FY 2008 – FY 2016
Monitoring & Evaluation Report

Allegheny National Forest

Forest Service **Allegheny National Forest** **October 2021**

For questions about the ANF's Monitoring Program,
or to request a copy of this or previous Monitoring & Evaluation Reports, please contact:

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Summary of Findings & Recommendations

The ANF has completed its ninth full year (FY 2008-2016) of implementation of the 2007 Forest Plan. Evaluation of monitoring information has resulted in the recommendation of adjustments to improve the implementation and/or effectiveness of management and/or monitoring practices, as well as a number of changes to the Forest Plan and Monitoring Program. Recommended changes to the Forest Plan include:

- Modify the Forest Plan in a manner that is consistent with the legal cases that have been decided since the Plan was affirmed with instructions
- Remove the following Forest Plan objectives:
    - establish a formal, multi-agency working group, including representatives from the ANF, PA DEP, and other state and Federal agencies, to coordinate policies and processes regarding the management of oil and gas resources and infrastructure on the ANF
    - provide optimum and suitable vegetative habitat for Indiana bat
- Modify the Forest Plan objective to work with appropriate representatives of the Seneca Nation of Indians to develop a confidential inventory of culturally sensitive sites by replacing "Seneca Nation of Indians" with "American Indian Tribes with ancestral ties to the ANF landscape"
- Update the Forest Plan to incorporate conservation measures specific to the northern long-eared bat (e.g., Eastern Region Conservation Measures) and remove those specific to the Indiana bat
- Update the Forest Plan to align with changes in direction on soils monitoring and remove the references to the superseded directives regarding use of a Regional soils disturbance threshold
- Expand the herbicides and treatment techniques available for NNIP treatment through, for example, amendment of the Forest Plan.

Recommended changes to the Monitoring Program include:

- Increase the evaluation frequency for the monitoring question, *How is the growing season length changing on the ANF?*
- Remove the following monitoring questions to reduce redundancy:
    - *How many acres of soil and water restoration have been accomplished?*
    - *How many riparian acres have been treated to improve vegetative diversity? Have prescriptions improved riparian conditions for the benefit of riparian-dependent resources?*
    - *How many miles of road have been decommissioned?*

1.0 Introduction

The purpose of this monitoring and evaluation report is to document implementation of the Allegheny National Forest's (ANF) 2007 Land and Resource Management Plan (Forest Plan) Monitoring Program during Fiscal Year (FY) 2008 through FY 2016. This report is not a decision document [36 CFR 219.12(d)(4)]; rather, it will help facilitate the determination by the responsible official of whether a change in plan components or other plan content that guide management of resources on the plan area may be needed (36 CFR 219.12(a)(1)).

Monitoring and evaluation are not only activities required by the National Forest Management Act (NFMA), but are also continuous learning tools that form the backbone of adaptive management. Monitoring involves the repeated collecting of data by observation or measurement. Evaluation involves analyzing and interpreting monitoring data.

Several kinds of activities may be referred to as monitoring. Programmatic monitoring tracks and evaluates trends of ecological, social, or economic outcomes. Project implementation monitoring monitors compliance with Forest Plan standards and guidelines. Effectiveness monitoring evaluates how effective management actions are at achieving desired outcomes. Validation monitoring verifies assumptions and models used in Forest Plan implementation. Finally, monitoring may also address issues for large geographic areas of which the ANF is a part.

Effective monitoring and evaluation of the Forest Plan fosters improved management and more informed planning decisions. It helps identify the need to adjust management direction, such as desired conditions, goals, objectives, standards and guidelines, as conditions change. Monitoring and evaluation helps determine how a Forest Plan is being implemented, whether plan implementation is achieving desired outcomes, and whether assumptions made in the planning process are valid.

This is the fourth monitoring and evaluation report published since the Forest Plan was finalized. It is the first report prepared since the Monitoring Program was updated in May 2016 to, in part, transition to the 2012 Planning Rule monitoring requirements (36 CFR 219.12[a][5]). This report is of value to USDA Forest Service leadership, managers and employees, as well as to the public. It provides a readily available reference document for Forest Service managers as they plan, evaluate the effects of actions on resources, and implement future projects. This report also describes to the public how their public lands are being managed and how effectively the commitments made to them within the Forest Plan are being met. This and older reports are available on the ANF planning website (https://www.fs.usda.gov/main/allegheny/landmanagement/planning) or by request (see the contact information on p. 2 of this report).

2.0 Forest Plan Monitoring Program

The minimum monitoring and evaluation components required of Forest Plans by the NFMA are established by a planning rule. The Monitoring Program in the ANF's Forest Plan was updated in May 2016 for consistency with the 2012 Planning Rule [36 CFR 219.12]. During this

"monitoring transition", the Monitoring Program was reviewed and modified to ensure it, at minimum, addressed:

1. The status of select watershed conditions.
2. The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.
3. The status of focal species to assess ecological conditions.
4. The status of a select set of ecological conditions that contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.
5. The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.
6. Measureable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
7. Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.
8. The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 USA 1604(g)(3)c)).

The Forest Plan was administratively changed to include the updated Monitoring Program (pp. 37-47[1]; https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd501043.pdf). Additional monitoring questions and indicators are also included in the Monitoring Program to inform the management of resources on the plan area, although not every plan component needs to have a corresponding monitoring question [36 CFR 219.12(a)(2)].

There are 67 monitoring questions in the Monitoring Program. Staffing and/or funding constraints may affect the level of monitoring that can be completed in a particular fiscal year. All monitoring questions were last evaluated in the FY 2008 – FY 2013 Monitoring & Evaluation Report (https://www.fs.usda.gov/main/allegheny/landmanagement/planning). Only those monitoring questions with a 2-year evaluation frequency (49) are addressed in this report. The other monitoring questions with 4, 5, or 6-year evaluation frequencies will be evaluated in future reports.

[1]When the Forest Plan was finalized in 2007, the Monitoring Program was found on pages 37-51. The Monitoring Program was updated in 2016, however, and pages 37-51 of the Forest Plan were replaced with the updated Monitoring Program.

3.0 Monitoring results

3.1 Cross-program monitoring

3.1.1 Effects of management practices

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
To what extent have standards and guidelines been applied?	Project-level implementation and effectiveness of Forest Plan design criteria	Annual	2 Years	FY 2013

Background – The purpose of implementation and effectiveness monitoring is to evaluate whether the applicable Forest Plan standards and guidelines were followed and if desired outcomes were achieved. Project-level effectiveness monitoring was conducted on select management practices from FY 2008 through FY 2016. In addition to the examples that follow, additional effectiveness monitoring completed included:

- *3.2.2 Effectiveness of non-native invasive plant controls*
- *3.7.3 Prescriptions and effects*
- *3.7.6 Effectiveness of herbicide design criteria*

Forest Road 230 timber sale

Protocol – On September 24, 2008, a NEPA review was conducted on two timber stands in the Forest Road (FR) 230 Timber Sale, part of the Spring Creek project. Fourteen resource specialists participated in the review with expertise in forestry (silviculture, sale administration, timber marking), wildlife management, soils, hydrology and landscape architecture present.

Results

Compartment 709/Stand 41 – Payment Unit 36

To protect water quality, mitigation measures require that wet areas be buffered from harvest activities with a minimum 25-foot buffer. This mitigation measure was properly applied to one small wet area on the eastern side of the stand. Herbicide treatments also protected the wet area by maintaining at least a 25-foot buffer. No additional wet areas were present.

Consistent with Forest Plan design criteria and Best Management Practices (BMPs), soil mitigation included advance layout of skid trails and no skid trails on grades greater than 15%. Both measures were properly applied. No excessive damage to soils was observed and no skidding occurred through seeps or springs. Approximately 2.6 % of the stand had soil disturbance associated with skid trails and landings (Table 1), less than the 15% Regional standard.

Table 1. Post-harvest soil monitoring of FR 230 Timber Sale – Payment Unit 36

Payment Unit	Acres	Acres in Skid trails	Acres in Landings	Acres in Ruts	Total Acres Disturbed	Percent Disturbed
36	22	0.56	0.03	0.01	0.60	2.6%

Visual mitigation measures included pulling the slash back 25 feet from the road and felling striped maple and beech along the road after applying herbicide. Both measures were completed as prescribed.

Wildlife mitigations involved leaving snags, den trees, and conifers. The number of wildlife reserve trees is provided in Table 2.

Table 2. Wildlife reserve trees in FR 230 Timber Sale – Payment Unit 36

	Snags	Den Trees	Potential Den trees	Hemlock	Cavity Trees	Boundary Reserve Trees	Reserve Trees
Total Trees	161	27	30	138	36	67	8
Trees / Acre	7.3	1.2	1.3	6.2	1.6	3.0	0.4

The measure that requires 5-10 snags per acre has been met. Retention of 16 live trees per acre has been met (since this is a partial harvest); however, substantial beech mortality occurred after the unit was marked and a few reserve trees were cut because of safety concerns. Retention of three live den trees is met if potential den trees are included.

Compartment 708/Stand 10 – Payment Unit 20

Mitigations for soils and water included buffering wet areas and using existing skid trails. One existing skid trail ran through a small wet area. This skid trail was used, and care was taken to avoid rutting and excessive soil damage. The unit was relatively flat and no skid trails exceeded a 15% grade. The main skid trails disturbed less than 15% of the unit acreage (Table 3).

Table 3. Post-harvest soil monitoring of FR 230 Timber Sale – Payment Unit 20

Payment Unit	Acres	Acres in Skid trails	Acres in Landings	Acres in Ruts	Total Acres Disturbed	Percent Disturbed
20	15	1.02	0.20	none	1.22	8.1%

No visual or recreation concerns were identified, and no mitigations were applied for these resources.

For the wildlife mitigation, 67 snags and 21 den trees (4.4 snags per acre and 1.4 den trees per acre) were left. The wildlife retention measure for a green partial harvest was:

Retain all snags > 9" DBH. Retain at least 16 live trees per acre ≥ 9" DBH. Mark and retain three live den trees per acre. Retain one live tree in the vicinity of about 1/3 of all large diameter (> 12") snags with exfoliating bark.

Since this treatment was a thinning, there are many more live trees retained than the minimum of 16 per acre. There were also many opportunities for additional den trees to develop over time.

Discussion – The mitigation measures were properly applied and were effective in avoiding/minimizing resource damage.

Recommendations – There are no findings from this project to recommend changes to standards and guidelines in the Forest Plan at this time.

Federal oil and gas development – Tract 13

Protocol – In July 2010, review was conducted on the Tract 13 Federal oil, gas, and mineral development (OGM; USA Minerals). This development had six wells drilled using the Energy Policy Action Section 390. The interdisciplinary review team reviewed the three wells located near, but not within, aquatic management zones. ANF, Pennsylvania Department of Environmental Protection (PA DEP), and USDI Bureau of Land Management (BLM) staff have continued inspecting the development since the project was implemented, including inspections by ANF staff in FY 2014.

Results and Discussion – The July 2010 review found that the environmental planning process was properly followed, and Section 390 criteria were fulfilled. The decision and implementation were consistent with 2007 Forest Plan direction. The proposed access roads and well pads were designed to protect surface resources, with a few noted exceptions.

The overall layout and implementation utilized the proper design features (e.g., BMPs) to minimize surface disturbance, sediment runoff, and impacts to surface resources. A small spring seep below well 1870 was protected. An exception was found to the 2070 Biological Diversity Guideline in that the seed mix approved in the Erosion and Sedimentation Control Plan contained non-native invasive plants (NNIP), e.g., birdsfoot trefoil, redtop, alsike clover, and timothy, and the allowance of hay for mulching did not conform to a material with the least likelihood of introducing unwanted vegetation.

An Erosion and Sedimentation Control Plan was implemented and was determined to be mostly effective. Good soil stabilization occurred on well sites and access roads. Silt fences were properly installed. Most cross drains had large rock placed at the ends as level spreaders to avoid concentrating flow on the forest floor.

The design features to limit sedimentation reaching intermittent stream crossings on FR 213 had not been implemented fully at the time of the July 2010 review. There was evidence of sediment delivery to these intermittent streams along FR 213. Some limestone had just been placed on FR 213 past the last access road where two intermittent stream crossings occurred. It was a large-size stone and appeared to be base material (it had not yet been graded). This did not comply

with the FR 213 road log specification which called for 8" of pit run covered with 4" of driving surface aggregate (DSA) limestone. The culverts that needed to be replaced in this section were not completed at time of review. The field review also identified NNIP in revegetated ditch lines on each well access road**.**

The follow-up inspections indicated FR 213 was surfaced with DSA limestone and culverts were replaced as required by the road log specifications. Additionally, all six well sites exhibited approximately 100% vegetative cover except for the driving access. All cut and fill slopes were stable with no evidence of movement. The well pads were clear of debris and clean. All drainage structures along the access roads were in working condition with no scour. Multiflora rose at these sites should be treated and monitored. Field surveys found it at proposed well sites 1866, 1869, and 1870. With new road corridors, openings, and ground disturbance, this species is very conducive to spread by birds.

Recommendations

- The implementation folder was very useful. Continue to use this approach on future federal minerals.
- Direct oil and gas administrators to reference Erosion and Sedimentation Control Plan requirements and the decision mitigations (Conditions for Approval) in inspections.
- When waivers for road construction work are issued in the Notice to Proceed (NTP), include timeframes for completion. State the need for final inspection acceptance of all required items.

Mud Lick and Chappel 2003 blowdown salvage sales

Background – On July 21, 2003, the ANF was affected by an unusual mesoscale convection system that resulted in an estimated 9,333 acres of blowdown across the Forest. Field crews assessed conditions in areas impacted by the storm over a period of months, in particular areas with concentrations of blown down trees. Timber salvage operation opportunities were identified on some areas of the ANF, and 19 Categorical Exclusion (CE) proposals were developed. Mud Lick and Chappel were two timber salvage sale projects that were approved through CEs. Both Mud Lick (27 acres) and Chappel (39 acres) CEs fell within Management Area (MA) 3.0 on the Bradford Ranger District. The Chappel blowdown area evaluated in this report is now part of MA 2.2 following the 2007 Forest Plan.

Protocol – On October 26, 2010, a NEPA review of Mud Lick and Chappel was conducted to determine if the projects were implemented in compliance with the mitigation measures in the decision documents. The Forest Silviculturist, Forest Hydrologist, Forest Ecologist, and Timber Sale Administrator for the two sales participated in the review.

Results

Mud Lick

Soils and water resources – The salvage operation occurred under optimal, i.e., dry, operating conditions during the summer of 2005, consistent with mitigation measures to protect group 2 soils. Consequently, skid trails were not rutted and did not affect future drainage. To avoid steep grades, skid trails on the east side of the unit were cut into the slope. Trails were constructed during dry conditions with no water evident on the ground surface at the time; however, subsurface flow was intercepted, and water now flows down a portion of the skid trail for less than 50 feet. The construction of water bars and dips on the skid trail minimized erosion and changes to hydrology and the cut appeared stable.

Skid trail pattern and density were affected by the pattern of blowdown and slope on the west and east side of the unit, respectively. On the unit's west side, much of the blowdown fell as patches of complete replacement with logs lying perpendicular to one another. The resulting unusual skid trail pattern (e.g., trails running parallel and in close proximity) was necessary as attempts to rotate logs resulted in greater damage to soil resources. Skid trails were designated in the western portion of the salvage area where group 2 soils were present. One wet area was observed on a skid trail in the western portion of the unit, but it did not contain any flowing water. On the unit's east side, skid trails were cut into the steep slopes, which led to a dense layout of wide trails. Some winching was used to pull logs to skidders on designated skid trails.

GIS and orthophotographs were used to determine if soil disturbance exceeded 15% of the unit. Skid trails were digitized on the unit's east side but could not be identified on the west side. In the field, most sections of skid trail on the western side of the unit were only slightly compacted and are expected to recover. On the east side, there were an estimated 1,858 feet of 13-foot-wide cut bench skid trails amounting to 0.55 acres of detrimental disturbance because the productive soil horizons were removed when the skid trail was cut. The landing on the east side added another 0.07 acres of disturbance. With a harvest area of approximately 6.3 acres, total soil disturbance on the east side represented 9.8%. While this is below the 15% disturbance limit, it is recommended that this method of extraction (cut bench skid trails for tree length skidding) be avoided. If conditions had not been so dry, disturbance could have been much greater.

Mud Lick Run, the stream flowing through the unit, was well-buffered and exceeded 100 feet in width on both sides. Down trees were not removed within the stream buffer. Blowdown that had fallen into the stream did not create pools or result in debris jams. This is likely due to the rockiness of the stream bed and steep slope.

While the deliberate tipping of stumps was not practiced, some stumps did tip back upright when the bole of the tree was removed.

Vegetation resources – The units were surveyed for sensitive and invasive plants prior to implementation of the timber sale.

Residual overstory canopy in the stand was quite variable, ranging from 10 ft^2/acre of basal area up to an estimated 80 ft^2/acre of basal area. The western portion of the stand had more standing trees remaining on site, while the eastern portion of the stand was nearly 100% blown down. The western portion of the stand more closely resembled a very patchy shelterwood seed harvest, rather than a salvage clearcut. It is anticipated that the seedling regeneration that persisted will be more dominated by shade intermediate and tolerant species, such as beech and birch, in the western portion of the stand, while more shade-intolerant regeneration, such as red maple, black cherry, and aspen, will persist in the eastern portion of the stand where near 100% blowdown occurred.

During the October 2010 monitoring review, black birch and American beech regeneration was observed on the west side of the unit. This side also supported vegetation indicative of wetter soils within its skid trails, including musclewood. Black birch and American beech regeneration was also observed on the east side as well as red maple, and pin cherry, with quaking aspen becoming established in the skid trails. Evidence of heavy deer browse was observed throughout the unit.

Natural seedling development was been monitored through stocking surveys completed in fiscal years 2006, 2008, and 2010. Stocking survey data from FY 2010 indicated the stand contained 95% interfering vegetation, with 63% of the plots stocked with tree seedlings. Seedling stocking consisted of red maple, birch, black cherry, red oak and black oak, with birch and red maple dominating the sapling size class. American hornbeam (musclewood or blue beech), hophornbeam (ironwood), and American witch hazel were also noted in the FY 2010 stocking survey. Interfering vegetation consisted of blackberry fern, grass, and birch. This unit had remedial reforestation activities approved in the Southwest Reservoir project, including site preparation, herbicide application, planting, release, and fencing.

Wildlife resources – There are no Indiana bat maternity colonies or roost trees known on the Forest. A bald eagle nest was identified and appropriately designated as a reserve area. An abundance of snags was retained and a native seed mix was used to stabilize trails and landings. Wildlife reserve areas were appropriately identified in the field and on the timber sale map, and observed during the salvage operation. Numerous live trees and potential roost trees were still standing and not salvaged. Trees with the tops snapped off or "cat-faced trees" were still standing and had not been harvested. Logs were hauled south on both FR 110 and 110a to Gibbs Hill Road; Longhouse Drive (FR 262) was not used for a haul route to avoid potential disturbance to an active bald eagle nest.

Social and heritage resources – The units were surveyed for heritage sites and cleared for layout and marking. Tree marking paint was applied on the side away from the road. There were no Concern Level 1 roads or trails associated with the unit. Slash disposal zones were indicated on the timber sale map and appeared to have been pulled back 15 feet and lopped down for an additional 25 feet along Concern Level 2 roads (FR 110, FR 120, and FR 141). Timber from the west half of the unit was decked on FR 141 and the road surface was not impacted. Timber from the eastern portion of the unit was decked on a small landing on the west side of FR 110. The landing was restored and reseeded. Both landings were located on or next to a road in order

to minimize soil disturbance. The unit was not located near the North Country National Scenic Trail and hauling occurred during the summer, so snowmobile trails were not affected.

Chappel

Soil and water resources – This area experienced nearly complete blowdown, making marking and reserve area layout challenging. The flagging that was used was overgrown by brush (and was difficult to see during salvage activities).

OGM development subsequent to the salvage operation placed a road and diversion ditch within the unit that significantly modified area hydrology making it difficult to ascertain the effects of salvage harvesting. It also removed evidence of some skid trail patterns that were used for salvage activities and it was not possible to estimate the extent of soil disturbance. The units were cut throughout the winter of 2004-2005 and completed by the summer of 2005. If conditions became wet or soft, skidding operations were suspended until ground conditions improved. Consequently, skid trails observed were not rutted and did not affect future drainage.

Skid trail pattern and density were affected by the pattern of blowdown, areas with rock, and the slope of the area. Most of the blowdown fell as large swaths with trees stacked on top of one another. There were no mapped group 2 or 3 soils in the unit, and skid trails were designated in the salvage area. Some winching was used to pull logs to skidders on designated skid trails.

A small seep was not buffered during the salvage operation. The seep was not indicated as a reserve area on the timber sale map, and it was also not observed during layout and marking of the stand, likely due to the density and height (stacking) of the blown down trees. There was no evidence that equipment crossed the seep, and it did not appear to be altered by the harvesting of blowdown.

A stream transitioning from ephemeral to intermittent was also observed within the blowdown area. An adequate buffer of 50 feet was applied to the stream, leaving no evidence of erosion or instability within the stream channel. Down trees were not removed within the stream buffer (Figure 1).

Figure 1. Photo taken from the center of riparian buffer along the stream channel within Chappel salvage sale.

While the deliberate tipping of stumps was not practiced, some stumps did tip back upright when the bole of the tree was removed.

Vegetation resources – The units were surveyed for sensitive and invasive plants prior to implementation of the timber sale.

Residual overstory canopy in the stand was somewhat variable. Most of the area had less than 10 ft^2/acre of basal area standing, while areas around the edges contained up to an estimated 80 ft^2/acre of basal area standing, particularly along the eastern boundary

Natural seedling development was monitored through stocking surveys completed in fiscal years 2006, 2008, and 2010. Stocking survey data from FY 2010 indicated the stand contained 97% interfering vegetation, with 49% of the plots stocked with tree seedlings. Seedling stocking consisted of red maple, birch, black cherry, red oak, aspen, sugar maple, and ash. Birch, black cherry and red maple dominated the sapling size class. American elderberry, red elderberry, and serviceberry were also noted in the FY 2010 stocking survey. Interfering vegetation consisted of blackberry fern, grass, pin cherry, beech, and birch. This unit was evaluated for remedial reforestation activities in the Morrison Run project, including site preparation, herbicide application, planting, release, fencing and fertilization.

During harvest activities, portions of the unit were found to contain wet soils and were dropped, leading to volume discrepancies in this unit. Consequently, the sale ended up being a scaled sale with volume scaled at the mill.

Wildlife resources – Given the unit experienced complete blowdown, the paint used to mark wildlife reserve areas did not persist, and subsequent construction of oil and gas roads through the unit made it difficult to determine whether wildlife reserve areas were retained during

implementation. However, some reserve areas in conjunction with water features were appropriately identified in the field, designated on the sale map, and avoided during salvage harvest activities. Some wet areas that were not identified during layout and buffered in reserve areas were subsequently identified during sale administration. These areas were dropped during sale administration and not salvaged. An area of larger boulders and rock outcroppings along the northwestern stand boundary was avoided entirely during layout of the unit.

There are no Indiana bat maternity colonies or roost trees known on the Forest and pre-implementation surveys did not document other threatened or endangered species or stick nests. The landing was located on an existing well pad and there was no need to reseed the landing. A native seed mix was used to stabilize trails. An abundance of snags, numerous live trees, and potential roost trees still standing were not salvaged. Trees with the tops snapped off or "cat-faced trees" were still standing and had not been harvested.

Social and heritage resources – The units were surveyed for heritage sites and cleared for layout and marking. No heritage sites were identified within these units. Tree marking paint was applied on the side away from the road. There was no Concern Level 1 or 2 roads or trails associated with the unit. The landing was located on an existing well pad and there was no need for restoration. The unit was not located near an ATV trail, the North Country National Scenic Trail, or other non-motorized trails, and hauling occurred during the summer, so snowmobile trails were not affected.

Discussion and Recommendations – In future blowdown or broad scale mortality assessments, consider providing field crews with consistent thresholds to categorize damage. Possible thresholds for ocular estimates could be less than 10% of the canopy still intact (catastrophic/stand reinitiating blowdown), 10 to 40% intact (heavy blowdown, salvage, may need to remove some standing trees, follow up with reforestation treatments), 40 to 70% standing (moderately heavy blowdown - poorly to moderately well stocked stand will remain, consider area for two-step regeneration sequence), and more than 70% standing (relatively light blowdown, well stocked stand will remain, but follow up assessment recommended).

It is recommended that the Chappel site be planted with quaking aspen, butternut, tulip poplar, basswood, and sugar maple. The site also needs to have interfering pin cherry, birch, beech and striped maple felled where they are overtopping desirable tree seedlings.
Bench cut skid trails should be avoided due to the disturbance to soils and alteration of hydrology.

Where heavy and moderately heavy blowdown occurs, map reserve areas using a GPS unit that can record coordinates of reserve areas.

Prescribed burn smoke monitoring

Protocol – The ANF monitored smoke during four prescribed fires: one in FY 2012, one in FY 2013, and two in FY 2015. In FY 2012 and FY 2013, smoke monitoring consisted of photographic documentation, and the use of an E-Sampler (a nephelometer which quantifies light scattering) to measure $PM_{2.5}$. FY 2015 smoke monitoring relied solely on the latter. The E-

Sampler is a good tool to estimate the number of fine particles in the air. The $PM_{2.5}$ benchmark that is used to estimate levels at which smoke would become a concern to human health is 35 $\mu g/m^3$ averaged over a 24-hour period. Small particles less than 2.5 micrometers in diameter (PM2.5) pose the greatest risk to human health because they can get deep into human lungs, and some may even get into the bloodstream. These small particles are found in smoke.

Results – The Upper Millstone prescribed fire (Burn Unit A; 25-30 acres) occurred March 22, 2012, on the Marienville Ranger District. The E-Sampler was set up approximately 300-600 meters northeast of Upper Millstone Burn Unit A the day before the burn, in a predetermined safety zone. Figures 2 and 3 show light smoke shortly after initial ignition and Figure 4 shows a very light smoke plume from approximately 5 miles away. The 24-hour average $PM_{2.5}$ for the day of the fire was 5 $\mu g/m^3$.

Figure 2. Light smoke after ignition of Upper Millstone Burn Unit A prescribed fire (March 22, 2012, 1347 ET)

Figure 3. Light smoke after ignition of Upper Millstone Burn Unit A prescribed fire (March 22, 2012, 1349 ET)

Figure 4. View from Route 66 Marienville Fire Tower, approximately 5 miles west of Upper Millstone Burn Unit A prescribed fire (March 22, 2012, 1448 ET)

The Southwest Reservoir prescribed fire occurred May 3, 2013, on the Bradford Ranger District. The size of this fire was 161 acres in size. The E-Sampler was set up on the Kinzua Dam, less than 1¼ miles away from the fire from May 2 through May 7. This location was chosen to monitor any potential smoke inversion following the fire, along a public roadway, below the burn site.

The concentration of $PM_{2.5}$ from May 2-May 7 at the Kinzua Dam is shown in Figure 5. The time is given in Greenwich Mean Time (GMT) which is four hours ahead of Eastern Daylight Time (EDT). The high $PM_{2.5}$ concentration (23 µg/m^3) occurred at 2200 GMT (1800 EDT), on May 3, the day of the burn. The day of the burn 24-hour average was 4 µg/m^3. On May 4, 0100 GMT (2100 EDT on May 3), the concentration was 7 µg/m^3. The 24-hour average for May 4 was 3 µg/m^3.

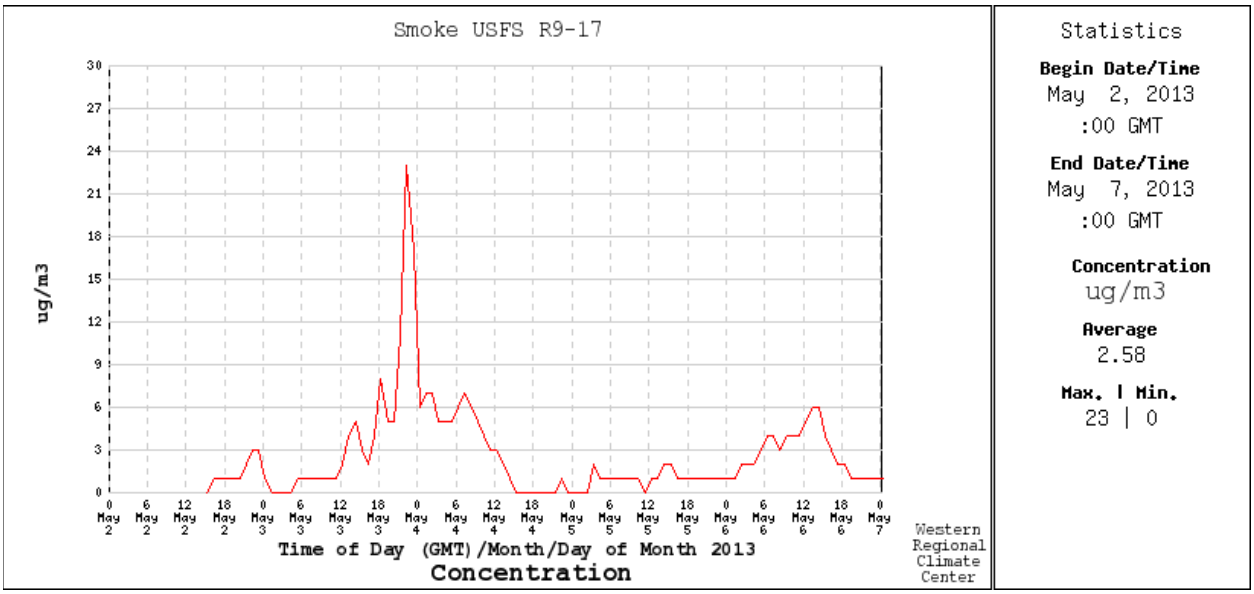


Figure 5. $PM_{2.5}$ concentration for May 2-May 7, 2012 (the Southwest Reservoir prescribed burn occurred on May 3, 2012)

The Coalbed Project, Unit 5 prescribed fire (Burn Unit A; 63 acres) occurred May 3rd, 2015, on the Marienville Ranger District. The E-Sampler was set up approximately ¼ mile east of the prescribed fire before the fire began and was taken down shortly after the fire was done. The average hourly $PM_{2.5}$ measured by the E-Sampler during the burn did not exceed 4 µg/m³.

The FR438D prescribed fire, near the Kalbfus Rod and Gun Club, occurred May 4, 2015, on the Bradford Ranger District. This fire was 24 acres in size. The E-Sampler was set approximately 500 feet east of the burn unit before the fire began and was taken down after the fire was complete. The average hourly $PM_{2.5}$ measured by the E-Sampler during the burn did not exceed 3 µg/m^3.

Discussion and Recommendations – All four prescribed burns remained well below the human health benchmark for $PM_{2.5}$. Continue smoke monitoring during selected prescribed burns.

National Best Management Practices monitoring

Protocol – A national Best Management Practices (BMP) monitoring program was developed by the USDA Forest Service to establish a consistent process to monitor and evaluate efforts to implement BMPs and the effectiveness of those BMPs at protecting water quality at multiple scales (USDA-FS 2012a). In FY 2013, an interdisciplinary team conducted a BMP review following the draft national BMP monitoring protocol for minerals management. From FY 2014 through FY 2016, BMP reviews were completed on 18 sites, following the national BMP monitoring protocols for recreation management, roads management, vegetation management, chemical uses, minerals management, and aquatic ecosystems. Six reviews were completed each year. At a minimum, two specialists completed each of these reviews, including the Forest Hydrologist and the specialist who was familiar with the project. Site selection was random for about half of the sites.

Results and Discussion

Recreation management

Motorized or non-motorized trail operation and maintenance

9/19/2014: A 1,320-foot section of the Rocky Gap Trail (Elkhorn Loop) was evaluated. The BMPs were found to be implemented properly. There was some evidence of sedimentation observed within riparian buffers, but it was not reaching a water body. This was occurring because this evaluation reach had a stream crossing on Elkhorn Run where there was an insufficient number of water control features (such as grade controls) on a steep approach. The desired result was partially achieved because most of the runoff was diverted into an effective filter and the sedimentation was more than 10 feet from the stream.

9/26/2014: A 960-foot section of the Spring Creek Horse Trail was evaluated. The BMPs for this project were found to be implemented properly. There was evidence of sediment deposition in Spring Creek, but it was not having a negative impact on the water resource. Sedimentation observed was transported, by Spring Creek, during high flows and deposited on an armored ford crossing (Figure 6). This occurred due to the ford's design and installation. Sediment collected on the ford because the rocks, placed to mark the trail route, are higher than the trail causing the water to slow and deposit sediment. Sedimentation deposition would not have occurred if the rocks were buried to the same elevation as the trail.

Figure 6. Armoring of ford approach at the Spring Creek Horse Trail

9/26/2016: A 1,320’ section of the Timberline ATV trail (Loop E), where it crossed Red Lick Run, was evaluated. The BMPs were found to be implemented correctly except for the drivable dips and leadoffs. On the steeper section of trail (17 %), the drivable dips were not built up high enough to divert runoff. Leadoffs were not excavated off trail far enough and runoff was diverting back onto the trail. Trail use was restricted within the past five years and treatments were applied to correct trail problems. On the section of trail outside of the stream crossing approach, there was no evidence of erosion or sedimentation reaching the stream. At the stream crossing approach, there was evidence of sediment transport to the stream, as indicated by traceable evidence from flow path and sediment-stained leaves. There was also some back instability from excess runoff flowing to a confined location, primarily due to an insloped trail causing erosion of material at the bridge footer. In contrast, an outlsoped trail would divert the water off the road (Figure 7). It was also noted that it would be beneficial to add a wing wall on this bridge to reduce slope erosion.

Figure 7. Sediment path flowing toward Red Lick Run resulting from a lack of defined leadoff ditches and inadequate trail maintenance

Roads management

Active road or waterbody crossing construction or reconstruction

9/14/2015: As part of the methods in this evaluation protocol, a culvert installation on FR 508 was reviewed during construction activity. This project was a replacement of an existing culvert (two-metal arched culverts) with a new culvert (26-foot wide, bottomless arch) to provide aquatic organism passage (AOP) and flood flow passage within Wintergreen Run. At the time of review, diversion of water and culvert installation was on-going. The flow was diverted to a confined channel between the concrete arch footers. Flow diversion did not cause excess turbidity; however, the State of Pennsylvania does not have a water quality standard for turbidity or sediment in which we could review. To construct the concrete footers, the footer hole had to be pumped dry. The contractor set up a discharge hose so that the turbid water flowed through vegetation, which acted as a filter before the discharge entered the stream. This method was effective at decreasing turbidity.

Completed road or waterbody crossing construction or reconstruction

9/24/2014: A culvert installation project on FR 119 was reviewed less than one year after the culvert was installed (9/30/2013). This project was a replacement of an existing culvert with a new culvert to provide AOP and flood flow passage on an intermittent tributary to East Hickory Creek. The original culvert was twice as long as the new culvert because the upstream half of the culvert was an entrance to an old non-system road. A portion of the roadbed was an entrance to a decommissioned road that was only used as a horse trail and no longer needed. The entrance to this road was obliterated by removing the upstream portion of the culvert. The culvert was already under contract when the culvert length was reduced from 70 to 35 feet. Implementation was carried out; however, the original plan did not adequately describe the level of restoration needed at the road decommissioning.

During installation of the new culvert, it was discovered that fill was eroding and depositing into the stream channel, causing some debris blockage and changes to waterbody geometry (Figure 8). This was caused by improper restoration at the decommissioned portion of the roadway which left the angle of the cut slope too steep. Erodible material and lack of bank armoring allowed stream flow to erode the toe of the slope.

Future work at this site will be needed to restore the channel shape and floodplain width. The banks upstream of the culvert will need to transition from a wide floodplain to a narrow culvert. Construction of wing walls/head walls and stable banks upstream of the inlet will be needed to transition the stream to the culvert. Improving this transition and installing wing walls would have reduced the observed collection of debris and materials at the inlet.

Aquatic organism passage was achieved at this culvert because it had streambed substrate throughout the length of the culvert. This project was only partially effective at reducing erosion in the ditch lines and providing a stable road surface. The roadway maintenance was effective and was not contributing sediment to the aquatic management zone of this perennial stream.

Figure 8. FR 119 culvert prior to culvert cleaning (top) and after cleaning of the inlet (bottom)

Road operation and maintenance

9/23/2014: A road maintenance contract was evaluated on a section of FR 145, where the road crossed a perennial tributary to Salmon Creek. At this evaluation, it was found that the road grading was ineffective because it had not reconnected the road runoff to the ditch. There was evidence (sediment accumulation) of sediment transport to the water body related to the road runoff. After the road was graded, berms created by the grader were left along the road and funneled runoff along the edge of the road, instead of directing the flow to the ditches. To correct this problem in the future, road grading should remove berms and restore road runoff connections to the ditches.

Additionally, this road has become entrenched due to surface erosion related to grading practices and the road grade itself. It was determined that the road reconditioning is required to reestablish

a crown so that runoff can be diverted to the ditches. The stream crossing culvert at this location was functioning properly. Issues at this site were corrected in 2016 using road maintenance funds and partnership funding from the Western Pennsylvania Conservancy (WPC).

9/26/2014: A road maintenance contract was evaluated for a section of FR 186 where the road crosses South Branch Kinzua Creek. The most recent grading at this location occurred two years prior. At this evaluation there was evidence of sediment transport to the water body due to the erosion of the road surfacing. It was noted that grading had left a berm along the road that directed road runoff to the stream, instead of dispersing the flow to a vegetated filter. Outside of the stream crossing, sedimentation was also noted where road runoff flowed to the water body. This was due to insufficient leadoff ditches to direct road runoff to vegetated filter areas. It also was noted that the bridge decking had accumulated excessive sediment and should be cleaned on a more frequent basis.

Active road decommissioning

7/7/2015: An active road decommissioning project of FR 226 was evaluated. BMP measures were applied along the majority of the road; however, they were found to be insufficient at the only stream crossing, which lacked temporary vegetative erosion control requirements. This stream crossing had evidence of localized sediment deposition and had the potential for erosion. This area was stabilized the following week using mulch and also was seeded. In addition, trees were felled across the road to help trap sediment and divert runoff. It was found that the excavator operator for this project was using methods that did not meet the guidelines for recontour decommissioning. Ditch lines were being installed to catch and deflect water, where the desired method is to spread out the flow of water except at natural drainage areas. Another section of road could have been recontoured to match the surrounding terrain.

Completed road decommissioning

9/26/2014: A completed road decommissioning project on FR 182 was evaluated. This road was decommissioned the year prior. It was determined that the project eliminated traffic on the decommissioned road, removed all road culverts, restored natural drainage, and re-contoured the roadbed to match the surrounding terrain. Also, the ripping of the roadbed has allowed trees and other native vegetation to re-establish on the roadway. BMP measures were effective at reducing erosion and sedimentation along the road. It was determined that the waterbody crossing, which was restored, had sufficient ground cover and was stable, except for a minor observation of lateral adjustment that is expected to stabilize naturally. It was noted that the stream crossing did not have enough material removed from the roadbed to establish a floodplain. This caused constriction at the stream and increased scour.

Stored roads

9/26/2016: A one mile section of FR 209 which was put into road storage 25 years ago was evaluated. Road storage BMPs appear to have been fully implemented, but they have not been effective at keeping sediment out of the ephemeral tributary to Queens Creek due to lack of maintenance. The evaluation found that lack of maintenance is now causing a risk of failure at

two culverts due to a plugged inlet, failing outlet, materials eroding at inlet, and inadequate culvert size. One of the culverts is recommended for temporary removal until the road is reopened. The other culvert requires headwalls to reduce maintenance needs. Additionally, the roadway was carrying water in ruts and over culverts. To remedy this, two water bars were recommended to be added to the road.

Vegetation management

Ground-based skidding and harvesting

For timber sales monitored overall, it was determined that the undisturbed forest floor effectively traps sediment and slows runoff. The only locations where sediment was reaching water resources was where skid trails crossed streams or wetlands. Water resource buffers were effective at minimizing the potential for sediment or herbicides to reach streams.

9/26/2014: A Marienville Ranger District overstory removal under the LMC Salvage Removals Sale was evaluated. Slight deficiencies were noted on implementation of erosion control for the skid trail. This was particularly noticeable because of the steep slope of the skid trail and the bare soil. The removal of the topsoil on this skid trail had taken away the nutrients needed for revegetation. Mulching guidelines were not followed on skid trail slopes greater than 25% and a brush and cover was required to protect soils. Dozer work to create water bars on the skid trail was accomplished at a later date and should have brought in additional slash.

The BMPs were found to be effective at protecting water quality. The appropriate buffers were applied to a perennial stream that flowed along this sale. Some erosion occurred on the skid trails, but no sedimentation traveled into riparian buffers. No evidence of bank damage or erosion or sedimentation were found in the riparian buffers. No water bodies were crossed in this sale. The landing of this sale was greater than 230 feet from a perennial stream and did not contribute sedimentation with the aquatic management zone.

7/8/2015: A Marienville Ranger District salvage treatment from the Pine Bunts Salvage Sale was evaluated. Application of BMPs was found to be deficient due to skid trail layout, mechanized equipment use, and vegetation treatments within riparian buffers. Layout did not identify a riparian buffer around a headwater stream. Evidence of erosion and sedimentation was found within the riparian buffers of an intermittent stream due to a water body crossing on the skid trails. The sections of skid trails that did not have water body crossings did not have sediment reaching streams.
The landing had some erosion from the surface runoff due to exposed bare ground, compaction, and rutting that was left on the landing; however, no sediment from the landing was reaching any riparian buffers.

Wet soil indicators were not avoided during skid trail layouts. This resulted in soil compaction, which did not revegetate. Also, deep ruts were left in the skid trail. Follow-up is required to decommission the old roadbed or add water bars to reduce ditch line runoff.

7/8/2015: A Bradford Ranger District 'Restore Understory to Mature Forest Conditions' treatment was evaluated as part of the Phillips Countyline Stewardship Project. The BMPs were fully implemented on this project and were found to be predominately effective at keeping sediment out of the waterway. This stand was near an unnamed intermittent stream, a tributary to Fourmile Run. Stream buffers were identified on maps and marked on the ground. Most of the buffers exceeded 50 feet. However, there was a small section where the buffer was only 28 feet, but negative impacts to the stream were not observed. Skid trails had BMPs such as water bars, piled slash, and drainage cross dips, but it was noted that more slash could have been placed on trails to minimize erosion. One of the skid trails also was documented as a source for some erosion and sedimentation. There was evidence of some sediment flowing from the skid trail to a wetland; however, it did not alter the waterbody. The erosion may have been caused by the skid trail being utilized in conditions that may have been too wet.

9/13/2016: A Marienville Ranger District thinning treatment (Unit 06) that was part of the Campbell Run Timber Sale was evaluated. The BMPs were fully implemented on this project and were found to be effective at keeping sediment out of the waterway. The unnamed tributary to Kinzua Creek was sufficiently buffered. There was a small seep that was missed during layout and it only had a 25-foot buffer. This was due to its small size and may have been dry during layout.

9/15/2016: A Bradford Ranger District salvage treatment (Unit 04) that was part of the FR 305 Salvage Sale was evaluated. The BMPs were fully implemented on this project and were found to be effective at keeping sediment out of the riparian buffers and waterway. It was documented, however, that steep skid trails did not have enough water bars to prevent runoff erosion down to mineral soils (Figure 9). Other skid trail layout options were considered, but the trails were too rocky and steep. The site was well-buffered from streams and wetlands, resulting in no sediment reaching any aquatic management zones.

Figure 9. A steep skid trail lacking adequate mulching or surface protection

Mechanical site treatment

8/8/2016: A NNIP mastication treatment was evaluated at Hopkins Farm on Marienville Ranger District. Mechanical mastication was completed to allow for increased regeneration. This was accomplished using a rubber-tracked skid steer to treat interfering vegetation. Reduced buffer widths were permitted for this treatment due to the low soils impact of this project. For example, a 10-foot perennial stream buffer distance was used rather than the usual 100-foot buffer. The evaluation found that there was no evidence of bank damage, erosion, or sedimentation. Deer browse was noted at the location and indicating the need for fencing.

Chemical uses

Chemical use near waterbodies

9/15/2016: An herbicide treatment, within Compartment 207, Stand 41 of the Mead's Mill project area, was evaluated. The Sulfometuron Methyl treatment had been applied on 9/3/2015. The BMPs were implemented properly. Monitoring data indicated that the chemical and residues from the chemical did not move beyond the target areas or within the water buffers. Water resources were protected by BMPs. Inspections were conducted during application and there were no spills or leaks recorded.

