United States Department of Agriculture

Biennial Monitoring Evaluation Report for the Years 2016 and 2017

Uwharrie National Forest

Croatan National Forest

Uwharrie Ranger District

Croatan Ranger District

This report was edited on April 11, 2019, to correct statements on pgs 8 and 62.

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Executive Summary

This 2018 biennial monitoring report for the Croatan and Uwharrie National Forests evaluates monitoring questions and indicators presented in the Plan Monitoring Program (PMP) in Chapter 4 of the Uwharrie Forest Plan and Chapter 5 of the Croatan Forest Plan, in relation to management actions carried out in the plan area. Findings and recommended changes are described in this evaluation report, indicating whether a change to the forest plan, management activities or monitoring program may be needed based on the new information. The primary evaluation period for this report is 2016 to 2017, although some indicators are reported for a longer duration, as this information is helpful in assessing trends.

Findings or recommended changes may not be reported for every monitoring question for the following reasons: the interval of data collection is beyond this reporting cycle, or more data is needed to understand the status or progress for achieving a plan component, or the results are inadequate to answer the monitoring question.

The monitoring evaluation is provided in two sections: 1) Unit-level monitoring questions and indicators by categories described in the 2012 Planning Rule; and 2) Region 8 Broad Scale monitoring questions. Most unit-level monitoring data are acquired primarily through field inventories, whereas the broad scale questions are generally addressed using secondary data. Findings and recommended changes are summarized below.

Summary of Unit-Level Findings: Uwharrie and Croatan National Forests

Unit-level monitoring questions and indicators for the Croatan and Uwharrie NFs were updated in 2016 and arranged by categories as described in the 2012 Planning Rule. For each category, there are unit-level monitoring questions, except category 6, which addresses climate change at a broader-scale. A summary of unit-level findings for the Croatan and Uwharrie NFs follows. Abbreviations included below reference the plan direction that is being monitored.

Category 1: The status of select watershed conditions.

Note: These are interim findings; the findings for this category are due for the 2020 Monitoring Report

- *Uwharrie NF: The Crow Creek-Uwharrie River watershed is moving toward properly functioning condition; trending toward desired condition (SWF-1) by completing objectives (SWF 1& 2) that restored stream channels in portions of Big Creek and Crow Creek.*

- *Uwharrie NF: Trends for the NC Index of Biotic Integrity (including Ephemeroptera, Plecoptera, Tricoptera, or EPT ratings) are stable for selected stream segments on the Uwharrie NF and consistently rated higher than streams on adjacent ownerships; thus indicating relatively healthy fish communities and trending toward desired conditions.*

- *Uwharrie NF: Species Richness for invertebrates are high for selected streams on the Uwharrie NF, inferring that aquatic systems are diverse and relatively healthy as demonstrated by both the EPT ratings for invertebrates and the EPT Biotic Index, thereby trending toward Desired Condition SWF-1.*

- *Croatan NF: No changes in watershed condition classes have occurred since the 2011 Watershed Condition Framework evaluation. The Holston Creek Watershed is planned for watershed improvements to bring it to properly functioning condition. Some improvements to watershed conditions were made at several stream crossings for aquatic organism passage.*

Category 2. The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems

Note: These are interim findings; the findings for this category are due for the 2020 Monitoring Report

- *The treatments of the selected terrestrial ecosystems on both the Uwharrie and Croatan NF are consistent with their forest plans, specifically the restoration of longleaf pine, and that the application of prescribed fire at consistently high levels has occurred (see category 7) such that both national forests are meeting objectives for fire-adapted ecosystems. More information is needed about the overall conditions of these systems as well as the conditions of oak-dominated ecosystems for the 2020 Monitoring Report.*

Category 3. The status of focal species to assess the ecological conditions under 36 CFR 219.9

- *Uwharrie NF: Trends of relative abundance for brown-headed nuthatch and acadian flycatcher are increasing, indicating that longleaf pine ecosystems and streamside zones are functioning.*
- *Uwharrie NF: Trends of relative abundance for scarlet tanager and pileated woodpecker are decreasing. Scarlet tanager abundance could be declining because brown-headed cowbirds are increasing due to amount of edge habitat from agricultural lands. The cause of decreasing trends of the snag dependent pileated woodpecker is unknown and further study is recommended.*
- *Uwharrie NF: Trends of relative abundance for Bobwhite Quail are declining, although the quality of early successional habitats have been improving, such as the return of bunch grasses due to the significant increase of prescribed fire. Further study is recommended.*
- *Croatan NF: The RCW population on the Croatan National Forest has increased slightly from the 64 clusters in the early 2000's, and has remained stable at around 67-71 active clusters for the last six years, with over 90% of those active clusters with documented breeding attempts. It appears as though the majority of longleaf pine habitat that is ecologically viable to RCW's has been occupied by the woodpecker. With continued prescribed burning, RCW populations on the Croatan are expected to remain stable.*
- *Croatan NF: Bear populations are becoming stable or slightly increasing on the Croatan National Forest. Trends from the counties that encompass the Croatan National Forest show harvest rates to be stable to slightly increasing.*

- *Croatan NF: Turkey hunter harvest rates from 2009-2017 indicate a stable to slightly increasing success rate, suggesting that the overall turkey population is also stable to slightly increasing.*

Category 4. The status of a select set of ecological conditions required under 36 CFR 219.9 to contribute to the recovery of federally listed threatened or endangered species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern.

- *Uwharrie NF: Due to the consistent application of prescribed fire in strategic locations; about 75% of Schweinitz's Sunflower populations are stable, whereas restoration is needed for populations which are along roadsides and are currently vulnerable to spraying and mechanical disturbance. New occurrences of rare species and communities have been found during this monitoring cycle, including an increased known acreage of from 54 to 172 acres of Dry Piedmont Longleaf Forest old growth trees, with some over 300 years of age.*
- *Croatan NF: The natural vegetative conditions on the 17 natural areas are in fair to excellent condition; none have degraded during this monitoring cycle. Rough leaved loosestrife, spring flowering goldenrod, and LeConte's thistle continue to persist on the national forest.*

Category 5. The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Note: These are interim findings; the findings for this category are due for the 2020 Monitoring Report.

- *Uwharrie NF: Progress toward completing the Uwharrie National Recreation Trail was made during this monitoring cycle, as approximately 60% of the plan objectives have been achieved.*
- *Uwharrie NF: Although conditions for all trails had improved recently, those conditions have degraded slightly during the past year. The Forest is positioned to improve trail sustainability and reduce the maintenance backlog in the next monitoring period.*
- *Croatan NF: Recreation Opportunity Settings have not changed at existing recreation sites during this monitoring cycle and are relatively intact.*

Category 6. Measurable changes on the plan area related to climate change and other stressors

See summary of broad-scale monitoring below.

Category 7. Social, Economic, and Cultural Sustainability must be addressed in the monitoring program

- *Uwharrie NF: An action plan to protect heritage assets has been initiated during this monitoring cycle. More than 8 significant heritage assets were protected successfully by decreasing disturbances from off highway vehicle use. Several structures on the*

This page was edited on April 11, 2019 to correct an inaccurate statement.

Corrected | P a g e   8

Thornburg farm were stabilized. While some sites continue to degrade, an overall reduction the maintenance backlog is occurring, which meets the intention of the plan and the cultural objective (Cultural-1).

- *Uwharrie NF: Efficient outcomes are achieved through increases of prescribed fire because longleaf ecosystems are being restored within the Wildland Urban Interface, thus providing human community wildfire protection while restoring longleaf ecosystems. The acreage of prescribed fire is consistently achieved at levels set in the plan objectives (Objective Fire-1).*

- *Croatan NF: Cultural and historic special interest areas were found to be stable during this monitoring cycle. Of 26 sites monitored, 20 are stable, but some sites are experiencing some degradation from camping activities and others may be due to rising sea levels.*

- *Croatan NF: The amount of prescribed fire has increased significantly over this monitoring cycle, up to levels desired in the forest plan. The amount and quality of prescribed fire has improved the quality of longleaf restoration on the national forest. Wildfire protection has been greatly enhanced through the development and implementation of Community Wildfire Protection Plans, as every community fire department within the planning area has a protection plan.*

- *Uwharrie & Croatan NFs: Both the Croatan and Uwharrie National Forests management has been responsive to the needs of local communities; such as projects for the transmission of water and electrical power, quarterly meetings with communities, and community agreements for wildfire protection.*

Category 8. The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 USC 1604(g)(3)(C).

- *Uwharrie and Croatan NFs: While all timber sale units have some degree of increased detrimental soil disturbance, none of the surveyed units exceeded the significant level; thus maintaining appropriate land productivity.*

Summary of Broad-Scale Findings

Category 6. Measureable changes on the plan area related to climate change and other stressors.

- *Temperature— Projections suggest that future warming is expected, resulting in 10-56 more days above 95F and 21-24fewer freezing days per year.*

- *Precipitation—Precipitation was historically variable and will likely continue to be variable from one year to the next. There does appear to be a trend toward a modest increase in total precipitation, with a small change in the number of dry days per year.*

Category 7. Progress toward meeting the desired conditions and objectives in the plan, including multiple use objectives. Social, economic, and cultural sustainability must also be addressed in the monitoring program.

- *Population growth rates for the surrounding areas of the Croatan (13%) and Uwharrie NFs (10%) are substantially higher than the US non-metro population growth rate (3%), indicating a potential higher degree of need for uses of the forest will continue into the near future.*
- *In 2015, a total of 6679 jobs were attributable to NFsNC program areas, with 91% attributed to recreation. The associated labor income for NFsNC was $227,200, which is about one fifth of the total Region 8 contribution of $1,011,632.*

Adaptive Management: Summary of Recommended Changes

Recommendations for changes to the Forest Plans, or the monitoring programs, or monitoring activities are show in Tables S1 and S2.

Table S1. Summary of Recommended Changes for Uwharrie NF by Monitoring Category

	Changes to the Plan	Changes to Monitoring Program	Changes to Monitoring Activities or Management Activities
1		Uwharrie Q1 and Q2: These questions will be combined by changing the question to examine the overall change in watershed condition classes, along with functional indicators consistent with the Watershed Condition Framework.	
2			Monitoring protocols for determining the "maintain, improve, or restore" classes for the selected terrestrial ecosystems are needed for the 2020 monitoring report. A system for modeling the condition classes with a follow-up site monitoring sampling program is recommended.
3		Develop monitoring questions for: 1) The amount and quality of snags for species such as pileated woodpecker; 2) The amount and quality of early seral habitat for species such as bobwhite quail.	Monitor brown headed nuthatch in all forest types, not just longleaf.
4			Uwharrie Q13; Develop a classification system for the 2020 monitoring cycle using criteria and measures for estimating the conditions of natural areas.
5			
7			
8			
Broad-scale		Develop a question to track land use changes	Recommend using satellite imagry (USGS: Sentinel) to track changes in land use

Table S2. Summary of Recommended Changes for the Croatan by Monitoring Category

	Changes to the Plan	Changes to Monitoring Program	Changes to Monitoring Activities or Management Activities
1		Croatan Q1 will be changed to examine the overall change in watershed condition classes consistent with the Watershed Condition Framework.	Make Progress on Croatan objectives 2.1.8.3 – 2.1.8.4 by mapping the acidic, non-acidic and brackish streams by the next monitoring cycle.
2			Monitoring protocols for determining the "maintain, improve, or restore" classes for the selected terrestrial ecosystems are needed for the 2020 monitoring report. A system for modeling the condition classes with a follow-up site monitoring sampling program is recommended.
3			
4		Croatan Q10: Replace mimic glass lizard with LeConte's thistle	
		Croatan Q11: Refine Q11 to focus on longleaf old growth	
			Croatan Q9: Develop a classification system for the 2020 monitoring cycle using criteria and measures for estimating the conditions of natural areas.
5	To conform with the policy of sustainable recreation, Change Objective 2.2.1.3 that specifies the construction of a group camp at Cedar Point.		
7			
8			Croatan: Conduct an assessment of soil moisture for timber sale units prior to logging activities.
Broad-Scale		Develop a question to track land use changes	Recommend using satellite imagery (USGS: Sentinel) to track changes in land use

Forest Supervisor's Certification
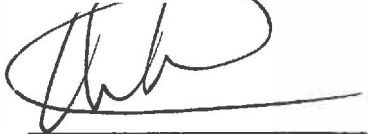
I have evaluated the monitoring results and recommendations in this report.

I have directed that the changes to the monitoring program above be implemented.

Changes to the monitoring and management activities should respond to these recommendations, unless new information or changed resource conditions warrant otherwise. I have considered funding requirements in the budget necessary to implement the actions.

The one suggested amendment to the Croatan plan will not be done at this time, but will be saved until such time as multiple plan amendments can be completed as batch, as completing this amendment must be made using the appropriate National Environmental Policy Act procedures.

With the appropriate changes, the *Revised Land and Resource Management Plan, Uwharrie National Forest* and the *Revised Land and Resource Management Plan, Croatan National Forest*; these plans are sufficient to guide management activities unless ongoing monitoring and evaluation identify further need for change.

_____

Allen Nicholas
Forest Supervisor
National Forests in North Carolina

2/8/19
_____
Date

Introduction

Purpose

The purpose of the biennial monitoring evaluation report is to help the responsible official determine whether a change is needed in forest plan direction, such as plan components or other plan content that guide management of resources in the plan area. The biennial monitoring evaluation report represents one part of the Forest Service's overall monitoring program for these national forest units. The biennial monitoring evaluation report is not a decision document—it evaluates monitoring questions and indicators presented in the Plan Monitoring Program (PMP) in Chapter 4 of the Uwharrie Forest Plan and Chapter 5 of the Croatan Forest Plan, in relation to management actions carried out in the plan area.

Monitoring and evaluation are continuous learning tools that form the backbone of adaptive management. For this reason, we will produce an evaluation report every two years. This is our first written report of this evaluation since the Uwharrie and Croatan Forest Monitoring Programs was transitioned to address requirements found in Forest Service Handbook (FSH) 1909.12 – Land Management Planning Handbook, Chapter 30- Monitoring (referred to in this report as the "2012 Planning Rule"). This report indicates whether a change to the forest plan, management activities or monitoring program may be needed based on the new information.

The 2018 biennial monitoring report for the Croatan and Uwharrie National Forests evaluates monitoring that occurred in the years 2016 and 2017 and is available at https://www.fs.usda.gov/detail/nfsnc/landmanagement/planning/

Report Objectives

There are several objectives for this report, including:

- Assess the current condition (i.e., status) and trend of selected forest resources.

- Document implementation of the Plan Monitoring Program (PMP), including changed conditions or status of key characteristics used to assess accomplishments and progress toward achievement of the selected Land Management Plan (LMP) components.

- Evaluate relevant assumptions, changed conditions, management effectiveness, and progress towards achieving the selected desired conditions, objectives, and goals described in the Forest Plan

- Assess the status of previous recommended options for change based on previous monitoring & evaluation reports.

- Document any scheduled monitoring actions that have not been completed and the reasons and rationale why it has not.

- Present any new information not outlined in the current plan monitoring program that is relevant to the evaluation of the selected monitoring questions.

- Incorporate broader scale monitoring information from the Regional Broader Scale Monitoring Strategy that is relevant to the understanding of the selected monitoring question.

- Present recommended change opportunities to the responsible official.

How to Use this Report

Periodic evaluations of conditions and trends of the monitoring questions form the basis for continuous plan improvement and provide information for responses to change. Using these evaluations, the agency will develop biennial reports with evaluations that reflect the current status and trends of desired conditions described in these forest plans.

Some monitoring needs benefit from a perspective that is at scales larger than either of these national forests. This is justified on the basis that some questions are more efficiently addressed for multiple national forests at the same time and that some issues are more meaningful at larger scales. To support needs of this kind, the 2012 Planning Rule requires that Regional Foresters develop broad-scale monitoring strategies (219.12 (b)). The Region 8 Broad Scale Monitoring questions relate to climate change information and social, economic, and or cultural conditions.

The monitoring evaluation is provided in two sections: 1) Unit-level monitoring questions and indicators by categories described in the 2012 Planning Rule; and 2) Region 8 Broad Scale monitoring questions.   Most unit-level monitoring data are acquired primarily through field inventories, whereas the broad scale questions are generally addressed using secondary data.

The Importance of Public Participation

These biennial reports will be developed by interdisciplinary teams (ID team) using collaborative engagement with the public as needed. The ID teams will develop a comprehensive evaluation of plan implementation and effectiveness, identifying any needs for adaptive responses. The agency will document the monitoring results and evaluations in the biennial report and make the report available to the public on the forest's website.

Monitoring and evaluations will build off previous reports and could lead to changes in forest plan direction or the monitoring program. For instance, desired conditions, objectives, standards and guidelines described in the forest plan may be modified and/or monitoring questions and indicators changed through the adaptive management approach. Significant findings that could lead to a change in the forest plan will be vetted through an open public involvement process before proposed changes are initiated.

About the Forest Plan Monitoring Programs

Roles and Responsibilities

The Forest Plan Monitoring Program requires a coordinated effort of many people, from the people who collect the data, to the people outside the Forest Service who provide feedback and assistance, to the decision-maker. The Forest Supervisor for the North Carolina National Forests is the Responsible Official for approving or modifying the monitoring plans. For additional information contact: National Forests in North Carolina,160 Zillicoa Ave, Asheville, NC. 28801,   828-257-4200. Attn: Michelle Aldridge, Planning Staff Officer.

How Our Plan Monitoring Program Works

Monitoring and evaluation requirements have been established through the National Forest Management Act (NFMA) at 36 CFR 219. Additional direction is provided by the Forest Service in Chapter 30 – Monitoring – of the Land Management Handbook (FSH 1909.12).

The Croatan and Uwharrie plan monitoring programs were updated in April 2016 for consistency with the 2012 planning regulations [36 CFR 219.12 (c)(1)]. Both monitoring programs were changed in each of the respective forest plans. Monitoring questions and indicators were selected to inform the management of resources on the plan area and not every plan component was determined necessary to track [36 CFR 219.12(a)(2)].

Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program. The 2018 biennial monitoring report for the Croatan and Uwharrie National Forests is posted on-line at https://www.fs.usda.gov/detail/nfsnc/landmanagement/planning/ in order to make this information available to the public.

Monitoring programs focus on providing information necessary to evaluate whether plan direction and management are effective in maintaining or achieving progress toward the desired conditions and objectives for the plan area. The monitoring program includes the specific monitoring questions and associated indicators that are to be used for forest plan evaluations, feedback for adaptive responses, and reporting. Monitoring questions and associated indicators are based on one or more plan components, but not every component has a corresponding monitoring question.

In the context of forest planning there are three main monitoring goals:

- Are we implementing the Forest Plan direction properly? Are we meeting our management targets and project guidelines? (implementation monitoring)

- Are we achieving our Forest Plan management goals and desired outcomes? (effectiveness monitoring)

- Is there a need to change to the Forest Plan direction?-(validation monitoring)

Implementation monitoring is important for tracking progress and accomplishments. However, it is effectiveness and validation monitoring that drive and support the adaptive management process. Effectiveness monitoring evaluates condition and trend relative to desired conditions. Validation monitoring tests hypotheses and provides information that might necessitate changes to desired conditions in the plan (e.g. is what we think the desired state should be really accurate?

Monitoring will provide information needed to address adaptive management including:

- Detect changing conditions, risks, and uncertainties that require adaptive responses; and

- Identify if a change to the plan monitoring program is warranted based on new information. Monitoring questions and indicators may be modified through the adaptive management approach over time as determined in the biennial reports and evaluations.

The updated monitoring programs (2016) for the Croatan and Uwharrie have aggregated the monitoring questions by categories used in the 2012 Planning Rule. Therefore, this report is formatted using those categories as described below.

Table Intro. Categories of monitoring questions and indicators based on the 2012 Planning Rule

Category	Description
Category 1	The status of select watershed conditions
Category 2	The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems
Category 3	The status of focal species to assess the ecological conditions under 36 CFR 219.9
Category 4	The status of a select set of ecological conditions required under 36 CFR 219.9 to contribute to the recovery of federally listed threatened or endangered species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern
Category 5	The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives
Category 6*	Measureable changes on the plan area related to climate change and other stressors
Category 7*	Progress toward meeting the desired conditions and objectives in the plan, including multiple use objectives. Social, economic, and cultural sustainability must also be addressed in the monitoring program.
Category 8	The effects of each management system to determine that they do not substantially and permanently impar the productivity of the land (16 USC 1604(g)(3)(c)

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* Categories 6 & 7 include questions and indicators reported as part of the broad-scale monitoring program.

Section 1: Unit Level Monitoring

Unit-level monitoring questions and indicators were updated in 2016 and arranged by categories as described in the 2012 Planning Rule. Most unit-level monitoring data are acquired primarily through field inventories and observations. In this section, monitoring questions and indicators for both the Croatan and Uwharrie National Forests monitoring programs are considered. The frequency for reporting varies by the question due to the type of information required, so every monitoring question and indicator need not be considered for this 2018 report. However, for those monitoring questions and indicators required for subsequent-year evaluation, a check of the monitoring process is disclosed.

Category 1: The status of select watershed conditions.

This category includes the monitoring questions relating to watershed conditions, water quality, and aquatic ecosystems. Tables 1A and 1B outline the monitoring questions and the applicable plan components for this category.

NOTE: The report timing for the questions in this category are due in 2020. For this report, the evaluation is considered a "readiness check" for 2020.

Table 1A: Monitoring Questions, Indicators, and Report Timing by National Forest for Category 1.

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q1.What are the trends in conditions for hydrologic stability?	%stream segment using: NC index of Biotic Integrity; NCEPT rating	4-year; Report timing: Year 2020
Uwharrie	Q2.What are the trends for instream and streamside habitat conditions for selected stream segments?	%stream segment using: NC index of Biotic Integrity; NCEPT rating	4-year; Report timing: Year 2020
Croatan	Q1.Are aquatic habitat and biota conditions of tidal and non-tidal streams progressing toward desired conditions?	%stream in the following classes: 1) functioning properly, 2) functioning at risk; 3) functionally impaired	4-year; Report timing: Year 2020

Table 1B: Plan Components for Category 1 by National Forest

National Forest	Plan Components
Uwharrie (DCs: SWF 1,2,3,6,8)	See Plan (pg 12-13) SWF 1,2,3,6,8 Aquatic ecosystems are diverse, with properly functioning streams providing high quality habitat for all native aquatic species… Road crossings allow for passage of fish and other aquatic animals up and down stream corridors… Stream channels retain connection to natural floodplains… Stream channels degraded by historic mining are exhibiting improved biological and hydrological conditions
Croatan (DC: 2.1.8)	See Plan (pg 49) Goal/DC 2.1.8 Protect or restore aquatic ecosystems across the range of aquatic ecological typesusing the highest quality reference site conditions Restore hydrologic function of altered landscapes. Favor native plants and animals in aquatic systems…
Uwharrie (Objective: SWF-1)	(Plan, p. 23) Over the planning period, 1,500 linear feet of aquatic habitat are restored on sites with NC Index of Biotic Integrity (NCIBI) and NC Ephemeroptera, Plecoptera, Tricoptera (NCEPT) ratings below "good." This work entails establishing cover by such methods as adding large

National Forest	Plan Components
	wood and boulders for in-stream habitat, establishing stream-shading riparian vegetation, eliminating sediment sources, etc.
Uwharrie (Objective SWF-2)	(Plan; p. 23)Over the planning period, 1,500 linear feet of unstable and/or poorly functioning stream channel are restored (in addition to the aquatic habitat restoration under Objective 1).
Croatan (Objective 2.1.8.3)	(Plan; p. 49)Determine the distribution and relative abundance of anadromous fish species. Inventory 5 miles of stream each year for anadromous fish occurrence. Coordinate the surveys with the National Marine Fisheries Service and the North Carolina Wildlife Resources Commission.
Croatan (Objective: 2.1.8.4)	(Plan; p. 49) Restore the natural hydrologic flow on about 2,300 acres where former wetlands were ditched and drained.
Croatan (Objective 2.1.8.5)	(Plan, p. 49)Maintain 36 miles of non-acidic freshwater streams to support largemouth bass populations, 32 miles of acidic freshwater streams to support redfin pickerel populations, 16 miles of brackish streams to support chain pickerel populations, and 2,800 acres of lakes.

New Science or New Information:

- Croatan NF: 27 Digital Terrain Models for Ecological Classification (Simon & Hayden, 2017)
  relationships among environmental variables that help determine ecological systems.

