	white-faced meadowhawk	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D

Scientific Name	Common Name	Watershed	Viability outcome from EIS viability	Viability outcome Alt A	Viability outcome Alt B	Viability outcome Alt C	Viability outcome Alt D	Viability outcome Alt E	Viability outcome Alt F	Viability outcome Alt G
Isonychia hoffmani	Hoffman's Isonychia mayfly	North Fork South Branch Potomac River	B	B	B	B	B	B	B	B
Nemotaulius hostilis	a limnephilid caddisfly	North Fork South Branch Potomac River	D	D	D	D	D	D	D	D
Glyptemys insculpta	wood turtle	South Fork South Branch Potomac River	C	C	C	C	C	C	C	C
		Cacapon River	B	C	C	C	C	C	C	C
		Shoemaker River-North Fork Shenandoah River	B	C	C	C	C	C	C	C
		Smith Creek-North Fork Shenandoah River	C	C	C	C	C	C	C	C
		Stony Creek-North Fork Shenandoah River	B	B	B	B	B	B	B	B
		Cedar Creek	B	C	C	B	C	B	C	B

*** Shaded cells indicate a change in viability**

REASONABLY FORESEEABLE DEVELOPMENT SCENARIO

FOR OIL AND GAS

FOR THE

GEORGE WASHINGTION NATIONAL FOREST

VIRGINIA AND WEST VIRGINIA

Prepared by:

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
EASTERN STATES
SOUTHEASTERN STATES FIELD OFFICE
411 Briarwood Drive, Suite 404
Jackson, MS 39206

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SUMMARY

A Reasonably Foreseeable Development Scenario (RFDS) for oil and natural gas is developed based on the assumption that all potentially productive areas can be open under standard lease terms and conditions except those areas designated as closed to leasing by law. It covers a time period of 15 years and includes all lands within the boundaries of the George Washington National Forest (GWNF) regardless of mineral estate ownership and adjacent non-forest lands.

Exploration on GWNF lands has been sparse and activity on surrounding lands has been minimal. Thus far, only five wells have been drilled on GWNF lands. All were designed to test a specific horizon and all were dry holes. Two small natural gas fields have been developed adjacent to GWNF lands, but, with the exception of one well, there has been no drilling activity since the 1990's.

Several oil and gas plays have been identified which cover the area of interest. As such, the oil and gas occurrence potential must be considered as high. One of these plays is related to the Marcellus Shale which is present on the surface and in the subsurface under more than half of the GWNF lands. With industry focus currently directed toward the exploration for and exploitation of organic shales and in particular the Marcellus, the oil and gas development potential is also considered as high.

It is foreseen that 20 vertical exploration/evaluation wells will be drilled over the next 15 years which will prove the presence of productive Marcellus Shale in the area of the GWNF. Additionally, 50 vertical and 249 horizontal development wells are forecast to be drilled over the timeframe of the RFDS. The initial gross surface disturbance associated with the exploration, development, and production activity in the GWNF is estimated at 1,515.53 acres. With partial surface reclamation following completion of productive wells, the net disturbance is projected at 953.47 acres. An additional 25 acres of lands are allocated for compression operations, produced water handling, material storage, and other facilities.

INTRODUCTION

The United States Department of Interior, Bureau of Land Management (BLM), Southeastern States Field Office prepared this Reasonably Foreseeable Development Scenario (RFDS) for Oil and Gas for the George Washington National Forest (GWNF). The RFDS is consistent with BLM Handbook 1624-1 and BLM Instructional Memorandum (IM) 2004-89. IM 2004-89 requires that the RFDS project a baseline scenario of activity assuming that all potentially productive areas are open to leasing under standard terms and conditions with the exception of those areas closing to leasing by law.

The RFDS is a reasonable, technical, and scientific estimate of anticipated oil and gas activity based on current information and data available. The baseline scenario presented in the document will be used by the United States Department of Agriculture Forest Service (FS) as the basis for determining the cumulative impacts from oil and gas activity relative to each alternative developed in the planning process.

DESCRIPTION OF GEOLOGY

The George Washington National Forest (GWNF), located in northwestern Virginia and eastern and northeastern West Virginia, is situated within portions of three physiographic provinces. From east to west, these are the Blue Ridge, the Valley and Ridge, and the Appalachian Plateau.

