Aquatic Resources

Introduction

The Land and Resource Management Plan (Forest Plan) for the Monongahela National Forest includes expectations to monitor and evaluate Forest management activities. Monitoring and evaluation help determine whether: 1) Forest Plan implementation is consistent with the goals, objectives, standards, and guidelines provided in Forest Plan direction; 2) Forest Plan direction is effective in bringing about desired results without causing undesired consequences; and 3) Forest Plan direction remains valid in light of new information or changed conditions. Results from implementation, effectiveness, and validation monitoring efforts can sustain existing Forest Plan direction and practices or they can be used to recommend changes in the Forest Plan.

Direction in the Forest Plan contains eight monitoring questions that are directly or indirectly related to aquatic resources management. The following report addresses the eight questions and summarizes the aquatic monitoring efforts conducted in FY 2008.

2008 Program Accomplishments

The Forest conducted various activities during FY 2008 for the purpose of managing aquatic resources in accordance with Federal and State laws, USDA and Forest Service policies, and Forest Plan direction. Table AR-1 identifies FY 2008 accomplishments that are most directly related to aquatic resources management on the Forest.

Table AR-1. Aquatic Resource Accomplishments in 2008

Products, Services, and Activities	Quantity
Streams on National Forest lands not meeting West Virginia State water quality standards (miles)	250[a]
Temporary Summer Employees (college students employed for aquatic resources inventory/monitoring)	4
Randolph County Outdoor Education Programs (aquatic modules)	12
Free Fishing Clinics and Other Aquatic Resources Outreach (events)	4
Mid-scale Resource Analyses (Watershed Assessments)	0
Project Level Aquatic Resources Coordination (Biological Evaluations reported in WFRP)	35
Road Decommissioning (miles) - FR242 in Clubhouse Run (WF Greenbrier River)	2.7[b]
Stream Channel Restoration (miles) – Laurel Run LWD project (Elk River)	0.5[b]
Stream Channel Restoration (miles) – Cove Run LWD project (WF Greenbrier River)	0.5[b]
Stream Channel Restoration (miles) – Elk Run LWD project (Big Run of the NFSB Potomac River)	1.5[b]
Stream Channel Restoration (miles) – Big Run Allotment riparian fencing and planting	0.5[b]
Riparian Restoration (acres) – Big Run Allotment riparian fencing and planting	11
Limestone Treatment to Acid Impaired Streams (miles) – Lambert Run and Coats Run	10
Limestone Treatment to Acid Impaired Lakes (acres) – Summit Lake	38
Cooperative Administrative Studies (Participating Agreements) – Brook Trout Study; Culvert Surveys	2

a = based on WV DEP 2006 303(d) impaired streams list (out of an estimated 2,753 total miles of Forest streams)
b = contribute toward specific Forest Plan objectives for aquatic resources management

Many of the accomplishment items listed in Table AR-1 represent products and services provided for public benefit. Some unlisted accomplishments include environmental assessments that provide a foundation for making land management decisions with the knowledge of potential effects to the condition and trend for aquatic resources. Other accomplishments consist of implementing specific land management activities designed to address particular Forest Plan objectives (Table AR-2) or issues related to the condition and trend of the aquatic environment. Environmental assessments and project implementation are often the culmination of various forms of monitoring efforts that range from specialist reviews of site-specific conditions to watershed-scale surveys and evaluations of ecosystems processes and conditions.

Table AR-2. Forest Plan Objectives Directly Related to Aquatic Resources Management

Forest Plan Objective	Fiscal Year 2008 Accomplishment	Total Accomplished under 2006 Forest Plan
Actively restore aquatic and riparian habitat conditions in 30-50 miles of stream.	2.5 miles	3.5 miles
Maintain at least 560 miles of coldwater stream habitat capable of supporting wild, naturally reproducing brook trout.	560 miles	560 miles
Decommission or reclaim at least 30 miles of roads that are no longer needed for achieving access management objectives.	2.7 miles	9.7 miles
Reduce aquatic habitat fragmentation associated with the Forest transportation system by correcting 30-50 passage barriers, according to aquatic priorities.	0	0

Monitoring and Evaluation

The Forest Plan identifies regulatory and discretionary requirements for monitoring the Plan implementation. To help answer monitoring questions about aquatic ecosystems, eight specific monitoring items have been identified based on key aquatic resource issues that surfaced during the forest plan revision process in 2006 (Table AR-3). These eight aquatic resource monitoring items are listed in the Forest's Monitoring Implementation Guide (MIG) along with other details that indicate the Forest's expectations for monitoring the Forest Plan and its implementation.

Aquatic resource monitoring issues are discussed in this report. The relationship between aquatic resource monitoring questions and monitoring issues is provided in Table AR-3. Current and future efforts to monitor aquatic resources on the MNF will increasingly strive to address these questions or modify them as needed to provide an effective feed-back mechanism for future planning and implementation of the Forest Plan.

The monitoring questions shown in Table AR-3 are somewhat different than the suite of questions that originally appeared in Chapter IV of the 2006 Forest Plan. The changes were based on specialist recommendations that were made in the MNF FY 2007 Annual Monitoring Report. These changes were made to the Monitoring Matrix in the Forest Plan through administrative corrections in December of 2008.

The first two questions in Table AR-3, #10 for management indicator species and #39 for sensitive species, are addressed through the monitoring conducted for questions 40, 41, 42, 43, and 44, which assess habitat conditions for these species.

Table AR-3. Forest Plan Monitoring Questions and Aquatic Resource Monitoring Issues

Monitoring Questions from Chapter IV of the MNF Forest Plan that are Related to Aquatic Resources	Monitoring Issues Addressed by each Question	Aquatic Resource Monitoring Issues from the Monitoring Implementation Guide
10. To what extent is Forest management moving toward desired habitat conditions for MIS and species associated with MIS habitats?	1, 2, 3, 4, 5, 7	1. Stream Water Chemistry 2. Stream Temperature 3. Stream Sedimentation 4. Aquatic Habitat Quality 5. Aquatic Habitat Connectivity 6. Aquatic Nuisance Species 7. Clean Water Act Compliance 8. Recreational Fishing
39. To what extent is Forest management contributing to the conservation of sensitive species and maintaining or restoring their habitat conditions?	1, 2, 3, 4, 5, 6, 7	
40. To what extent are Forest management and other external influences (such as acid deposition) beneficially or adversely affecting water quality or quantity?	1, 2, 3, 4, 7	
41. To what extent is Forest management beneficially or adversely affecting soil erosion and stream sedimentation processes?	3, 4, 7	
42. To what extent is Forest management beneficially or detrimentally affecting the physical conditions of aquatic ecosystems, including riparian ecosystem function and health?	1, 2, 3, 4, 5, 6, 7	
43. To what extent is Forest management influencing the viability of native and desired non-native species (e.g., RFSS and MIS) or otherwise affecting species composition and habitat productivity?	1, 2, 3, 4, 5, 6, 7, 8	
44. To what extent is Forest management influencing populations of terrestrial or aquatic non-native species that threaten native ecosystems?	6	
46. Is the Forest providing adequate habitat to meet the demand for wildlife and fisheries related social and recreational opportunities?	1, 2, 3, 4, 5, 7, 8	

In addition, the Forest Plan establishes a monitoring framework and suggests prioritization criteria to help focus monitoring efforts. Monitoring efforts pursued for aquatic resources during FY 2008 help address various monitoring elements described in the Forest Plan. Table AR-4 lists the focused aquatic resource monitoring efforts conducted during FY 2008.