Data

- Fish Community Assessment (NCIBI; 201X)
  Measures diversity and abundance of fish on selected stream segments
- Aquatic Invertebrate Community Assessment (EPT Rating, 201X) (Uwharrie)
  Measures the diversity and abundance of invertebrates on selected stream segments
- Aquatic Invertebrate Community Assessment (EPT Biotic Index; 201X) (Uwharrie)
- Watershed Condition Framework for Uwharrie & Croatan (Dodd; 2011)
  Initial assessment of watershed conditions on the Croatan and Uwharrie
- Stream Channel Rapid Assessments (Dodd, 2015 to present)
  Uwharrie: Moccasin Creek; Dutch John Creek; Big Creek; McCleans Creek; Crow Creek

Figure 1A. Index of Biotic Integrity for the Uwharrie compared with other ownerships.
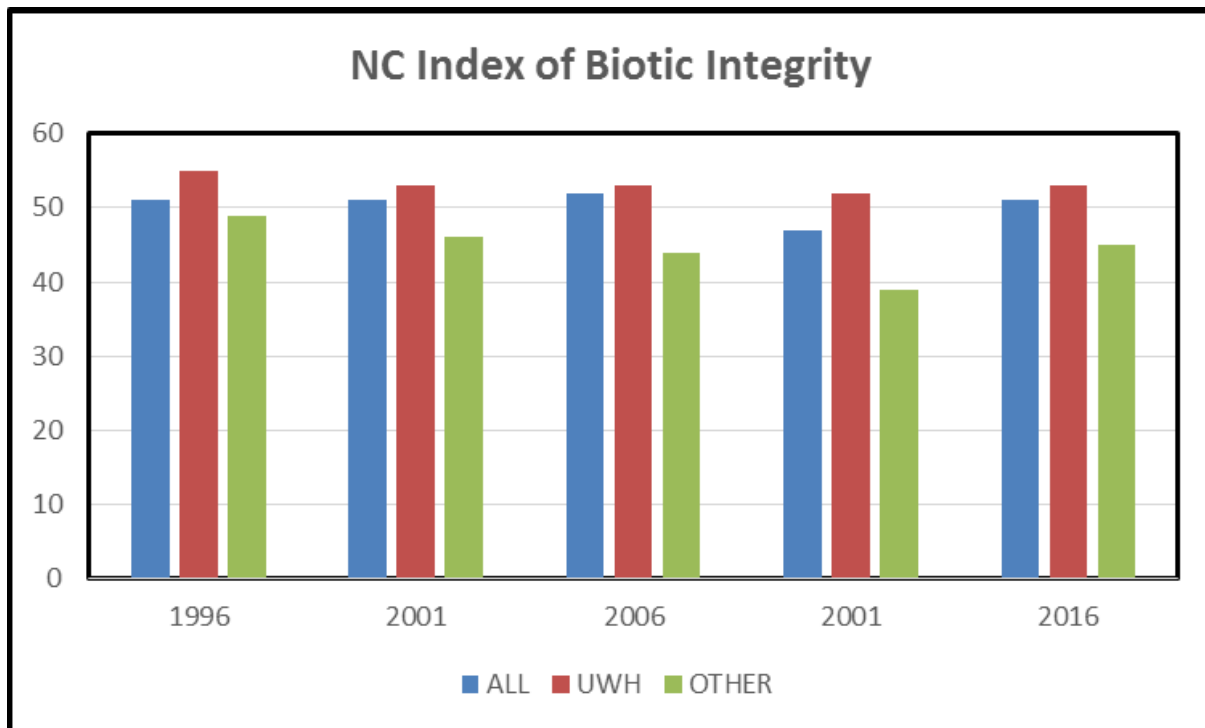
Figure 1B. EPT Rating for the Uwharrie compared with other ownerships
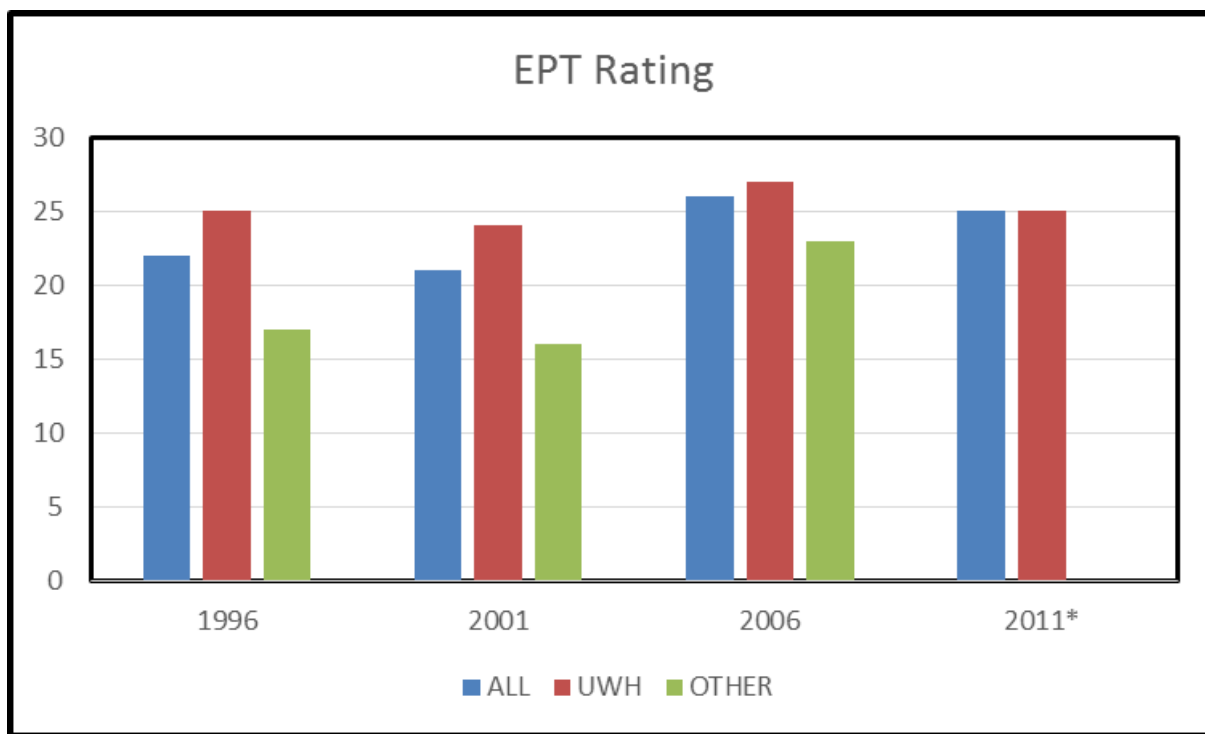
Figure 1C. EPT Biotic Index for the Uwharrie compared with other ownerships

EPT Biotic Index

(Bar chart showing EPT Biotic Index values for years 1996, 2001, 2006, and 2011* with three series: ALL, UWH, OTHER)
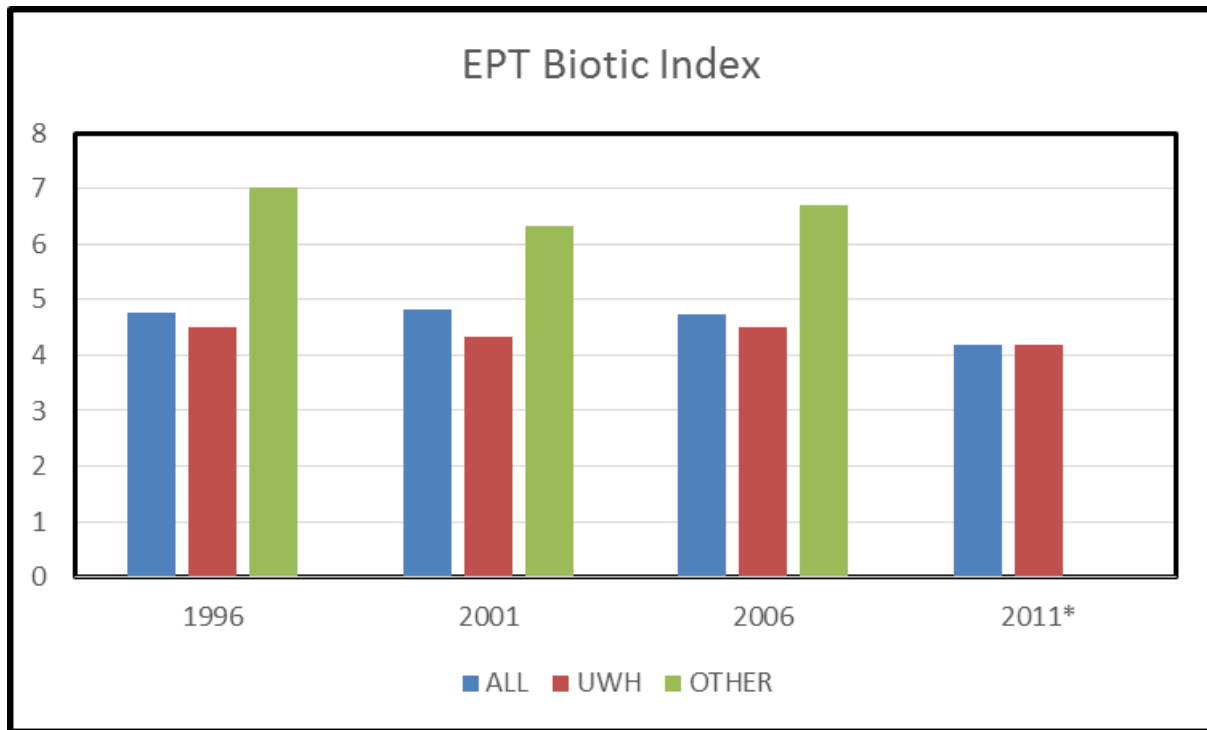
Table 1C. Watershed Condition Framework Evaluation for Uwharrie (6th level HUCs; 2011)

Watershed	Total Acres	FS AC	% FS	Condition Score
Betty McGees Creek-Uwharrie River	20038	2387	12	1
Hannahs Creek-Uwharrie River	21058	3159	15	2
Barnes Creek	15415	4324	28	2
Crow Creek-Uwharrie River	28957	3817	13	2
Outlet Uwharrie River	20266	11534	57	2
Beaverdam Creek-Yadkin River	42391	7317	17	2
Wood Run-Lake Tillery	11359	4285	38	2
Clarks Creek	21241	1211	6	2
Densons Creek	22264	1340	6	2
Rocky Creek	18793	3625	19	2
Eury Dam-Little River	31952	3406	11	2
Cheek Creek	20720	2306	11	2
Big Town Creek-Little River	27581	1454	5	2

Table 1D. Watershed Condition Framework Evaluation for Croatan (6th Level HUCs; 2011)

Watershed	Total Acres	FS Ac	% FS	Condition Score
Mill Creek	23050	12697	55	2
Headwaters Brice Creek	28773	17798	62	1
Outlet Brice Creek	13661	6278	46	2

Watershed	Total Acres	FS Ac	% FS	Condition Score
Cherry Point Marine Corps Air Station-Slocum Creek	37613	9571	25	2
Cherry Point-Hancock Creek	18155	7369	41	1
Clubfoot Creek	23612	5772	24	2
Black Swamp Creek	22402	17517	78	2
Holston Creek	9751	8603	88	2
Black Swamp Creek-White Oak River	11511	2370	21	1
Hunters Creek	21767	19095	88	1
Mulberry Creek-White Oak River	8515	1653	19	2
Hadnet Creek	11427	8627	75	2
Pettiford Creek	12084	7837	65	2
White Oak River	21381	1155	5	2
Bogue Banks-Bogue Sound	12878	1295	10	2
Upper Newport River	21382	13526	63	1
Middle Newport River	24602	8903	36	2
Black Creek	8540	4058	48	1
Harlowe Creek	7959	859	11	2
Newport Marshes-Lower Newport River	24597	1329	5	2
Town of Salter Path-Jumping Run	18878	3392	18	2

Findings and Discussion:

<u>Uwharrie NF</u>

- *The Crow Creek-Uwharrie River watershed is moving toward properly functioning condition; trending toward desired condition (SWF-1) by completing objectives (SWF 1& 2) that restored stream channels in portions of Big Creek and Crow Creek.*

  Since the development of the Uwharrie Plan in 2012 stream rehabilitation activities have occurred in the Crow Creek – Uwharrie River 6th-level Watershed (HUC = 030401030502). This watershed became a Forest Priority watershed with a comprehensive Watershed Restoration Action Plan in 2018. More watershed improvement work is planned in the watershed. The other 12 watersheds for the Uwharrie remain unchanged since the 2011 Watershed Condition Framework evaluation.

  In 2015 through 2017, 2,265 linear feet of Big Creek and 1,500 linear feet of Crow Creek stream channels were rehabilitated; thus completing those objectives of the Uwharrie Plan. Monitoring of photo points shows that hydrologic stability, habitat quality and diversity were shifted toward an improving trend in these stream reaches. During this same time, two road/stream crossing, on Big Creek and Crow Creek, were improved to provide aquatic organism passage; thereby reconnecting several miles of stream channel to year round aquatic movement.

- *Trends for the NC Index of Biotic Integrity (including EPT ratings) are stable for selected stream segments on the Uwharrie NF and consistently rated higher than streams on adjacent ownerships; thus indicating relatively healthy fish communities and trending toward desired conditions.*

  Scores above 48 on the NCIBI reflect a rating of good or better (Figure 1A). All stream segments on the Uwharrie are rated higher than 48; which infers a relatively healthy fish community.

- *Species Richness for invertebrates are high for selected streams on the Uwharrie NF, inferring that aquatic systems are diverse and relatively healthy as demonstrated by both the EPT ratings for invertebrates and the EPT Biotic Index, thereby trending toward Desired Condition SWF-1.*

  Scores above 21 for the EPT rating are good or better (Figure 1B). All stream segments monitored on the Uwharrie are rated 21 or higher, suggesting a relatively diverse invertebrate populations. Lower scores for the EPT Biotic Index are better—below 5.18 are good or better (Figure 1C). All of the Uwharrie selected stream segments were below 5.18

  Specifically within the watershed, stream rehabilitation work occurred on the Uwharrie N.F. on Crow Creek and Big Creek (a major tributary to Crow Creek). The objective of the stream

rehabilitation work was to enhance channel stability and aquatic habitat diversity currently in a degraded condition from past land use. This work entailed using reference reach details to reshape stream banks to stable slopes; remove stream side berm material to connect streams from floodplains; construct instream structures using logs and boulders to stabilize the channel and improve aquatic habitat; and plant riparian-type vegetation.

<u>Croatan NF</u>

- *No changes in watershed condition classes have occurred since the 2011 Watershed Condition Framework evaluation. The Holston Creek Watershed is planned for watershed improvements to bring it to properly functioning condition, Several road/stream crossings have improved conditions for fish passage.*

The Watershed Restoration Action Plan for the Holston Creek Watershed will address AOP needs, sediment sources and unstable stream conditions during 2020 through 2025. Other watersheds are in the initial planning stages of action plan development on the Croatan. Until now, watershed-wide projects have not been implemented to move *functioning at risk* watersheds toward *properly functioning*. There are currently seven 6th-level watersheds, of the twenty-two watersheds on the forest, considered as properly functioning (32 percent). The remaining 15 watersheds are functioning at risk (68 percent).

Watershed restoration and improvements to water and soil quality have occurred on the Croatan NF over the last decade through implementation of changes in general management, such as eliminating soil bedding and addressing erosion and aquatic organism passage (AOP) at road/stream crossings. Specific improvements to the forest have been focuses on timber stands, transportation systems and wildlife habitat.

Adaptive Management Recommendations

<u>Recommendations for Forest Plan Components:</u> none

<u>Recommendations for Monitoring Program:</u>

- *Uwharrie Q1 and Q2: These questions could be combined by changing the question to examine the overall change in watershed condition classes, along with functional indicators that follow the Watershed Condition Framework.*

NCIBI, EPT Ratings, and EPT Biotic Indicies are indicators of watershed change, and should be used to determine the overall conditions of watersheds. These indicators should also be identified as "selected" rather than "%" stream segments for technical accuracy

- *Croatan Q1 should be changed to examine the overall change in watershed condition classes.*

The functional indicators are described as functioning properly, at risk or impaired, but the question should be refined to examine the change in overall watershed conditions.

Recommendations for Monitoring or Management Activities:

- *Make Progress for Croatan objectives 2.1.8.3 – 2.1.8.4 by mapping the acidic, non-acidic and brackish streams by the next monitoring cycle.*

Category 2. The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems

The purpose for this category is to monitor and report on selected terrestrial ecosystems. (Note: the aquatic ecosystems were reported in Category 1 of this report). Tables 2A and 2B outline the monitoring questions and the applicable plan components for this category.

NOTE: The report timing for the questions in this category are due in 2020. For this report, the evaluation is considered a "readiness check" for 2020.

Table 2A. Monitoring Questions, Indicators and Report Timing by National Forest for Category 2.

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q3. What are the conditions of longleaf pine ecosystems and the trends for restoring these systems?	Determine the Maintain, Improve, or Restore Condition Classes. Key Characteristics include: open longleaf canopy; understory grasses or shrubs; fire as an ecological process	4-year; Report Timing: Year 2020
Uwharrie	Q4. What are the conditions of oak-hickory forests and the trends of restoring those forests?	Determine the Maintain, Improve, or Restore Condition Classes. Key Characteristics include: canopy composition, gaps, and understory composition	4-year; Report Timing: Year 2020
Uwharrie	Q5. What are the conditions of shortleaf pine woodlands and the trends for restoring these systems?	Determine the Maintain, Improve, or Restore Condition Classes Key characteristics include: canopy composition, understory grasses, fire return of 3-5 years	4-year; Report Timing: Year 2020
Croatan	Q2. Are pine savannas, pine flatwoods, and woodlands improving toward desired conditions?	Determine the Maintain, Improve, or Restore Condition Classes Key Characteristics include: open longleaf canopy; understory grasses or shrubs; fire as an ecological process	4-year; Report Timing: Year 2020

| Croatan | Q3.Are hardwood cypress wetlands maintained and functioning as planned? | Determine the Maintain, Improve, or Restore Condition Classes.

Key Characteristics include: composition dominated by cypress or wet hardwoods. | 4-year; Report Timing: Year 2020 |
| --- | --- | --- | --- |
| Croatan | Q4. Are upland hardwood condition maintained or improving? | Conditions of upland hardwoods.

Key Characteristics: hardwood canopy, presence of hard and soft mast | 4-year; Report Timing: Year 2020 |

Table 2B: Plan Components for Category 2 by National Forest

National Forest	Plan Components
Uwharrie (DCs:Veg-1)	(Plan, p. 5) Veg-1 Longleaf pine and oak-hickory woodlands with small canopy gaps, interspersed with glades and Piedmont prairies, occupy portions of the forest where they occurred historically. These woodlands contain mixed ages with old trees and old forest conditions, as well as canopy openings that provide habitat for federally listed, sensitive and locally rare species.
Uwharrie (DC: Veg-2)	(Plan p. 5) Veg-2 Plant communities that were more common in the past occur on appropriate sites across the forest. Examples include longleaf pine woodlands, shortleaf pine woodlands, and oak-hickory forests.
Uwharrie (DC: Veg-8)	(Plan, p. 6) Veg-8

The composition, structure, and processes of ecological systems are improving. Ecological systems are defined by groups of plant associations occurring in regions of similar physical conditions and biological potential. |
| Uwharrie (DC: Veg 8; Table 2-1 | (Plan; p. 10) <table><tr><td>Selected ecological system</td><td>Existing Acres (2010)</td><td>Desired Acres</td></tr><tr><td>Longleaf pine woodland</td><td>2,300</td><td>7,560</td></tr><tr><td>Shortleaf pine-oak</td><td><20</td><td><100</td></tr></table> |

National Forest	Plan Components		
	Xeric Oak	See below	2990
	Dry Oak Hickory Felsic Forest	See below	20,800
	Dry Mesic Oak-Hickory Forest	See below	11,060
		Note: total existing of all 3 oak types is approximately 19,600ac	Approximate total desired of all oak types is 34,850 ac
Uwharrie (Objective 2)	(Plan; p. 21) Move toward restoring the desired vegetation conditions on a minimum of 4,500 acres over the planning period. Begin restoration of site-appropriate vegetation each year on an average of at least 200 acres of potential oak-hickory sites and 100 acres of potential longleaf pine sites.		
Croatan (Objective: 2.1.1.6)	(Plan; p. 46) Maintain the existing 12,000 acres of longleaf pine forest type as longleaf savanna.		
Croatan (Objective 2.1.4.2)	(Plan, p. 47) Conserve and restore upland mesic hardwoods, cypress-tupelo swamp forests, southern wet pine forests, woodlands and savannas, and upland longleaf pine through management prescriptions that allow for developing older stand conditions		

New Science or New Information: none

Data

     FACTS database

Uwharrie NF

Table 2C. Activity in Selected Ecological Systems for Uwharrie NF (3-year)

Selected Activity	Acres	Purpose
Plant Shortleaf	236	Restoration of shortleaf pine
Plant Longleaf	31	Restoration of longleaf pine
Longleaf Release	148	Removal of competing vegetation

Pine Thinnings	141	Loblolly and Shortleaf
Treat NNIS	62	Control invasive species

Croatan NF

Table 2D.   Activity in Selected Ecological Systems for Croatan NF (3-year)

Selected Activity	Acres	Purpose
Planted Longleaf	136	Restoration from loblolly to longleaf
Longleaf Release	188	Removal of competing vegetation
Pine Thinnings	505	Foraging habitat and insect prevention
Midstory Control	2,372	Conditions for herbaceous understory

Discussion and Findings

- *The treatments of the selected terrestrial ecosystems on both the Uwharrie and Croatan NF are consistent with their forest plans, specifically the restoration of longleaf pine, and that the application of prescribed fire at consistently high levels has occurred (see category 7) such that both national forests are meeting objectives for fire-adapted ecosystems.   More information is needed about the overall conditions of these systems as well as the conditions of oak-dominated ecosystems for the 2020 Monitoring Report.*

Uwharrie NF: The selected ecosystems for the Uwharrie NF are longleaf pine, shortleaf pine, and oak-hickory forests. Treatment activities have focused on longleaf pine and shortleaf pine during this management cycle (Table 2C), along with consistent prescribed fire (see Category 7) then significant achievements are being made toward desired conditions.

Croatan NF: The selected ecosystems for the Croatan NF are longleaf pine, hardwood cypress wetlands, and upland hardwoods. Treatment activities have focused on longleaf pine (Table 2D) during this monitoring cycle and along with more than 20,000 acres of prescribed fire (See Category 7) then conditions are trending toward the goals in the forest plan.

For both national forests, comprehensive systems for determining the "maintain, improve, or restore" classes for the selected terrestrial ecosystems are needed.

Adaptive Management Recommendations for Category 2

Recommendations for Forest Plan: none

Recommendations for Monitoring Program: none

Recommendations for Monitoring Activities or Management Activities:

Monitoring protocols for determining the "maintain, improve, or restore" classes for the selected terrestrial ecosystems are needed for the 2020 monitoring report. A system for modeling the condition classes with a followup site monitoring sampling program is recommended. References include the following:

- *Field Manual for Rapid Assessment Metrics for Wildlife and Biodiversity in Southern Open Pine Ecosystems, Nature Serve, 2016;*
- *Rapid Assessment Metrics for Longleaf Pine Ecosystems on the Francis Marion National Forest, Natureserve, 2018*

Category 3. The status of focal species to assess the ecological conditions under 36 CFR 219.9

The purpose of this category is to estimate the functioning of ecosystems and habitats by determining the presence or absence of focal species. Tables 3A and 3B outline the monitoring questions and the applicable plan components for this category.

Table 3A Monitoring Questions, Indicators, and Report Timing by National Forest for Category 3

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q6.What is the status of brown headed nuthatch as a focal species for the function of longleaf pine ecosystems?	Presence/Absence	2-year; Report timing: Year 2018
Uwharrie	Q7.What is the status of Scarlet Tanager as a focal species for the function of dry oak and oak hickory forests?	Presence/Absence	2-year; Report timing: Year 2018
Uwharrie	Q8.What is the status of Acadian Flycatcher as a focal species for the function of streamside zones?	Presence/Absence	2-year; Report timing: Year 2018
Uwharrie	Q9.What is the status of Pileated Woodpecker as a focal species for the function of large canopy trees and presence of snags	Presence/Absence	2-year; Report timing: Year 2018
Uwharrie	Q10.What is the status of Northern Bobwhite Quail as a focal species for the conditions of early successional habitat?	Presence/Absence	2-year; Report timing: Year 2018
Croatan	Q5.What is the status of Red-Cockaded Woodpecker to assess the ecosystem functioning of pine savannas, flatwoods, and woodlands?	Active clusters	2-year; Report timing: Year 2018
Croatan	Q6.What is the status of black bear to assess ecosystem function and connectivity of hardwood cypress wetlands?	Harvest trends, Mortality data	2-year; Report timing: Year 2018
Croatan	Q7.What is the status of eastern wild turkey to assess the function of upland hardwoods?	Harvest trends; summer brood counts	2-year; Report timing: Year 2018

Table 3B. Plan Components relevant for Category 3 by National Forest.

National Forest	Plan Components
Uwharrie (DC: Veg-8)	(Plan, p. 6) Veg-8. The composition, structure, and processes of ecological systems are improving. Ecological systems are defined by groups of plant associations occurring in regions of similar physical conditions and biological potential (Relates to the purpose of monitoring focal species)
Uwharrie (DC: Veg 1)	(Plan, p. 5) Veg-1. Longleaf pine and oak-hickory woodlands with small canopy gaps, interspersed with glades and Piedmont prairies, occupy portions of the forest where they occurred historically. These woodlands contain mixed ages with old trees and old forest conditions, as well as canopy openings that provide habitat for federally listed, sensitive and locally rare species. (Relates to Q6 and Q7 for Uwharrie)
Uwharrie (DC: WLF-1)	(Plan, p. 11) WLF-1. Habitat is present for the diversity of native animal species typical of the Piedmont ecoregion - vertebrates, invertebrates, game and non-game, including reptiles and amphibians.
Croatan (DC: 2.1.1)	(Plan, p.46) 2.1.1. Recover a viable population of RCW through joint efforts with Marine Corps Base Camp Lejeune and Holly Shelter Gamelands.
Croatan (DC: 2.1.5.a)	(Plan, p. 48) 2.1.5.a. Provide suitable habitat conditions for long-term viability of the black bear population on the CNF.
Croatan (DC: 2.2.7)	(Plan, p. 49)2.1.7. Maintain naturally occurring hardwood forests that are dominated by hard mast producing tree/shrub species. Restore these forests where the ecological classification predicts upland hardwood landtypes.
Uwharrie (Objective: 1)	(Plan, p. 21) Over the planning period, maintain as longleaf pine woodlands the 2,300 acres identified in 2010 as existing longleaf pine.
Croatan (Objective: 2.1.1.1	(Plan, p.46)2.1.1.1. Meet a long-term population objective of 137-169 RCW clusters. 2.1.1.2. Maintain the existing 63 active RCW clusters. 2.1.1.3. Establish 20 to 26 new RCW clusters over the next 10 years (2002 - 2012). 2.1.1.4. Establish 50 to 63 new clusters during the next 30 years

New Science or New Information

The Roberdo South Project (2018) to improve and restore 2,167 acres of longleaf pine habitat.

The American Birding Association changed the genus of the Red-cockaded Woodpecker from *Picoides* to *Dryobates* recently.

Data

> R8 Breeding Bird Surveys (Uwharrie)
>
> RCW Monitoring (Croatan)
>
> NC Wildlife Commission Harvest Data and Brood Counts (Croatan)

Uwharrie NF

Note that in the subsequent bird survey figures, surveys were not conducted in 2002, 2014, and 2015, and survey data had not yet been entered for 2017, so these years are survey gaps. Where species do not show data for other years, it is because species were not observed that year. For species that were counted every year except 2002, 2014, 2015, and 2017, trend lines on the bar graphs ignored these survey gaps years in creating the trend lines. However, for species that were only reported a few years total, survey gap years were considered as no count years in the trend lines.

