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 in order to satisfy legal requirements, agency directives, and Plan direction. 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.

Monitoring and evaluation of aquatic resources is necessary to help answer questions about Forest Plan implementation and direction related specifically to Forest Plan goals, objectives, and desired conditions for aquatic ecosystems. Direction in the 2006 revision of the Forest Plan contains 10 monitoring questions related to aquatic resources management. These monitoring questions are designed to help focus monitoring efforts on the Forest's obligation to satisfy legal mandates, agency directives, and Forest priorities.

2007 Accomplishments

The Forest conducted various activities during FY 2007 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 2007 accomplishments that are most directly related to aquatic resources management on the Forest.

Table AR-1. Aquatic Resource Accomplishments in 2007

Products, Services, and Activities	Quantity
Streams on National Forest lands (miles)	2,753
Streams on National Forest lands not meeting WV State water quality standards (miles)	250
Lakes on National Forest Lands (acres)	250
Temporary Summer Employees (college students employed for aquatic resources inventory/monitoring)	6
Randolph County Outdoor Education Programs (aquatic modules)	18
Free Fishing Clinics and Other Aquatic Resources Outreach (events)	5
Mid-scale Resource Analyses (Watershed Assessments)	1
Project Level Aquatic Resources Coordination (Biological Evaluations reported in WFRP)	38
Stream Channel Restoration (miles) – Big Run Allotment Riparian Restoration	*1
Riparian Restoration (acres) – Big Run Allotment Riparian Restoration	26
Limestone Treatment to Acid Impaired Streams (miles)	10
Limestone Treatment to Acid Impaired Lakes (acres)	38
Cooperative Administrative Studies (Participating Agreements)	5

*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 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 specific 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 2007 Accomplishment	Total Accomplished under 2006 Forest Plan
Actively restore aquatic and riparian habitat conditions in 30-50 miles of stream.	1	1
Maintain at least 560 miles of coldwater stream habitat capable of supporting wild, naturally reproducing brook trout.	560	560
Decommission or reclaim at least 30 miles of roads that are no longer needed for achieving access management objectives.	0	0
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 2006 revision of the Forest Plan for the Monongahela National Forest (MNF) identifies legal and regulatory requirements for monitoring the implementation of the Forest Plan. 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 recent forest plan revision process (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.

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.

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
26. 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	
39. To what extent are Forest management and other external influences (such as acid deposition) affecting water quality, quantity, and physical conditions of aquatic ecosystems?	1, 2, 3, 4, 5, 7	
40. To what extent is Forest management affecting riparian ecosystem function and health?	2, 3, 4, 5	
41. To what extent is Forest management affecting soil erosion and stream sedimentation processes?	3, 4, 7	
42. To what extent is Forest management affecting the aquatic community, including habitat connectivity and invasive/non-native conditions and effects?	2, 3, 4, 5, 6, 7	
43. To what extent is Forest management contributing to the restoration of healthy watersheds and aquatic ecosystems?	1, 2, 3, 4, 5, 6, 7	
44. To what extent is Forest management providing ecological conditions to maintain viable populations of native and desired non-native species?	1, 2, 3, 4, 5, 6, 7, 8	
45. To what extent is Forest management contributing or responding to populations of terrestrial or aquatic non-native species that threaten native ecosystems?	6	
48. Is the Forest providing adequate habitat to meet the demand for wildlife-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 2007 help address various monitoring elements described in the Forest Plan. Table AR-4 lists the focused aquatic resource monitoring efforts conducted during FY 2007.

Table AR-4. Aquatic Resource Monitoring Efforts in FY 2007

Monitoring Activity	Quantity
Stream Water Chemistry (sites)	97
Aquatic Ecological Unit Inventory and Monitoring – Aquatic Habitats/Populations (sites)	21
Aquatic Organism Passage Inventory/Assessments (sites)	18
Summer Stream Temperature Regime (sites)	36
East Gauley Mountain Monitoring – Aquatic Habitats/Populations/Sediment (streams)	7
Hillslope Hydrology Study	1

Following are descriptions, evaluations, conclusions, and recommendations associated with monitoring efforts conducted during FY 2007 for aquatic resources.

Monitoring Question 39 - To what extent are Forest management and other external influences (such as acid deposition) affecting water quality, quantity, and physical conditions of aquatic ecosystems?

Water Chemistry and Acid Deposition

Water chemistry is one of the fundamental components of aquatic ecosystems. The geologic composition of watersheds is a primary factor that influences water chemistry of surface waters such as streams and lakes. Highly diverse surficial geologies across the MNF possess inherent physical and chemical characteristics of bedrock and soils that give rise to surface waters with variable chemical properties, including buffering capacities for neutralizing acid inputs. Aquatic ecosystems on the MNF exhibit a wide range of surface water chemistries both spatially and temporally. Favorable water chemistry is critical to maintaining healthy, productive aquatic ecosystems. Aquatic ecosystems that are moderately low to very low in their capacity to neutralize acidic inputs, owing to the influence of the surficial geologic composition within their watersheds, typically experience more pronounced detrimental effects associated with acid deposition.

The MNF has routinely conducted monitoring of water chemistry properties in streams across the Forest since 2001. Forest-wide water samples have been analyzed for measures of pH, acid neutralizing capacity (ANC), major cations and anions, and conductivity. These measures of stream chemistry are helpful in assessing the condition and health of aquatic ecosystems and in monitoring the sensitivity of these ecosystems to acid deposition. For example, harmful effects to certain aquatic organisms begin to occur as pH values fall below 6.0; detrimental effects occur to most aquatic organisms as pH falls below 5.0. Also, ANC values less than 50 micro equivalents per liter (ueq/L) indicate a system is acid sensitive, values between 0 and 25 ueq/L suggest systems likely experience episodic acidification during storms events, and negative ANC values indicate systems likely are already experiencing harmful effects related to chronic acidification.

Water samples are typically collected semi-annually across the Forest – in the spring during relatively higher run-off conditions and in the fall during lower base flow conditions. Figure AR-1 shows ANC values for stream samples collected during spring and fall of 2007. The data helps illustrate the seasonal influences on ANC values. An overwhelming majority of spring ANC values are noticeably less than fall ANC values for the same sample site, though there are some exceptions.

Water samples collected at higher flow conditions, particularly as a consequence of snow-melt and rapid soil water discharge during the late winter to spring period, are expected to possess chemical characteristics that are more heavily influenced by atmospheric deposition rates (*e.g.* acid rain/snow-melt). During lower base flow conditions, stream water is expected to possess chemical characteristics that are more heavily influenced by soil and geochemical properties of contributing watershed areas due to a longer residence time for water in the soil. Other inputs into aquatic ecosystems, such as acid mine drainage or artificial liming of surface waters, can also affect stream water chemistry and generate conditions that are atypical for the environmental setting.

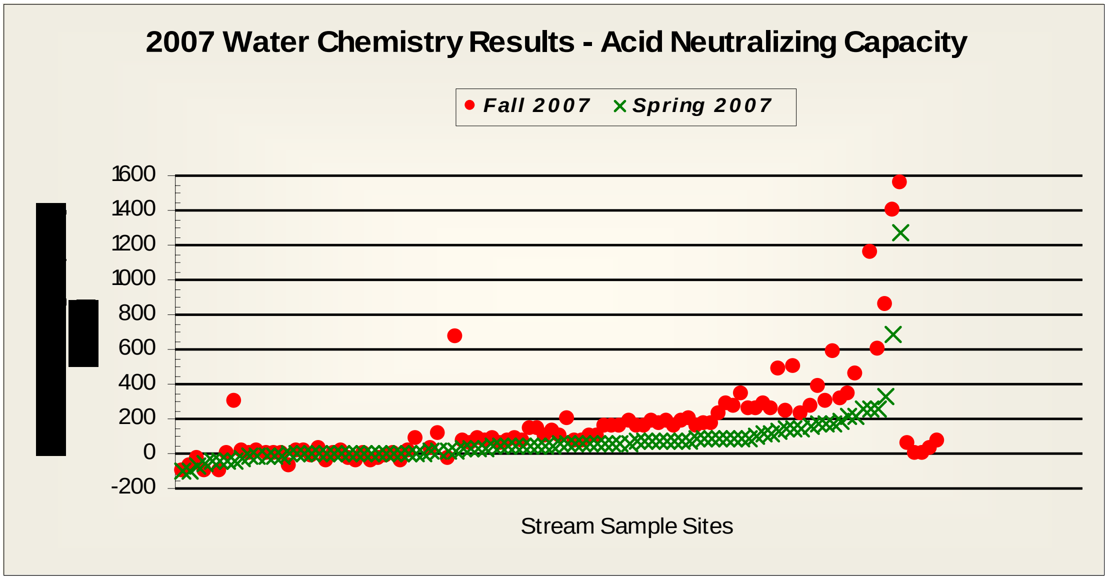

Figure AR-1. Acid Neutralizing Capacity (ANC) for Stream Samples Collected during Spring and Fall of 2007

Given that fluctuations of surface water chemistry can depend on stream flow conditions, precipitation events, and seasonal/weather-related factors, it is important for monitoring efforts to characterize the range of water chemistry conditions at each monitored site. Understanding the seasonal range of water chemistry allows for broader utility of the data in assessing stream conditions, habitat potential, and other attributes related to aquatic ecosystems. In addition, this data is vital to monitoring long-term trends of aquatic ecosystems across the Forest.