Structure

Blue Ridge Province

The Blue Ridge Province is an area of largely igneous and metamorphic rocks that have been thrust over younger Cambrian and Cambro-Ordovician sedimentary rocks. According to the USGS in the 1995 National Oil and Gas Assessment, “the Province underlies parts of eight States from central Alabama to southern Pennsylvania. Along its western margin, the Blue Ridge is thrust over the folded and faulted margin of the Appalachian basin, so that a broad segment of Paleozoic strata extends eastward for tens of miles, buried beneath these subhorizontal crystalline thrust sheets (Harris and others, 1981). At the surface, the Blue Ridge consists of a

mountainous to hilly region, the main component of which are the Blue Ridge Mountains that extend from Georgia to Pennsylvania. Surface rocks consist mainly of a core of moderate-to high-rank crystalline metamorphic or igneous rocks, which, because of their superior resistance to weathering and erosion, commonly rise above the adjacent areas of low-grade metamorphic and sedimentary rock. The province is bounded on the north and west by the Paleozoic strata of the Appalachian Basin Province and on the south by Cretaceous and younger sedimentary rocks of the Gulf Coastal Plain. It is bounded on the east by metamorphic and sedimentary rocks of the Piedmont Province."

In a Description of the Geology of Virginia (James Madison University), the Blue Ridge is characterized structurally "as a large, eroded anticline overturned to the west. The core of the anticline is composed of igneous and metamorphic rocks collectively known as the Grenville, although there are also late Proterozoic intrusives and sediments present too. They are the oldest rocks in the state at 1.1 billion back to 1.8 billion years. The east and west flanks of the anticline are much younger volcanics and clastic sediments. Stratigraphic thicknesses range from about 3000 meters to 7000 meters. The final filling of the graben and creation of a divergent continental margin is preserved in the metamorphosed lava flows (Catoctin) and sedimentary rocks (Chilhowee Group and Evington formation) about 570-600 million years old."

Valley and Ridge

The majority of the GWNF lies within the Valley and Ridge Province. The Valley and Ridge represents a physiographic province of the larger Appalachian division which extends from southeastern New York, northwestern New Jersey, northeastern and central Pennsylvania, western Maryland, eastern West Virginia, northwestern and southwestern Virginia, and into Tennessee, Georgia, and Alabama. The Valley and Ridge forms an arc between the Blue Ridge Mountains on the east and the Appalachian Plateau on the west.

The province includes the Great Valley which is an expansive, flat region composed of complexly folded and faulted Cambrian and Ordovician carbonates and the Ordovician aged Martinsburg Shale. The Great Valley extends west to east from North Mountain to the Blue Ridge and is some 20 miles wide.

From North Mountain westward to the Allegheny Front, a distance of about 50 miles, are a series of northeast-trending mountains and valleys from which the Valley and Ridge Province is named. The ridges are comprised of resistant beds of sandstones, conglomerates, or quartzites and the valleys of less resistant carbonates and shales. Formations in the Valley and Ridge are thrust faulted and folded into anticlines and synclines and range in age from Cambrian to Lower Mississippian. The Valley and Ridge province is divided into several sharply defined anticlinal complexes separated by much broader synclinal zones. The most persistent of these synclinoria, the westernmost, extends 250 mi from central Pennsylvania to southern Virginia and averages 10-20 mi in width.

The majority of the GWNF lies within the Valley and Ridge Province between the Little North Mountain Fault and the Allegheny Plateau. This area is part of the Broadtop Synclinorium. Jacobeen and Kanes (1974) state, "Component structures of the Broadtop synclinorium include: Broadtop syncline (Broadtop coal basin) of Pennsylvania; Town Hill syncline, Whip Cove West anticline, Whip Cove syncline, Whip Cove East anticline, Spring Gap syncline, Sideling Hill syncline of Maryland and West Virginia (Tilton et al., 1927); and the Bergton-Crab Run anticline of Virginia (Brent, 1960). In this synclinorium, surface outcrop consists of predominantly Carboniferous and Devonian strata. Ordovician to Lower Devonian rocks comprise the cores of bounding anticlinoria."

Allegheny Plateau

The Allegheny Structural Front is the transition zone between the highly folded and faulted formations of the Valley and Ridge and the relatively flat lying rocks of the Allegheny (Appalachian) Plateau. Formations exposed on the Allegheny Front range in age from Middle Devonian to Lower Mississippian. Only a small portion of the GWNF, that located in Highland County, Virginia, lies within the Allegheny Plateau Province.