Figure 3A. Trend in Relative Abundance of Brown-Headed Nuthatch across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
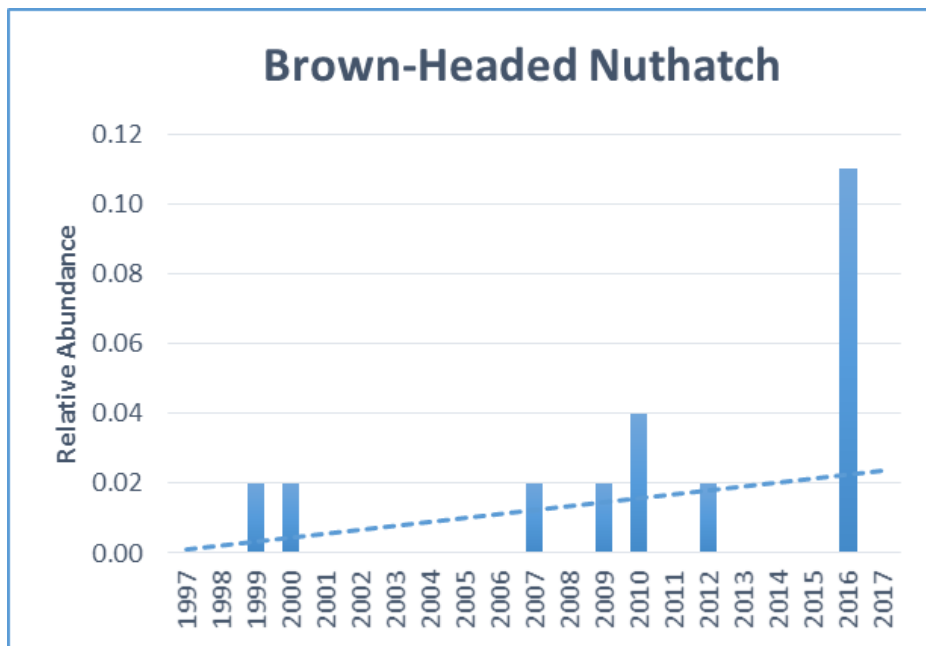
Figure 3B. Trend in Relative Abundance of Scarlet Tanager in All Habitat Types across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
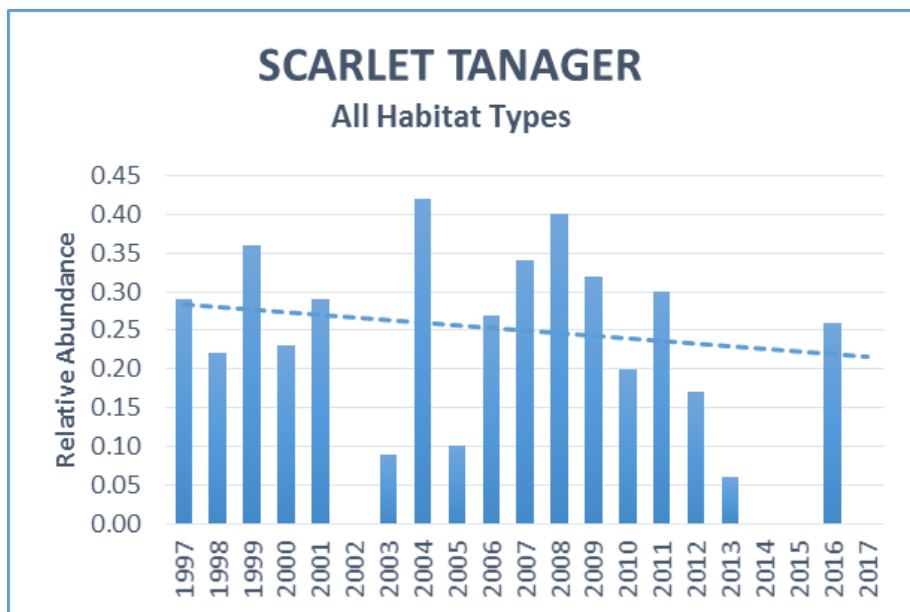
Figure 3C. Trend in Relative Abundance of Scarlet Tanager in Old Growth Habitats across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).

SCARLET TANAGER
Old Growth/ Late Successional Habitats
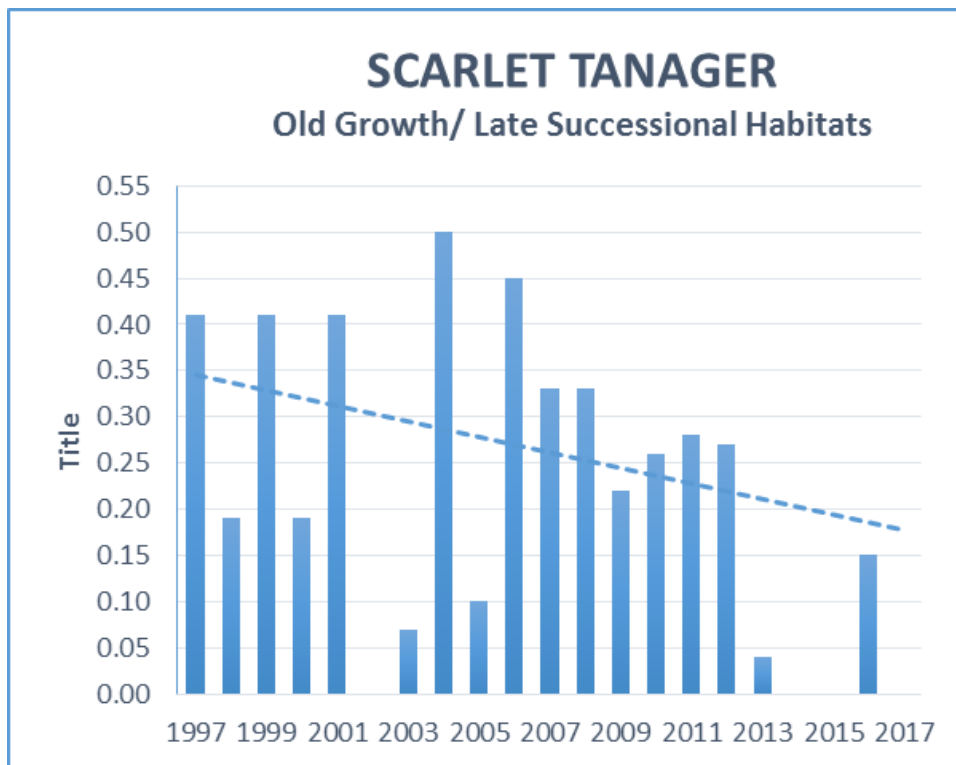
Figure 3D. Trend in Relative Abundance of Brown Headed Cowbird in Old Growth Habitats across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).

BROWN-HEADED COWBIRD
in Old Growth/Successional Forests
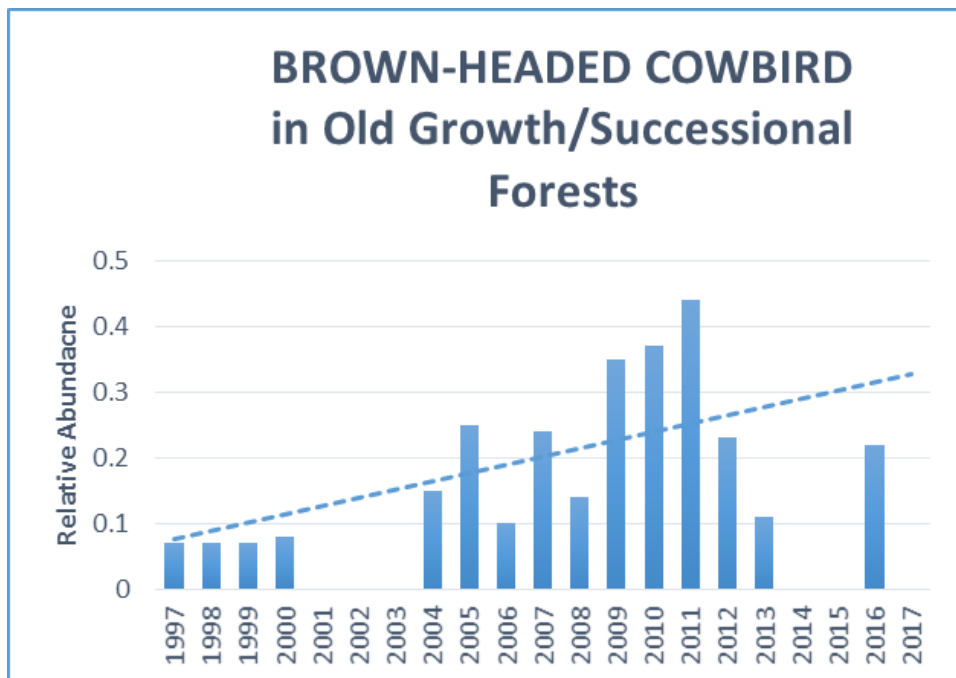
Figure 3E. Trend in Relative Abundance of Acadian Flycatcher across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
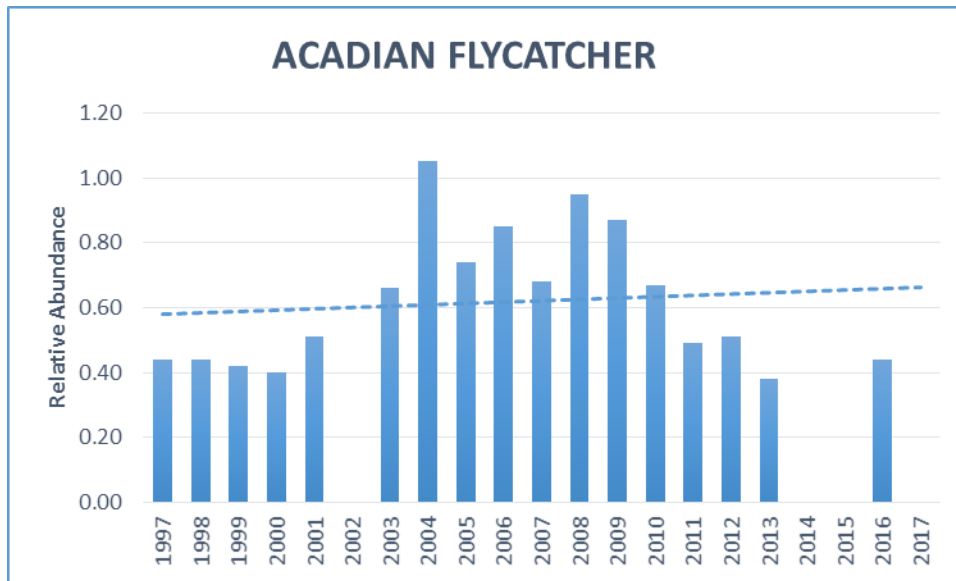
Figure 3F. Trend in Relative Abundance of Pileated Woodpecker across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
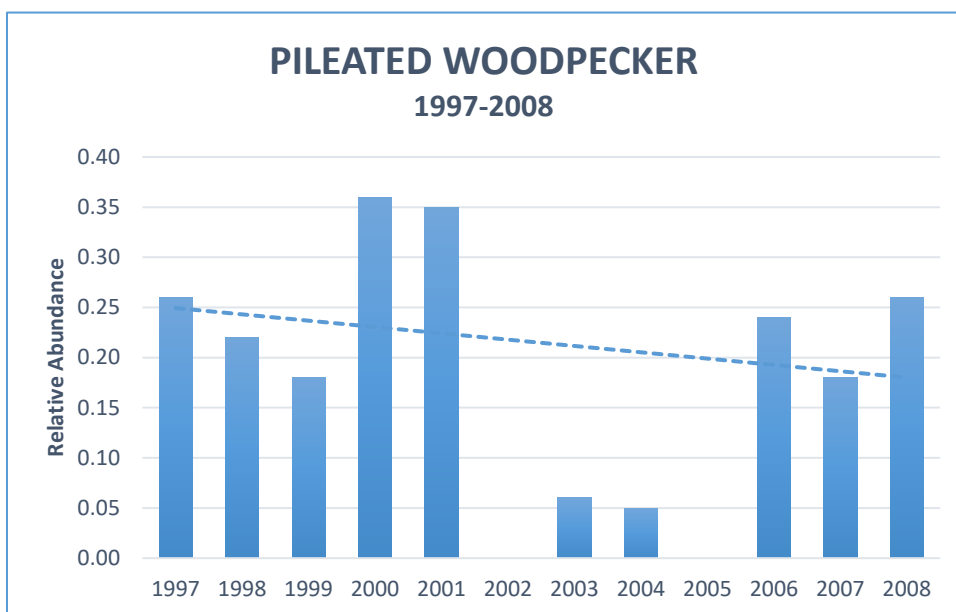
Figure 3G. Trend in Relative Abundance of Pileated Woodpecker in All Habitat Types across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
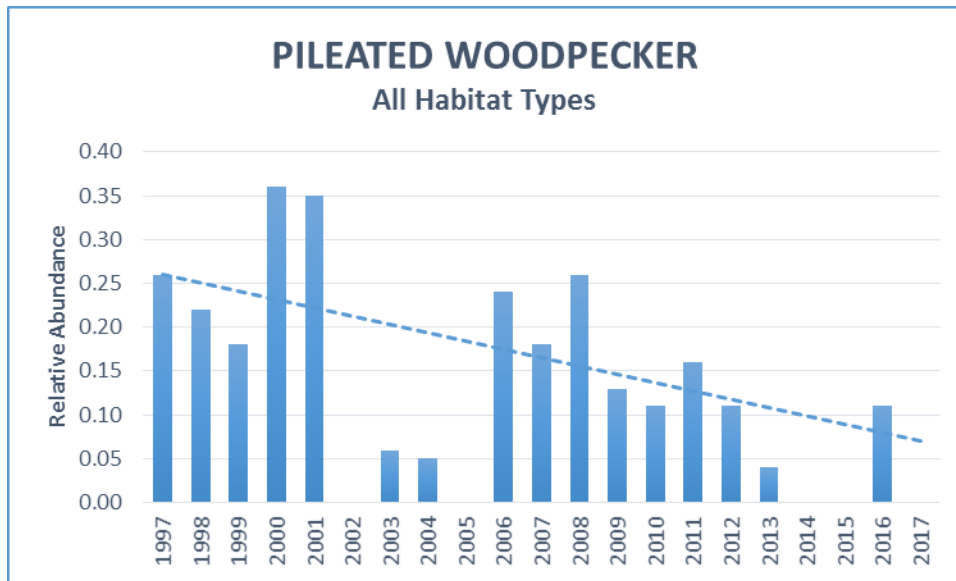
Figure 3H. Trend in Relative Abundance of Northern Bobwhite Quail across the Uwharrie National Forest, 1997-2016 (data source: R8Bird 2018).
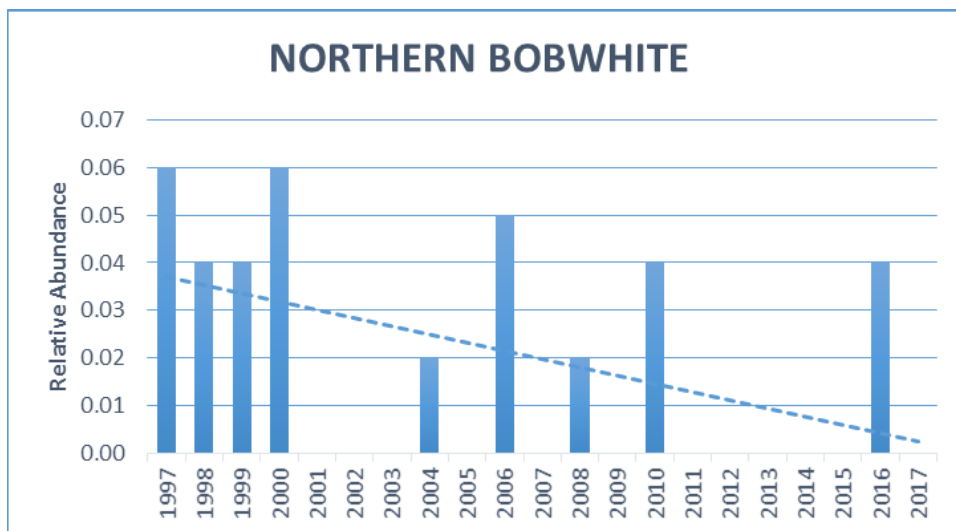
Croatan NF:

The **Red-cockaded Woodpecker** (RCW), *Dryobates borealis*, is a Federally listed Endangered Species that is dependent on mature pine savanna, flatwoods, and woodlands. The population on the Croatan grew from 44 clusters to 64 clusters from 1992 to 1997. This increase was done by managing the existing habitat. Populations declined after the 1996-97 hurricane season, though had increased to pre-hurricane levels in 2001 where the population of RCW's has remained relatively stable since then.

Increased efforts to target longleaf pine ecosystems began in 2002 under the Revised Land and Resource Management Plan (LRMP) for the Croatan National Forest. Prescribed fire has been increasingly implemented, covering over 20 thousand acres the last 3 years, resulting in more acres of longleaf habitat maintained or improved. The Holsten Hunter Project was signed in 2018 to improve and restore 2,923 acres of longleaf pine habitat in the Croatan National Forest. Prescribed fire is also being increasingly used as a restoration tool, which should maintain or improve habitat quality.

Results

Year	# Active Clusters	# Breeding Clusters
2018	69	66
2017	68	65
2015	68	67
2016	71	66
2013	69	67
2012	70	67

Black Bear: The Black Bear, *Ursus americana*, requires large tracts of land, with linkages between patches of suitable habitat, hard mast foods, escape cover for bears hunted with dogs, and freedom from motorized disturbances.

The North Carolina Black Bear Management Plan 2012-2022 developed by the North Carolina Wildlife Resources Commission (NCWRC) analyzed bear population trends using variable harvest levels and bear occupancy of all available habitat within the Coastal Bear Management Unit (CBMU). Trends showed that an increase in bear populations through the 1990's, the population began to stabilize in the early 2000's before increasing again beginning in 2006.

Prescribed fire on the Forest is a critical tool used to maintain or enhance woodland and savannah habitats that are important for summer foraging (i.e. huckleberry and blackberry). The natural mosaic pattern of these burns allow for enough retaining cover to provide for escape.

The Holsten Hunter project will be treating 2,923 acres of longleaf habitat, but will not be altering hardwood corridors or bottomland forests that provide the majority of the black bears habitat needs.

Harvest data below is provided by NCWRC biologists.

Harvested in the Croatan
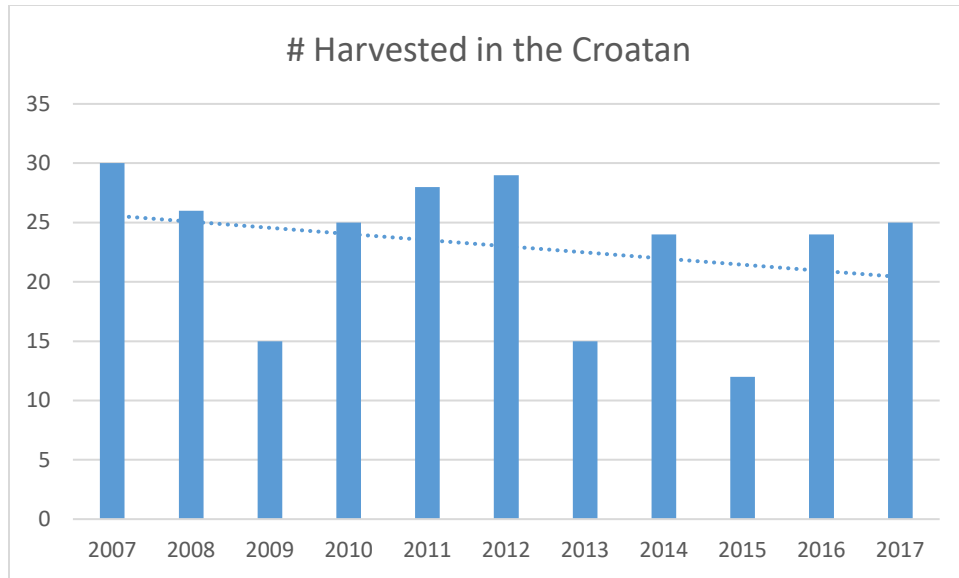
Figure 1. Bear hunter harvested within the Croatan National Forest.

Bear Harvested by County
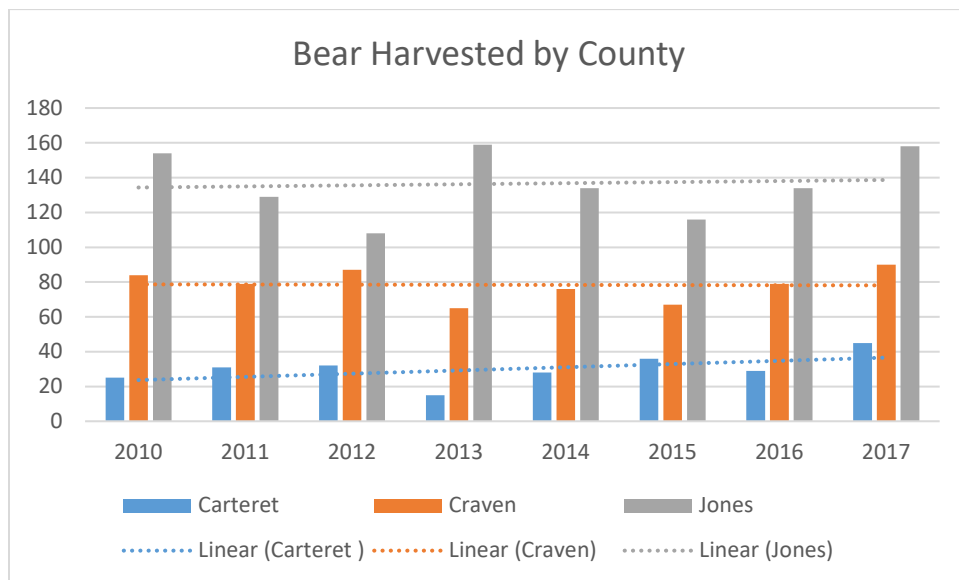
Figure 2. Bear hunter harvested on the broken down by counties that encompass the Croatan National Forest.

The Wild Turkey, *Meleagris gallopavo*, rely heavily on acorns and other hard mast produced by oaks, beeches, and hickory in upland hardwood forests. Oaks are a keystone species in eastern wildlife communities, used throughout different stages by at least 186 species of birds and

mammals. Oak dominated forest types have been in gradual decline across the Southeast due to residential and commercial development, conversion to pine plantations and farmland, and oak decline. Because the Wild Turkey is so dependent on oak mast production it has been selected as the species indicator of upland hardwood landtypes.

Summer brood counts and harvest rates reported by the NCWRC for Wild Turkey from 2009-2017.
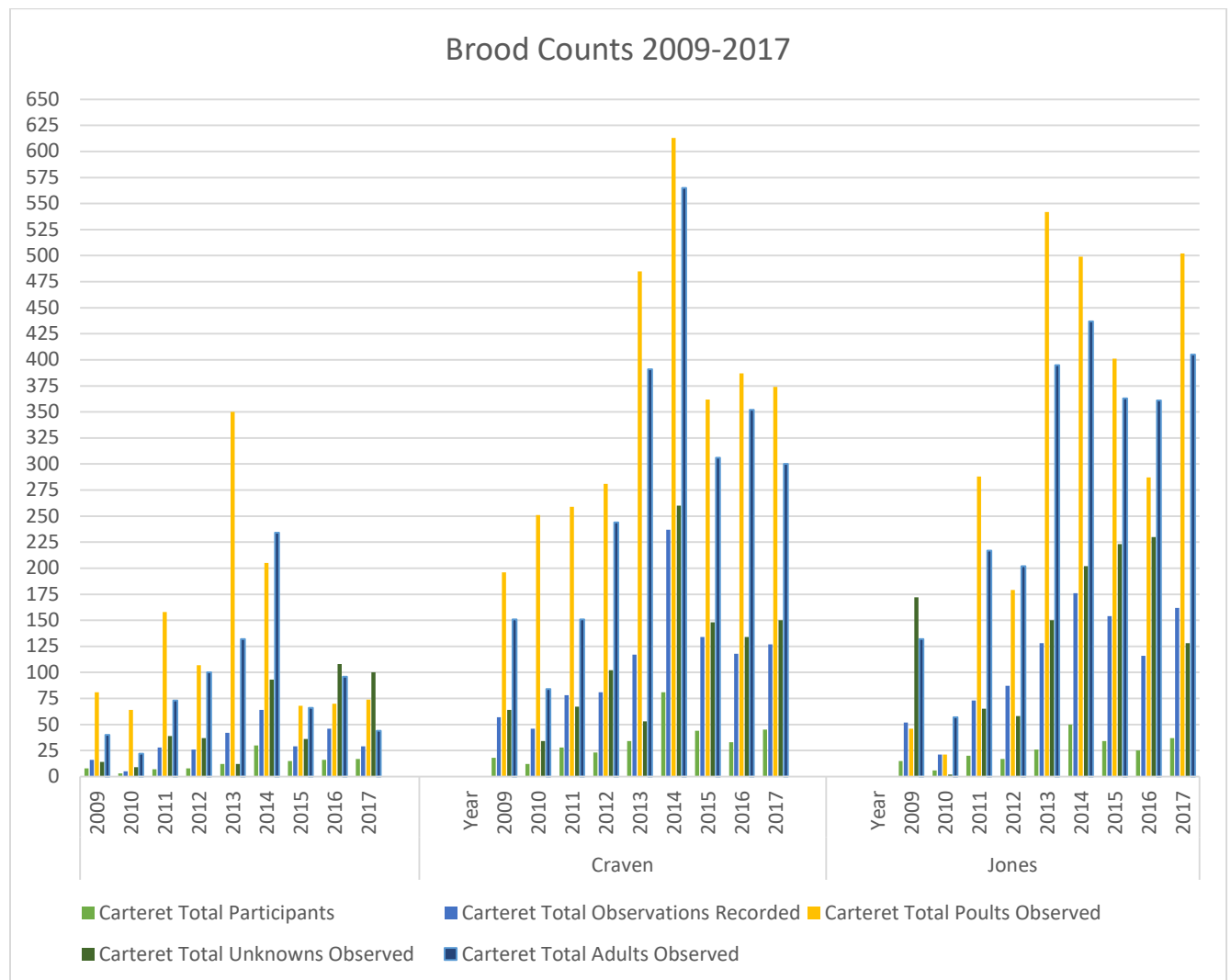
Figure 3. Wild Turkey brood counts by county encompassing Croatan National Forest

Croatan Gameland Wild Turkey Harvest

2009	36
2010	37

2011	54
2012	44
2013	66
2014	40
2015	45
2016	43
2017	45

Table 1. Wild Turkey hunter harvest in the Croatan National Forest, 2009-2017.