Table AR-4. Aquatic Resource Monitoring Efforts in FY 2008

Monitoring Activity	Quantity
Stream Water Chemistry (sites)	99
Aquatic Ecological Unit Inventory and Monitoring – Aquatic Habitats/Populations (sites)	30
Aquatic Organism Passage Inventory/Assessments (sites)	29
Summer Stream Temperature Regime (sites)	40
East Gauley Mountain Monitoring – Aquatic Habitats/Populations/Sediment (streams)	7

The following are descriptions, evaluations, conclusions, and recommendations associated with monitoring efforts conducted during FY 2008 for aquatic resources.

Monitoring Question 40 - To what extent are Forest management and other external influences (such as acid deposition) affecting water quality or quantity?

Water Chemistry and Acid Deposition

The MNF has routinely monitored water chemistry conditions in streams across the Forest since 2001. Forest-wide water chemistry monitoring is typically conducted semi-annually – in the spring during relatively higher run-off conditions and in the fall during lower base flow conditions. Water samples are analyzed for measures of pH, acid neutralizing capacity (ANC), major cations and anions, and conductivity. These measures are helpful in assessing the condition and health of aquatic ecosystems and in monitoring the sensitivity of these ecosystems to acid deposition.

Since the fall of 2001, the MNF has developed a water chemistry dataset from approximately 800 water samples collected at 225 different stream locations distributed throughout the Forest. Water samples were collected at 99 stream locations during the spring of 2008 and at 96 locations during the fall of 2008 (Figure AR-1). Details of the chemical analyses of the 2008 stream water samples are available in project files at the MNF Supervisor's Office. A brief summary is provided in this report.

Figure AR-1. Acid Neutralizing Capacity (ANC) for Stream Samples Collected during Spring and Fall of 2008

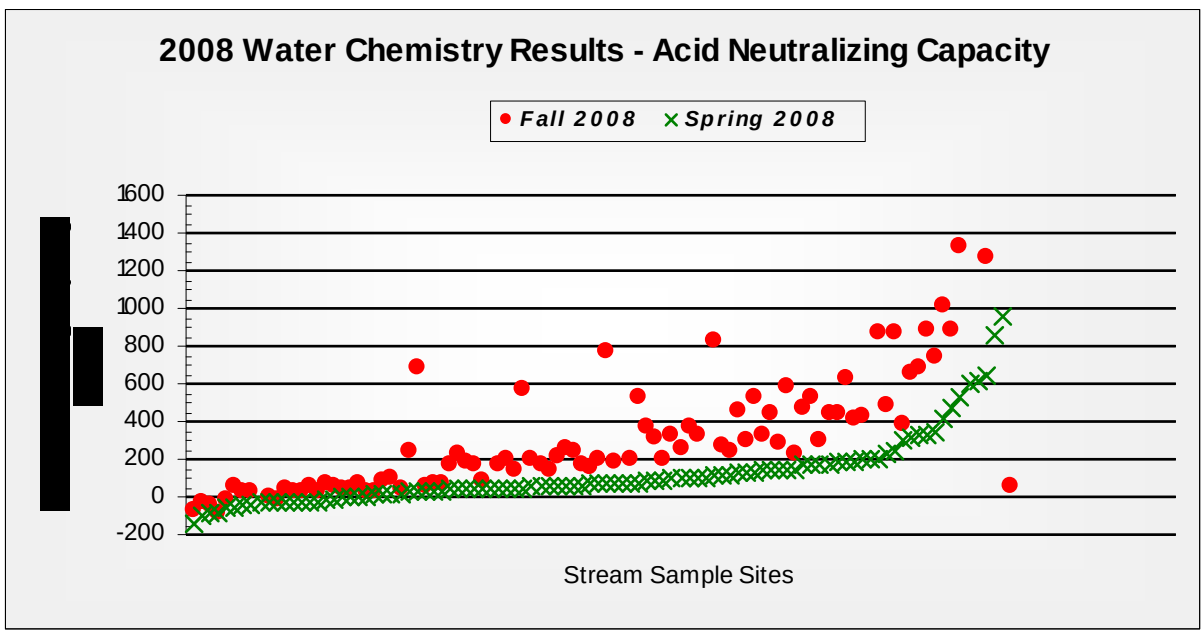
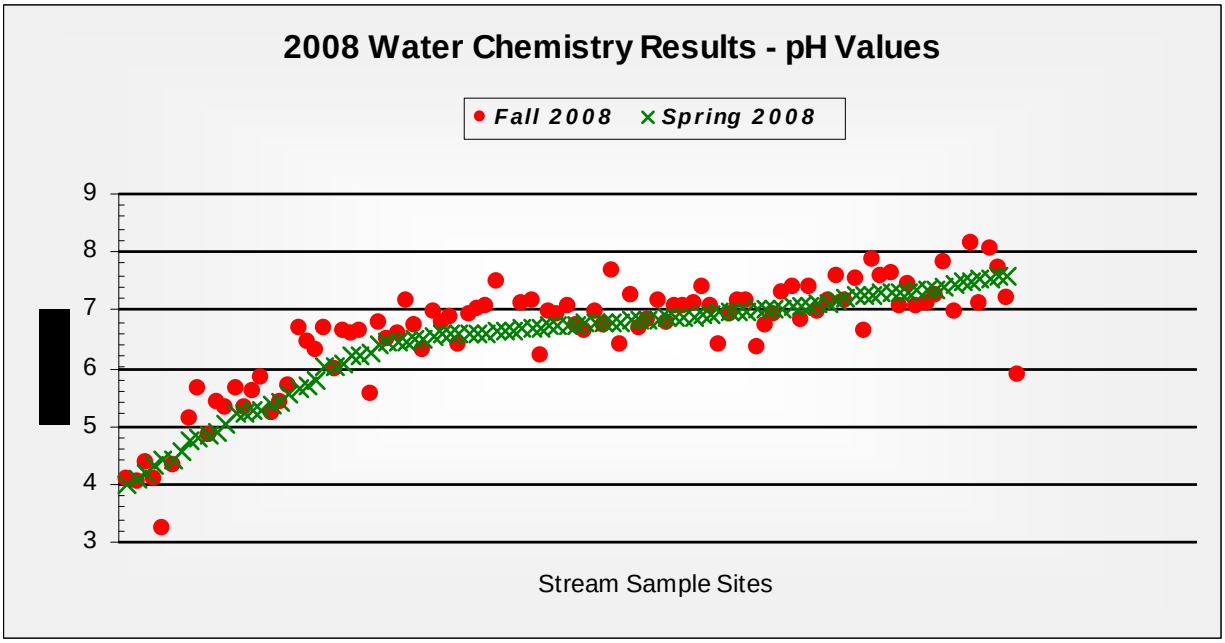


Figure AR-1 shows ANC values for stream samples collected during spring and fall of 2008. The data helps illustrate seasonal influences on water chemistry parameters such as ANC values. In the spring, ANC values ranged from -141.4 in Yellow Creek to 952.0 in Windy Run. In the fall, ANC values ranged from -617.3 in North Fork Blackwater River to 1,924.1 in North Fork Anthony Creek. Of the 95 streams that had spring and fall samples, 93 streams had spring ANC values that were lower than their fall ANC values, which is typically the case. Two streams, Big Stonecoal Run and the North Fork Blackwater River, had fall ANC values that were lower than the spring samples. It is particularly noteworthy that in the NF Blackwater River, ANC was significantly lower in the fall (-617.3 ueq/L) than spring (41.3 ueq/L). This difference may be attributed to the proportional contribution of acid mine drainage to the total volume of stream flow during the different sample periods, but additional investigation is warranted.