Since the fall of 2001, the MNF has collected and analyzed 600 water samples from 190 different stream locations scattered throughout the Forest. Water samples were collected at 99 of these locations during the spring of 2007 and at 98 of these locations during the fall of 2007. Forty of the 99 locations sampled in 2007 had not previously been sampled as part of on-going Forest-wide water chemistry monitoring efforts. Detailed results of chemical analyses of water samples are available in project files. A brief summary is provided in this report.

During the spring of 2007, measures of pH and ANC ranged from a low of 3.84 and -106 ueq/L, respectively, in Yellow Creek (in the Otter Creek Wilderness), to a high of 8.00 and 1267 ueq/L, respectively in Sawmill Branch (of the North Fork South Branch Potomac River watershed). During the fall of 2007, measures of pH ranged from a low of 3.78 in Yellow Creek to a high of 7.77 in Sawmill Branch. Measures of ANC ranged from a low of -105 ueq/L in Big Stone Coal Run (Dolly Sods Wilderness) to a high of 1559 ueq/L in Sawmill Branch during the fall of 2007.

Figure AR-2 displays the relationship and range in values for pH and ANC among the 600 samples that have been collected from 190 stream locations on the MNF since the fall of 2001.

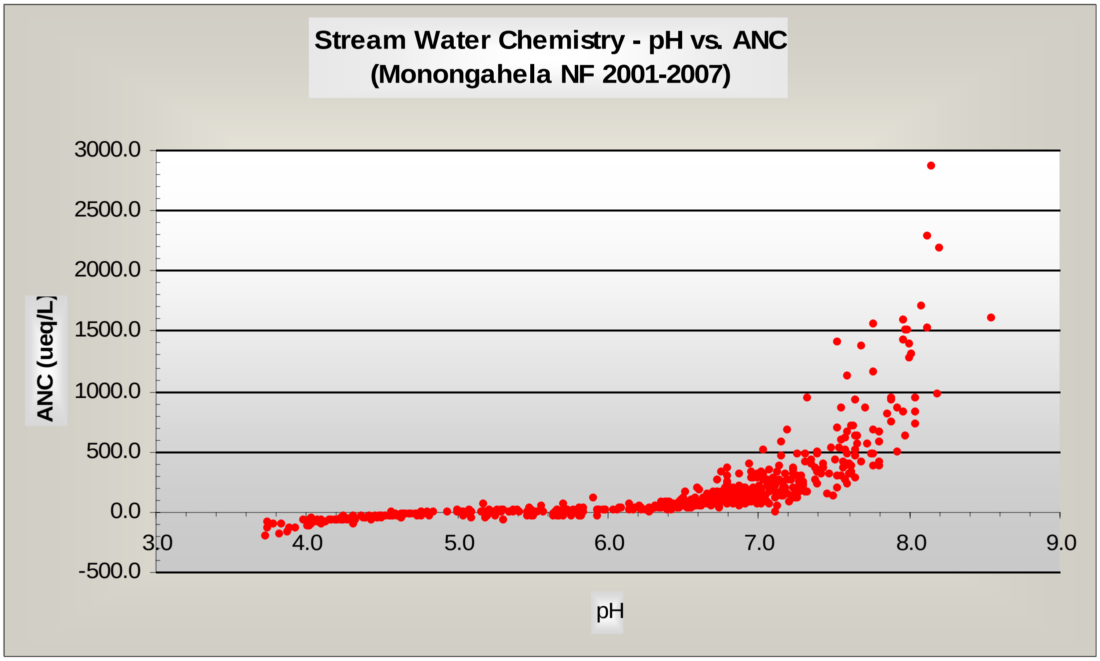

Figure AR-2. Plot of pH vs. Acid Neutralizing Capacity (ANC) for 600 Samples Collected from the Fall of 2001 through the Fall of 2007

It should be noted that stream chemistry for some acidic streams have been altered by the introduction of limestone sand. The West Virginia Division of Natural Resources (WVDNR) treats 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 contemporaneously 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 major determinant for stream chemistry is associated with inherent watershed characteristics such as bedrock type and composition, soils, landform, and vegetation, as well as the level of acidic inputs. Water chemistry monitoring indicates that streams that tend to be more acidic and weakly buffered against acid inputs are those associated with watersheds composed largely of geologies in the higher acid sensitivity classification used by the MNF. Alternatively, streams that tend to be more circum-neutral on the pH scale and adequately buffered against acid inputs (ANC values greater than 50 ueq/L) are those associated with watersheds composed of geologies in the moderate or lower acid sensitivity classifications used by the MNF.

Stream chemistry data from Forest-wide monitoring efforts document a considerable range for water quality, aquatic habitat potential, and stream sensitivity to acidification in streams, and to some degree lakes, across the MNF. Measures of pH and ANC are used as focal water chemistry indices due to the strong association with inherent watershed characteristics, responsiveness to agents of changing conditions, and reflection of consequences for dependent aquatic communities. For the 600 stream samples collected across the MNF since 2001, ANC was found to be less than 50 ueq/L from one or more samples at 89 of the 190 stream sample locations. Of these 89 sample locations, 38 locations had ANC values between 0 and 25 ueq/L from one or more samples, and 48 locations had ANC values less than 0 ueq/L from one or more samples.

Aquatic communities are, in part, a reflection of the water chemistry associated with their environment. As such, aquatic population vigor, species composition, and system productivity can serve as bio-indicators for the quality of various environmental conditions, including water chemistry. Many streams that have been monitored for water chemistry characteristics have also had other aquatic ecosystem attributes assessed. Assessments of fish populations suggest water chemistry is the most limiting environmental factor for stream productivity in streams that exhibit low to negative ANC values. For example, Coal Run of the Otter Creek Wilderness and Little Fork of the Williams River watershed experience pH levels below 5.0 and negative ANC values. Fish population surveys found no fish in reference reaches established for these streams despite the occurrence of suitable conditions for other aquatic habitat attributes needed to sustain fish assemblages.

Results from coordinated water chemistry and fish population surveys raise concerns for the long-term health and sustainability of some aquatic ecosystems on the MNF. Stream acidification may be a more immediate issue for aquatic systems that currently exhibit a greater vulnerability to acidification. However, given that various aquatic organisms posses life histories that require migration between a range of habitats distributed throughout stream systems and an interdependence among various aquatic organisms that function at a broader ecosystem level, ramifications of stream acidification are likely to extend to aquatic communities beyond those most directly affected by stream acidification in the near term.

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 ecological classification system or otherwise characterize aquatic communities across the Forest and monitor trends.

Influences to physical conditions are addressed elsewhere in this report. To clarify the intent and scope of this monitoring item, it is recommended that we change the wording to say: *To what extent are Forest management and other external influences, such as acid deposition, beneficially or adversely affecting water quality/quantity?*

Stream Temperature

Stream temperature is one environmental factor that can influence the species composition of aquatic communities and the relative health of individual populations that inhabit aquatic ecosystems. Stream temperature affects various bio-physical and physicochemical properties associated with aquatic environments (such as respiration rates for aquatic inhabitants and dissolved oxygen capacity for water features). Stream temperatures can place physiological constraints on the type and abundance of aquatic organisms that could otherwise be supported by aquatic habitats.

Aquatic ecosystems typically exhibit signature stream temperature patterns or stream temperature regimes that develop in response to prominent and persistent associations between land form, climate patterns, watershed hydrologic properties, and other watershed characteristics. Aquatic inhabitants frequently exhibit life history strategies that are adapted to specific stream temperature regimes and the associated environmental cues which function to initiate behavior critical for sustaining population viability for aquatic species over the long term. Changes to stream temperature regimes can result in modifications to aquatic species composition as well as population vigor.

Stream temperatures can be influence by many factors. Various environmental conditions that can influence stream temperatures have been altered considerably from reference conditions that existed prior to European settlement. Although various disturbance mechanisms continue today, the most pronounced changes to reference stream temperatures on the Forest arguably occurred as a consequence of timbering activities during the late 1800s and early 1900s. Results from the timbering activities and ensuing fires effectively eliminated forest cover, increased road densities, accelerated erosion and stream sedimentation rates, reduced natural stream channel integrity, and degraded aquatic habitat composition and quality. Changes to any one of these conditions could trigger alterations to stream temperatures. The substantial changes that occurred to watersheds and streams suggest stream temperature regimes likely experienced significant alterations. Changes to stream temperature regimes likely included increased daily temperature fluctuations as well as increased extent and duration of summer maximum temperatures and possibly winter minimum temperatures.