Discussion and Findings

Uwharrie NF

- *Trends in relative abundance for Brown-headed Nuthatch and Acadian Flycatcher are increasing, indicating that longleaf pine ecosystems and streamside zones are functioning.*
- *Trends of relative abundance for Scarlet Tanager and Pileated Woodpecker are decreasing. Scarlet Tanager abundance could be declining because Brown-headed Cowbirds are increasing due to amount of edge habitat from agricultural lands. The cause of decreasing trends of the snag dependent Pileated Woodpecker is unknown and further study in cooperation with partners is recommended.*
- *Trends in relative abundance for Bobwhite Quail are declining, although the quality of early successional habitats have been improving, such as the return of bunch grasses due to the significant increase of prescribed fire. Further study in cooperation with partners is recommended.*

Brown Headed Nuthatch: A small population has existed on the Uwharrie, associated with small, fragmented longleaf stands. Current trends for the Brown-headed Nuthatch appear to be stable with a slight increase in frequency observed across all habitat types on the Uwharrie, and occurred for the first time in longleaf habitats during migratory bird monitoring over the last two years. Numbers of nuthatches observed also appear to be going up in more recent years.

Increased efforts to target longleaf pine ecosystems began in 2002, which may correlate with the increase in nuthatch observations during migratory bird monitoring. These increases may be tied to improvement of existing longleaf habitats on the Uwharrie that have become ecologically functional after a more frequent fire regime was introduced. As longleaf ecosystem restoration continues there should be an expected increase in frequency and numbers of Brown-headed Nuthatches counted during surveys.

Scarlet Tanager: Relative abundance of the Scarlet Tanager appears to be declining at a moderate rate across the Forest. The decline is more significant when looking at old growth and late successional forested habitats. During this time period Brown-headed Cowbirds have significantly increased in these old growth and late successional habitats on the Uwharrie (Figure 4). The increase in Brown-headed Cowbirds into old growth and late successional habitats is likely correlated to the decline of Scarlet Tanagers on the Uwharrie.

The Uwharrie National Forest proclamation boundary is heavily fragmented by private inholdings, many of which are agricultural homesteads and private timberlands. Agricultural lands created the edge habitat preferred by the cowbirds, allowing them to become established around intact woodlands. Private timberlands are frequently sold off to residential housing developers, increasing fragmentation of dense canopy forests. These developments are often adjacent to intact stands, increasing the amount of edge habitat that allows for the cowbirds to move further into forested habitats.

Acadian Flycatcher: Relative abundance of the Acadian Flycatcher populations appears to be stable or slightly increasing across the Forest. This may indicate an increase in streamside forested habitat quality and quantity. Adherence to the Streamside Forest Guidelines in the Uwharrie LRMP has protected these forest habitats from fragmentation and insulated them from the edge habitat that cowbirds prefer.

Pileated Woodpecker: Migratory bird monitoring data from 1997-2017 indicates a decreasing population of the Pileated Woodpeckers on the Uwharrie National Forest. This decrease appears to be accelerating when compared to the 1997-2008 rate of decline.

Reasons for the decline are not clear-- it is likely a result of multiple factors culminating in the declining numbers of these snag dependent species. Factors may include past timber practices that reduced the number of trees that would eventually become snags suitable for nesting, fire suppression history and techniques, and/or increase in nest predators (e.g. squirrels, raccoons) due to decrease or lack of larger predators (e.g. bobcats, grey fox). Pileated woodpeckers still appear to be common throughout the Forest, though the rate of decline is of concern.

Northern Bobwhite Quail: These results show a steady decline in the number of times the Northern Bobwhite is counted during migratory bird monitoring, although the technique is not designed to detect species such as quail. Numbers of bobwhite observed appear to remain stable, however the frequency of observations has declined. This may be a natural variance as habitat in areas is burned at different intervals and they move in and out of areas, or a sign of a decline in overall population numbers.

Prescribed fire has been frequently applied on the Uwharrie for the last 10 years, averaging about 2,000 acres burned every year. The number of acres burned been increasing in recent years, providing more quality early successional habitat, as long as native plants and bunchgrasses are returning to these burned sites.

Openings are maintained on the Uwharrie as game fields, mostly for Mourning Dove. These fields are mowed or disked every year and planted with nonnative plants such as mullet to attract dove. Nonnative plants may be a factor in the bobwhite decline, as the quality of the seed protein may not be providing the nutrients required for population growth. Loss of native bunch grasses that provide ideal nest sites, such as big bluestem, will reduce nest success, reducing population numbers.

Croatan NF

- *Croatan NF: The RCW population on the Croatan National Forest has increased slightly from the 64 clusters in the early 2000's, and has remained stable at around 67-71 active clusters for the last six years, with over 90% of those active clusters with documented breeding attempts. It appears as though the majority of longleaf pine habitat that is ecologically viable to RCW's has been occupied by the woodpecker. With continued prescribed burning, RCW populations on the Croatan are expected to remain stable.*
- *Croatan NF: Bear populations are becoming stable or slightly increasing on the Croatan National Forest. Trends from the counties that encompass the Croatan National Forest show harvest rates to be stable to slightly increasing.*
- *Croatan NF: Turkey hunter harvest rates from 2009-2017 indicate a stable to slightly increasing success rate, suggesting that the overall turkey population is also stable to slightly increasing.*

Red-cockaded Woodpecker: The RCW population on the Croatan National Forest has increased slightly from the 64 clusters in the early 2000's, and has remained stable at around 67-71 active clusters for the last six years, with over 90% of those active clusters with documented breeding attempts.

It appears as though the majority of longleaf pine habitat that is ecologically viable to RCW's has been occupied by the woodpecker. While some of the more isolated breeding clusters that existed previously (10+years) have become inactive, the clusters in continuous habitat and/or habitat with good connectivity have continued to persist for many decades. The clusters in continuous, connected habitat have been the source of budded and new clusters in recent years (<10 years).

Longleaf pine habitat restoration projects have been implemented, removing loblolly pine plantations and replanting longleaf in the resulting openings. The restoration process is underway, however this is a long process that will become ecologically functional to RCW's in no less than 40 years. Even then it will likely only be able to serve as foraging habitat, won't be become breeding habitat for another 20 years after that. In the interim, with continued prescribed burning, RCW populations on the Croatan are expected to remain stable.

Black bear: Bear harvest rates appear to be slightly decreasing when looking at the data for the Croatan as a whole, however, hunter success and reporting can vary from year to year due to a

wide variety of factors not related to population size. Trends from the counties that encompass the Croatan National Forest show harvest rates to be stable to slightly increasing. The majority of the landscape outside of the Forest are developed and heavily roaded. This suggests that the bear population in the counties is likely sourced from the Croatan. The surrounding agricultural areas provide for higher foraging values that increase fitness, however, reproductive success is heavily influenced by having refuge from disturbance and year-round forage provided by the Forest. Overall, bear populations are becoming stable or slightly increasing on the Croatan National Forest.

Wild Turkey: Turkey summer brood reporting is highly variable due to being voluntary to submit either online or by mail. Peak participation has been 81 participants in 2014 from Craven County and a low of 3 participants in 2010 from Carteret County. Variations in reporting can dramatically affect the data collected and numbers reported. Removing the outliers and looking at the total of all individuals counted indicates a stable population. The ratio of poults to adults varies widely from year to year, though this appears to be a natural fluctuation likely related to weather (e.g. wet springs lower chick survival rates).

Hunter harvest rates from 2009-2017 indicate a stable to slightly increasing success rate, suggesting that the overall turkey population is also stable to slightly increasing.

Adaptive Management Recommendations for Category 3

Recommendations for Changes to Forest Plan Component: none

Recommendations for Monitoring Program

- *Develop monitoring questions for: 1) The amount and quality of snags for species such as pileated woodpecker; 2) The amount and quality of early seral habitat for species such as bobwhite quail.*

These questions would examine conditions needed to help explain the declines in relative abundance of pileated woodpecker and bobwhite quail.

Recommendations for Monitoring Activities or Management Activities:

- *Monitor brown headed nuthatch in all forest types, not just longleaf.*

    Brown headed nuthatch: Current monitoring should continue to use Forest-wide data across all habitat types as longleaf restoration efforts are initially implemented. This will increase sample size and strength of analysis in future reports. Restoration of longleaf ecosystems can be a decades-long process in some cases, and many stands won't become ecologically viable for the nuthatches for many years.

- *Assess suitablity of using the existing NCWRC quail monitoring program on the Uwharrie National Forest to assess species' trends.*

- *Choose Red-cockaded Woodpecker woodpecker cavity sites after analysis*

  As habitat becomes available, RCW's will begin to expand. In order to accelerate the process, cavity inserts and cavity drilling will be used in suitable areas that are closer to the size class and habitat conditions that will successfully promote viable RCW clusters. It will remain important to choose these areas carefully, to analyze habitat structure, size of stand, and connectivity to ensure breeding success and population growth.

- *For bears, maintain diversity of habitats, including hardwoods and riparian corridors*

  Continue to buffer bottomland hardwoods and riparian corridors from pine-centric treatments to retain the characteristics that constitute those types of habitats. Continue prescribed fire program across the landscape that maintains the diversity of habitats on the Forest.

- *For turkeys, ensure upland hardwoods are sustained during longleaf restoration*

  Continue to ensure upland hardwoods are protected during treatments for longleaf pine restoration. Identify any upland hardwoods that are being outcompeted by faster growing, shade tolerant species, in fire suppressed areas.

Category 4. The status of a select set of ecological conditions required under 36 CFR 219.9 to contribute to the recovery of federally listed threatened or endangered species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern.

The purpose of this category is to monitor conditions that are required for rare species; to demonstrate conformance with both the Endangered Species Act and the planning regulations at 36 CFR 219.9. Tables 4A and 4B outline the monitoring questions and the applicable plan components for this category.

Table 4A. Monitoring Questions, Indicators, and Report Timeline by National Forest for Category 4.

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q11. What are the trends in Schweinitz's sunflower across the UNF?	Counts per population	2-year; Report timing: Year 2018
Uwharrie	Q12. What are the trends in element occurrences across the forest?	Extent of occurrences and threats	2-year; Report timing: Year 2018
Uwharrie	Q13. Are botanical special interest areas fully functioning?	Extent of EO's; Threats; NNIS; Fire in fire adapted systems	2-year; Report timing: Year 2018
Uwharrie	Q14. What are the trends of NNIS?	Acres treatment by plant location	2-year; Report timing: Year 2018
Croatan	Q9. What are the conditions of special interest natural areas on the CNF?	Condition to continue supporting rare species	2-year; Report timing: Year 2018
Croatan	Q10. What are the occurrences of specific at risk species?	Occurrences of: R. Leafed loosestrife; S. Flowering goldenrod; Mimic glass lizard	2-year; Report timing: Year 2018

National Forest	Monitoring Question	Indicator	Report Timing
Croatan	Q11.What are the amounts and conditions of old growth in each ecological type	Acres of old growth in each ecological type	2-year; Report timing: Year 2018
Croatan	Q12. What is the status of rare landtypes in the plan area?	Amount and Condition: Canebrakes; Marsh; Maritime Forest; Atlantic white cedar	2-year; Report timing: Year 2018

4B: Plan Components for Category 4 by National Forest

National Forest	Plan Components
Uwharrie (DCs: Veg-3)	See Plan (pg 5) Veg 3 Over the planning period, Schweinitz's sunflowers that historically occurred across the Piedmont of North and South Carolina are restored on appropriate sites…Other rare plant species are maintaining or increasing in number of occurrences.
Uwharrie (DC: Veg-5)	See Plan (pg 5) Veg-5 Biological diversity is evident across the forest and is further enhances by a system of biological interest areas. All plant communities found on the Uwharrie NF are represented in this system…
Uwharrie (Objective: 3)	(Plan, p. 21) Over the planning period, restore to appropriate sites 5 to 13 subpopulations of Schweinitz's sunflower…
Uwharrie (Objective: 4)	(Plan; p. 21)Over the planning period, to enhance habitat of Schweintz's sunflower…create 15-30 canopy openings of ½ to 2 acres in size across longleaf pine and oak-hickory restoration areas that are within the Schweinitz's Sunflower Habitat Management Area.

National Forest	Plan Components
Croatan (DC: 2.1.1)	(Plan; p. 44)Recover a viable population of RCW through joint efforts with Marine Corps Base Camp Lejeune and Holly Shelter Gamelands
Croatan (Objective: 2.1.1,1)	(Plan; p. 46) Meet a long-term population objective of 137-168 RCW clusters
Croatan (DC: 2.1.3a)	(Plan, p. 47) Maintain viable populations of endangered, threatened, sensitive, and locally rare species on the CNF
Croatan (Objective: 2.1.3.3)	(Plan, p. 47) …During the next 10 years, establish: Two new subpopulations of flowering goldenrod, One new subpopulation of mimic glass lizard; One new subpopulation of Carolina goldenrod; Five new populations of rough-leaved loosestrife
Croatan (Objective: 2.1.3.4)	(Plan, p. 47) Restore…500 acres of canebrake, 7 acres of marsh, 10 acres of maritime forest, and 25 acres of Atlantic White Cedar.

New Science or New Information

- Longleaf old growth. Inventory by UNC-Greensboro.   2017.

Data

> Field recon for Schweinitz's Sunflower (Uwharrie) (2016-2018)
> - Onsite inventories of Schweinitz's sunflower
>
> NC Natural Heritage Database (2018)
> - NC Heritage Program Database
>
> Field visits for special interest natural areas (Croatan) (2017-2018)

Table 4C. Schweinitz's Sunflower Occurrences (Uwharrie NF)

Element Occurrence Number	Location	Stem Count
Parent EO 44	NC 109	1760 (stable)
Parent EO 110	Badin Area	488 (4 of 6 populations-stable)
Parent EO 111	Roberdo Area	7 populations (stable); 1 population (declining)
	Clark's Grove	2100 (stable & increasing)
Parent EO's 145, 146,148	Northern UNF	50 each
Parent EO 15		34 (potentially extirpated)
Parent EO 178		0

Table 4D. New Element Occurrences found on the Uwharrie NF since January 2017

Plant Species		
Common Name	**Scientific Name**	
Bog Spicebush	Lindera subcoriacea	
Mountain camelia	Stewartia ovata	
Carolina thistle	Cirsium carolinianum	
Crested coralroot	Hexalectris spicata	
Bog oatgrass	Danthonia epilis	
Slender Blue Iris	Iris prismantica	
Mountain witch alder	Fothergilla major	
Rare Communities		
Hillside Seepage Bogs		
Piedmont Boggy Streamheads		

Xeric Hardpan Forests		
Dry Piedmont Longleaf Pine Forest		
New Species		
Quillwort Species (new)	Name to be determined	

Table 4E. List of Special Interest Natural Areas with Estimates of Conditions (Croatan NF)

Special Interest Natural Area	Condition Estimate
Croatan Pocosins	Good
Cedar Point/White oak river marshes	Excellent
Flanner Beach Natural Area	Fair – Hurricane Florence damage
Gum Swamp Bottomland Hardwood Forest	Not checked
Hadnot Creek Ponds and Longleaf Pine Woods	Good
Hibbs Road Ridges	Good (2018 Burn)
Holsten Creek/Heywood Landing	Good(2018 Burn)
Hunters Creek Upland Forest	Excellent (some NNIS)
Island Creek Natural Area	Good (some NNIS and unauthorized bike trails)
Little Road Longleaf Pine Savannas	Excellent
Millis Road Savannas and Pocosins	Excellent (2017 burn)
Millis Swamp Road Pinewoods	Good
Nine Foot Road/Broad Creek Pinewoods	Good (2018 Burn)
Nine Foot Road/Roberts Rd Limesink Ponds	Excellent (2018 Burn)
Patsy Pond Limesink Complex	Good (2018 Growing Season burn)

Special Interest Natural Area	Condition Estimate
Pettiford Creek Open Flatwoods	Good (2017 Burn)
Pringle Road Bay Rims	Excellent (2017 Burn)

Excellent Condition: The entire natural area is in a "maintain" condition class
Good Condition: More than half of the natural area is in a "maintain" condition class
Fair Condition: High quality vegetative patches are scattered throughout the natural area.

Table 4F. At risk plant species on the Croatan NF

Common Name	Scientific Name	Number of EO's
Rough Leaved Loosestrife	Lysimachia asperulifolia	62
Spring Flowing Goldenrod	Solidago verna	41
Leconte's thistle	Cirsium lecontei	10

Figure 4A. Locations of Schweinitz's Sunflower Management Areas (Uwharrie NF)
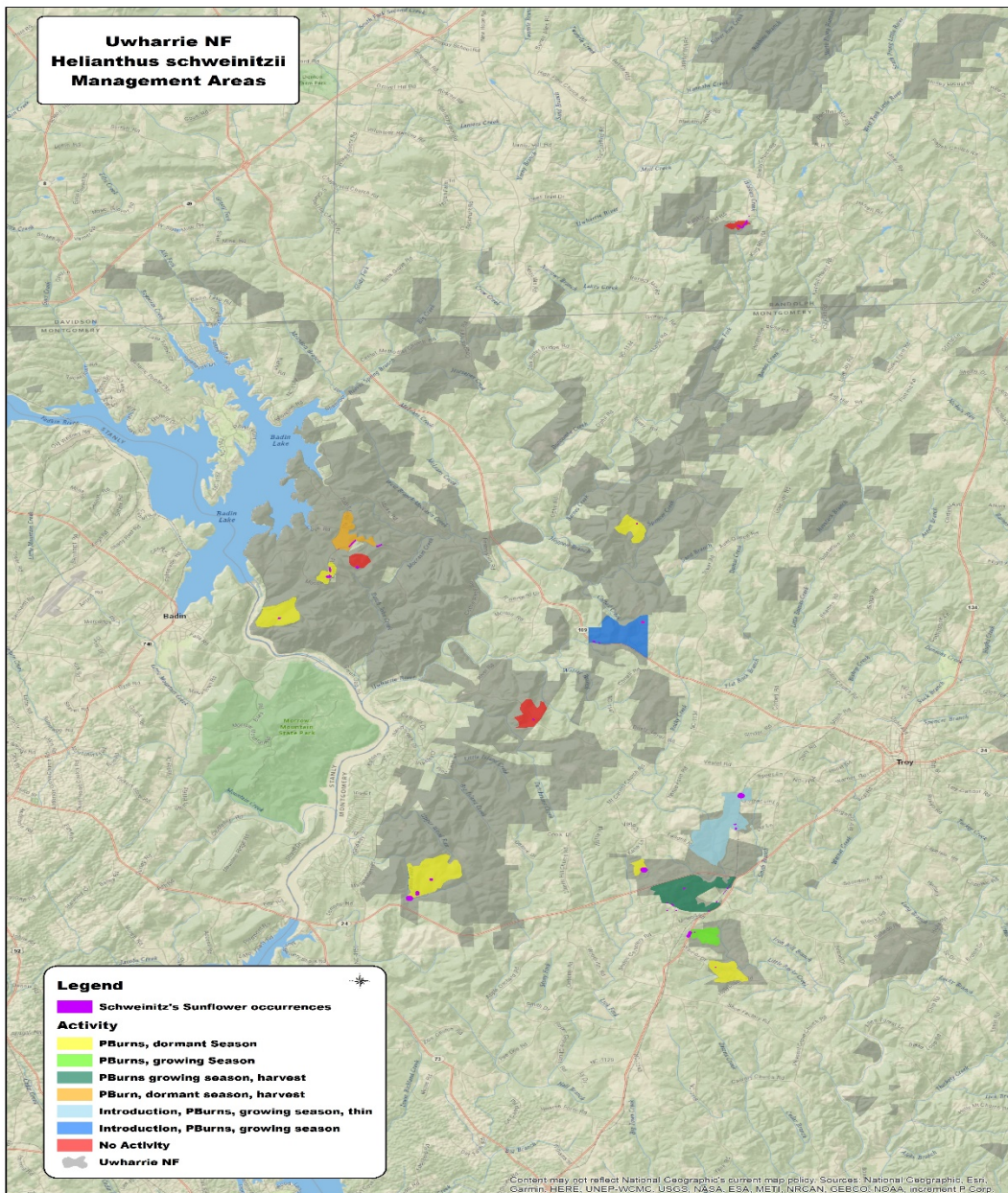
Figure 4B. Location of Longleaf Old Growth Patches on Uwharrie NF (UNC-Greensboro)
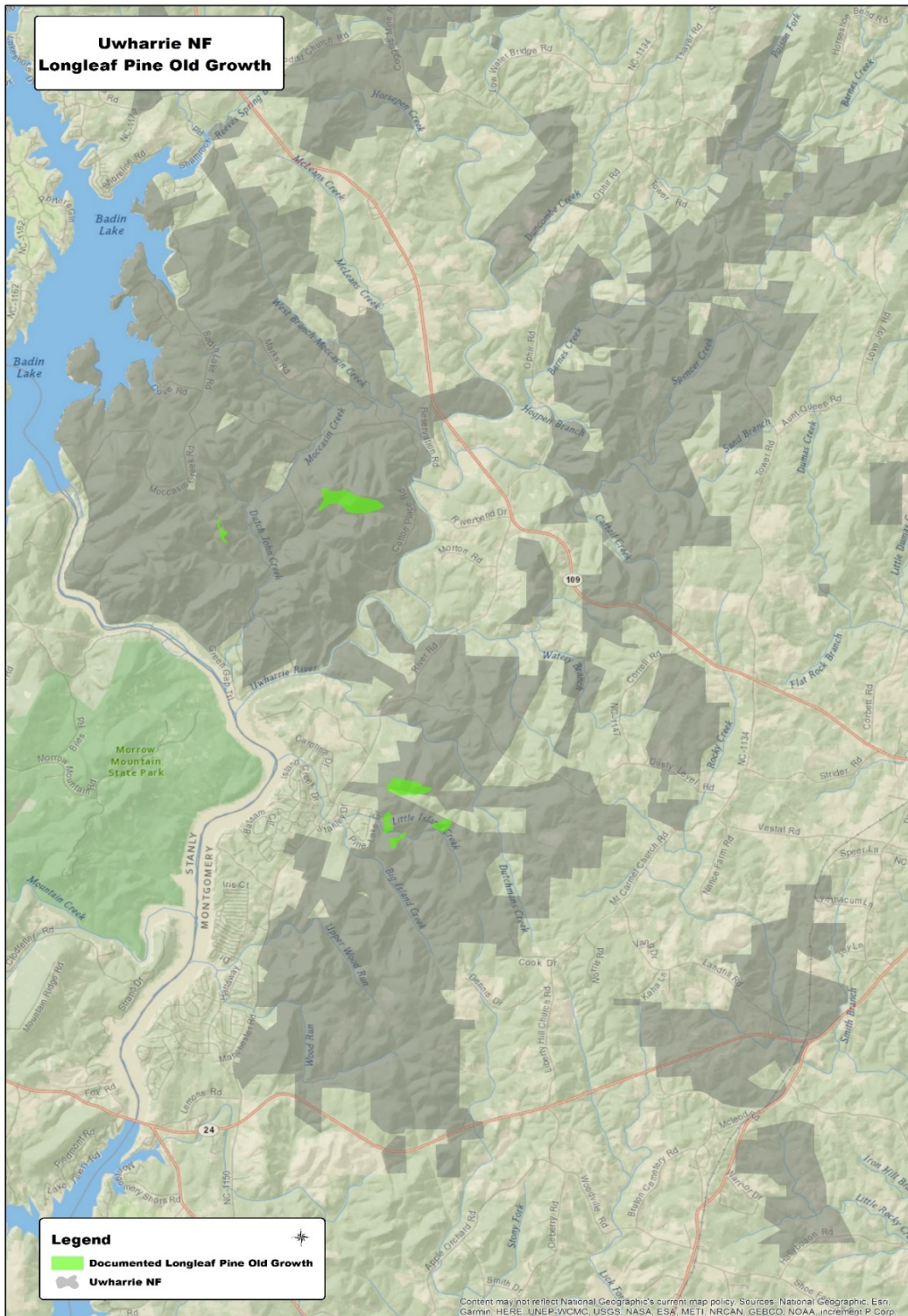
Discussion and Findings

Uwharrie NF

- *Due to the consistent application of prescribed fire in strategic locations; about 75% of Schweinitz's Sunflower populations are stable, whereas restoration is needed for the remaining populations. New occurrences of rare species and communities have been found during this monitoring cycle, including 172 acres of longleaf old growth trees-some over 300 years of age.*

Schweinitz's Sunflower: As shown in Table 4C; about 13 populations of this species are stable and approximately 3 are declining or may be extirpated. The stable populations should be attributed to consistent prescribed fire to maintain open conditions (Figure 4A). Two populations were transplanted in locations where habitats were suitable. Providing open canopy conditions using thinning also has improved habitat for schweinitz's sunflower.

Element Occurrences: New occurrences for 7 rare species and five rare communities have been documented during this monitoring cycle (Table 4D). One new species (tentatively called Isoetes uwharrie) has been found by researchers from Old Dominion University and the Smithsonian. These species and communities with new occurrences require open canopy conditions, which are created and maintained using prescribed fire. A study by UNC-Greensboro dendrology department found approximately 172 acres of old growth longleaf trees on the national forest (Figure 4B.)

Croatan NF

- *The natural vegetative conditions on the 17 natural areas are in fair to excellent condition; none have degraded during this monitoring cycle. Rough leaved loosestrife, spring flowering goldenrod, and LeConte's thistle continue to persist on the national forest.*

Special Interest Natural Areas: To summarize Table 4E; there are 17 natural areas; 2 in excellent condition, 4 in good condition; 6 in fair condition. Three of these natural areas were not visited during this monitoring cycle. The condition of those natural areas that have been visited are in stable –the condition of each natural areas has been maintained during this monitoring cycle.

At risk plant species: Element occurrences for at risk plant species were obtained from the NC Natural Heritage Program (Table 4F) and briefly described as follows.

- **Rough leaved loosestrife (*Lysimachia asperulifolia*).** There are 62 element occurrences (EOs) for Rough leaved loosestrife on the Croatan NF in the NC NHP database. Populations of this species are especially numerous in the southern section of the forest, where it is found in suitable habitat south of Millis and Roberts Road from Hibbs Road west to Pettiford Creek. All of this area has been burned in the past 2 years, which has greatly benefitted Rough leaved loosestrife.

  Rough leaf loosestrife is found on hydric soils, and as such should not be impacted by any mechanical management or recreational activities, which should not be permitted in these areas. With regular burning, populations of Rough leaved loosestrife should continue to flourish on the Croatan.

- **Spring flowering goldenrod (*Solidago verna*)** There are 41 records for Spring flowering goldenrod on the Croatan in the NC NHP database. At present the Croatan is a stronghold for this rare species, with several populations numbering hundreds of plants. However, one large population of this species has recently been directly impacted by widening of NC17 and more large populations will be impacted by the construction of the Havelock bypass, beginning in

2019. The USFS will coordinate with DOT on mitigation efforts for the impacted populations, and the USFS will resurvey and assess the status of all populations of this plant on the Croatan NF.