Aquatic ecosystems

Completed aquatic ecosystem improvements

9/10/2015: A large wood stream restoration project was evaluated. This project was constructed on the Branch (tributary to Salmon Creek on the Marienville Ranger District) to protect against bank erosion along FR 145 in September 2014. This project involved temporary access routes, instream excavation of pools and channel realignment, and placement of logs and rootwads along the channel bank. The evaluation found that temporary vegetation cover on the steep hill side was insufficient due to the insufficient application of mulch; however, the floodplain and bank ground cover did meet standards. The lack of vegetative cover did not appear to be contributing excessive erosion. Overall, the two objectives of this project were met: improving aquatic habitat and stabilizing the eroding road bank. This project decreased the amount of erosion and sedimentation at this site.

Minerals management

Active construction of mineral exploration sites

9/2013: The Warrant 2921 shale gas well was evaluated. The well pad had been constructed, but the well was not drilled because the operator was waiting for the water management plan to complete drilling and hydraulic fracturing. Since this well was drilled to access privately owned minerals, NEPA and 2007 Forest Plan standards and guidelines were not applicable.

The Plan of Operations was implemented as planned, including construction of the site and implementing Erosion and Sedimentation Control Plans. It was determined that design of well pad layout may have been improved if resource concerns, e.g., LiDAR modeled streams and research areas, had been provided to the company for their consideration during the planning process and layout.

Part of the well was near an aquatic management zone. The effectiveness evaluation found evidence of sediment transport to a wetland. The width of the aquatic management zone of 25 feet was found to be too narrow, which appears to have caused changes to algal growth in the wetland from the increased water temperature and light. In addition, the location of the infiltration/sedimentation basin discharged just upstream of this wetland. The drainage from the entire well pad is directed to this location through extensive rock-lined ditches. The impacts to this wetland may have been reduced if the water had been discharged away from this resource. The impacts appear at this time to be minimal and beneficial uses were not being impacted. There was no evidence of hazardous chemicals, leachates, human trash or human waste.

9/27/2016: A newly constructed well pad, near FR 117 in Warren County, was evaluated. The well pad and road had been completed, but the company was waiting to hydro-fracture the well. There was no current activity at the time of review. The BMPs at this site were fully implemented. No leaks or spills were documented. This site was within 160 feet from of an intermittent stream; no uncontrolled erosion or sedimentation leaving the site was documented.

Recommendations

BMP monitoring is a consistent and effective way to ensure that the ANF is utilizing BMPs and to ensure that the BMPs are working effectively to minimize and control non-point source pollution and maintain water quality. This monitoring process is planned to be continued in the future. Listed below are additional recommendations specific to management activities that should be considered:

- BMPs need to be designed and implemented so that they will hold up to trail and road use for the length of time between maintenance (e.g., use of more durable materials at rolling dips, which will hold up to ATV/dirt bike traffic).
- On roads and trails, particular attention to surfacing, road shape, and drainage near water body crossings should be made.
- Grading contracts should be written to address the removal berms on the edge of the road and restore connection to the ditches for road surface runoff.
- When project oversight is not present, plans need to adequately describe the level of restoration needed at stream crossings during road decommissioning.
- Follow-up maintenance, on the stored section of FR 209, is required to remove a failing culvert.
- Skid trails should be covered with a sufficient amount of branches and debris as to reduce erosion on steep slopes.
- Provide oil and gas companies with information on resource concerns to consider during planning process and layout. This exchange of information was actually occurring with

two of the larger oil and gas operators on the Forest around the time of the FY 2013 review.

- Per the FY 2013 minerals management review:
    - To reduce the changes in water temperature around the wetland, trees should be planted to provide shade around the wetland.
    - Instead of controlling all the site drainage at one infiltration basin, it may be better to distribute the outflows over multiple locations.

3.1.2 Comparison of projected and actual outputs and services

Monitoring Questions	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How do actual outputs and services compare to those projected?	Comparison of actual outputs to those projected in Forest Plan (Tables 2-4)	Annual	2 Years	FY 2013

Background – A listing of the outputs and services projected by the Forest Plan are found in Tables 2 and 3 under the Estimated Forest Activities section within Part 2 – Strategy of the Forest Plan (USDA-FS 2007a, pp. 21 – 23). The activity levels displayed in Tables 2 and 3 are estimates only and assume full implementation of the Forest Plan. They are not Forest Plan decisions, should not be confused with Forest Plan objectives, and are neither minimums nor limitations. They are the result of prescriptions applied in the SPECTRUM model or amounts projected by ANF resource specialists that move the current conditions toward the desired conditions described in the Forest Plan.

The actual average annual activity or treatment level accomplished for FY 2008-2016 reflects the rate of movement toward the desired conditions. For some new activities, it may take several years for site-specific project planning to be completed and then build up toward the level of activity projected in the Forest Plan. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

The Allowable Sale Quantity (ASQ) in Table 4 (USDA-FS 2007a, p. 24) is a Forest Plan decision and represents the maximum amount of timber that can be harvested from ANF lands suitable for timber production. Although the ASQ is identified as an annual average quantity for each decade of the plan, the actual amount accomplished, i.e., awarded (sold to a purchase), in any one year may be either below or above the identified ASQ as long as the totals for the decade are not exceeded.

Protocol – To facilitate a comparison on the progress toward these activities, the tables that follow display the same activities by resource area with the average annual projected level for the first decade and the FY 2008 – FY 2016 actual accomplishment.

Results, Discussion, and Recommendations by Resource Area

3.1.2.1 Recreation activities

The information that follows reflect FY 2008-2013 recreation accomplishments. Staffing limitations did not allow for the compilation and evaluation of FY 2014-2016 data for this report. This information will be updated in the next monitoring and evaluation report. Recreation activities include motorized and non-motorized trail construction, dispersed site enhancement in Concentrated Use Areas (CUAs), construction/reconstruction of developed facilities, and wilderness areas managed to standard (Table 4).

Table 4. Comparison of projected recreation activities (USDA-FS 2007a, p. 21-22) to actual accomplishments (FY 2008-2016)

Management Activity	Projected Average Annual Level (Decade 1)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Motorized Trail Construction (Miles)	4	87	17.4
Non-motorized Trail Construction (Miles)	5	134	26.8
Dispersed Site Enhancement in Concentrated Use Area (Each)	1	26	5.2
Construction/Reconstruction of Developed Facilities (Each)	2	3	0.6
Wilderness Areas Managed to Standard (Each)	4[1]	2	2

[1] The ANF only contains two congressionally designated wilderness areas that are subject to this management activity.

Motorized trail construction – The ANF utilizes user-generated funds for reconstruction of approximately three miles of the off-highway vehicle (OHV) trails on the ANF annually. In addition to the work on the OHV trail system, since FY 2010, the ANF has utilized remaining snowmobile grooming funds to work with the five local snowmobile clubs to improve the nearly 370-mile snowmobile trail system. As a result, approximately $60,000 of Pennsylvania Department of Conservation and Natural Resources (PA DCNR) grant money has been used to improve approximately 70 miles of the snowmobile trails. Also, two miles of the Timberline ATV trail were rerouted utilizing the Forest's construction and maintenance crew in FY 2012 to protect timber rattle snake habitat. This was funded through a $120,000 PA DCNR grant.

Non-motorized trail construction – Thirty-eight miles of the Spring Creek horse trail were constructed in FY 2012 and FY 2013 in Forest and Elk Counties. This work was completed utilizing $1.5 million of American Recovery and Reinvestment Act (ARRA) funding. The ANF also worked the Pennsylvania Equine Council (PEC) on signing of the horse trail along with the DCNR to complete the signing of the trail.

Utilizing approximately $820,000 of ARRA funds, the ANF has been able to work with the Student Conservation Association (SCA) to improve approximately 96 miles of the North Country National Scenic Trail.

Dispersed site enhancement in Concentrated Use Areas – Dispersed sites along the Clarion River from Millstone Creek to Irwin Run received work in FY 2008 to reduce resource damage. User-developed sites were reduced from 46 to 26 and hardening parking areas has protected the recreation resource from the impact of overuse. Regular law enforcement patrols ensure camping occurs in designated areas.
In the Kelly Pines dispersed area, maintenance projects were accomplished through a partnership with volunteers from the Fayette County Chapter of the PEC. Projects in the camping area included work such as cleaning of tie stalls, roofs, restrooms, and fire rings, refreshing stall bedding, and mowing, removing brush, and trimming and falling of hazard trees.

Wilderness Areas managed to standard – In order to meet this goal, the 10-Year Wilderness Stewardship Challenge was developed by the Chief's Wilderness Advisory Group (WAG) as a quantifiable measurement of the Forest Service's success in wilderness stewardship. The goal identified by the WAG, and endorsed by the Chief, is to bring each and every wilderness under Forest Service management to a minimum stewardship level by the 50th Anniversary of the Wilderness Act in 2014. The first year of the Challenge was FY 2005. Both wilderness areas on the ANF are being managed to meet the minimum standards set forth in the Challenge (see *Manage wilderness areas to meet Wilderness Stewardship Challenge*).

3.1.2.2 Prescribed burning by resource objective

Prescribed burning activities include acres treated to support forest regeneration (Figure 10), to support wildlife improvements, and to reduce hazardous fuels (Table 5).

Table 5. Comparison of acres of projected prescribed burning activities (USDA-FS 2007a, p. 22) to actual accomplishments (FY 2008-2016) by resource objective

Management Activity	Projected Average Annual Level (Decade One)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Prescribed Burning by Resource Objective (Acres)			
Silviculture/Reforestation	104	756	84
Wildlife	300	517.1	57.4
Hazardous Fuels Reduction	250	1,273	141.6

Allegheny National Forest
FR 492-494 Prescribed Burn
Site 2B

Photos By: Craig Kostrzewski

April 19, 2012

April 20, 2012
1 day post-burn

June 25, 2012
67 days post-burn

May 16, 2013
1 yr., 27 days post burn

July 3, 2013
1 yr., 75 days post burn

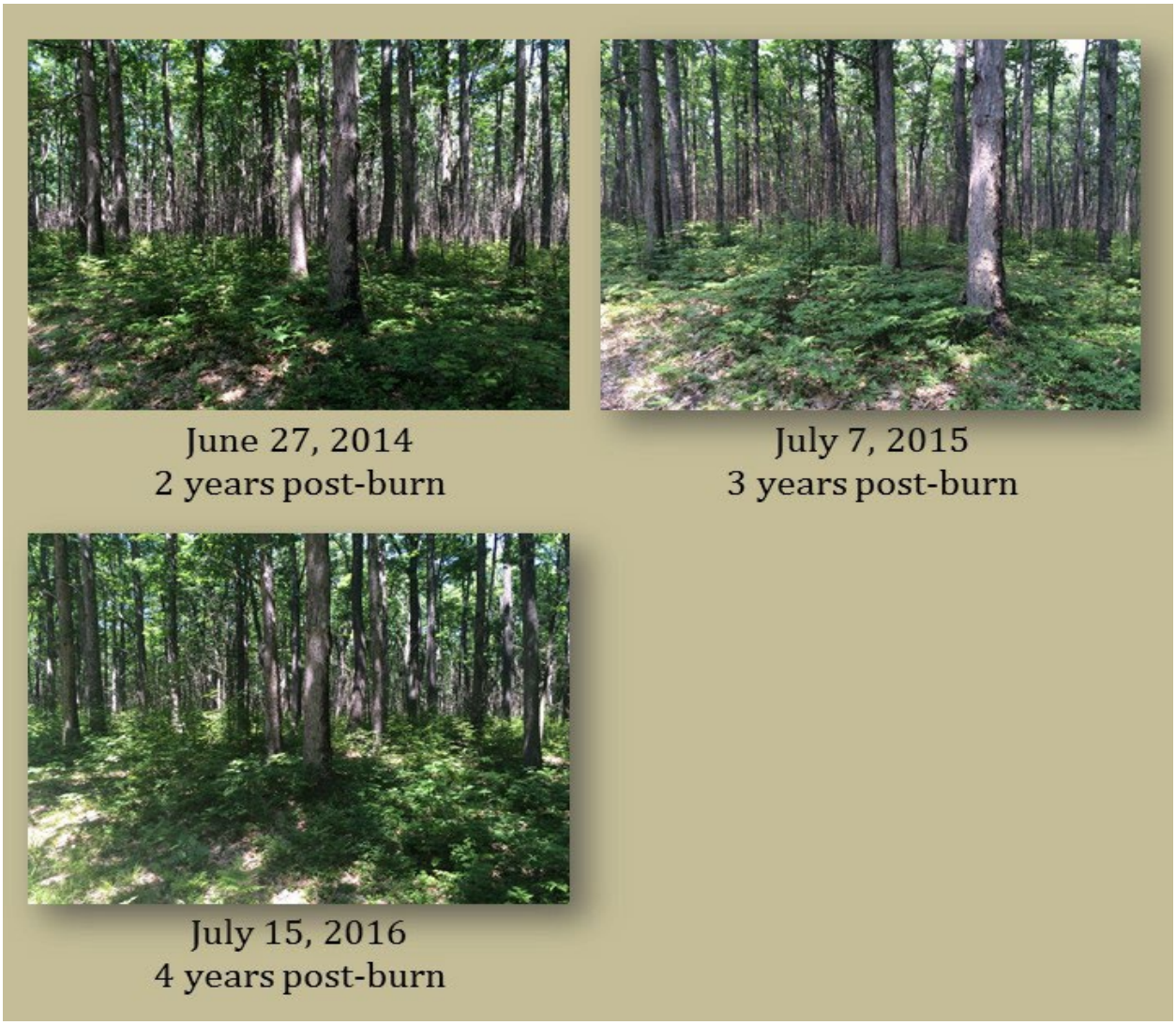


Figure 10. Prescribed oak understory burn near Jakes Rocks

A prescribed (understory) burn was implemented near Jakes Rocks on April 19, 2012 to restore fire-adapted (oak/hickory) forest ecosystems. Objectives were to reduce 1-hour fuels (0-1/4" diameter), reduce 10-hour fuels (1/4-1"), topkill hardwood stems of competing vegetation ≤4" DBH and provide light to oak seedlings (if present), recycle nutrients back to the soil, and provide for wildlife foraging and nesting opportunities. This particular burn unit was heavily populated with red maple seedlings and mountain laurel (fire adapted shrub species). This burn unit also has small area of pitch pine, which is also indicative of a highly fire adapted site.

The spring surface burn successfully consumed surface fuels and top killed both red maple and other competing species in the understory (Figure 10). Anticipated response of fern growth occurred. Over time, additional red maple, stressed by the burned, were root-killed and removed from the unit, which also increased light to the forest floor, providing opportunity for oak and hickory seedlings to become established. Overstory mortality of mature trees was kept to less than 10%, as prescribed. A second prescribed burn is planned for this unit to continue the facilitation of ecosystem restoration and habitat management. Additionally, the ANF is planning

for larger landscape-scale prescribed burns in the future to mimic historic burn regimes and fire return intervals, and better utilize limited resources and funding to capture the limited weather burn windows that occur in northwest Pennsylvania.

3.1.2.3 Reforestation activities

Reforestation activities include scarification for oak, release for species diversity, site preparation, pre-commercial thinning, fencing, fertilization, and herbicide treatment for reforestation (Table 6).

Table 6. Comparison of acres of projected reforestation activities (USDA-FS 2007a, p. 22) to actual accomplishments (FY 2008-2016)

Management Activity	Projected Average Annual Level (Decade 1)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Scarification for Oak	104	0	0
Release for Species Diversity	1,727	5,423	602.6
Site Preparation	1,992	19,057	2,117.4
Pre-commercial Thinning	80	30	5
Full Planting Tree Seedlings	0	307.5	34.2
Fencing	1,701	400.4	44.5
Fertilization	215	478	53.1
Herbicide Treatment for Reforestation	2,368	9,719.4	1,079.9

Scarification for oak – Scarification for oak occurs in oak stands being regenerated and is used to prepare a seedbed for seedling establishment and to incorporate acorns into the soil. No scarification for oak occurred between FY 2008 and FY 2016 because other techniques, such as low shade removal and prescribed fire, are being applied to promote oak seedling establishment.

Release for species diversity – Release treatments occur in young, forested areas in order to maintain competitiveness of desirable tree seedlings and enhance species diversity in the future forest. The number of acres receiving release treatments is lower than that projected in the Forest Plan, primarily because less final harvesting occurred in the past nine years than projected in the Forest Plan. However, average annual release treatments have increased as final harvest rates increase since the last evaluation period (487.5 acres/year during FY 2008-2013).

Site preparation – Site preparation consists of non-commercial felling of small trees so sunlight reaching the forest floor is increased, and tree seedlings can become established. Approximately 106% of the annual acreage projected for site preparation in the Forest Plan was treated between FY 2008 and FY 2016. This includes pre-harvest site preparation treatments in stands considered less than fully stocked, in order to promote tree seedling establishment more quickly without an interim shelterwood seed cut. Similar to release treatments, average annual site preparation treatments have increased since the last evaluation period (1,860.7 acres/year during FY 2008-2013).

Pre-commercial thinning – Pre-commercial thinning removes trees in a stand that are not old enough for a commercial treatment in order to control species composition, maintain stand diversity, improve stand quality, and to increase growth rates on preferred trees. Trees are left on site where they are felled. The acreage treated with pre-commercial thinning is lower than that projected in the Forest Plan. In most cases, the benefits to stand composition and quality can be achieved commercially once young stands have reached commercial treatment size.

Planting – The ANF has experienced very good success in reforesting areas with natural seedling regeneration (see *3.7.1 Stocking within five years of regeneration harvests*). Fill-in, or supplemental planting, was conducted on 307.5 acres of the ANF between FY 2008 and FY 2016 (average of 34.2 acres annually). These areas were planted primarily to restock areas damaged by catastrophic wind damage, or to supplement natural seedling abundance and diversity. Species planted included white oak, chestnut oak, red oak, cucumber-tree, tulip poplar, and eastern white pine. Survival of planted seedlings is monitored in the first- and third-year following planting.

Fencing – Fencing has been used for a number of decades on the ANF to protect tree seedlings from deer browsing impacts. Staff closely monitor the need to use area fencing to reduce deer browsing impacts, and decide to fence areas only after it has been determined deer browsing impacts are causing insufficient seedling numbers or species diversity to develop on specific sites of the Forest. The average annual number of areas fenced remains substantially below Forest Plan projections. Forest Plan projections for the use of fencing were based on full Forest Plan implementation at 2005 deer population levels. In 2005, the average deer density was estimated to be 26.6 deer per square mile. Since 2005, average deer densities have dropped to an estimated 11.6 deer/mi^2 on the Kinzua Quality Deer Cooperative (KQDC) and 19.7 deer/mi^2 outside of the KQDC (see *3.9.4 Manage deer density*). Additionally, regeneration harvesting that occurred between FY 2008 and FY 2016 is less than that projected for Forest Plan implementation (Table 9). As a result, the need to fence has remained low.

Fertilization – Fertilizer to promote rapid seedling growth was not applied between FY 2008 and FY 2014, with small fertilization programs being implemented in FY 2015 and FY 2016. Fertilization tends to favor black cherry growth and is typically applied on the ANF when very high deer browsing impacts are limiting seedling height growth. Reductions in deer browsing impacts, coupled with naturally occurring increases in species diversity resulted in a reduced need for fertilizer application in recent years on the ANF. Fertilization rates remain far below (~25%) levels projected in the Forest Plan.

Herbicide treatment for reforestation – Approximately 38% of the annual acreage projected for herbicide application in the Forest Plan was treated between FY 2008 and FY 2013, while the average from FY 2008 to FY 2016 increased to around 46% of projected Forest Plan levels. As shelterwood seed cutting and regeneration harvesting increases, acreages treated with herbicides will also increase.

3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities

Fuels, NNIP, wildlife, fish, and stream activities include mechanical hazard fuels treatments, manual/mechanical and herbicide treatment of NNIP, herbicide treatment for wildlife objectives, wildlife opening creation, wildlife enhancements, stream restoration, and fish habitat structures (Table 7).

Table 7. Comparison of projected Fuels, NNIS, Wildlife, Fish, Stream, and Watershed Activities (USDA-FS 2007a, p. 22) to actual accomplishments (FY 2008-2016)

Management Activity	Average Annual Projected Level (Decade 1)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Mechanical Hazard Fuel Treatments (Acres)	350	3,405[1]	378[1]
Manual/Mechanical Treatment for Non-native Invasive Plant Species (Acres)	500	959.7	106.6
Herbicide Treatment for Non-native Invasive Plant Species (Acres)	110	574.2	63.8
Herbicide Treatment for Wildlife Objective (Acres)	105	149	16.6
Wildlife Opening Creation (Acres)	15	47	5.2
Wildlife Enhancements (Acres)	1,600	61,986	6,887
Stream Restoration (Miles)	2	445	49
Fish Habitat Structures (Acres)	32	1,345	149
Soil and Water Improvements (Acres)[2]	30	1,000.5	111
Riparian Corridor Restoration (Acres)[2]	750	0	0

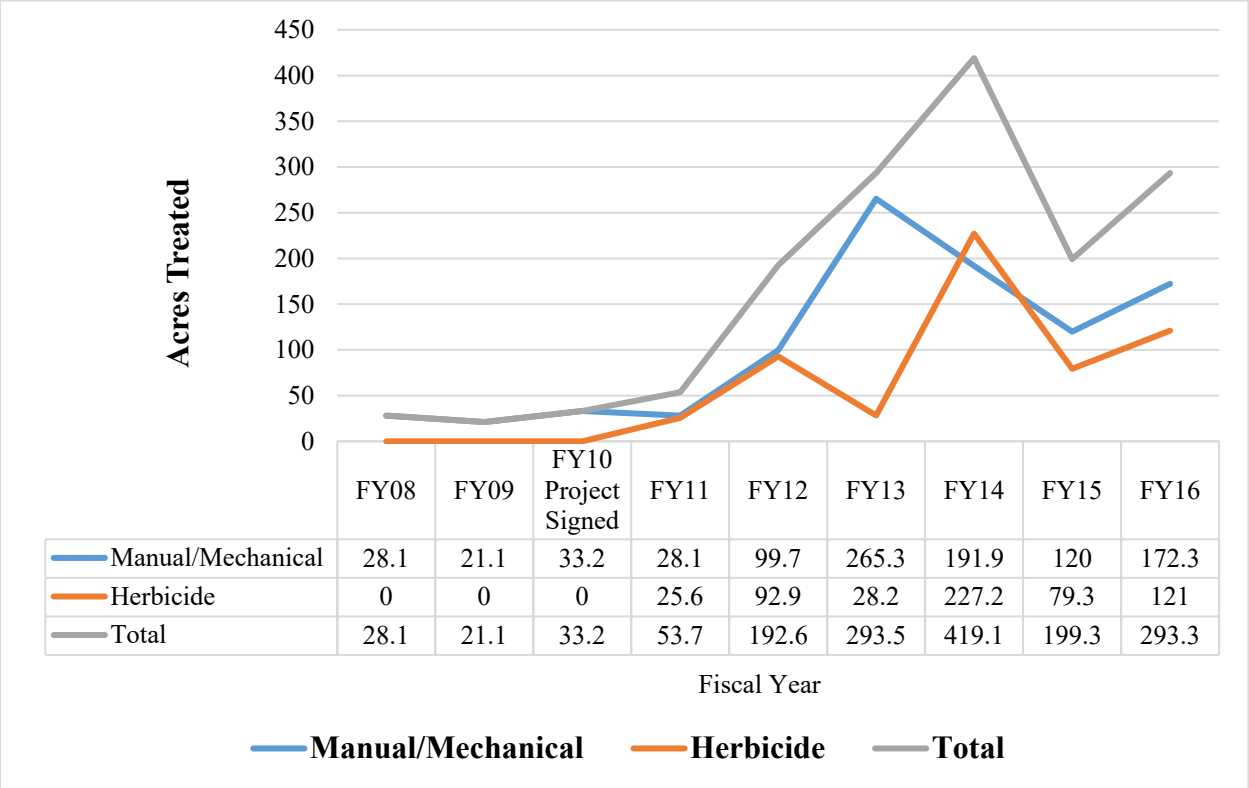
[1] Mechanical Hazardous Fuel Treatments Total and Annual Accomplishment acreage changed since the last evaluation period (FY 2008-2013). In FY 2013, the ANF modified this definition and now only counts activities in fire-adapted forest types, e.g., oak forest types, which resulted in a sharp reduction in the accounting of mechanical (non-burning) hazardous fuel treatments.
[2] In the Forest Plan, these two projections were left off of Table 2 (USDA-FS 2007a, p. 22).

Mechanical hazardous fuel treatments – The Forest Plan FEIS (USDA-FS 2007b, p. 2-52) defined mechanical hazardous fuel treatments as completed through non-burning methods. These methods included timber harvest, site preparation, release cutting, and roadside brushing. A total of 3,405 acres was treated during FY 2008-2016 with an average of 378 acres treated annually.

Prior to FY 2013, the ANF counted mechanical hazardous fuel treatments in all forest types. In FY 2013, the ANF modified this definition and now only counts activities in fire-adapted forest types, e.g., oak forest types, which resulted in a sharp reduction in the accounting of mechanical (non-burning) hazardous fuel treatments.

In FY 2015, the ANF, Pennsylvania Department of Conservation and Natural Resources – Bureau of Forestry (PA DCNR-BOF), and Warren and Forest Counties planning commissions partnered and completed a Community Wildfire Protection Plan/Firewise plan for both Warren and Forest Counties. Community Wildfire Protection plan/Firewise plan will enable Federal, state and local partners to compete for funding for hazardous fuels projects and compete for grants for joint training session for first responders.

Manual/mechanical/herbicide treatment for non-native invasive plant species – A total of 1,533.9 acres of NNIP were treated across the ANF from FY 2008 through FY 2016 (Figure 11). This equates to an average of 170.4 acres treated annually. Treatments were accomplished via stewardship contracts, ANF staff, Federal Correctional Institute (FCI) McKean prison crew, Youth Conservation Corps (YCC), and student interns. Some of the species treated included: garlic mustard (*Alliaria petiolata*), goatsrue (*Galega officinalis*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thungbergii*), exotic bush honeysuckles (*Lonicera* sp.), glossy buckthorn (*Frangula alnus*), Japanese knotweed (*Fallopia japonica*) and purple loosestrife (*Lythrum salicaria*).



	FY08	FY09	FY10 Project Signed	FY11	FY12	FY13	FY14	FY15	FY16
Manual/Mechanical	28.1	21.1	33.2	28.1	99.7	265.3	191.9	120	172.3
Herbicide	0	0	0	25.6	92.9	28.2	227.2	79.3	121
Total	28.1	21.1	33.2	53.7	192.6	293.5	419.1	199.3	293.3

Figure 11. Acres of non-native invasive plants treated FY 2008-2016

In-house treatments of satellite infestations are critical in conserving the best of the best ecological areas that are not already being impacted by NNIP and one of the key opportunities to do so is through the FCI McKean prison crew. It is recommended that this resource remain available not only for the work the crew completes, but also for the opportunity it provides crew members to develop job skills. It is recommended the ANF continue and expand the use of prison crews from FCI McKean for the treatment of NNIP on the ANF.

Programmatic herbicide use for NNIP treatment was analyzed and approved under the 2007 Forest Plan. It took three years to move from planning in subsequent project-level environmental analyses to implementation in order to treat NNIP with glyphosate, one of the two approved herbicides under the Forest Plan, the other being sulfometuron methyl. Beginning in FY 2012, NNIP treatment acres have increased through the use of stewardship contracting through integrated resource timber sale contracts (IRTC) and stand-alone service contracts funded through retained receipts. Stewardship funding is the primary funding source for NNIP treatment, without which little to no NNIP treatment would be accomplished as other appropriated sources of funding can typically only cover salary costs. It is recommended the ANF continue and expand the use of stewardship authority to accomplish NNIP treatments through both IRTCs and retained receipts.

Through ongoing treatment, it has been realized that there is a need to have additional chemicals and treatment techniques to be able to adequately address certain NNIP species, the size of their infestations and to also expand the scope of treatment to new areas. The most critical technique needed is the ability to be able to conduct basal bark treatments for glossy buckthorn in order to be effective in treating the large infestations currently found on the ANF in Forest County. It is recommended the ANF expand the chemicals and treatment techniques available for NNIP treatment through, for example, amendment of the Forest Plan. Additionally, there are MAs on the ANF that have not been included in project-level analyses and are not anticipated to be included in the near future in which NNIP treatment is needed, the west side of the Allegheny Reservoir for example.

Herbicide treatment for wildlife objective – One hundred forty-nine acres were treated with herbicide for to benefit wildlife including the treatment of warm and cool season grass openings for NNIP to improve wildlife habitat. Most treatments were conducted in constructed/maintained wildlife openings.

Wildlife opening creation – Forty-seven acres of wildlife openings were created. This involved clearing the area of trees, shrubs, and large rocks, followed by seeding, fertilizing, and planting. Some openings were planted in warm season grasses while others were planted in cool season grasses with a scattering of shrubs and fruit trees.

Wildlife enhancements – A total of integrated 61,986 acres of integrated wildlife enhancements were implemented, including: wildlife opening construction, rehabilitation, and maintenance; planting of fruit trees, shrubs, mast trees, and conifers; establishment of warm season grass fields, vernal pools and wildlife meadows; building, installing, and maintaining nest boxes and bat boxes; and forest vegetation management activities benefiting wildlife habitat. This high average of accomplishments is due to a change in accounting of accomplishments from FY 2007. Since wildlife enhancement acres can be counted as integrated accomplishments and include activities such as stand regeneration (which creates early successional habitats) and young stand tending treatments (to promote mast producing species) the ANF has exceeded the wildlife enhancement Forest Plan objective.

Stream restoration – A total of 107 projects restored and enhanced aquatic ecosystems within 445 stream miles using structural or non-structural improvements, including: road and stream crossing decommissioning, dam removals, installation of fish habitat improvement structures, riparian plantings, stream bank stabilizations, aquatic organism passage projects, and the annual Allegheny River Cleanup, Conewango Creek Cleanup, and Brokenstraw Creek Cleanup.

Fish habitat structures – A total of 1,345 acres of fish habitat improvement were accomplished by the placement of fish habitat structures (Christmas trees, porcupine cribs, and junior porcupine cribs) and the annual cleanup of the Allegheny Reservoir and Tionesta Lake. The counting of the lake and reservoir cleanup towards accomplishments was implemented in FY 2014 and has significantly increased the average annual output from 16 acres/year for the FY 2008-2013 evaluation period to 149 acres/year for the present reporting period.

Soil and water improvement – A total of 1,000.5 acres of soil and water improvements were made from FY 2008 through FY 2016, averaging 111 acres annually, which is well above the projected decadal annual average of 30 acres. This high average of accomplishments is due to a change in accounting of accomplishments from FY 2007. Since soil and water acres can be counted as integrated accomplishments, i.e., secondary benefits to soil and water resources are realized from activities completed by other programs such as roads, recreation, and NNIP treatments, the ANF has exceeded the Forest Plan objective.

Soil and water restoration include a variety of projects that maintain or improve watershed health. Projects include road and stream crossing improvements, reduction in sediment from road reconstruction and limestone surfacing, installation of fish habitat improvement structures, riparian plantings, large wood addition projects, stream bank stabilizations, Allegheny River Cleanup, Allegheny Reservoir Cleanup, Conewango Creek Cleanup, Brokenstraw Creek Cleanup, and Tionesta Lake Cleanup. Also, 25% of the area that has a prescribed burn performed on it counts as soil and water improvement from nutrient recycling perspective. Treatment of NNIP that change soils and impact native vegetation, such as buckthorn or knotweed, also realize soil and water improvements.

A significant amount of this restoration included improvement to road conditions which reduced sedimentation and runoff or allowed for passage of high flows to decrease downstream erosion. These activities included projects such as installing extra crossdrains to divert water to filter strips instead of directing it to streams and the application of driving surface aggregate limestone.

From FY 2014 to FY 2016, there was an increase in the number of plugged oil and gas wells. Though not projected in the 2007 Forest Plan, well plugging contribures towards soil and water improvements. In FY 2015, at least 39 wells were plugged. When these are plugged and restored, soils recover, revegetation occurs, and the potential for contamination of aquifers decreases.

There has been an increase in restoration projects due to collaboration with our partners in the Allegheny WINs Coalition. They have taken the lead on numerous projects, providing funding, labor, and contracting for multiple projects that have benefited the watersheds in the ANF. WINs Coalition volunteers and partners have also surveyed streams for problem areas and

identified restoration sites. These projects can be viewed in the WINs Coalition annual reports (http://www.fs.usda.gov/main/allegheny/workingtogether/partnerships).

Riparian corridor restoration – From FY 2008 through FY 2016, no site-specific prescriptions were implemented to restore compositional and/or structural diversity of riparian corridors. Although this activity has not been implemented, it is important and should be completed. With the workload of restoration projects, road work, upland vegetation treatments, and OGM development, the focus for riparian areas has been the avoidance and mitigation of impacts rather than active management. Treatments have been proposed and approved in projects, but not implemented to date. Some of these proposals for improvements to riparian areas are in hemlock stands and implementation should consider the risk of attracting HWA to these stands versus the benefit of improving overall hemlock health. Where thinning treatments of hemlocks stands occurs, these areas should be monitored for HWA. In the future, aspen regeneration treatments that occur in riparian areas should be tracked.

3.1.2.5 Transportation activities

No Forest Plan objectives were set for road construction, reconstruction, or area cleared for gravel pits. The level of annual accomplishment (Table 8) is dependent on the location and amount of timber offered for sale each FY. These actions support the Transportation System goal listed in the Forest Plan: Forest infrastructure, including facilities and transportation systems, will provide a safe, efficient, and economical system that is responsive to public and administrative needs; having minimal adverse effects on ecological processes and ecosystem health, diversity, and productivity; and is in balance with needed management actions (USDA-FS 2007a, p. 16).

Table 8. Comparison of transportation activities projected in Forest Plan (USDA-FS 2007a, p. 22) to actual accomplishments (FY 2008-2016)

Management Activity	Average Annual Projected Level (Decade 1)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Road Construction – Existing Corridor (Miles)	13	31.8	3.5
Road Construction – New Corridor (Miles)	5	9.9	1.1
Road Reconstruction (Miles)	100	352.4	39.2
Road Decommissioning (System; Miles)	2	5.8	0.6
Area Cleared for Gravel Pits (Acres)[1]	5	14.2	1.6

[1] Conversion from cubic yards of stone to acres cleared for pits: 9700 cubic yards per acre.

Road construction/reconstruction – A large portion of the road construction and reconstruction occurred on timber sales to provide access for hauling timber and protecting soil and water resources from adverse effects attributed to runoff. Additional funding for road reconstruction was provided through the ARRA. Some ARRA projects were on Township roads in support of general Forest traffic and/or future timber sales.

The 31.8 miles of road construction – existing corridor occurred predominantly on existing oil and gas roads that were upgraded to Forest Service standards and guidelines under timber sale contracts. The 9.9 miles of road construction – new corridor created new access to timber harvest units where none existed. The rate of road construction – new corridor has decreased, with only 0.6 miles having been constructed in since the FY 2008-2013 evaluation period. The 352.4 miles of road reconstruction involved work on existing roads beyond the level of annual maintenance directed through timber sales and public works contracts.

Road decommissioning – The level of road decommissioning refers only to Forest Service system roads of which 5.8 miles were decommissioned. No Forest Service system roads were decommissioned during FY 2014-2016.

Area cleared for gravel pits – The pit run stone material used for Forest Service road work equated to roughly 137,750 cubic yards of material, or 14.2 acres between 2008 and 2013. Twenty-nine stone pits were expanded between 2014 and 2016, resulting in approximately 14.5 acres of expansion during that time frame.

3.1.2.6 Timber harvest management practices by Management Area

Table 9 compares Forest Plan projected estimates of timber harvest activity by MA during the first decade of Forest Plan implementation with the actual activity or treatment level accomplished, i.e., awarded (sold to a purchaser), during FY 2008-2016. The sum of all individual treatment activities does not equate to the total acreage of projected timber harvest because more than one type of harvest activity may occur on any given acre. For example, an area may be thinned in one decade, followed by a shelterwood seed cut and removal cut in the following decade.

Intermediate thinning – The rate of intermediate thinning harvests sold has declined since the last evaluation period. During FY 2008-2013, intermediate thinning harvests averaged around 932 acres annually, while in the FY 2014-2016 period they averaged around 826 acres annually. For the FY 2008-2016 evaluation period, intermediate thinnings averaged around 897 acres, less than Forest Plan projections.

In contrast to the last evaluation period, the intermediate thinning figures displayed in Table 9 do not include salvage and sanitation harvests, which occur in response to tree decline and mortality. These acreages were not estimated in the Forest Plan, as they are difficult to predict and frequently consist of unscheduled, light treatments designed to salvage scattered down or dying trees to recover their economic value. These treatments are not prescribed or implemented as an intermediate thinning designed to accelerate overall stand growth and yield and are thus not included in Table 9 or addressed by this monitoring question.

Shelterwood seed cuts – Shelterwood seed cuts sold during FY 2008-2013 were below projections in the Forest Plan (60% of Forest Plan projections for the first decade of implementation), and remained below Forest Plan projections during FY 2008-2016, particularly in MA 3.0. Shelterwood seed cuts sold, have generally been increasing since implementation of

the Forest Plan began. Overall, shelterwood seed cuts sold between FY 2008 and FY 2016 have annually averaged 66% of Forest Plan projections for the first decade of implementation.

In addition to shelterwood seed cuts, 28,776 acres total, or 3,197 acres annually, of pre-harvest site preparation and herbicide treatments were implemented between FY 2008 and FY 2016 (a number of areas received both treatments). These treatments occurred in stands that were considered less than fully stocked and are designed to promote tree seedling establishment more quickly, without an interim shelterwood seed cut. These pre-harvest treatments are investments that were implemented using newer stewardship contracting and agreement authorities, which have provided opportunities to accomplish work that otherwise would not have been possible given typical funding levels. Once seedlings are established in these areas, final harvests may occur.

Final even-aged regeneration harvests – Final harvests typically follow shelterwood seed cuts and reforestation treatments and occur once adequate tree seedlings have become established. Final harvests levels are gradually increasing and are expected to continue to increase as seedlings become established in areas where the regeneration process has been initiated. However, final harvests sold during FY 2008-2016 remain below Forest Plan projections, particularly in MA 3.0. Final harvests sold during this time frame annually have averaged 36% of Forest Plan projections for the first decade of implementation, up from 27% of projections reported during FY 2008-2013. This level of stand regeneration is not resulting in desired age and structural class objectives, and desired vegetation conditions established in the Forest Plan (see *3.7.4 Provide vegetative diversity*).

There are several reasons that final harvests sold are below levels projected in the Forest Plan. These include the number of shelterwood seed cuts initially prescribed, interfering vegetation that must be treated to promote tree seedling establishment, more sporadic and less abundant seed crops for some tree species, poorly distributed seed trees where mortality or windthrow has impacted overstory tree stocking, and inadequate tree seedling establishment.

Uneven-aged regeneration harvests – Single tree and group selection uneven-aged regeneration harvests fall below levels projected in the Forest Plan for MAs 2.1 and 2.2. Conversely, MA 3.0 did not have any uneven-aged harvests projected in the Forest Plan, while 265 acres of uneven-aged harvests were sold between FY 2008 and FY 2016. In these areas, uneven-aged regeneration methods were prescribed in order to better meet Scenic Integrity Levels (SILs), maintain wildlife structural habitat needs, and minimize potential impacts to wet soils. Overall, uneven-aged regeneration harvests sold between FY 2008 and FY 2016 annually have averaged 17.6% of Forest Plan projections for the first decade of implementation. New techniques in sustaining forest types on the ANF using uneven-aged regeneration methods are being applied, with an emphasis on monitoring treatment effectiveness and adjusting if needed in order to achieve desired vegetation conditions.

Table 9. Comparison of acres of projected timber harvest management practices by Management Area (USDA-FS 2007a, p. 23) to actual accomplishments (FY 2008-2016)

Management Area	Average Annual Projected Level (Decade One; Rounded to Nearest 10 Acres)	Total Actual Accomplishment	Actual Average Annual Accomplishment
Intermediate Thinning (Green or Scheduled Only) [1]			
MA 1.0	0	66[2]	7.3
MA 2.2	20	588	65.3
MA 3.0	940	7,084	787.1
MA 6.1	40	281	31.2
MA 7.2	0	30[3]	3.3
MA 8.6	0	23[4]	2.5
Total Intermediate Thinning	**1,000**	**8,072**	**896.9**
Shelterwood Seed Cut			
MA 1.0	30	128	14.2
MA 2.2	40	178	19.8
MA 3.0	1,740	10,253	1,139.2
MA 6.1	30	169	18.8
MA 8.6	0	167[4]	18.6
Total Shelterwood Seed Cut	**1,840**	**10,895**	**1,210.6**
Acres of Final Even-aged Regeneration Harvest (Shelterwood Removal Cut and/or Clearcut)			
MA 1.0	30	0	0
MA 2.2	20	371[5]	41.2
MA 3.0	1,690	5,198	577.6
MA 6.1	10	84[6]	9.3
MA 7.2	0	27[7]	3.0
MA 8.6	0	31[4]	3.4
Total Even-aged Regeneration Harvest	**1,750**	**5,711**	**634.6**
Acres of Uneven-aged Regeneration Harvest			
MA 2.1	50	0	0
MA 2.2	620	641	71.2
MA 3.0	0	265[8]	29.4
MA 6.1	10	154	17.1
Total Uneven-aged Regeneration Harvest	**670**	**1,060**	**117.8**

[1]Intermediate thinning acreages have been updated in this monitoring and evaluation report to reflect only green or scheduled intermediate thinning treatments. As the Forest Plan did not project any salvage or sanitation treatments, which often occur in response to unexpected tree decline or mortality, those salvage and sanitation acreages are not included here. The vast majority of salvage harvests implemented have been to salvage economic value of trees killed by insects, disease or windthrow.

[2] 66 acres of intermediate thinning was prescribed to enhance the health of stands (Brush Creek Project) in MA 1.0, a MA that did not have any intermediate thinning projected in the Forest Plan.

[3] 30 acres of intermediate thinning occurred in MA 7.2 in order to enhance the health of red pine stands surrounding the Hearts Content Campground and Day Use area.
[4]23 acres of intermediate thinning, 167 acres of shelterwood seed harvest, and 31 acres of shelterwood removal harvests were sold in Kane Experimental Forest as part of research studies. As this is an Experimental Forest, and managed for research and demonstration, the Forest Plan did not project scheduled timber harvest in this area.
[5]All final harvests in MA 2.2 occurred in shade-intolerant forest types and were either in response to tree mortality caused by wind and/or insects and disease, designed to create early successional vegetation, or in areas where the even-aged regeneration process was initiated prior to 2007.
[6] Even-aged regeneration harvesting figures for MA 6.1 have been corrected since the last time this monitoring question was updated (FY 2013), resulting in four fewer acres of even-aged regeneration harvesting.
[7]A 27-acre shelterwood removal was sold in MA 7.2 as a continuation and final harvest in an oak study with the USDA Forest Service Northern Research Station. This final harvest is consistent with Forest Plan direction for MA7.2 (Forest Plan, p. 139).[8]265 acres of single tree or group selection was prescribed in three areas within MA 3.0 in order to maintain more contiguous forest cover for wildlife, riparian habitats, and scenic integrity.
With the exception of intermediate thinning, actual acres sold for various types of timber harvest using different silvicultural methods were less than that projected in the Forest Plan. This means that achievement of desired vegetation conditions is less than that projected in the Forest Plan.

Although below projected Forest Plan levels, regeneration harvests (shelterwood preparation and seed, two-aged and final harvests) sold on the ANF continue to increase. Overall, approximately 58% of harvests sold during the last evaluation consisted of even-aged regeneration treatments, compared with a higher average of 65% during FY 2008-2016. Most recently, 72% of FY 2016 harvests sold consist of even-aged stand regeneration treatments, and 25% consisted of final regeneration harvests.

Final regeneration harvest rates continue to lag behind projected levels in the Forest Plan, particularly in MA 3.0. However, shelterwood seed cuts sold exceed final harvest acreages sold (by nearly twice as much), and a substantial number of acres have either received a shelterwood seed cut or pre-harvest reforestation treatments, or are under contract to receive a shelterwood seed cut. It is expected that final harvest rates will increase in future years as tree seedlings become established in these areas and the final regeneration harvests are implemented.

In the long term, if acres treated through timber harvest continue to be lower than Forest Plan projections, landscape-level desired vegetative conditions and Forest Plan goals and objectives related to forest vegetation will not be met. It is recommended to increase implementation rates in order to better meet landscape level Forest Plan desired conditions, goals, and objectives, with a particular emphasis on increasing final harvest rates within MA 3.0. Continue monitoring outputs and services designed to move the Forest towards desired landscape-level vegetation conditions.