Evaluation, Conclusions, and Recommendations for Stream Temperature Monitoring

The Forest has routinely deployed temperature logging devices annually in streams across the Forest since 2003. Temperature loggers were placed at 42 stream locations across the Forest from June to October, 2007. However, only 36 of these devices were retrieved as the others could not be relocated. Since native brook trout (*Salvelinus fontinalis*) are identified as the only aquatic management indicator species in the 2006 Forest Plan, stream temperature data are summarized in Table AR-5 for optimal and lethal stream temperature ranges described for brook trout (Raleigh 1982).

Table AR-5. Summary Data of Stream Temperatures Monitored during Summer 2007

Stream Name	Elevation	Maximum 24-hr Minimum (°Celsius)	Maximum 24-hr Maximum (°Celsius)	Total Days Monitored	Days w/Averages Exceeding Optimal	Days w/Max Exceeding Lethal Maximum for Extended Exposure	Days w/Max Exceeding Lethal Maximum for Short-term Exposure
Long Run	1240	15.44	16.61	102	0	0	0
Windy Run	2800	16.96	17.72	97	0	0	0
Briggs Run	1360	17.23	18.06	102	0	0	0
Big Run	2560	16.49	18.20	99	0	0	0
Elk Run	2720	17.44	18.22	99	0	0	0
Sevenmile Run*	2420	17.63	18.51	101	1	0	0
Panther Camp Run	2400	17.39	18.53	102	0	0	0
Snyder Run	2240	18.13	19.10	102	7	0	0
Teeter Camp Run	2560	18.27	19.39	102	7	0	0
Laurel Run	2300	18.72	19.56	101	18	0	0
Sawmill Branch	2520	18.56	19.70	102	10	0	0
Shavers Run	2330	18.51	20.08	97	16	0	0
Big Run	3615	18.37	20.10	102	6	0	0
Laurel Run	2240	18.96	20.10	101	19	0	0
Twomile Run	2120	18.58	20.20	101	23	0	0
Little Black Fork**	1980	18.56	20.27	98	17	0	0
Bear Run	2080	17.75	20.34	103	2	0	0
Laurel Lick Run	2800	18.15	20.72	102	20	0	0
Dry Run	1800	18.70	20.82	102	21	0	0
Laurel Run	1840	20.01	20.87	101	39	0	0
Seneca Creek	3560	18.01	20.89	99	7	0	0
Five Lick Run	3100	18.82	21.08	102	17	0	0
Stewart Run	2540	19.34	21.10	103	20	0	0
Anthony Creek, N. Fork	2400	19.27	21.13	101	28	0	0
Meadow Creek	2240	19.63	21.60	101	43	0	0
Meadow Creek	2675	20.01	21.70	101	34	0	0
Glady Fork, W. Fork	2915	18.22	21.72	102	17	0	0
Coles Run	2105	20.89	21.80	101	40	0	0
Big Draft*	1900	20.25	21.99	101	33	0	0
Seneca Creek	2120	20.13	22.73	102	60	7	0
Anthony Creek, M. Fork	2220	21.96	23.45	101	82	19	0
Minear Run**	1800	18.37	23.50	102	2	0	0
Anthony Creek, N. Fork	2025	21.44	26.43	101	72	48	9
Meadow Creek	2650	23.83	28.05	101	79	61	17
Anthony Creek, M. Fork**	2030	23.09	29.17	101	93	72	24
South Branch Potomac**	1160	25.65	29.77	102	96	88	60

* Stream channel was dry when temperature monitoring device was retrieved.
**Monitoring device was found partially or completely dislodged from deployment seating in the stream bed.

Only six of the 36 streams monitored for stream temperatures above possessed 24-hour average stream temperatures that remained within the optimal range for brook trout populations - less than 18 degrees Celsius (°C). Stream temperature data indicate that 30 of 36 streams monitored during 2007 possess summer stream temperatures that 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 30 streams are expected to be adequate to support year-round brook trout populations.

Alternatively, six monitored streams exhibited summer stream temperatures that can be lethal to brook trout given various durations of exposure. Extended periods of exposure can be characterized as several hours to days. Short-term exposure can be characterized as several minutes to hours. Three streams monitored during 2007 possessed temperatures that can be lethal following extended periods of exposure. Another three streams possessed temperatures that are lethal to brook trout after only short-term exposure.

Stream temperature monitoring devices have a known accuracy for sensing and recording stream temperature measurements where the device is 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.

A total of 127 stream locations have been monitored since 2003 to assess summer stream temperature regimes. Figure AR-3 shows maximum 24-hour temperature metrics summarized for all 127 steams.

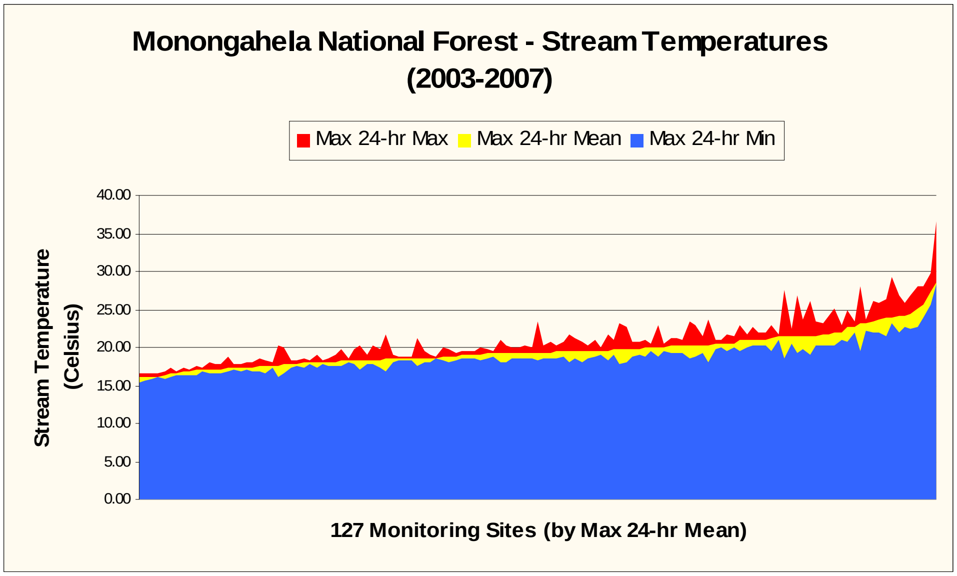

Figure AR-3. Maximum Values for 24-hour Maximum, 24-hour Mean, and 24-hour Minimum Summer Stream Temperatures Recorded for 127 Sites Monitored since 2003

Though summer stream temperatures for most monitored streams remain within reported tolerance threshold for the Forest's only aquatic management indicator species (wild brook trout), a vast array of unique temperature patterns exist within and between streams. An example of the unique qualities of stream temperature regimes is visually represented by irregularity in the width of the different colored bands displayed in Figure AR-3. This data suggests the potential for stream temperature to be a constraint for coldwater biota even in streams where exposure to lethal extremes is not detected.

Assessment of watershed characteristics and other environmental conditions may help explain variation in stream temperature data collected from different streams. Preliminary assessment of stream temperature datasets from various watersheds across the Forest suggest significant correlations exist between stream temperature and watershed characteristics that include watershed area, stream length, stream elevation, percent forested area (for both riparian area and watershed area), percent wetlands, road density (for both riparian area and watershed area), and stream crossing density. Efforts to understand more about associations between summer stream temperatures across the Forest and environmental influences is ongoing.

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 variation 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 40. To what extent is Forest management affecting riparian ecosystem function and health?

Substantial improvements in Forest Plan standards and guidelines for protecting riparian ecosystems and resources were adopted in the 2006 Forest Plan, over those found in the 1986 Forest Plan. Most timber harvests and road building activities conducted in 2007 were planned under older standards and guidelines for riparian resource management but were implemented with the goal for consistency with the new 2006 Forest Plan riparian management direction.

Riparian area monitoring for timber harvest and road development projects did occur in 2007, but was not systematic or well coordinated. Monitoring was largely limited to observations made by a number of watershed personnel while conducting a variety of other field work or monitoring visits. Forest management activities included primarily timber harvest/road building projects or their planning, and to some degree range allotment management.

Forest Roads

Road planning and development are largely accomplished in a manner with protection of riparian ecosystems and resources in mind. Frequently areas are avoided when planning new roads when substantial adverse effects to aquatic and riparian resources might result. The Cherry River Environmental Assessment and Decision Notice (2006) provide examples of this protection. Road development where impacts will occur are planned and designed to reduce riparian and aquatic effects. Timber harvest activities are now planned to relocate new roads away from larger perennial streams, reduce small stream impacts, and restore/obliterate old poorly placed roads that have substantial riparian area and aquatic impacts. These planning principles are now being used in development of projects in the Upper Greenbrier Watershed, as an example. Seven miles of old road restoration in an area of substantial riparian and other watershed impacts occurred in 2007 within the Lower Williams River area of the Forest.