Spring flowering goldenrod has responded well to increased sunlight after timber treatments on the Croatan. The plant is found on slightly loamy soils, which can quickly become overgrown with hardwoods if not regularly burned.

- **LeConte's thistle (*Cirsium lecontei*)**   There are 10 records for LeConte's thistle on the Croatan area in the NC NHP database, but several of these have not been found recently and are considered historic. Several of the other records are for populations with only a few individuals. This is one of the rarest plants on the forest. The Havelock Bypass project will impact at least one and possibly 2 populations of this plant. The USFS will work closely with DOT to help ensure the success of mitigation efforts for this plant, and regularly monitor and carefully manage all populations of this plant on the Croatan NF.

LeConte's thistle is found in open wet savannas on loamy soils. These habitats are prone to invasion by hardwoods, and the necessary open conditions for LeConte's thistle are best maintained by regular and frequent prescribed burning. Mechanical treatments in these areas should be undertaken only in dry periods, to limit disturbance to the wet soils.

Adaptive Management Recommendations for Category 4

Recommendations for Forest Plan*: none*

Recommendations for Monitoring Program

- *Croatan Q10: Replace mimic glass lizard with LeConte's thistle*

LeConte's thistle has recently been found on the national forest and could provide conditions for its persistence.   Mimic glass lizard is no longer considered a rare species.

- *Croatan Q11: Refine Q11 to focus on longleaf old growth*

In the fire adapted ecosystems, most natural communities do not exhibit old growth characteristics, with the exception of the longleaf ecosystem, where older and larger trees can persist where frequent fire occurs. Older forests are common in the wetlands.

Recommendations for Monitoring Activities:

- *Uwharrie Q13; Croatan Q9: Refine a classification system using criteria and measures for estimating the conditions of natural areas.*

A consistent classification system for identifying the conditions of natural areas are needed for both national forests

Category 5. The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

The purpose of this category is to monitor several important conditions that contribute to social sustainability in forest plans. Tables 5A and 5B outline the monitoring questions and the applicable plan components for this category.

NOTE: The report timing for the questions Q15 (Uwharrie) and Q13,Q14 (Croatan) in this category are due in 2020 or 2022. For these questions, the evaluation is considered a "readiness check" for 2020 reporting and beyond

Table 5A. Monitoring Questions, Indicators, and Report Timing by National Forest for Category 5.

National Forest	Monitoring Question	Indicators	Report timing
Uwharrie	Q15.What amount and kind of visitor use activities are occurring on the UNF and how satisfied are people with their experience?	NVUM Surveys	6-year; Reporting timing: Year 2022
Uwharrie	Q16.What are the trends in trail conditions?	Miles of trail maintained to regional standards; Change on amount of trail maintenance backlog	2-year; Report timing: Year 2018
Uwharrie	Q17.What is the percent of completion of the Uwharrie National Recreation Trail?	Additions to the Uwharrie National Recreation Trail	2-year; Report timing: Year 2018
Croatan	Q13.What amount and kinds of public use activities are occurring on the CNF and how satisfied are people with their experience?	NVUM Surveys	6-year; Report timing: Year 2022
Croatan	Q14.What are the changes in conditions of ROS settings?	Change in ROS settings	4-year; Report timing: Year 2020

Table 5B. Plan Components relevant for Category 5 by National Forest

National Forest	Plan Component
Uwharrie (DC: TRL 1)	(Plan, p. 15) TRL-1. Exceptional trails are available for hikers, horseback riders, off-roaders,mountain bikers, hunters, and anglers. The trails are designed, constructed, and maintained so that a variety of levels of challenge is available and other forest resources such as soil and water are protected.
Uwharrie (DC: TRL 5)	(Plan, p. 16)TRL-5. The 50-mile Uwharrie National Recreation Trail is complete and marked for hikers. That portion on national forest system lands has high scenic integrity
Uwharrie (Objective: 1)	(Plan, p. 25) 1. Each year until the maintenance backlog is depleted, an average of 10 combined miles of substandard hiking, bike, horse, or OVH trail are improved, with the emphasis being horse trails and OHV trails in the Badin Lake area.
Croatan (DC: 2.2.1)	(Plan, p.50) 2.2.1. Provide a wide range of safe and enjoyable recreation opportunities focusing on water, with settings varying from rustic and natural to more developed….
Croatan (Objective: 2.2.1.3)	(Plan, p. 50) 2.2.1.3. Increase capacity for rustic developments in natural appearing water-based sites (semi- primitive motorized ROS class) by 50 percent. Construct a group camp at Cedar Point.

New Science or New Information: none

Data

NVUM Data collection 2018, Results in 2020 (Uwharrie)

Annual Reporting for trail maintenance

Table 5C. Trail Maintenance data for Uwharrie NF

Year	Maintained (miles)	Improved (miles)	Maintained to Standard (miles)
2011	20.6	4.88	25.4
2013	44.0	0.64	37.0
2015	20.6	0	59.8
2016	39.3	0.8	41.7
2017	2.35	0	2.35

Table 5D. Trail Maintenance Backlog on Uwharrie NF

Non-motorized trails	70 miles
Motorized trails	17 miles

Table 5E. Additions to the Uwharrie National Recreation Trail (Uwharrie NF)

Years	Additional Tracts (Ac)	Additional Trail Miles	Total Trail Miles
2016-2018	3 tracts (547 ac)	10 miles	30 miles

Table 5F. Recreation site improvements on Croatan for 2017

Location	Improvement
Pinecliff Area	New equestrian parking
Cahooque Creek	Boat ramp rehabilitation

Discussion and Findings

Uwharrie NF

- *Progress toward completing the Uwharrie National Recreation Trail was made during this monitoring cycle, as approximately 60% of the plan objectives have been achieved.*

- *Although conditions for all trails had improved recently, those conditions have degraded during the past year due to the lack of Recreation Trail Program Grant funding, which is likely to be restored next year.*

NVUM Surveys: The FY 2018 National Visitor Use Monitoring will be completed on the UNF by September 30, 2018. The data is being collected by contractors through the University of Tennessee. Generally, the report and analysis takes 18 months to 2 years to be completed and distributed to the National Forests.

Trail Maintenance: A drop in the amount of mileage maintained, improved or maintained to standard was the lack of Recreation Trail Program Grant (RTP) funding received. This was due to a major backlog at the State Trails Program. Because of this lack of funding the motorized trails have not received any significant maintenance with equipment since the winter of FY2016 (actual time trail work completed was February / March of 2016). In FY2018 several of the RTP Grants were sent to the Forest to be used. Several of the projects were put into contracting but none of the work will start until fall of FY2019.

Trial Maintenance Backlog: Change in the amount of trail maintenance backlog was decreasing until the backlog of RTP grants. There is probably 70 miles of trail maintenance that is backlogged for the non-motorized trail system and all 17 miles of the motorized trails are now backlogged. Approximately, 2/3 of the motorized trails will receive maintenance starting in January of 2019 and they will be maintained to standard.

Uwharrie National Recreation Trail: Tract additions for the Uwharrie National Recreation Trail realignment and re-creation have included the King Mountain Tract, the Little Long Mountain Tract, and the Klaussner Tract for a total of 546.84 acres as of August 2018. This has added approximately 10 miles to the length of the Uwharrie National Recreation Trail (UNRT). The trail is now approximately 30 miles. There is another acquisition that should occur in the fall of FY2019, which will connect the UNRT all the way up to High Pines Church Road (SR 1143). From there the Forest will then need to make the final connection to the Birkhead Mountains Wilderness Area and then do a few reroutes to get the trail back to be 50 miles in length.

Croatan NF

- *Recreation Opportunity Settings have not changed at existing recreation sites during this monitoring cycle are relatively intact.*

ROS Settings: The ROS settings have not changed at existing recreation sites.
The Croatan did add a new equestrian parking lot in the Pinecliff area in 2017. It provides full access in an urban setting. The remoteness is of little relevance because of its location. There has been heavy modification to the natural setting of the site, which is compatible to the urban setting. This facility is primarily designed for user comfort and convenience. Synthetic material that is harmonious to the environment has been incorporated into the design. There are no noticeable impacts due to site hardening. Regimentation and controls are obvious and numerous. There are sophisticated information exhibits.

Cahooque creek boat ramp was restored this year. No change in in ROS settings.

This page was edited on April 11, 2019 to correct an inaccurate statement.

Corrected | P a g e   62

Adaptive Management Recommendations for Category 5

Recommendations for Forest Plan:

- *To conform with the policy of sustainable recreation, Change Objective 2.2.1.3 that specifies the construction of a group camp at Cedar Point.*

Capacity for rustic development has not increased. There was no group site constructed at Cedar Point campground because the capacity to manage additional recreation sites is not feasible due to current staffing level and does not reflect the policy of sustainable recreation. The objective to add a group site at Cedar Point should be removed from the plan in the future.

Recommendations for Monitoring Program: none

Recommendations for Monitoring Activities or Management Activities: none

Category 6. Measurable changes on the plan area related to climate change and other stressors

This category is discussed as part of the Broad-scale monitoring that is addressed in section 2 of this document.

Category 7. Social, Economic, and Cultural Sustainability must be addressed in the monitoring program

The purpose of this category is to track selected conditions that contribute to social sustainability according to planning regulations of 36 CFR 219.8(b). Tables 7A and 7B outline the monitoring questions and the applicable plan components for this category.

Table 7A. Monitoring Questions, Indicators, and Report Timing by National Forest for Category 7

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q23.What are the trends in protection, and/or stabilization and preservation of cultural or historic sites?	# High Priority Sites Maintained	2-year; Report timing: Year 2018
Uwharrie	Q24.What are the risks of wildfire that may affect local communities and what strategies may provide for community protection from wildfire?	Amount, timing, and location of prescribed fire; Fire regime condition class	2-year; Report timing: Year 2018
Croatan	Q23.Are local communities attaching special significance to the natural and cultural attributes of the CNF as contributing to their well-being, and if so, how is this attachment exhibited through community actions?	# Action Plans collaborated with local communities; # Special Events.	2-year; Report timing: Year 2018
Croatan	Q24.What are the conditions of cultural and historic Special Interest Areas?	Changes in cultural/historic site conditions; monitored, stabilized, investigated, and protected from vandalism	2-year; Report timing: Year 2018
Croatan	Q25.What are the risks of wildfire that may affect local communities and what strategies may provide for community protection from wildfire?	Projects through Community wildfire protection plans	2-year; Report timing: Year 2018

Table 7b. Plan Components relevant for Category 7 by National Forest.

National Forest	Plan Component
Uwharrie (DC: ARC-1) Cultural	(Plan, p. 13) ARC-1. Cultural resources are protected from loss. Significant sites are stabilized, treated, managed and preserved for their historical research value.
Uwharrie (DC FM-1) Fire	(Plan, p. 10) FM-1. There is increasing evidence of prescribed fire used to restore the structure, composition, and ecosystem processes in ecological systems. Forest ecosystems are well-adapted to fire occurrence.
Uwharrie (DC: FM-2) Fire	FM-2. The composition, structure and density of vegetation reduce potential fire behavior, including the rate of spread, flame length, spotting potential, and the likelihood of a surface fire transitioning to crown fire.
Uwharrie (Objective: 1) Fire	(Plan, p.23) Each year an average of 3,000 to 6,000 acres are prescribe burned to create open canopy conditions, reduce mid-canopy, and move toward ecological conditions described in goal/desired condition VEG-8. Public and firefighter safety will be the first priority in fire management activities
Uwharrie (Objective: 1) Cultural	(Plan, p.24) 1. Each year until the existing backlog is depleted, identified deferred maintenance needs are addressed on an average of five significant sites that are vulnerable to degradation.
Croatan (DC: 2.7.3.b) Local Community	(Plan, p.61)2.7.3.a Provide opportunities for the local populations to develop a unique connection - a sense of place – to the CNF.
Croatan (DC: 2.7.3.b) Local Community	(Plan, p.61)2.7.3.b. Work collaboratively with local governments to identify complementary goals for land management and to seek input on implementation of the CNF Plan's goals and objectives.
Croatan (Objective: 2.7.3.1-2)) Local Community	(Plan, p.61)2.7.3.1. Develop action plans with local communities and governments to sustain the places and features that make the area unique. 2.7.3.2. Sponsor special events in conjunction with local communities to help develop sense of place with population segments.
Croatan	(Plan, p.61)2.7.3.3. Manage, protect, preserve and interpret heritage

National Forest	Plan Component
(DC:2.7.3.3) Cultural	resources. Encourage scientific research at sites.
Croatan (DC:2.7.3.d)) Fire	(Plan, p.61)2.7.3.d. Collaborate with local entities to create defensible space (as it relates to wildfire), and to inform about the use of fire.
Croatan (DC:2.5.2a) Fire	(Plan, p.57)2.5.2.a. Use prescribed fire to restore the structure and composition of longleaf and mixed pine, prepare seedbeds for longleaf pine restoration, control competing pine species, and improve existing longleaf pine stands. Improve browse, open understory conditions and maintain mast production for black bears, turkeys, and white-tailed deer using techniques that will create mosaic burning patterns.
Croatan (Objective: 2.5.2.1) Fire	(Plan, p.57)2.5.2.1. Apply fire to 2750-3500 acres to reduce woody vegetation and logging debris for seedbed preparation of pine stands.

New Science or New Information

New science for both districts: https://sdd.nc.gov/sdd/DataDownload.aspx

Data

       Infrastructure Corporate Database (Cultural Resources)

       Facts Corporate Database (Fire)

       Notes from local collaborative meetings; PALs Datatbase

Table 7c. Area of prescribed fire on Uwharrie NF

Year	# Prescribed Fires	Acres of Prescribed Fire
2015	22	4,923
2016	14	4,876
2017	20	4,534
2018	20	4,918

Table 7d. Wildfire incidents on the Uwharrie NF

Year	# Fires	Acres of Fire
2015	4	26
2016	16	192
2017	13	1718
2018	4	10

Table 7e. Area of prescribed fire on the Croatan NF

Year	# Prescribed Fire	Acres of Prescribed Fire
2015	11	8,926
2016	25	16,389
2017	33	21,420
2018	51	26,707

Table 7F. Wildfire incidents on the Croatan NF

Year	# Fires	Acres of Fire
2015	4	10
2016	13	1,717
2017	16	192
2018	4	10

Table 7G. List of Community Wildfire Protection Plans by County and Fire District on the Croatan

County	Fire District
Craven	New Bern
	Township 7 VFD

County	Fire District
	Township 6 VFD
	Havelock FD
	Cherry Point FD
	Harlowe FD
Carteret	Newport FD
	Mill Creek VFD
	Wildwood FD
	Broad and Gales Creek VFD
	Western Carteret VFD
	Stella VFD
Jones	Maysville VFD
	Pollacksville VFD

Table 7H. Partial List of Collaborators and Purpose of Collaboration (Croatan NF)

Collaborator	Purpose
Onslow Bight Conservation Group	Quarterly meetings for coordinating proposals and among adjacent landowners, including potential volunteer work
The Nature Conservancy; Department of Defense	Coordinating prescribed burning on private and public ownerships for the purposes of longleaf restoration and red-cockaded woodpecker recovery. Approximately 5 meetings/year; and 1 meeting/year for general public
Holston Creek Timber Sale	The interagency partnership in the Onslow Bight Conservation Forum were invited to participate, including the Department of Defense – Navy and Marines, US Fish and Wildlife Service, North Carolina Forest

Collaborator	Purpose
	Service, North Carolina Natural Heritage Program, North Carolina Wildlife Resources Commission, a local biologist, Coastal Land Trust, The Nature Conservancy, and North Carolina Coastal Federation.
Sierra Club; NC Natural Heritage Program	To develop and sponsor public information programs about the rare species, natural communities and their needs for protection
Local Conservation Groups and SHPO	To develop and sponsor public information programs about heritage sites and protection measures for these sites

Table 7J. Uwharrie NF: Projects listed in the PALs Database during this monitoring cycle (2015-2018)

Project Name	Purpose
AT&T	Road easement permit renewal
Energy United EMC	Electrical lines permit renewal
Flintlock Powerline Installation	Recreation Facility Improvement
Prescribed burn project	Fuels mgmt. and habitat improvement
FY17 Prescribed burn project	Fuels mgmt. and habitat improvement
Lakeview Off Highway Vehicle Construction	Trails management
Montgomery County Water System Permit	Special uses permit
Morgan Equestrian Trail Reroute	Trails management
Native Species Restoration Project	Hand tool release of vegetative understory
Newport Road Easement	Utility line easement
Randolf Telephone Permit	Co-op Telephone company permit renewal
Roberdo South Project	Vegetative treatments (approx. 2,200)

Project Name	Purpose
Robin Sage Permit renewal	Military training permit
Rudolf Abandoned Mine Closure	Badin Lake Area –2 mines closed
Uhwarrie National Recreation Trail Re-route	Re-routing approx. 2 miles
Woodrun Bike Trail Extension	Trail mgmt.

Table 7K. Croatan NF: Projects listed in the PALs Database during this monitoring cycle (2015-2018)

Project Name	Purpose
Catfish Lake Impoundment Improvements	Water control; habitat improvement
Havelock Water Well Pad Expansion	Rehab and new well construction
Coastal Carolina Regional Airport Runway	Runway expansion to improve glidepath
Croatan Prescribed Burning Project	Approx. 20,000 ac on 3yr fire return interval
Havelock ByPass, US 70, DOT project	NCDOT proposed bypass construction
Hill Fields Parking Area Improvements	Recreation facility improvements & road management
Holston Hunter Farm Bill Project	Habitat Improvement, Timber Sales, Fuels Treatments (approx. 3,000 ac)
Piedmont Natural Gas Permit	Permit renewal
West Carteret Water Corp. Water Line Ext	Water line permit

Figure 7A. Uwharrie: Locations of Prescribed Fires and the Wildland Urban Interface

UWHARRIE NATIONAL FOREST
WUI

N

Olive Jones
GIS Editor
08/13/2018

Legend:
- Roads
- Water
- WUI
- FY16 Rxburns
- FY17 Rxburns
- FY18 Rxburns
- Wilderness
- FS Land
- Private

0   2.75   5.5
Miles
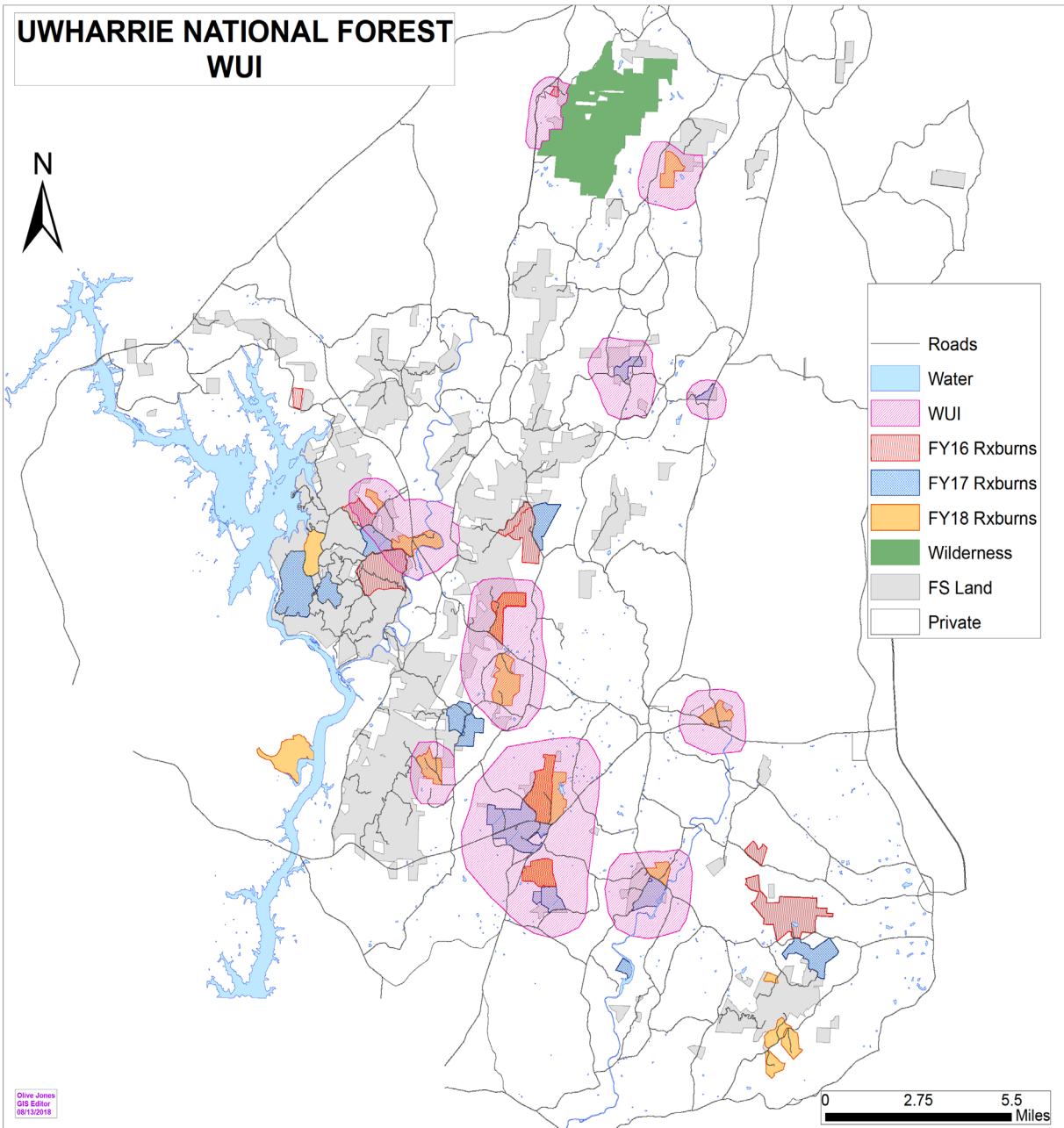
Figure 7B Croatan: Locations of Prescribed Fires and the Wildland Urban Interface

CROATAN NATIONAL FOREST
THREE YEAR BURN ROTATION

N

Trent River
Brice Creek
Neuse River
Catfish Lake
Long Lake
Great Lake
Little Lake
Ellis Lake
White Oak River
Bogue Sound
Atlantic Oce

Roads
Water
Three Year Burn Rotation
2016
2017
2018
DOD Land
Wilderness
FS Land
Private

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GIS Editor
08/08/2018

1:85,500
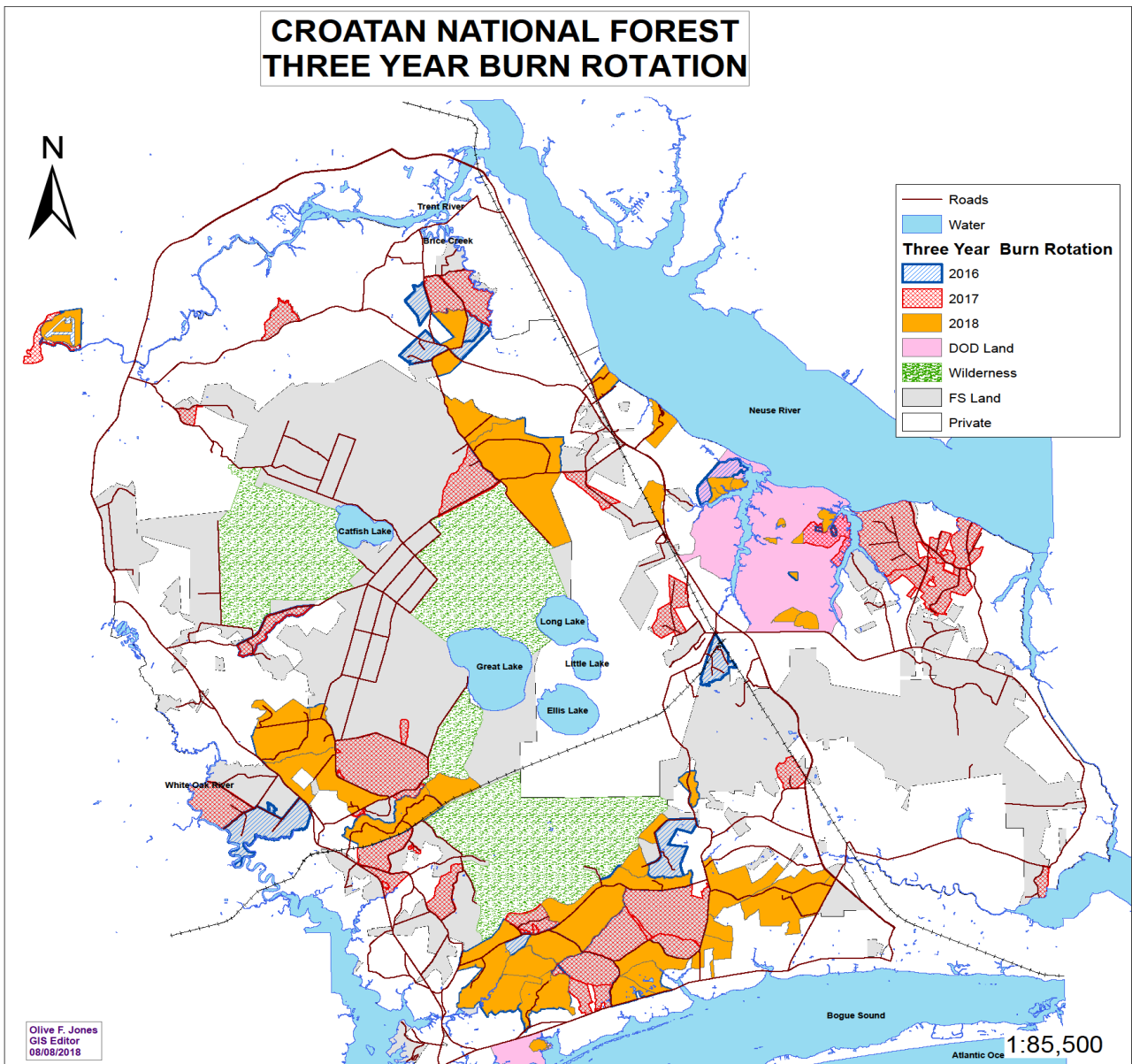
Discussion and Findings:

Uwharrie NF

- *An action plan to protect heritage assets has been initiated during this monitoring cycle. More than 8 significant heritage assets were protected successfully by decreasing disturbances from off highway vehicle use. Several structures on the Thornburg farm were stabilized. While some sites continue to degrade, an overall reduction the maintenance backlog is occurring, which meets the intention of the plan and objective (Cultural-1)*

Cultural Resources: A total of twenty-five sites were monitored on the Uwharrie National Forest between October 1, 2015 and September 30, 2017. Fifteen sites were stable. Nine sites experienced disturbance through recreational use (OHV trail, horseback riding and gold panning). The remaining site is National Register Eligible Buck Mountain Fire Tower in need of a structural assessment.