3.1.2.7 Timber volume sold

One key decision of the Forest Plan is the identification of the ASQ of timber. The ASQ is measured in cubic feet, although conversions are produced for board feet. Table 10 compares the FY 2008-2016 actual amount accomplished, i.e., awarded (sold to a purchaser) with the ASQ in the cubic volume measure and the board foot equivalent. Only the cubic volume is the controlling measure for evaluating compliance with the requirement not to exceed the ASQ in the plan period. Since FY 2007 was a transition year, the first full year in Decade 1 was actually FY 2008.

Timber volume awarded in FY 2008-2016 averaged 5.4 million cubic feet per year, or approximately 61% of that projected in the Forest Plan to be awarded annually.

Table 10. Comparison of average annual Allowable Sale Quantity (USDA-FS 2007a, p. 24) to timber volume sold (FY 2008-2016)

Forest Plan Harvest Volume Unit of Measure	Average Annual ASQ (Decade 1)	FY 2008[1]	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	Actual Average Annual ASQ
Million Cubic Feet (MMCF)	8.9	2.9	4.3	6.4	6.5	5.8	5.4	5.9	5.3	5.8	5.4
Million Board Feet Equivalent (MMBF)	54.1	17.7	26.7	39.3	40.2	35.8	33.3	36.3	33.0	36.2	33.2

[1] FY 2008 volume sold is correctly reported here; it was incorrect in the FY 2008 Monitoring and Evaluation Report.

Timber from the ANF has substantial economic value and contributes to local and regional economies. The volume awarded in FY 2008-2016 had a total value of $66.74 million, averaging $7.42 million annually. During this time frame, timber sold in FY 2009 had the lowest total value at $5.94 million, and timber sold in FY 2010 had the highest total value at $10.03 million. Prior to 2008, the value of timber sold on the ANF was substantially higher, totaling $117.34 million for the six-year period between 2002 and 2007, and averaging $19.56 million annually during this time frame, nearly three times the current annual amounts. Timber markets worldwide and locally experienced a dramatic downturn in 2008, and overall value of timber sold on the ANF has not recovered to pre-2008 levels.

Many factors influence the overall value of the volume offered, including timber markets, demand for timber products, species, overall quality, amount of sawtimber, and size classes of timber being sold. Partial harvests such as intermediate thinnings and shelterwood seed cuts tend to remove more trees in the smaller size classes, resulting in less overall value. Conversely, final harvests results in the removal of most of the trees in the stand, and typically include the largest and highest value trees. Timber values regionally have very slowly been increasing, and the expectation is that timber values sold on the ANF will also increase at modest rates.

3.1.3 Comparison of actual and estimated costs

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What are actual costs in comparison to estimated costs?	Comparison of estimated and actual costs of Forest Plan implementation	Annual	2 years	FY 2013

Background – This question addresses the cost of Forest Plan implementation and what funding has been available to meet the management benchmarks set in the Forest Plan, e.g., Forest Plan objectives. As such, this monitoring question indirectly addresses the 2012 Planning Rule monitoring requirements by monitoring the Forest's financial capacity to meet the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Costs are estimated annually before each FY begins as the Forest's program of work is developed taking into account program needs, e.g., salary, materials, supplies, contracts, agreements, vehicle use, etc., for the upcoming FY. In practice, however, the Forest's planned program of work, and in turn to the cost estimated to implement it, are the funding allocated to the ANF. The actual cost of Forest Plan implementation for each FY is reflected in the Forest's actual expenditures realized during the FY (October 1 – September 30) as it executes its planned program of work.

Results – The program areas displayed in the first column of Table 11 include most of the Forest's annual operations. These operations relate to specific management goals and objectives in the Forest Plan. On average, the Forest's actual expenditures were about 92% of estimated costs with a range of 70% (FY 2012) to 99% (FY 2014).

Table 11. Annual estimated and actual costs of Forest Plan implementation (FY 2008-2016)

		2008		2009	
Fund Name	**BLI**	**Estimated**	**Actual**	**Estimated**	**Actual**
		National Forest Systems - NFNF			
Inventory & Monitoring	NFIM	$ -	$ -	$ 651,800	$ 623,255
Landowner Management	NFLM	$ 246,000	$ 231,894	$ 321,500	$ 309,973
Minerals & Geology Management	NFMG	$ 892,000	$ 827,585	$ 1,974,235	$ 2,203,548
Native Plants	NFN3	$ 28,000	$ 26,653	$ -	$ -
Forest Planning	NFPN	$ 108,000	$ 102,267	$ 120,000	$ 113,234
Recreation, Heritage, & Wilderness	NFRW	$ 899,800	$ 899,912	$ 997,532	$ 1,084,232
Timber Sale Management	NFTM	$ 1,639,800	$ 1,514,829	$ 2,145,464	$ 2,156,825
Vegetation & Watershed Management	NFVW	$ 775,200	$ 709,382	$ 933,301	$ 862,950
Wildlife & Fisheries Habitat Management	NFWF	$ -	$ -	$ 348,300	$ 354,206
Total National Forest Systems - NFNF	**NFNF**	**$ 4,588,800**	**$ 4,312,521**	**$ 7,492,132**	**$ 7,708,222**
		Wildland Fire Management - WFWF			
Wildland Fire Preparedness	WFPR	$ 310,000	$ 279,596	$ 425,000	$ 423,584
Hazardous Fuels Reduction	WFHF	$ 54,000	$ 49,824	$ 54,000	$ 58,577
Total Wildland Fire Management - WFWF		**$ 364,000**	**$ 329,420**	**$ 479,000**	**$ 482,160**
		Capital Improvements & Maintenance - CMCM			
Facilities Capital Improvements & Maintenance	CMFC	$ 119,000	$ 111,717	$ 1,196,000	$ 1,127,895
Legacy Roads (TRTR)	CMLG	$ 209,000	$ 192,160	$ 145,700	$ 94,307
Roads Capital Improvements & Maintenance	CMRD	$ 1,180,100	$ 1,103,727	$ 1,296,900	$ 1,289,855
Trails Capital Improvements & Maintenance	CMTL	$ 278,600	$ 253,674	$ 265,000	$ 259,711
Facilities Maintenance (CP09)	CP09	$ 285,000	$ 282,748	$ 292,400	$ 267,659
Total Capital Improvements & Maintenance - CMCM		**$ 2,071,700**	**$ 1,944,026**	**$ 3,196,000**	**$ 3,039,427**
		Land Acquisition - LALW			
Land Acquisition	LALW	$ 35,000	$ 36,464.96	$ 14,000	$ 7,655.48
Total Land Acquisition - LALW		**$ 35,000**	**$ 36,465**	**$ 14,000**	**$ 7,655**
Total Appropriated Funds		**$ 7,059,500**	**$ 6,622,432**	**$ 11,181,132**	**$ 11,237,465**
		Perms & Trust Funds (Not All Inclusive)			
Cooperative Work - NONAGT Based	CWF2	$ 350,000	$ 300,442	$ 355,300	$ 376,349
Cooperative Work - Other	CWFS	$ 140,500	$ 73,608	$ 192,935	$ 40,355
Regional K-V Sale Area Projects	CWK2	$ -	$ -	$ -	$ -
K-V Sale Area Projects	CWKV	$ 1,154,400	$ 1,029,087	$ 1,600,000	$ 1,129,320
Unit Recreation Enhancement	FDDS	$ 250,000	$ 210,854	$ 184,000	$ 98,041
Federal Highways	various	$ 31,000	$ 26,817	$ 10,000	$ 7,992
Maps for Visitors & Other Rec (MVIS & MSEQ)	MAPS	$ 10,000	$ -	$ 16,000	$ -
Reforestation Trust Funds	RTRT	$ 234,000	$ 223,531	$ 226,100	$ 221,546
Salvage Sale	SSSS	$ 1,456,351	$ 1,222,111	$ 1,000,000	$ 715,890
Stewardship Contracting	SSCC	$ -	$ -	$ -	$ -
Timber Pipeline - Sale Prep	TPPS	$ 918,800	$ 858,623	$ 723,000	$ 568,911
Total Perms & Trust Funds		**$ 4,545,051**	**$ 3,945,073**	**$ 4,307,335**	**$ 3,158,404**
OVERALL TOTAL		**$ 11,604,551**	**$ 10,567,505**	**$ 15,488,467**	**$ 14,395,868**
PERCENT SPENT		**91%**		**93%**	

		2010		2011	
Fund Name	**BLI**	**Estimated**	**Actual**	**Estimated**	**Actual**
		National Forest Systems - NFNF			
Inventory & Monitoring	NFIM	$ 618,000	$ 608,802	$ 477,000	$ 441,533
Landowner Management	NFLM	$ 274,000	$ 299,923	$ 248,000	$ 257,714
Minerals & Geology Management	NFMG	$ 1,225,892	$ 1,537,362	$ 892,152	$ 919,869
Native Plants	NFN3	$ 20,000	$ 18,440	$ 18,000	$ 14,135
Forest Planning	NFPN	$ 146,000	$ 138,724	$ 84,000	$ 81,048
Recreation, Heritage, & Wilderness	NFRW	$ 952,436	$ 962,664	$ 929,716	$ 820,689
Timber Sale Management	NFTM	$ 2,797,038	$ 2,743,141	$ 2,625,947	$ 2,520,273
Vegetation & Watershed Management	NFVW	$ 579,161	$ 549,897	$ 671,656	$ 634,263
Wildlife & Fisheries Habitat Management	NFWF	$ 360,000	$ 361,498	$ 351,000	$ 368,655
Total National Forest Systems - NFNF	**NFNF**	**$ 6,972,527**	**$ 7,220,450**	**$ 6,297,471**	**$ 6,058,179**
		Wildland Fire Management - WFWF			
Wildland Fire Preparedness	WFPR	$ 405,000	$ 368,132	$ 416,000	$ 362,167
Hazardous Fuels Reduction	WFHF	$ 64,000	$ 51,735	$ 218,000	$ 216,348
Total Wildland Fire Management - WFWF		**$ 469,000**	**$ 419,868**	**$ 634,000**	**$ 578,515**
		Capital Improvements & Maintenance - CMCM			
Facilities Capital Improvements & Maintenance	CMFC	$ 486,000	$ 463,825	$ 221,000	$ 224,817
Legacy Roads (TRTR)	CMLG	$ 905,000	$ 915,131	$ 75,000	$ 75,155
Roads Capital Improvements & Maintenance	CMRD	$ 1,356,387	$ 1,358,522	$ 1,029,169	$ 1,007,454
Trails Capital Improvements & Maintenance	CMTL	$ 299,000	$ 285,066	$ 340,028	$ 331,920
Facilities Maintenance (CP09)	CP09	$ 265,000	$ 259,041	$ 282,700	$ 264,042
Total Capital Improvements & Maintenance - CMCM		**$ 3,311,387**	**$ 3,281,584**	**$ 1,947,897**	**$ 1,903,389**
		Land Acquisition - LALW			
Land Acquisition	LALW	$ 25,000	$ 15,955.14	$ 34,000	$ 27,660.11
Total Land Acquisition - LALW		**$ 25,000**	**$ 15,955**	**$ 34,000**	**$ 27,660**
Total Appropriated Funds		**$ 10,777,914**	**$ 10,937,857**	**$ 8,913,368**	**$ 8,567,742**
		Perms & Trust Funds (Not All Inclusive)			
Cooperative Work - NONAGT Based	CWF2	$ 500,000	$ 365,552	$ -	$ 941,511
Cooperative Work - Other	CWFS	$ 27,991	$ 20,712	$ 25,504	$ 16,079
Regional K-V Sale Area Projects	CWK2	$ 820,000	$ 799,960	$ 622,000	$ 606,848
K-V Sale Area Projects	CWKV	$ 1,627,000	$ 1,034,064	$ 1,400,000	$ 1,009,880
Unit Recreation Enhancement	FDDS	$ 96,698	$ 50,859	$ 252,000	$ 76,145
Federal Highways	various	$ 20,000	$ 11,157	$ 25,000	$ 8,774
Maps for Visitors & Other Rec (MVIS & MSEQ)	MAPS	$ 55,000	$ 6,750	$ 10,000	$ -
Reforestation Trust Funds	RTRT	$ 201,000	$ 193,334	$ 140,000	$ 138,603
Salvage Sale	SSSS	$ 371,498	$ 345,304	$ 294,000	$ 206,215
Stewardship Contracting	SSCC	$ 130,722	$ 56,027	$ 113,000	$ 73,017
Timber Pipeline - Sale Prep	TPPS	$ 362,000	$ 265,835	$ 590,000	$ 489,693
Total Perms & Trust Funds		**$ 4,211,909**	**$ 3,149,555**	**$ 3,471,504**	**$ 3,566,765**
OVERALL TOTAL		**$ 14,989,823**	**$ 14,087,412**	**$ 12,384,872**	**$ 12,134,508**
PERCENT SPENT		**94%**		**98%**	

		2012		2013	
Fund Name	**BLI**	**Estimated**	**Actual**	**Estimated**	**Actual**
		National Forest Systems - NFNF			
Inventory & Monitoring	NFIM	$ 413,516	$ 272,146	$ 414,000	$ 357,945
Landowner Management	NFLM	$ 248,000	$ 187,059	$ 217,932	$ 246,605
Minerals & Geology Management	NFMG	$ 1,206,932	$ 866,706	$ 1,245,000	$ 1,143,517
Native Plants	NFN3	$ -	$ -	$ -	$ -
Forest Planning	NFPN	$ 53,000	$ 44,323	$ 66,000	$ 60,146
Recreation, Heritage, & Wilderness	NFRW	$ 928,066	$ 720,438	$ 849,042	$ 793,510
Timber Sale Management	NFTM	$ 2,683,858	$ 1,947,838	$ 2,841,336	$ 2,841,631
Vegetation & Watershed Management	NFVW	$ 810,000	$ 602,343	$ 815,085	$ 734,474
Wildlife & Fisheries Habitat Management	NFWF	$ 392,000	$ 284,805	$ 392,000	$ 370,651
Total National Forest Systems - NFNF	**NFNF**	**$ 6,735,372**	**$ 4,925,659**	**$ 6,840,395**	**$ 6,548,478**
		Wildland Fire Management - WFWF			
Wildland Fire Preparedness	WFPR	$ 360,000	$ 231,656	$ 360,000	$ 302,128
Hazardous Fuels Reduction	WFHF	$ 80,000	$ 76,314	$ 80,000	$ 70,692
Total Wildland Fire Management - WFWF		**$ 440,000**	**$ 307,970**	**$ 440,000**	**$ 372,820**
		Capital Improvements & Maintenance - CMCM			
Facilities Capital Improvements & Maintenance	CMFC	$ 196,000	$ 150,307	$ 181,000	$ 160,535
Legacy Roads (TRTR)	CMLG	$ -	$ -	$ 100,000	$ -
Roads Capital Improvements & Maintenance	CMRD	$ 987,031	$ 719,300	$ 1,037,842	$ 1,067,865
Trails Capital Improvements & Maintenance	CMTL	$ 458,996	$ 330,245	$ 257,000	$ 228,557
Facilities Maintenance (CP09)	CP09	$ 280,000	$ 158,652	$ 280,000	$ 328,277
Total Capital Improvements & Maintenance - CMCM		**$ 1,922,027**	**$ 1,358,504**	**$ 1,855,842**	**$ 1,785,234**
		Land Acquisition - LALW			
Land Acquisition	LALW	$ 31,000	$ 27,089.10	$ 27,000	$ 27,927.21
Total Land Acquisition - LALW		**$ 31,000**	**$ 27,089**	**$ 27,000**	**$ 27,927**
Total Appropriated Funds		**$ 9,128,399**	**$ 6,619,222**	**$ 9,163,237**	**$ 8,734,460**
		Perms & Trust Funds (Not All Inclusive)			
Cooperative Work - NONAGT Based	CWF2	$ 951,000	$ 524,839	$ 764,000	$ 311,672
Cooperative Work - Other	CWFS	$ 25,000	$ 2,958	$ -	$ 5,481
Regional K-V Sale Area Projects	CWK2	$ 68,700	$ 60,845	$ 77,000	$ 80,334
K-V Sale Area Projects	CWKV	$ 1,350,000	$ 844,451	$ 1,347,000	$ 930,438
Unit Recreation Enhancement	FDDS	$ 62,000	$ 45,931	$ 383,000	$ 162,086
Federal Highways	various	$ 16,040	$ 11,130	$ 2,000	$ 2,073
Maps for Visitors & Other Rec (MVIS & MSEQ)	MAPS	$ 15,000	$ -	$ 15,000	$ -
Reforestation Trust Funds	RTRT	$ 126,000	$ 111,898	$ 156,600	$ 154,282
Salvage Sale	SSSS	$ 330,000	$ 273,914	$ 475,000	$ 393,034
Stewardship Contracting	SSCC	$ 87,000	$ 84,800	$ 82,000	$ 78,599
Timber Pipeline - Sale Prep	TPPS	$ 230,000	$ 147,051	$ 1,134,000	$ 1,121,471
Total Perms & Trust Funds		**$ 3,260,740**	**$ 2,107,817**	**$ 4,435,600**	**$ 3,239,471**
OVERALL TOTAL		**$ 12,389,139**	**$ 8,727,039**	**$ 13,598,837**	**$ 11,973,931**
PERCENT SPENT		**70%**		**88%**	

		2014		2015	
Fund Name	**BLI**	**Estimated**	**Actual**	**Estimated**	**Actual**
		National Forest Systems - NFNF			
Inventory & Monitoring	NFIM	$ 433,000	$ 419,402	$ 519,000	$ 506,355
Landowner Management	NFLM	$ 195,000	$ 185,448	$ 205,000	$ 213,800
Minerals & Geology Management	NFMG	$ 1,157,201	$ 1,138,796	$ 1,109,301	$ 1,089,793
Native Plants	NFN3	$ -	$ -	$ -	$ -
Forest Planning	NFPN	$ 91,300	$ 91,352	$ 45,000	$ 43,431
Recreation, Heritage, & Wilderness	NFRW	$ 829,722	$ 789,146	$ 882,364	$ 816,385
Timber Sale Management	NFTM	$ 3,488,845	$ 3,493,238	$ 3,424,679	$ 3,336,392
Vegetation & Watershed Management	NFVW	$ 1,217,764	$ 1,355,136	$ 1,189,629	$ 1,169,501
Wildlife & Fisheries Habitat Management	NFWF	$ 490,870	$ 502,712	$ 464,718	$ 489,480
Total National Forest Systems - NFNF	**NFNF**	**$ 7,903,702**	**$ 7,975,230**	**$ 7,839,691**	**$ 7,665,137**
		Wildland Fire Management - WFWF			
Wildland Fire Preparedness	WFPR	$ 79,652	$ 62,460	$ 78,801	$ 49,840
Hazardous Fuels Reduction	WFHF	$ 400,000	$ 358,023	$ 375,026	$ 344,711
Total Wildland Fire Management - WFWF		**$ 479,652**	**$ 420,483**	**$ 453,827**	**$ 394,551**
		Capital Improvements & Maintenance - CMCM			
Facilities Capital Improvements & Maintenance	CMFC	$ 145,000	$ 152,774	$ 164,000	$ 156,140
Legacy Roads (TRTR)	CMLG	$ 225,000	$ 223,416	$ -	$ -
Roads Capital Improvements & Maintenance	CMRD	$ 980,754	$ 1,046,632	$ 952,000	$ 1,153,815
Trails Capital Improvements & Maintenance	CMTL	$ 272,000	$ 252,394	$ 273,000	$ 254,464
Facilities Maintenance (CP09)	CP09	$ 289,000	$ 293,271	$ 234,000	$ 224,499
Total Capital Improvements & Maintenance - CMCM		**$ 1,911,754**	**$ 1,968,487**	**$ 1,623,000**	**$ 1,788,918**
		Land Acquisition - LALW			
Land Acquisition	LALW	$ 67,800	$ 63,441	$ 32,000	$ 18,569
Total Land Acquisition - LALW		**$ 67,800**	**$ 63,441**	**$ 32,000**	**$ 18,569**
Total Appropriated Funds		**$ 10,362,908**	**$ 10,427,641**	**$ 9,948,518**	**$ 9,867,175**
		Perms & Trust Funds (Not All Inclusive)			
Cooperative Work - NONAGT Based	CWF2	$ 499,138	$ 741,967	$ 489,411	$ 465,557
Cooperative Work - Other	CWFS	$ 9,422	$ 8,038	$ 14,178	$ 8,207
Regional K-V Sale Area Projects	CWK2	$ 90,000	$ 90,988	$ 247,000	$ 190,394
K-V Sale Area Projects	CWKV	$ 1,019,015	$ 927,170	$ 1,249,500	$ 1,229,291
Unit Recreation Enhancement	FDDS	$ 287,584	$ 161,530	$ 230,326	$ 219,694
Federal Highway	various	$ 2,200	$ 2,256	$ -	$ -
Maps for Visitors & Other Rec (MVIS & MSEQ)	MAPS	$ 19,000	$ 15,446	$ 729	$ 760
Reforestation Trust Funds	RTRT	$ 207,852	$ 196,712	$ 120,000	$ 104,389
Salvage Sale	SSSS	$ 487,400	$ 360,699	$ 499,008	$ 445,477
Stewardship Contracting	SSCC	$ 746,591	$ 698,676	$ 711,683	$ 712,815
Timber Pipeline - Sale Prep	TPPS	$ 341,000	$ 267,756	$ 297,000	$ 233,287
Total Perms & Trust Funds		**$ 3,709,202**	**$ 3,471,237**	**$ 3,858,835**	**$ 3,609,871**
OVERALL TOTAL		**$ 14,072,110**	**$ 13,898,878**	**$ 13,807,353**	**$ 13,477,046**
PERCENT SPENT		**99%**		**98%**	

		2016	
Fund Name	**BLI**	**Estimated**	**Actual**
		National Forest Systems - NFNF	
Inventory & Monitoring	NFIM	$ 423,000	$ 409,495
Landowner Management	NFLM	$ 217,000	$ 219,368
Minerals & Geology Management	NFMG	$ 1,172,000	$ 1,141,988
Native Plants	NFN3	$ -	$ -
Forest Planning	NFPN	$ 45,000	$ 44,975
Recreation, Heritage, & Wilderness	NFRW	$ 862,500	$ 847,330
Timber Sale Management	NFTM	$ 3,436,300	$ 3,395,233
Vegetation & Watershed Management	NFVW	$ 1,302,000	$ 1,289,657
Wildlife & Fisheries Habitat Management	NFWF	$ 467,000	$ 468,410
Total National Forest Systems - NFNF	**NFNF**	**$ 7,924,800**	**$ 7,816,456**
		Wildland Fire Management - WFWF	
Wildland Fire Preparedness	WFPR	$ 94,000	$ 102,256
Hazardous Fuels Reduction	WFHF	$ 395,000	$ 331,150
Total Wildland Fire Management - WFWF		**$ 489,000**	**$ 433,405**
		Capital Improvements & Maintenance - CMCM	
Facilities Capital Improvements & Maintenance	CMFC	$ 156,000	$ 166,020
Legacy Roads (TRTR)	CMLG	$ 378,000	$ 376,700
Roads Capital Improvements & Maintenance	CMRD	$ 964,000	$ 936,075
Trails Capital Improvements & Maintenance	CMTL	$ 240,000	$ 246,463
Facilities Maintenance (CP09)	CP09	$ 194,000	$ 203,076
Total Capital Improvements & Maintenance - CMCM		**$ 1,932,000**	**$ 1,928,334**
		Land Acquisition - LALW	
Land Acquisition	LALW	$ 47,000	$ 54,246
Total Land Acquisition - LALW		**$ 47,000**	**$ 54,246**
Total Appropriated Funds		**$ 10,392,800**	**$ 10,232,442**
		Perms & Trust Funds (Not All Inclusive)	
Cooperative Work - NONAGT Based	CWF2	$ 548,628	$ 495,429
Cooperative Work - Other	CWFS	$ 34,550	$ 26,922
Regional K-V Sale Area Projects	CWK2	$ 300,000	$ 311,087
K-V Sale Area Projects	CWKV	$ 548,628	$ 495,429
Unit Recreation Enhancement	FDDS	$ 169,021	$ 110,813
Federal Highways	various	$ 157,526	$ 98,058
Maps for Visitors & Other Rec (MVIS & MSEQ)	MAPS	$ -	$ -
Reforestation Trust Funds	RTRT	$ 229,727	$ 209,565
Salvage Sale	SSSS	$ 539,864	$ 444,748
Stewardship Contracting	SSCC	$ 601,706	$ 583,153
Timber Pipeline - Sale Prep	TPPS	$ 947,548	$ 932,176
Total Perms & Trust Funds		**$ 4,077,198**	**$ 3,707,381**
OVERALL TOTAL		**$ 14,469,998**	**$ 13,939,823**
PERCENT SPENT		**96%**	

Discussion – Although the tables do not account for the entire budget, e.g., project earmarks, cost pools, and some other administrative costs, it does address most of the resource-related work that was completed to support implementation of the Forest Plan.

The average amount of expenditure indicates that Forest funding allocations were adequate to accomplish its program of work related to Forest Plan implementation and that the Forest not

only stayed within its budget allocated by Congress, but effectively and efficiently spent the allocated resources. One exception appears to FY 2012; however, during the fourth quarter of FY 2012, all Forest Service units were impacted by fire borrowing as funding allocated to the ANF was transferred to cover the cost of suppressing wildland fire.

In 2005, the annual cost of full Forest Plan implementation was projected to be $26,358,000 for the first decade (not adjusted for inflation; USDA-FS 2007b, p. B-81). While the methods of tracking costs have changed and the FEIS projection does not necessarily translate to current budget divisions, the Forest has only received and spent an average of 52% and 48% of the total projected cost of full Forest Plan implementation, respectively. While this represents an increase since the last evaluation period (FY 2008-2013) when the Forest received and spent an average of 51% and 45% of the total projected cost of full Forest Plan implementation, respectively, this also demonstrates that the Forest is operating at a financial level that would make it difficult, if not impossible, to meet all management benchmarks set in the Forest Plan, e.g., Forest Plan objectives.

Recommendations – Continue to monitor expenditures with the objective to efficiently and effectively spend the Forest's allocated budget to meet the needs of Forest Plan implementation.

3.1.4 Length and timing of growing season

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How is the growing season length changing on the ANF?	Length and timing of the frost-free season	Annual	2 years	N/A

Background – The 2012 Planning Rule requires the Monitoring Program of all Forest Service units to monitor measureable changes related to climate change and other stressors that may be affecting the plan area. Climate change is indicated by observed changes in biological processes such as growing season length, shifts in flowering phenology, and changes in wildlife emergence and migration. During the monitoring transition, the ANF selected to monitor the length of the growing season as a change related to climate change that may be affecting the Forest. Growing season length is one of the best predictors of the timing of plant flowering and has often been overlooked when modeling the potential impacts of how plants will respond to changes in climate conditions (Park and Mazer 2018). Growing season length can be estimated by the period of time between the last spring freeze and first autumn freeze (climatological growing season) when the air temperature drops below the freezing point of 32°F (USEPA 2016b, Linderholm 2006). This is referred to as the frost-free season.

Protocol – Data on annual growing season length (as defined by the length of the frost-free season) were secured from the Pennsylvania State Climatologist showing the first and last freeze dates for three locations just outside the Forest: Warren, Ridgway, and Bradford, Pennsylvania. The Warren and Ridgway sites are part of the National Weather Service Cooperative Observer Network and the Bradford site is at the Bradford Regional Airport.

Results

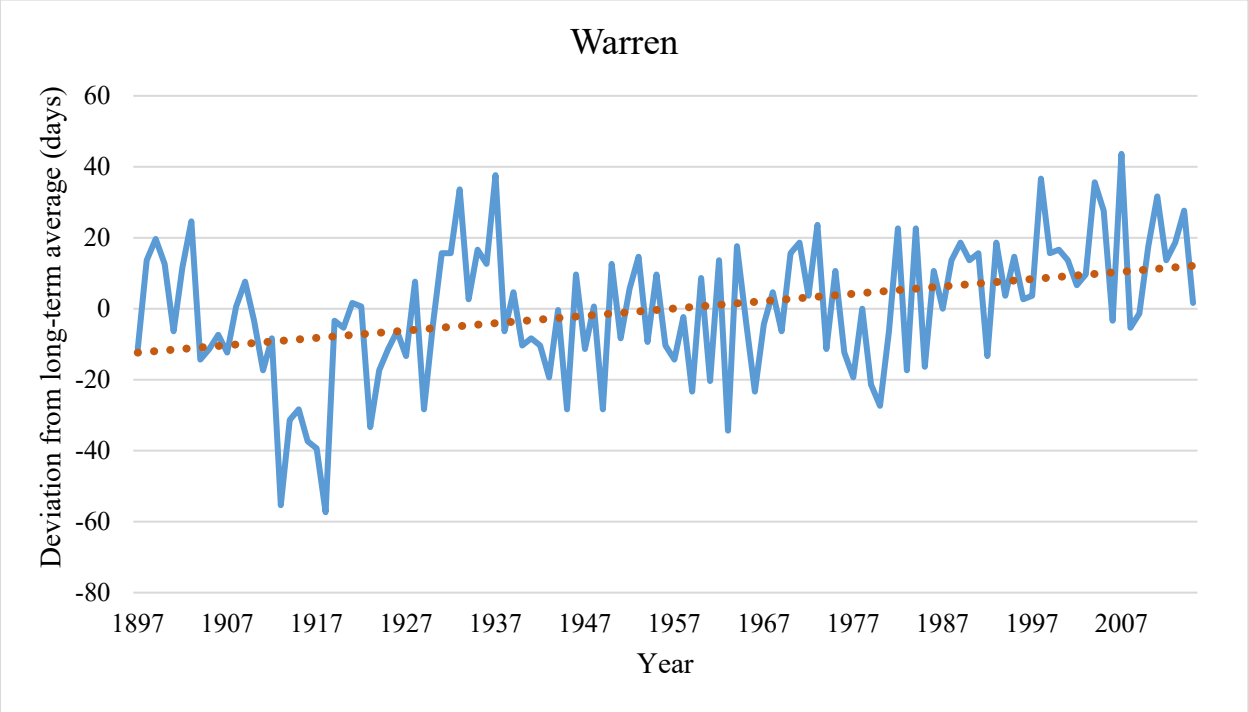


Figure 12. Length of growing season based on data from the National Weather Service Cooperative Observer Network site in Warren, PA

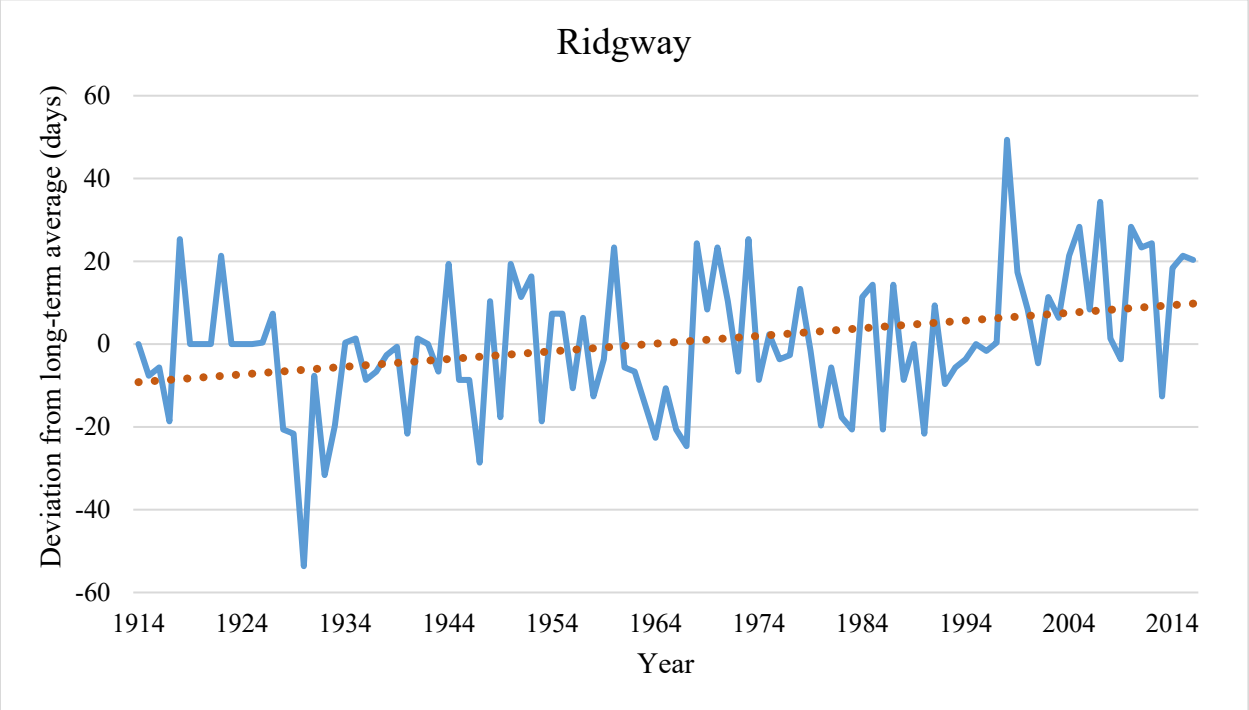


Figure 13. Length of growing season based on data from the National Weather Service Cooperative Observer Network site in Ridgway, PA

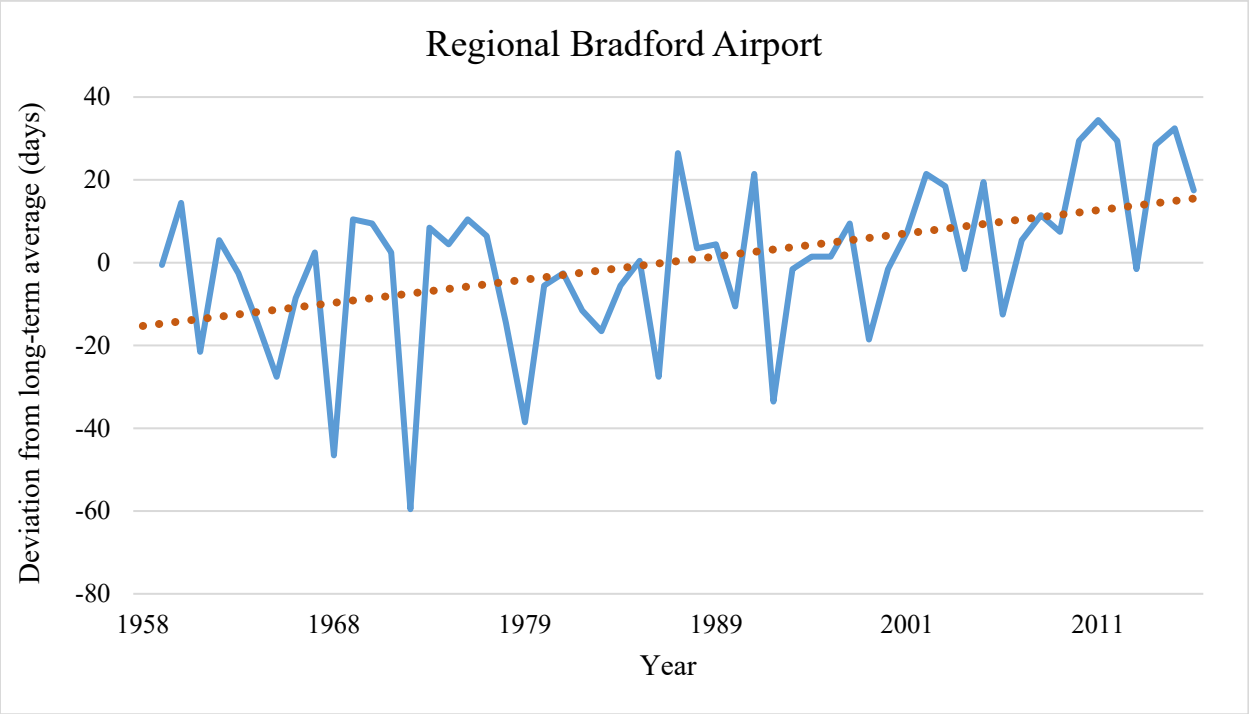


Figure 14. Length of growing season based on data from the Bradford Regional Airport, PA

Discussion – The average length of the growing season in the lower 48 states has increased by about two weeks since the beginning of the 20th century with a particularly large and steady increase occurring over the last 30 years (USEPA 2016b). A large body of research using observations from the last 50 to 110 years concurs that the frost-free season has lengthened by 10 to 20 days at global, hemispheric, and national scales, primarily due to an earlier onset of spring, although fall frosts are also arriving later to a degree (Butler-Leopold et al. 2018, USEPA 2016b). Projecting ahead over the 21st century, the growing season length is expected to increase by up to one month across the Mid-Atlantic Region (Butler-Leopold et al. 2018).

Data from three locations just outside the Forest also reflect the trend of an increasing length of the growing season (as defined by the length of the frost-free season; Figures 12-14). For further discussion of observed and projected changes in the length of the growing season across the Mid-Atlantic Region, as well as other changes related to climate change that may be affecting the ANF, see the Mid-Atlantic Forest Ecosystem Vulnerability Assessment and Synthesis (Butler-Leopold et al. 2018; https://forestadaptation.org/assess/ecosystem-vulnerability/mid-atlantic).

Recommendations – Continue to annually collect data on frost-free season length. Given changes in climate and their potential effects occur over relatively long temporal scales, update the Monitoring Program to evaluate this data at a more appropriate (longer) frequency, e.g., 10-year intervals, rather than every two years.

3.2 Noxious weeds monitoring

3.2.1 Establishment of seed and mulch mixes that limit spread of invasive species

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Have seed and mulch mixes been established for the ANF that will limit the spread of invasive species?	Number of seed and mulch mixes approved for use	Annual	2 years	FY 2013

Background – Forest Plan goals for noxious weeds include collaborating with agencies/entities to establish seed and mulch mixes appropriate to limit introduction and spread of invasive species for use on the ANF (USDA-FS 2007a, p. 18). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring progress toward meeting the desired conditions and objectives in the Forest Plan, including providing for multiple use opportunities.

Protocol – Forest Service Manual 2070 Vegetation Ecology, Forest Service Manual 2900 Invasive Species Management.

Results – ANF staff have reviewed seed mix recommendations from the Ruffed Grouse Society and the Pennsylvania Biological Survey's Vascular Plant Technical Committee developed for use on oil and gas sites being developed on private and state forest lands (PA DCNR-BOF 2016). The recommendations discuss the use of native and non-invasive non-native plant species for revegetation projects. Some species have been included in a couple of test locations on the ANF

Discussion – Ground disturbance from oil and gas operations (i.e., road and well pad construction) contributes to the most acres of revegetation need on the ANF and using better seed mixes and mulch materials are key in conserving biodiversity. Efforts have also been made to change species in former seed mixes used on the ANF that contained non-native invasive species. There is a need and request to look at mixes for different types of projects. A 'one seed mix for all' approach is not appropriate for all types of ground disturbance. For example, one seed mix for road work may not be the best choice for timber sale landings, and warm season grasses are not appropriate for a culvert replacement project.

Recommendations –Refine seed mixes for timber sales and road work so that desirable cover is established. Continue working with Timber Sale Administrators and Engineering staff. Continue to work with native seed suppliers to produce genetically appropriate seed that is readily available for use on the ANF.

3.2.2 Effectiveness of non-native invasive plant controls

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How effective have herbicide and manual invasive species controls been at eliminating targeted species?	Acres treated and effectiveness of treatment	Annual	2 years	FY 2013

Background – Forest Plan objectives include treatment of 300 to 600 acres of invasive plants, annually (USDA-FS 2007a, p. 18). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

The ANF Invasive Plant Species of Concern List consists of two parts: Early Detection and Rapid Response (species not yet known to occur within the ANF proclamation boundary, but are of concern and when found are priority for treatment) and species with documented occurrence within the ANF proclamation boundary. This list also notes whether species are on the Pennsylvania noxious weed control list and what class they are in, as well as their ranking for treatment priority (1-5 with 1 being the highest priority for treatment).

Not all species are treated everywhere, every time. When prioritizing NNIP species for treatment year by year for the ANF, a number of factors are considered, including: available funding; type of funding, available staff, approved NEPA areas; size of infestations in relation to funding (i.e. contracting versus in-house staff treatments); where infestations occur in relation to ongoing activities such as timber sales, infestations in relation to rare plant occurrences, etc. Treatments are looked at on a Forest-wide basis as well as partner opportunities.

Monitoring treatment efficacy is an important and required part of a comprehensive invasive species management program. Monitoring treatment efficacy helps to validate treatment priorities, adapt future treatment techniques to meet project needs, determine the effect of treatments on non-target organisms, and generally complete project implementation.

Protocol – As defined in the protocol (USDA-FS 2014b), this monitoring is done the same year as treatment, and typically at the same time as treatment. This monitoring is different than what is typically considered long-term monitoring and the ANF has developed categories and local guidance (Table 12). From a national accomplishment reporting standpoint, at least 50% of the total acres treated must be monitored for treatment efficacy to receive accomplishment credit and the accomplishment will be accounted for in the fiscal year in which the monitoring occurred, regardless of the year in which the treatment occurred.

Table 12. Categories and ANF guidance for effectiveness monitoring

Code	Percent Efficacy	Rating	Description	ANF Guidance
0	0%	No effect	No effect can be detected on the target species population.	N/A

Code	Percent Efficacy	Rating	Description	ANF Guidance
03	1%-5%	Failure	Little to no effect can be detected on the target species population.	N/A
15	6%-25%	Poor	Treatment killed less than a quarter of the target species population.	N/A
35	26%-50%	Marginal	Less than half of the target species population was controlled	N/A
65	51%-75%	Fair	Over half of the target species population was controlled.	N/A
85	76%-90%	Good	Treatment was successful in killing most of the target species population	Used for some herbicide treatment where target vegetation is either dense or tall (i.e., multiflora rose, Japanese barberry, glossy buckthorn) and not all plants may be effectively foliar sprayed
95	91%-99%	Excellent	Over 90% of the target species population has been killed with the treatment.	Mastication with habitat machine. Used for mowing.
100	100%	Complete	Not a single individual of the target species population was found after a complete survey of the site. Infestation was eradicated on the site.	Used for hand pulling, herbicide treatment, e.g., hand pulling of garlic mustard where able to pull all plants or herbicide treatment.

Results – A total of 1,533.9 acres of NNIP were treated across the ANF from FY 2008 through FY 2016 (see *3.1.2.4 Fuels, non-native invasive plant, wildlife, fish, and stream activities*).

Manual and mechanical treatment has proven effective in controlling some species, especially annual (e.g., mowing of yellow rocket, *Barbarea vulgaris*) and biennial species (pulling of garlic mustard) in which treatments are targeted before seed set to reduce seed production and lessen seed banking. Manual and mechanical treatments were also used where herbicide use is currently prohibited under the Forest Plan, even when using aquatic labeled products in riparian buffer areas. For species such as Japanese knotweed, while manual treatment is not effective in removing the infestation from the current location, it helps in lessening seed/propagule production that can move off-site and create new infestations.

Manual treatments are effective in first reducing seed production and the standing biomass of some plants. Subsequent herbicide treatment can then be more effective by being able to thoroughly cover vegetation and the amount of herbicide used is greatly reduced by treating smaller plants.

Year-after treatment monitoring of select stewardship service work sites within Coalbed ReAd (Bradford Ranger District) and Clarion Highlands FR 237 (Marienville Ranger District) show excellent (91%-99%) and complete (100%) mortality of target species such as multiflora rose

(*Rosa multiflora Thunb*.), Japanese barberry (*Berberis thunbergii DC),* and Morrow's honeysuckle (*Lonicera morrowii*), using manual, mechanical and chemical methods.

Discussion – A combination of manual/mechanical treatments and herbicide use has been effective in eliminating targeted species in some treatment areas. An integrated approach is used to minimize harm to the environment and human health, and apply the most economical use of the resources at hand.

Recommendations – While effectiveness monitoring is required for target accomplishment credit, it is also important to continue monitoring select locations for year-after treatment effectiveness in terms of resprouts, seed banks, or missed plants. It is recommended to have at least one seasonal dedicated to NNIP treatment per District whose sole responsibility is NNIP contract administration, treatment and monitoring. Finally, it is recommended the ANF expand the chemicals and treatment techniques available for NNIP treatment through, for example, amendment of the Forest Plan.

3.3 Recreation monitoring

3.3.1 Manage dispersed sites and concentrated use areas to prevent resource damage

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are dispersed sites and Concentrated Use Areas being managed to prevent resource damage?	Level of resource damage	Annual	2 years	FY 2013

Background – Forest Plan objectives include increasing the number of inventoried dispersed sites and CUAs managed to standard to reduce health, safety, and resource impacts caused by unmanaged recreation use in the general forest area (USDA-FS 2007a, p. 18). In addition, as funding allows, efforts are focused on providing ancillary support facilities, such as parking areas and toilets, as needed, to protect resources and the environment. Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and
- Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – During project-level planning, CUAs are inventoried and evaluated, allowing for a decision to be made as to whether dispersed sites should be kept, closed, or rehabilitated. District recreation staff perform weekly operations and maintenance of both developed and dispersed recreation sites and Law Enforcement Officers (LEOs) continue to monitor these areas with a concentrated focus during peak recreational use over spring/summer months.