Timber Harvest

Riparian ecosystems and resources are being largely protected during the conduct of Forest harvesting activities. Monitoring in 2007 was not systematic but occurred during a variety of field work and visits to planned and active harvest activities. The 2006 Forest Plan riparian management direction and standards are complied with in timber harvesting. Harvest units largely are planned away from perennial streams and larger intermittent streams, with full Forest Plan riparian protection or greater. Most areas of potential riparian impact are on smaller intermittent and ephemeral streams. Observations made in 2007 indicate routine compliance with riparian management direction. Monitoring in an active timber sale took place in the Day South sale of the Marlinton District. Monitoring of planned activities in a number of upcoming timber sale areas indicates riparian ecosystem protection will be achieved (sale areas included in decisions for the Cherry River, Upper Williams, and Little Beech environmental analyses).

Un-permitted Roads

Some roads on Forest lands are not under Forest permits but are in use by the public under some previously existing right of access, usually private landowner rights. Some of these roads are in poor locations near streams, and have substantial detrimental effects on aquatic and riparian ecosystems. Road improvement in 2007 for access to private land along Rattlesnake Run of the Cheat District was in a poor streamside location and adversely affected the riparian resource. An un-permitted road along Twin Run of the Potomac District to access private lands closely follows the stream, with substantial impact to the riparian area. Other similar situations exist. In many of these cases, it is not possible to restrict the use because of legal issues, and not feasible to develop alternative access. In such cases, riparian ecosystem impacts will continue, even if sedimentation problems are mitigated.

Range Allotments

The Forest has around 6,000 acres being managed for grazing in range allotments. Some of these allotments have streams flowing through the interior, and some of these streams are fenced to keep the cattle out of the water and riparian area, while some are not. The Forest has had an active program of fencing streams within or adjacent to allotments since 2001, to limit cattle impacts to water quality and the streamside zone, and to 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 (Shearer North and South, Friel Run, Day Run, and Big Run) allotments. In 2007 thousands of feet of fencing were installed in the Big Run allotment, beginning the riparian restoration process and substantially reducing water quality impacts from cattle in this important headwater of Big Run. Big Run is a highly valued native brook trout stream, and a headwater of the North Fork South Branch Potomac River. Additional riparian area fencing is planned for 2008 in the Big Run allotment and efforts are being pursued to implement the 2007 NEPA decision to fence similar areas in the Mullenax allotment in the headwaters of Elk River.

Monitoring Question 40. Evaluation, Conclusions, and Recommendations

FY 2007 monitoring indicates that riparian ecosystem function and health are being protected in the conduct of timber harvesting and road development to standards consistent with the 2006 Forest Plan direction. Adverse impacts to riparian areas are in some cases unavoidable, such as at stream crossings by roads, but these are avoided when possible, or held to the least 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 road restoration projects 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.

It is also recommended that Monitoring Question 40 be combined with other similar questions (42 and 43) in order to reduce overlap of issues. The new monitoring questions would read: *To what extent is management of National Forest System lands beneficially or adversely affecting the physical conditions of aquatic ecosystems including riparian ecosystem function and health?*

Monitoring Question 41. To what extent is Forest management affecting soil erosion and stream sedimentation processes?

Stream sedimentation is a primary issue of concern in resource protection and management of Forest water resources, aquatic habitats, and biota. In-stream 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 have the potential to increase sedimentation by increasing rates of soil erosion, triggering mass wasting events, or changing rates or distribution of flow and runoff that can stimulate erosion and transport greater amounts of sediment. Increased sediment introduction and storage in streams results in impaired water quality and value, impaired aquatic habitat, and detrimental effects to fish and other aquatic biota.

Erosion and sediment sources within the Forest can come from recreation developments, mineral development activities, or any other management action that disturbs soil or subjects soil to increased rates of erosion and soil loss. It is commonly accepted, however, that roads are the primary source of accelerated soil erosion and sediment source areas in Forest management activities, including timber harvesting activities. Roads may be typed in a number of ways (forest roads and highways, timber haul roads, temporary roads, skid roads and trails, and woods roads) but collectively, they are the dominant form of earth disturbance in National Forest management and by far the greatest management-related source of stream sediment.

Monitoring of Forest management effects on accelerated soil erosion and stream sedimentation processes has been focused largely on road contributions. Generally, monitoring has focused on the contributions of roads developed for timber harvesting - timber haul roads, skid roads, and trails. Monitoring in FY 2007 was largely directed at the effects of timber harvest related roads.

Hillslope Hydrology Study

A cooperative study with the USFS Northern Research Station was initiated in 1999 to answer several sediment-related questions for forested watersheds. Questions were generated for hill slope and within-channel processes of sedimentation, dealing with sediment delivery to channels in both a roaded/harvested watershed and an undisturbed watershed. Questions included:

1. How much sediment is delivered from the hillside to a stream channel naturally, and from road construction and harvesting?
2. What hillslope attributes control sediment delivery to the channel?
3. What percent of sediment generated off of roads reaches the stream channel?
4. How does sediment generation from hillsides compare to sediment yield by streamflow?
5. How is channel morphology affected by road construction, especially stream crossings, and how do these changes compare to those that occur naturally from large runoff events?

The roaded/harvested watershed included new road construction through the watershed, ground-based and cable harvesting within the watershed, and limited skid road development and use within the ground-based harvest units. Road construction started in July 2002, with timber harvesting and skid road construction beginning in 2003. All road construction and harvesting activities were completed by late 2006. Field data collection ended in summer 2007, but sample processing is still ongoing and should be completed by summer 2008. Much additional data analysis and report preparation remains to be done, and little is available at this time in terms of final results and conclusions.

Evaluation, Conclusions, and Recommendations for the Hillslope Hydrology Study

One completed product has been submitted, a final technical report from West Virginia University based on thesis work by a graduate student in the Division of Forestry and Natural Resources. The report is entitled *Modeling Sediment Movement in Forested Watersheds Using Hill-slope Attributes* (December 2007). Conclusions and implications from the study are useful, and have much to say about road effects and controlling sediment. This study found the primary factor affecting sediment delivery to the stream in the treated watershed was the haul road, and that the road construction activity greatly increased sediment delivery (much more than before or after road construction). Peak sediment delivery occurred during and directly after haul road construction, with the majority of this post-construction sediment coming from “road fillslopes located just downslope of the stream crossings.” Road design features and construction activity led to "enormous additions of sediment" to the stream, primarily due to steep fillslopes in the stream crossing approaches. That is, a substantial portion of the sediment delivered to the stream was from bulldozer activity when these fillslope sections were constructed. Another contributing factor was inadequate Best Management Practices (BMP) application during the first months following construction. The study reports that constructing roads in steep terrain with deep fills over stream crossings creates "a tremendous amount of disturbance" and a variety of sediment-related problems. Another study conclusion is that residual trees present during and after a harvest, particularly those nearest streams, need greater attention to protection because of the increased risk of knockdown and windthrow that can result in increased sediment inputs.

Management implications derived from the study were reported as follows:

- Minimize soil surface disturbance; plan more efficient roads that reach more areas, and do not construct unneeded roads
- Apply BMPs thoroughly and quickly during and after an operation.
- Focus sediment control more acutely on the discrete areas of sediment contribution, especially fillslopes/cutbanks near streams and drainage outlets.
- Avoid constructing roads parallel to streams on approach and departure from crossings.
- Keep fillslope material greater than 25 meters from the stream channel (as much as possible).
- Properly grade and stabilize all areas of disturbance (cut-and-fill slopes, road surfaces, log landings, skid roads, etc.)
- Rip-rap all water drainage outlets to prevent channeling and soil erosion.
- Use stream crossing structures such as temporary bridges where possible.
- Consider treatments for (greater protection of) residual trees.

Results of this study are not final, and will be in preparation for several years. Various other aspects of this study will be reported as data analysis, graduate theses, scientific journal articles, and other reports are finalized.

Preliminary indications are that truck haul roads are a major source of stream sediment; stream crossings (by any type of road) can be, and frequently are, the highest risk areas for sediment generation; and road design, construction methods, and BMP implementation are major factors in contributing sediment delivery to stream channels. Many of these observations are supported by the results of road monitoring conducted by a Forest Service interdisciplinary team on this same road in 2004. Particular attention was given to road construction practices and timing of BMP applications during that monitoring. Some of the study observations indicate that:

- Road design is one critical aspect of controlling sedimentation, and more attention needs to be paid to design (and location) features, particularly in steep or otherwise sensitive terrain.
- Road construction practices (timing, project duration, pioneering, stream crossing construction methods, construction standards, shutdowns) are another critical factor, and sometimes have exposed weak points in the ability to control sedimentation. Improved construction practices are needed, and this may require a combination of improvements to road construction contracts, and better inspection/monitoring of projects as they progress.
- Performance and timing of BMP implementation is a third critical factor, especially at and near stream crossings, and the timing of some of that necessary work was not satisfactory for controlling sediment. Improved transfer of required BMP standards and other sediment control measures into contracts is needed. Improved contract administration is needed to

ensure that all required BMPs are implemented properly, effectively, in the most critical areas and as soon as possible (timely) in the construction process.