The Uwharrie National Forest has implemented a management plan for protecting cultural resource sites along the Off Highway Vehicle (OHV) trail system. This plan includes the use of barricades placed along the trail in order to deter users from driving over and/or disperse camping on known significant cultural resources. Eight of the twenty-five sites monitored in FY16 & FY17 were located within the barricade protection areas. All of the sites monitored showed a significant decrease in large vehicle traffic and dispersed camping within the site boundaries. Four of the sites showed increased user created trails. The trails were created by horseback riders and/or smaller vehicles such as four wheelers and motorcycles which are able to get through barricade gaps. Natural erosion is still occurring on all sites monitored, particularly within the trail prism and site boundary intersection.

A Forest Service partnership with Central Michigan University known as "Alternative Break" has continued the preservation of the National Register Listed Thornburg Farm. Three National Register contributing structures were stabilized and interpreted in FY16 and FY17. University students travel to the site during winter break and work with master carpenters to restore historic structures.

Gold panning continues to disturb cultural resources located within adjacent river/stream terraces. Of particular concern is stream bank excavation and rock movement within water courses. Monitoring of one site noted gold panning participants moving larger rocks/boulders in order to divert the water into undisturbed banks.

- *Efficient outcomes are achieved through increases of prescribed fire (Uwharrie), because longleaf ecosystems are being restored within the Wildland Urban Interface, thus provided human community wildfire protection while restoring longleaf ecosystems. The acreage of prescribed fire is consistently achieved with levels set in the plan objectives (Objective Fire-1).*

Prescribed Fire: The district is currently burning right at the target amounts described in the forest plan and able to accomplish those acres consistently. Fortunately; the areas that have the highest concentration of WUI areas are also the same areas that contain longleaf pine. So,

multiple important objectives are achieved on the same piece of ground with one single treatment. The longleaf areas are burned more frequently and those communities that are adjacent or nearby receive protective treatments more often because of the longleaf presence.

Croatan NF

- *Cultural and historic special interest areas were found to be stable during this monitoring cycle.   Of 26 sites monitoring, 20 are stable, while some sites are experiencing some degradation from camping activities and others may be due to rising sea levels.*

Cultural Resources: A total of twenty-six sites were monitored on the Croatan National Forest between October 1, 2015 and September 30, 2017. Twenty sites were stable. Two sites experienced disturbance through recreational use (camping). Three sites have increased shore erosion by Brice's Creek and Neuse River. It was also noted in areas with shore erosion the current understory was dying and developing into a wetter environment. This could be related to a rising water table. The remaining site is a National Register Eligible Newport-Simmons Fire Tower in need of a structural assessment.

The Croatan cultural and historic Special Interest Areas are mostly stable.

The National Register Eligible prehistoric site within the Holland Point SIA and unevaluated sites within the Brice Creek SIA continue to erode due to their close proximity to the White Oak River/Brice Creek and rising water tables.

The Island Creek SIA has experienced an increase in user created trails which have impacted known historic and prehistoric sites.

The large historic cemetery in the White Oak River SIA has been researched and stabilized. The African-American ancestors of the displaced Long Point community along with the non-profit Croatan Coalition group have partnered with the Forest Service to research, protect, maintain and preserve the cemetery and postbellum agricultural complex. Metal detecting continues to disturb known sites within the White Oak SIA.

The Camp Patterson SIA was disturbed by DOT road construction activity. National Register Eligible CCC Camp Patterson mitigation measures were conducted by Forest Service and DOT archeologists. Preservation and protection activities were carried out on existing historic CCC camp foundations. Interpretive signage and trail are being formulated/designed as part of the mitigation.

- *The amount of prescribed fire has increased significantly over this monitoring cycle, up to levels desired in the forest plan. The amount and quality of prescribed fire has improved the quality of longleaf restoration on the national forest. Wildfire protection has been greatly enhanced through the development and implementation of Community Wildfire Protection Plans, as every community fire department within the planning area has a protection plan.*

Prescribed Fire: The amount and locations of prescribed fires are helping to develop the desired conditions described in the plan. Averaging more than 20,000 acres per year on a 3-year burning cycle contributes to restoring longleaf pine (Table 7E). Community Wildfire Protection Plans are developed and implemented for every community fire department within Croatan National Forest plan area. (Table 7G).

- *Both the Croatan and Uwharrie National Forests management has been responsive to the needs of local communities; such as projects for the provision of water and electrical power, quarterly meetings with communities, and agreements for wildfire protection.*

Local Communities: Question 27 of the Croatan Monitoring Program is focused on tracking local community involvement and attachment to the land through collaborated action plans. A partial list of collaborators and the purpose for collaboration is shown in Table 7H. Equally important is the level of collaborative effort needed to develop and implement Community Wildfire Protection Plans, as shown in Table 7G. The list of projects from the PALs database (Table 7K) shows that more than half the decisions made on the Croatan National Forest help to serve the needs of local communities, such as the provision of water and electrical power. On the Uwharrie NF, the project mix (Table 7J) shows that not only provision of water, telephone and electrical services are facilitated through permits, but also, many projects for enhancing recreation facilities and trails that respond to local community requests made during the Uwharrie forest planning process.

Adaptive Management Recommendations for Category 7

Recommendations for Forest Plan: none

Recommendations for Monitoring Program: none

Recommendations for Monitoring Activities or Management Activities: none

Category 8. The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 USC 1604(g)(3)(C).

The purpose of this category is monitor soil productivity in order to meet legal requirements of the National Forest Management Act. Tables 8A and 8B outline the monitoring questions and the applicable plan components for this category.

Table 8A. Monitoring Questions, Indicators, and Report Timing by National Forest for Category 8.

National Forest	Monitoring Question	Indicator	Report Timing
Uwharrie	Q26. Are there significant changes in soil productivity?	Percent detrimental soil disturbance at selected sites	2-year; Report timing: Year 2018
Croatan	Q27. Are there any impairments to soil productivity? And if so, what are the restoration strategies	Best Management practices monitoring	2-year; Report timing: Year 2018

Table 8B. Plan Components for Category 8 by National Forest

National Forest	Plan Components
Uwharrie (DC: SWF-10)	(Plan, p. 13) SWF-10: Soil productivity is sustained through nitrogen and carbon fixation, mineral release from parent material, decaying organic matter, and translocation of nutrients. Erosion and compaction are infrequent occurrences.
Uwharrie (Guideline SWF-2)	(Plan, p. 35)SWF Guideline 2: Major soil disturbances that expose the soil surface or substantially alter soil properties such as temporary roads, skid trails, landings, and rutting should not occupy more than 15 percent of forest vegetation management treatment areas except for watershed improvements, restoration of species, or to correct soil and water problems.
Croatan	Major soil disturbances that expose the soil surface or substantially alter soil properties such as temporary roads, skid trails, landings, and rutting should not occupy more than 15 percent of forest vegetation management treatment areas except for watershed improvements, restoration of species, or to correct soil and water problems.

New Science or New Information

- Croatan: Watershed Condition Framework (since the 2002 plan was approved)

Data

- Annual Compliance Surveys using Forest Soil Disturbance Protocols (Page-Dumroese; 2009)
  Data from Compliance Checks of Timber Sale operations for the Uwharrie and Croatan NFs

Table 8C. NFsNC 2010-2016 Uwharrie N.F. Soil Quality Monitoring Results with Detrimental Soil Disturbance.

Survey Year	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
2010	Wood Duck	1	Pre	113	5.6	0	5.6
		2	Pre	44	1.5	0	1.5
		3	Pre	29	1.3	0	1.3
		4	Pre	25	1.3	0	1.3
		5	Pre	46	0.8	0	0.8
2011	Wood Duck	1	Post	113	6.5	0	6.5
		2	Post	44	2.5	0	2.5
		3	Post	29	3.3	0	3.3
		4	Post	25	3.0	3.3	6.2
		5	Post	46	2.1	0	2.1
2010	Old Ridge	1	Pre	31	0	0	0
		2	Pre	24	0	0	0
		3	Pre	38	0	0	0

Survey Year	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
2011	Old Ridge	1	Post	31	2.2	1.4	3.5
		2	Post	24	2.5	2.6	5.0
		3	Post	38	1.0	3.3	2.6
2010	*Stinger*	*1*	*Pre*	*61*	*1.7*	*0*	*1.7*
		2	*Pre*	*53*	*1.3*	*0*	*1.3*
2011	Stinger	2	Post	53	10.1	0	10.1
2012	Stinger	3	Post	15	3.0	0	3.0
		4	Post	59	3.6	0	3.6
		5	Post	8	5.0	0	5.0
		6	Post	15	4.3	0	4.3
2013	Buckhorn	1	Post	105	1.1	0	1.1
		2	Post	80	0.9	2.9	3.8
		3	Post	42	0.6	0	0.6
		4	Post	28	0	0	0
		5	Post	38	1.4	0	1.4
2015	Hornet	1	Post	13	1.6	0	1.6
		2	Post	8	3.4	3.0	7.1
		3	Post	24	0.9	7.0	7.5
		4	Post	31	1.0	0	1.0
		5	Post	10	2.8	0	2.8
		6	Post	21	2.2	0	2.2

Survey Year	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
2016	Hornet	7	Post	19	4.0	0	4.0
		10	Post	33	1.7	0	1.7
	Northwest	1	Post	48	9.2	0	9.2
		2	Post	6	5.2	3.3	8.5
		3	Post	20	3.4	3.0	6.4
		4	Post	17	2.4	0	2.4
		5	Post	17	0	3.5	3.5
	Reeves Spring	2	Post	8	1.8	0	1.8
		3	Post	18	3.2	3.3	6.5
		4	Post	37	1.6	3.2	4.8

Table 8D. NFsNC 2012-2016 Croatan N.F. Soil Quality Monitoring Results with Detrimental Soil Disturbance.

Survey Year	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
2012	Downy	1	Post	21	0	7.5	7.5
	Nine-foot	3	Post	32	1.1	3.1	4.3
		5	Post	34	0.4	5.8	6.2
	North Little Road	1	Post	55	0.3	1.0	1.4

Survey Year	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
		2	Post	99	0.2	4.3	4.6
2013	Flicker	7	Post	32	0	4.5	4.5
	Nine-foot	1	Post	17	5.4	3.5	8.9
	Sapsucker	3	Post	32	0.9	0	0.9
		5	Post	89	1.2	0	1.2
2015	Cotton Mouth	9	Post	37	0.5	13.0	13.5
		10	Post	37	0.5	13.0	13.5
2016	Hairy	2	Post	32	2.0	0	2.0
	Millis	1	Post	24	5.2	0	5.2
		2	Post	18	6.3	0	6.3

Discussion and Findings

- *While all timber sale units have some degree of increased detrimental soil disturbance, none of the surveyed units exceeded the significant level; thus maintaining appropriate land productivity*

Uwharrie: A summary of the SQM data is presented in Table 8C. All timber sale units surveyed post-harvest were ground-based harvested and had some degree of detrimental soil disturbance, however all disturbance was below the significant level (15% as specified in the standard). Several units, surveyed pre-harvest in 2010, were resurveyed the year following logging. Although an increase in disturbed area occurred from pre-harvest, the units surveyed maintained appropriate land productivity.

Croatan: A summary of the SQM data is presented in Table 8D. All timber sale units surveyed post-harvest were ground-based harvested and had some degree of detrimental soil disturbance, however all disturbance was below the impairment level. It is worth noting that soil disturbance is generally higher within the unit (e.g. off landings and skid roads) than on other Forest units. This is likely a result of harvesting techniques used on the coast not implemented to this extent elsewhere, such as chopping vegetation throughout the unit for site preparation to restore longleaf pine. Also, soil conditions can be very moist to wet when harvested, resulting in notable soil disturbance off designated skid roads.

Adaptive Management Recommendations for Category 8

Recommendations for Forest Plan: none

Recommendations for Monitoring Program: none

Recommendations for Monitoring or Management Activities:

- *Croatan: Conduct an assessment of soil moisture for timber sale units prior to logging activities.*

Croatan: There generally are not notable impairments occurring on the forest when applying the 15 percent guideline, and Forest standards are comprehensive. These standards might be difficult to implement across a unit that has varying soil moisture content. Recommend that Forest personnel do a unit-wide assessment of soil moisture prior to logging to inform the loggers of areas of concern that will need to be avoided by ground disturbing equipment.

Section 2: Broad Scale Monitoring

This section reports the results of the Southern Region Broad-Scale Monitoring strategy, specific to North Carolina. The questions addressed using broad scale monitoring are cited in Category 6, Climate Change, and Category 7, Social and Economic contributions. The monitoring questions are the same for both national forests, except one additional question on the Croatan NF about sea level rise.

Category 6: Broad Scale: Measureable changes on the plan area related to climate change and other stressors that may be affecting the plan area.

This category includes the monitoring questions relating to broad scale changes in the environment.

NOTE: The report timings for the questions in this category are determined by the Southern Regional Office, Atlanta, Ga.

Table 2-1. Monitoring Questions for Category 6.

Monitoring Questions
How has climate variability changed and how is it projected to change across the region? (Uwharrie Q18; Croatan Q15)
How is climate variability and change influencing the ecological, social, and economic conditions and contributions provided by the plan areas in the region? (Uwharrie Q19;Croatan Q16)
What effects do national forests in the region have on a changing climate? (Uwharrie Q20; Croatan Q17)
Are land cover changes occurring due to sea level rise, especially lands adjacent to tidal streams? (Croatan Q18)

Climate Variability and Projected Changes:

This climate summary is from the Southern Region Broad-Scale Monitoring strategy and is based on climate models originally developed for the United Nations Intergovernmental Panel on Climate Change, downscaled by Pierce et al.[2] and available from the USDA Southeast Climate Hub's Climate by Forest tool which is an adaptation of the National Oceanic and Atmospheric

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[2] Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology, volume 15, page 2558-2585. http://loca.ucsd.edu/~pierce/IEPR_Clim_proj_using_LOCA_and_VIC_2016-06-13b.pdf

Administration's Climate Explorer.[3] The Climate by Forest tool produces graphs and tables showing historic and future projected conditions for two possible greenhouse gas emissions scenarios. [4]

About the data—the climate data considered in this report are based on both historical observations and future projections:

> *Historic climate*— for all observed data, the gray bars are plotted with respect to the 1961-1990 mean.[5] The black line shows gridded historical observations.

> *Future climate:* The modeled future climate projections are Localize Constructed Analogs ([LOCA)](#) downscaled from the Coupled Model Intercomparison Project Phase 5 (CMIP5) model realizations. This includes the hindcast (historical) and the projected (future) climate for the RCP4.5 (low) and RCP8.5 (high) emission scenarios. Each year, the range is defined by the highest and lowest model values for that year across all 32 models and the central line represents the weighted mean across all models.[6,7]

How the results are produced—the results summarized in this section represent an analysis area defined by a bounding box surrounding the Lower Terraces ecological subsection (LT – 232Ia[8]). Data are retrieved dynamically from a NOAA-funded site at Cornell University (DeGaetano et al.[9]).

Best Available Science—these results represent the best available scientific information for evaluating climate, but limitations must be understood to make meaningful interpretations:

> *Accuracy and precision*— One may assess model performance by comparing model reconstructions of the historical period with historical observations. For this evaluation, the envelope of model realizations used to reconstruct historical conditions aligned very well with the gridded historical observations themselves (Figure 1 and 2). The same models that produced accurate historical reconstructions were used to develop climate projections based on specific emissions pathways. By using results from multiple models (i.e., model agreement/uncertainty), this analysis incorporates a diversity of scientific approaches to modeling the climate system. This analysis is agnostic about how best to represent the physics of the coupled ocean and atmosphere, its sensitivity to greenhouse gases, and resultant climate changes that emerge at a regional level or at the scale of

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[3] U.S. Federal Government. 2018. U.S. Climate Resilience Toolkit Climate Explorer. [Online] https://climate-explorer2.nemac.org Accessed August 8, 2018.

[4] U.S. Forest Service. 2018. U.S. Climate By Forest (adaptation of Climate Resilience Toolkit Climate Explorer). [Online] http://climate-by-forest.nemac.org Accessed August 8, 2018.

[5] https://www.esrl.noaa.gov/psd/data/gridded/data.livneh.metvars.html

[6] Taylor K. E., Stouffer R. J., Meehl G. A. (2012): An overview of CMIP5 and the experiment design. Bulletin of the American Meteorological Society, 93, 485-498, doi:10.1175/bams-d-11-00094.1.

[7] Sanderson,B.M. and M.F.Wehner (2017):Weighting strategy for the Fourth National Climate Assessment.In: Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Change Research Program [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 644-653.

[8] Keys, J.E.; Cleland, D.T.; McNab, W.H. 2007. Delineation, peer review, and refinement of subregions of the conterminous United States. Gen. Tech. Report WO-76A. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p.

[9] DeGaetano, A.T., W. Noon, and K.L. Eggleston (2014): Efficient Access to Climate Products in Support of Climate Services using the Applied Climate Information System (ACIS) Web Services, Bulletin of the American Meteorological Society, 96, 173–180

analysis used here. The methods used here are not concerned with examining precise conditions in a specific year in the future. Instead, we analyze a weighted average of model results to provide general guidance about trends and trajectories that are well-supported by modeling studies.

The accuracy of model results relates most closely to future emissions, which themselves will be determined by future human decisions. Human decisions about greenhouse gas emissions cannot be accurately modeled, so the Climate by Forest tools adopts two emissions pathways that are frequently used in climate science.

Each interpretation section in this report addresses these characteristics of accuracy and precision. There are other limitations of these data that are inherent to the systems, models, and assumptions used to develop them that are not readily assessed, but should be considered contextually as these are considered alongside other sources of information, including findings from peer-reviewed literature and local expertise.

Reliability—the results presented in this report are based on peer-reviewed science being widely applied within the National Climate Assessment. [10]

Relevance—Relevance is assessable through geographic and attribute-level considerations. The Climate by Forest tool summarizes results at the ecological subsection scale, which is not perfectly coincident with the boundaries of our area of interest (i.e., Croatan and Uwharrie National Forests), but given the coarseness of the climate data and other sources of uncertainty, the selected subsection (LT – 232Ia) provides a representative sample that can be reasonably applied to the area of interest as a whole and represents areas that, at least historically, have similar climates. While there are additional climate variables that are relevant to the mission and operations of the Croatan and Uwharrie National Forests, the selected attributes cover the major physical variables of temperature and precipitation and give sufficient insight into potential influences on resources and management activities.

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[10] https://science2017.globalchange.gov/downloads/

Figure 2-1—Charlotte Belt ecological subsection (Keys et al. 2007)
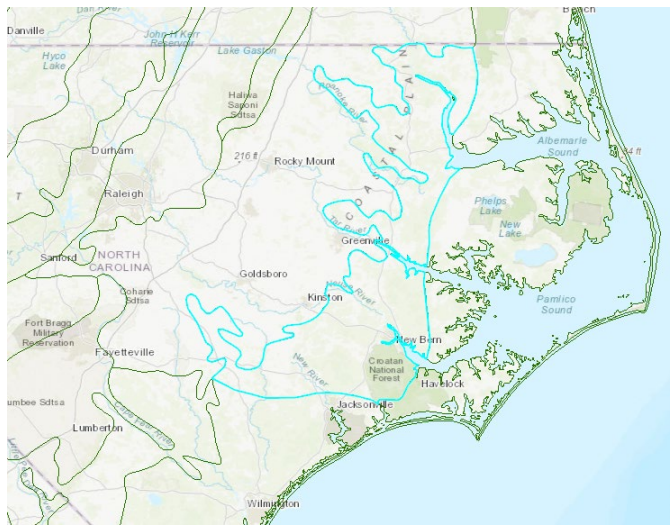
Temperature

Both greenhouse gas concentration pathways (i.e., RCP4.5 and RCP8.5) indicate that by mid-century (2036-2065 compared with 1961-1990 baseline) LT – 232Ia would see statistically significant increases in the average daily maximum and minimum temperatures, increases in the average number of days per year above 95F, and a decrease in the average number of days with lows below freezing (32F) per year across all levels of model uncertainty (Table 2-2; Figure 2-2):

- Change in average daily maximum temperature and average daily minimum temperature are similar and show a mean increase of 4.0F to 4.8F across RCP4.5 to RCP8.5, respectively. Average daily maximum temperature shows nearly identical increases relative to average daily minimum temperature.
- The number of days per year with maximum temperature above 95F show a mean increase of about 24 to 33 days across RCP4.5 to RCP8.5, respectively. The number of days per year with minimum temperature below 32F show a mean decrease of about 21 to 25 days for RCP4.5 and RCP8.5, respectively.

Table 2-2— Projected range of change in temperature and precipitation variables by the period 2036-2065, using RCP4.5 and RCP8.5 over the 1961-1990 baseline period.

Variable		Model Uncertainty		
		Minimum	Mean	Maximum
Average Daily Maximum Temperature (F)	RCP4.5 Change	2.9	4.0	4.9
	95% Confidence Interval	0.3	0.2	0.4
	Statistical Significance	S	S	S
	RCP8.5 Change	3.7	4.8	5.7
	95% Confidence Interval	0.4	0.3	0.5
	Statistical Significance	S	S	S
Average Daily Minimum Temperature (F)	RCP4.5 Change	3.1	3.9	4.5
	95% Confidence Interval	0.3	0.2	0.4
	Statistical Significance	S	S	S
	RCP8.5 Change	4.2	4.8	5.0
	95% Confidence Interval	0.4	0.3	0.5
	Statistical Significance	S	S	S

Variable		Minimum	Mean	Maximum
Days per Year Maximum Temperature above 95F (days)	RCP4.5 Change	4.6	24.3	44.2
	95% Confidence Interval	0.8	1.5	4.6
	Statistical Significance	S	S	S
	RCP8.5 Change	10.2	33.4	55.5
	95% Confidence Interval	2.0	3.2	4.8
	Statistical Significance	S	S	S
Days per Year Minimum Temperature below 32F (days)	RCP4.5 Change	-19.0	-21.0	-18.0
	95% Confidence Interval	2.3	1.3	2.8
	Statistical Significance	S	S	S
	RCP8.5 Change	-21.2	-25.0	-23.5
	95% Confidence Interval	2.4	1.8	3.0
	Statistical Significance	S	S	S

S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval is plus or minus (+/-).

Figure 2-2— Projected temperature variables for the Southern LT – 232Ia under RCP 4.5 and RCP 8.5 for (A) average daily maximum temperature, (B) average daily minimum temperature, (C) days per year with maximum temperature above 90 degrees F, and (D) days per year with minimum temperature blow 32 degrees F.
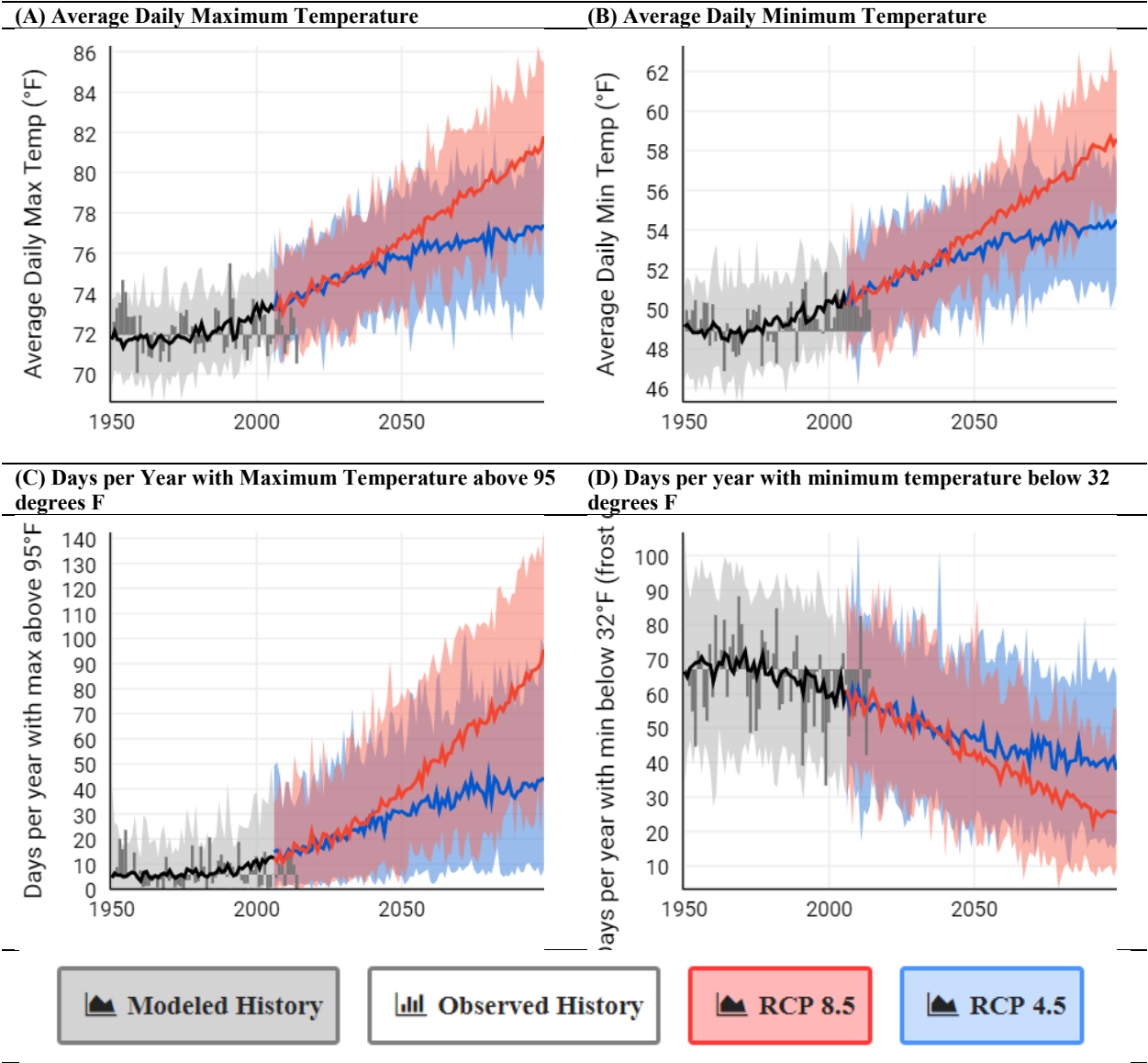
Precipitation

Changes in total precipitation and number of dry days per year for the LT – 232Ia are less clear than temperature, but the results do show a statistically significant increase for both RCPs, but not for all levels of model uncertainty (table 2-3; figure 2-3):

- Change in total precipitation are similar across greenhouse gas concentration pathways and show a mean increase of 2.9 and 3.0 inches for RCP4.5 and RCP8.5, respectively.
- The number of dry days per year show a mean increase of about 2 to 4 days across RCP4.5 to RCP8.5, respectively.