STRATIGRAPHY

The following formations crop out in the GWNF.

- Pocono Formation – Massive gray sandstone with some dark shale
- Hampshire Formation – Chiefly red sandstone; some flagstones, shales, and mudrock.

- Foreknobs Formation (formerly Chemung) - Green and greenish-gray, thin- to thick-bedded, fossiliferous (most notably large crinoid stems) quartz sandstone and shale and minor quartz-pebble conglomerate.
- Brallier Formation - Olive-gray, thin-bedded, micaceous, sparsely fossiliferous siltstone, shale, and thin lithic sandstone. Thickness: 1500 to 2200 feet.
- Millboro Shale (Marcellus) and Needmore Formation - Millboro Shale: black, fissile shale, with thin bentonite beds. Near the base is an interval of dark-gray, aphanic, thinbedded limestone (Purcell Member?). Needmore Formation: olive-gray, weathered, fossiliferous shale, with thin bentonite beds. Composite thickness 800 to 1200 feet.
- Ridgeley Sandstone, Helderburg, and Cayugan Groups – Calcareous sandstone; limestone, cherty in part; and calcareous shale; fossiliferous.
- Keefer, Rose Hill, and Tuscarora Formations – Quartzarenite, dusky-red shale, and sandstone.
- Massanutten Sandstone – Quartzarenite with lenses of conglomerate.
- Juniata, Reedsville, Trenton, and Eggleston Formations – Dusky-red shale, mudstone, and sandstone; shale and limestone
- Martinsburg Formation – Gray shale, sandstone, and siltstone; gray argillaceous limestone.

PAST AND PRESENT OIL AND GAS EXPLORATION ACTIVITY

Regional seismic exploration was conducted in the late 1960’s and early 1970’s from the Blue Ridge, through the Valley and Ridge, and into the Appalachian Plateau Province utilizing Vibroseis on existing major east-west roads. Several of these lines crossed through the area of the GWNF. Additional seismic exploration was conducted in the general area in the late 1970’s and early 1980’s in response to industry interest in the Eastern Overthrust Belt in which most of the GWNF is situated. Five wells in Virginia and two wells in West Virginia were drilled in the overthrust belt in response to these efforts. The primary objective was the middle Devonian Oriskany Sandstone. None of the wells were productive.

There are five wells drilled on GWNF lands – four exploratory and one development. All were dry holes. There are other exploratory wells drilled on private lands between or within the GWNF, but only one discovery was made, that in the Bergton area of Rockingham County.

The only recent exploration activity in the area of the GWNF has been the Hardy County, West Virginia well drilled by Carrizo Marcellus, LLC in March 2010.

PAST AND PRESENT OIL AND GAS DEVELOPMENT ACTIVITY

The discovery of natural gas in the Devonian Oriskany Sandstone at Bergton Field located in Rockingham County, Virginia led to the drilling of 18 development wells. 7 were initially productive, but all are now plugged and abandoned.

There has been a well drilled in Hardy County, West Virginia on the Bergton structure. The well specifically targeted the Marcellus Shale. The same company that drilled the Hardy County well has applied for a permit to drill a Marcellus test on the Bergton structure in Rockingham County, Virginia.

The only other field of consequence near the GWNF is the Thornwood-Horton Field located in Pocahontas County, West Virginia. The field, which is immediately adjacent to GWNF lands in northwestern Highland County, Virginia, produces from the Oriskany Sandstone. One of the wells in that field communitized GWNF lands into the production unit for the well.

Other than the new Hardy County, West Virginia well and the proposed Rockingham County, Virginia well, activity in the area in and surrounding the GWNF has been nonexistent since the late 1990's.