During the spring of 2008, measures of pH ranged from a low of 3.98 in Yellow Creek (Otter Creek Wilderness) to a high of 7.60 in Elklick Run (West Fork Greenbrier River drainage). In the fall, pH values ranged from a low of 3.23 (NF Blackwater River) to a high of 8.14 (Elk River). Fall pH values are usually higher due to base flows having a longer contact time with soil base cations than that which occurs during spring runoff. In 2008, a number of streams had higher pH levels in the spring than they did in the fall. Of the 95 streams that had spring and fall samples, 33 of them had lower pH levels in the fall than spring. It is hypothesized that extremely low flow conditions in the fall might have increased the influence of tannic acids associated with leaf packs more than normal. The tannic acids may have been enough to influence pH but not enough to greatly influence ANC (Dr. Pam Edwards, pers. comm.). Figure AR-2 displays the range in pH values for the streams sampled in 2008.

Figure AR-2. Plot of pH values collected in the spring and fall of 2008.



It should be noted that the West Virginia Division of Natural Resources (WVDNR) treat some acidic streams with limestone sand to help mitigate detrimental effects associated with stream acidification. Streams treated with limestone sand subsequently exhibit increased values for ANC and pH. As a result, these streams become better suited to accommodate acid-sensitive aquatic biota that otherwise may not exist or exist to a lesser extent. Several streams treated with limestone sand are sampled as part of the Forest's water chemistry monitoring efforts.

Evaluation, Conclusions, and Recommendations for Water Chemistry and Acid Deposition

The Aquatic Resources section of the 2007 Monitoring and Evaluation Report for the Monongahela National Forest (pages 94-97) provides a broader discussion of the interpretation and application of stream water chemistry monitoring results from the Monongahela National Forest. However, it is worth reiterating in this report that aquatic communities are, in part, a reflection of the water chemistry associated with their environment. Results from water chemistry monitoring document a considerable range in water quality conditions in streams across the Forest and offer insight into an element of constraint placed on these aquatic ecosystems as a function of the acidification phenomenon.

Recommendations: It is recommended that stream water chemistry continue to be monitored semi-annually across the Forest. This information is needed to continue to characterize a baseline for the Forest's diverse aquatic ecosystems, enable long-term trend monitoring for stream water chemistry, compliment similar efforts to monitor the effects of acid deposition on soil nutrient levels and air quality, and facilitate efforts to analyze and model scenarios that may offer unforeseen management options that address stream acidification issues.

It is recommended that data from stream water chemistry monitoring be used along with data from other aquatic ecosystem assessments to develop an aquatic ecological classification system or otherwise characterize aquatic communities across the Forest and monitor their trends.

Stream Temperature

Stream temperature is an environmental factor that influences the species composition of aquatic communities and the relative health of individual populations. Stream temperature affects various bio-physical functions and physicochemical properties (such as respiration rates of organisms and dissolved oxygen capacity for water). Stream temperatures can be a limiting factor for aquatic organisms in otherwise suitable habitat types. Further discussion of the ecological significance of stream temperature regimes and the implications associated with land management considerations can be found in the Aquatic Resources section of the 2007 Monitoring and Evaluation Report for the Monongahela National Forest (pages 98-101).

Since 2003, The Forest has annually deployed temperature logging devices in streams across the Forest. In FY 2008, temperature loggers were placed in 41 streams to record data from June to October. It should be noted that extremely dry conditions in the fall of 2008 resulted in seven temperature loggers potentially being exposed to air temperatures as streams dried up. Table AR-5 displays a summary of the data collected from the 41 temperature loggers. Since the Forest Plan identifies wild brook trout (*Salvelinus fontinalis*) as an aquatic management indicator

species, stream temperature data are summarized in Table AR-5 in terms of optimal and lethal stream temperature ranges described for brook trout (Raleigh 1982).

Table AR-5. Summary Data of Stream Temperatures Monitored during Summer 2008

Stream Name	Max. 24-hr Minimum (°Celsius)	Maximum Temperature (°Celsius)	Total Days Monitored	Days w/Avg. Exceeding Optimal (18°C)	Days w/Max Exceeding Sub-lethal (>22°C)	Days w/Max Exceeding Lethal (>25°C)
Clubhouse Run	15.80	16.96	104	0	0	0
Little River (WFGBR)	17.46	23.06	104	15	9	0
Little River (WFGBR)	17.56	20.08	104	2	0	0
Span Oak Run	16.13	17.63	108	0	0	0
Cove Run	17.87	21.63	103	29	0	0
Cove Run	16.11	17.06	103	0	0	0
Iron Bridge Run	16.15	17.58	104	0	0	0
Iron Bridge Run	15.53	16.53	104	0	0	0
Mill Run	17.46	22.08	104	13	1	0
Mill Run	16.77	18.46	104	0	0	0
WF Greenbrier River	18.79	21.49	104	20	0	0
Gertrude Run	16.84	21.92	104	4	0	0
Elklick Run (WFGBR trib)	18.41	23.11	104	22	7	0
Fox Run	16.11	17.53	98	0	0	0
Fox Run	18.22	22.85	98	14	4	0
WF Greenbrier River	18.39	20.75	104	7	0	0
Elklick Run	18.22	19.44	98	14	0	0
Coal Run	17.20	18.15	97	0	0	0
Otter Creek	19.22	20.79	97	29	0	0
Condon Run*	14.46	14.67	98	0	0	0
Yellow Creek	14.58	15.13	98	0	0	0
Little Stonecoal Run	16.44	17.39	92	0	0	0
Red Creek	18.91	24.92	92	35	18	0
Stonecoal Run	17.01	18.77	92	0	0	0
Fisher Spring Run	14.98	15.68	96	0	0	0
Red Creek	18.72	22.23	96	15	1	0
South Fork Red Creek	17.20	19.39	96	0	0	0
Laurel Creek**	16.68	17.44	99	0	0	0
Widemouth Run**	16.25	17.84	100	0	0	0
Douthat Creek	17.77	19.15	99	2	0	0
Bird Run**	16.42	18.49	103	0	0	0
Knapp Creek**	18.65	20.75	103	16	0	0
Sugar Camp Run**	17.27	19.65	105	1	0	0
Moore Run	17.08	18.58	105	0	0	0
Horsecamp Run	17.68	18.84	99	1	0	0
Whites Run	17.20	18.13	96	0	0	0
High Ridge Run	19.37	20.25	98	26	0	0
Long Run**	18.58	20.10	95	9	0	0
Galford Run - Left Prong	16.25	18.08	105	0	0	0

Stream Name	Max. 24-hr Minimum (°Celsius)	Maximum Temperature (°Celsius)	Total Days Monitored	Days w/Avg. Exceeding Optimal (18°C)	Days w/Max Exceeding Sub-lethal (>22°C)	Days w/Max Exceeding Lethal (>25°C)
Stony Run - unnamed trib	15.84	17.15	105	0	0	0
Spice Run**	17.68	20.44	105	2	0	0

* Site may actually be located in unnamed tributary to Condon Run.
** Streams were intermittent or dry during portions of the sampling period. Unclear if data is compromised.