Recommendations: Follow-up on these study findings and management implications is needed, to improve road construction and management practices that contribute to sedimentation effects. Improvements should focus on the factors identified above: road design, contract items and language, and contract administration.

More interdisciplinary monitoring of road construction and maintenance projects is needed, similar to that conducted in 2004 on the road in the Hillslope Hydrology Study. More time and resources to accomplish monitoring are needed to fulfill Forest Plan monitoring commitments, document goal accomplishment, and support adaptive management.

Also, special studies of this type have proven to be of great benefit in increasing understanding of resource effects, validating assumptions and BMP effectiveness, and highlighting areas of needed improvement. More such studies are needed to continue fine-tuning our management practices and programs, and continue managing the land while reducing adverse effects on resources. It is recommended that special study needs be routinely developed as needed to answer important resource management questions, and funding provided to support those efforts.

Day South Timber Sale, Harvest Unit #2

Monitoring occurred in harvest unit #2 of this sale on the Marlinton District, to address issues of soil erosion and potential for stream sedimentation associated with access road, log landing, and skid roads within the unit boundary. The unit is on a hillside with predominantly moderate to steeper slopes, in soils formed from the Mauch Chunk geologic formation (rated severe for erosion hazard). (Refer to the Soil Scientist's monitoring report for details on soil conditions and soil resource monitoring in the Day South Sale.) Monitoring occurred in December 2006 while the harvest unit was active, beyond the end of the normal operating season, although weather conditions had been relatively dry with no recent precipitation. Despite this, the soil scientist reported that "soil moisture was excessively high" and substantially affecting moisture-related conditions within the skid roads. Hydrologist monitoring focused on skid road layout, and in particular the long climbing skid road from the landing to the top of the active harvesting, which had long sustained grades of 20 percent and greater. Because of the dry weather conditions at the time there was no substantial or continuous runoff down the climbing skid road, and no direct hydrologic connection between the climbing skid road and non-perennial stream channels to the southeast (in a headwater tributary to Mountain Lick Run).

<u>Evaluation, Conclusions, and Recommendations for Day South Harvest Unit #2</u>

Primary concerns with this active harvest unit involved the length and steepness of the climbing skid road, soil wetness, the need for temporary waterbars for runoff control, operations outside the normal operating season, and the potential for sediment movement to streams in the event of moderate or greater precipitation (Figure AR-4). Recommendations were made to the District Ranger for temporary waterbars in skid roads, suspension of operations for winter shutdown, and implementation of temporary soil erosion control measures (mulch) within the landing and lower skid road. Harvesting operations were suspended for the winter soon thereafter, and winter shutdown procedures were implemented.

Figure AR-4. Skid Road Soil Disturbance in Day South Harvest Unit #2

Shortly after winter shutdown of the unit in December, a moderate rainfall event occurred within the watershed. Monitoring of water resource effects was conducted by collecting grab samples of runoff, and testing for turbidity (water clarity). Precipitation was lighter in intensity at the outset of sample collection, increasing to moderate during the collection, but never hard or intense. During sampling, substantial runoff from the climbing skid road was not occurring, or had not yet begun. Sampling ended as darkness fell, so effects later in the evening were not documented. Water samples were collected from the FR 437 ditchline below the unit boundary and down-grade from its access road, into a small headwater channel receiving the ditchline runoff, and then downstream in the perennial channel system (headwaters to Mountain Lick Run) for a distance of a quarter mile or so. Turbidity was measured in nephelometric turbidity units (NTU). Follow-up storm event monitoring of turbidity effects at Harvest Unit #2 was needed during additional periods of winter and spring precipitation in 2007, but this never occurred.

Additional observations at Harvest Unit #5 near and along FR 437 occurred in December 2006. It was also a ground-based skidding unit, but in much less steep terrain, and harvesting had been completed within a dry period in just over two weeks, with cutting complete by November 16, 2006. Skid road closure had been completed before the December monitoring visit.

Grab samples documented sediment leaving the area of harvesting (unit #2) in the FR 437 ditchline, and entering a small headwater channel of Mountain Lick Run a few hundred feet away. No obvious runoff connections between skid roads or the landing and the FR 437 ditchline could be seen at the time, but sediment from the unit harvesting was being transported by ditchline water. The lower intensity of the rainfall was at least partially responsible for limited surface runoff at the time.

Despite the low to moderate rainfall intensity, turbidity in the ditchline was elevated at the start of monitoring (168 and 115 NTU). In the first headwater channel that ditchline water flowed into but before the point of mixing, turbidity was 31 NTU. The combined flow after a segment of mixing still had higher turbidity (48-60 NTU) than other nearby channels (18-27 NTU) that were not affected by the harvest unit but still flowed from above and under FR 437 in culverts, and also received ditchline runoff. The increase in turbidity was not large, but likely would not be in compliance with State water quality rules, which are quite strict. After additional downstream mixing, turbidity returned to what it had been (31 NTU) above FR 437 and before ditchline inputs of sediment. An hour or more after the start of collecting water samples, repeat sampling in the ditchline and above FR 437 (same locations) indicated a substantial increase in turbidity in the ditchline (331 NTU), but only a slight increase (35 NTU) in the stream above the road and ditch entrance. (Downstream effects at this time were not repeated due to impending darkness.) Thus it appeared that sediment leaving the vicinity of the harvest unit was increasing, possibly due to the duration and increasing intensity of the rain event, and as disturbed soils became more saturated. Effects that likely occurred after dark were not observed or documented.

The question was raised about whether the sediment runoff in the FR 437 ditchline might be coming from the road itself, and not from the harvest unit. There is no doubt that a small amount of the sediment measured in the ditchline was coming off the road. However, the sediment in the ditchline was felt to be primarily from a fresh and substantial sediment source, not the road itself, and only one vehicle passed on the road during the time of sample collection there. Also, ditchline water was observed along some other FR 437 segments within the same general area but away from the harvest unit, and was mostly clear to slightly turbid, but much less turbid than the ditchline below Harvest Unit #2.

In contrast to Unit #2, Unit #5 appeared to be well stabilized, with no substantial sediment leaving the site or in the FR 437 ditchline at the time of turbidity monitoring. Some of this was likely due to the timing of the harvest completion and prompt erosion control, but also due to terrain and landform differences that affected unit design and runoff characteristics.

December 2006 monitoring at Harvest Unit #2 indicated that sediment was leaving the area and entering a stream system. Although sediment effects were occurring, it was not because of substantial operational problems in the harvest unit. At the time of the monitoring, the unit had been shut down for winter, and erosion control measures were in place. The climbing skid road had been water-barred as well as other contour skid roads, the landing had been graded and mulched, and the log truck road into the landing was surfaced with large stone and gravel. This information indicates that sedimentation effects can occur even under modest storm runoff conditions, and despite implementation of erosion control measures.

Follow-up visits to Unit #2 in summer 2007 documented a large slug of sediment on the forest floor near the tight turn along the upper third of the long, steep skid road (Figure AR-5). The deposited slug of sediment appeared to be the result of a large slurry of water and sediment that had accumulated in the well-entrenched skid road prior to breaching the outside embankment of the skid road at the tight-radius turn. The sediment slug partially buried the head of what was either a previously existing ephemeral stream channel or a newly created channel that developed in response to altered drainage patterns from the skid road. Although skid roads in Unit #2 appeared to have been rehabilitated to typical skid road specifications sometime prior to the July site visit, fresh sediment deposits remained visibly evident in the headwater stream channel at a distance of more than 150 feet down slope from the skid road and sediment slug. Informal monitoring of timber harvesting activities associated with this unit indicates that precautions about soil erosion and sediment inputs to streams have materialized. Ground-based harvesting was the method selected in the EA for this unit, although helicopter harvesting had also been considered in the EA. Soil wetness and other soil sensitivity factors, slope steepness within the unit, and skid road location and water control issues raise substantial concern for controlling sediment in Unit #2 and in similar situations.

Figure AR-5. Sediment Slug Coming off Skid Road in Day South Harvest Unit #2

<u>Recommendations</u>: It is recommended that alternative harvest methods would be much more effective at reducing sedimentation where there is a higher risk from erosive soils that are highly subject to movement. Cable yarding may have less impact and risk for sedimentation where terrain and access conditions are appropriate. Helicopter yarding would substantially reduce erosion and sedimentation effects in these high sensitivity areas. Changes in unit design could also help reduce risk of these effects.

Monitoring of this type is routinely needed at pre-determined and agreed-upon areas of harvesting to document resource effects and compliance with State CWA water resource rules. Monitoring should be incorporated into Environmental Analysis decisions.