OIL AND GAS OCCURRENCE POTENTIAL

The BLM RFDS Handbook, H-1624-1, recommends that all areas within USGS or other defined plays should be given a high potential rating for oil and gas occurrence potential. In the Appalachian Basin Province evaluation of the USGS 1995 National Oil and Gas Assessment, R. T. Ryder defined some 34 real and hypothetical conventional and continuous (unconventional) plays. Four of these plays directly relate to the part of the Appalachian Basin Province where the GWNF is located. These are:

6702 Upper Cambrian, Ordovician, and Lower/Middle Silurian Thrust Belt

6716 Upper Silurian Sandstone Gas

6718 Silurian and Devonian Carbonate Thrust Belt

6720 Oriskany Sandstone Gas/Faulted Anticlines

In response to markedly higher natural gas prices in the 1990's, the Barnett Shale in Texas became a target for exploration and development activities. The play was only marginal from an economic stand point until new drilling and completion techniques were applied, thus demonstrating the viability of continuous resource plays. Since that time, development of continuous resource plays, including the Marcellus Shale, has been at the forefront of industry activity in the United States. Trillions of cubic feet of natural gas reserves have been added as a result of this activity.

In a 2002 assessment of undiscovered oil and gas potential of the Appalachian Basin Province, Milici and others outlined various conventional and continuous (unconventional) oil and gas resources. In this report, the Marcellus Shale Assessment Unit of the Devonian Shale-Middle and Upper Paleozoic Total Petroleum System was estimated to contain a mean value of potential resources of 1.9 TCF, with a range of 822 BCF to 3.67 TCF. Since that time, the Marcellus and other black organic shales in the Appalachian Basin have become the focus of intense exploration and development efforts. In response to these efforts, potential recoverable reserve estimates for the Marcellus Shale have now been projected by industry to as high as 50 TCF (Engelder 2008).

Patchen and Avary (2008) state, "The Middle Devonian Marcellus Shale is the oldest, thickest and most widespread of four formations in the Hamilton Group of central and eastern New York. This black shale unit extends from New York southward to Virginia and West Virginia, and westward into eastern Ohio where it pinches out beneath the Middle Devonian unconformity. In Ohio, the Marcellus Shale generally is not separated from younger rocks in the lower Olentangy Formation; in Virginia, the Marcellus usually is included in the basal portion of the thick Millboro Shale. Throughout the basin, the Marcellus Shale overlies the Onondaga Limestone or eastern facies equivalents, the Huntersville Chert or Needmore Shale." Enomoto (2009) states,

"In the Virginia portion of the Appalachian Basin, the Devonian Mahantango Formation and the Marcellus Shale are mapped collectively as one unit that is named the Millboro Shale. This unit in Virginia consists of black, fissile shale units, with interbeds of dark gray argillaceous limestone or calcareous shale. Thin, dark gray, aphanitic limestone beds occur near the base. Geophysical logs from wells drilled in Highland and Rockingham counties, Virginia, indicate that the thickness of the Millboro Shale ranges from 368 to 570 feet thick in this region."

The Marcellus Shale underlies more than 50 percent of the area of the GWNF. When coupled with previously defined plays, the oil and gas occurrence potential of the GWNF is considered as high.

OIL AND GAS DEVELOPMENT POTENTIAL

Well log data from wells drilled in the area indicate that the Marcellus Shale is present in the subsurface. Data evaluated from the cuttings from several of these wells and from samples taken from outcrop, show that the Marcellus Shale in the area of the GWNF has sufficient organic content and thermal maturity to be productive of natural gas (Enomoto, 2010). Patchen and Avary (2008) state, "the thickest accumulation of this organic-rich black shale occurs along the eastern side of the basin from New York to Virginia where thermal maturity is the highest. This combination of thick, thermally mature (dry gas window) black shales with well-developed regional fracture sets makes the Marcellus Shale an attractive play along the eastern side of the basin far from historical shale play areas as well as in the center of the basin," including the Valley and Ridge of Virginia and West Virginia.

There is some general interest in the area as a well targeting the Marcellus Shale has been drilled in Hardy County, West Virginia and another is being permitted by the same company across the state line in the Bergton area of Rockingham County, Virginia. One reason for the interest this area is the proximity of natural gas pipelines. The results of natural gas production from these wells and other new wells if drilled, coupled with evaluations of the log data from previous exploratory wells both within and adjacent to the GWNF, should serve as the basis for the leasing and future development of the Marcellus Shale resource in the GWNF.

TYPICAL DRILLING AND COMPLETION SCENARIO

Drilling

Both vertical and horizontal wells will be utilized for the exploration and development of the Marcellus Shale resource in the GWNF. The true vertical depth (TVD) of these wells will range between 1000' and 8000'. Actual measured depths (MD) should range between 4000' and 12,000'.