Evaluation, Conclusions, and Recommendations for Stream Temperature

Of the 41 streams monitored in FY 2008, 20 had 24-hour average stream temperatures that remained within the optimal range for brook trout populations—less than 18 degrees Celsius (°C)—and 35 remained below 22°C. Streams meeting this temperature criterion do not exceed stream temperatures that are reported to be lethal for brook trout given various durations of exposure. Therefore, temperature regimes associated with these 35 streams are expected to be adequate to support year-round brook trout populations. The remaining six streams had some days exceeding sub-lethal temperatures of 22°C (range 1-18 days), but zero days exceeding the lethal limit of 25°C.

Temperature loggers record stream temperatures specific to the site where they are placed. However, streams often possess micro-habitats associated with areas of groundwater up-welling or springs where water temperatures may deviate from those recorded at the location of the monitoring device. Thus, aquatic biota may be able to seek micro-habitats within streams that would otherwise appear to be intolerable. In situations where micro-habitats are relied upon to provide thermal refuge from conditions that are less tolerable but more ubiquitous throughout the stream, stream temperature regimes may remain a primary limiting factor for the health and productivity of aquatic inhabitants.

Recommendations: It is recommended that stream temperature monitoring continue on an annual basis in streams across the Forest. A more complete analysis of the developing stream temperature dataset is needed to help explain variations in the dataset. An increased understanding of the relationships between various environmental conditions, management actions, and stream temperature characteristics can help identify opportunities to better manage watersheds for desired conditions.

Monitoring Question 41 - To what extent is Forest management beneficially or adversely affecting soil erosion and stream sedimentation processes?

Stream sedimentation is a primary concern in protection and management of water resources. Many streams on the Forest are currently affected by increased levels of fine sediment that impairs the health of aquatic ecosystems, with a special concern on the productivity of native brook trout. Sediment originates mainly from upland sources delivered to streams through several transport processes (erosion, head-cutting, mass wasting) and from within-channel sources of bank erosion and sediment transport from the upstream channel network.

Management actions that disturb soils—such as roads, logging, recreation sites and mineral developments—can increase erosion and sedimentation due to increased rates of soil loss. It is commonly accepted that roads are the primary source of accelerated soil erosion and sediment associated with Forest management activities. This is why we emphasize minimizing road-related impacts and decommissioning roads to improve watershed and aquatic conditions.

Stream sedimentation monitoring is routinely conducted as a component of Forest-wide stream surveys on the MNF. These surveys investigate the particle size distribution of stream sediments (pebble counts), the percentage of fine sediments within samples of potential trout spawning gravels (percent fines), the stability of stream channel sediments (Riffle Stability Index – RSI), and the stability of stream banks (bank instability). In addition to the data collected during stream surveys, fine sediment samples are collected annually in seven tributaries of Elk River as part of the East Gauley Aquatic Monitoring Plan (1997).

Monitoring Question 41 - Evaluation, Conclusions, and Recommendations

Table AR-6 provides a summary of preliminary results from stream sediment assessments conducted on various streams during FY 2008.

Table AR-6. Summary Data of Stream Sediment Monitored during Summer 2008

Stream Name	% FineSediment	Stream Name	% FineSediment
Anthony Creek	14.4	Laurel Fork (upper)	36.3
Beaverdam Run	35.4	Laurel Run	17.8
Big Draft	18.5	Little River Upper	34.4
Black Mountian Run	-	Meadow Creek	-
Clover Run Left Fork	-	Old Road Run	34.1
Clubhouse Run	19.6	Poca Run	25.7
Cove Run	28.6	Thorny Creek	10.2
EF Greenbrier- upper	29.5	Big Run – Abb Run*	36.0
Elk Run	11.8	Big Run – Dry Branch*	22.8
Fill Run	27.0	Bradshaw Run*	31.3
Five Lick Creek	15.3	Chimney Rock Run*	28.3
Grassy Run	42.1	Laurel Run*	37.3
Laurel Creek	25.1	Props Run*	37.8
Laurel Creek_Douthat	19.6	Rose Run*	29.2

*Elk River Tributary, part of the East Gauley Aquatic Monitoring Plan.

Fine sediment in stream channels can affect water quality and trout productivity. The reproductive success of native brook trout can be reduced as levels of fine sediment increase. On the MNF, fine sediment is defined as particles less than 4mm in size, which approximates the size of a brook trout egg. Samples are collected in potential spawning gravels and when fine sediment comprises 20%+ of the gravel sample (by weight), productivity to trout productivity can be impaired. Of the 25 samples collected in 2008, 17 samples (68%) had levels of fine sediment exceeding 20%. The findings from 2008 are similar to our overall results that show that approximately 2/3 of the streams sampled have levels of fine sediment exceeding 20%.

In streams with elevated levels of fine sediment, further evaluation is needed to determine if sediment is indeed a limiting factor, or other issues such as water chemistry maybe limiting the aquatic biota. Additional evaluations would also allow for the identification of sources of sediment and potential watershed improvement opportunities.

Recommendations: It is recommended that sediment monitoring continue on an annual basis in streams across the Forest. An increased understanding of the relationships between various environmental conditions, management actions, and stream sediment characteristics can help identify opportunities to better manage watersheds for desired conditions.

Monitoring Item 42 - To what extent is Forest management beneficially or detrimentally affecting the physical conditions of aquatic ecosystems, including riparian ecosystem function and health?

The Forest implemented a number of projects and inventories in FY08 that contribute to the restoration of healthy watersheds and aquatic ecosystems. Inventories included the continuation of data collection using a standardized survey protocol to collect aquatic ecological information that provides a basis for restoration decisions and helps to effectively prioritize and implement restoration activities.

Riparian Ecosystem Function and Health

Direction in the Forest Plan includes standards and guidelines that are designed to protect aquatic and riparian resources from potentially damaging effects associated with various land management activities. Forest activities were observed during 2008 to assess whether they were being implemented in a manner that is consistent with Forest Plan direction for aquatic and riparian resources management. Monitoring of activities in and around streams and riparian areas was largely limited to incidental observations from different watershed personnel pursuing a variety of other field work. Activities that were monitored for consistency with Forest Plan direction for riparian resources primarily included timber harvests, road development projects, and conditions within grazing allotments.

Forest Roads

Road planning and development efforts are pursued with consideration for protecting riparian resources and associated aquatic ecosystems. Typically, if new road construction is deemed necessary to meet management objectives, they are planned to avoid risks that would likely contribute substantive adverse effects to aquatic and riparian resources. Planning efforts for new timber harvests seek opportunities to modernize the Forest transportation system by locating or relocating roads in more suitable locations away from streams. Unneeded and poorly located roads are often identified for corrective actions such as heavy maintenance upgrades, road storage or obliteration in order to reduce adverse impacts to riparian areas and stream ecosystems. These principles are currently being used to develop project proposals in the Upper Greenbrier River Watershed. In addition, riparian and aquatic resources benefitted from the decommissioning of 2.7 miles of Forest Road 242 along Clubhouse Run in the West Fork Greenbrier River watershed and the installation of barriers to illegal motorize vehicle use on

system trails along the West Fork Greenbrier River tributaries. In other areas of the Forest, several more miles of roads were inventoried in the Upper Williams River in preparation for decommissioning in subsequent years.

Timber Harvest

Forest Plan direction requires protection of stream and riparian ecosystems when implementing land management activities. Timber harvesting activities have the potential to impact streams and riparian areas if planned mitigations and project designs are not properly implemented.