Results – Since FY 2007, areas along the Clarion River as well as within the Southwest Reservoir, Upper Kinzua, Sugar Run, Salmon West, Millsteck, and Pine Bear projects have

undergone extensive inventorying accompanied by the decision to close numerous dispersed sites and keep or rehabilitate many others. Rehabilitation of sites has involved providing hardened parking areas, installing vault toilets, installing natural barriers (rocks, earthen mounds, native plantings) and implementation of a numbering system to allow for more effective forest patrols by Forest Protection Officers (FPOs) and LEOs. Increased FPO and LEO patrols have been effective at monitoring compliance and enforcing regulations to prevent resource damage in these areas as evidenced by observations of forest-users restricting their camping activities to designated sites and not expanding the footprint of their impact beyond what is already being used.

Discussion – The FPO and LEO patrols are effective at providing enforcement of compliance issues such as restricting camping to the actual site and not allowing further impacts. These monitoring efforts reveal that if these sites were left unchecked (i.e., should there be no FPO or LEO patrols to provide compliance with forest rules, such as no littering), they would reach a condition that would be unsustainable to maintain. This would happen despite the fact that recreation staff spend a considerable amount of effort cleaning these sites after the holiday weekend. While the Forest is currently able to manage impacts to these areas, the future challenge will be balancing this need with other needs of equal or greater necessity in the face of limited budgets and reduced staffing.

Monitoring of dispersed sites and CUAs also provides opportunities for observing forest-user trends with these areas. As expected, use is heavy just before and during holidays over the spring and summer starting just prior to Memorial Day and reducing after Labor Day. Dispersed sites along the Tionesta Creek and the CUA along Clarion River are often filled days prior to any three-day holiday weekend. These waterfront sites are highly sought-after, providing campers riverfront access and a more primitive camping experience away from the holiday crowds often encountered at developed recreation areas. Days prior to the actual weekend, sites begin to fill with multiple tents and campers.

Recommendations – There is a need for dispersed sites and CUAs to be managed to prevent resource damage. If left unchecked the sites would undoubtedly grow over time as campers slowly creep out beyond the designated camp site through actions such as adding more tents or campers. In addition, forest users could develop additional primitive sites simply by stopping at an area and deciding it should be a campsite and not realizing the impacts their actions create. The FPO and LEO patrols help to reduce the impacts at existing sites and prevent any unauthorized sites from being established.

Continue to inventory and evaluate dispersed sites during project-level planning. Continue to utilize FPO and LEO patrols in areas where investments have been made to prevent overcrowding during peak seasons, minimize health and safety concerns, and resource degradation.

3.3.2 Resource damage occurring from motorized and non-motorized use in authorized areas

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Is resource damage occurring from motorized and non-motorized use in unauthorized areas?	Level of resource damage	Annual	2 years	N/A

Background – This question is the result of modification made during the monitoring transition. The original Monitoring Program question asked: *Is resource damage from equestrian use occurring outside of EUAs*? The question largely focused on unauthorized equestrian use and although the original intent may have been to curtail it from areas outside of Equestrian Use Areas (EUAs), unauthorized use should be a concern throughout the Forest. During the monitoring transition, the question was modified in the updated Monitoring Program to ask: *Is resource damage occurring from motorized and non-motorized use in unauthorized areas*?

The intent of the new question in the updated Monitoring Program is to better address unauthorized recreational use (ATVs, OHVs, mountain bikes, and equestrians) in areas where unacceptable cultural or natural resource damage occurs. This also includes compliance with wilderness regulations where no mechanized use is allowed. This information can also provide management with opportunities to evaluate if areas should be considered for additional use if appropriate, such as a designation for multiple uses on a trail. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – Visual inspections determine if an unauthorized use is occurring in an area or on a trail. Forest staff, volunteers, and user groups also help to provide information on unauthorized use by reporting resource damage resulting from user-created trails and also rutting and erosion caused by unauthorized ATV/OHV use.

Results – Resource damage on equestrian and hiker-only trails continues to be localized and limited to user-defined trails. On occasion, reports of mountain bike use on hiker-only trails have been reported. Evidence of tire treads in the trail bed have been observed on the Minister Creek Trail, but no resulting resource damage has occurred.

Although ATV use is authorized on designated trails, unauthorized use continues throughout the Forest. The largest unauthorized use throughout the forest is ATVs on forest roads and in powerline and oil/gas pipeline rights-of-way (ROWs). These ROWs serve as unauthorized ATV traffic corridors. Evidence indicates use is originating from locally owned camps and residences. Resource damage occurs in the ROWs as a result of rutting and erosion caused by ATVs. The Gregg Hill, Jonesburg, and German Hill areas receive a concentration of this unauthorized use.

Discussion – The Forest offers information to visitors on allowable uses in specific areas on ANF trails. Forest visitors can find this information through a variety of sources. The Supervisor's or District Offices are well stocked with informational brochures and staffed with customer service representatives. The Forest website is also a source of information. In the field,

informational signs are located at trailheads. Collaborating with local tourism bureaus and businesses so that outfitters, guides, and organizations such as the Pennsylvania Wilds are included helps to reach Forest visitors and inform them of the appropriate use of the ANF. In addition, the routine and seasonal increase of FPO and LEO patrols provide opportunities to observe and report incidents of unauthorized use and serve to increase compliance and awareness with Forest-users.

The Forest also works closely with OGM operators and special-use permit holders to coordinate access to their ROWs. This includes adding entry gates to affected roads. In FY 2016, the Forest began including Operation and Management (O&M) Plans to Special Use Permits. The O&M Plans have terms and conditions which address unauthorized use and resource damage caused by ATVs in ROWs.

Recommendations – Continue to provide, and update as needed, information to Forest users through sources identified above. Ensure informational and interpretive signs in the field are checked and maintained on a routine basis, including the replacement of worn out or damaged signs. Also, develop a sign plan for trails and areas experiencing unauthorized use. Maintain an FPO cadre for supplemental patrols and public outreach on the ANF. Continue FPO and LEO patrols and maintain collaborative efforts with user groups, local businesses, and tourism bureaus. Maintaining effective communication with OGM operators and conducting annual compliance inspections of Special Use permitted ROWs is critical to identifying and addressing unauthorized ATV use in ROWs.

3.4 Trails monitoring

3.4.1 Management of trails

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are Trail Management Objectives being met? Are trail design standards, maintenance/construction specifications, and scheduling appropriate for the type and frequency of use each trail receives?	Status of Trail Management Objective implementation and assessment of trail condition	Annual	2 years	N/A

Background – This question is the result of a modification made during the monitoring transition. The original Monitoring Program question asked: *Have trail classes and permitted uses been established? How many miles of trail (per trail type) have been constructed or reconstructed? Have maintenance and construction priorities been established? Are trails constructed and maintained to standard? Have limited use trails been converted to sustainable multiple use trails based on compatible uses and resource constraints?* During the monitoring transition, the question was modified in the updated Monitoring Program to ask: *Are Trail Management Objectives being met? Are trail design standards, maintenance/construction specifications, and scheduling appropriate for the type and frequency of use each trail receives?*

The documentation of Trail Management Objectives (TMOs) for each National Forest System (NFS) trail is a prerequisite for completing an effective trail condition assessment survey and subsequent prescriptions for the work needed to meet trail standards. Trail Management Objectives also ensure the objectives for a trail are consistent with the Forest Plan, District and Forest travel management plans, and anticipated future land management actions. They require updating if the management intent for the trail, special considerations or other factors change.

The use of TMOs more effectively answers the parts of the original Monitoring Program question regarding the establishment of trail classes and maintenance priorities as well as the maintenance and construction of trails to Forest Service standard. In turn, TMOs address the Forest Plan objective for all trails: establish trail classes, permitted uses, construction, reconstruction, and maintenance priorities (USDA-FS 2007a, p. 18). Therefore, the new question in the updated Monitoring Program addresses the 2012 Planning Rule monitoring requirements of monitoring the status of:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and
- Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – The Infrastructure Database (INFRA) is the database that houses trails and other infrastructure data. The TMOs provided the objectives for each trial, while Trail Assessment and Conditions Surveys provide information on trail conditions relative to Forest Service standards. These are conducted within the first year after a trail is maintained or constructed to meet standards, and result in updates to trails data within the INFRA database.

Results – The ANF maintains and updates its TMOs as required and adheres to the USDA Forest Service Trail Management Objectives, including the Standard Trail Plans and Specifications for design, construction, and maintenance of NFS trails and trail bridges. The Standard Trail Plans and Specifications were developed to assist with trail design, construction, maintenance, inventory, condition assessment, and the assembly of trail construction plan packages.

Discussion – During FY 2014-2015, the Forest conducted trail maintenance on a total of 77 miles of designated motorized use trails on the Marienville Ranger District. The work included graveling and redressing the trail tread, replacing undersized culverts, and clearing and re-establishing outflow ditches to control erosion. Also, the Forest designed the Kinzua Valley Trail and constructed the segment from the Village of Westline to the Red Bridge Recreation Area. Final construction was accomplished by the Kinzua Valley Trail Club in FY 2016. Also, in FY 2016, the Forest designed and reconstructed the East Branch Spring Creek Bridge on the Timberline ATV Trail.

In the summer of 2016, phase one of trail construction was completed on 10 miles of the Jakes Rock Mountain Bike Trail. Pennsylvania Kinzua Pathways, in partnership with the Northern Allegheny Mountain Bike Association raised the funds to hire Trail Solutions to design and flag the trail. Another 35 miles of trail is planned for construction.

Additionally, the following project planning decisions related to trail construction and management were completed for the following projects between 2014 and 2016. These decisions authorize trail improvements that contribute towards providing a diversity of motorized and non-motorized trails on the ANF that are well managed, meet user expectations, and minimize resource damage on the forest.

- Jakes Rocks Epic Mountain Bike Trail (Bradford Ranger District)
- Little Seeker ASL Trail Realignment (Marienville Ranger District)
- North County Trail Realignment (Marienville Ranger District)
- Watson Farm ASL Realignment (Marienville Ranger District
- Beanfields Safe Access Project (Bradford Ranger District)

Recommendations – A Trail Maintenance Plan should be developed to provide a schedule for basic trail maintenance needs. The purpose of trail maintenance is to reduce user safety issues and to prevent further resource degradation caused by damaged, poorly designed, or faulty trail features, trail bridges and/or blockages in the trail corridor, such as fallen trees.

The plan would incorporate a list of basic trail maintenance tasks to be performed according to Forest Service trail guidelines in Forest Service Handbook 2309.18. Trail maintenance would be completed in accordance with the standards established for each trail based on its Trail Management Objectives and would be consistent with the management direction provided in the trail class matrix.

3.4.2 Evaluate ANF road system suitability for snowmobile use

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are roads and trails designated for snowmobile use marked and signed?	Status of snowmobile trail marking and signage	Annual	2 years	FY 2013

Background – Forest Plan objectives include evaluating ANF road systems to identify which roads are suitable for snowmobile use by utilizing the Travel Management Process (USDA-FS 2007a, p. 18). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and
- Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – Regulations governing motor vehicle use on National Forests have been established under the 2005 Travel Management Rule (36 CFR Parts 212, 251, 261, and 295 Travel Management; Designated Routes and Areas for Motor Vehicle Use). The CFR makes a distinction between 'motor vehicles' and 'over-the-snow vehicles'. Travel management planning is required by each National Forest for motor vehicles but is optional for over-the-snow vehicles.

Results – Roads and trails designated for snowmobile use are marked and signed and illustrated on the 2012 Snowmobile Trails Map. This map meets the requirement of 36 CFR 212.55 to publish an over-the-snow map and is a key component of identifying approved trail routes for the public. In partnership with the Pennsylvania State Snowmobile Association, the snowmobile trail system was marked and signed in FY 2013.

In addition, the Forest currently has three Challenge Cost Share Agreements with local snowmobile clubs to help with grooming the trails and providing proper trail signage. The clubs also help with seasonal maintenance by assisting each spring with opening trails and inspecting trails for hazards such as downed trees.

Discussion – The clear identification of roads, trails and areas for motor vehicle use on each National Forest will: enhance overall management of NFS lands; sustain natural resource values through more effective management of motor vehicle use; enhance opportunities for motorized recreation experiences on NFS lands; address needs for access to NFS lands; and preserve areas of opportunity for non-motorized travel and experiences.

Even though over-the-snow vehicles are exempt from mandatory designation, restrictions or prohibitions may be proposed following the procedures included within the body of 36 CFR 212, subpart B, including public involvement, coordination with governmental agencies, revision of designations, and application of criteria in 36 CFR 212.55. The ANF used the procedures outlined in 36 CFR 212.55 to evaluate additions to the snowmobile trail system.

Recommendations – The Forest is required by law in the Travel Management Rule to evaluate and update as needed, a motor vehicle use map on an annual basis. The Forest will also adhere to any changes and/or new directives regarding travel management planning for OHVs, including over- the-snow vehicles. Specific to over-the-snow vehicles, the Forest will continue to maintain a Snowmobile Trails Map to show where it is legal for the public to ride.

3.4.3 Facilitate regular grooming of designated snowmobile trail system

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
To what degree has the ANF contributed to snowmobile grooming?	Miles of snowmobile trails groomed	Annual	2 years	FY 2013

Background – Forest Plan objectives include facilitating regular grooming of the designated snowmobile trail system if Commonwealth funding is available (USDA-FS 2007a, p. 18). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and
- Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – Recreation personnel along with the grooming contractor develop a weekly grooming schedule that is dependent upon weather conditions. The grooming contract administrator keeps track of how much time is spent grooming trails in order to help determine overall accomplishment and program of work in the recreation program. An annual accomplishment report details what trails were groomed and what efforts were made to facilitate regular grooming.

Results – During the last evaluation period, two Forest Service snow grooming machines were used for grooming trails across the entire Forest at least twice a week when conditions were favorable (109.39 miles of the Allegheny Snowmobile Loop and 78.09 miles (29%) of the 269.06 miles of connector trails on the ANF). A Challenge Cost Share Agreement continued with the Forest County Snowmobile Club to groom an additional 34.58 miles (13%) of connector trails on the Forest. In addition to this agreement, two Challenge Cost Share Agreements were developed with the Tionesta Valley Snowmobile Club and the Marienville Trail Riders Snowmobile Club to groom 8.33 (3%) and 55.06 miles (20%) of connector trails, respectively.

From FY 2014 to 2016, the ANF continued the three Challenge Cost Share Agreements with the snowmobile clubs: Forest County, Marienville Trail Riders, and Tionesta Valley. The Forest County Snowmobile Club groomed approximately 33 miles of connector trails and a section of the Allegheny Snowmobile Loop (ASL). The agreement with the Marienville Trail Riders Snowmobile Club provided for grooming of approximately 49 miles of connector trails and also a section of the ASL. The agreement with the Tionesta Valley Snowmobile Club provided for grooming approximately 11 miles of the ASL. The sections of the ASL groomed by the clubs were also groomed by the ANF's contractor. This increased the sustainability of favorable riding conditions on the popular trail, especially on weekends.

In addition, approximately 115 miles of the ASL along with 84 miles of connector trails were groomed under contract. Two grooming machines were used for grooming. The larger groomer was operated in the northern portion of the Forest to groom a short section of Trail 1 of the ASL, the connector Trail 1A to the Pennsylvania/New York state line, and several other connector trails. The smaller groomer was primarily used on sections of Trail 1 traversing the western, southern, and eastern portions of the Forest. When weather conditions are favorable, grooming usually occurred on Thursday and Friday nights starting in January while conditions allowed. During the 2014-2015 winter, the contractor groomed a total of 2,815 miles of snowmobile trails. In contrast, during the 2015-2016 winter, only 200 miles of trails were groomed.

Discussion – Groomed trail mileage varied from year to year depending on the amount of snow and equipment reliability. For FY 2008 to FY 2013, the Forest met the objective of regular trail grooming. Winter conditions were favorable for maintaining the snowmobile trails during the winter of 2014 – 2015. A good base of snow and cold temperatures allowed for optimal grooming thereby providing a quality recreation experience for snowmobile riding. The warm weather the following winter (2015 – 2016) greatly affected the amount of snowmobile use and grooming on ANF trails. A trend in warmer winters will further impact this activity on the ANF.

Recommendations – The ANF should continue to evaluate options for leveraging resources that most effectively maintain the snowmobile trail system.

3.5 Heritage monitoring

3.5.1 Develop management plans for preservation of cultural resources

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many management plans have been completed?	Number of management plans developed	Annual	2 years	FY 2013

Background – One of the Forest Plan objectives is to develop management plans for long-term preservation of heritage resources that are either listed on or eligible for the National Register of Historic Places (NRHP; USDA-FS 2007a, p. 19). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – This question can be answered by counting the number of heritage management plans that were developed for cultural resource sites determined to be eligible or potentially eligible for the NRHP.

Results – No heritage management plans have been developed for cultural resource sites determined to be eligible or potentially eligible for the NRHP from FY 2008 to FY 2016.

Discussion – The ANF is not meeting Forest Plan goals and objectives set forth in the Forest Plan (USDA-FS 2007a, pp. 13 and 19). The development of heritage management plans is essential to properly managing the cultural resources within the Forest. Funding, staffing and workload levels on the ANF influence the degree to which Forest Plan objectives are achieved and this has constrained the ability to develop heritage management plans.

Recommendations – To the extent funding, staffing, and workload levels allow, the ANF should develop heritage management plans for the eligible and potentially eligible sites within the ANF.

3.5.2 Evaluate heritage sites

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many evaluations have been completed? How many heritage resources have been nominated?	Number of evaluations and nominations	Annual	2 years	FY 2013

Background – One of the Forest Plan objectives is to reduce the backlog of heritage sites that require evaluation and nomination to the NRHP (USDA-FS 2007a, p. 18). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – This question can be answered by counting the number of formal evaluations that have taken place of cultural resource sites that require evaluation for the NRHP, and counting the number of sites that have been nominated for the NRHP.

Results – Thirty-nine sites were formally evaluated between FY 2008 and FY 2013 and one site was nominated and listed to the NRHP (Irwin Run Historic Site). Five sites were formally evaluated from FY 2014 to FY 2016 for the NRHP, and one site (Loleta Recreation Area) was nominated and listed on the NRHP.

Discussion – The majority of the survey time, research, and report writing conducted by ANF heritage staff is Section 106 (of the National Historic Preservation Act) compliance work in support of other programs. This Section 106 work involves Phase I archeological surveys with any sites recorded that may be eligible or need further evaluation for the NRHP avoided by ground-disturbing activities at a predetermined distance. This standard of "flag and avoid" cultural resource sites by a "predetermined distance" allows the site to be preserved for future evaluation (Phase II and III).

The ANF has partnered with the Pennsylvania State Historic Preservation Office (SHPO) and their summer intern program in a Challenge Cost Share Agreement. The SHPO interns have worked on Civilian Conservation Corps site evaluations within the Forest. These sites are mostly architectural in nature, with some camps having an archeological component, and require very little excavation for eligibly determinations. The SHPO interns have also gathered the required data and plan on making a formal determination of eligibility for the General Irvine estate.

From FY 2008 to FY 2013 approximately 9,000 acres were surveyed for cultural resources, 124 new sites were found, 48 sites were monitored, and eight interpretive projects were completed. From FY 2014 to FY 2016 nearly 10,700 acres were surveyed for cultural resources, and 64 new sites were recorded. In addition, a total of 274 heritage field studies and 290 archeological/cultural resources survey reports were conducted and produced by ANF heritage staff or Cultural Resource Management contractors. Also, seven data recovery projects were conducted, and five archeological sites were rehabilitated, stabilized, protected, and monitored.

Recommendations – The ANF should continue to look for opportunities to complete evaluative work either through additional internal staffing (temporary or permanent), contractors or partnerships. The ANF should also continue and expand the Challenge Cost Share Agreement with the Pennsylvania SHPO summer intern program. The focus of this program has been to work on eligibility determinations of historic sites on the ANF, and their work has been crucial for nominating sites for the NRHP.

3.5.3 Develop an inventory of culturally sensitive sites

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Has an inventory of sites culturally sensitive to American Indian Tribes with ancestral ties to the ANF landscape been completed?	Status of culturally sensitive site inventory	Annual	2 years	FY 2013

Background – One of the Forest Plan objectives is to work with appropriate representatives of the Seneca Nation of Indians (SNI) to develop a confidential inventory of culturally sensitive sites (USDA-FS 2007a, p. 19). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including providing for multiple use opportunities.

The inclusion of all tribes with ancestral ties to the ANF is mandatory with Section 106 of the National Historic Preservation Act and is essential to identifying culturally sensitive sites and potential Traditional Cultural Properties (TCPs). As such, the monitoring question in the original Monitoring Program (*Has an inventory of SNI culturally sensitive sites been established?*) was modified to the current question in the updated Monitoring Program (*Has an inventory of sites culturally sensitive to American Indian Tribes with ancestral ties to the ANF landscape been completed?*) to include the ethnographic information of all American Indian Tribes with ancestral ties to the ANF, and not just the SNI.

Protocol – This question can be answered by asking if an inventory has been completed of culturally sensitive sites to America Indian Tribes with ancestral ties to the ANF.

Results – No inventory of culturally sensitive sites to America Indian Tribes with ancestral ties to the ANF has been completed from FY 2008 to FY 2016.

Discussion – Initially, Section 106 consultation on the ANF was with SNI. This is the federally recognized tribe, which is geographically located nearest to the ANF, has deep-rooted ancestral ties with the Forest, and has expressed the most interest in the undertakings within the ANF. Since 2014, the list of consulting Tribal Nations has expanded to 14 tribes. From FY 2014 to 2016 the ANF has sent out a total of 104 notification and consultations letters to each of the Tribal Historic Preservation Officers (THPOs) of the 14 consulted tribal nations concerning federal undertaking within the Forest. Some of these THPOs have been consistent in replying to these consultation requests, and have contributed ethnographic information concerning cultural resource sites, culturally sensitive areas, and TCPs.

There has been ongoing and consistent dialogue between the SNI and the ANF concerning archeological and culturally sensitive sites to the SNI. ANF staff have been in constant dialogue with SNI representatives to identify culturally sensitive areas, exchange ethnographic information concerning indicator species used to identify potential heritage sites, and enter into Challenge Cost Share Agreements (such as the Longhouse Project) for mutually beneficial projects. ANF staff worked with SNI representatives to gather ethnographic information

concerning the three Earthworks Prehistoric Sites located on the ANF and is using this information to start to develop a Resource Management Plan for these cultural resources.

Recommendations – The ANF should make a deliberate and concerted effort to reach out to all 14 Tribal nations and their THPOs in order to complete a comprehensive inventory of culturally sensitive sites to America Indian Tribes with ancestral ties to the ANF. This could involve formal invitation letters, sit-down meetings, on-site visits, and ethnographic research outside the normal Section 106 compliance consultation.

The ANF should continue to work with the SNI and other interested Tribal Nations in gathering ethnographic information on the Buckaloons Prehistoric Sites and the Earthworks Prehistoric Sites in order to develop the site management plans and determine their eligibility for the NRHP. Both these sites are well established culturally sensitive sites to the SNI.

It is recommended the Forest Plan objective associated with this monitoring question be modified as the monitoring question was, i.e., work with appropriate representatives of American Indian Tribes with ancestral ties to the ANF landscape to develop a confidential inventory of culturally sensitive sites.

3.6 Scenery monitoring

3.6.1 Maintain or exceed scenic integrity levels

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are we meeting or exceeding scenic integrity levels?	Scenic integrity levels as seen from Concern Level 1 and 2 travel routes and use areas	Annual	2 years	FY 2013

Background – Forest Plan objectives include maintaining or exceeding Scenic Integrity Levels (SILs) as seen from Concern Level (CL) 1 and 2 travel routes and use areas (USDA-FS 2007a, p. 19). Therefore, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and
- Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Protocol – SILs are used as a primary indicator for measuring effects of proposed project activities, i.e., an Indicator Measure of whether the activities proposed in each project alternative would meet the established Forest Plan SIL of the area as seen from CL 1 or 2 view facilities.

Results – With the implementation of Forest Plan design criteria and project-specific mitigation measures, all vegetation management project activities have met established SILs from CL 1 or 2 view facilities.

Discussion – While Forest Plan design criteria and project-specific mitigation measures have been implemented, effectiveness monitoring has not been conducted to determine if SILs from CL 1 or 2 view facilities have been maintained post implementation.

Recommendations – Monitoring should be conducted from a sample of implemented vegetation management projects to evaluate the effectiveness of design criteria and project-specific mitigation measures in meeting SIL objectives.

Continue to use SIL as a primary indicator for measuring effects in project-level scenery management analysis.

3.7 Vegetation monitoring

3.7.1 Stocking within five years of regeneration harvest

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Have lands been adequately restocked within five years of regeneration harvest?	Percent seedling stocking at five years following even-aged or uneven-aged regeneration harvest	Annual	2 Years	FY 2013

Background – Forest Plan goals for vegetation management include providing a diversity of vegetation patterns across the landscape that represents well distributed habitats, a range of forest age classes and vegetative stages, a variety of healthy functioning vegetation layers, moderate to well-stocked forest cover, and the variety of vegetation species or forest types necessary to achieve multiple resource objectives and sustain ecosystem health (USDA-FS 2007a, p. 14). Regeneration harvests are designed to regenerate mature forest areas to well-stocked young forested areas in order to help achieve Forest Plan desired conditions and goals. This monitoring question helps measure how well we are achieving landscape-level goals and objectives, and stand level regeneration objectives of sustaining well-stocked forest cover.

A Forest Plan reforestation standard calls for final harvests, single tree or group selection harvests to only occur where adequate restocking through natural regeneration of desired trees within five years is highly probable (USDA-FS 2007a, p. 69). Stocking surveys occur in all regeneration harvests to monitor tree seedling development, how well we are meeting this standard, and help determine the need for additional reforestation treatments. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities; and

- Effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 U.S.C. 1604(g)(3)(C)).

Protocol – Monitoring for this question evaluates tree seedling stocking five years following final harvest. All final harvest areas that were five years post-harvest between FY 2008 and FY 2016 are evaluated here, including regeneration harvests completed prior to the current Forest Plan. Stocking surveys were completed on the ground in each regeneration harvest area using ANF and UDSA Forest Service Northern Research Station (NRS) stocking survey guidelines (USDA-FS 2007a, p. 69; Appendix A p. A-2). Even-aged regenerated stands on the ANF are considered adequately restocked when at least 70% of sampled plots are stocked with acceptable seedlings at least three years old (USDA-FS 2009). Stands that are being regenerated using single tree selection must have at least 30% of sampled plots stocked with acceptable seedlings at least three years old (USDA-FS 2009).

Stocking surveys were conducted during the 2008-2016 summer growing seasons when species composition and health of the vegetation were easiest to identify. Stocking surveys were conducted by systematically sampling seedling regeneration on sample plots, using direction provided in the ANF Seedling Stocking Examination, Evaluation and Certification handbook (USDA-FS 2009). Personnel summarized stocking survey results for each regenerated stand, by type of harvest activity and year the harvest cut occurred. Tree seedling stocking is monitored in all regeneration harvests on the ANF until they are considered fully stocked and acceptable species composition is achieved.

Results

Scheduled green harvests

Even-aged (single-age) harvests – Seedling success rate for green even-aged (single-age) treatments averages 93.5% (Table 13). Reforestation success within five years of green, even-aged (single-age) regeneration harvests (considering harvests completed between FY 2003 and FY 2011) ranges from 91.0% (FY 2003 harvests) to 100% (FY 2009 and FY 2011 harvests).

Table 13. Percent of acres stocked within five years of regeneration harvest cut

Fiscal Year Cut	5th-Year Survey Fiscal Year	Even-aged Prescription				Uneven-aged Prescription	
		Green		Mortality Salvage		Green	Mortality Salvage
		Final Harvest	Two-age	Final Harvest	Two-age	All	All
2003	**2008**	91.0%	100.0%	100.0%	-	-	-
2004	**2009**	94.2 %	-	100.0%	0.0%	100.0%	-
2005	**2010**	95.6%	100.0%	68.7%	-	-	-
2006	**2011**	92.2%	100.0%	38.9%	-	45.9%	-
[1]2007	**2012**	91.3%	44.8%	80.1%	-	100.0%	97.2%
2008	**2013**	95.6%	51.2%	68.0%	-	100.0%	35.3%

Fiscal Year Cut	5th-Year Survey Fiscal Year	Even-aged Prescription				Uneven-aged Prescription	
		Green		Mortality Salvage		Green	Mortality Salvage
		Final Harvest	Two-age	Final Harvest	Two-age	All	All
2009	**2014**	100.0%	-	100.0%	-	-	100.0%
2010	**2015**	85.8%	100.0%	100.0%	-	27.5%	100.0%
2011	**2016**	100.0%	100.0%	100.0%	-	68.1%	100.0%
Total Acres Cut FY 2003-2011		4,531	441	886	16	518	397
Average 5th-Year Restocking (Percent)		93.5%	86.6%	84.5%	0%	68.3%	77.3%
Average 5th-Year Restocking with Probable Success Included (Percent)		97.9%	100.0%	92.8%	100.0%[2]	74.3%	88.9%

[1] Drought Year – when PDSI (Palmer Drought Severity Index) was less than -2 (-2 = moderate drought) for part of the growing season.
[2] One salvage two-aged regeneration harvest totaling 16 acres, which was implemented in FY 2004, had 55% seedling stocking in 2009 and is considered a "probable success" per ANF seedling stocking handbook direction (USDA-FS 2009).

Even-aged (two-age) harvests – Reforestation success for two-aged regeneration harvests ranges from 44.8% (FY 2007 green harvest) to 100% (FY 2003, FY 2005, FY 2006, FY 2010, and FY 2011 green harvests). When areas that are nearly fully stocked and considered probable successes are included, reforestation success for two-aged regeneration harvests is 100% for both green and mortality salvage treatments (see footnote 2 to Table 13). A "probable success" indicates that seedling stocking is present on over 50% of sampled plots in even-aged regeneration harvests, and that the stand has a high likelihood of successful restocking based on sampled seedling data. Stands in this category are monitored until they are considered fully stocked and acceptable species composition is achieved.

Uneven-aged harvests – Seedling success rate for green uneven-aged treatments was substantially lower (68.3% average) than even-aged (single-aged) treatments. Some of these treatments occurred during times of high deer populations and applied pre-2007 Forest Plan design criteria for uneven-aged regeneration methods. Additionally, most of the treatments evaluated here are single tree selection harvests that are only successful in regenerating black birch, with very little seedling establishment by other species.

Mortality salvage harvests

Mortality and blowdown regeneration harvests reflect wider yearly fluctuations in five-year success rates, most likely because seedlings were not in place before catastrophic events (e.g., windstorm, insect or disease) occurred.

Even-aged (single-aged harvests) – Restocking success in even-aged (single-aged) salvage harvests ranges from 38.9% (FY 2006 harvest) to 100% (FY 2003, FY 2004, FY 2009, FY 2010, FY 2011 harvests), with an average of 84.5% for this time frame (compared with 93.5% average for similar green harvests).

Uneven-aged harvests – Restocking success in uneven-aged salvage harvests that occurred during this time frame and ranged between 35.3% and 100%, an indication of variable seedling abundance when catastrophic events occurred. Fifth-year restocking success for uneven-aged salvage harvests averaged 77.3% during this time frame.

The highest success rate for salvage regeneration harvests (84.5% average) is for even-aged (single-aged) harvests. In all cases, reforestation success rates were quite variable, and indication of highly variable seedling abundance that was present in these areas when catastrophic events occurred. Overall, reforestation success rates are fairly good considering these harvests are a response to a natural catastrophic event. Significantly fewer acres of salvage harvest occur than green harvest; the FY 2003-2011 salvage harvest program represented approximately 19% of the green harvest program (up from 14% reported in the FY 2008-2013 Monitoring and Evaluation Report).

Discussion – Fifth-year reforestation success is best in scheduled green, even-aged harvests. Of the categories of regeneration harvest listed, scheduled green even-aged (single-aged) final harvests had the greatest success rates with an average regeneration success rate of 93.5% between FY 2003 and FY 2016, followed by green two-aged final harvests with an average regeneration success rate of 86.6% for this time period. When regenerated areas that are nearly fully restocked and considered probable successes are included, the average is 97.9%.

Uneven-aged harvests continue to have poor fifth-year reforestation success; however, as mentioned above, these results reflect initial single tree selection harvest stocking levels rather than results that would be expected if subsequent group selection harvests occur in these areas. Single tree selection harvests are typically prescribed on the ANF to be followed up with group selection harvests once adequate desired tree seedlings are established. Group selection would create more suitable conditions for a greater diversity of tree seedlings to develop in uneven-aged harvests and are thus expected to increase success rates for stand restocking with using uneven-aged regeneration methods. Post-2007 uneven-aged treatments are implemented using updated guidelines contained in the 2007 Forest Plan, which were formulated to improve the success of uneven-aged treatments as a stand regeneration method to sustain a diversity of tree species. These treatments will typically utilize a group selection uneven-aged regeneration method, very few of which have been implemented so far, and are thus not reflected in these results monitoring results. We anticipate implementation of group selection harvests that follow newer criteria in the 2007 Forest Plan will yield greater success with uneven-aged regeneration methods.

Averages for both green and salvage regeneration harvests indicate adequate restocking is being achieved within five years of regeneration harvest the vast majority of the time. Those that do not achieve restocking objectives within five years of regeneration harvest will have additional

reforestation treatments prescribed, including supplemental planting in some cases, and monitored until they are considered fully stocked.

Recommendations – No changes are recommended at this time. Continue to monitor tree seedling development success and the need for additional reforestation treatments to assure timely and adequate tree seedling stocking in regeneration harvests.

Since uneven-aged treatment success rates are less than desired, continue to implement uneven-aged treatments through an adaptive management approach, taking into account the new direction noted in the Forest Plan (USDA-FS 2007a, pp. 64-66, 68-69, A-2, A-4 – A-19, A-23 – A-28). Effective evaluation of Forest Plan uneven-aged management guidelines could take up to fifteen years to provide enough time for first entry harvest, follow-up reforestation treatments, development of tree seedlings, and implementation group selection harvest (recommended in most cases).

3.7.2 Maximum opening size from even-aged management

Monitoring Questions	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the maximum size opening from even-aged management? Is there a need to change the standard?	Maximum size in acres of temporary openings created from even-aged management	Annual	2 years	FY 2013

Background – The Forest Plan contains standards and guidelines for allowable temporary maximum opening sizes that result from even-aged regeneration treatments. A temporary opening is created through a final harvest silvicultural treatment and is intended to be re-occupied by young trees. Temporary openings are dominated by trees and saplings less than 15 feet tall that, with time will grow into a mature forest. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Vegetation harvests sold for even-aged regeneration harvests were compiled from vegetation databases, including TIM and FACTS. Maps were reviewed for final harvest areas that were sold from FY 2008 to FY 2016 to identify adjacent shelterwood removal, clearcut, overstory removal, or two-aged harvest prescriptions and determine the maximum and minimum size of temporary openings by MA.

Results – Table 14 displays the minimum, maximum, and average size of areas sold for final harvest resulting in temporary openings.

Table 14. Size of final harvests by Management Area in acres (FY 2008-2016)

Management Area	Minimum	Maximum– Scheduled Green Harvests	Maximum– Unscheduled Salvage Harvests	Average	Forest Plan Maximum
2.2	2	37	32	17.7	20[1]
3.0	2	40	68	20.5	40
6.1	6	27	11	13.7	40
7.2	27	27	n/a	27.0	n/a
8.6	7	16	n/a	10.3	40

[1] Forest Plan guidelines for MA 2.2 specify that oak, white pine, and aspen forest types may be regenerated with even-aged methods on areas up to 20 acres (USDA-FS 2007a, p. 111). An acreage limit for other forest types is not specified, though even-aged regeneration methods for shade-intolerant forest types are permitted.

Discussion – The size of temporary openings created through scheduled green harvests cannot exceed 40 acres, as specified in the Forest Plan (USDA-FS 2007a, p. 68), except as approved by the Regional Forester. As can be seen from Table 14, the size of green final harvests in timber sales conformed to Forest Plan direction.

MA 2.2 guidelines provide additional direction that temporary opening sizes in oak, white pine, and aspen forest types should be less than 20 acres (USDA-FS 2007a, p. 111). An acreage limit for other forest types is not specified, though even-aged regeneration methods for shade-intolerant forest types are permitted. Eight final harvests in MA 2.2 resulted in temporary openings that exceed 20 acres, most by less than five acres. All of these final harvests were the result of stand regeneration prescriptions initiated prior to 2007 and when the MA was changed to 2.2. All of these areas had received shelterwood seed cuts that were consistent with 1986 Forest Plan direction and were initially prescribed for single-aged shelterwood removal final harvests. To maintain greater consistency with MA 2.2 vegetation desired conditions, all but one of these even-aged prescriptions was changed to a two-aged final harvest, which retains more legacy trees and structural diversity within resulting temporary openings.

The shelterwood removal sold in MA 7.2 is a continuation and final harvest of an oak stand that is part of a research study with NRS. This final harvest is consistent with Forest Plan direction for MA 7.2 (USDA-FS 2007a, p. 139).

Unscheduled salvage treatments occur in response to catastrophic forest damage from wind, insects, or disease. Salvage regeneration treatments are designed to regenerate heavily damaged or declining stands in order to restore fully stocked forested stands to these sites. In these cases, the size of the damaged area was determined by the disturbance event which, in turn, determined the size of the subsequent silvicultural treatment. Salvage temporary openings created in response to tree mortality and decline are not constrained in size by the Forest Plan (USDA-FS 2007a, p. 68). The maximum size of salvage final harvests sold in response to damaging agents was 68 acres, and occurred in MA 3.0 (Table 14).

Discussion – The size of final harvest units in timber sales awarded between FY 2008 and 2016 conformed to MA direction. There is no need identified to change these items.

Recommendations – Continue monitoring the size of temporary openings created through shelterwood removals, clearcuts, or two-aged harvests to ensure Forest Plan standards and guidelines are met.

3.7.3 Prescriptions and effects

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How have prescriptions and effects been measured?	Comparison of desired (silvicultural prescription) and actual residual stand stocking, composition and structure	Annual	2 years	FY 2013

Background – The purpose of this monitoring item is to measure how well silvicultural prescriptions met desired objectives, and therefore also effects. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 U.S.C. 1604(g)(3)(C)).

Silvicultural prescriptions include a description of existing stand stocking (crowding) and desired stocking levels that will achieve defined silvicultural objectives. They also specify the desired structure and species composition in terms of residual stocking within broad tree diameter classes. Treatments are prescribed to move the stand from existing toward desired conditions. Silvicultural objectives can include providing additional growing space throughout the stand to enhance overall growth and vigor, or they may have an objective of reducing overstory stocking in order to reduce shading of the forest floor so seedlings can become established, to meet stand regeneration objectives. Silvicultural prescriptions quantify existing and desired stocking in two ways: relative density and basal area.

Relative density

Relative density is a measure of crowding or stocking among the trees of a stand. It is also correlated to the degree of understory shading. In addition to basal area measurements, relative density also takes into account the space requirement for different tree species, stand stratification (vertical layering), and crown shape. As a result, relative density provides a more realistic estimation of overstory crowding and subsequent shading of the forest floor than basal area (Brose et al. 2008).

Basal area

ANF silvicultural prescriptions and marking guidelines for implementation also describe existing and desired stand stocking in terms of basal area per acre (a measure of stocking based on square feet of standing growing stock per acre), most often by size class. Compared to relative density, basal area is a more readily measured stand characteristic that can be quickly checked in the field by marking crews with a prism.

Protocol – Silvicultural prescriptions and their effects are monitored by completing marking checks in stands that have been marked to implement a silvicultural prescription. Overstory plots are systematically established throughout a stand. At each plot, a 10 Basal Area Factor wedge prism is used to determine tally trees. Trees of all species, larger than 6-inch DBH are tallied in 2-inch diameter classes and identified as a "cut" or "leave" tree. Plot data are then summarized in SILVAH, a local stand analysis program developed by the NRS to evaluate vegetation data, quantify vegetative characteristics of a stand, and to develop silvicultural prescriptions. SILVAH was used to summarize marking check plot data and compared to the original silvicultural prescription to assess if residual composition and stocking objectives were met.

Results – Timber sale marking checks were conducted on 141 stands prescribed for partial harvest by gathering new silvicultural examination plot data for stands that had been marked to implement silvicultural prescriptions on the ANF. Certified Forest Service silviculturists prepared or reviewed all prescriptions. Coordination with other resource uses was considered good for all reviewed stands. A desired mix of species, along with less common tree species were retained in all reviewed stands, consistent with silvicultural prescriptions.

Tables 15 and 16 summarize monitoring and evaluation of prescription effectiveness in achieving prescribed stand stocking levels as measured by relative density and basal area, respectively.

Table 15. Prescription effectiveness monitoring using marking checks for relative density objectives (FY 2008-2016)

	Degree to which Prescription Achieved Specified Relative Density Objective (Percent of Monitored Stands)		
Treatment	**Very Good (<10% Relative Density Difference)**	**Acceptable (11-20% Relative Density Difference)**	**Marking Did Not Fully Meet Prescribed Objective (> 20% Relative Density Difference)**
Intermediate Thinning	55%	26%	19%
Shelterwood Preparation Cut[1]	67%	33%	-
Shelterwood Seed Cut	54%	43%	3%
Two-aged shelterwood establishment cut[2]			100%
Single Tree Selection	29%	43%	29%

[1] Only three stands were evaluated.
[2] Only one stand was evaluated.

Table 16. Prescription effectiveness monitoring using marking checks for basal area objectives (FY 2008-2016)

	Degree to Which Prescription Achieved Specified Basal Area Objective (Percent of Monitored Stands)		
Treatment	**Very Good (<10 ft²/ac Basal Area Difference)**	**Acceptable (11-20 ft²/ac Basal Area Difference)**	**Marking Did Not Fully Meet Prescribed Objective (>20 ft²/ac Basal Area Difference)**
Intermediate Thinning	50%	28%	21%
Shelterwood Preparation Cut[1]	67%	-	33%
Shelterwood Seed Cut	47%	37%	16%
Two-aged shelterwood establishment cut[2]	67%	33%	12%
Single Tree Selection	29%	29%	43%

[1] Only three stands were evaluated.
[2] Only one stand was evaluated.

Intermediate thinning

Timber sale marking checks were completed for 58 intermediate commercial thinning prescriptions on the ANF. Intermediate thinning has an overall objective in reducing stand crowding (stocking) in order to enhance overall stand growth, vigor, composition, and quality. Overall, 81% of intermediate thinning prescriptions evaluated met specified relative density stocking objectives. 78% percent of sampled stands met basal area stocking objectives specified in silvicultural prescription.

Eleven of the 58 stand monitored (19%) had residual relative densities that deviated by more than 20% of the target amount, and twelve (21%) had residual basal areas that deviated by more than 20 ft²/ac of that specified. Between relative density and basal area measures, seven monitored stands (12%) did not reduce stand stocking enough to fully meet intermediate thinning stocking goals. In all cases, the thinning will result in a reduction in stand crowding (stocking). In all cases, stands marked for intermediate thinning that were monitored will result in a reduction in stand crowding (stocking) and increased growing space for residual trees. Treatment of these stands will still result in an overall increase in growth and vigor of residual trees, but not to the degree at the stand level that would have been realized by achieving stocking levels specified in the silvicultural prescriptions.

Shelterwood preparation cut

Timber sale marking checks were completed for three shelterwood preparation cut prescriptions. These treatments were prescribed in oak forest types in order to enhance growth and vigor of oak seed trees, and to ultimately sustain oak composition in the longer term. Field checks revealed that all of the shelterwood preparation cut prescriptions evaluated met specified relative density stocking objectives, while 67% met basal area stocking objectives specified in silvicultural prescription. One stand reduced basal area more than specified in the silvicultural prescription, potentially creating light conditions that will favor non-oak species. An adequate seed source, including oaks and a diverse mix of other tree species were retained.

Shelterwood seed cut

Timber sale marking checks were completed for 70 shelterwood seed cut prescriptions on the ANF. Shelterwood seed cuts are prescribed to increase light levels to the forest floor in order to promote tree seedling establishment. Overall, 97% of shelterwood seed cut prescriptions evaluated met specified relative density stocking objectives. Eighty-four (84%) of sampled stands met basal area stocking objectives specified in silvicultural prescription.