In the GWNF, the likely drilling medium for vertical wells will be air or air-mist. For horizontal wells, air or air-mist will be used to the kickoff point, then either water or oil based drilling mud will be used for the radius turn and horizontal lateral portion of the hole.

Vertical wells are drilled from the surface to a point in the subsurface directly below the surface location. Horizontal wells are drilled from the surface to a point in the subsurface some hundreds or thousands of feet from the surface location. In each instance, conductor casing is run to a depth of 30, 60, or 90 feet. Drilling then continues to a point below the level of any aquifers or other zones that contain fresh water and a string of protective casing is run to that depth and cemented to surface. The setting of the surface casing isolates and protects fresh water and other important zones from contamination by connate waters, drilling mud, and hydraulic fracture fluids.

Below the surface casing, vertical wells are drilled through the objective horizon. Once total depth is reached, a string of production casing is run and cemented in place with the level of cement sufficient for isolation of the productive interval. Horizontal wells are drilled to a point below the surface casing to the kickoff point where the well is steered from the vertical to the horizontal utilizing a medium or long radius turn. The well is designed for the borehole to enter the objective horizontally and then drill the lateral within the objective formation. Measure While Drilling (MWD) equipment and Geosteering software allow for the drilling of the borehole in a determined direction and attitude. Once Total Depth (TD) is reached, production casing is run to or near the total drilled depth and cemented in place with the level of cement sufficient for isolation of the productive interval. Horizontal lateral length will average 4000'.

By law in Virginia, vertical wells must be drilled at least 2500 feet apart. At a minimum, the vertical well spacing unit is 112.69 acres – a circle with a 1250' radius. For horizontal wells, the unit size is 320 acres – a rectangle with dimensions of 2640' X 5280'. Horizontal laterals will be drilled parallel to the long side and are required to have 600' of separation. There is also a 300' offset from the unit boundary requirement thus limiting maximum lateral length to 4680'. As a result, a maximum of 3 laterals can be drilled in each horizontal well unit.

Over the 15 year time frame of the RFDS, the average cost for a completed vertical well is estimated to average $2,500,000. For horizontal wells, the estimate is between $6,000,000. and $9,000,000. per well. Although the well cost for a horizontal well is 2 to 4 times higher than that for a vertical well, the potentially productive formation exposed in the horizontal borehole is 10 or more times greater. Recoverable reserves in horizontal wells are normally higher also. Recoverable reserves are estimated at 1,000,000 MCF/well for vertical wells and 3,000,000 MCF/well for the horizontal ones.

Based on the above averages, the drilling, completion, and production costs of the wells projected to be drilled in the GWNF is $2,042,000,000. The estimated ultimate recoverable reserves (EUR) developed from the drilling of these forecast wells is 817,000,000 MCF.

Completion

The higher cost for a horizontal well is the result of the increase in measured depth due to the length of the lateral and also the added stimulation cost. The typical vertical shale well is usually perforated over the potentially productive interval and stimulated by one hydraulic fracture treatment. The typical horizontal well, on the other hand, often undergoes 10 or more staged fracture treatments each the same size as that for a vertical well. This again relates to the demonstrably increased productiveness inherent to horizontal drilling.

Hydraulic fracture stimulation is utilized in many wells, but is a necessary process for wells drilled in low permeability reservoirs like shales. An estimated 90% of the natural gas wells in the US use hydraulic fracturing to produce gas at economic rates.

The hydraulic fracturing of horizontal wells requires large volumes of water. Each stage of the stimulation uses 10,000 to 12,000 barrels of water (420,000 to 504,000 gallons). Usually 10 or

more treatments are necessary in order to stimulate the entire productive horizon requiring 100,000 to 120,000 barrels of water (4.2 to 5.0 million gallons). During initial post treatment flowback, only 20 percent or less of the fracture fluid is recovered. The rest of the fluid is produced over time. The returning fracture fluid can be treated and reused, treated and disposed of at the surface, or disposed of by underground injection. Both state and federal agencies have oversight of surface disposal. The EPA or EPA-delegated state program have oversight of underground injection.

RFD BASELINE SCENARIO ASSUMPTIONS AND DISCUSSION

The initial assumption is that all potentially productive areas can be open under standard lease terms and conditions except those areas designated as closed to leasing by law. It covers a time period of 15 years and includes all lands within the boundaries of the George Washington National Forest regardless of mineral estate ownership and adjacent non-forest lands where oil and gas activity may impact Forest lands.