Increasingly, pre- and post-harvest activities include the use of herbicides to control undesirable vegetation within harvest units. In FY 2008, the potential impacts of herbicides on riparian vegetation and aquatic resources were monitored in four units of the Little Beech timber sale in the Glady Fork watershed. The units that were monitored were selected due to soil and water concerns. Riparian areas were delineated within the units and drift cards were utilized to detect drift of herbicides into the riparian areas. Cards were placed at multiple transects within the riparian areas and evidence of minor herbicide drift was detected in 3 of the 4 units. Site visits were made several weeks after the herbicide applications to assess effects to vegetation. Although herbicide drift into riparian areas was detected to some level in three of the four units monitored, the drift was inconsequential as essentially no effects to riparian vegetation were observed during subsequent site visits. In contrast, vegetation within the treatment areas was noticeably affected by the herbicide treatments as designed. Water samples collected pre-treatment, during treatment, and post treatment did not detect chemicals from the various herbicides that were sprayed. A complete report of the herbicide monitoring effort for the Little Beech timber sale is available in the project file.

Range Allotments

The Forest has approximately 6,000 acres in range allotments and some of these allotments have streams flowing through their interior. To limit cattle impacts to water quality and the streamside zones, the Forest has had an active program of fencing streams within or adjacent to allotments, to protect and restore riparian ecosystem health and function. Progress has been slow because of funding limitations and other related reasons. In the last six years, fencing streams within allotments has helped restore riparian areas and protect water quality in five allotments (Shearer North and South, Friel Run, Day Run, and Big Run). In 2008, an additional 11 acres of riparian area were fenced in the Big Run allotment to protect aquatic and riparian resources, and a total of 37 acres were planted with native spruce, willow, and dogwood species. Big Run is a highly valued native brook trout stream and a headwater of the North Fork South Branch Potomac River. This was the second year of improving conditions within the allotment through fencing, water development, and riparian planting. The decision has been made to pursue a similar project for riparian and stream protection in the Mullenax Allotment located in the headwaters of the Elk River. Implementation of the Mullenax riparian fencing and restoration project is planned for 2009.

Aquatic Ecological Unit Inventory and Monitoring

The MNF uses standardized survey protocols to conduct aquatic ecological unit inventory and monitoring (AEUI) of stream ecosystems across the Forest. Surveys for AEUI are designed to

expand on existing knowledge of conditions and trends associated with physical and biological components of aquatic ecosystems on the Forest and to contribute toward long-term monitoring needs. During 2008, the Forest dedicated a summer watershed crew to conduct surveys of valley segments, stream reaches, and channel units in 23 stream systems across the Forest. Physical dimensions were measured for flood prone area, stream channel dimensions and aquatic habitats. Measurements were also taken of stream substrates in riffle habitats and gravel bar formations to assess channel stability. Potential spawning substrates were sampled to determine the percentage of fine sediment composition that can serve as an index for the quality for brook trout spawning habitat and aquatic macro-invertebrate habitat. The overall composition of stream substrates and aquatic cover attributes were visually assessed within reference reaches. Large woody debris was inventoried according to size classifications to assess structural diversity within streams. Fish population assemblages were sampled to assess species composition and other population characteristics used to evaluate the health of biotic communities (Table AR-7).

Table AR-7. Summary Data for Aquatic Ecological Unit Inventory and Monitoring Conducted during FY 2007

Stream	Rosgen Type	% Fast Habitat	% Slow Habitat	RPD[1]	Bank Instab.[2]	Riffle Stab. Index	% Fines	Cover[3]	LWD[4]	Fish Biomass (lbs/acre)
Anthony Creek	B1/4c	9.6	90.3	0.58	R	89.2	14.4	G	S	59.3
Beaverdam Run	E4	51.1	48.9	0.23	C	85.7	35.4	P	S	52.8
Big Draft	B3	65.8	34.2	0.25	R	87.9	18.5	P	M	6.9
Black Mountain Run	F3b	71.6	28.4	0.20	O	80.2	40.2	F	S	32.7
Clover Run Left Fork	F3b	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Clubhouse Run	B3	81.3	18.7	0.15	C	95.7	19.6	P	A	17.4
Cove Run	B3	67.4	32.6	0.27	O	100.0	28.6	P	S	39.7
EF Greenbrier-upper	B3c	71.4	28.6	0.57	C	96.2	29.5	P	M	25.6
Elk Run	B1	51.8	48.2	0.28	O	50.3	11.8	P	A	39.1
Fill Run	B3c	72.2	27.8	0.27	C	97.1	27.0	P	M	34.4
Five Lick Creek	C3b	59.2	40.8	0.21	C	76.1	15.3	F	M	82.1
Grassy Run	C3b	88.4	11.6	0.14	C	97.7	42.1	P	A	13.8
Laurel Creek	C3b	74.5	25.5	0.28	R	91.0	25.1	P	S	N/A
Laurel Crk_Douthat	B4C	54.3	45.7	N/A	O	99.1	19.6	G	A	N/A
Laurel Fork-upper	C3	32.2	67.8	0.27	C	95.8	36.3	P	S	28.7
Laurel Run	F3/4	81.4	18.6	0.38	O	84.4	17.8	G	M	14.2
Little River Upper	C3/5	53.0	47.0	0.42	C	87.1	34.4	P	M	34.7
Meadow Creek	F6	16.2	83.8	0.35	R	64.2	N/A	P	M	19.3
Old Road Run	F4	28.6	71.4	0.56	C	100.0	34.1	P	M	44.3
Poca Run	B3a	83.3	16.6	0.18	R	94.8	25.7	P	A	40.9
Thorny Creek		58.9	41.1	0.24	R	89.9	10.2	P	S	33.4

1: Residual Pool Depth - measure of pool quality
2: Bank Instability - R = rare; O = occassional; C = common
3: Instream Cover - G = good; F = fair; P = poor
4: Large Woody Debris - A = abundant; M = moderate; S = scarce

Preliminary results of AEUI surveys on the MNF during 2008 are summarized in Table AR-7. Surveyed stream reaches represent B, C, E, and F type channels (Rosgen 1994). Channel types characteristically exhibit inherent physical properties as a function of channel-forming

hydrologic processes. However, inherent channel properties can deviate considerably for a given channel type in response to influential disturbance mechanisms that vary in nature, extent, and duration. Results from the 2008 AEUI surveys reflect stream conditions that have been altered by a variety of natural and human-induced disturbances.

Aquatic habitat composition is a measure of different types of habitats such as cascades, riffles, runs, glides, and pools. Each type of aquatic habitat offers unique habitat elements for various aquatic inhabitants. Therefore, it is desirable for streams to possess a diversity of habitat types to support healthy aquatic communities. Habitat types have been generally categorized as slow water and fast water habitats for purposes of analysis in this report.

Slow water habitats that also tend to be deeper, such as pools and glides, provide critical rearing and over-wintering areas for brook trout and other aquatic species that are native to streams on the Forest. Fast water habitats, such as riffles and runs, are also important for many of the Forest's aquatic inhabitants. The physical composition and quality of aquatic habitats is naturally a reflection of dynamic channel processes that influence stream channel integrity. Slow water habitats can be compromised and potentially converted to shallow, fast water habitats in stream systems that become unstable and function outside of an established dynamic equilibrium. As streams recover from destabilizing influences and re-establish dynamic equilibrium, slow water habitats can reform to become more abundant and of better quality. General stream conditions across the Forest indicate that slow water habitats are frequently limited in abundance, poorly developed, or both. By contrast, shallow, fast water habitats are typically over-represented in streams on the Forest.