Two of the 70 stands evaluated (3%) deviated by more than 20 ft^2/ac of target residual basal area. Eleven (16%) of the evaluated stands had residual basal areas that deviated by more than 20 ft^2/ac of that specified. Four of these stands were marked more than 20 feet above specified basal area stocking. Subsequent non-commercial site preparation will reduce basal area more by removing poles and low shade from the stand. Seven of these stands reduced basal area more than specified, but still retained a diversity of seed trees well distributed across these stands. The overall prescription objective of increasing light to the forest floor and providing well distributed seed trees was met in all stands evaluated. All stands that receive a shelterwood seed cut are closely monitored to determine if seedlings develop or if subsequent reforestation treatments are needed in order to achieve regeneration objectives and proceed to the final removal harvest.

Two-aged shelterwood establishment cut

Timber sale marking checks were completed for one two-aged shelterwood establishment prescription. Two-aged shelterwood seed cuts are prescribed to increase light levels to the forest floor in order to promote tree seedling establishment. This establishment cut will be followed by the final harvest which will leave at least approximately 20-25% full stocking to create a two-aged stand. The stand monitored reduced residual density and basal area to desired levels.

Single tree selection

Timber sale marking checks were completed for seven single tree selection prescriptions. Single tree selection has an objective of removing individual trees or small clusters of trees to increase sunlight on the forest floor for tree seedling establishment and transition even-aged stands towards an uneven-aged structure. Typically, single tree selection is followed by group selection on the ANF once sufficient desirable trees seedlings are established.

All single tree selection prescriptions monitored met prescription objectives of removing individual trees or small clusters of trees to increase sunlight on the forest floor for seedling establishment. Five stands evaluated met specified relative density and four met specified basal area. Adequate, well-distributed seed trees are present in all stands evaluated. All stands that receive a single tree selection harvest are closely monitored to determine if seedlings develop or if subsequent reforestation treatments are needed.

Discussion – Overall, the monitored silvicultural prescriptions integrated various resource considerations and met objectives to move landscapes towards desired conditions established in the Forest Plan. All prescriptions evaluated retained a diversity of tree species. Monitoring

revealed that some sampled stands were marked by inexperienced crews, while others were mature stands with declining overstory health that influenced prescription implementation.

When comparing the marking checks completed during FY 2008-2013 to FY 2014-2016, the most notable change in the degree to which prescriptions achieved specified relative density and basal area objectives was a decrease in the percent of stands in the "very good" category, and increases in the percent of stands in the "acceptable" and "did not fully meet prescribed objective" categories. This change is likely the result of implementing treatments in mature stands with increasing overstory decline and mortality – a result of multiple forest health concerns. In some cases, marking guides were prepared from stand data that did not accurately describe existing conditions. Because the monitored silvicultural prescriptions specified removal of unacceptable growing stock and declining stems, stands with substantial amounts of these can frequently be marked to lower than desired residual structures. In addition, these stands tend to have non-uniform residual structures that can be difficult to accurately sample with a systematic approach.

Recommendations – Ongoing follow-up conversations with District silviculture staff regarding prescription effectiveness monitoring has resulted in the following recommendations:

- Continue monitoring implementation of silvicultural prescriptions in all types of prescriptions.
- Continue utilizing relative density measures of stand crowding in silvicultural prescription development.
- Continue utilizing local guidelines for silvicultural prescription development in Allegheny Plateau hardwoods (Marquis, et al. 1994).
- Recognize the dynamic nature and changing health of forest stands on the ANF, and utilize adaptive management techniques when developing appropriate silvicultural prescriptions.
- Continue utilizing the standardized ANF silvicultural prescription template, which is designed to ensure all measurable components of silvicultural prescriptions are addressed, as well as long-term objectives.
- Ensure that the inventory used to write a prescription accurately represents current conditions on the ground. It is recommended the updated inventory data is collected in the following situations:
    - Existing data is older than 10 years.
    - Original stand boundaries are substantially different than actual treatment boundaries.
    - When stand composition, stocking, health, or tree distribution has changed since the last inventory (e.g., beech bark disease (BBD), windthrow, general decline, etc.).
- Clumpy stocking in the stand being marked may end up being marked to a lower relative density than specified due to the removal of trees in more densely stocked portions of these stands. Where clumpy distribution occurs, or mortality such as BBD-caused mortality has impacted a stand, a shelterwood seed cut may require the residual relative density to fall below 50%

- Account for sapling stocking in the prescription when it exceeds 5% of the total stand relative density.
- Assess prescription effectiveness on a frequent basis with marking crews, particularly inexperienced crews.

3.7.4 Provide vegetation diversity

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How does the diversity of age classes and structural conditions compare to plan objectives?	Age class/structural condition distribution by acres	Annual	2 years	FY 2013

Background – Forest Plan objectives include sustaining a diversity of vegetative structural stages and age classes across the landscape. Early structural stages created by timber harvest or natural disturbance were projected to comprise 8-10% of the forested landscape (USDA-FS 2007a, pp. 11 and 19). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the:

- The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems; and
- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Structural stages were summarized using vegetation data in the Field Sampled Vegetation (FS Veg) database. Age class information was used as an overall proxy for structural stage, similar to those used in the Forest Plan FEIS (USDA-FS 2007b).

Results – Table 17 summarizes desired structural stages (USDA-FS 2007a, p. 19) and age classes (USDA-FS 2007b, p. 3-137) projected for Decade 1 of Forest Plan implementation compared to present conditions.

Table 17. Desired and present condition for structural stage (age class) distribution (percentage of the ANF)

Structural Stage (Age Class)	Desired Condition Decade 1*	Present Condition FY 2013*	Present Condition FY 2016*
Early Structural (dominant tree layer <5 inches DBH; 0-20 years old)	8%	3.4%	3.2%
Mid Structural (dominant tree layer 5-20 inches DBH; 21-110 years old)	72%	76.3%	73.6%
Late Structural (dominant tree layer ≥ 20 inches DBH; ≥ 111 years old)	10%	10.3%	13.2%

*Note: Totals do not add up to 100%. Forest plan projections were for forested lands only on the ANF. The remainder is non-forest or developed land condition.

Discussion – Desired ecosystem conditions for the Forest include sustaining a diversity of vegetative structural stages and age classes across the landscape. Early structural stages created by timber harvest or natural disturbance were projected to comprise 8-10% of the forested landscape (USDA-FS 2007a, pp. 11 and 19). Presently, approximately 3.2% of the ANF, or less than half of that desired, is in an early structural condition (less than 20 years old). This acreage (17,377 acres) represents approximately 4.6% of the total suitable forestland on the ANF. This acreage is slightly less than that reported in during the last evaluation period (FY 2008-2013) This is because creation of very young forest vegetation (0-10 years old) is not keeping pace with the rate that older-early structural vegetation (0-20 years old) is progressing into the mid-structural age class.

Mid-structural age classes are presently slightly above desired Forest Plan levels, while late structural age classes are increasing beyond Forest Plan desired levels. This is a reflection of the even-aged nature of forest vegetation on the ANF and the overall age of the vegetation, which originated when the entire area was intensively harvested by early settlers between the 1890s and early 1930s. Late structural vegetation levels will continue to exceed desired Forest Plan levels at higher magnitudes unless younger structural vegetation is sustained at levels closer to those desired in the Forest Plan.

Even-aged regeneration harvests, or final harvests are implemented in order to sustain a constant flow of new, early structural age classes on the landscape, and to keep pace with early structural classes that progress into older structural classes. Final even-aged regeneration harvests typically follow shelterwood seed cuts and reforestation treatments, and occur once adequate tree seedlings have become established. Final harvest rates have been below projected Forest Plan levels (see *3.1.2.6 Timber harvest management practices by Management Area*), consequently sustaining less than desired levels of early structural age class vegetation.

There are several reasons that final harvests sold, and consequently early structural age class abundance are below levels projected in the Forest Plan. These include: the number of shelterwood seed cuts initially prescribed; interfering vegetation that must be treated to promote tree seedling establishment; more sporadic and less abundant seed crops for some tree species; poorly distributed seed trees where mortality or windthrow has impacted overstory tree stocking; and inadequate tree seedling establishment. Additionally, poor timber markets in recent years have slowed harvest rates for shelterwood seed cuts that have been sold or are under contract, delaying subsequent reforestation treatments and final harvests. Funding and staffing levels on the ANF also determine the degree to which Forest Plan objectives and desired conditions are achieved.

In the long term, if even-aged and uneven-aged regeneration harvests continue to be lower than the stated objectives, landscape-level desired vegetative structural stages and age classes will not be sustained at levels sufficient to meet desired Forest Plan ecosystem conditions. In fact, the longer implementation rates are below those listed in Forest Plan objectives, the more skewed age class distribution will become towards late structural classes.

Recommendations – It is recommended to increase regeneration treatments on the ANF in order to move forest age class and structural stage distribution toward desired conditions in the Forest Plan.

3.7.5 Changes in forest health

Monitoring Question	Monitoring Indicators	Monitoring Frequency	Evaluation Frequency	Last Updated
What are significant changes in forest health? What threats to forest health are present?	Status of impacts from insects and disease, and overall forest health conditions	Annual	2 years	FY 2013

Background – This monitoring question evaluates the status of impacts on forest health from insects and disease. As such, it addresses the 2012 Planning Rule monitoring requirement of monitoring the measureable changes related to climate change and other stressors that may be affecting the plan area.

Protocol – The following specific types of forest health monitoring occurred during the fiscal years between 2008 and 2016. Data collection adhered to standard agency protocol or Forest Health Monitoring (FHM)/Forest Inventory and Analysis (FIA) protocol. All collected information was stored in agency databases or in field notes. Monitoring activities included:

- Informal observations made by Forest field-going personnel;
- FHM/FIA forested land plot data collection from FY 1998 to FY 2016;
- Summer aerial detection surveys by USDA-Forest Service Northeastern Area, State and Private Forestry Forest Health Protection (FHP), PA DCNR-BOF, and Forest personnel;
- Field surveys conducted by FHP entomologists and pathologists, and Forest personnel; and
- Observations by PA DCNR-BOF and Pennsylvania Department of Agriculture (PDA) and USDA-Animal and Plant Health Inspection Service (APHIS) personnel.

Additional information on exotic forest pest species and their status nationwide can be found at www.aphis.usda.gov. The USDA-Forest Service Northeastern Area website (www.na.fs.fed.us) provides additional information regarding the current status of both native and exotic forest pests in the Northeastern United States.

Aerial surveys are conducted with two observers looking for signs of tree canopy discoloration, defoliation, damage, or death while flying evenly spaced flight lines in a fixed-wing aircraft, looping back until the entire ANF is covered. Observers use a digital aerial sketch mapping (DASM) system to identify, sketch, and rate the severity of any areas noted to contain tree discoloration, defoliation, or tree mortality, and attempts are made to identify their causes. The DASM system is linked to a Global Positioning System (GPS) to map the exact location of the plane and flight lines, creating an accurate sketch map produced in real time. Subsequent

ground-truthing of aerially-mapped tree decline, damage, or mortality occurs to further assess the extent and cause of the damage.

In FY 2011, in addition to aerial surveillance surveys, the ANF began employing moderate resolution imaging spectroradiometer (MODIS) data to assess disturbance events. These data are acquired from the Forest Service Health Technology Enterprise Team's Forest Disturbance Mapper (FDM).

The MODIS and normalized difference vegetation index (NDVI) data have a resolution of 240 m^2 (14.2-acre pixel) and are created from a 16-day interval composite. The FDM data utilized by the ANF are 3-Year Real Time Forest Disturbance (RTFD) data. The three-year RTFD dataset is a digital change detection product that compares the current RTFD greenness (derived from NDVI) to a three-year baseline of greenness. The RTFD is designed to detect short-term defoliation forest disturbance in deciduous forests.

Results

The following provides an update to the previous forest-wide discussion of forest health that was published in the Forest Plan Final Environmental Impact Statement (FEIS; USDA-FS 2007b, pp. 3-78 to 3-105). Substantial detailed background information, organized by individually named insect, disease, or category of threat to forest health, can be found in the referenced documents. The following discussion is by exception; topics discussed here will include only those where there is new information to report. The information reported below applies to the Forest, both to areas that have had management activity as well as to those areas that have had little or no activity, unless otherwise noted. If references pertain to areas outside of the Forest, it will be noted as such.

Aerial surveillance results

FY 2008 – An aerial survey flight conducted in July 2008 detected a total of 51,711 acres with visible damage within the proclamation boundary of the ANF (Figure 15). Ground-truthing surveys revealed that a number of different agents and defoliators were active on a variety of hardwoods and conifers. The most commonly reported agents on hardwoods were BBD and leaf anthracnose. The most common conifer damage appeared confined to pine plantations and was due to various pine beetles.

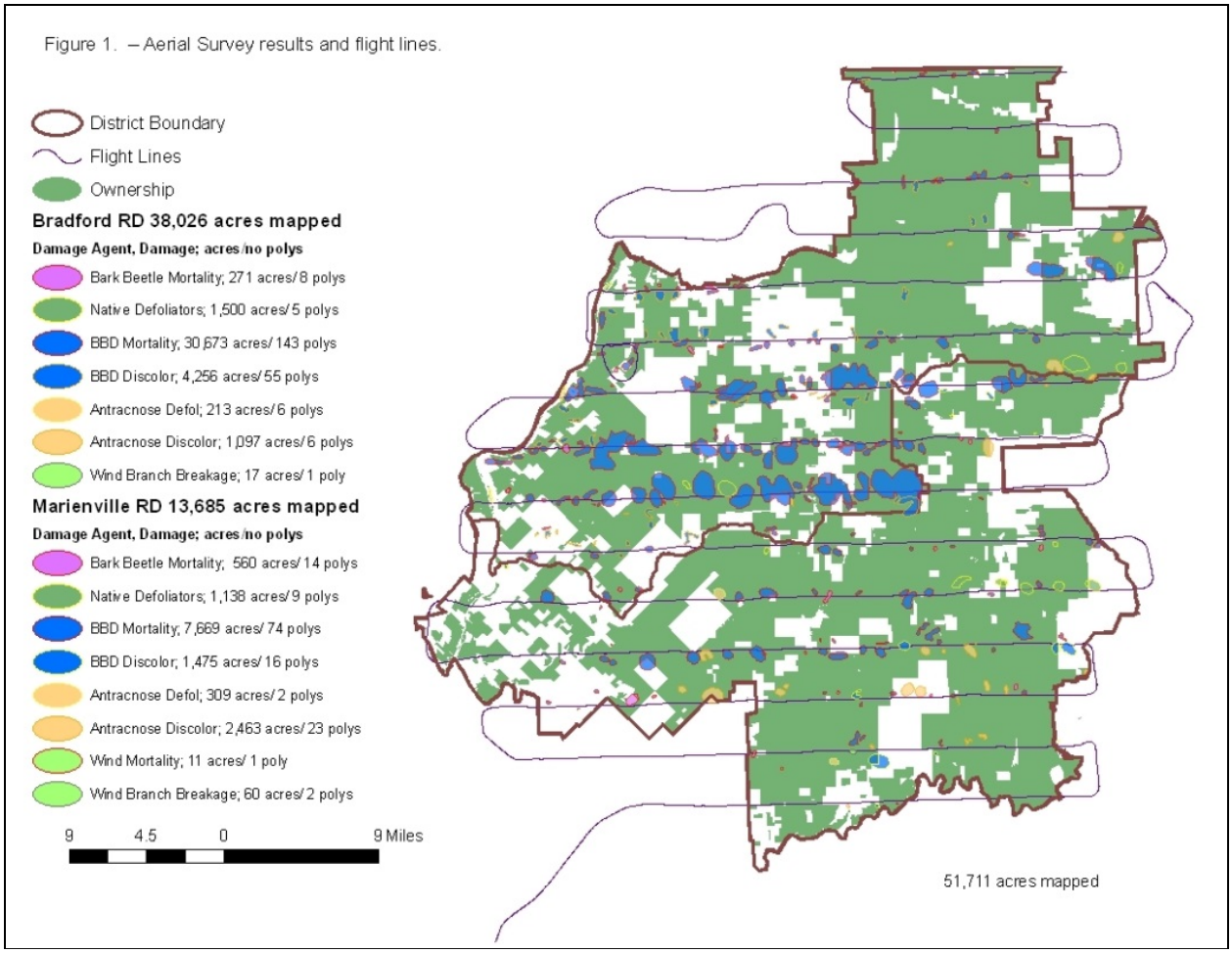


Figure 15. Map of FY 2008 Forest Health Monitoring aerial survey results and flight lines

FY 2009 – The 2009 aerial surveillance flight detected 18,402 acres of visible damage within the proclamation boundary of the ANF (Figure 16). This was a significant decline from the 51,711 acres of damage observed during the 2008 aerial surveillance flight. This reduction was due primarily to a decrease in observed damage caused by BBD in 2009. The decline and mortality of trees caused by BBD was still quite evident in the Tionesta Scenic and Research Natural Areas in 2009, as seen by the larger area of BBD damage mapped in the eastern central portion of the Forest. Ground-truthing surveys revealed that, in reality, a number of different agents and defoliators were active on a variety of hardwoods and conifers. The most commonly reported being BBD and leaf anthracnose on hardwoods and various pine beetles on conifers confined to pine plantations.

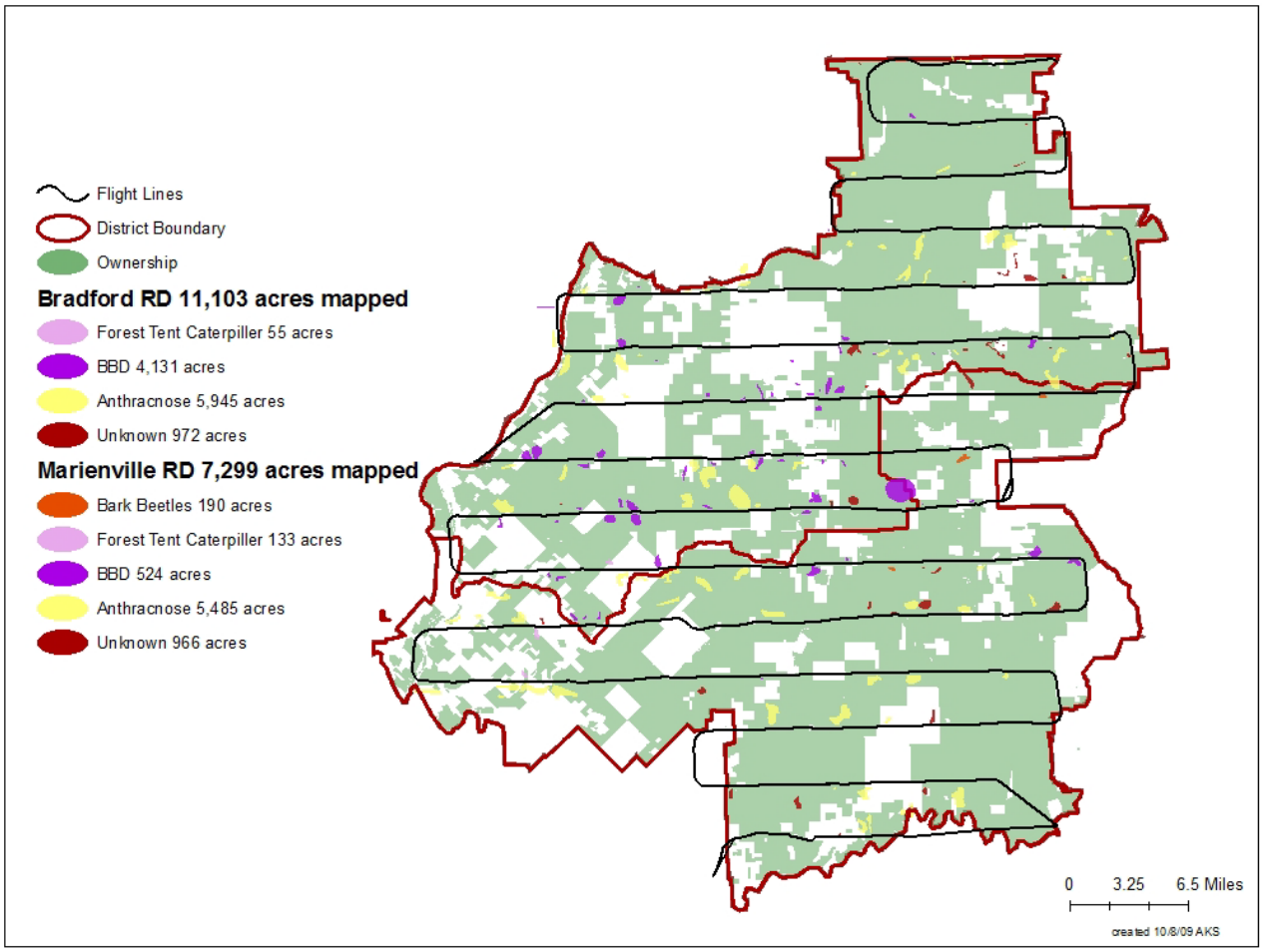


Figure 16. Map of FY 2009 Forest Health Monitoring aerial survey results and flight lines

FY 2010 – The July 2010 aerial surveillance flight detected another reduction in the amount of visible damage within the proclamation boundary of the ANF. A total of 13,955 acres of visible tree visible damage was mapped, down from the 18,402 acres observed during the 2009 flight (Figure 17). As in 2009, this reduction was due primarily to less observed damage from BBD. As in the previous year, ground-truthing surveys also revealed that a number of different agents and defoliators were active on a variety of hardwoods and conifers. Frost and forest tent caterpillars (FTC) were the most common agents reported on hardwoods, and various pine beetles caused the most frequently observed damage on conifers in pine plantations.

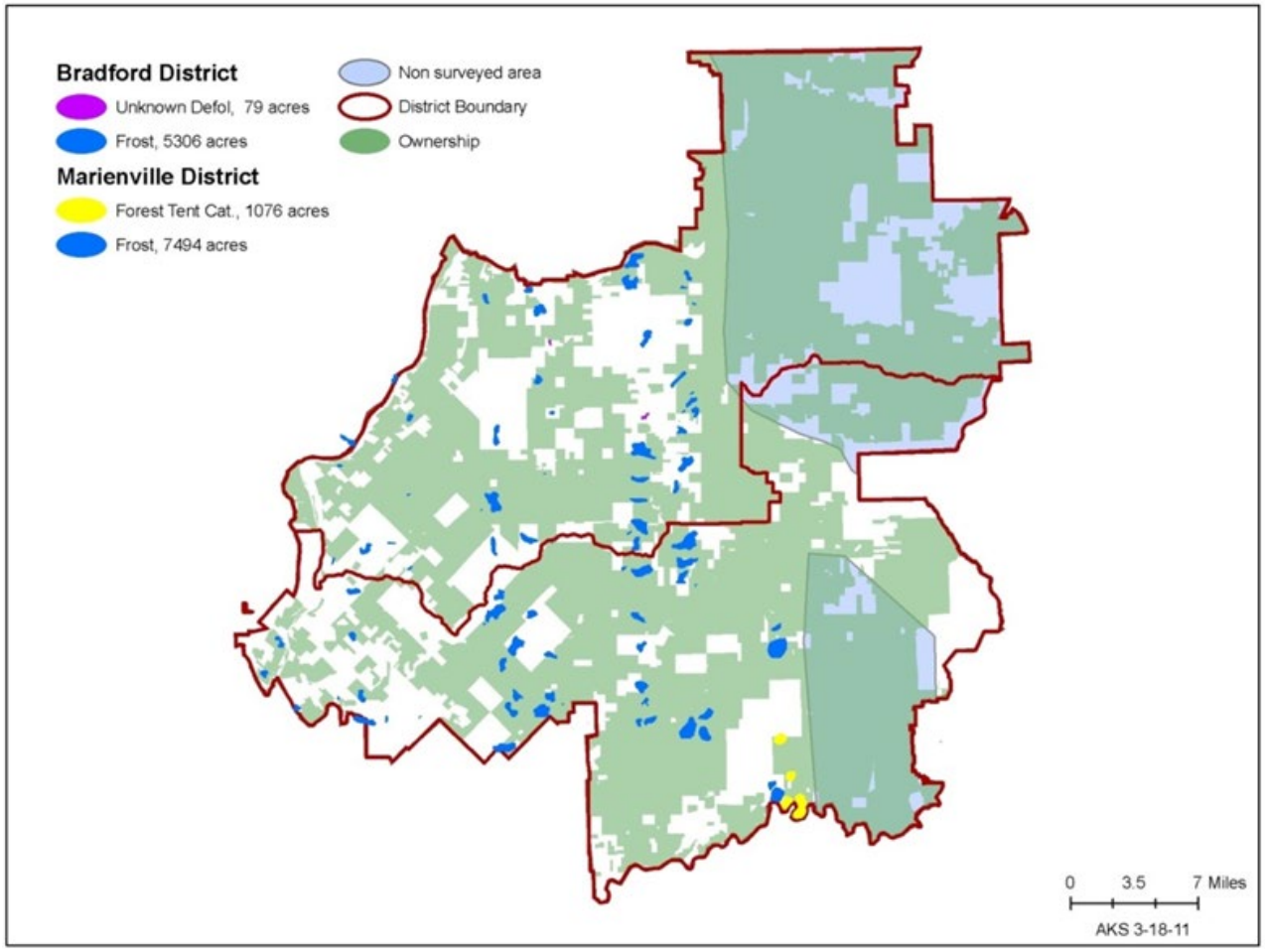


Figure 17. Map of FY 2010 Forest Health Monitoring aerial survey results

FY 2011 – The July 2011 aerial surveillance flight detected a noticeably decreased amount of visible damage within the proclamation boundary of the ANF (Figure 18), with a total of 4,348 acres, a decline from 13,955 acres observed during the 2010 flight. This reduction is primarily due to less observed damage from frost and FTC damage. Ground-truthing surveys revealed that a number of different agents and defoliators were active on a variety of hardwoods and conifers. The most commonly reported hardwood damage agents were caused by unknown defoliators. Toward the end of the growing season, based on field reports and the phone calls received by the ANF, the defoliation was likely a result of complex of native defoliators, of which the fall webworm was the most commonly reported. Native defoliation was observed on both Ranger Districts, with 1,994 acres observed on the Bradford Ranger District and 382 acres on the Marienville Ranger District. The FTC was active in 2011, defoliating 1,110 acres across the Forest. In addition, 962 acres of oak and maple anthracnose were observed on the Marienville Ranger District.

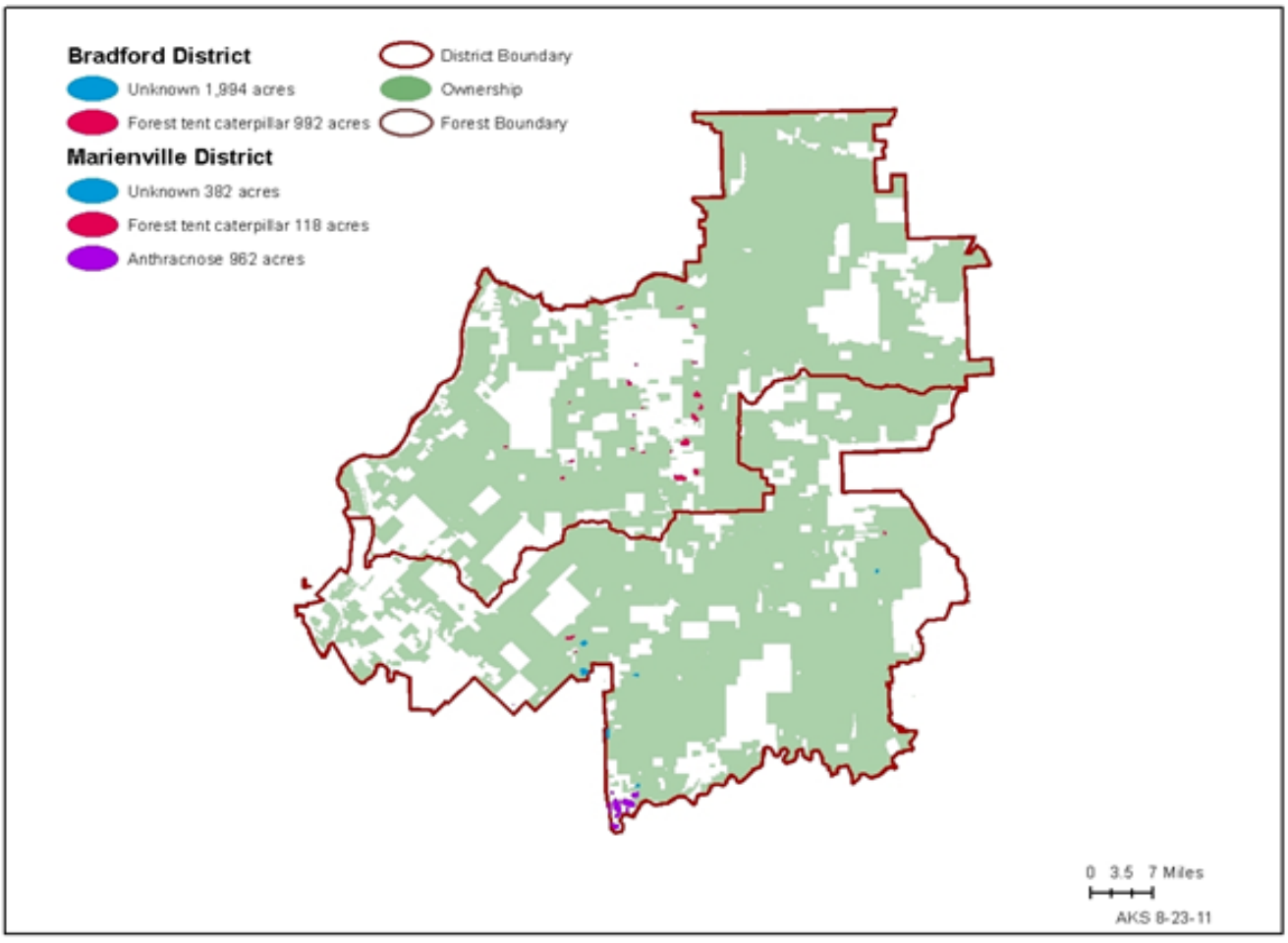


Figure 18. Map of FY 2011 Forest Health Monitoring aerial survey results

FY 2012 – The July 2012 aerial surveillance flight identified 1,574 acres of visible damage within the Forest's proclamation boundary, a decline from the previous year that observed 4,348 acres of damage (Figure 19). The reduction during this year was primarily due to less observed damage from anthracnose and native defoliator damage. Drought stress, mortality and some gypsy moth activity were also reported on both Ranger Districts.

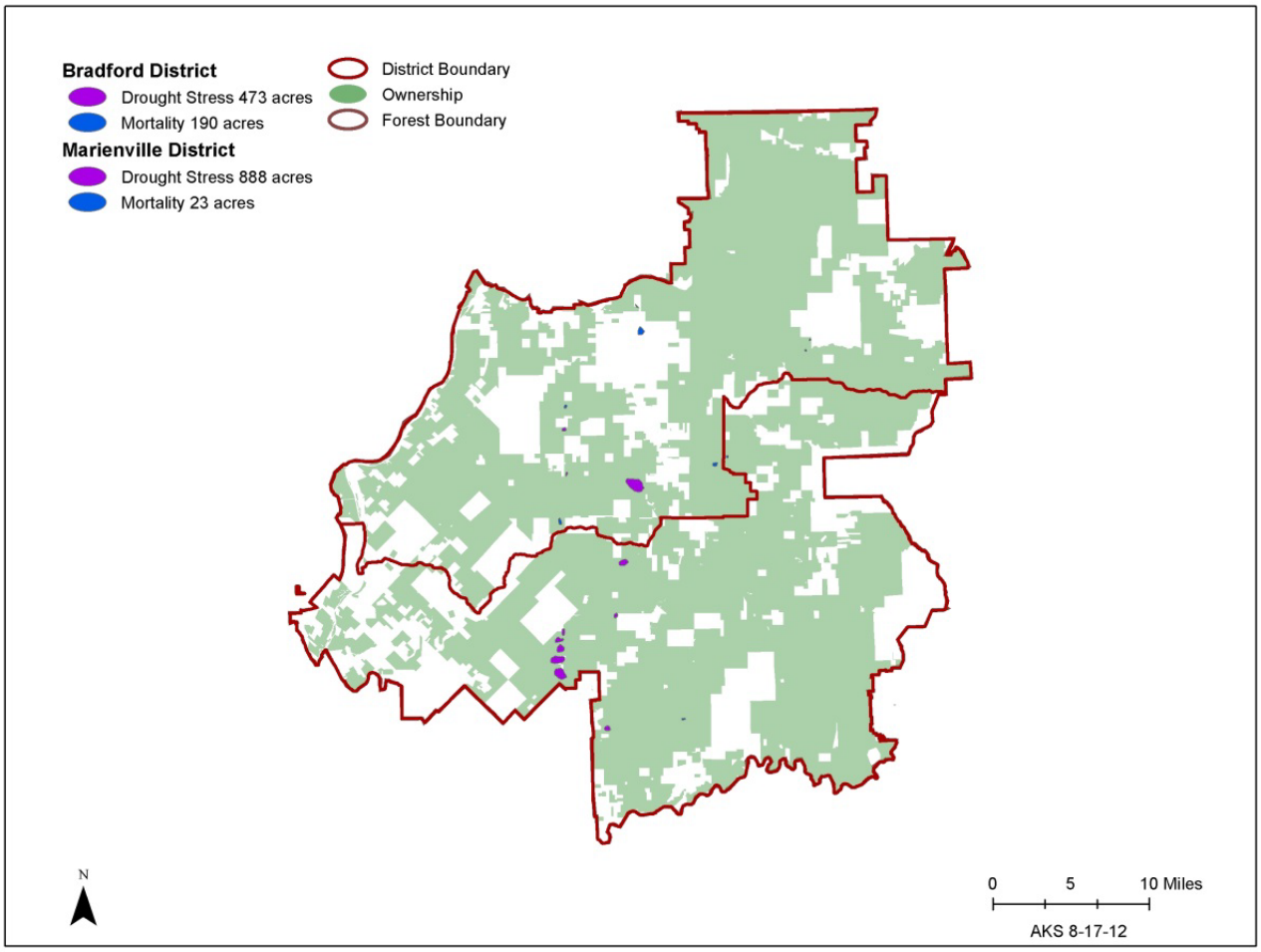


Figure 19. Map of FY 2012 Forest Health Monitoring aerial survey results

FY 2013 – Observations made during the July 2013 aerial surveillance flight identified conditions that departed considerably from previous year observations. A total of 77,351 acres of visible damage was mapped during the aerial surveillance flight within the Forest's proclamation boundary, predominantly from gypsy moth defoliation (Figure 20, State data). Monitoring of the MODIS satellite data showed that peak disturbance occurred between June 10 and 25. During this time, approximately 189,994 acres of detectable departure from the 3-year historical baseline was identified (Figure 20, FDM data). ANF staff members conducting field work reported high levels of gypsy moth defoliation across the Forest, with complete defoliation identified in areas around the Allegheny Reservoir and Kinzua Dam. The majority of defoliated areas fell within areas that are not actively managed on the ANF and are dominated by oak species. Despite the high level of defoliation, by mid- to late- summer an almost complete recovery of the canopies was observed in most areas.

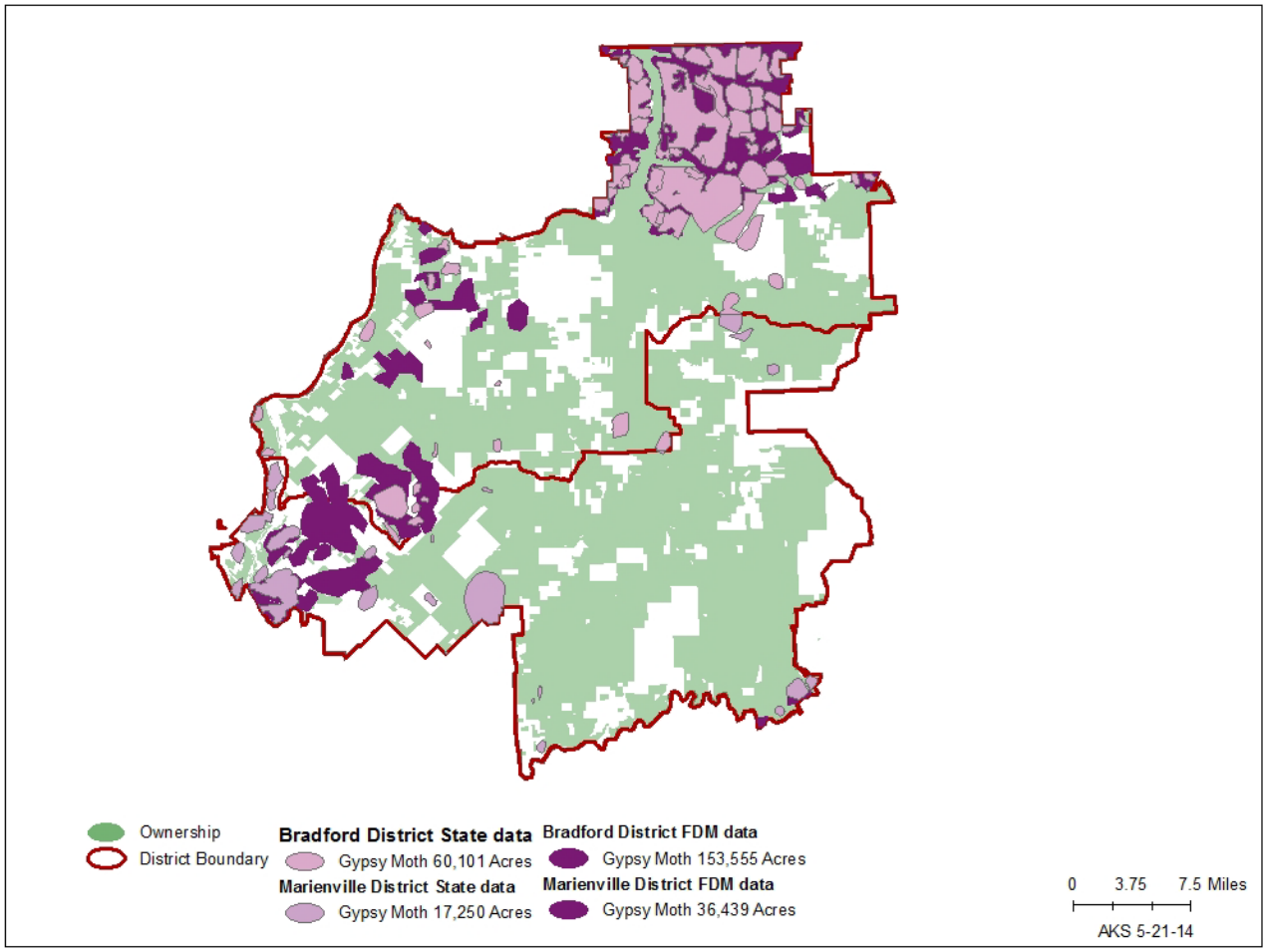


Figure 20. Map of FY 2013 Forest Health Monitoring aerial survey results and Forest Disturbance Mapper results

FY 2014 – Aerial surveillance flights observed a total of 4,507 acres with visible damage within the proclamation boundary of the ANF in 2014 (Figure 21). Ground-truthing surveys revealed that a number of different agents and defoliators were active on a variety of hardwoods and conifers. The most commonly reported agent on hardwoods was leaf anthracnose. Cherry scallop shell moth (CSSM) caused detectable defoliation on the Bradford Ranger District.

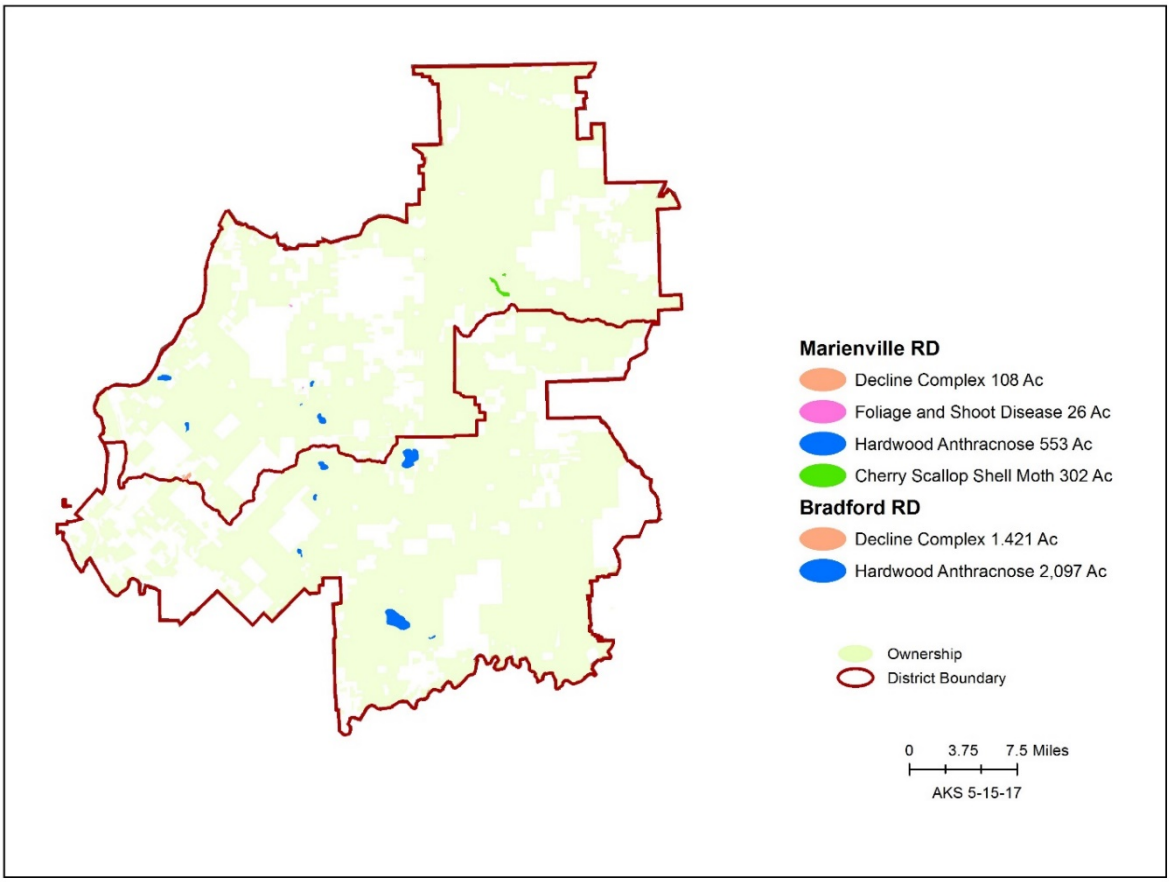


Figure 21. Map of FY 2014 Forest Health Monitoring aerial survey results

FY 2015 – A total of 56,655 acres of detectable damage occurred within the proclamation boundary of the ANF in 2015 (Figure 22). This was a significant increase from the 4,501 acres of damage observed during 2014 surveillance. This increase was due primarily to an increase in observed damage caused by CSSM defoliation. There was also an increase in BBD occurrence. A number of different agents and defoliators were active on a variety of hardwoods and conifers.

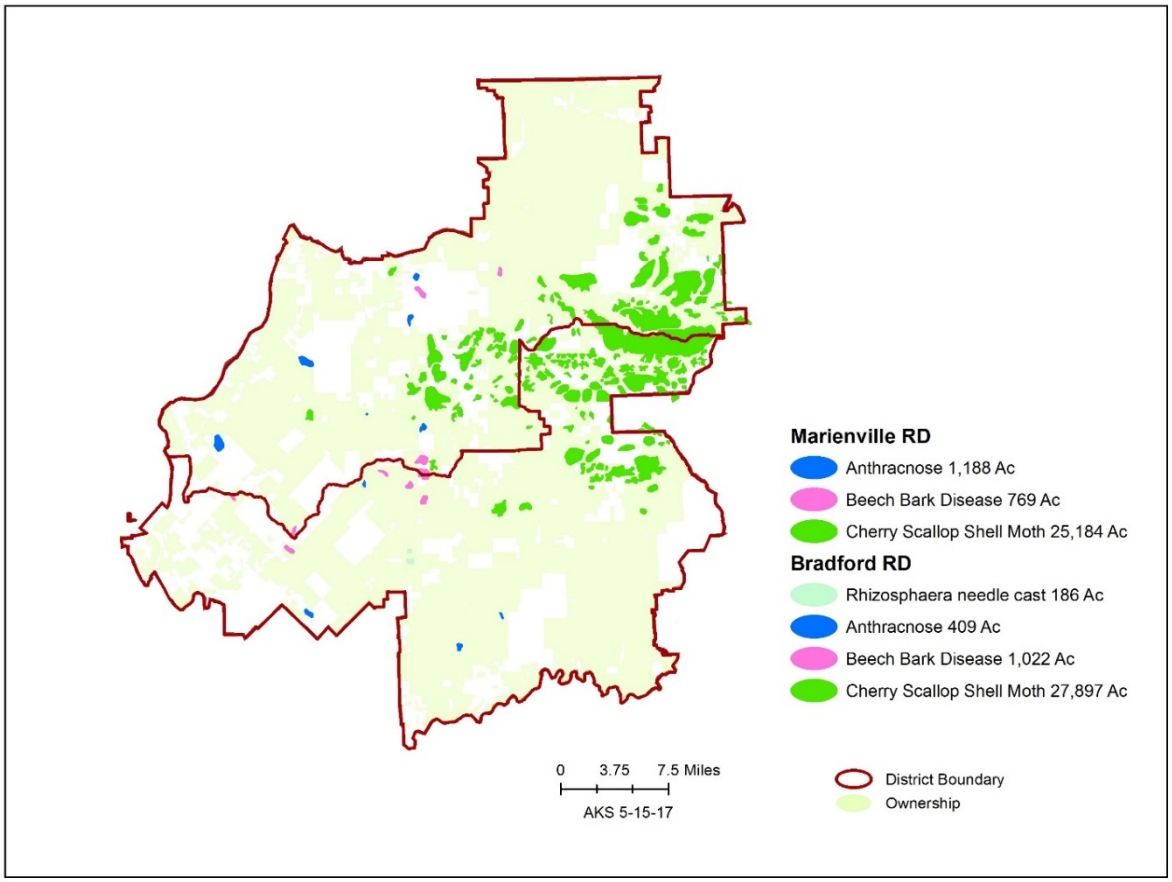


Figure 22. Map of FY 2015 Forest Health Monitoring aerial survey results

FY 2016 – There was a slight reduction in the amount of detectable damage within detected the proclamation boundary of the ANF in 2016. A total of 50,863 acres of visible tree damage was mapped, down from the 56,665 acres observed during the 2015 survey (Figure 23). CSSM was the primary disturbance mapped. There was a reduction of 3,326 acres of detectable CSSM damage and a shift to the south. Pine needle rust was the primary damage causing agent within the pine stands.