Additional assumptions include:

- Initial and primary activities will be directed toward exploration and development of the resources of the Marcellus Shale.
- The Marcellus Shale underlies 569,763 acres of the 1,065,499 acre GWNF. Of this total, 484,299 acres are projected to be capable of natural gas production from the Marcellus Shale.
- Seismic exploration will utilize existing roads for Vibroseis and not result in any appreciable surface disturbance.
- Minimum well spacing and unit size will be governed by rules and regulations the various state authorities designated for oversight of oil and gas operations.
- Access roads construction disturbance is based on a 30’ wide ROW. The actual travel surface and buffer area, however, is anticipated to be less than 30’.
- Well pad and pit size will vary between 2.07 acres for vertical wells to 5.74 acres for multi-well locations.

- For productive wells, those portions of the well site not necessary for production facilities and well operations will be reclaimed. For non productive wells, the entire area will be restored.
- For productive wells, all production facilities will be located on the initial well pad.
- Well gathering and other pipelines will utilize existing access and other road right of ways. Utility lines will also be constructed within existing access roads right of ways.
- Wells drilled to test other, deeper horizons that may become of interest can be drilled from facilities constructed for the exploitation of the Marcellus Shale, either concurrent with or after development.
- Compression, processing, produced water, and material storage facilities will most likely be constructed on private lands, but could be constructed on GWNF lands. 25 acres of land is allocated for the construction of these facilities.

SURFACE DISTURBANCE DUE TO OIL AND GAS ACTIVITY

Access Roads and Well Pads

The two primary sources of surface disturbance from oil and gas exploration and development activity are well (drill) pad construction and the building of access roads to the well site. In situations where production is not established, the well site and the access road are reclaimed. In situations where production is established, a portion of the well site is reclaimed and the access road is upgraded for long term use.

New well roads would be necessary to access drill sites from the existing GWNF road system or from other highways. Access roads are generally constructed for temporary use during the drilling phase of operations. After production is established, access roads are upgraded with a single lane or wider all weather travel surface for long term use. For purposes of the GWNF RFDS, disturbance estimates were based on access roads having a consistent 30’ construction limit width. All access roads would be constructed under established GWNF guidelines.

Well pads vary in size depending on the type of well to be drilled, well depth, the number of wells to be located on the same pad, and local topography. Well pad size can also be proportional to the type and amount of equipment and material needed to complete the well once drilling has

ended. Well pad size in the area of the GWNF is projected to vary between 2.07 for a single vertical well location to 5.24 acres for typical 3 well directional or horizontal well sites.

Each drilling rig can on average drill and complete approximately 1 horizontal well in this area every 3-4 weeks (12-17 wells/year) or 1 vertical well every 10-14 days (26-35 wells/year). To fully develop the resource in the GWNF would require some 20 rigs, each drilling 15 horizontal wells per year over the 15 year life of the plan. Given the number of wells and rigs required, a projected increasing natural gas supply in the U.S., the need for projected steady gas pricing through the year 2025, and simply that there are better areas for Marcellus Shale exploitation, full development of the resource in the GWNF is not a likely scenario within the operative time frame of the plan.

Forecast Development and Disturbance

The development of the Marcellus Shale resource within the GWNF is anticipated as follows:

- Seismic Exploration (Vibroseis): 163 miles on existing roads (casual use minimal disturbance)
- Exploration/Evaluation Wells - Vertical (20 drilled from a single 2.07 acre pad): 41.32 acres
- Exploratory/Evaluation Wells Access Roads (1.5 miles/well): 109.09 acres
- Development Wells-Vertical (50 drilled from single 2.07 acre pad): 103.31 acres
- Development Wells-Vertical Access Roads (1.0 miles/well): 181.82 acres
- Development Wells-Horizontal (249 drilled from a 5.74 acre 3 well pad): 476.35 acres
- Development Wells-Horizontal Access Roads (83 X 2.0 miles/pad): 603.64 acres
- Total Initial Disturbance from exploration and development: 1515.53 acres
- Total Area Reclaimed Following Well Completion: 562.06 acres
- Total Net Disturbance from exploration and development: 953.47
- Area allocated for Compression operations, gas processing, produced water handling, and material storage facilities: 25 acres
- Percentage of Leasable Forest Acres disturbed by oil and gas operations is less than two-tenths of one percent.

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