Table 2-3—Projected range of change in precipitation variables by the period 2036-2065, using RCP 4.5 and RCP 8.5 over the 1961-1990 baseline period.

		Model Uncertainty		
Variable		**Minimum**	**Mean**	**Maximum**
Total Precipitation (inches)	RCP 4.5 Change	0.1	2.9	6.8
	95% Confidence Interval	1.0	0.8	2.0
	Statistical Significance	NS	S	S
	RCP 8.5 Change	0.8	3.0	5.9
	95% Confidence Interval	1.0	0.6	1.6
	Statistical Significance	NS	S	S
Dry Days per Year	RCP 4.5 Change	-2.0	1.8	7.5
	95% Confidence Interval	3.3	1.5	2.6
	Statistical Significance	NS	S	S
	RCP 8.5 Change	-1.4	3.8	11.4

	95% Confidence Interval	2.6	1.1	2.7
	Statistical Significance	NS	S	S

S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval value is plus or minus (+/-).

Figure 2-3— Projected precipitation variables for the LT – 232Ia under RCP 4.5 and RCP 8.5 for (A) average total precipitation and (B) average dry days.
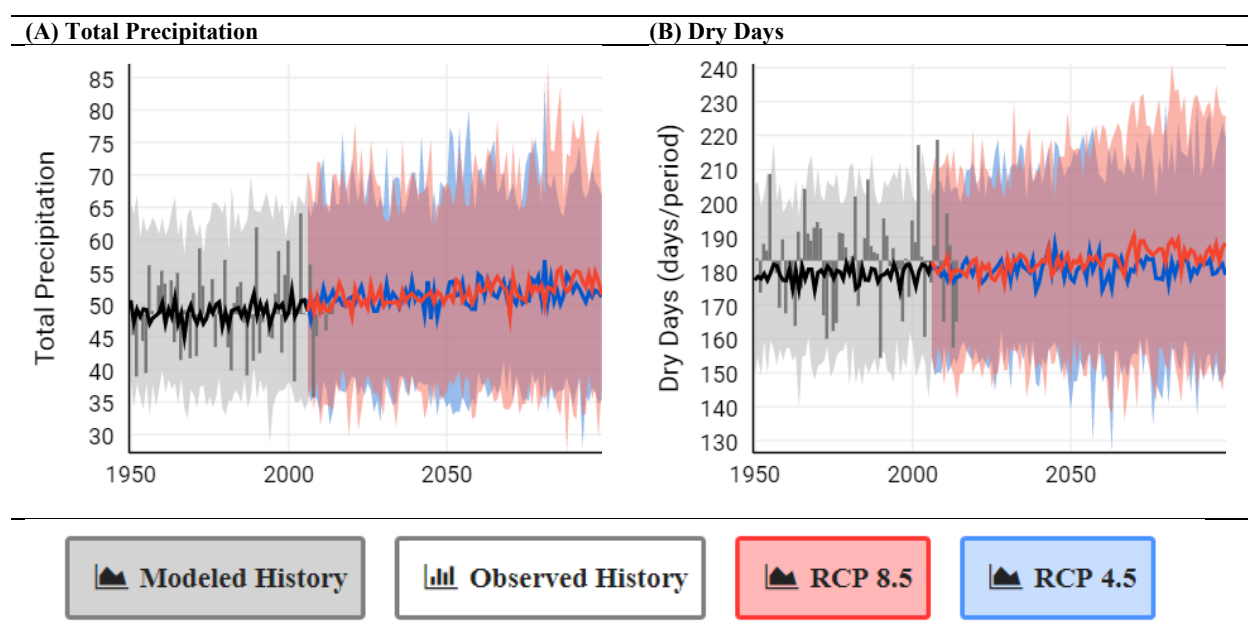
Discussion and Findings

- *Temperature— Projections suggest that future warming is expected, resulting in 10-56 more days above 95F and 21-24fewer freezing days per year.*
- *Precipitation—Precipitation was historically variable and will likely continue to be variable from one year to the next. There does appear to be a trend toward a modest increase in total precipitation, with a small change in the number of dry days per year.*

Adaptive Management Considerations

Forestlands across the region are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and

changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes could be negative, natural resource management can help mitigate these impacts. Responses informed by the best current science enable natural resource professionals within the Forest Service to better protect the land and resources and conserve the region's forestlands into the future. Table 2-4 provides a summary of climate related findings and potential responses. This table was developed using the USDA Forest Service's TACCIMO tool fact sheets for the Croatan and Uwharrie NFs.

Table 2-4. Summary of findings and adaptive management considerations.

	Findings	Adaptive Management Considerations
Forest Health (Duerr & Mistretta, 2013; Gan, 2004; Funk et al., 2008; Greenberg et al., 2013; Jianbang, 2004; Miller et al., 2013; Sasek & Strain, 1990)	Higher temperatures will allow many invasive and aggressive plant and insect species to outcompete or negatively affect native species. Plants such as kudzu Japanese honeysuckle are expected to move rapidly into new areas.	Manage tree densities to reduce vulnerability of forest stands. Continually monitor for the movement of invasive species, especially following a severe event.
Plant Communities (Bernazzani et al., 2012; Buehl et al., 2012; Hansen et al., 2001; Hellmann et al., 2008; McNulty, 2002)	Heat stress may limit the growth of some species. Widespread dieback may result from increased stresses from drought and pest outbreaks. Intensified weather events are expected to lead to changes in plant community composition.	Increase a range of ages and species to provide for ecological integrity and thus reduce susceptibility of stands. Focus restoration efforts in disturbance prone forests.
Animal Communities (Ayres & Lobardero, 2000; Blaustein et al., 2010; Corn, 2005; Currie, 2001; Joyce et al., 2008; Lawler & Olden, 2011; Matthews et al., 2004; Shoo et al., 2011; Torti & Dunn; 2005)	Amphibians may be most at risk due to changes in water temperature and dependencies on moisture. Some avian populations may decrease as a result of food source and habitat loss. Some mammal populations may increase due to higher winter survival rates.	Provide materials that will improve/supplement habitat conditions for amphibians. Create habitat corridors, assist in species movement, and identify high-value conservation lands adjacent to National Forests.
Extreme Weather	The potential for severe storms is expected to	Use prescribed burning as a management option for

	Findings	Adaptive Management Considerations
(Bernazzani et al., 2012; Buehl et al., 2012; Hansen et al., 2001; Hellmann et al., 2008; McNulty, 2002)	increase. More intense hurricanes are expected to make landfall. Extended periods of higher temperatures and drought may contribute to larger and more frequent wildfires.	reducing the impacts of future increases in wildfires. Identify areas that provide valuable ecosystem services and are also vulnerable to extreme weather, then plan conservation strategies accordingly.
Plant Communities (Carpenter et al., 1992; Erwin, 2009; Karl et al., 2009; McDonnell et al., 2015; Rieman et al., 2010; Seager et al., 2009; Stoh et al., 2008; Wisser et al., 2013)	Shifts in rainfall patterns will lead to periods of flooding and drought. Heavy downpours and intense storms can increase sedimentation in waterways, leading to poor water quality.	Focus attention on and near smaller, isolated water systems that are more vulnerable to large floods or debris flow. Restore and reinforce vegetation in headwater and marsh areas to help alleviate runoff of sediment.
Recreation (Bernazzani et al., 2012; Buehl et al., 2012; Hansen et al., 2001; Hellmann et al., 2008; McNulty, 2002)	More hot days could increase the number of mosquito and ticks and, potentially, lead to an increase in vector-borne illness. Recreation areas could see a decrease in summer-time visitors as a result of more days of extreme heat.	Communicate early warnings for those populations that are more vulnerable to heat illnesses and monitor early outbreaks of disease.

Carbon Stocks

The monitoring elements are carbon stocks, carbon stock change, and the influence of disturbance and non-disturbance factors on carbon storage.

Carbon uptake and storage are some of the many ecosystem services provided by forests and grasslands. Through the process of photosynthesis, growing plants remove carbon dioxide (CO_2) from the atmosphere and store it in forest biomass (plant stems, branches, foliage, and roots) and much of this organic material is eventually stored in forest soils. This uptake and storage of carbon from the atmosphere helps modulate greenhouse gas (GHG) concentrations in the atmosphere. Estimates of net annual storage of carbon indicate that forests in the United States (U.S.) constitute an important carbon sink, removing more carbon from the atmosphere than they are emitting (Pan et al. 2011). Forests in the U.S. remove the equivalent of about 12-19 percent

of annual U.S. fossil fuel emissions or about 206 teragrams of carbon after accounting for natural emissions, such as wildfire and decomposition (US EPA 2015, Janowiak et al. 2017).

Forests are dynamic systems that naturally undergo fluctuations in carbon storage and emissions as forests establish and grow, die with age or disturbances, and re-establish and regrow. Forests release CO_2 into the atmosphere when trees and other vegetation die, either through natural aging and competition processes or disturbance events (e.g., combustion from fires). This process transfers carbon from living carbon pools to dead pools, which also release carbon dioxide through decomposition or combustion (fires). Management activities include timber harvests, thinning, and fuel reduction treatments that remove carbon from the forest and transfer a portion to wood products. Carbon can then be stored in commodities (e.g., paper, lumber) for a variable duration ranging from days to years, or, in the case of some structural timber, from many decades to centuries. In the absence of commercial thinnings, harvests, and fuel reduction treatments, forests will thin naturally from mortality-inducing disturbances or aging, resulting in dead trees decaying and emitting carbon to the atmosphere.

Following natural disturbances or harvests, forests re-establish and regrow, resulting in the uptake and storage of carbon from the atmosphere. Over the long term, through one or more cycles of disturbance and regrowth (if the forest regenerates after the disturbance), net carbon flux (the balance from accumulation and loss) is often zero (McKinley et al. 2011). Although disturbances, forest aging, and management are often the primary drivers of forest carbon dynamics in some ecosystems, environmental factors such as atmospheric CO_2 concentrations, climatic variability, and the availability of limiting forest nutrients, such as nitrogen, can also influence forest growth and carbon dynamics (Casperson et al. 2000; Pan et al. 2009).

In this section, we provide an assessment of the amount of carbon stored on the Uwharrie and Croatan National Forests (baseline carbon stocks) and how disturbances, management, and environmental factors have influenced carbon storage overtime. This assessment primarily used two recent U.S. Forest Service reports: the Baseline Report (USDA Forest Service 2015) and Disturbance Report (USDA Forest Service, in review). Both reports relied on Forest Inventory and Analysis (FIA) and several validated, data-driven modeling tools to provide nationally consistent evaluations of forest carbon trends across the National Forest System. The Baseline Report applies the Carbon Calculation Tool (CCT) (Smith et al. 2010), which summarizes available FIA data across multiple survey years to estimate forest carbon stocks and changes in stocks at the scale of the national forest from 1990 to 2013. The Baseline Report also provides information on carbon storage in harvested wood products (HWP) for each Forest Service region.

The Disturbance Report provides a national forest-scale evaluation of the influences of disturbances and management activities, using the Forest Carbon Management Framework (ForCaMF) (Healey et al. 2014, 2016; Raymond et al. 2015). This report also contains estimates of the long-term relative effects of disturbance and non-disturbance factors on carbon stock change and accumulation, using the Integrated Terrestrial Ecosystem Carbon (InTEC) model (Chen et al. 2000; Zhang et al. 2012). The key findings from these reports are summarized here. Collectively, these reports incorporate advances in data and analytical methods, representing the best available science to provide comprehensive assessments of National Forest System carbon trends.

In 1954, the Uwharrie and Croatan National Forests (NFs) were administratively combined with the Nantahala-Pisgah National Forest (N-PNF) to form the administrative unit of the National Forests in North Carolina (NFs in NC). According to recent estimates from the latest FIA inventory, the Uwharrie and Croatan NFs accounts for about 20 percent of the forested area in the NFs in NC. The model results presented here, including the baseline carbon stocks and impacts of disturbances and other factors, are available only for combined NFs in NC. However, the following assessment uses information on the forested area, forest types, and disturbances of the Uwharrie and Croatan NFs relative to the entire NFs in NC to provide a reasonable interpretation of how these model results may apply more specifically to the Uwharrie and Croatan NFs.

Are changes needed to forest plan direction, management activities, or the monitoring program based on monitoring results? Carbon stocks in the Uwharrie and Croatan NFs appear to be increasing. The effects of the main forest carbon influences including timber harvesting, fires, and aging are small relative to the total amount of carbon stored on the forests. There is no need to for change in plan direction of management activities in response to the findings presented below.

Carbon Stocks and Influences

According to results of the Baseline Report, carbon stocks in the NFs in NC increased from 79.1±7.1 teragrams of carbon (Tg C) in 1990 to 91.1±11.3 Tg C in 2013, a 15 percent increase in carbon stocks over this period (Fig. 2-4).[11] The Uwharrie and Croatan NFs together contains about 18 Tg of carbon, which is about 20 percent of the total
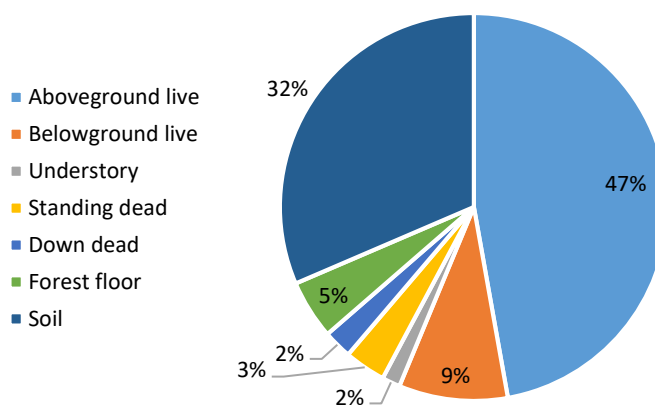
Figure 2-5. *Percentage of carbon stocks in each of the forest carbon pools for the National Forests in North Carolina in 2013.*

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[11]This report uses carbon mass, not CO_2 mass, because carbon is a standard unit and can easily be converted to any other unit. To convert carbon mass to CO_2 mass, multiply by 3.67 to account for the mass of the O_2.
1000 teragrams (Tg) =1 petagram (Pg)
1000 teragrams = 1 billion metric tonnes
1000 teragrams = 1 gigatonne
1 teragram = 1 million metric tonnes
1 teragram = 1 megatonne
1 megagram (Mg) = 1 metric tonne

carbon stocks in 2013.[12] Despite some uncertainty in annual carbon stock estimates, reflected by the 95 percent confidence intervals, there is a high degree of certainty that carbon stocks on the NFs in NC have been stable or increased from 1990 to 2013 (Fig. 1). Most forest carbon stocks in the NFs in NC, about 47 percent, are stored in the aboveground portion of live trees (Fig. 2-5). The second largest carbon pool is soil carbon, storing another 32 percent.
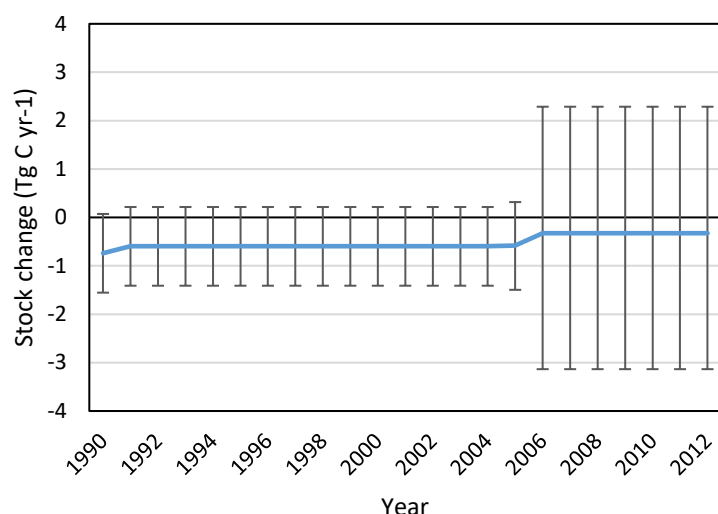

Figure 2-6. *Carbon stock change from 1990-2012 for National Forests in North Carolina bounded by 95 percent confidence intervals (error bars). A positive value indicates a carbon source and a negative value indicates a carbon sink.*

The annual carbon stock change can be used to evaluate whether a forest is a carbon sink or source in a given year. Carbon stock change is typically reported from the perspective of the atmosphere. A negative value indicates a carbon sink: the forest is absorbing more carbon from the atmosphere (through growth) than it emits (via decomposition, removal, and combustion). A positive value indicates a source: the forest is emitting more carbon than it takes up. Annual carbon stock changes in the NFs in NC ranged from -0.74 ± 0.81 Tg C per year (gain) to -0.33 ± 2.7 Tg C per year (gain) (Fig. 2-6). The uncertainty between annual estimates can make it difficult to determine whether the forest is a sink or a source in a specific year (i.e., uncertainty bounds overlap zero) (Fig. 2-6). However, the trend of increasing carbon stocks from 1990 to 2013 (Fig. 2-4) over the 23-year period strongly suggests that the NFs in NC are a modest carbon sink.

1 metric tonne = 0.98 U.S. long ton

1 metric tonne per hectare = 0.4 U.S. long tons per acre

carbon (C) mass * 3.67 = carbon dioxide (CO_2) mass

[12] This estimate does not contain forested area in the Nantahala-Pisgah National Forest in North Carolina. Estimate obtained using EVALIDator (https://apps.fs.usda.gov/Evalidator/evalidator.jsp) which queries the Forest Inventory & Analysis database.

Carbon trends on the Uwharrie and Croatan NFs were influenced by timber harvesting, fire, the legacy of historical land management, as well as climate and environmental factors. According to satellite imagery, the most
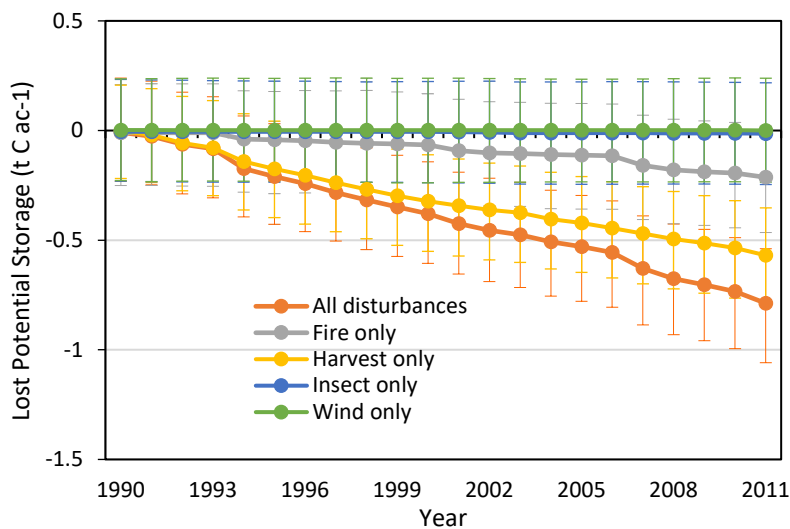

Figure 2-8. *Lost potential storage of carbon (non-soil) as a result of fire, insects, harvest, and wind (abiotic) on National Forests in North Carolina for the period 1990–2011. (Figure 2j in Appendix A, USDA Forest Service, in review).*
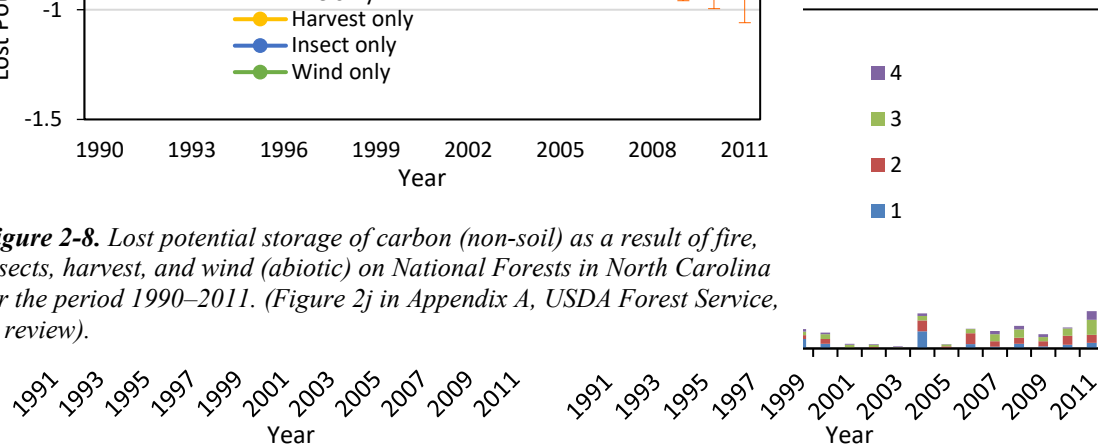

Figure 2-7. *Percentage of the forested area disturbed in the Uwharrie and Croatan National Forests by (a) harvests, insects, fire, and abiotic (wind) and (b) by magnitude classes of Disturbance characterized by Percent Change in Canopy Cover (CC). 1) 0-25 percent CC, 2) 26-50 percent CC, 3) 51-75 percent CC, and 4) 76-100 percent CC. Disturbed area estimates do not include disturbances or forested area in Nantahala-Pisgah NF.*

prevalent disturbance during this period was timber harvesting. However, harvests were relatively small, affecting on average 0.47 percent of the forested area in the Uwharrie and Croatan NFs annually and a total of about 10 percent of the forested area over the 21-year period (Fig. 2-7a). About 60 percent of these timber harvests since 1990 were characterized as low to moderate intensity, resulting in less than a 50 percent reduction in canopy cover (Fig. 4b). Forest carbon losses associated with harvests have been small compared to the total amount of carbon stored in the Forests. For all forests in the NFs in NC, harvests resulted in a loss of about 0.57 metric tonnes per acre (0.9 percent) of non-soil carbon from 1990 to 2011 (Fig. 2-8). Although the Uwharrie and Croatan NFs account for about 20 percent of the forested area in NFs in NC, about 59 percent of the harvests between 1990 and 2011 occurred in these Forests. Thus, the impact of harvests on carbon storage on the Uwharrie and Croatan NFs alone is likely larger than what is represented in Figure 2-8, which includes all NFs in NC. Furthermore, these estimates do not account for either continued storage of harvested carbon in wood products or the effect of substitution. Carbon storage in harvested wood products (HWPs) and landfills has increased across all national forests in the southeastern United States since the early 1900s. However, recent declines in timber harvesting across national forests in the Southern Region have slowed the rate of carbon accumulation in the product sector (USDA Forest Service, in review).

The second most common disturbance on the Uwharrie and Croatan NFs during 1990-2011 was

fire, affecting on average 0.25 percent of forested area annually. Some prescribed fires may have been undetected because they did not cause a change in canopy cover and instead just burned along the forest floor with very low intensity. Overall, on the NFs in NC, fires detected over this 21-year period resulted in the loss of approximately 0.21 metric tonnes per acre (0.4 percent) of non-soil carbon (Fig. 2-8). About 36 percent of the fires on the NFs in NC between 1990 and 2011 occurred on the Uwharrie and Croatan forests, suggesting that the effects of fires on carbon storage on the Uwharrie and Croatan NFs alone were likely slightly larger than what is represented in Fig. 2-8.
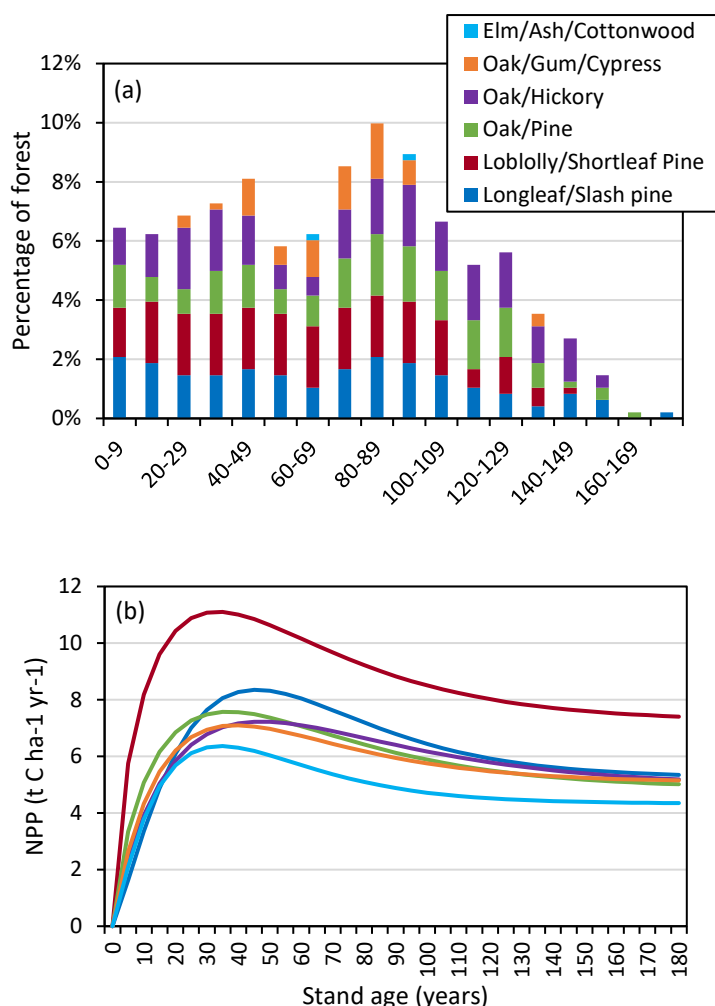

Figure 2-9. *(a) Stand age distribution in 2011 and (b) net primary productivity (NPP)-stand age curves for forest type groups in Uwharrie and Croatan National Forests. Stand age distribution does not include stands from the Nantahala Pisgah NFs.*

Stand age serves as a proxy for past disturbances and management activities, which can also drive forest carbon dynamics over the long-term (Pan et al. 2011b). When a forested stand is disturbed by a severe, stand-replacing event, the age of the stand resets to zero and the forest begins to regrow. About 44 percent of the stands on the Uwharrie and Croatan NFs are older, with a small pulse of stand establishment roughly 80-90 years ago (Fig. 2-9a). This period of somewhat elevated stand establishment came after decades of intensive timber harvesting and land clearing for agriculture throughout the 19th century, followed by a period of forest recovery in the early to mid-20th century. However, continued timber harvesting on the Forests have resulted in most stands being relatively young to middle aged (Fig. 2-9a). Forests are generally most productive when they are young to middle age, then productivity peaks and declines or stabilizes as the forest canopy closes and as the stand experiences increased respiration and mortality

of older trees (Fig. 2-9b).