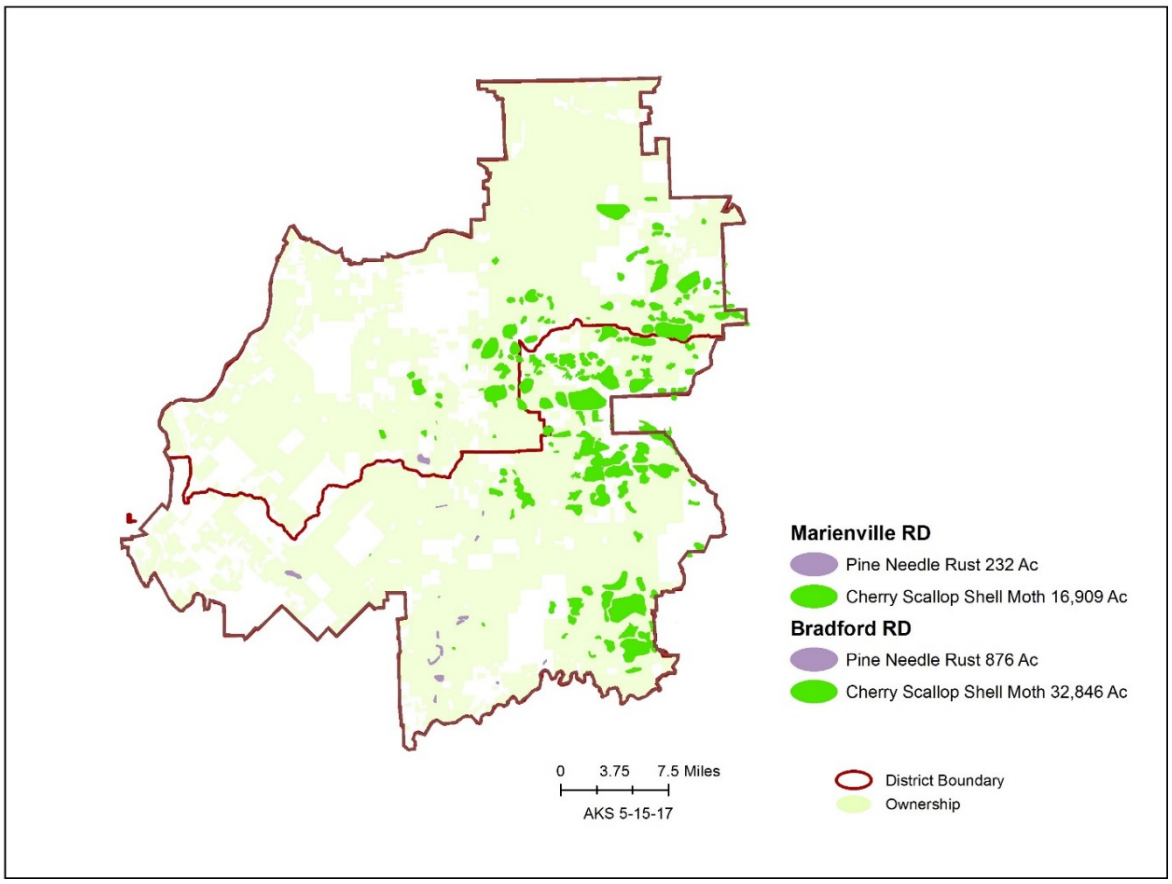


Figure 23. Map of FY 2016 Forest Health Monitoring aerial survey results

Native insects

Native insects and diseases (e.g., CSSM, FTC, pine budworm, oak leaf tier, elm spanworm, fall webworm, anthracnose and bark and ambrosial beetles) have caused defoliation, discoloration, dieback and mortality during the past 20 years on the Forest, and throughout Pennsylvania in combination with overstocking and competition among trees.

Conifer decline and mortality – No new information since the last evaluation period.

In FY 2008, 831 acres of conifer mortality was mapped. Most of this mortality was observed in pine plantations and was likely due to overstocking and competition among trees, combined with beetle infestations. In FY 2009, 850 acres of conifer mortality and decline was mapped on the

ANF, virtually unchanged from 2008 observations. Most of this mortality was observed in pine plantations and was likely due to overstocking and competition among trees, combined with beetle infestations. Management to reduce stocking and competition would improve overall stand vigor and health in these areas.

Cherry scallop shell moth (*Hydria prunivorata*) – CSSM is a mid-season defoliator that predominantly affects black cherry trees. Historically, CSSM has caused substantial defoliation approximately every ten years. The last substantial defoliation occurred in 1996, and the current outbreak is on its fourth year. Outbreaks typically last for three to four years and begin to decline when the egg parasite wasp (*Telenomus sp.)* populations increase to adequate levels to control the CSSM population.

Fall webworm (*Hyphantria cunea*) – No new information since the last evaluation period.

The fall webworm (FWW) feeds on a wide variety of hosts including: hickory, walnut, maple, elm, and cherry. Damage from the FWW occurs late in the year and is usually cosmetic. As such, treatment is usually not necessary.

The ANF experienced an outbreak of FWW in the late summer of 2011 and 2012. Black cherry trees were the primary species affected by this outbreak (Figure 24).

Figure 24. Fall webworm defoliation of black cherry

Data from MODIS and the Eastern Forest Environmental Threat Assessment Center (EFETAC) indicated that a total of 22,162 acres were affected by FWW, with 16,268 acres of light, 4,872 of moderate, and 1,022 acres of severe change in the NDVI during August and September 2011 (Figure 25). Because the FWW is a late-season defoliator and outbreaks typically last one to two years, it is not normally considered a forest pest or an agent of high tree mortality. However, trees that experience high defoliation from it are more likely to suffer reduced growth and branch dieback. No FWW control measures were undertaken on the Forest, although the FWW

population was not expected to decline in 2012, especially in the newly infested areas. During the 2011 outbreak, it was recognized that it would take several seasons for the population of FWW's natural predators to increase to a level at which the FWW population could be controlled.

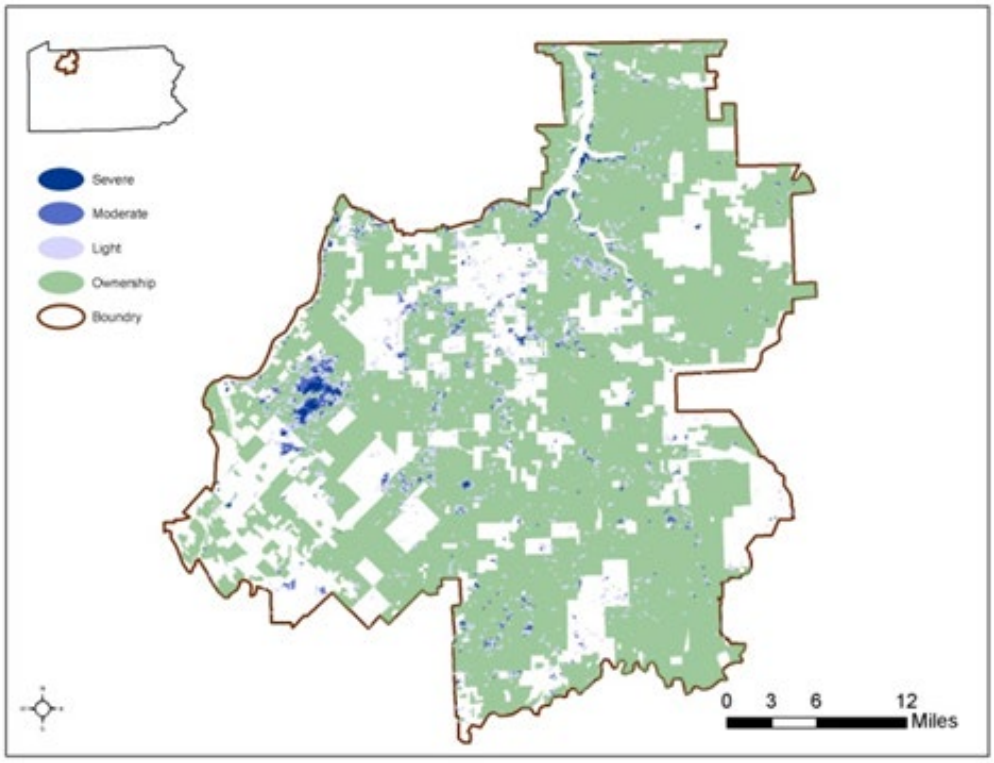


Figure 25. Map illustrating forest disturbance on the ANF as indicated by the Forest Disturbance Mapper change assessment for September 29, 2011

A second year of FWW outbreak was experienced on the ANF in late summer of 2012, and black cherry remained the species that was primarily affected. Data from MODIS and EFETAC indicated that a total of 20,572 acres were affected by FWW in 2012, with 14,942 acres of light, 3,374 of moderate, and 2,256 acres of severe change in the NDVI (Figure 26). As in 2011, no FWW control measures were undertaken on the ANF.

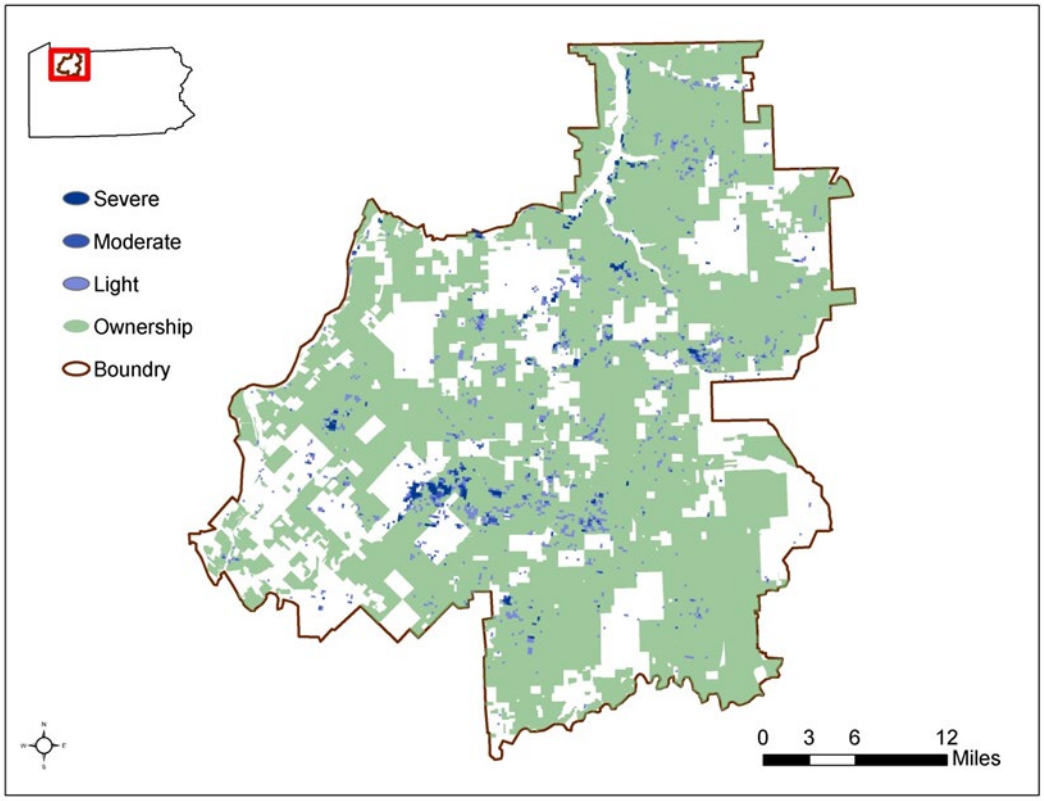


Figure 26. Map illustrating the forest disturbance on the ANF as indicated by the Forest Disturbance Mapper change assessment for September 22, 2012

No late season FWW defoliation outbreaks were observed in 2013. As a result, it was concluded that FWW populations had returned to pre-outbreak levels.

As a consequence of the defoliation of black cherry on the ANF in 2011 and 2012, the ANF initiated an assessment of black cherry crown health in 2014. In the past 10 years, black cherry on parts of the ANF has suffered from crown injury and mortality caused by high wind events in July 2003, July 2004, and more recently in July 2012. Foresters have also reportd sporadic seed production and poor seedling establishment and growth during the last decade. The purpose of this assessment is to evaluate the impact of multiple stressors including fall webworm defoliations and windstorm damage by following the trajectory of black cherry crown health over three years using a network of FHM plots on the ANF, and to assess seed production and seedling regeneration on associated plots.

Forest tent caterpillar (*Malacosoma disstria)* – No new information since the last evaluation period.

The FTC primarily attacks sugar maple, oak, poplar and other deciduous hardwoods. FTC populations have caused extensive defoliation throughout Pennsylvania since 2006. Region-wide outbreaks of it have been documented since colonial times and can last from six to 16 years in the northeast. Low winter temperatures and predation by the pupal parasitoid *Sarcophaga aldrichi* and a larval pathogen, *Furia gastopachae*, usually combine to reduce populations.

The FTC reached outbreak levels between 2007 and 2009 in the northern tier counties of Pennsylvania east of the ANF in Potter and McKean Counties. In 2009, over 370,000 acres of Pennsylvania was defoliated, two-thirds of which was characterized by heavy defoliation (PA DCNR-BOF 2009).

The FTC again reached outbreak levels 2010 in the north central counties of Pennsylvania, with over 520,000 acres of defoliation being observed in Potter, Tioga, Clinton and Lycoming Counties (PA DCNR-BOF 2010). By 2011, FTC populations had declined statewide, though over 25,000 acres with tree mortality in north central counties was attributed to 2007-2010 FTC defoliation (PA DCNR-BOF 2011).

The FTC was active on the ANF in 2010 and 2011, with over 1,000 acres of defoliation detected during aerial surveillance flights both years. No FTC damage was detected in 2012 or 2013 on the ANF.

Exotic insects

Gypsy moth (*Lymantria dispar*) – The gypsy moth was introduced into the United States from France in 1869 (USDA-FS 2007b, pp. 3-96 and 3-97), and has been present on the ANF since the early 1980s. Populations have been kept in check in recent years by a nuclear polyhedrosis virus (*Nucleopolyhedrosis* virus) and a fungus (*Entomophaga maimaiga*). The fungus requires high spring humidity and moderate temperatures to germinate and spread and it appears that moist spring conditions favor fungal and viral gypsy moth controls on the ANF.

With the exception of a very small amount of light defoliation in 1999 and 2003 and widespread defoliation in 2013, no measurable gypsy moth defoliation was detected on the ANF between 1993 and 2016. While gypsy moth defoliation increased in central and eastern Pennsylvania in 2008 (766,507 acres of moderate to severe defoliation), 2014 (214,972 acres of moderate to severe defoliation), and 2015 (691,881 acres of moderate to severe defoliation), no defoliation was detected on the ANF (Pennsylvania Forest Health Highlights 2008, 2014 and 2015, https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml). In early 2009 and 2016, gypsy moth spray programs were initiated in these areas treating 177,688 acres and 135,898 acres, respectively, significantly reducing the defoliation levels during those years.

It was projected that gypsy moth populations would increase in 2013 across the state and in Clarion, Forest, Jefferson, McKean, Potter Tioga and Venango Counties (DCNR-BOF 2012). During the spring of 2013, the ANF experienced an outbreak of the gypsy moth causing widespread defoliation in June, predominantly around the Allegheny Reservoir. Data from the FDM identified nearly 190,000 acres of detectable change within the ANF proclamation boundary at that time. Field personnel later reported that previously defoliated areas were undergoing widespread re-foliation by mid-July.

Several nearby landowners, including New York Office of Parks, Recreation, and Historic Preservation (Allegany State Park), PA DCNR-BOF, and the U.S. Army Corps of Engineers (USACE) treated for gypsy moth in 2013.

In an effort to estimate gypsy moth population densities and to assess the need for treatments in FY 2014, gypsy moth egg mass surveys were conducted in 35 locations on 190 plots over 7,859 acres across the Forest during the fall of 2013 (Figure 27). Average egg mass densities ranged from 0 (less than 250 egg masses per acre-densities sufficient to predict background or only nuisance levels of gypsy moth defoliation) to 1,020 masses per acre, which indicated that the population had greatly declined over the summer season likely due to viral and fungal infections. In addition, extensive larval mortality was noted in almost all of the surveyed areas, suggesting that natural agents such as viral and fungal infections were effectively controlling the population. Overall, low levels of gypsy moth defoliation are predicted for the ANF in FY 2014, with the exception of Cornplanter Bay, Hodge Bay, and Hopewell Campground. These locations contained egg mass densities sufficient to predict localized, moderate to heavy defoliation in FY 2014. Aerial surveillance in 2014 resulted in no noticeable gypsy moth defoliation mapped (Figure 21), indicating gypsy moth populations had returned to pre-outbreak levels.

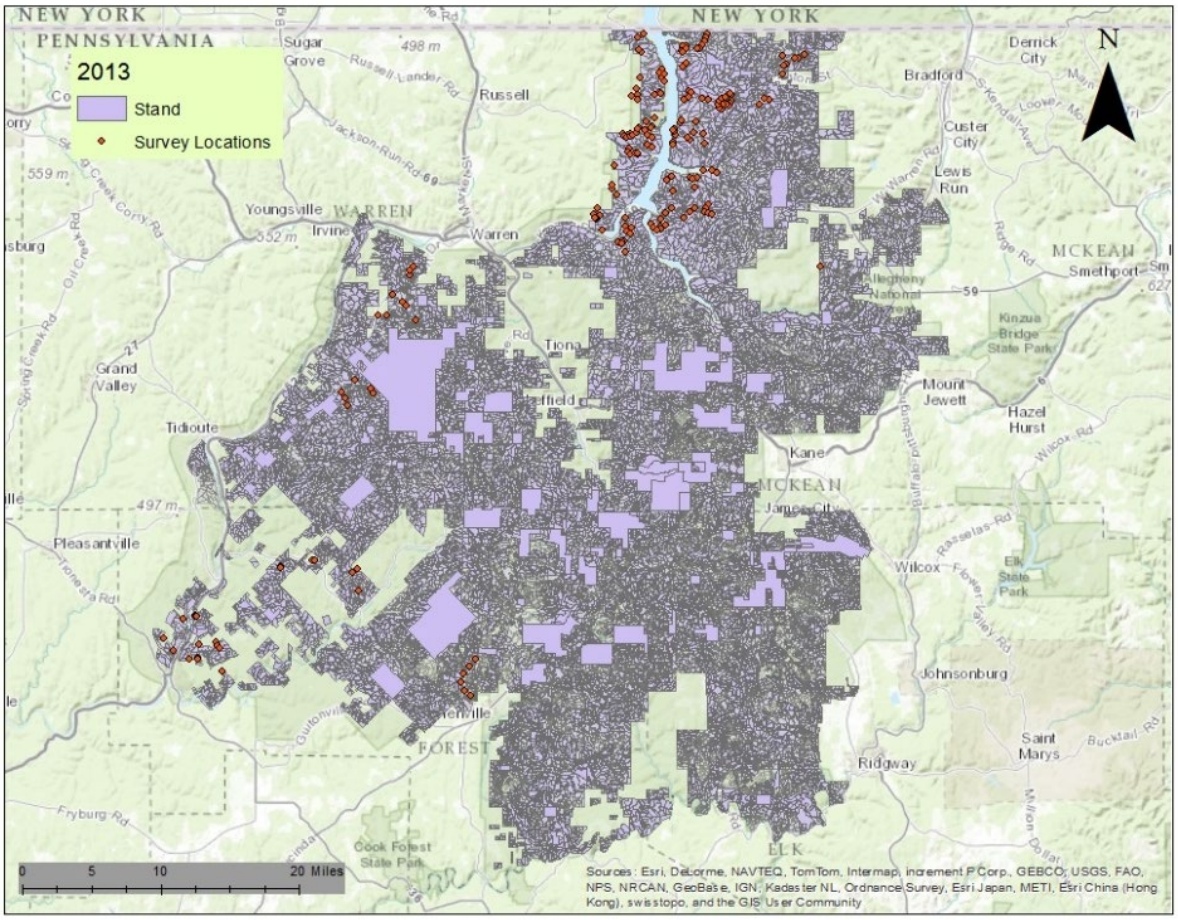


Figure 27. Map of areas surveyed for gypsy moth egg masses on the ANF in the fall of 2013

Oak species comprise approximately 9 percent of the ANF's basal area and are concentrated along major drainages across the Forest. The recurrence of destructive gypsy moth outbreaks throughout the Forest has the potential to cause additional mortality of oak species on the ANF. There is likelihood for gypsy moth populations to build up again to a level that will require

treatment in the future. Oak decline and oak wilt are other serious threats to the health of oaks on the ANF. The National Insect and Disease Risk Assessment (Krist Jr. et al. 2014) predicts the ANF could lose 18% of the oak basal area over the next 15 years.

Asian longhorned beetle (*Anoplophora glabripennis*) – No new information since the last evaluation period.

The Asian longhorned beetle (ALB) is an introduced pest that originated in China. ALB is a wood borer that infests a range of host trees including maples, birches, and elms (Figure 28).

Figure 28. Asian longhorned beetle (from Dean Morewood, Health Canada, Bugwood.org)

It was first discovered in the United States in 1996 in Brooklyn, NY. Since then, additional populations have been found in New York, New Jersey, Illinois, and Massachusetts, and Ohio where eradication efforts are ongoing. In August of 2008, the ALB was identified in Worcester, Massachusetts far outside the range of any previously known populations. This population is believed to be eight to 10 years old, and efforts to eradicate it have resulted in the destruction or treatment of nearly 35,000 infested or high-risk trees within a 74-square mile quarantine area. In June of 2011, the ALB was discovered in Clermont County, Ohio. Efforts to eradicate it have resulted in the destruction or treatment of nearly 35,000 infested or high-risk trees within a 61-square mile quarantine area.

Surveys for ALB have occurred in Pennsylvania since 2005. However, ALB has not yet been detected on the ANF, or in Pennsylvania.

Emerald ash borer (*Agrilus planipennis*) – Emerald ash borer (EAB) is an exotic beetle (USDA-FS 2007b, p. 3-104) native to Asia (China, Japan, Korea, Mongolia, and the Russian Far East) that attacks all species of ash trees. EAB is identified by its oblong, metallic green body that is about half an inch long (Figure 29). It is primarily spread by humans through movement of untreated wood infested with EAB (such as firewood) into un-infested areas. Since 2002, it has caused the mortality of an estimated 50 million ash trees. Currently, there are no effective landscape scale treatment options for EAB.

Figure 29. Emerald ash borer (from David Cappaert, Michigan State University, Bugwood.org)

Since its detection in 2002 in Detroit, Michigan, EAB has spread to 21 eastern and Midwestern states, and Ontario, Canada (Figure 30). In 2007, it was detected for the first time in Pennsylvania in Butler and Allegheny Counties. Between 2007 and 2016, the PDA increased EAB survey intensity across the state.

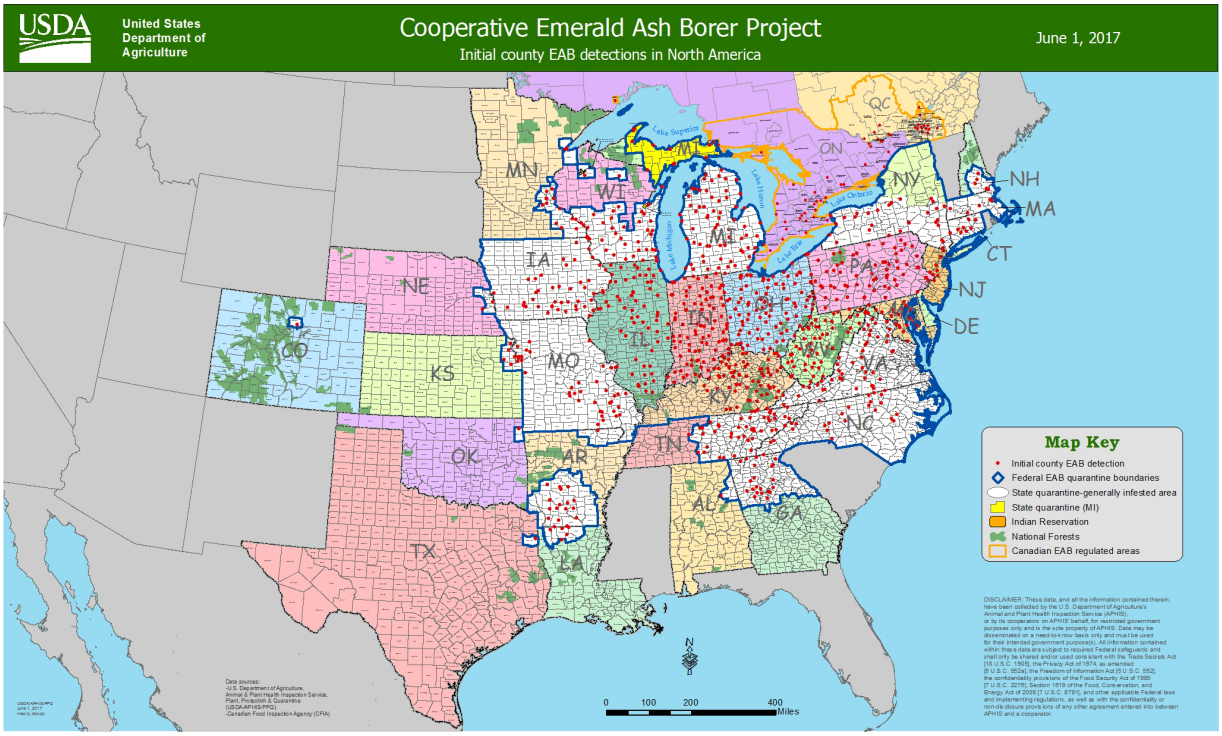


Figure 30. Emerald ash borer distribution as of June 2017

In 2008, two levels of survey were used in Pennsylvania to try and detect EAB. One was a delimiting survey using a 1.5 x 1.5-mile grid (1 trap/grid) in areas within 100 miles of the quarantined counties and the other was a detection survey outside the generally infested counties. Both surveys were used to determine whether additional infestations were present. In total, 8,000 purple prism traps (Figure 31) baited with manuka oil were deployed within the state across 35 counties. Mercer County, Pennsylvania had the only new population detected by these surveys, and was added to the Pennsylvania EAB Quarantine at that time. Since then, 18 new counties have been infested in Pennsylvania. Warren, Forest and Elk Counties were infested in 2013 and McKean County was infested in 2015.

Figure 31. Emerald ash borer prism trap

As part of the state-wide 2008 EAB delimiting survey, 924 prism traps were placed within the ANF proclamation boundary; 594 of these were placed on ANF lands. Additionally, FHP personnel placed prism traps at 11 locations on the ANF, focusing trapping efforts around high use recreation areas with ash trees present. Visual and sweep net surveys were periodically conducted in conjunction with the prism trapping efforts. No EAB detections were made in the immediate ANF area (Warren, Elk, Forest, and McKean Counties).

In 2009, PDA survey crews placed panel traps baited with manuka and phoebe oil on a 1.5-mile grid in 15 western counties, including Warren and Forest Counties. In the remainder of the state, including McKean and Elk Counties, surveys focused on high-risk areas such as campgrounds, industrial areas, highways and private lands. No EAB detections were made in the immediate ANF area (Warren, Elk, Forest, and McKean Counties).

Prior to 2013, the closest identified EAB population was detected in 2009 in Randolph, Cattaraugus County New York, approximately 11.5 air miles north of the ANF. In June 2013, EAB was detected near the Clarion River on the ANF. EAB was also detected in Warren and Forest Counties in 2013, on private lands within the ANF proclamation boundary.

County by county quarantines on the movement of ash nursery stock, green lumber and any other ash material, including logs, stumps, roots and branches, and all wood chips were implemented by PDA between 2007 and 2010. By the end of 2010, the PDA had imposed quarantines on 42 Pennsylvania counties to slow the spread of EAB. Due to the number of EAB detections in Pennsylvania and adjacent counties in neighboring states, in April of 2011 the internal state quarantine restricting the movement of ash within Pennsylvania was rescinded.

In addition, PDA has quarantined the movement of any firewood of any species into the state of Pennsylvania from any other state since 2007. Ohio, West Virginia and New York also have quarantines on the movement of any firewood of any species into any of these states.

In order to prevent movement of infested firewood to the ANF, a firewood closure order has been in effect since July 2007. Periodic surveys of campers were conducted in 2007 and 2008 to ascertain the origin of firewood brought to the ANF, as well as educate visitors about the importance of not moving firewood. In 2007, the year EAB was discovered in Pennsylvania, 51% of firewood brought to the ANF originated from quarantined counties in Pennsylvania or from out of State. With effective public education, this figure was reduced to 25% in 2008. Surveys indicated that 93% of campers use firewood during their stay. A quick survey conducted in five ANF developed campgrounds on July 6, 2009 revealed:

- Approximately 60% of campers interviewed were familiar with EAB,
- All but one individual were aware of the ANF firewood restriction, and
- Over half of the visitors were from Elk, Forest, McKean or Warren Counties.

The reduction in firewood movement into the ANF is likely due to widespread public education efforts by a number of federal and state agencies (Figure 32). The ANF developed an EAB communication plan, which is periodically reviewed and updated. State personnel also increased their public education and outreach efforts within Pennsylvania.

Figure 32. Firewood alert sign with an EAB survey panel trap in the background

During the summers of 2011 and 2012 the Forest Service TEAMS Enterprise Unit and ANF personnel conducted a survey of prioritized recreation areas and other high value stands on the ANF. The purpose of this project was to: 1) identify stands that are susceptible and vulnerable to

EAB, 2) inventory these stands, and 3) prioritize stands for monitoring and ash management. More than 1,500 acres within and around recreation areas on the ANF were surveyed in this project (Figure 33).

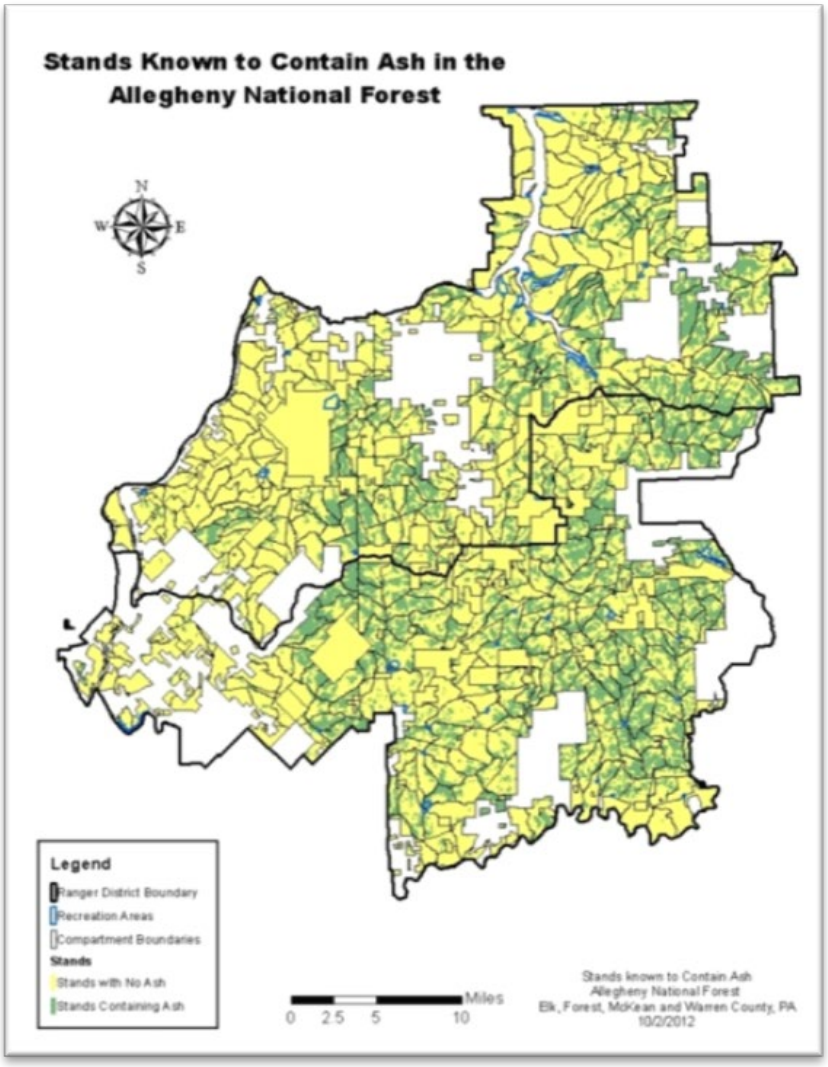


Figure 33. Stands known to contain ash on the ANF

Recreation areas are the most visited areas of the Forest, but many have never had the trees and vegetation inventoried. With forest health issues such as EAB and hemlock woolly adelgid (HWA) looming it is important to have inventory and tree data regarding these recreational areas because these areas often serve as pathways for introduction by visitors, and trees in these areas are of high aesthetic value.

In an effort to preserve genetic material (germplasm), ANF personnel collected ash seed in 2011 and 2013 for long-term storage at national and regional seed repositories. Ash species comprise approximately 2.5% of the overall basal area across the ANF. Substantial ash mortality is likely to occur over the next 10 years, posing risk to forest health and public safety. The National Insect and Disease Forest Risk Assessment (Krist Jr. et al. 2014) predicts the ANF could lose

29% of the ash basal area in the next 15 years. In total, near 100% loss of ash basal area is anticipated on the Forest.

Chemical (insecticide) stem injection of emamectin benzoate to 539 ash trees across the ANF was completed in 2015 in order to conserve ash genetic material (germplasm) and seed sources on 27 plots across the ANF. These treatments are part of a research study being conducted in partnership with the USFS Northern Research Station and USFS State and Private Forestry, Forest Health Protection group. Additionally, 131 trees were treated in 12 developed and dispersed high use recreation areas to sustain aesthetic values associated with these trees.

Hemlock woolly adelgid (*Adelges tsugae*) – HWA is a non-native insect native to Asia that has the potential to cause substantial hemlock mortality or decline on the ANF in the future (USDA-FS 2007b, pp. 3-103 and 3-104). HWA is a tiny insect that lays its egg sacs, which look like woolly cotton, on the base of hemlock needles, and because of its small size, the identification of its egg sacs are used to determine its presence in an area (Figure 34). HWA are also unique in that populations consist of females that reproduce asexually. Once a HWA infestation occurs, tree mortality normally occurs within four to seven years after infestation, threatening the unique and valuable ecosystem hemlock provides.

Figure 34. Hemlock woolly adelgid egg sacs on hemlock needles (from Connecticut Agricultural Experiment Station)

HWA was first detected in the northeastern United States near Richmond, Virginia in the early 1950s on exotic tree species that a private collector had planted in his arboretum. HWA was first detected in southeastern Pennsylvania in the late 1960s, and as of 2013 is present in 58 of the 67 counties in Pennsylvania and 18 mid-Atlantic and northeastern states. In 2005, HWA was detected in Elk County at approximately 25 miles from the Forest boundary, the nearest known infestation to the ANF until 2013. The infested trees were destroyed; however, HWA still persists in the area of the initial detection.

Eastern hemlock comprises approximately 10% of the overall basal area on the ANF, occurs across the entire forest and is largely concentrated in ecologically important areas such as riparian zones. The current and continued spread of HWA is devastating this species with unique ecosystem values in the eastern United States, and high levels of hemlock mortality are anticipated in the coming decades. The National Insect and Disease Forest Risk Assessment (Krist Jr. et al. 2014) predicts the ANF could lose 31% of the overall eastern hemlock basal area in the next 15 years. The risk model predicts that 26% of eastern hemlock mapped on the ANF will experience a 25% or greater loss of basal area over the next 15 years.

Since 2004, forest personnel have annually surveyed 48 to 104 hemlock stands on the ANF. In 2009, HWA detection surveys were conducted in 70 stands on the ANF. In 2010 efforts to better map hemlock resources were undertaken in an attempt to develop a hemlock risk map for the ANF and better focus survey efforts. In addition, 34 stands were surveyed for HWA. Detection surveys occurred within 35 stands during fiscal year 2011. Thirty-six stands were surveyed for HWA infestations in 2012. No HWA infestations were identified between 2004 and 2012.

In 2013, two workshops were held on hemlock conservation and HWA identification for the general public and interested volunteers. Private citizens contributed a considerable effort to hemlock conservation efforts on the Allegheny Plateau, and citizens and citizen groups adopted 37 areas for HWA monitoring, predominantly on the ANF. An estimated 1,913 acres and 862 hemlocks were surveyed for HWA by volunteers.

In 2013, the first HWA infestation was identified on the ANF, along the Clarion River. Later in 2013, additional HWA infestations were identified in the West Fork area of the Tionesta Research Natural Area, along the Allegheny River and at Webbs Ferry boat launch. In the spring of 2013, infestations were also identified in Cook Forest and Clear Creek State Parks.

Between 2004 and 2013, DCNR-BOF personnel treated over 27,000 individual hemlock trees (nearly 400,000 inches of stem diameter) with individual stem pesticide treatments to reduce impacts from HWA in infested trees and slow HWA spread in the Commonwealth (Marasco and Weiss 2013). Between 2014 and 2016, over 11,650 individual hemlock trees (nearly 198,000 inches of stem diameter) were treated (Pennsylvania Forest Health Highlights 2014, 2015 and 2016, https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml). The DCNR-BOF has also worked on developing an effective biological control for HWA by releasing three species of predatory beetles: *Laricobius nigrinus*, *Sasajiscymnus tsugae,* and most recently *Laricobiu osakensis.* Between 1999 and 2016, over 193,500 of the predatory beetles have been released in Pennsylvania, including in nearby Cook Forest State Park, in order to help control HWA populations.

In order to develop an all-lands, landscape-scale strategy for hemlock conservation, the ANF entered into a collaborative partnership with The Nature Conservancy (TNC) and a number of organizations and landowners across the High Allegheny Plateau in 2012. The purpose of this partnership was to identify high value hemlock areas for long-term conservation, regardless of ownership. Over 50 agencies, companies, organizations, institutions and individuals have collaborated on this effort to conserve hemlock trees on the High Allegheny Plateau (Figure 35).

Three workshops were held in 2012 and 2013 to identify priority hemlock conservation areas across the plateau. These collaborative efforts have identified sixty areas (approximately 174,000 acres) for conservation on the ANF, with 14 of the 60 areas considered highest priority, including six focal areas totaling approximately 47,000 acres (Figure 36).

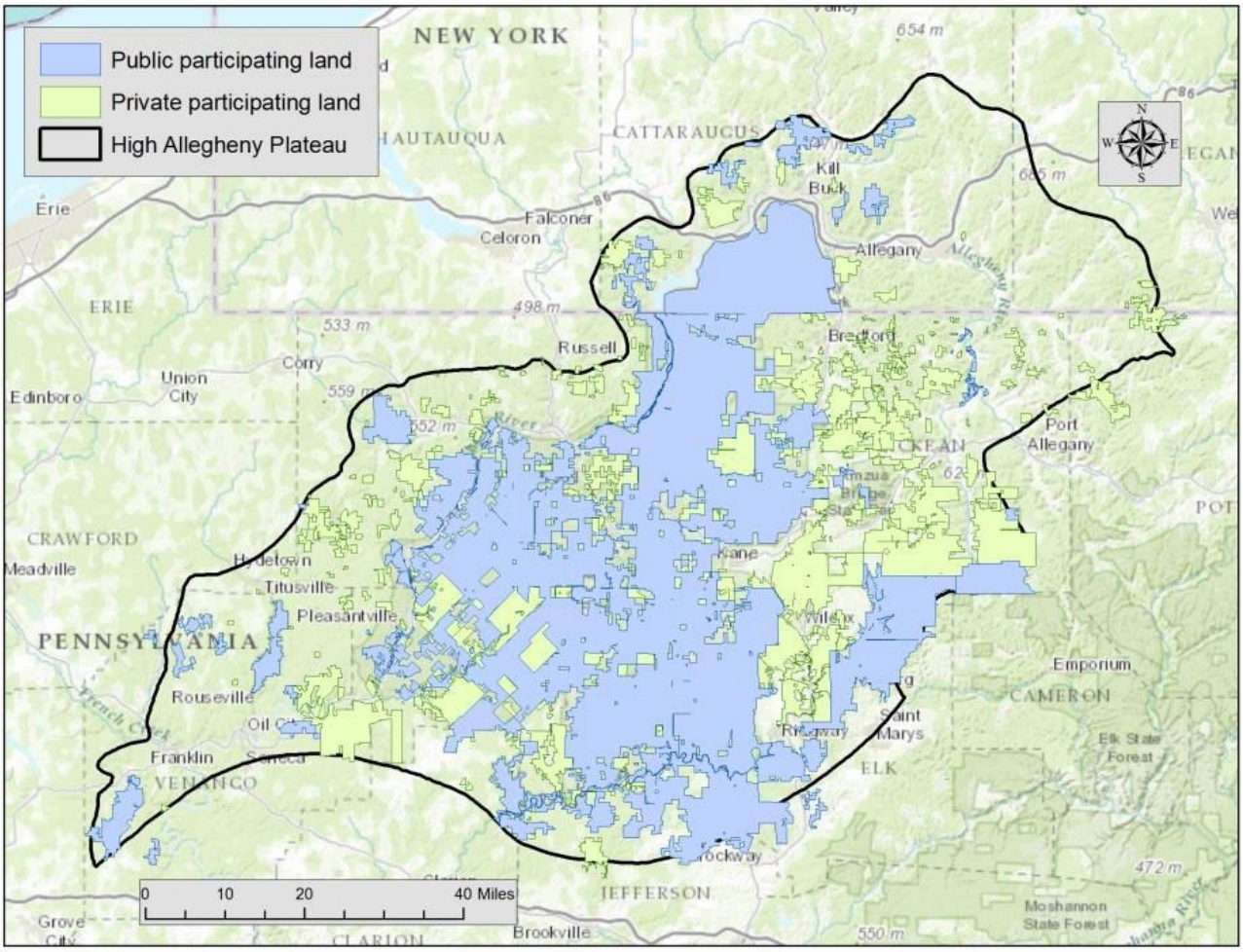


Figure 35. Public and private participating landowners in the High Allegheny Plateau Hemlock Conservation Strategy

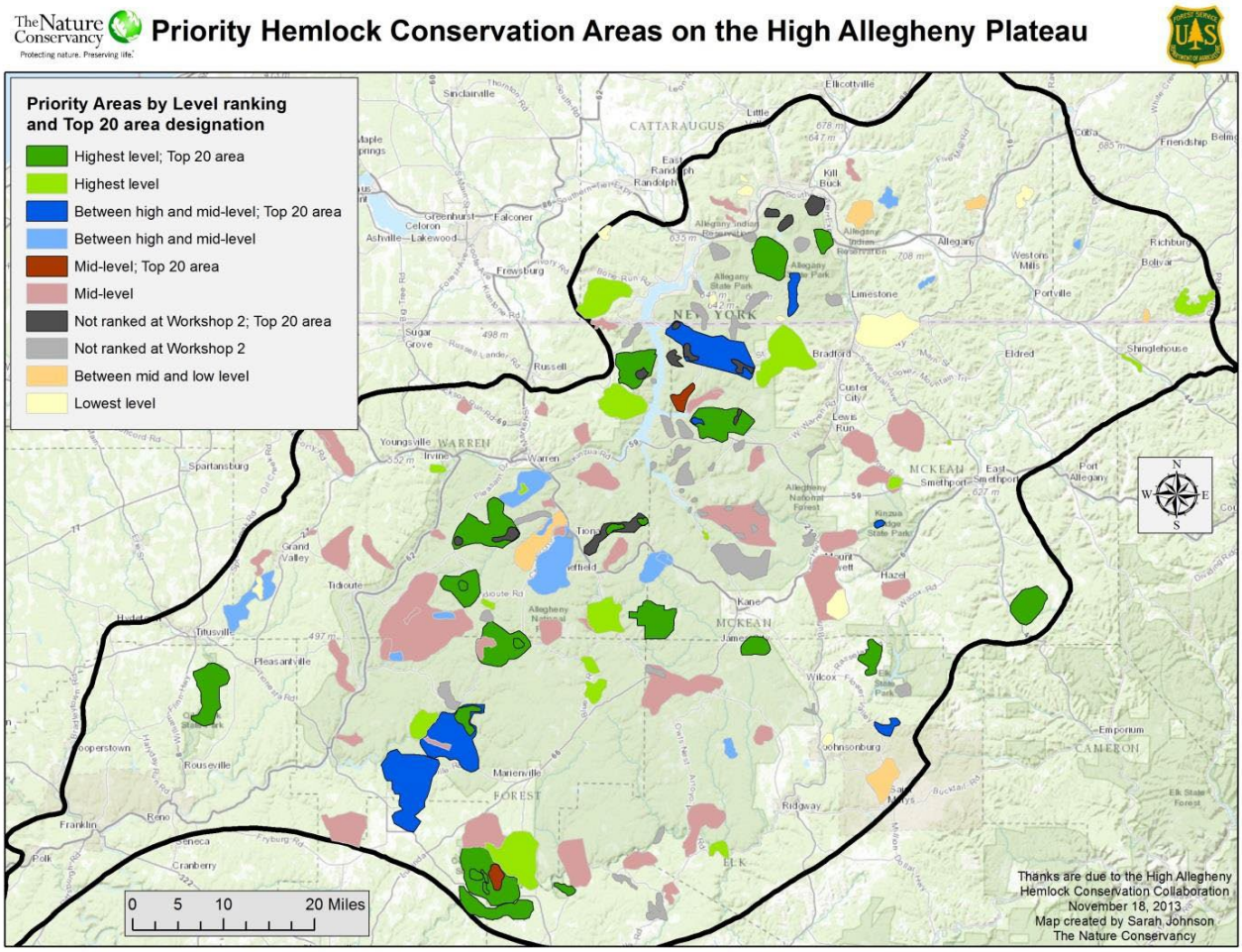


Figure 36. Priority Hemlock Conservation Areas on the High Allegheny Plateau

The products of this collaboration are available on TNC's website:

- *Web Map can be accessed here*: https://tnc.maps.arcgis.com/home/item.html?id=a7dcd307215c4c0fb77ae7c64378d111

- *A Readme document can be accessed through the Description section of the web map home page, or here*: http://tnc.maps.arcgis.com/sharing/rest/content/items/83157150a9224099b0f6599119238d4e/data

Part of the High Allegheny Plateau Hemlock Conservation Strategy has involved consultation with Camcore for genetic conservation of eastern hemlock. The objective of Camcore's hemlock gene conservation project is to maintain, in perpetuity, viable seed reserves and plantations of hemlock that will be available for breeding and restoration efforts once effective HWA management strategies are in place. In October 2013, a local hemlock seed collection workshop was hosted by TNC for collaborators in the hemlock conservation strategy. Robert Jetton of Camcore instructed workshop participants in assessing hemlock seed ripeness and collection

protocols. Seeds from previous collections have been placed into cold storage for long-term preservation at seed repositories in Raleigh, North Carolina (operated by Camcore), and Fort Collins, Colorado (USDA-Agricultural Resource Service-National Germplasm Repository). Plantations have also been established in Brazil (Camcore member Rigesa), Chile (Camcore member Bioforest-Arauco), and the United States.