Special Use Road

Monitoring at an access road across Forest land to private property on the Cheat Ranger District (Toothman special use road) was conducted in July 2007 to identify sedimentation effects from the road, and needed improvements to reduce those effects. Monitoring was conducted by the Forest Hydrologist and an Engineer.

<u>Evaluation, Conclusions, and Recommendations for Special Use Road</u>

Results indicated that erosion was occurring on much of the road, and that direct pathways for sedimentation to the nearby stream existed in several spots along the road. (The road lies within an area that is headwaters to Stump Run, a native brook trout stream.) Also, much of the road stabilization and erosion control measures required of the permittee were not in place, and the permittee was not in compliance. Needed improvements were identified and transmitted to appropriate Forest personnel, for the permittee to implement. Recommended improvements included control of unauthorized public access with a gate, road grading and shaping to remove ruts, installation of drivable dips for cross-drainage and hardening with stone, and road surface hardening in approaches to and through small channel fords. Satisfactory compliance by the permittee had not yet occurred at the end of the 2007 year.

Monitoring of a cross-section of special use permits by watershed staff should occur each year to help ensure that aquatic resource goals and water quality protection (from sedimentation) are being achieved in the Special Uses program area.

State Road 94/5, Morris Creek

A partnership to treat sedimentation and aquatic passage issues associated with a gravel-surface state road was initiated in 2007, and it is expected to continue for several more years. The road is SR 94/5, located within the Morris Creek watershed of the Cherry River, on the Gauley Ranger District. Morris Creek is a native brook trout stream, but brook trout populations and other aquatic biota are impaired by a combination of acidity, sedimentation, and aquatic habitat fragmentation. Substantial sedimentation comes from the SR 94/5 driving surface, which has very inadequate drainage and erosion control measures. Additional sedimentation comes from a severely undersized crossing structure at Morris Creek that routinely overflows in storm runoff events, forcing streamflow into and down the state road and carrying much road material and sediment with it. Considerable sediment finds its way back into Morris Creek and downstream to Cherry River. The undersized low water crossing is also a total barrier to aquatic passage. The need for this project was approved in the Cherry River EA, subject to obtaining funding. Partnership with the State Division of Highways (WV-DOH) will cooperatively treat sediment sources along the road by improving drainage and soil protection, and replacing the passage barrier with a bridge.

Monitoring of sedimentation effects and road conditions, and inventory of needed improvements occurred in June and August of 2007. Monitoring identified the number and severity of sediment source areas along this road. Inventory of road drainage deficiencies and a preliminary survey of drainage improvement needs and design items were conducted in August with WV-DOH.

<u>Evaluation, Conclusions, and Recommendations for State Road 94/5</u>

The Forest is pursuing multiple opportunities at this time to fund a substantial portion of the work. WV-DOH will also be contributing funds and manpower to accomplishing our mutual goals. Detailed planning and design work will commence when adequate funding is obtained.

State roads contribute substantial portions of sediment loads in some high priority streams and watersheds. Partnerships with the State have been very successful in the past in reducing sedimentation and improving aquatic habitats. This and other similar partnerships should continue to be encouraged and developed for priority streams to continue progress toward improved aquatic habitats and populations. The ability of the State to address these issues for streams that are of priority interest to National Forest management, but independent of Forest Service partnership opportunities, is frequently very limited and not likely to occur.

Forest Road 869 Construction and Winter Shutdown

In early December 2006, monitoring of a FR 869 (Cheat District) was conducted together with Engineering Technician and Engineering Representative Willard Church. This road was under construction but not completed, and going into winter shutdown of activity. The field visit was to identify the adequacy of winter shutdown measures for erosion and sediment control.

Evaluation, Conclusions, and Recommendations for Forest Road 869

Several inadequacies were identified, and corrective actions were communicated to both Engineering and the District Ranger. Those actions included:

- Remove sediment at culvert near state highway and protect inlet/outlet.
- Install substantially more temporary waterbars/dips in unfinished road surface.
- More and better installation of sediment traps at runoff discharge points.
- Extensive mulching of disturbed area cutslopes and road surface.

Some sediment was found to be leaving the site near the highway, and entering a small channel above the Cheat River. Recommended corrective actions were felt to be very important for controlling sediment off this unfinished road during the winter period of inactivity. Engineering promptly communicated the desired erosion control measures to the contractor, and measures were implemented in a timely manner. Follow-up monitoring at this road after the corrective shutdown measures were accomplished indicated general compliance with recommended actions. Some waterbars could have been larger, but were only needed for the shutdown period, and some sediment traps seemed marginal in likely effectiveness. Also, some of the mulching was very light and not likely effective, while other areas were more adequately mulched. In general, the applied measures would likely control most sediment losses during shutdown.

Road construction is a critical activity in terms of erosion and stream sedimentation, as described in the Hillslope Hydrology Study section of this report. Winter shutdown is one of the more critical periods of time because of soil moisture, precipitation, low evapo-transpiration, frequent thawing, and because contractors and inspectors are not routinely present to quickly identify developing problems and take corrective actions. When corrective actions are needed after shutdown, it is sometimes much more difficult and costly to accomplish. It may also result in even more sedimentation if the road or BMP measures in place are damaged or compromised.

More interdisciplinary monitoring of construction activities before winter or other periods of extended shutdown is needed to ensure that all needed erosion and sediment control measures are being effectively/timely implemented. More coordination between Watershed and Engineering on construction contracts should occur to ensure that needed BMPs and other measures are being effectively included in contracts and implemented in the field. Interdisciplinary monitoring of construction activities on an annual basis is needed to document achievement of Forest goals and Forest Plan requirements.

Recommendation for the Stream Sedimentation Monitoring Question: To clarify the intent and scope of this monitoring question, it is recommended that we change the wording to say: *To what extent is Forest management beneficially or adversely affecting soil erosion and stream sedimentation processes?*

Monitoring Question 42. To what extent is Forest management affecting the aquatic community, including habitat connectivity and invasive/non-native conditions and effects?

The response to this monitoring question focuses on the habitat connectivity issue. Invasive or non-native species are addressed in Monitoring Question 45, below.

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. Identifying artificial aquatic passage barriers and eliminating these features as sources of habitat fragmentation is a goal of the Forest Plan where risk of genetic contamination, predation, or competition with undesired fish species is not a concern.

The MNF received federal highway funds for aquatic passage (HTAP) during FY 2007 to assess aquatic organism passage (AOP) associated with road stream crossings on the Forest. With few exceptions, stream crossings were prioritized for surveying based on results from Forest-wide watershed integrity assessments and consideration of potential habitat fragmentation effects on aquatic populations. A few road stream crossings were included based on information needs for current project planning efforts. Results from this process produced a prioritized list of streams crossings to be surveyed during FY 2007. As such, stream crossings selected for surveying during 2007 were located within priority watersheds that possess important though potentially fragmented aquatic habitats associated with special status species (*e.g*. Regional Forest sensitive species, Forest management indicator species, and endemic species).

Table AR-6 lists the 18 steam crossings locations that were surveyed in 2007 according to the National Inventory and Assessment Procedure developed by the USDA Forest Service National Technological and Development Program (San Dimas protocol). Total station survey equipment was used to collect data of the physical measurements of stream crossing structures and surrounding stream features. This data can be used with FishXing software to model various aquatic passage scenarios for aquatic species of interest. Fish populations were sampled at two stream crossing sites to aid the investigation of crossing structure effects on fish populations. In addition, survey data were collected at reference stream reach locations and in the vicinity of each stream crossing to facilitate the development of conceptual designs for potential corrective actions of passage barriers. Lastly, GPS locations were collected when conditions allowed and digital pictures were taken of stream crossing structures and other pertinent stream features.

Table AR-6. Aquatic Organism Passage (AOP) Surveys Conducted during FY 2007

Stream Name	Road Crossing		Stream Name	Road Crossing
Black Mtn. Run	FR216		Little Low Place	FR60
Cove Run	Rail Trail		Little River	FR17
Cove Run	FR44		Long Run	FR57
Craig Run	FR429		Mikes Run	FR44
Elk Lick Run	FR44		Morris Creek	SR94
Fox Run	FR44		Poca Run	FR52
Fox Run	FR369		Stony Run	FR757
Gertrude Run	FR44		Sutton Run	FR1678B
Jonathan Run	FR429		Williams River	FR999

Monitoring Question 42. Evaluation, Conclusions, and Recommendations

The purpose of the 2007 AOP surveys was to evaluate stream crossing structures suspected of inhibiting aquatic organism passage, potentially impairing the productivity of associated aquatic communities, and possibly contributing to viability risks for populations of aquatic species. Although data from the 2007 surveys were not synthesized and available at the time this report was prepared, preliminary judgment of the surveys indicates that artificial barriers to aquatic organism passage are having considerable effects on aquatic habitat connectivity. Results from these surveys are expected to help the Forest develop and implement a strategy to achieve a specific Forest Plan objective to correct 30-50 aquatic passage barriers, according to aquatic priorities, during the 10-year horizon of the Forest Plan.