Large Woody Debris Additions

Aquatic habitat conditions across the Forest are affected by a loss of large woody debris (LWD). Large woody debris is important for a number of functions in perennial, intermittent, and ephemeral channels. In perennial streams, LWD increases habitat complexity by scouring pools, trapping spawning gravels, providing hiding cover, and helping to dissipate stream energy. In intermittent and ephemeral channels LWD helps to trap and store sediment in the watershed, provides structure for channel stability, and helps retain.

Past logging activities have left most streams on the Forest with limited levels of LWD. The extensive clear cutting around the early 1900's removed trees adjacent to stream channels that were the source of LWD. Recruitment of LWD has been greatly reduced for the past 70+ years. The low levels of LWD in stream channels have resulted in stream environments that are simplified and generally lack adequate pool habitat and hiding cover. A review of stream survey data from 1996-1998 reveals the effect of LWD absence. The most common channel type of the stream reaches inventoried was "plane bed". Plane bed reaches are generally featureless, with limited habitat complexity. Of the 670 stream reaches that were inventoried, 293 (44%) were classified as plane bed (data on file at the MNF Supervisors Office). The remaining reach types were cascades (15%), bedrock (12%), beaver (8%), pool-riffle (8%), step pool mix (7%), and pool-riffle mix (5%). The amount of plane bed reaches should decrease as LWD increases. Over time this will improve pool development and result in more step pool and pool-riffle reaches.

Today, the riparian timber stands are maturing and natural recruitment of LWD is expected to increase as trees die and fall into the stream channels. Protecting riparian timber stands to retain this source of recruitment is important for the restoration of aquatic habitat conditions and the protection of water quality. Opportunities also exist to increase the amount of LWD in stream channels by actively adding wood to channels.

In FY08, LWD was increased in an estimated 2.5 miles of aquatic habitat across three streams. Over 100 trees were felled during project implementation, and in-channel structure was obviously increased. Onsite trees were directionally felled into the streams from adjacent timber stands. Trees selected for felling were distributed to avoid modifying riparian conditions such as stream shading. The variety of species utilized represented the composition of the riparian stands, and the trees were felled at a range of orientations to the channel to mimic natural recruitment processes. Heavy equipment was not used to place the wood and high flows will be allowed to rearrange and entrain the LWD within the channels.

Habitat Connectivity

Annual and seasonal variation of habitat conditions such as stream flows, stream temperature, and water chemistry can bring about shifts in species distribution as aquatic organisms migrate to seek more favorable habitat conditions. The ability for aquatic populations to move between habitats in response to environmental conditions or other instinctive behavior is dependent on the availability and accessibility of these habitats. Stream crossings associated with features such as roads and trail systems frequently inhibit or completely prevent aquatic organism passage between suitable habitats. It is a goal of the Forest Plan (WF04) to identify artificial aquatic passage barriers and eliminate these features as sources of habitat fragmentation where risk of genetic contamination, predation, or competition with undesired fish species is not a concern.

Building upon a multi-year effort to inventory aquatic organism passage at priority culverts, the Monongahela National Forest entered into a Participating Agreement (08-PA-11092100-023) with the Aquatic Research Center of the Indiana Biological Survey (ARC) to investigate 30 culverts in 2008. The purpose of the agreement was to use the National Inventory Assessment Protocol (NIAP), the 'coarse screening filters' developed and validated by Coffman, and biological sampling to assess the passage status of selected crossings in the MNF. The coarse screening filters use stream and culvert dimensions, characteristics, shape, condition, and survey data to categorize a crossing as passable, impassable, or indeterminate based on the swimming and leaping abilities of fishes. There are three filters that are considered in the determination: Filter A is calibrated for strong swimmers and jumpers, such as adult trout; Filter B is calibrated for moderate swimmers and jumpers such as juvenile trout and cyprinids; and Filter C is for weak swimmers and jumpers such as darters and sculpin. Biological sampling of fish and crayfish on each side of the crossing is used to compare biotic integrity, diversity, and community structure to further determine the impacts of the crossing. Results of the NIAP, biological survey, and coarse filter evaluation—along with a GIS map, site drawings and photos of each crossing—were compiled and provided to the Forest. The resulting data enable us to target specific crossings for replacement or modification to better facilitate aquatic movement and improve biotic integrity. The report has already been utilized to help set Forest priorities for aquatic organism passage (AOP) opportunities.

Table AR-6 lists the 30 steam crossing locations that were to be inventoried according to the Participating Agreement using the NAIP, also know as the San Dimas protocol. The ARC results of the 'course screening filters' based on the physical data collected at each site. For sites with more than one pipe, the most favorable result of the course screening is shown.

Table AR-6. Aquatic Organism Passage (AOP) Surveys Conducted during FY 2008

Stream	Road	Filter A	Filter B	Filter C
Long Run	SS2	Impass.	Impass.	Impass.
Briggs Run	SS2	Impass.	Impass.	Impass.
Sawmill Branch	SS28/10	Impass.	Impass.	Impass.
Grants Branch	SS29	Impass.	Impass.	Impass.
Nans Branch	SS29	Indeterm.	Impass.	Impass.
Upper Two Springs	SS29	Pass.	Pass.	Pass.
Lower Two Springs	SS29	N/A	N/A	N/A
UNT2 EF Glady*	FS385A	Indeterm.	Impass.	Impass.
EF Glady*	fs385	Pass.	Pass.	Pass.
Tingler Run*	ss40	Pass.	Pass.	Pass.
EF Glady*	fs183	Indeterm.	Indeterm.	Indeterm.
UNT1 EF Glady	fs183	Indeterm.	Impass.	Impass.
UNT4 EF Glady	fs183B	Indeterm.	Impass.	Impass.
Millstone Run	ss37/8	Indeterm.	Impass.	Impass.
UNT UNT2 Mtn Lick*	ss250/8	Pass.	Pass.	Pass.
Johns Run*	ss250/4	Indeterm.	Indeterm.	Indeterm.
Louck Run*	fs183	Indeterm.	Impass.	Impass.
Three Springs*	fs229	Indeterm.	Indeterm.	Indeterm.
Three Springs*	fs162	Pass.	Pass.	Impass.
UNT4 Glady Fork*	fs162	Impass.	Impass.	Impass.
UNT2 WF Glady	fs44	Indeterm.	Impass.	Impass.
Indian Run	fs361	Impass.	Impass.	Impass.
Hobson Run	ss15/3	Indeterm.	Impass.	Impass.
RF Clover Run	ss15/3	Indeterm.	Impass.	Impass.
Craig Run*	fs429	Pass.	Indeterm.	Impass.
Jonathan Run	fs429	Indeterm.	Impass.	Impass.
Laurel Run	fs86	Indeterm.	Impass.	Impass.
UNT1 White Oak Fork	fs133	Impass.	Impass.	Impass.
White Oak Fork	fs133C	Indeterm.	Impass.	Impass.
White Oak Fork	fs86	Indeterm.	Impass.	Impass.

* Crossings with more than one pipe. The most favorable passage condition is shown.

Monitoring Question 42 - Evaluation, Conclusions, and Recommendations

Riparian Ecosystem Function and Health

FY 2008 monitoring indicates that riparian ecosystem function and health are being protected in the implementation of timber harvesting and road development to standards consistent with

Forest Plan direction. Adverse impacts to riparian areas are in some cases unavoidable, such as at stream crossings by roads, and in these instances we try to have the least amount of impact feasible. Riparian ecosystem health continues to be impacted by existing uses and facilities, such as existing roads of all kinds, some recreation developments, and grazing allotments. But Forest restoration activities are improving riparian function and health annually through such projects as road decommissioning and range allotment fencing.