Chemical (insecticide) soil injections of imdacloprid were used around 828 eastern hemlock trees in 2016 to suppress HWA populations at 4 sites. Three of these sites contained known HWA infestations (Webbs Ferry, Allegheny River and Clarion River locations). One site, Hearts Content Scenic Area, had 448 old growth eastern hemlock treated as a preventative measure to reduce likelihood for HWA infestation within this National Natural Landmark.

Sirex woodwasp (*Sirex noctilio*) – No new information since the last evaluation period.

The introduced sirex woodwasp (SWW) is Eurasian in origin (Europe, Asia and northern Africa). The SWW leaves tell-tale damage such as resin (sap) streaks on infected trees and their attacks suppress and weaken the pine tree (Figure 37). Pine areas that are growing on poor sites that have overstocked conditions and contain overtopped/damaged trees are locations in which tree mortality caused by SWW generally occurs.

Figure 37. Sirex woodwasp damage to stem of a pine tree (Dennis Haugen, Bugwood.org**)**

The SWW was initially discovered in the northeastern United States in New York State in 2004 and in Pennsylvania, Tioga and Bradford Counties, in 2006. By 2007, SWW was identified in numerous counties in northern, central, and western New York, as well as McKean County, Pennsylvania. The McKean County initial detection site was comprised of both adult and larvae in an abandoned Christmas tree plantation of Scots pines near Kane, Pennsylvania. In 2008, it was detected in Potter County in a red pine stand.

The ANF has conducted surveys for the SWW, and there have been no SWW detections on the ANF.

In New York State, SWW has been found colonizing Scots, red, and white pines. In the Southern Hemisphere where it was also inadvertently introduced, the SWW has caused up to 80% tree mortality in exotic pine plantations, most of which contain North American pine species, such as Monterey pine. The SWW has caused severe economic damage where it has been introduced due to extensive tree mortality that infestations have caused. However, many countries have been successful in managing its presence using biological control agents such as a parasitic nematode and hymenopteran parasitoids.

Pine species comprise 3.2% of the overall basal area on the ANF and occur as concentrated plantations, in small groups, or as scattered trees. Pine species on the ANF are threatened by SWW which has been detected on other lands around the ANF. The National Insect and Disease Forest Risk Assessment (Krist Jr. et al. 2014) predicts that the ANF may lose 3% of host species (pines) over the next 15 years.

Native tree diseases

Many native tree diseases are active on the ANF. The majority of them occur at background levels, with the exception of oak, maple, and sycamore anthracnose and leaf spot which can be locally heavy in areas, such as in 2009. These diseases rise and fall based on local environmental conditions and species mix and have been relatively stable across the forest between FY 2008 and FY 2016.

Anthracnose – No new information since the last evaluation period.

Anthracnose is a leaf blight caused by a fungus native to the area. Wet, cool spring weather, such as that experienced in 2009 and 2011 promotes this disease. The severity of the outbreak varies with tree species and ranges from light to complete defoliation which results in reduced growth and the predisposition of affected trees to other stressors. The scorched, blotched, and tattered fungus-infected leaves give trees an unsightly and reddish-brown appearance that is visible from a distance.

Thousand canker disease – No new information since the last evaluation period.

Thousand canker disease (TCD) was detected in Bucks County, Pennsylvania, in August 2011. This disease is caused by the fungus *Geosmithia morbida*. The fungus is vectored by the walnut twig beetle (*Pityophthorus juglandis*) which carries the fungus as it tunnels beneath the bark, causing small cankers to form. Repeated beetle attacks and the formation of multiple cankers disrupt the tree's vascular system, leading to dieback and eventual death of the tree. TCD is a threat to both commercial and wildland walnut (*Juglans*) species, including butternut trees. While it has been known to occur throughout much of the southwestern United States, it has only recently been detected in the eastern United States. The PDA has quarantined the movement of black walnut material from Bucks County.

Exotic tree diseases

Sudden oak death – No new information since the last evaluation period.

Sudden oak death is caused by the plant pathogen *Phytophthora ramorum*. One of the major mechanisms of transmission is rainwater and waterways. The spores usually take advantage of a tree wound to infect a tree. Once infected, trees may display sap bleeding cankers on their trunks, and dieback of the foliage, eventually causing the death of the tree.

To date, no sudden oak death disease has been identified on the ANF.

Chestnut blight – No new information since the last evaluation period.

Chestnut blight is caused by the pathogenic fungus *Cryphonectria parasitica* and was accidentally introduced to North America in the 1900s from Asia. The fungus enters the tree through wounds and grows beneath the bark eventually killing the cambium of the tree resulting in tree mortality. The blight has been present in Pennsylvania and on the ANF since the early 1900s.

The ANF, along with the Eastern Region of the Forest Service, has been a partner in the American Chestnut Foundation's effort to develop a blight-resistant hybrid American chestnut, for eventual restoration purposes. The ANF has plans to plant approximately 600 hybrid American chestnut ("restoration chestnut") seedlings from the American Chestnut Foundation in 2014, as a progeny test of "restoration chestnut" competitiveness and blight resistance in natural settings. Similar progeny test plantings across the eastern United States will inform future restoration efforts for American chestnut.

Butternut canker – No new information since the last evaluation period.

Butternut canker is caused by a fungus (*Sirococcus clavigignenti-juglandacearum*). Its origin is unknown, but it is thought that it originates from Asia. It is now found throughout the United States and Canada.

As with other fungi, it infects trees via wounds or broken branches, after which it germinates and creates cankers on the tree. The cankers eventually girdle the tree, cutting off the movement of nutrients and causing dieback. Trunk cankers eventually kill the tree.

Butternut canker caused mortality of the majority of the ANF's butternut trees in the early to mid-1900s. However, some butternut trees have survived the canker. In 2007, over 250 reported butternut trees were evaluated as part of a special project on the ANF, and 95 of these were found to be free of butternut canker. In 2008, 56 of these apparently healthy butternut trees were genetically tested by Notre Dame University researchers, with 49 of them confirmed to be pure butternut (*Juglans cinerea*). The remaining trees are either Japanese walnut (*Juglans ailantifolia*) or hybrids of the two species.

In February 2009, scion (branch) material was collected from 27 of the healthy, genetically confirmed native butternut trees. The scions were grafted to black walnut root stock. The resulting "ramets" were brought back to the ANF and planted on the Marienville Ranger District in 2012 in order to establish a seed orchard of canker-resistant butternut trees for eventual restoration purposes. The butternut orchard is being maintained and the ANF is continuing efforts to grow and restore this species.

Beech bark disease complex – No new information since the last evaluation period.

The BBD complex is an exotic insect/disease complex that has cause substantial beech mortality on the ANF and in the eastern United States (USDA-FS 2007b, pp. 3-97 – 3-99). Monitoring of the advance of BBD on the ANF began in 1979. A biological evaluation of the BBD complex and integrated pest management guidelines was developed for the ANF in 1990. Annual monitoring reports since the early 1990s for the ANF have reported the impacts and spread of the BBD complex.

The insect component of the complex (a scale) was first detected on the Forest in the early 1980s and is now present throughout the entire Forest. In 2001, the killing front covered 42% of the Forest and it continued to expand southwest through the Marienville Ranger District (Figure 38). As of 2010, the killing front of the disease complex covered the entire ANF.

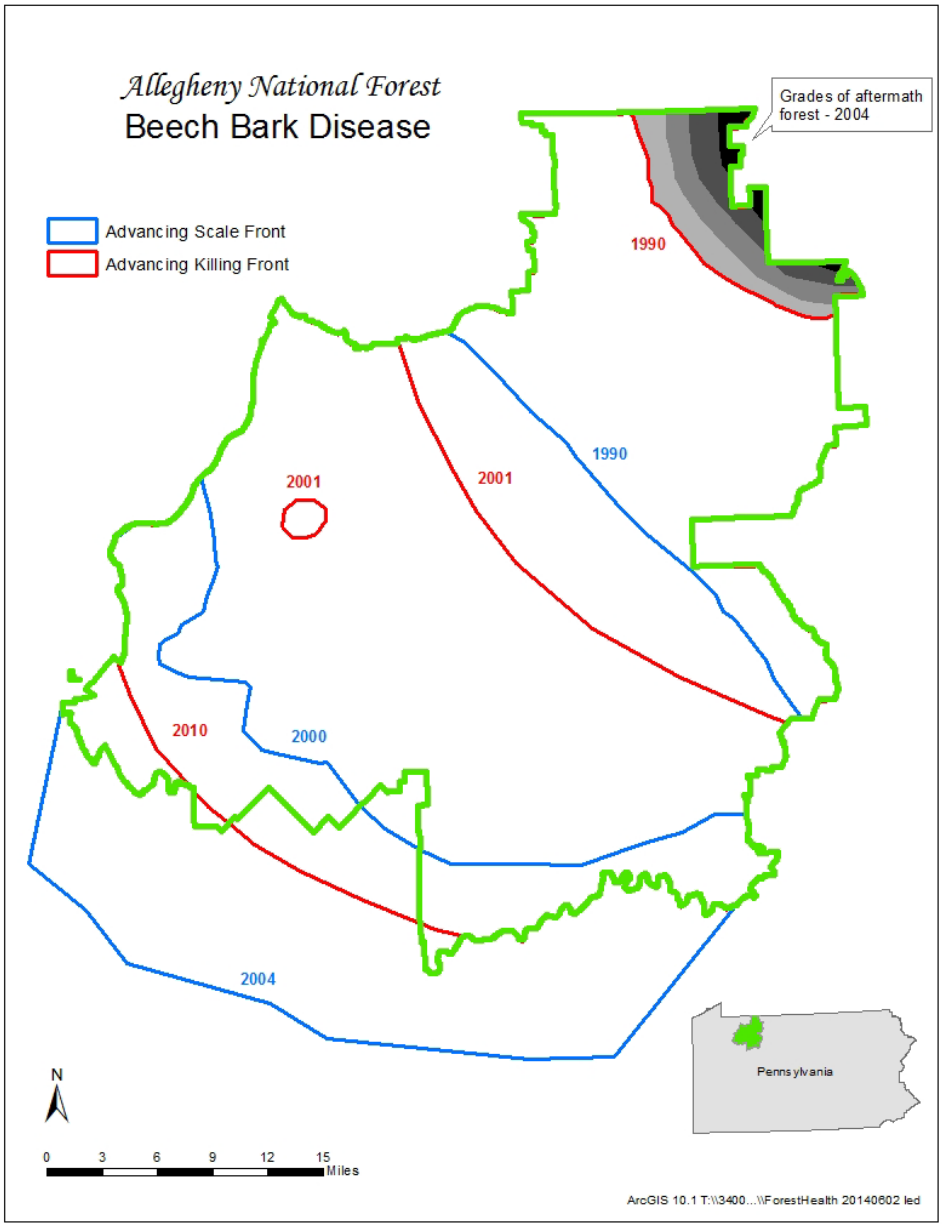


Figure 38. Map of the ANF illustrating the movement of beech bark disease across the forest

As the killing front spread across the ANF, beech decline and mortality has rapidly occurred, resulting in mortality of an estimated 60-70% of overstory beech trees during the first wave of infestation, targeting the largest individuals first (Figure 38). Subsequent waves of scale infestation result in additional mortality over time, working down through beech size classes. In FY 2009, aerial surveys identified 4,655 acres of new BBD related mortality and discoloration across the ANF. However, this was substantially less than the 44,073 acres of BBD related mortality and discoloration mapped in FY 2008. This could be due to several factors at the time of flight, including visibility and patterns of surveillance flights. It is believed that the primary factor for this observed decrease is that, as the disease progresses across the ANF, crown discoloration become less evident from the air as affected beech trees succumb and snap off or fall.

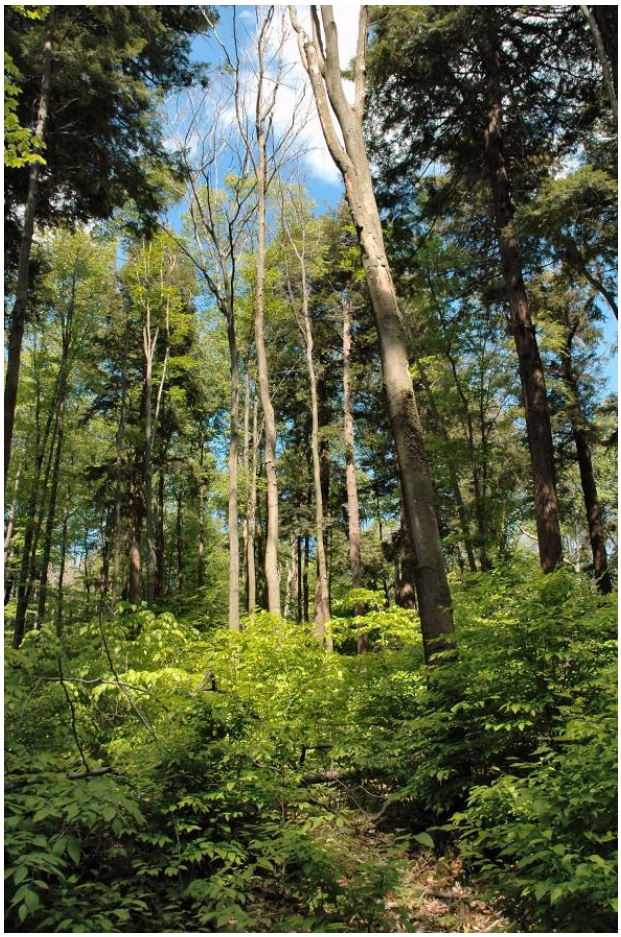


Figure 39. American beech mortality in Tionesta Research Natural Area, with beech root suckers in understory

In New England, where the BBD complex has been present and killing American beech for over 50 years, an average of half the trees die, and only 1% the trees appear immune to the complex (Houston et al. 2005). It is likely that ANF American beech are similar, with perhaps 1-5% of the trees ultimately being resistant to the disease complex (Koch pers. comm. 2013). Given the lack of landscape-level control techniques for the BBD complex, methods utilized on the ANF to address BBD primarily include silvicultural techniques to favor the resistant 1% of the American beech by discriminating against the susceptible 99%.

The National Insect and Disease Forest Risk Assessment (Krist Jr. et al. 2014) predicts the ANF will experience an additional loss of 17% of overall American beech basal area in the next 15 years. The risk model predicts that 54% of American beech on the ANF will experience a 25% or greater loss in basal area over the next 15 years.

Forest Plan guidelines suggest that beech trees with characteristics indicating BBD resistance be retained, while discriminating against those beech trees that are susceptible to the disease complex (USDA-FS 2007a, p. 94). Marking guidelines used on the ANF since 1992 have included direction to retain American beech trees that have characteristics indicating they may be

resistant to BBD complex (USDA-FS 1993). For the past twenty years, ANF personnel have been favoring beech with smooth bark and little scale, while discriminating against beech with scale, nectria, roughened bark, tarry spots, or thinning crowns. At the same time, efforts are made to reduce overall beech abundance, particularly those beech that are susceptible to the complex in order to provide growing space for either resistant beech or other tree species. ANF personnel have periodically participated in local training conducted by FHP personnel (Morgantown, West Virginia) and Dr. David Houston that was designed to assist ANF personnel in implementing these guidelines. Most recently, training in identifying resistant/immune beech trees was provided for ANF staff by FHP plant pathologists and entomologists in May 2010.

American beech trees that are stressed or killed by BBD complex sprout prolifically from the intact root system (Figure 39). These sprouts or root suckers are of the same genetic make-up of the parent tree, and thus susceptible to the BBD complex. These dense root sprouts prevent the regeneration of other hardwood or coniferous tree species, eventually becoming a BBD "aftermath forest" where smaller size beech brush cycles through waves of BBD. The resulting beech brush interfering vegetation is reduced through various treatments, in order to promote establishment of a diversity of tree species, including resistant healthy American beech.

In the spring of 2003, ANF personnel and plant pathologists with FHP identified over 120 healthy American beech trees in eight forest stands in the northeastern portion of the ANF where the BBD complex has been present the longest. Most of the other beech trees in this area had succumbed to the disease complex. These trees have been periodically monitored since that time and most remain scale free to this day, indicating that they have a high probability of being resistant to the BBD.

In three of the stands mentioned above, Forest personnel are participating in a joint research project designed to test whether additional growing space created by removing or killing susceptible beech trees and beech sprouts creates sufficient growing space around resistant stems to give resistant root sprouts an advantage, thereby increasing the resistant beech composition in the young forest that develops. Shelterwood harvest and herbicide treatments have been completed in these areas, and tree regeneration monitoring is in progress.

In February and December 2008, scion (branches) were collected from 12 of the resistant American beech originally identified in 2003 (Figure 40), with the long-term objective of developing a seed orchard of trees containing genetic material from these potentially resistant trees. The scion collected were sent to NRS at Delaware, Ohio, where they were grafted to beech root stock. Once these grafted seedlings (ramets) were further challenged by beech scale to confirm their resistance to the scale insect, the ramets were planted to establish a seed orchard on Pennsylvania state land in 2011 and in 2012. Additional scions were collected from eight trees in 2010 to provide for additional genetic diversity for the future seed orchard. Seed from this seed orchard will be used for restoration of healthy American beech on the ANF and other ownerships in the future as a joint effort between the ANF, NRS, FHP, and Michigan and Pennsylvania state agencies.

Figure 40. American beech scion collected

Climate/environmental factors

Drought – In 2014 and 2016, the northwest portion of Pennsylvania had 6% above normal rainfall and normal rainfall, respectively (Pennsylvania Forest Health Highlights 2014, 2016; https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml). Data were not available for 2015.

Precipitation is normally plentiful throughout the year, averaging 40 to 45 inches annually on the ANF. Between 1972 and 1987, the Forest experienced a relatively drought-free period. However, significant droughts occurred in 1988, 1991, 1995, 1999, 2001, 2010 and 2012 based on the Palmer Drought Severity Index (PDSI; less than or equal to -1, predominantly during the growing season). Between 2002 and 2009, rainfall was close to or above historical average conditions. In 2011, rainfall was above historical average conditions, and in 2013 rainfall was within normal historical ranges. Drought can be an important contributor to forest decline or tree mortality particularly when it occurs during successive years or when it is concurrent with, closely precedes, or closely follows periods of substantial tree defoliation or some other environmental or biological factor that significantly stresses the trees.

Weather conditions during 2009 were cooler than normal. Late frost and freeze events between May 19 and 25 caused damage to tree foliage, flowers, and subsequent seed production on oaks, beech and sugar maple on the ANF.

Ozone – Prolonged exposure of sensitive plants to chronic and acute ozone exposures in a predisposing environment (usually adequate soil moisture and open stomata that allow ozone to

enter the plant) can result in visible foliar symptoms which are used to detect and monitor ozone stress in the forest. Ozone exposure can also lead to growth loss and biomass reduction in plants.

Ozone biomonitoring, the systematic examination of vegetation for symptoms of ozone injury, is one of the health-based indicators used by FIA. FIA implemented a national ozone biomonitoring program in 1994 that grew to include over 1,200 biomonitoring field sites in 47 states. The FIA biomonitoring provides information on visible symptoms of ozone rather than ozone concentrations in the air. The ANF joined the program in 1998 and implemented biomonitoring procedures on an enhanced sampling grid through 2007. The ANF initiated a forest ozone biomonitoring program in 2009. Forest health and biomonitoring on the ANF follows national protocols.

An interpretation of the ozone injury data published in 2008 presents a national ozone risk that indicates the ANF is at low risk for ozone impacts to forest ecosystems (Smith et al. 2008). Additionally, although ozone monitoring representative of the ANF shows that ozone concentrations vary from year to year, the ozone concentration is currently below the National Ambient Air Quality Standard (NAAQS) and is in attainment (< 70 ppb) based on ozone monitoring at the Kane Experimental Forest (KEF) Clean Air Status and Trends NETwork (CASTNET) site 112 (Figure 41 and Table 18 under Air Quality). The three-year average at the KEF CASTNET site 112 for 2013-2015 was 65 ppb (USEPA 2016a), a decrease compared to 67 ppb for 2010-2012 (USEPA 2013).

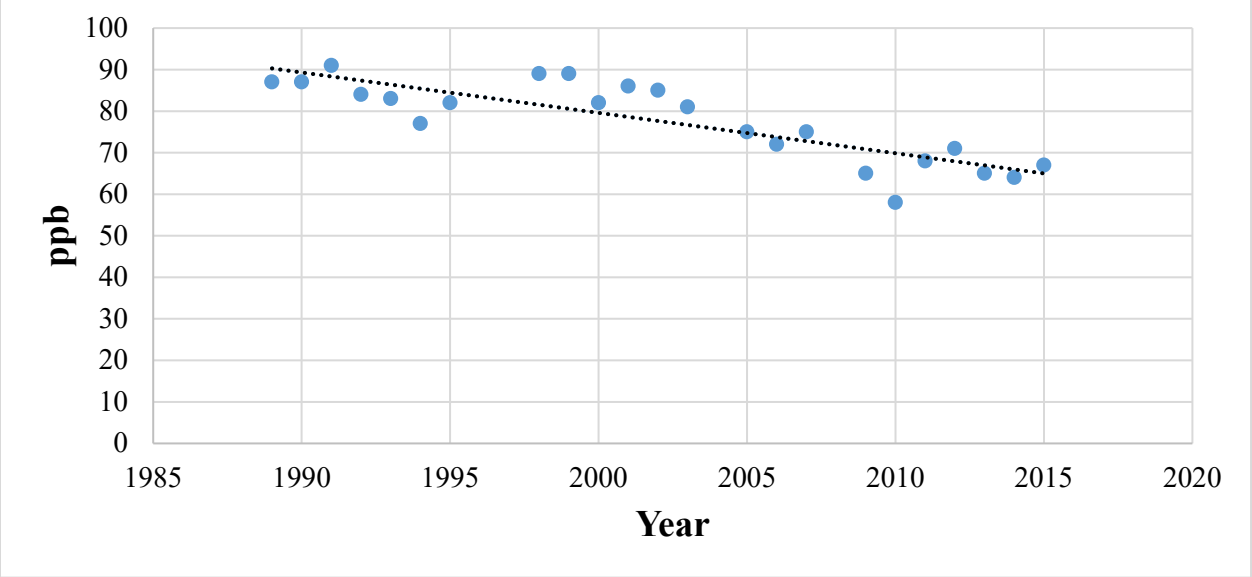


Figure 41. Annual fourth highest 8-hour daily maximum ozone concentration (EPA standard) as measured at the Kane Experimental Forest Clean Air Status and Trends NETwork site 112

The average biosite index value (a measure of ozone damage to ozone sensitive plant species) was determined for inventoried sites in Pennsylvania (ranged from 48 to 134 sites per year) and the ANF (the number of plants evaluated ranged from 2,229 to 11,147 per year) between 1998 and 2007 (Figure 42). While there was an overall downward trend in ozone injury conditions for both Pennsylvania and the ANF, there were fluctuations within the monitoring period.

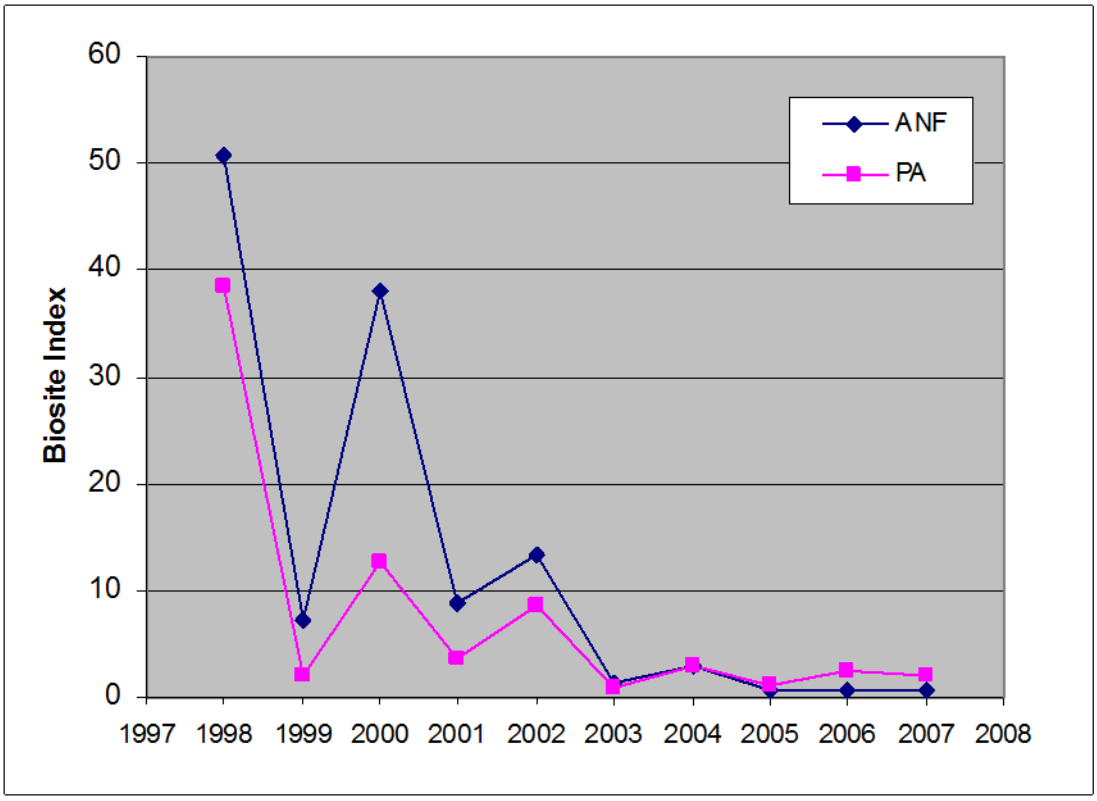


Figure 42. Biosite index for the ANF and Pennsylvania (FY 1998-2007)

No ozone biomonitoring occurred in 2008. In 2009, 14 plots were visited, and ozone injury was recorded at one plot. In 2010, 16 plots were visited, and ozone injury was recorded at one site. In 2011, 16 plots were visited, and no ozone injury was recorded. In 2012, eight plots were visited, and no ozone injury was recorded. In 2013, 15 plots were visited, and ozone injury was recorded at five sites. Biomonitoring was not conducted in 2014, but resumed in 2015. In both 2015 and 2016, 10 plots were visited. There were four plots showing damage in 2015 and two plots in 2016, with less than 5% of the sampled plants for each year showing injury. For both years, on one of the visited plots the damage was extremely localized around a natural gas well.

Some of the variability from 1998 through 2007 can be explained by drought conditions such as in 1999 and 2001 (Figure 43). During a drought, ozone uptake by plants is prevented when the leaf stomates, which allow for the exchange of gases with the atmosphere, are closed. This effectively reduces foliar injury response of ozone sensitive species. A most recent summary of regional ozone biomonitoring indicated that although the percent injured plants and the biosite index declined from 1994 to 2010, the percent of injured sites showed a less obvious downward trend (Smith et al. 2012).

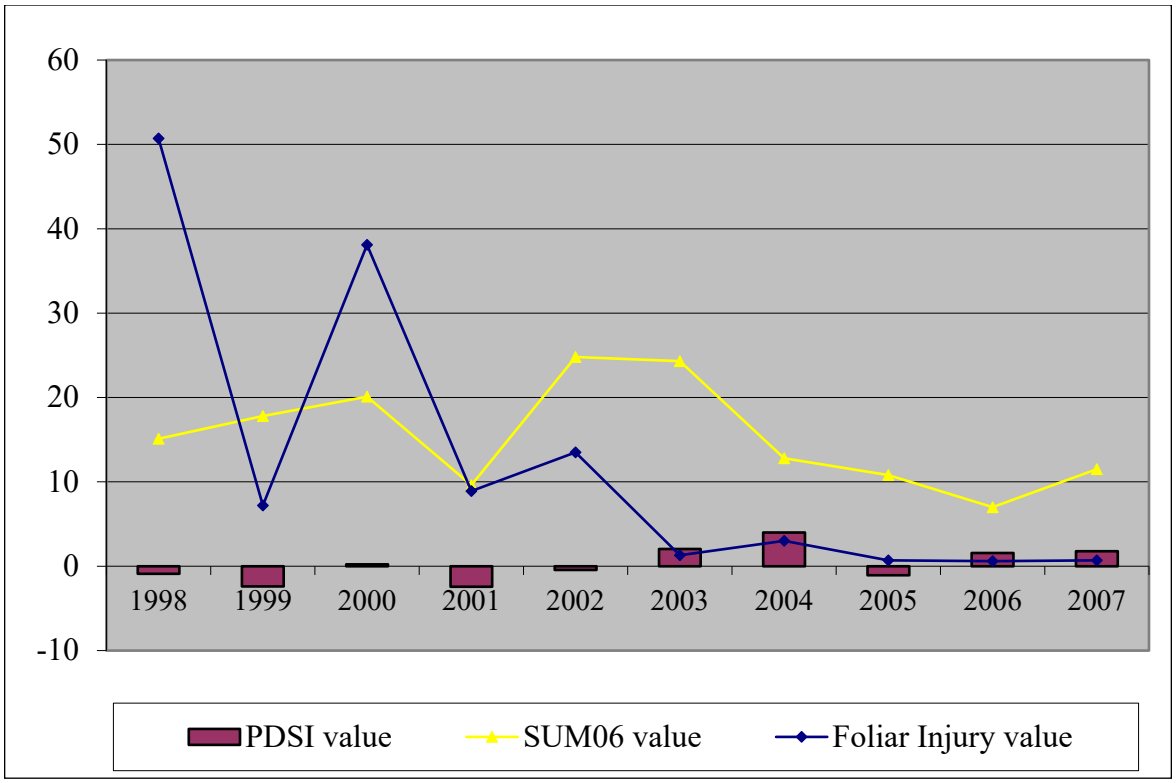


Figure 43. Foliar injury (biosite index values), soil moisture (PDSI values), and ozone exposures (SUM06 values) for the ANF (FY 1998-2007)

Site/species nutrient capability – There is no new information to report.

Atmospheric deposition – Deposition of sulfur and nitrogen compounds as sulfate (SO_4), ammonium (NH_4), and nitrate (NO_3) can cause harmful effects to both aquatic and terrestrial ecosystems. SO_4, NH_4, and NO_3 deposition can cause stream acidification and leaching of important soil nutrients, as well as cause harmful effects to both aquatic and terrestrial systems. NH_4 and NO_3 can also cause eutrophication, or nutrient enrichment that negatively impacts water quality, aquatic biota, and may increase invasive species growth, particularly plants. SO_4 is a product of sulfur dioxide produced primarily from the combustion of coal at electrical generating units. The source of NH_4 deposition is primarily agriculture (fertilizer application and livestock waste), while NO_3 is a product of nitrogen oxides derived from both the combustion of fuel at very high temperatures (such as in power plants, industrial boilers, and automobiles) as well as from various agricultural processes.

Deposition can occur in three forms: dry, wet, and cloud. Dry deposition is the direct fallout of fine particulates and gases from the atmosphere. Dry SO_4 is less than 4% of the total sulfur deposition, dry NH_4 is less than 3% of the total nitrogen deposition, and dry NO_3 is less than 1% of the total nitrogen deposition as measured at KEF112 for the years 2012-2014 (USEPA 2016a). Wet SO_4 is the largest component of sulfur deposition during this period, and wet NH_4 is the largest component of nitrogen deposition during this period (USEPA 2016a). Wet deposition occurs when acidic pollutants combine with water in the atmosphere, which is then deposited in

the form of rain, snow, or hail. Cloud deposition occurs when droplets of acid-containing water from clouds are deposited onto the earth's surface, typically at higher elevations.

Deposition monitoring of wet SO_4, wet NH_4, and wet NO_3 is measured on the ANF at the National Atmospheric Deposition Program/National Trends Network (NADP) monitoring station. The NADP site on the ANF (PA29) is located at the KEF. Wet deposition of SO_4, NH_4, and NO_3, as well as acidity (measured as pH), for 1985 through 2016, are shown for PA29 in Figures 44-47 (NADP 2017). Over the past three decades plus, the precipitation continues to be acidic, but it is much less acidic now than it was during the 1980s due primarily to pollution controls required by the Clean Air Act.

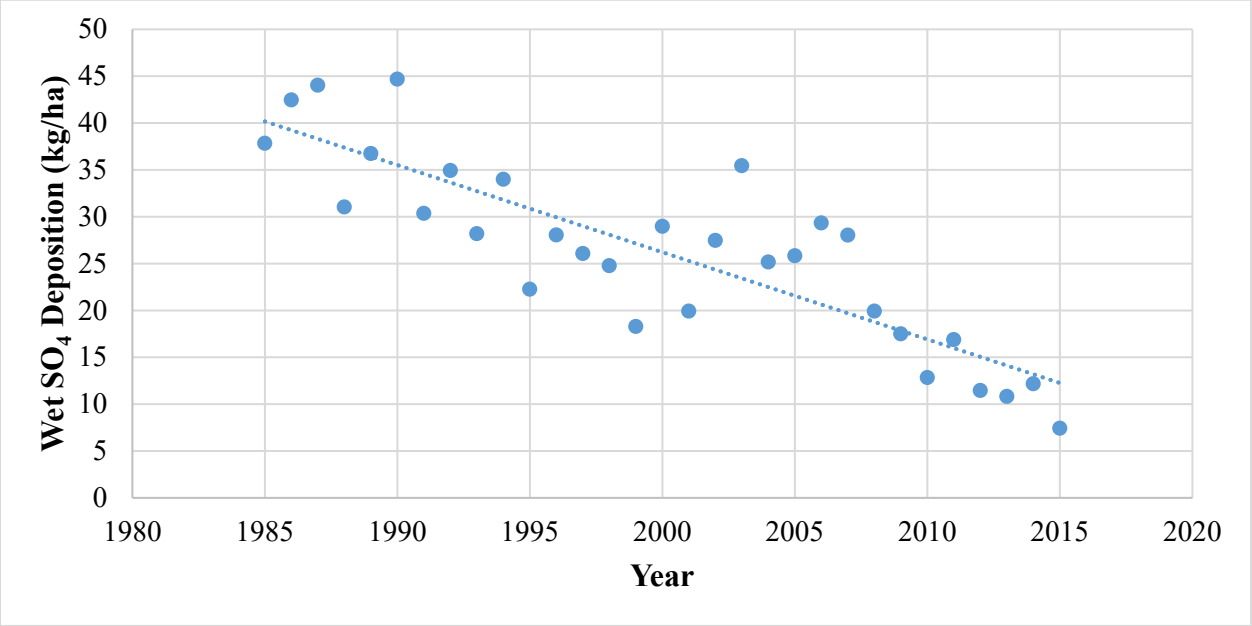


Figure 44. Wet sulfate (SO_4) deposition as measured on the ANF at the National Atmospheric Deposition Program/National Trends Network monitoring station (PA29) at the Kane Experimental Forest (1985-2016)

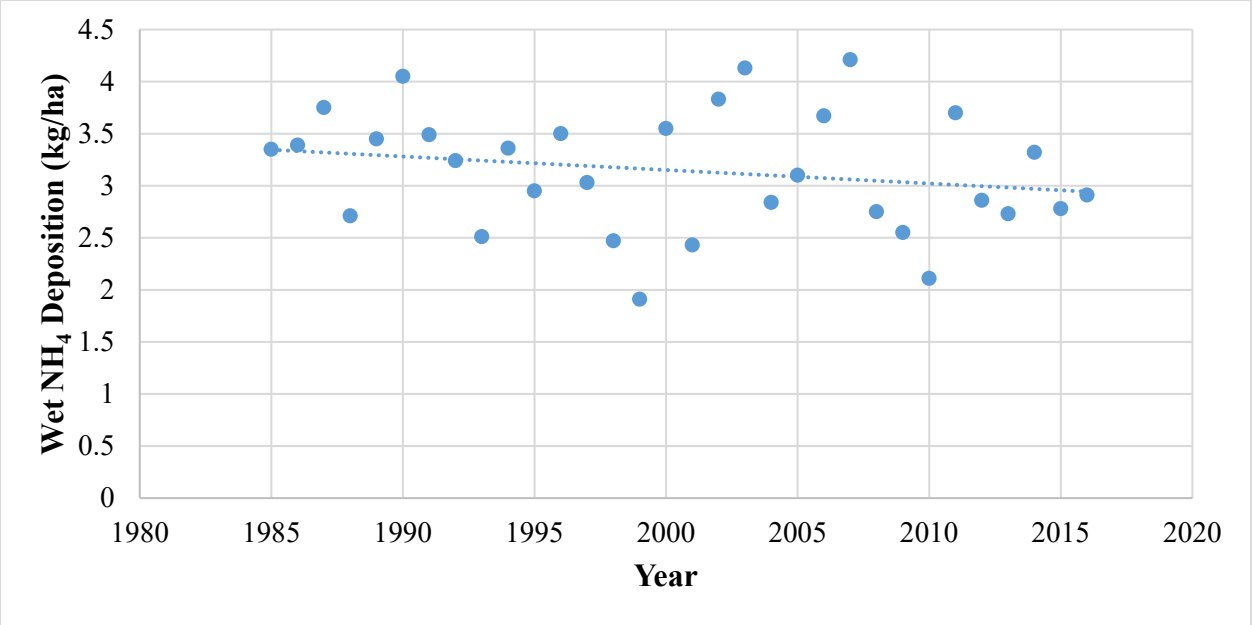


Figure 45. Wet ammonium (NH_4) deposition as measured on the ANF at the National Atmospheric Deposition Program/National Trends Network monitoring station (PA29) at the Kane Experimental Forest (1985-2016)

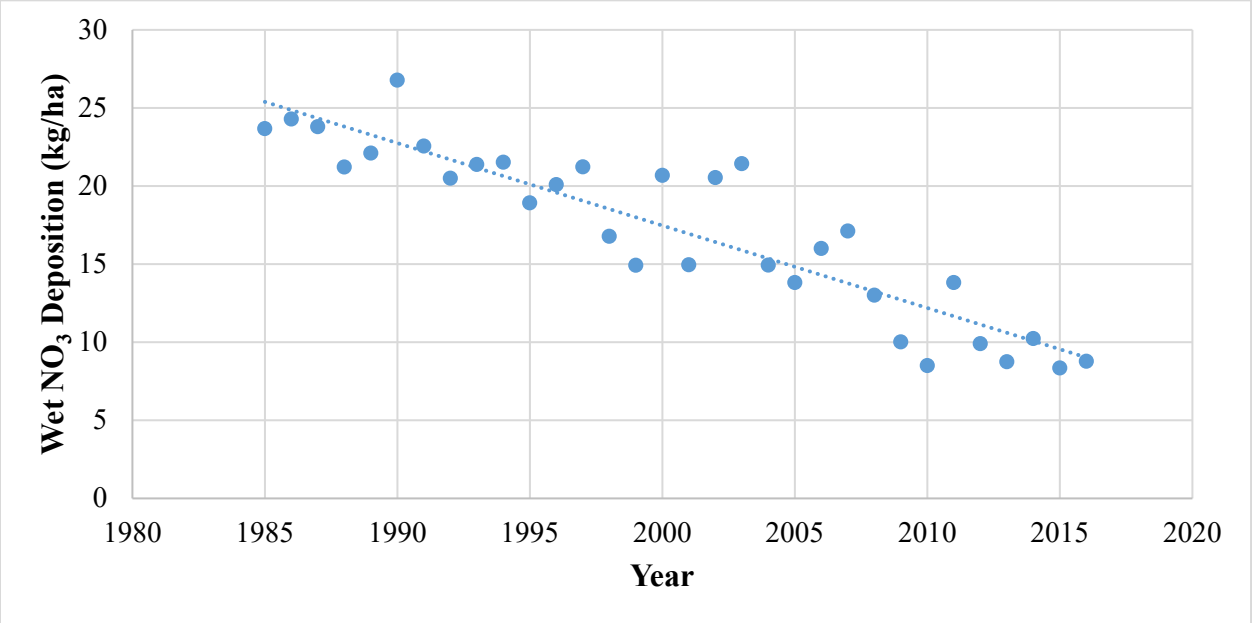


Figure 46. Wet nitrate (NO_3) deposition as measured on the ANF at the National Atmospheric Deposition Program/National Trends Network monitoring station (PA29) at the Kane Experimental Forest (1985-2016)

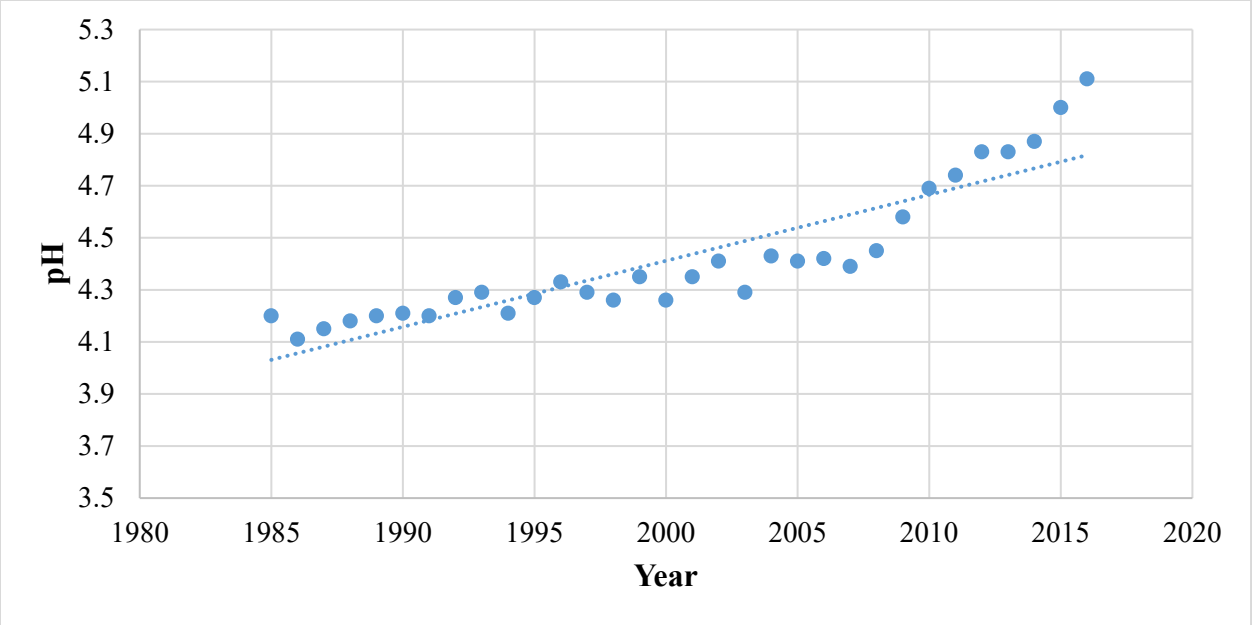


Figure 47. Acidic deposition (pH) as measured on the ANF at the National Atmospheric Deposition Program/National Trends Network monitoring station (PA29) at the Kane Experimental Forest (1985-2016)

Mercury is not one of the six criteria pollutants listed in the NAAQS, but it is another important environmental contaminant that reaches the Forest through atmospheric deposition. The primary source of anthropogenic mercury is the combustion of coal. Mercury is relatively stable and accumulates in the environment until conditions are right for conversion to its most toxic form, methyl mercury (MeHg). Mercury deposition monitoring values do not indicate how mercury will be altered in the environment to produce MeHg. Various environmental characteristics within a watershed influence the methylation of mercury, including the percentage of wetland acres and the depth of lakes receiving deposition (Sams 2007). The MeHg is ingested by aquatic organisms and bioaccumulates as it makes its way through the food chain, finally affecting humans when fish are consumed. Unhealthy levels of MeHg have led to fish consumption advisories in many states, including Pennsylvania. MeHg has also been found in numerous species of wildlife, such as loon and mink.