Recommendations: It is recommended that AOP surveys be continued to obtain a more complete inventory of potential artificial barriers to aquatic organism passage 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.

It is also recommended that Monitoring Question 42 be combined with other similar questions (40 and 43) in order to reduce overlap of issues. The new monitoring questions would read: *To what extent is management of National Forest System lands beneficially or detrimentally affecting the physical conditions of aquatic ecosystems including riparian ecosystem function and health?*

Monitoring Item 43. To what extent is Forest management contributing to the restoration of healthy watersheds and aquatic ecosystems?

There were no major watershed or aquatic habitat restoration projects on the Forest during FY 2007. In order to effectively prioritize and implement restoration activities, though, intensive data collection needs to occur to provide a basis for restoration decisions. To that end, the Forest has been using a standardized survey protocol to collect aquatic ecological information.

Aquatic Ecological Unit Inventory and Monitoring

Stream systems consist of a primary collector stream and a network of smaller tributary streams. Fluvial processes associated with stream systems serve important functions related to landscape forming processes (including upland soil erosion, transport of materials downslope, and flood plain development) as well as aquatic habitat development and maintenance. Stream systems have three hierarchical levels nested within watershed units: valley segments, stream reaches, and channel units. Understanding conditions and trends at various hierarchical levels of stream systems can be valuable for making informed land management decisions to achieve desired Forest goals and objectives.

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 2007, the Forest dedicated a summer watershed crew to conduct surveys of valley segments, stream reaches, and channel units in various stream systems across the Forest.

Forest Service crews conducted AEUI surveys associated with valley segment and stream reach classifications, aquatic habitat inventory, and fish population assessments in 21 reference stream segments during the summer of 2007. 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 (LWD) 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 assess the health of biotic communities.

Preliminary results of AEUI surveys on the MNF during 2007 are summarized in Table AR-7. Surveyed stream reaches represent A, B, C, 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 2007 AEUI surveys reflect stream conditions that have been altered by a variety of natural and human induced disturbances.

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)
Big Run (NFSBPR)	F3b	82.9	17.1	0.29	O	82	24.2	P	S	51.8
Briggs Run	B4	61.1	38.8	0.36	R	81	24.5	P	S	40.8
Coal Run	A3a+	64.3	35.7	0.36	R	66	30.6	F	M	0.0
Daniels Creek	C4	83.3	16.7	0.25	C	84	29.7	P	M	18.2
Galford Run	F3b	89.0	11.0	0.13	O	82	6.2	P	S	40.5
Hinkle Run	B3c	77.6	22.4	0.20	R	94	-	F	S	19.4
Laurel Fork	B3c	92.9	7.1	0.32	R	69	14.9	F	S	18.9
Laurel Run	B4	49.6	50.4	0.43	R	71	15.7	P	S	40.4
Little River (EFGB)	F3	48.2	51.8	0.80	O	86	-	P	S	238.9
Little River (WFGB)	C3	84.7	15.2	0.20	R	93	29.1	P	S	26.2
Long Run	C3b	84.0	16.0	0.25	C	87	26.6	P	A	44.1
Maxwell Run	F3b	80.6	19.4	0.10	O	96	26.1	F	S	54.6
Mikes Run	C4	42.7	57.3	0.47	O		31.6	P	M	13.9
Mountain Lick Run	C3	41.6	58.4	0.54	O	81	17.6	P	M	38.2
Mullenax Run	B1c	89.5	10.5	0.16	O	74	29.6	F	S	15.1
N. Fork Anthony Ck	C4	30.0	70.0	0.34	O	93	5.3	P	S	59.1
Sawmill Run	F3b	87.4	12.6	0.32	O	88	21.2	F	S	55.2
Seneca Creek	B4	77.2	22.8	0.24	C	88	16.3	P	S	72.2
Stewart Run	C3	47.7	52.3	0.46	O	87	22.6	P	S	91.6
Stony Run	B3a	88.4	11.6	0.18	O	71	10.0	P	M	36.1
W. Fork Glady Fork	C3b	36.1	63.9	0.72	R	83	30.2	F	M	27.9

1: residual pool depth - measure of pool quality
2: R = rare; O = occassional; C = common
3: G = good; F = fair; P = poor
4: A = abundant; M = moderate; S = scarce

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.

Monitoring Item 43. Evaluation, Conclusions, and Recommendations

Habitat composition data from the 2007 surveys indicate that more than half of the reaches surveyed possessed less than 25 percent of their surface area in slow water habitat. Rosgen C-type channels possessed the 5 greatest percentages of slow water habitats, although slow water habitat was not well-represented in all C-type channels surveyed. Residual pool depth (RPD) is a measure of pool development and can serve as an index of pool quality. Four of the 5 streams with the best measures of RPD were also associated with C-type channels. By the very nature of their fluvial geomorphic properties and position along the stream continuum, C-type channels characteristically possess some of the best pool habitats in stable stream systems.

The integrity of stream channels is often measured in terms of stream bank erosion and stream bed stability. Measures of stream bank integrity indicate 15 percent of streams reaches surveyed during 2007 had common occurrences of bank instability, 52 percent had occasional bank instability, and 33 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 70 percent of stream reaches surveyed during 2007. Stream reaches exhibiting the greatest stream bed stability (RSI < 80) also lacked common occurrences of bank instability.

Other characteristics surveyed during 2007 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. More than 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 67 percent of the stream reaches surveyed received a poor rating and the remaining reaches received a fair rating; no reaches were considered to have good cover. Inventories of LWD indicate that 67 percent of the stream reaches surveyed possessed a scarce amount of LWD, 29 percent possessed a moderate quantity of LWD, and only one stream reach was considered to have an abundance 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 2007. Fish biomass was calculated for each fish species encountered during the population surveys. Results of this data show that total fish biomass ranges from a high of 239 lbs/acre in Little River (East Fork Greenbrier River) to a low of 0 lbs/acre in Coal Run (acidified tributary to Otter Creek). Brook trout populations were present in 80 percent of the stream reaches surveyed. Biomass of brook trout ranged from a high of 58 lbs/acre to a low of 0.9 lbs/acre.

Variation in fish biomass highlights 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.

It is also recommended that Monitoring Question 43 be combined with other similar questions (40 and 42) in order to reduce overlap of issues. The new monitoring questions would read: *To what extent is management of National Forest System lands beneficially or detrimentally affecting the physical conditions of aquatic ecosystems including riparian ecosystem function and health?*

Monitoring Question 44. To what extent is Forest management providing ecological conditions to maintain viable populations of native and desired non-native species?

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 WV Dept of Environmental Protection (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 monitor 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".

<u>Monitoring Question 44. Evaluation, Conclusions, and Recommendations</u>

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. While some water quality related sources of stream impairment do exist, such as upland erosion leading to stream sedimentation, the large majority of MNF streams are still categorized as meeting water quality standards and supporting designated uses. 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 2006. 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. It 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". Also, some streams included as impaired streams are new in the 2006 list (*i.e.* they were not listed in 2004), while some streams have been de-listed in 2006 for one of several possible reasons.

A number of streams within the proclamation boundary of the MNF are included in the 2006 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 2006 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. This report highlights 303(d) listed streams that have more than negligible National Forest land ownership within their watersheds.

Mercury impairment: Two streams are listed as being mercury impaired. These are Dry Fork (44.8 miles impaired) and Shavers Fork (96.9 miles), both in the Cheat River drainage. The source of the impairment is listed as unknown. It is believed that the primary source of this impairment is from atmospheric deposition of mercury, coming largely from coal-fired power plants. National Forest management has no (direct) connection to this mercury impairment.

PCB impairment: Two streams are listed for PCB impairment. These are Shavers Fork (96.9 miles) and South Branch Potomac River (154.1 miles). The source of the impairment is listed as unknown. These are major river systems, and much of their river corridors are in private ownership. There are a wide variety of past and present land uses and development, including industry, that occupy their watersheds. National Forest management has no connection to this PCB impairment.

Iron impairment: One stream is listed for iron impairment. This is the Cherry River (10.5 miles) within the Gauley River watershed. The source of the impairment is listed as unknown. The river corridor is largely in private ownership, and most of its contributing watershed is in private ownership. There is a substantial amount of past and active mining for coal within the private lands but it is not known if there is a connection. National Forest management is not contributing to this condition.