Recommendations: Continue riparian ecosystem restoration activities through road closure or decommissioning projects and riparian area fencing in range allotments to reduce sources of stream sedimentation, improve water quality, address modifications to hillslope hydrology, and restore aquatic and riparian ecosystem health and function.

Conduct riparian ecosystem monitoring by an interdisciplinary team annually, with a systematic approach to project selection and motoring protocol. No changes in Forest Plan direction are recommended at this time.

Aquatic Ecological Unit Inventory and Monitoring

Habitat composition data from 2008 indicate that 16 of the streams surveyed (80%) were dominated by fast water habitats and 50% of those (8 streams) had at least 70% of their surface area in fast water habitat. These findings are generally consistent with prior surveys and what we expect to see until channel structure, especially in terms of large woody debris, and channel integrity improve. Habitat composition is also a function of broader fluvial geomorphic channel types, which is characterized by the survey data. The surveyed streams represent a range of Rosgen channel classifications that form the baseline from which altered conditions through time may be measured as these surveys are replicated in the future.

Residual pool depth (RPD) is a measure of pool development and can serve as an index of pool quality. The data collected on RPD also forms the baseline data for the streams surveyed and can be used as an indicator of changes in pool quality associated with changes in channel conditions. The expectation is, as channel structure and channel integrity improve, so will pool quality, which would be reflected in higher RPD numbers when streams are re-surveyed.

The integrity of stream channels is often measured in terms of stream bank erosion and stream bed stability. Measures of stream bank integrity indicate 45 percent of streams reaches surveyed during 2008 had common occurrences of bank instability, 20 percent had occasional bank instability, and 35 percent had rare instances of bank instability. Riffle stability indices (RSI) (Kappesser 2002) suggest that stream bed substrates are mobile and highly unstable in more than 85 percent of stream reaches surveyed during 2008. Fifteen of the surveyed streams had RSI scores of equal to or greater than 85, indicating unstable systems with excess riffle sediment.

Other characteristics surveyed during 2008 to help assess the condition and trend of steams on the Forest include the percentage of fine sediment in potential brook trout spawning gravel, the composition of in-stream cover, and inventories of LWD. Nearly 60 percent of the stream reaches analyzed for fine sediment possessed levels in excess of 20 percent. Results of in-stream cover composition show that 75 percent of the stream reaches surveyed received a poor rating.

Inventories of LWD indicate that 75 percent of the stream reaches surveyed possessed scarce to moderate amounts of LWD and the remaining 25% had abundant levels of LWD.

Information about fish populations can be useful for assessing and monitoring the health and productivity of aquatic ecosystems. Fish population assessments were conducted in conjunction with AEUI habitat assessments during 2008. Fish biomass was calculated for each fish species encountered during the population surveys. Results of this data show that total fish biomass ranged from a high of 82.1 lbs/acre in Five Lick Creek, a tributary to the Laurel Fork, to a low of 6.9 lbs/acre in Big Draft where only nongame species were collected. Brook trout populations were present in 65 percent of the stream reaches surveyed. Biomass of brook trout ranged from a high of 50 lbs/acre to a low of 2.8 lbs/acre in streams where brook trout were sampled.

Variation in fish biomass highlights the differences in productivity between streams. Variation in productivity between some streams may partially be explained by more obvious differences, such as stream size or geologic setting. However, productivity for most streams on the Forest is also believed to be a function of the quality of in-stream habitat conditions and general health of the stream system as a whole. Results from AEUI surveys are critical for addressing these and other questions related to aquatic habitats and populations across the Forest and monitoring aquatic resource trends through time to determine if Forest goals and objectives are being met.

Recommendations: Aquatic ecological unit inventory and monitoring data is an important element to understanding the condition, trend, processes, and functions of aquatic ecosystems and their contributing watershed areas. It is recommended that AEUI surveys be continued to obtain a more complete dataset for evaluating land management proposals and assessing trends. The utility of information collected to date will not be fully realized until a more complete dataset is available and synthesized for interpretative value. Synthesis and interpretation of this information is on-going.

Habitat Connectivity

Based upon the NAIP, 23 of the 29 culverts that were inventoried were determined to be ‘impassable’ or indeterminate. Of the remaining culverts, four are considered ‘passable’, one is passable for strong swimmers, but impassable for moderate and weak swimmers, and one is passable for strong and moderated swimmers and but impassable for weak swimmers. Most impassable ratings were due to large outlet drops.

Overall, a total of 13 species of fish were collected and the most common were western blacknose dace (*Rhinichthys atratulus*), mottled sculpin (*Cottus bairdi*), and brook trout (*Salvelinus fontinalis*). Crayfish were present at all sites that were biologically sampled, except two. A total of 345 individuals were collected and they were all rock crayfish (*Cambarus bartonii carinirostris*).

Results from these surveys are expected to help the Forest develop and implement a strategy to achieve a specific Forest Plan objective (WF08) to correct 30-50 aquatic passage barriers, according to aquatic priorities, during the 10-year horizon of the Forest Plan. The use of a partnership agreement to acquire this data was a useful tool.

Recommendations: Given the number of passage problems associated with stream crossings that were identified by this and other efforts on the Forest, it is recommended that AOP surveys be continued to obtain a more complete picture of opportunities across the Forest. This information is crucial to meeting various Forest Plan goals and objectives related to aquatic resources management. Utilize information from AOP surveys and other aquatic habitat and population assessments to develop a strategy for correcting barriers to aquatic passage.

Monitoring Question 43 - To what extent is Forest management influencing the viability of native and desired nonnative species (e.g., RFSS and MIS) or otherwise affecting species composition and habitat productivity?

Aquatic species viability was recently assessed during Forest Plan revision and reported in the Final Environmental Impact Statement for Forest Plan Revision and its Appendices (2006). The answer to this monitoring question is essentially a synthesis of all the other monitoring questions for Aquatic Resources, because species viability is the end result of managing for clean water, healthy riparian areas, and productive aquatic ecosystems.

One way of evaluating the ecological conditions needed to maintain species viability is through compliance with the federal Clean Water Act (CWA). Compliance with CWA requirements is an important aspect of management and protection of water quality and aquatic resources on the National Forest. Authority to implement and regulate CWA programs is delegated to the state of West Virginia, and overseen by the U.S. Environmental Protection Agency. The West Virginia Department of Environmental Protection (WV-DEP) is the state agency with primary responsibility for implementation and enforcement of CWA programs.

WV-DEP programs to control pollution include the control of both point sources and non-point sources of pollution. Point source control programs regulate individual pollution sources through a permitting program known as the National Pollutant Discharge Elimination System (NPDES). The non-point source control program regulates pollution from a wide variety of non-point sources by requiring the use and maintenance of Best Management Practices (BMPs) for the reduction and control of non-point source pollutants. Forestry (forest management) is one of the categories of activities that fall under non-point source control programs.

Forest conformity with CWA goals and regulations is accomplished through compliance with state BMP programs and by implementing Forest Plan direction, which may exceed state BMP requirements. The MNF also manages a number of point-source facilities (sewage treatment systems) and these are operated in compliance with state NPDES permitting requirements.