Model results show that collectively the NFs in NC were most rapidly accumulating carbon from the 1950s through 1970s (Fig. 2-10) (positive slope) as a result of regrowth following disturbances and land use change in the early 1900s and heightened productivity of the young to middle-aged forests. As stand establishment declined and more stands reached slower growth stages around the1970s and 1980s, the rate of carbon accumulation declined (negative slope). However, these results include forests from the Nantahala-Pisgah NF, which contain much older forests and less productive forest types. Thus, the rate of carbon accumulation on the Uwharrie and Croatan NFs due to disturbances and aging is likely much higher and did not decline like on the Nantahala-Pisgah NF.

Climate and environmental factors, including elevated atmospheric CO_2 and nitrogen deposition, have also influenced carbon accumulation on the Uwharrie and Croatan NFs. Recent warmer temperatures and precipitation variability may have stressed forests, causing climate to have a negative impact on carbon accumulation since the 1990s (Fig. 2-10). Conversely, increased atmospheric CO_2 and nitrogen deposition have potentially enhanced growth rates and helped to counteract ecosystem carbon losses from disturbance, aging, and climate. There has been considerable debate regarding the effects of elevated CO_2 on forest growth and biomass accumulation, thus warranting additional study (Körner et al. 2005, Norby et al. 2010; Jones et al. 2014; Zhu et al. 2016).
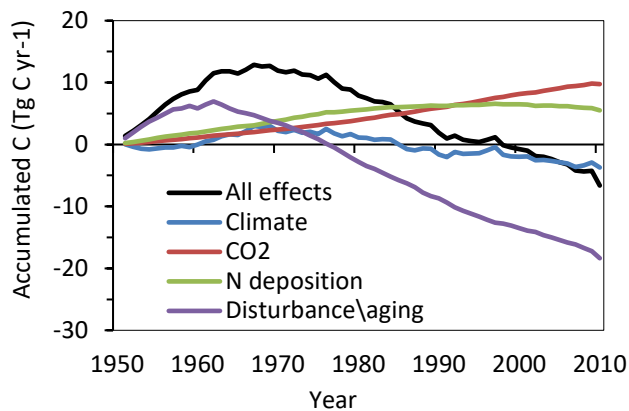

Figure 2-10. Accumulated carbon in National Forests in North Carolina due to individual disturbance/aging, non-disturbance factors, and all factors combined for 1950–2010, excluding carbon accumulated pre-1950

Future Carbon Conditions

Under changing climate and environmental conditions, forests of the Uwharrie and Croatan NFs may be at increasing risk of many stressors, including moisture stress, extreme temperatures, insects and diseases, and the spread of invasive species. Forests in the Croatan NF, which is located on the coast, are at especially high risk of flooding due to sea-level rise as well as damage from extreme weather events such as more frequent and intense hurricanes that are projected under a warming climate (McNulty et al. 2015). These potentially negative effects might be offset somewhat by the positive effects of longer growing season, more precipitation, and elevated atmospheric CO_2 concentrations. However, it is difficult to judge the effects of these factors and their interactions on future carbon dynamics of the Uwharrie and Croatan NFs.

The population in the region is growing, and some conversion of forested lands to non-forest purposes is likely to occur on private lands adjacent to and near the Uwharrie and Croatan NFs. Converting forest land to a non-forest use removes a very large amount of carbon from the forest and inhibit future carbon storage, because regrowth is inhibited. However, national forests tend to experience low rates of land-use change, and thus, forest land acreage is not expected to change substantially within the Uwharrie and Croatan NFs in the future. Forested area on the Uwharrie and Croatan NFs will be maintained as forest into the foreseeable future, which will allow a long-term continuation of carbon uptake and storage.

Discussion and Findings:

- Forest carbon stocks increased by 15 percent on the NFs in NC between 1990 and 2013, indicating a carbon sink.
- Forests are mostly young to middle aged and therefore are highly productive and likely to continue to act as a carbon sink into the future. Timber harvesting has been the most prevalent disturbance detected on the Uwharrie and Croatan NFs between 1990 and 2011. Forest carbon losses associated with harvests have been small compared to the total amount of carbon stored in the NFs.
- Negative impacts on carbon stocks caused by disturbances and environmental conditions have been modest and exceeded by forest growth.

Adaptive Management Considerations

- Monitoring forest responses to changing climate and environmental conditions and potentially alter management activities to enable forests to better adapt to these changing conditions will be important.
- To maintain ecosystem services and co-benefits, including carbon uptake and storage, the Uwharrie and Croatan NFs will need to continue maintaining forests as forests.
- Future versions of the carbon assessments could be made more relevant by providing estimates specific to the plan area for the Uwharrie and Croatan NFs, instead of the entire administrative unit (i.e., NFs in NC) or region.

References for the carbon evaluation

Caspersen J.P., S.W. Pacala, J.C. Jenkins, G.C. Hurtt, P.R. Moorcroft, and R.A. Birdsey. 2000. Contributions of Land-Use History to Carbon Accumulation in U.S. Forests. Science 290: 1148-1151.

Chen, W., J.M. Chen, and J. Cihlar. 2000. Integrated terrestrial ecosystem carbon-budget model based on changes in disturbance, climate, and atmospheric chemistry. Ecological Modelling 135: 55-79.

Healey, S P., C.L. Raymond, I.B. Lockman., A.J. Hernandez, C. Garrard, and C. Huang. 2016. Root disease can rival fire and harvest in reducing forest carbon storage. Ecosphere 7: e01569.

Healey SP, S.P. Urbanski, P.L. Patterson, and C. Garrard. 2014. A framework for simulating map error in ecosystem models. Remote Sensing of Environment 150: 207-217.

Janowiak, M., W.J., Connelly, K. Dante-Wood, G.M. Domke, C. Giardina, Z. Kayler, K. Marcinkowski, T. Ontl, C. Rodriguez-Franco, C. Swanston, C.W. Woodall, and M. Buford. 2017. Considering Forest and Grassland Carbon in Land Management. Gen. Tech. Rep. WO-95. Washington, D.C.: United States Department of Agriculture, Forest Service. 68 p.

Jones, A.G., J. Scullion, N. Ostle, P.E. Levy, and D. Gwynn-Jones. 2014. Completing the FACE of elevated CO2 research. Environment International 73: 252–258.

Körner, C., R. Asshoff, O. Bignucolo, S. Hättenschwiler, S.G. Keel, S. Peláez-Riedl, et al. 2005. Carbon flux and growth in nature deciduous forest trees exposed to elevated CO2. Science 309: 1360–1362.

McKinley, D.C., M.G. Ryan, R.A. Birdsey, C.P. Giardina, M.E. Harmon, L.S. Heath, et al. 2011. A synthesis of current knowledge on forests and carbon storage in the United States. Ecological Applications 21: 1902-1924.

McNulty, S., S. Wiener, E. Treasure, J. Moore Myers, H. Farahani, L. Fouladbash, D. Marshall, R. Steele, D. Hickman, J. Porter, S. Hestvik, R. Dantzler, W. Hall, M. Cole, J. Bochicchio, D. Meriwether, and K. Klepzig. 2015: Southeast Regional Climate Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies, T. Anderson, Ed., United States Department of Agriculture, 61 pp.

Norby, R.J., J.M. Warren, C.M. Iversen, B.E. Medlyn, and R.E. McMurtrie. 2010. CO_2 enhancement of forest productivity constrained by limited nitrogen availability. Proceedings of the National Academy of Science 107: 19368-19373.

Pan, Y., R.A. Birdsey, J. Fang, R. Houghton, P.E. Kauppi, W.A. Kurz, O.L. Phillips, et al. 2011a. A large and persistent carbon sink in the world's forests. Science 333: 988–993.

Pan, Y., J.M. Chen, R. Birdsey, K. McCullough, L. He, and F. Deng. 2011b. Age structure and disturbance legacy of North American Forests. Biogeosciences 8:715-732.

Pan Y, R. Birdsey, J. Hom, and K. McCullough. 2009. Separating effects of changes in atmospheric composition, climate and land-use on carbon sequestration of U.S. mid-Atlantic temperate forests. Forest Ecology and Management 259:151–164.

Raymond C.L., S.P. Healey, A. Peduzzi, and P.L. Patterson. 2015. Representative regional models of post-disturbance forest carbon accumulation: Integrating inventory data and a growth and yield model. Forest Ecology and Management 336: 21-34.

Smith, J.E., L.S. Heath, and M.C. Nichols. 2010. U.S. Forest Carbon Calculation Tool: forest-land carbon stocks and net annual stock change. Revised. Gen. Tech. Rep. NRS-13. Newtown Square, PA: US Department of Agriculture Forest Service Northern Research Station. 2010; 34 p.

USDA Forest Service. 2015. Baseline estimates of carbon stocks in forests and harvested wood products for National Forest System Units, Southern Region. 45 pp.

USDA Forest Service. In review. Assessment of the influence of disturbance, management activities, and environmental factors on carbon stocks, Southern Region. 90 pp.

US EPA. 2015. US inventory of greenhouse gas emissions and sinks: 1990 – 2013. Executive Summary. EPA 430-R15-004 United States Environmental Protection Agency. Washington, D.C. 27 pp.

Zhang, F., J.M. Chen, Y. Pan, R. Birdsey, S. Shen, W. Ju, and L. He. 2012. Attributing carbon changes in conterminous U.S. forests to disturbance and non-disturbance factors from 1901-2010. Journal of Geophysical Research 117: G02021.

Category 7. Broad-Scale: Social, Economic, and Cultural Sustainability must be addressed in the monitoring program

Table 2-5. Broad Scale Monitoring Question in Category 7.

Monitoring Question		
What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region? (Uwharrie Q25; Croatan Q26)		

Economic Conditions in Region 8, Specific to North Carolina

To address broad-scale economic conditions, the Southern Region examined and reported indicators by planning unit across the region. This report extracts information specific to North Carolina from the region-wide analyses.   The indicators are: population change, employment, income, payments to counties, forest operations, and economic contributions by program areas.

Population Growth

Population growth can be an indicator of a region's desirability to live and work. Growing populations and associated development usually creates greater demand on forest resources and may affect the perceived aesthetics and uses associated with Forest Service lands. For example, the challenge of maintaining the quality of visitors' experiences while providing forest products and cultural and recreational experiences to a greater number of people become more difficult with population growth. Other challenges include the following:

- Growing populations, specifically homes, near public lands may contribute to the costs of fighting wildland fires;

- Increased population of residential areas surrounding the forest also increases the region's need for infrastructure and may place greater pressure on the forest to provide utility right-of-ways, for example, to meet the region's growing infrastructure needs;

- While living close to public lands may provide residents with amenities such as convenient access to recreation and wildlife viewing, increased forest congestion causes disamenities such as crowds, litter, and noise (Garber-Yonts 2004; Bolitzer and Netusil 2000; Moore et al. 1992).

As shown in Table 2-6, the population change of the surrounding area of the Croatan and the Uwharrie NFs are near the average population growth rates for Region 8 and the nation. For example, new residents may be drawn to the surrounding area of the Croatan NF, which is one of the few national forests in the nation that is close to the Atlantic Ocean. In addition, retirees from military installations, such as Cherry Point Marine Air Base and Camp Lejeune, may take permanent residences, which would increase population growth.

Population growth rates for the surrounding areas of the Croatan (13%) and Uwharrie NFs (10%) are substantially higher than the US non-metro population growth rate (3%), indicating a potential higher degree of need for uses of the forest will continue into the near future.

Table 2-6. Population and population change

Planning Unit	2000	2016	Percent Change 2000-2016
Croatan	161,649	182,180	13%
Nantahala-Pisgah NF	820,564	943,759	15%
Uwharrie	305,600	335,760	10%
Region 8 (excl. El Yunque)	10,740,464	12,348,312	15%
United States	282,162,411	323,127,513	15%
US (Non metro)	45,201,471	46,494,722	3%

Data Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C., reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps; U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates.

Unemployment

The unemployment rate provides insight into the correspondence between residents' skills and employment opportunities. The unemployment rate is the percentage of the labor force that is unemployed. The natural rate of unemployment is believed to fall somewhere between 5 and 6 percent and allows workers to move between jobs and industries without signaling broad economic distress.

Table 2-7, shows that the unemployment rate for the surrounding areas of the Croatan and Uwharrie NFs are nearly 5 percent and within an acceptable range for stable economies.

Table 2-7. Unemployment rate, 2016

Location	2016
Croatan	5.2%
Nantahala-Pisgah NF	4.6%
Uwharrie	4.9%
Region 8** (excl. El Yunque)	5.1%
United States	4.9%
US (Non Metro)	5.4%

***Reported as a population weighted average of Forest-level unemployment rate. Some counties are double counted if they are included in more than one Forest impact area.*

Data Source: U.S. Department of Labor. 2018. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, D.C., reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps; U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates.

Income and Poverty

Per capita income is an indicator of economic well-being. Income can be an important consideration because low income populations may be more vulnerable to any adverse effects that result from changes to forest management. For example, if people must travel farther to access recreation sites this increases the cost to use recreation sites and this may have a disproportionate effect on low income households.

Table 2-8 shows that the surrounding area of Croatan NF exceeds the average income levels for both Region 8 and US non-metro areas. This may be a result of a high government employment, such as the Cherry Point Marine Corps Base and Camp Lejeune, as well as a high tourist destination for beaches along the Atlantic seaboard.   The surrounding area of the Uwharrie NF shows somewhat slightly less of the average income levels for the region and US non-metro areas. Potential reasons for lower incomes around the Uwharrie NF compared with the Croatan are the more rural landscapes and fewer high density towns or cities adjacent to the forest.

Poverty rates for the surrounding areas of the NFs are consistent with income levels. Areas near the Croatan NF have lower than average poverty rates compared with Region 8 but slightly higher than the US non-metro areas. Areas around the Uwharrie NF are about the same poverty rates as Region 8, but slightly higher than US metro areas.

Poverty is an important indicator of both economic and social well-being. Individuals with low incomes are more vulnerable to a number of hardships which may negatively affect their health, cognitive development, emotional well-being, and school achievement. In general, low income individuals tend to rely more heavily on natural resources and depend more directly on NFS lands for sustenance and home heating.

Table 2-8. Per capita income and population poverty levels, 2016

Planning Unit	Per capita income	Percent of population below poverty level
Croatan	$ 44,153	15%
Nantahala-Pisgah NF	$ 37,623	18%
Uwharrie	$ 35,575	17%
Region 8	$ 38,237	18%
US (Non Metro)	$ 39,024	13%

Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C., and U.S. Department of Commerce. 2017. Census Bureau, American Community Survey Office, Washington, D.C. reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps. Downloaded May 24, 2018; U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates, available at https://factfinder.census.gov. Downloaded June 7, 2018.

Payments to States and Counties
The National Forests and Grasslands make payments to states and local governments through three programs. These are Federal Payments In-Lieu of Taxes (PILT) and Forest Service county payments--the Secure Rural Schools Act (SRS) or the Federal 25 Percent Fund and Payments to Grassland counties via the Bankhead-Jones Farm tenant Act. PILT are not reported here. While local governments receive these payments, they are largely outside the control of National Forest management. Generally larger payments reflect larger acres under Federal management.

Forest Service County Payments. Counties receive revenue sharing payments from commercial activities on Federal lands, such as oil and gas leasing, livestock grazing, and timber harvesting. For National Forests, beginning in 1908 the payment was 25-percent of the moneys received annually. Since 2008 the payments are based on 25-percent of the 7-year rolling average annual receipts. These payments are commonly called 25-percent payments. However, in 2000, the Secure Rural Schools and Community Self-determination Act was passed which offered a guaranteed source of payments that was not tied to annual commercial revenue on National Forests. The vast majority of counties in the planning areas of influence in Region 8 elected to receive the Secure Rural Schools Act State Payment share in fiscal year 2017 and not the 25-

percent payments. Table 2-9 shows the Forest Unit and per-acre revenue from Secure Rural School and 25-percent Forest Service payments in fiscal year 2017. Payments to counties with National Grasslands are made through the Bankhead-Jones Farm Tenant Act. These payments are similar to 25-percent payments, but not reflected in the below table.

The Secure Rural Schools Act has periodically lapsed due to not being reauthorized by Congress. Without reauthorization these payments revert to 25 percent payments. The 25-percent payments are, in many cases, significantly smaller than the Secure Rural Schools Act payments.

Table 2-9. Secure Rural Schools (SRS) Act Payments (per ac) and 1908 Act 25 Percent Payments, 2017(total)

National Forest	Acres	Total payment	Average payment per Acre
Croatan NF	161,325	148,190	$ 0.92
Nantahala and Pisgah NFs	1,043,297	1,354,315	$ 1.30
Uwharrie NF	51,398	75,615	$ 1.47
Region 8 Total	12,241,944	25,486,446	$ 2.08

Note: Chichasaway is not included in R8 total.

Payments to counties with National Grasslands (e.g. LBJ/Caddo) are made through the Bankhead-Jones Farm Tenant Act, which is not included in the R8 Total.

Source: USDA Forest Service ASR: Final Payment Detail Report PNF (ASR-10-02) Available at: [https://www.fs.usda.gov/main/pts/securepayments/projectedpayments Downloaded May 23](https://www.fs.usda.gov/main/pts/securepayments/projectedpayments)*, 2018.*

Payments to states and local government support public services in communities near the National Forests and Grasslands and contribute to employment and labor income in the counties that surround the forest. Forest Service payments to local governments in sparsely populated and low-income areas are likely to be particularly meaningful, since these areas typically get less revenue from property, sales, and income taxes to fund local government operations.

Forest Operations

National Forests and Grasslands operations and infrastructure include personnel, program activities, roads, and facilities that contribute to the use and enjoyment of the forest.

In North Carolina, a combined annual budget (including expenditures and salaries and fire expenditures) was $29.8 million in fiscal year 2016; of which about 56 percent on salary and 44 percent on non-salary expenditures (Table 2-10). It should be noted that 2016 had an uncharacteristic distribution between salary and nonsalary expenditures because the NFsNC was in the middle of a workforce planning initiative and hiring freeze. While the distribution was unusual, the total expenditures in 2016 are representative of recent years.

Table 2-10. Expenditure by Forest Planning Unit, FY2016

Planning Unit	Salary	Nonsalary
NF in North Carolina	$ 16,726,864.58	$ 13,162,510.27
Region 8	**$ 186,358,415.40**	**$ 124,584,883.09**

Source: USFS, Forest Economic Analysis Spreadsheet Tool (FEAST), version Aphelia 10/24/2017.

These expenditures support programs, such as providing recreation opportunities, wildlife habitat, and ecosystem restoration projects.

The National Forests and Grasslands' operational expenditures contribute to economic activity in the communities that surround the forest. Forest Service employees live in these communities and spend their income on housing, food, and a variety of other local goods and services. The forest's non-salary expenditures generate economic activity in businesses that supply goods and services to support Forest Service programs. The economic contributions to the local economies of the National Forests and Grasslands expenditures are captured in the *Economic Contribution Analysis* section of this report.

Economic Contribution Analysis

The economic contribution analysis estimates the role of Forest Service resources, uses, and management activities on employment and income in the communities that surround National Forests and Grasslands.

The role of the National Forests and Grasslands in their respective regional economies was modeled with IMPLAN Professional 3.1 software using 2015 data. IMPLAN is an input-output model. Input-output analysis represents linkages between sectors in an economy. IMPLAN not only examines the direct contributions from the National Forests and Grasslands, but also indirect and induced effects. Indirect employment and labor income effects occur when a sector purchases supplies and services from other industries in order to produce their product. Induced effects are the employment and labor income generated as a result of spending new household income generated by direct and indirect employment. For example, visitors to NFsNC spend money on accommodation and food. Accommodation and food service businesses buy supplies from other businesses. The employees of these firms spend their earnings on a variety of goods and services. These transactions result in direct, indirect, and induced effects, respectively, in the regional economy. Direct, indirect, and induced effects are combined in the discussion of effects.

IMPLAN uses Forest Service data on expenditures and resource uses to estimate the economic consequences of National Forests and Grasslands management.

The National Forests and Grasslands area of influence for these economic contribution analysis are not the same as those considered for the indicators above. For these analyses an economic area of encompasses a contiguous set of counties where direct expenditures are made by the following groups: recreationists, timber harvesters, timber processors, minerals and energy producers and local government (from revenue sharing and payments in lieu of taxes). These economic areas of influence include a larger collection of counties than those considered above.

Employment by Program Area

The extraction and consumption of forest products (for example, timber, minerals, and forage), recreation visitors, and forest expenditures (for example, equipment and salaries) all contribute to the economic activity in the region. Based on IMPLAN analysis, Table 2-11 shows the number of jobs attributable to various Forest Service program areas. In all of Region 8, local and non-local recreation visitors account for nearly 50 percent of all jobs, contributing a total approximate 14,229 of the 24,268 jobs on an average annual basis. However, in North Carolina the local and non-local recreation visitation accounts for 91 percent of the total jobs contributed by the national forests. The Forest Service expenditures category captures both salary and non-salary expenditures. The jobs contributed by Forest Service expenditures in all of Region 8 make up 19 percent of the total contribution, whereas about 6 percent of the total jobs contributed by the NFsNC are attributable to their expenditures.

Table 2-11. Total number of jobs contributed by program area for Region 8 & NC (2015)

Program area	R8 Jobs	NC Jobs
Recreation	14,229	6064
Grazing	80	0
Timber	4,208	95
Minerals	174	2
Payments to States/Counties	1,038	116
Forest Service Expenditures	4,536	402
Total Region 8 Forest Management	24,268	6679

Note: Direct, indirect, and induced effects are combined in this table.

The Region 8 reported figures are a summation of the analysis for each planning unit within R8. Figures for NC are shown separately.

The job estimates serve as an annual average, but they do not differentiate between the provision of full-time, part-time, or seasonal work.

Due to changes in the methods used to define the areas of influence 2015 estimates are not strictly comparable to earlier year estimates. The economic area of influence used for the above analysis is likely different than the areas used for individual Forest analysis. Therefore, these numbers are not strictly comparable to other reports.

Source: Economic Contributions at a Glance, 2015 via personal communications with Susan Winter, WO EMC, May 13, 2018; 2014 reports available at https://www.fs.fed.us/emc/economics/contributions/at-a-glance.shtml

Labor Income by Program Area

Table 2-12 displays labor income attributable to various Forest Service programs. The jobs estimates, presented above, offer an incomplete picture of the National Forests and Grasslands' contributions to the regional economies. Labor income estimates help to clarify the role of forest management in supporting livelihoods in communities near the National Forests and Grasslands. Not all jobs are equivalent. Whereas Table 2-11 indicated program area contributions to regional employment, Table 2-12 demonstrates the contribution in terms of labor income. Combined these reveal that jobs across the entire R8 associated with mining or forest service expenditures on forests or grasslands pay more, on average, than jobs associated with timber. Some factors which contribute to the differences in labor income include whether the job is seasonal or part-time and education or skill level required.

Table 2-12. Total labor income, by program area for Region 8 and North Carolina

Program area	R 8-Total Labor Income (thousands of 2015 dollars)	NC-Total Labor Income (thousands of 2015 dollars)
Recreation	$454,544	$192,355
Grazing	$1,162	0
Timber	$216,010	$4,519
Minerals	$17,657	$104
Payments to States/Counties	$50,441	$5,869
Forest Service Expenditures	$271,820	$24,174
Total Region 8 Forest Management	$1,011,632	$227,200

Note: Direct, indirect, and induced effects are combined in this table.

The Region 8 reported figures are a summation of the analysis for each planning unit within R8. Figures for NC are shown separately.

Due to changes in the methods used to define the areas of influence 2015 estimates are not strictly comparable to earlier year estimates. For this reason, the economic area of influence used for the above analysis is likely different than the areas used for individual Forest analysis. Therefore, these numbers are not strictly comparable to other reports.

Source: Economic Contributions at a Glance, 2015 via personal communications with Susan Winter, WO EMC, May 13, 2018; 2014 reports available at https://www.fs.fed.us/emc/economics/contributions/at-a-glance.shtml

Adaptive Management Considerations

For future reporting.

- Supplement population growth with some statistics on new housing starts or other land use changes that could assist with estimating the potential change in management challenges due to socio-economic factors.
- Report Payment in Lieu of Taxes so that long term trends can be determined.
- Employment by sector would be a useful statistic to demonstrate differences in the structure of the economy across various planning units.

References Cited for socio-economic subsection

Bolitzer, B. and N.R. Netusil. 2000. "The Impact of Open Space on Property Values in Portland, Oregon." Journal of Environmental Management. 59:185-193.

Garber-Yonts, B.E. (2004). "The Economics of Amenities and Migration in the Pacific Northwest: Review of Selected Literature with Implications for National Forest Management." General Technical. Report PNW-GTR-617. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 48 pages.

Moore R., A. Graefe, R. Gitelson and E. Porter. (1992). "The Impact of Rail-Trails: a Study of the Users and Property Owners from Three Trails." Washington, DC: Rivers, Trails, and Conservation Assistance Program, National Park Service.

Seesholtz, D.; Wickwar, D.; Russell, J. 2006. Social economic profile technical guide. USDA Forest Service, Inventory Monitoring Institute.

Stedman, R. 2003. Sense of place and forest science: toward a program of quantitative research. Forest Science. 49(6): 822–829.

U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates.

U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates, available at https://factfinder.census.gov. Downloaded June 7, 2018.

USDA Forest Service ASR: Final Payment Detail Report PNF (ASR-10-02) Available at: https://www.fs.usda.gov/main/pts/securepayments/projectedpayments Downloaded May 23, 2018.

USDA Forest Service. Economic Contributions at a Glance, 2015 via personal communications with Susan Winter, WO EMC, May 13, 2018; 2014 reports available at https://www.fs.fed.us/emc/economics/contributions/at-a-glance.shtml

U.S. Department of Commerce. 2017. Census Bureau, American Community Survey Office, Washington, D.C. reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps. Downloaded May 24, 2018

U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C., reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps

U.S. Department of Labor. 2018. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, D.C., reported by Headwaters Economics' Economic Profile System, headwaterseconomics.org/eps.