Aluminum (dissolved) impairment: Six streams and rivers are listed for dissolved aluminum impairment. The North Fork Blackwater River has 8 miles listed and the source is listed as unknown, although considerable old coal mining within its watershed may have a possible connection. An estimated 96 additional miles of rivers and streams are listed for dissolved aluminum impairment. All 96 additional miles are located in the southwest portion of the Forest within areas dominated by the acidic Pennsylvania age bedrock. Listed streams include the North Fork Cherry River, Cranberry River, Williams River, Middle Fork Williams, and Sugar Creek (of the Williams). The most likely explanation for aluminum impairment is the leaching of aluminum from the soil by waters made acidic by the acidic bedrock and exacerbated by acid deposition effects. National Forest management is not considered to be a causal factor.

pH: Forty-four streams (172 miles) within certain watersheds of the National Forest are listed for pH impairment. The source of pH impairment is listed as unknown for all impaired segments. Numerous other stream segments on the Forest would likely be listed as pH impaired as well but sufficient data has not been collected to characterize all streams. All streams listed as pH impaired fall within these larger watersheds: Dry Fork of Cheat, Shavers Fork, North Fork Cherry, Upper Gauley, Cranberry, and Williams Rivers. All listed streams are within areas dominated by the acidic Pennsylvania age bedrock mentioned above, and this is the major contributing factor to their acid-impaired condition. Acid deposition is also contributing to the highly acidic condition of some waters. Also, some old coal mining activities produce acid mine drainage (AMD) which can further add to acid impaired conditions in streams, such as the old drift mine AMD discharge in the head of Bear Run (headwaters of the North Fork Cherry River). The West Virginia DNR treats a substantial number of acid-impaired streams within the MNF with limestone sand to raise the pH and alkalinity within those streams and in downstream waters. Bear Run is among the streams treated with limestone sand. With perhaps a few exceptions, acidic stream segments treated with limestone sands are not listed as pH impaired.

Routine Forest management activities are not believed to substantially contribute to pH impaired conditions in streams. However, possible connections between timber harvesting and soil calcium depletion in certain sensitive watersheds are under study. One of the streams listed as pH impaired is Desert Branch (of the North Fork Cherry) and Desert Branch is one of the watersheds under study for soil chemistry effects from harvesting. Stream chemistry is strongly connected to the soil chemistry and geology within its watershed.

CNA-Biological: CNA stands for "conditions not allowable." CNA-Biological is a criterion of stream health used to assess whether the Aquatic Life designated use is being achieved. It is a measure of biological condition and used to determine the degree of impairment. CNA-Biological uses a benthic macro-invertebrate index score (West Virginia Stream Condition Index or WVSCI) to assess biological integrity. Sediment is one of the stream environment conditions that can affect the WVSCI score but other factors or conditions can also affect the score.

Five streams (32 miles) were listed as impaired for CNA-Biological and the sources were identified as unknown. The longest segment is Red Creek (of Dry Fork River) with 19.8 miles listed impaired. The lower reaches of Red Creek from its mouth are entirely in private ownership and this section is heavily impacted by flood damage (and subsequent mechanical dredging of the stream channel), sedimentation, and acidic waters from upstream tributaries. The rest of Red Creek flows through designated Wilderness or undeveloped headwaters that possess flood-damaged stream channels and acidified tributary stream flows. These conditions may collectively be responsible for listing Red Creek. Four other streams (about 12 miles) are also listed as impaired for CNA-Biological. These streams are all primarily in private ownership where extensive roads, agriculture, residential, and other developments along and near the streams are likely contributing sources of the impairment. None of these CNA-Biological listings are substantially connected to National Forest management actions.

Fecal Coliform: A number of streams are listed for fecal coliform impairment and the sources are identified as unknown. Fecal coliform problems in streams are usually from livestock waste sources or from inadequate or nonexistent sewage treatment and failing septic systems. Frequently, grazing along streams with uncontrolled animal access to the water is a major source of fecal coliform contamination.

Two major river systems are listed for fecal coliform impairment: the Tygart and Greenbrier Rivers. The Tygart Valley River is listed for 78.7 miles of its length. Essentially all of the Tygart Valley River is bounded by private ownership which is heavily developed and contains extensive agriculture and grazing. The Greenbrier River and some of its tributaries (hundreds of miles) are newly listed for fecal coliform impairment in the 2006 report. These new listings in the Greenbrier are a result of new data collected since the 2004 303(d) report listings. Nearly all of the listed streams flow through private ownership, though National Forest System lands occur in the extreme headwaters. Private land use is heavily agricultural and grazing oriented and control of cattle access to streams is almost non-existent. Sewage treatment in portions of the watershed is known to be inadequate. These are believed to be the primary sources of the fecal coliform problems in the Greenbrier system.

The MNF maintains a very small grazing allotment in the extreme headwaters of Stony Creek (in the Greenbrier River watershed near Marlinton) and Stony Creek is one of the listed streams. The MNF constructed riparian exclosure fencing in this small allotment during 2002 to keep cattle out of headwater channels in the Stony Creek watershed. However, cattle have extensive access to Stony Creek and its tributaries on private land downstream from National Forest System land.

Sediment: Sediment is a widespread and substantial source of water quality and aquatic habitat impairment state-wide. Forest management activities are a potential source of pollutants, mostly sediment related, that can have detrimental effects to stream ecosystems. Despite this, there are no streams within MNF lands that are 303(d) listed for sediment impairment. As with other impairment criteria, it is likely that sediment impairment is taking place in some streams but there is currently insufficient data to characterize streams with respect to sediment impairment. Based on incidental observations and isolated investigations by Forest personnel, as well as reports from forest visitors, sources of stream sedimentation have primarily been observed in connection with road features (*e.g.* system roads, timber haul roads, skid roads, and improperly abandoned roads). However, CWA water quality criteria and designated uses are primarily being maintained and protected. Compliance with Clean Water Act requirements and State administered programs is being achieved.

Point Source Pollution: The Forest Service owns and operates several point sources of pollution. These include sewage treatment facilities at administrative sites, campgrounds, and picnic areas. All such facilities are permitted under the State of WV permitting authority (NPDES), operated in compliance with permit requirements, and monitored to assure satisfactory performance. All National Forest NPDES permitted facilities are in compliance with their permits and achieving specified performance standards. CWA requirements are being met.

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.

To clarify the intent and scope of this monitoring item, it is recommended that we change the wording to say: *To what extent is management of National Forest System lands influencing the* *viability of native and desired non-native aquatic species (e.g. RFSS and MIS) or otherwise affecting species composition and productivity of aquatic environments?*

Monitoring Question 45. To what extent is Forest management contributing or responding to 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 of 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.

The final report for Agreement 04-PA-11092100-070 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*).

Monitoring Question 45. 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.

To clarify the intent and scope of this monitoring item, it is recommended that we change the wording to say: *To what extent is management on National Forest System lands influencing populations of terrestrial or aquatic non-native species that threaten native ecosystems?*

Monitoring Question 48. Is the Forest providing adequate habitat to meet the demand for wildlife-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 2007, 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 and hold 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 48. 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 educational. 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.

To clarify the intent and scope of this monitoring item, it is recommended that we change the wording to say: *Is the Forest providing adequate habitat to meet the demand for wildlife and fisheries related social and recreational opportunities?*

Table AR-8. Summary of Recommended Changes to Forest Plan Monitoring Questions

Recommended Replacement Questions for Chapter IV of the Forest Plan	Association with Current Forest Plan Monitoring Question(s)	Monitoring Issues that the Replacement Question Will Address
To what extent is management of NFS lands influencing the viability of native and desired non-native aquatic species (e.g., RFSS and MIS) or otherwise affecting species composition and productivity of aquatic environments?	10, 26, 42, 44	Stream Water Chemistry Stream Temperature Stream Sedimentation Aquatic Habitat Quality Aquatic Habitat Connectivity Aquatic Nuisance Species CWA Compliance Recreational Fishing
To what extent is management of NFS lands and other external influences (such as acid deposition) beneficially or detrimentally affecting water quality/quantity?	39, 43	Stream Water Chemistry Stream Temperature Stream Sedimentation Aquatic Habitat Quality Aquatic Habitat Connectivity Aquatic Nuisance Species CWA Compliance
To what extent is management of NFS lands beneficially or detrimentally affecting the physical conditions of aquatic ecosystems, including riparian ecosystem function and health?	40, 43	Stream Water Chemistry Stream Temperature Stream Sedimentation Aquatic Habitat Quality Aquatic Habitat Connectivity Aquatic Nuisance Species CWA Compliance
To what extent is management of NFS lands beneficially or detrimentally affecting soil erosion and stream sedimentation processes?	41, 43	Stream Water Chemistry Stream Temperature Stream Sedimentation Aquatic Habitat Quality Aquatic Habitat Connectivity Aquatic Nuisance Species CWA Compliance
To what extent is management of NFS lands influencing populations of terrestrial or aquatic non-native species that threaten native ecosystems?	45	Aquatic Habitat Connectivity
Is the Forest providing adequate habitat to meet the demand for wildlife and fisheries related social and recreational opportunities?	48	Stream Water Chemistry Stream Temperature Stream Sedimentation Aquatic Habitat Quality Aquatic Habitat Connectivity CWA Compliance Recreational Fishing