WV-DEP has established water quality standards and designated uses for all waters of the state, as required by the CWA. Water quality standards specify the water quality required to achieve the designated use of each particular water body. Some examples of designated uses include water contact recreation, propagation and maintenance of fish and other aquatic life, and public water supply. Each of the designated uses has associated criteria (numeric or narrative) that describe specific conditions that must be met to ensure the water can support that use.

Water quality conditions and trends for streams and other water bodies are documented by monitoring efforts. Measured in-stream water quality data are compared with water quality standards to determine the use attainment status of the water body. A water body is considered impaired if it violates quality standards or does not meet its designated uses. Impaired waters are then placed on the state's "impaired water bodies list" [303(d) list], and scheduled for development of a Total Maximum Daily Load (TMDL) by WV-DEP to correct the impairment. TMDLs may be developed to address both point and non-point sources of impairment. Some impaired or threatened waters are deemed not to need a TMDL, such as those whose impairment is attributable to "natural factors".

Monitoring Question 43 - Evaluation, Conclusions, and Recommendations

The majority of streams (and stream miles) within the MNF are meeting state water quality standards and all their designated uses, as described in the State Legislative Rule, 47CSR2, Requirements Governing Water Quality Standards. However, many streams have not been sampled yet and lack sufficient data or information to make a determination.

The most recent state 303(d) impaired streams list was developed and reported to US-EPA in 2008. It lists streams by major watershed and the criteria for which that stream is being categorized as impaired, and gives the length/reach description for the impaired segment. A wide variety of impairment criteria are listed: pH, CNA-Biological, aluminum, mercury, iron, PCBs, fecal coliform, and others. The list identifies the source of the impairment, if known, and the expected year of TMDL development. In some cases TMDLs may not be developed by the state for many years. For most listed streams, the source of the impairment is "Unknown".

A number of streams within the proclamation boundary of the MNF are included in the 2008 303(d) list. Many of these are entirely within private ownership and involve no National Forest ownership within their watersheds. Many other streams on the 303(d) list may have limited amounts of National Forest System land within their watersheds but the listed stream segments are not (or largely not) flowing through or adjacent to National Forest ownership. Remaining waters within the proclamation boundary of the MNF that are listed on the 303(d) list fall partially or entirely within National Forest lands. The State's 2008 303(d) list may be found on the West Virginia DEP website at www.wvdep.org and a copy is maintained in the MNF Supervisors Office. An analysis of the 2008 list as it relates to Forest streams has not yet been completed, but we do not anticipate a large difference from prior year findings.

Recommendations: It is recommended that the MNF continue to work with the West Virginia Watershed Management Framework and WV-DEP to: 1) ensure Forest activities are conducted in a manner that facilitates compliance with water quality criteria in the CWA; and 2) identify opportunities to improve water quality in stream segments placed on the state's 303(d) list of impaired water bodies

It is recommended that a standardized process be developed for implementation, effectiveness, and validation monitoring of Forest Plan standards and guidelines with respect to water quality issues.

Monitoring Question 44 - To what extent is Forest management influencing populations of terrestrial or aquatic non-native species that threaten native ecosystems?

The MNF entered into a participating agreement (Agreement Number 04-PA-11092100-070) with West Virginia University and the West Virginia Cooperative Fish and Wildlife Research Unit in 2004 to synthesize existing distribution data for fishes occurring within the MNF proclamation boundary. Though distribution updates were sought for all fish species occurring within the proclamation boundary, this effort had an emphasis on fish species listed as Regional Forester's Sensitive Species (RFSS) and those identified as non-native species. In addition, an effort was made to estimate the abundance of RFSS and non-native fish species within the Greenbrier River system of the MNF. The final report of this study was submitted to the Forest in August, 2007, and is available in the project file.

This report includes the results from two master's theses and dot-distribution maps that document known locations of fish species within the MNF proclamation boundary. Among various findings from this effort, there is a reported range expansion for several non-native fishes, including whitetail shiner (*Cyprinella galactura*), telescope shiner (*Notropis telescopus*), Roanoke darter (*Percina roanoka*), rainbow darter (*Etheostoma caeruleum*), and variegate darter (*Etheostoma variatum*).

In FY 2008, Didymo geminate, a freshwater alga, was first reported on the Forest in the Glady Fork and Gandy Creek. Since that time, additional populations have been identified in other streams, on and off Forest, and the initial spread appears to be fairly rapid. The MNF is actively working with the West Virginia Division of Natural Resources and other partners, to increase public awareness about didymo to reduce the spread.

Monitoring Question 44 - Evaluation, Conclusions, and Recommendations

The ecological implications of the expanding distribution of non-native species are not well-understood for four of the five species reported above. However, recent research has found that the invasion of variegate darter into streams of the New River system is threatening the genetic integrity of endemic populations of candy darter (*Etheostoma osburni*) through hybridization. Populations of candy darter within the Anthony Creek watershed, tributary to the Greenbrier River, already appear to have been genetically swamped out by the invasion of variegate darter.

Currently, the expanded range of variegate darter within the MNF proclamation boundary appears to be restricted to streams in the lower portion of the Greenbrier River system. Streams that occur on the MNF in the upper portion of the Greenbrier River watershed may have a pivotal role to play in the conservation of candy darter.

Recommendations: It is recommended that the Forest continue to work with researchers and other partners to identify issues related to aquatic nuisance species and develop action plans to protect native and desired non-native aquatic species from being deleteriously affected.

Monitoring Question 46 - Is the Forest providing adequate habitat to meet the demand for wildlife and fisheries related social and recreational opportunities?

The WVDNR has developed a procedure to directly apply limestone sands to surface waters to help mitigate some of the effects of acid deposition on stream water chemistry. In 2008, the Forest continued on-going cooperative efforts with WVDNR to treat the effects of stream acidification on various recreational fisheries across the Forest. Glade Run and Lambert Run are tributaries to the Shavers Fork, which is a popular recreational fishing destination on the Forest. Limestone sand treatment to Glade Run and Lambert Run helped mitigate the effects of acid deposition in these tributary streams as well as segments of the Shavers Fork downstream from these tributaries.

Coats Run is a tributary to the North Fork Cherry River and is the primary water source for Summit Lake. This stream is treated with limestone sand primarily to help mitigate the effects of acid deposition on the water chemistry of the 38-acre lake. Summit Lake serves as a popular recreational fishery that supports a seasonal coldwater fishery for stocked trout and a warm water fishery for bass and sunfish. The effects of limestone treatments to the lake are likely transferred to downstream reaches of Coats Run and the North Fork Cherry River below Coats Run.

In addition to treating a number of other acid sensitive streams on the Forest with limestone sands to promote recreational fishing opportunities, WVDNR also utilizes numerous high-profile streams on the MNF to stock hatchery-reared fish for recreational fishing. Though habitat conditions in some stocked streams are not ideally suited for a quality year-round trout fishery, they are sufficient for a seasonal put-and-take fishery.

Monitoring Question 46 - Evaluation, Conclusions, and Recommendations

Various efforts are continuously pursued by the MNF and others to provide and promote sustainable recreational fishing opportunities across the Forest. Efforts span a range of management issues including aquatic habitat protection and enhancement, aquatic population assessment and conservations, and public outreach and education. As a tribute to these efforts, streams on the MNF are popular destinations particularly for many trout fishing enthusiasts.

Recommendations: It is recommended that the MNF continue to coordinate with WVDNR in efforts to manage fisheries resources and provide for recreational fishing opportunities across the Forest.