Mercury deposition is measured at KEF as part of the Mercury Deposition Network (MDN). The KEF mercury site (PA29) has been operational since 2010. Values show a wide variation at the PA29 site (Figure 48).

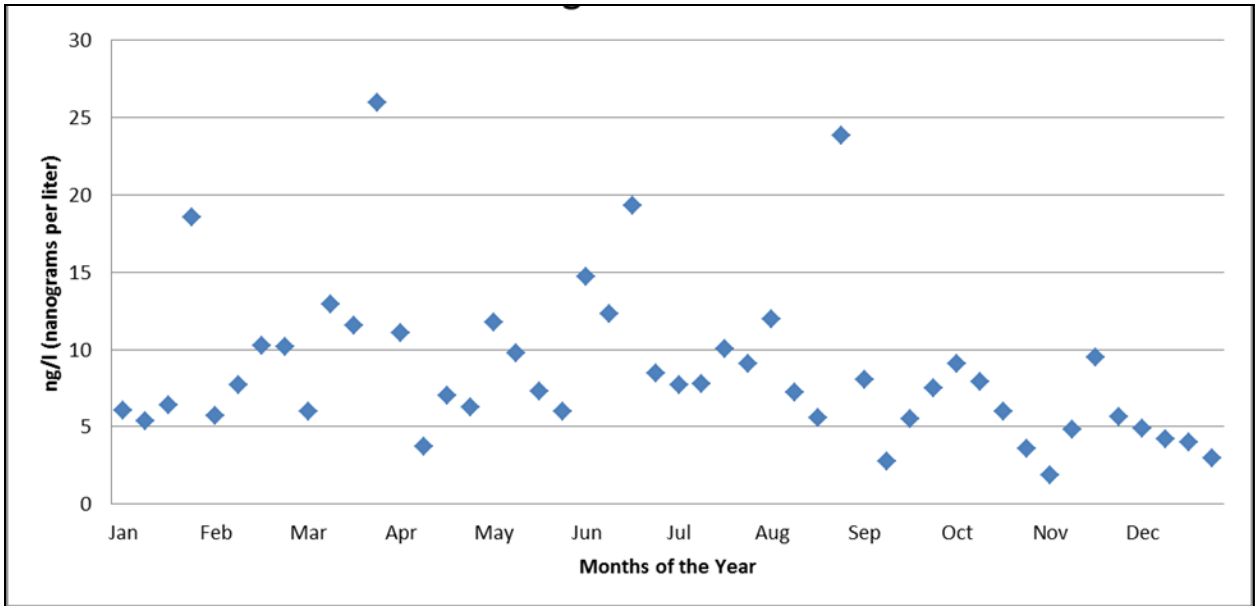


Figure 48. Mercury concentration deposition as measured on the ANF at the Mercury Deposition Network site (PA29) at the Kane Experimental Forest (January – December 2012)

Air quality – The Clean Air Act, last amended in 1990, requires the United States Environmental Protection Agency (EPA) to set NAAQS for six common air pollutants (USEPA 2016c). These "criteria pollutants" are commonly found and can be hazardous to human health, the environment, and can potentially cause property damage. The EPA regulates these six pollutants by setting scientifically-based permissible levels. The six criteria pollutants identified by the EPA are: ground-level ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter ($PM_{2.5, 10}$), and lead (Pb).

O_3, which occurs naturally in the stratosphere, protects life on Earth. However, ambient, or ground-level O_3 (smog), is a harmful secondary pollutant which is not emitted directly from a stack or tail-pipe. Rather, O_3 is formed when nitrogen oxides (NO_x) and volatile organic compounds (VOC) combine in the presence of heat and sunlight. Nitrogen oxides come primarily from burning fossil fuels at high temperatures; VOC are emitted from vehicles, industrial processes, and primarily from natural sources such as trees and shrubs. Research has shown that in the eastern United States there is an over-abundance of naturally-occurring VOC. O_3 formation on the ANF is therefore "NO_x-limited", which means that the concentration of ambient O_3 is primarily dependent on the amount of NO_x emitted into the air. Pennsylvania O_3 levels are attributable to local influences and, to a more significant extent, to O_3 and O_3 precursors transported from outside Pennsylvania from states to the south and west (PA DEP 2009a).

SO_2 is a highly reactive gas which has adverse effects on the respiratory system and 93% of SO_2 emissions are created by fossil fuel combustion at power plants and other industrial facilities (USEPA 2017b). Other sources include industrial processes such as extracting metal from ore, and burning high-sulfur-containing fuels by locomotives, large ships, and non-road equipment.

CO is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, which contributes over half of CO emissions nationwide. Other sources include construction equipment, industrial processes, and wood burning.

NO_x are a group of highly reactive gasses for which NO_2 is the indicator. Emissions from cars, trucks, buses, power plants, and off-road equipment create NO_2 which contributes to ground-level O_3, and fine particle pollution.

Particulate matter is composed of small particles and liquid droplets which can be inhaled and affect the heart and lungs. Particulate matter between 2.5 and 10 micrometers (PM_{10}) are "inhalable coarse particles" found near roadways and dusty industries. Particulate matter 2.5 micrometers and smaller ($PM_{2.5}$) are "fine particles" found in emissions from motor vehicles and wood burning, and can cause reduced visibility or regional haze over large areas. Most states have finalized Regional Haze State Implementation Plans for controlling emissions that will reduce visibility impairing pollutants that affect the ANF. Historically, the ANF has had some of the poorest visibility in the nation, primarily due to fine ammonium sulfate particles in the atmosphere (Hand et al. 2011); however, based on fine particulate measurements taken at Maurice K. Goddard State Park, Pennsylvania, and Quaker City, Ohio, since 2001, both southwest of ANF, and generally upwind of the ANF, long distance visibility has doubled on the haziest days of the year (FED 2017) due to emission reductions upwind.

Pb smelters are the leading cause for Pb emissions and, to a lesser extent, waste incinerators, utilities and lead-acid battery manufacturers. The nearest Pb smelter is located in southwestern Pennsylvania, about 128 miles from the ANF.

Monitoring of the NAAQS occurs at the state level and is enforced through EPA-approved State Implementation Plans. The plans typically include a collection of monitoring devices throughout the state which provide actual measurements of the concentrations in the air and identify whether an area is meeting the air quality standards. Areas which meet the standards are considered in "attainment" status, while those that do not meet the standards are considered in "nonattainment" status. States with nonattainment areas must implement strategies which will reduce emissions.

The nearest EPA-approved monitoring station for O_3 is at the KEF, while the nearest EPA-approved monitoring stations for CO, NO_2, $PM_{2.5}$, and PM_{10} are located in Erie, Pennsylvania. There is an EPA-approved monitor for SO_2 located in the city of Warren, Pennsylvania. The nearest monitor for lead is located in Beaver County (USEPA 2017a).

Currently, the four-county area of Pennsylvania in which the ANF is located is in attainment of all the NAAQS except SO_2 (Table 18; USEPA 2017a). Effective October 4, 2013, an area consisting of Conewango Township, Glade Township, Pleasant Township, and the City of Warren were designated as a nonattainment area for pollutant SO_2 (USGPO 2013). The Commonwealth of Pennsylvania is directed by the Clean Air Act to meet the 1-hour SO_2 standard for this newly designated nonattainment area as expeditiously as practicable, but no later than October 4, 2018 (USGPO 2013). A portion of the newly designated SO_2 nonattainment area, in the vicinity of the City of Warren, is within the proclamation boundary of the ANF.

Table 18. National Ambient Air Quality Standard criteria pollutant attainment status

Criteria Pollutant	Averaging Time	Level	Attainment (USEPA 2017a)
O_3	8 hour	70 ppb	Yes
SO_2	1 hour	75 ppb	No
CO	8 hour	9.0 ppm	Yes
NO_2	1 hour	100 ppb	Yes
PM_{10}	24 hour	150 $\mu g/m^3$	Yes
$PM_{2.5}$	Annual	12 $\mu g/m^3$	Yes
Pb	3 month average	0.15 µg/m3	Yes

The National Energy Technology Laboratory constructed an air quality monitoring laboratory to measure ambient concentrations at three locations during a seven-month period from 2010-2011 on the ANF (Figure 49). The focus of the laboratory deployment was to try to determine if an area relatively unimpacted by OGM development would have different air quality from two sites that were located near oil and natural gas development activities. The study concluded (Pekney et al. 2014):

> Concentrations of criteria pollutants O_3 and NO_2 did not vary significantly from site to site; averages were below NAAQS. Concentrations of VOC associated with oil and natural gas (ethane, propane, butane, and pentane) were highly correlated. Differences between the two impacted and one background site were difficult to discern, suggesting that the monitoring laboratory was a great enough distance downwind of active areas to allow for sufficient dispersion with background air such that the localized plumes were not detected.

Figure 49. The National Energy Technology Laboratory air quality monitoring laboratory

Wind events – Data are not yet available.

Wind events are a fairly common disturbance on the ANF. Wind events impacted the ANF in a storm that occurred in July of 2012, predominantly affecting areas on the Marienville Ranger District. Over 800 acres of scattered and concentrated blown down trees were mapped following the July 2012 storm.

Ice storms – There is no new information to report.

Conclusions – Numerous stressors, native and introduced insects and diseases threaten the health of ANF forest ecosystems. Recent introductions of HWA and EAB are of particular concern. Continued mortality and changes in forest structure resulting from BBD continues to be of concern on the ANF. These factors alter natural disturbance regimes and change stand trajectories, changing forest composition, structure and function. A number of management activities, projects, and strategies on the ANF are specifically designed to reduce impacts from destructive insects and diseases.

Recommendations – Continue insect and disease detection and monitoring activity as a cooperative effort with FHP. Maintain health of forest stands by maintaining adequate growing space and site resources through thinning. Enhance the diversity of forest vegetation in terms of composition and structure, in order to improve resiliency of the forest and reduce level of impact from insects and diseases, particularly those that are introduced.

ANF Forest Plan direction provides for emphasizing integrated pest management methods to prevent or minimize pest problems, using the most current science and available control methods. For those insects and diseases that present new threats to Forest tree species (such as EAB, HWA, and SWW), continue monitoring for their presence on the ANF, and develop and implement strategies and action plans for these pests that integrate newly identified or state-of-the-art pest control techniques. Continue monitoring overall health and status of affected tree species. Continue to assess the need for public education (firewood movement) and monitor effectiveness of education and outreach efforts.

3.7.6 Effectiveness of herbicide design criteria

Monitoring Question	Monitoring Indicators	Monitoring Frequency	Evaluation Frequency	Last Updated
How effective are herbicide design criteria in protecting water? To what extent are herbicides drifting into buffer areas? Are water quality protection criteria being met?	Herbicide damage visible within established buffers and water quality monitoring near areas treated with herbicides	Annual	2 years	FY 2013

Background – Forest Plan components include treating interfering understory vegetation while protecting water quality through application of standards and guidelines. This monitoring question addresses how effective herbicide design criteria are in protecting water quality as well as the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting

the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

3.7.6.1 Monitoring indicator 1 – herbicide damage within established buffers

Protocol

Broadcast herbicide application – Visual monitoring was completed in a sample of areas that received broadcast herbicide treatment between FY 2007 and FY 2015 to determine if standards and guidelines specified in the Forest Plan to maintain water quality were being appropriately implemented and if they were effective in protecting wetland management zones, riparian corridors and water quality during vegetation management activities.

A random sample representing a range of 10-30% of treated blocks was selected for monitoring. The sample included selections from both glyphosate (Accord® or Rodeo®) and sulfometuron methyl (Oust®) mix treatment areas, and sulfometuron methyl (Oust®) only treatment areas. Overall, 22% of all areas treated with broadcast herbicide between FY 2007 and FY 2015 were included in a random sample and monitored for implementation of adequate buffers along water features.

The monitoring occurred one to two years following herbicide treatment, during July and August, when herbicide injury or death on plants was readily evident. The monitoring was occasionally performed during and after a rain event. The wet conditions assisted in identifying water features such as wetlands, seeps, springs, vernal pools, and ephemeral, intermittent, and perennial streams within the buffer areas.

The perimeter of each monitored sample area was walked, as well as the boundary of all buffer areas within treatment blocks. A visual assessment of any herbicide injury or death of vegetation was completed to determine if any overspray or herbicide damage resulted within buffer areas or outside the treatment boundary. Based on the appearance of targeted vegetation within treatment blocks, it was ascertained if similar herbicide damage occurred outside of any treatment blocks, or within any buffer areas. Distances of overspray past buffer boundary were measured at time of monitoring and the distances from buffer boundary and overspray lines were measured to water features. Areas of overspray were documented on field-drawn maps.

To determine the required buffer distances in areas where water features were located, water type definitions were used from the References for Water Point Data Dictionary and the Summary of Vegetation Management Buffers (standards and guidelines) for Wetland Management Zones and Riparian Corridors from the 2007 Forest Plan. Where inconsistencies with Forest Plan standards were noted, a follow-up visit was conducted with the ANF Herbicide Contract Administrator, the Forest Hydrologist and/or the Forest Fisheries Biologist, and District personnel involved with herbicide treatment area layout and administration. The purpose of the follow-up visit was to reassess field observations and identify operational improvements to ensure Forest Plan standards and guidelines are correctly implemented.

Seven areas treated with herbicides in FY 2011 that lie within the thirteen percent of the ANF that drains into the Allegheny River (13% Area) were monitored for specific riparian buffers. Monitoring of these seven areas occurred one to two months after treatment and focused on assessing buffers designated in the field for protection of water quality. One area treated with herbicides in FY 2015 was located in the 13% Area, and it was monitored the following year. Areas treated with herbicides within the 13% Area must maintain larger buffers than treatments on the rest of the ANF (USDA-FS 2007a, p. 74-75 and 83).

Right-of-way herbicide application – Electric utility companies must manage vegetation beneath and adjacent to the electric conductors and structures on their rights-of-way (ROW) in order to provide safe, reliable electricity to its customers. These companies apply herbicides to control tall growing vegetation on sections of their ROW for electrical distribution and transmission across the ANF. Herbicide application on powerline utility corridors on the ANF was evaluated and approved in the Vegetation Management on Electric Utility Rights-Of-Way FEIS (USDA-FS 1997).

Part of the assessment for vegetation management in electric utility corridors included mitigation measures to protect water quality (USDA-FS 1997 pp. V-123 – V-125). Stream or wet area buffers were designed to protect vegetation within the buffer zone and to prevent herbicide entry into surface water. The buffer strategy described includes the following:

- No herbicide shall be applied within 10 feet of standing or flowing water.
- No picloram or triclopyr and no high-volume foliar application methods shall be used within 75 feet of standing or flowing water.

The FEIS also included a monitoring plan that called for a random visual sample of 10% of the stream or wet area buffers established in the treated areas.

During each of the buffer zone location visits, herbicide inspection forms were completed, photographs were taken, and GPS coordinates of each buffer zone sample site were taken.

Results

Broadcast herbicide application – Table 19 summarizes broadcast herbicide application monitoring of treatments that occurred between FY 2008 and FY 2016.

Table 19. Broadcast herbicide application monitoring summary (herbicide application occurred in FY 2007-2015 with subsequent monitoring in FY 2008-2016)

Fiscal Year Treated	Treated Acreage	Treated Areas	Fiscal Year Monitored	Stands Monitored	Water Buffers	Inadequate Water Buffers	Water Buffers with Herbicide Damage
2007	885	50	2009	11	6	1	0
2008	666	43	2009	9	4	1	0
2009	710	44	2011	11	2	1	0
2010	603	39	2011	12	2	0	0
2011	1,409.4	70	2013	8	1	0	0
2012	960	57	2013	8	2	0	0
2013	942	51	2014	20	6	1	0
2014	974	48	2016	10	9	0	1
2015	1,151	58	2016	10	13	1	1
Total	**8,300**	**460**	**2009-2016**	**99**	**45**	**5**	**2**

2007 treatment areas – Of the 11 sampled stands from FY 2007 herbicide treatments, six contained buffers along streams. Five of these buffers exceeded Forest Plan standards for buffer widths to protect water quality during herbicide application. The sixth buffer was insufficient. A 50-foot buffer was established along an intermittent stream where water was flowing the day of treatment, consistent with Forest Plan standards. However, a 200-foot portion of this intermittent stream, where dry the day of treatment, should have had a buffer designated for 10 feet along both sides of the drainage. The dry portion of the drainage was indistinct with heavy fern and was likely missed during layout of the treatment block. No visible injury or death of vegetation from herbicide treatment was noted inside any designated watercourse or other buffer areas.

2008 treatment areas – Of the nine sampled stands from FY 2008 herbicide treatments, four contained buffers along streams. Three of these buffers exceeded Forest Plan standards for buffer widths to protect water quality during herbicide application. The fourth designated buffer varied between three and 10 feet in width along an intermittent stream. This buffer should have been 10 foot wide along the entire length of the dry intermittent stream. No visible injury or death of vegetation from herbicide treatment was noted inside any designated watercourse or other buffer areas.

2009 treatment areas – Of the 11 sampled stands from FY 2009 herbicide treatments, two contained buffers around water features. One of these buffers exceeded Forest Plan standards for buffer widths to protect water quality during herbicide application. The other buffer should have been larger in order to better protect a seep, even though it was dry at the time of herbicide application. The area contains sphagnum moss, rushes, and violets. This area was visited by the Forest Fisheries Biologist and Forest Silviculturist, who followed up with District personnel regarding this stand. This wet area should be avoided or mitigated in next harvest entry and a logging plan prepared in advance for accessing the remainder of the unit. No visible injury or death of vegetation from herbicide treatment was noted inside any designated watercourse or other buffer areas.

2010 treatment areas – Of the 12 sampled stands from FY 2010 herbicide treatments, two contained buffers around water features. Both buffers exceeded Forest Plan standards for buffer widths to protect water quality during herbicide application. One could have been widened to incorporate more wetland vegetation in the stand; however, the buffer width met Forest Plan standards for intermittent streams. No visible injury or death of vegetation from herbicide treatment was noted inside any designated watercourse or other buffer areas.

2011 treatment areas – Of the eight sampled stands from FY 2011 herbicide treatments, one contained a buffer to protect water quality along a stream. The buffer width exceeded Forest Plan standards to protect water quality during herbicide application. No herbicide damage was observed within the buffer. No overspray was observed in any of the eight sampled stands.

2012 treatment areas – Of the eight sampled stands from FY 2012 herbicide treatments, two contained buffers along streams. Both exceeded Forest Plan standards for buffer widths to protect water quality during herbicide application. No herbicide damage was observed within either of the buffers. No overspray was observed in any of the eight sampled stands.

2013 treatment areas – Of the 20 sampled stands from FY 2013 herbicide treatments, six stands had some type of water buffer. The monitoring found that these buffers were effective at protecting water features. No herbicide damage was observed within the buffers. No overspray was observed in any of the 20 sampled stands. Limited data was collected on the width of these buffers to compare with Forest Plan standards for buffer widths. One stream was documented that it only had a minimum of 20' buffer for a short distance.

2014 treatment areas – In August and September 2016, 10 sampled stands from FY 2014 herbicide treatments were monitored. Five of these stands contained buffers around water features, while the remaining five stands had buffers to protect patches of desirable tree regeneration or poorly drained soils where operation may have caused rutting. All five of the units with water buffers were in full compliance with Forest Plan guidelines. These buffers were protecting either intermittent streams, a wet area, or a seep. All of these buffers exceeded the 10-foot (dry water course) or 25-foot (water flowing at time of treatment) minimum width for buffers protecting intermittent streams and wet areas from broadcast herbicide applications.

In one of the monitored areas, while the boundary was marked to an adequate minimum width of 28 feet, there were several areas where herbicide overspray was evident, particularly around the head of the stream, but also in the middle section. The observed overspray ranged from 7 to 15 feet from the boundary. This was likely due to operator error and poor visibility of buffer flagging.

2015 treatment areas – Of the 10 sampled stands from FY 2015 herbicide treatments, six of the stands contained water features within the buffers. These water features included

intermittent streams, vernal pools, wet areas, and seeps. Two of the stands had water features located outside of the areas. Three of the stands contained no standing or flowing water at time of monitoring.

One stand contained a vernal pool outside the unit that was insufficiently buffered from equipment travel. Vernal pools require a 25-foot buffer for herbicide application, and a 100-foot buffer for equipment travel. The vernal pool monitored contained a 92-foot buffer, well above the required buffer width for herbicide spray. However, equipment may have traveled in along the edge of the buffer to spray away from the vernal pool and associated intermittent stream and into the treatment area, resulting in equipment travel in the outer eight feet of the buffer. At time of observation, the vernal pool did contain live tadpoles. Pictures were taken to document the vernal pool.

Signs of overspray during herbicide treatment were observed in one buffer that contained a water feature. Distances from water features to visible herbicide spray lines in buffers containing water features were sufficient by Forest Plan standards in all stands. On the days of visual monitoring of this sample area, a rain event occurred making intermittent water features more visible. On September 3, 2015, when actual herbicide treatment was being administered, the weather was very dry possibly and intermittent streams were dry at the time of treatment.

13% Area – Of the seven stands monitored in FY 2011, four did not contain water features requiring a buffer (Table 20). Three stands contained water features that were insufficiently buffered and did not meet Forest Plan guidelines for protection of northern riffleshell and clubshell mussels in the 13% Area. However, all but one of these stands had sufficiently sized buffers that were consistent with standards for protection of water quality outside the 13% Area during herbicide application. The stand treated in FY 2015 met Forest Plan guidelines for the 13% Area.

Table 20. 13% Area broadcast herbicide application monitoring summary

Year of Application / Year of Monitoring	Treatment Area	Water Feature	Required Buffer	Actual Buffer	Length of Water Section not in Compliance
2011 / 2011	**5, 7, 20, 22/23**	none	n/a	n/a	n/a
2011 / 2011	**6**	intermittent stream	50' plus 2' for every 1 percent of slope	28'-31'	approx. 100'-150'
2011 / 2011	**25**	vernal pool (20' diameter)	100' for heavy equipment and vegetation removal; 10' if dry or 25' if wet for herbicide application	50'-70'	approx. ¾ of vernal pool perimeter for heavy equipment
2011 / 2011	**26**	intermittent streams	50' plus 2' for every 1 percent of slope	15'-55'	approx. a few hundred feet
2011 / 2011		spring/stream (assuming stream is perennial since being fed by spring)	perennial stream: minimum 100', or 50' plus 4' for every 1 foot of slope, whichever is greater	30'-50' as measured at three locations near the spring origin	approx. a couple hundred feet
2015 / 2016	**B-6**	seep	25'	40'	0'
2015 / 2016	**B-6**	intermittent stream	50' plus 2' for every 1 percent of slope	50'	0'
2015 / 2016	**B-6**	intermittent stream	50' plus 2' for every 1 percent of slope	50'	0'

Right-of-way herbicide application

2007 ROW treatments – Four of the 34 buffer sites implemented in FY 2007 were randomly selected for inspection in the field in FY 2009. These buffers were implemented with application of selective low volume foliar application of herbicides in utility corridors. On August 13, 2009, the four sites were visited by representatives from the electric utility companies who applied the treatment as well as a silviculturist and the Forest Fisheries Biologist from the ANF.

Random sampling and field inspection of sampled sites near areas with standing or flowing water demonstrated that at least a 10-foot buffer zone was maintained during transmission and distribution ROW herbicides treatments.

2008 ROW treatments – During July and August 2008, selective low volume and high volume foliar applications of herbicides were implemented to maintain desirable vegetation conditions in electric utility corridors on the ANF.
Seven of the 61 buffer sites implemented in FY 2008 were randomly selected for inspection in the field in FY 2009. The seven random samples for FY 2008 represented 11% of the total buffer zones for that year.

Visual inspection of seven buffer zones was conducted to determine any herbicide damage present on vegetation within any of the buffer zones. No evidence of herbicide damage on vegetation was found within any of the seven buffer zone locations inspected. The effects of the herbicide application were noted outside of the buffer zones inspected.

2009 and 2010 ROW treatments – Four of the 38 buffer sites where herbicide was applied in FY 2009 and FY 2010 were randomly selected for inspection in the field. On July 14, 2011, four randomly chosen buffer zone locations were visited by representatives from the electric utility companies who applied the treatment as well as a silviculturist and the Forest Fisheries Biologist from the ANF. Selective low volume foliar or stump treatments were applied at these sites. All randomly selected buffer zones near areas with standing or flowing water demonstrated that at least 10-foot buffers were maintained during the treatments.

Discussion – Instances of insufficient buffers along water features are relatively few, and when they do occur it is mostly due to a small amount of over spray or improper measuring of the buffer during layout. Where buffers were insufficient, the water resources were still protected because the spray did not reach the water, indicating the buffer distances are sufficient for protection of water quality.

Between FY 2007 and FY 2015, 8,300 acres (460 sites) were treated with broadcast herbicide applications on the ANF. Of the 460 sites, 99 stands (21%) were randomly selected to monitor buffers applied during herbicide treatment. The 99 sampled stands contained 45 water features with buffers designated on the ground to protect water quality during herbicide application. Of the 45 buffers, 40 (89%) were sufficient and met Forest Plan standards for protection of water quality during herbicide application. Two buffers had a few small areas of herbicide damage within them, but no herbicide reached any water sources, indicating buffer widths specified in the Forest Plan are sufficient and that herbicide application design criteria are effective at protecting water.

The requirement for buffering of intermittent streams and spring seeps that are dry during herbicide application was new with implementation of the 2007 Forest Plan. The required buffer for dry intermittent streams or spring seeps is 10 feet. Early monitoring indicated a need to improve intermittent stream identification skills and ensure appropriate buffers were delineated in the field. Since implementation of the 2007 Forest Plan began, specialists have been working with District contract administrators to ensure dry intermittent streams are properly identified and protected during layout of buffers, and that buffer widths are consistent with Forest Plan standards. Follow-up with District staff has occurred following buffer monitoring and field visits occurred where necessary to identification include laying out treatment area boundaries in the

spring, prior to leaf out, when less well defined water features are more evident. As can be seen in Table 19, two instances of inadequate buffer width were noted in monitored stands since 2010. For both of these cases, the impact was for a short distance and the herbicide did not reach the water resource (an intermittent stream in 2013 and vernal pool in 2015).

Requirements for larger buffer widths within areas that fall within the 13% Area were initially overlooked by District staff and did not meet Forest Plan guidelines for protection of northern riffleshell and clubshell mussels; however, all but one of these areas had sufficiently sized buffers that were consistent with standards for protection of water quality outside the 13% Area during herbicide application, so no effect to mussels was expected. As a result of this monitoring, the Forest Silviculturist and Forest Fisheries Biologist followed up with District staff and contract administrators in 2011 to reiterate special guidelines relative to herbicide application within the 13% Area. Additionally, a comprehensive table comparing vegetation management, equipment, and herbicide limitations within wetland management zones and riparian corridors within the 13% Area and the remainder of the ANF was developed early in FY 2012 and distributed to ANF silviculture, timber layout and marking, and herbicide contract administration staff. This table consolidates related Forest Plan standard and guideline information from the different sections: 2150 (Environmental Management), 2500 (Watershed and Air) and 2600 (Wildlife, Fish and Sensitive Plant Habitat). Requirements for the 13% Area were followed in 2015, showing improvement in monitoring. Subsequent monitoring in areas treated with herbicides in the 13% area found that buffer widths were sufficient (Table 20). The findings of the ROW monitoring showed that the mitigation measures were being followed and that buffer widths specified in the FEIS are adequate in size as no evidence of herbicides reaching or entering any water courses was found.

3.7.6.2 Monitoring indicator 2 – water quality monitoring

Protocol – Stands planned for a broadcast herbicide application treatment are annually reviewed to determine if they would be appropriate to monitor for the effectiveness of buffers implemented to prevent herbicides from entering water. One 20-acre treatment unit (Compartment 244, Stand 19) was selected to monitor in FY 2015 because a portion of the stand to be treated was located in close proximity to a perennial stream. Little Arnot, a perennial fish-bearing stream, is located to the south of the treatment site. Also, an unmapped tributary flows outside of the eastern boundary of the stand.

Pre-treatment water samples were taken by hand at a control site (upstream of the treatment site) and the treatment site on Arnot Run the morning of August 17, 2015. Pre-treatment samples were collected to set the baseline and determine if any of the herbicides were already present in the water. Two automatic samplers, American Sigma® Model 900, were also used to collect pre-treatment samples and samples during treatment at the control and treatment sites on Little Arnot Run (Figure 50).

Figure 50. American Sigma® Model 900 automatic samplers at control and treatment sites on Little Arnot Run

The samplers each hold up to 24-350 ml glass bottles in which the water is collected. The sampler is equipped with a pump and hosing with a filter screen to pull water from the stream and fill the sample bottles. A programmable instrument on the samplers was set to collect four samples over a 24-hour period, each consisting of four individual pumpings of about 175 ml taken every six hours. Two 350 ml bottles were filled during each 24-hour sample because the laboratory conducting the analysis required at least 500 ml of sample. Once the two sample bottles were filled with the four pumpings, someone would retrieve the bottles and return them to the office where they were placed into a refrigerator until it was shipped to a lab for analysis.

Analytical Pesticide Technology Laboratories, Inc., of Wyomissing, PA, conducted the chemical analysis. Only certain samples were designated for analysis based on the protocol outlined in the document Vegetation Management on Electric Utility Rights-of-Way (USDA-FS 1997). The protocol outlines analyzing several samples, including the pre-treatment samples, 1st 24-hour water sample, 2nd 24-hour water sample, and the 1st 0.25" rainfall. These samples, along with all control samples, were collected and stored in case any of the treatment samples came up positive for the herbicides. If a positive reading resulted from any of the downstream collections, then the water collected from the control site would also be analyzed to see whether or not the source was from the treatment site.

The detection limits used by the lab were very sensitive. For glyphosate, aminomethyl phosphoric acid (AMPA), and sulfometuron methyl, the detection limit was set at 0.0005 ppm. AMPA, a derivative of glyphosate resulting from the breakdown of glyphosate by microflora, does not have a separate criterion. Because of its similarities to glyphosate, 0.0005 ppm was used as a water quality protection criterion for AMPA also.

Results – The first treatment site sample was taken at 0915 on August 17, 2015, before the start of the herbicide treatment (Table 21). The herbicide spraying started at 1047 that same day and concluded at 1239. The 24-hour sampling continued for four days after the herbicide treatment. The first significant rainfall greater than 0.25" occurred on August 20, 2015 and amounted to 0.8 inches. This increased streamflow in Little Arnot Run and the tributary that flowed to the east of

the treatment stand. Detection limits for both glyphosate and sulfometuron methyl criterion were not exceeded (Table 22).

Table 21. Field data collection during water quality monitoring of Little Arnot Run

Date	Sample ID	Upstream (Control) Time	Downstream (Treatment) Time	Rain Gauge Time	Rainfall (inches)	Comments
8/17/2015	5 (Pre)	0815	0915	0730	0	Set pumping to start at 1230
8/18/2015	1	1340	1355	1230	0.08	Collected first set of bottles
8/19/2015	2	1645	1700	1620	0.00	2nd 24-hour period
8/20/2015	3	1642	1700	1618	0.8	1st significant rainfall sampling
8/21/2015	4	1644	1700	1625	0	Monitoring of potential runoff from the site

Table 22. Results of Little Arnot Run water samples

Sample	Date	Glyphosate (ppm)	AMPA (ppm)	Sulfometuron Methyl (ppm)
Downstream 1st 24-hour composite period	8/17/2015 – 8/18/2015	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm
Downstream 2nd 24-hour composite period	8/18/2015 – 8/19/2015	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm
Downstream 24-hour composite before1st rainfall of 0.25”	8/19/2015 – 8/20/2015	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm
Downstream 24-hour composite after 1st rainfall of 0.25”	8/20/2015 – 8/21/2015	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm	Not detected-<0.0005 ppm

Discussion – During the four days of monitoring for herbicide from the treatment site, detectable amounts of glyphosate, AMPA, or sulfometuron methyl were not found in the water samples collected from Little Arnot Run. The unit was laid out with sufficient buffers that prevented any over spray or herbicide from reaching the water or channel. The buffer between the treated site and the stream exceeded the Forest Plan standard for herbicides of 25 feet to flowing water (USDA-FS 2007a, p. 78). Since this was a reforestation treatment following timber harvest activities, riparian buffers were followed and Little Arnot, a perennial stream, was buffered 100 feet. These herbicides, after they are applied, normally move no more than a few inches off-site and bind tightly to soils.

Recommendations – Continue monitoring representative samples of herbicide treatment areas to ensure Forest Plan standards and guidelines relative to herbicide application are being implemented. Also, operationally:

- Continue to ensure personnel laying out herbicide treatment boundaries and surveying sites for water or other sensitive features pay particular attention to less obvious water features that are dry at the time of treatment, such as intermittent streams, in order to ensure they are adequately buffered per Forest Plan standards.
- Continue to provide training, if necessary, for contract inspectors in the identification and delineation of intermittent streams and other water resources.
- Strive to lay out smooth treatment area boundaries without sharp corners that the equipment operator is unable to navigate.
- Ensure adequate flagging is hung to indicate treatment area and buffer boundaries, particularly where heavy understory vegetation and brush is present. This includes hanging flagging as high as possible, with long streamers where heavy brush exists.
- Reflag buffers prior to herbicide application, if necessary, following a wet weather event to ensure the distance to water feature compliance standards are met.
- Layout personnel should strive to walk unit boundaries prior to vegetation leafing out in order to better see water features, pipelines, and other features that should be avoided during treatment.
- Layout personnel need to survey for water features that fall within 100' of the treatment area boundary, to ensure they are properly buffered even if they fall outside the treatment area boundary.
- Ensure herbicide contract inspectors document condition of buffered water features at the time of treatment. Due to variable soil and climatic conditions, it is difficult to conclude whether a buffered feature was dry or contained flowing water at the time of treatment if not documented.
- Clearly document decisions made on treatment day (based on weather, topography, etc.) on stand data sheet.
- Do not assume that buffers designated during timber sale layout are adequate.
- Label the purpose of reserve areas, especially when they contain water features.
- Maintain maps showing movement of herbicide machine.

3.7.7 Effect of management activities, natural events, and other disturbances on large dead, damaged, or diseased trees

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How are management activities, natural events, and other disturbances affecting large dead, damaged, or diseased trees?	Presence/absence of pileated woodpecker	Annual	2 years	N/A

Background – The 2012 Planning Rule requires the Monitoring Program of all Forest Service units to monitor the status of focal species to assess the ecological conditions required under 36 CFR 219.9. In that context, a focal species is "[a species] whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the [forest] plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area" (36 CFR

219.19). During the monitoring transition, the ANF selected the pileated woodpecker to serve as a focal species for the ecological integrity (composition, structural, function, and connectivity) of large dead, damaged, or diseased trees.

Protocol – During field reconnaissance, wildlife biologists document (including location and date) the sightings, aural identification, and telling excavation of pileated woodpeckers.

Results – Between 3/30/2016 and 9/13/2016, nine sightings, 15 aural identifications, and eight excavations of pileated woodpecker were documented across the Marienville Ranger District. All but two of these documentations were made at different locations. One location documented two individuals by sight and another location documented the same individual by both sight and call.

Discussion – Since presence/absence is the monitoring indicator, the conclusion for these locations could be that management activities, natural events, and other disturbances are maintaining adequate numbers of large dead, damaged, or diseased trees across the landscape.

Even with a formalized monitoring protocol (see Recommendations section below), the data gathered may still not be useful in answering the monitoring question in its entirety. The ANF has been experiencing forest health stressors (e.g., insects and disease) that are anticipated to recruit more dead, dying, and diseased trees across the landscape. Perhaps a better question would focus on how management, insects, and disease influence snag longevity, or a modeling exercise to look at the distribution of these features. The ANF has completed snag longevity studies to gain knowledge of the value of retaining snags, snag recruits and live trees through the marking guideline. Review the results of this study once the data are analyzed.

Recommendations – Discuss this monitoring question and indicator and reconsider its value to the Monitoring Program and management of the ANF. If this question is retained, finalize a formal monitoring protocol for pileated woodpecker including a methodology that incorporates scale for a meaningful analysis. As an example, the monitoring protocol may be completed using playback calls or collecting data along a fixed transect or fixed plots.

3.8 Watershed and air monitoring

3.8.1 Complete soil and water restoration projects

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many acres of soil and water restoration have been accomplished?	Acres of soil and water restoration projects	Annual	2 Years	FY 2013

Background – Forest Plan objectives include completion of soil and water restoration projects on 10 to 50 acres, annually. As such, this monitoring question addresses the 2012 Planning Rule

monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan.

Protocol – Soil and water restoration projects are completed by a variety of resource staff. Reported acres meet the WO definition of soil and water restoration:

> Includes treatments to protect, maintain, improve or restore water or soil resources. Treatments may be focused on soil productivity; quality and quantity of surface or ground water resources; or timing of water flows per Forest Service Manual 2520. Land treatments, structures and other non-structural measures may be implemented. Land treatments may include those intended to protect, maintain, improve or restore: soils and plant cover to prevent erosion, sedimentation and flooding; water infiltration, conservation or chemistry; water flows and geomorphic processes; or soil quality and productivity. Structural measures are those commonly used to control water flow or supply, thus protecting, maintaining, improving or restoring soil stability, natural geomorphic processes, flood attenuation, runoff dispersion, infiltration or evaporative processes. Include non-structural measures, such as liming to reduce acidity, and restoration treatments when not required to mitigate another project.

Results – Annual soil and water restoration averaged 111 acres from FY 2008 through FY 2016 (Table 23), exceeding Forest Plan objectives.

Table 23. Acres of soil or water resources protected, maintained or improved to achieve desired watershed conditions (FY 2008-2016)

Fiscal Year	Soil and Water Restoration (Acres)
2008	139
2009	71
2010	108
2011	42.5
2012	184.5
2013	125
2014	129
2015	95.5
2016	106
Total	1000.5

Discussion and Recommendations – See *3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*. Also, this question is already adequately addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*). As such, it is recommended to remove this question from the Monitoring Program to reduce redundancy.

3.8.2 Restore compositional/structural diversity of riparian areas

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many riparian acres have been treated to improve vegetative diversity? Have prescriptions improved riparian conditions for the benefit of riparian-dependent resources?	Acres of riparian area treated and effect of treatment	Annual	2 Years	FY 2013

Background – Forest Plan objectives include applying site-specific prescriptions to restore compositional and/or structural diversity of riparian corridors on 50 to 100 acres annually (USDA-FS 2007a, p. 19). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, as well as the Forest Plan goal of providing:

> Riparian areas that have dynamic, multi-age and multi-layered vegetative communities that promote floodplain structure, stream channel stability; aquatic diversity and natural recruitment of large woody debris and other sources of organics. Provide riparian areas that are occupied by vegetation that provide habitat for riparian dependent species (USDA-FS 2007a, p. 14).

Protocol – Vegetation treatments are proposed within riparian corridors to restore compositional and/or structural diversity of riparian corridors. Upon implementation, these acres are reported as acres of soil and water improvement and enhanced wildlife habitat. These treatments should then be monitored to determine effectiveness in restoring compositional and/or structural diversity.

Results – From FY 2008 through FY 2016, no site-specific prescriptions were implemented to restore compositional and/or structural diversity of riparian corridors.

Discussion and Recommendations – See *3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*. Also, this question is already adequately addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*). As such, it is recommended to remove this question from the Monitoring Program to reduce redundancy.

3.8.3 Status of water quality

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of water quality on the ANF?	Discussion of water quality monitoring and macroinvertebrate sampling	Annual	2 years	FY 2013

Background – This monitoring question addresses the Forest Plan goal to:

> Maintain or restore watersheds and their associated stream and groundwater processes, channel stability, riparian resources, and aquatic habitats to a functional condition. Provide quality, quantity, and duration of stream flow to maintain levels that support desired aquatic species or the most restrictive beneficial use (USDA-FS 2007a, p. 14).

This monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the:

- Status of selection watershed conditions;
- Status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems; and
- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities, and

The discussion of water quality monitoring will help identify whether water quality standards are being met throughout the Forest. This information is supplemented by an analysis of macroinvertebrate sampling as an indicator of the health of the streams on the ANF.

3.8.3.1 Monitoring indicator 1 – water quality monitoring

Protocol – Water quality data on the ANF is collected by Forest staff during various site surveys and fish sampling. State and federal agencies also collect water quality data on the ANF along with County Conservation Districts, Western Pennsylvania Conservancy (WPC), and Trout Unlimited (TU) Chapters. Information was gathered from internal and external sources to assess the status of water quality on the ANF.

Pennsylvania Department of Environmental Protection

Stream designation evaluations – The PA DEP is in charge of determining the designation of waters of the Commonwealth, as well as determining streams that are not meeting water quality standards. The DEP has approved protocols it uses for these determinations (see PA Code Title 25 Chapter 93: http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/025/chapter93/chap93toc.html&d=).

Aquatic Biology Investigation – In 2013, PA DEP examined 24 streams from six drainages across a variant of geologic formations to determine if they are impacted by natural acidification or acid deposition. Spring and fall macroinvertebrate surveys were conducted along with aluminum concentration sampling. In addition, the assessment sought to determine if impacts from acid deposition were enough to merit aquatic life use impairments. Per PA DEP, acid deposition aquatic life use impairment occurs when aquatic life appears to be depressed in a stream year-round from acidification. The stream should also exhibit dissolved aluminum concentrations greater than 150 ppb during high flows to conclude acidification is from precipitation, not due to natural conditions.

Western Pennsylvania Conservancy Shale Gas Study – As part of a broader monitoring effort across Pennsylvania, the WPC initiated an ecological assessment of areas of high ecological value that may be under threat from development activities associated with shale natural gas development (WPC 2015). The WPC assessment focused on obtaining baseline species and habitat data from specific locations that support rare and important wildlife species. In addition, WPC collected field measurements, grab samples, and macroinvertebrate data to characterize baseline conditions of water quality. The locations that were sampled in the ANF are shown in Figure 51.

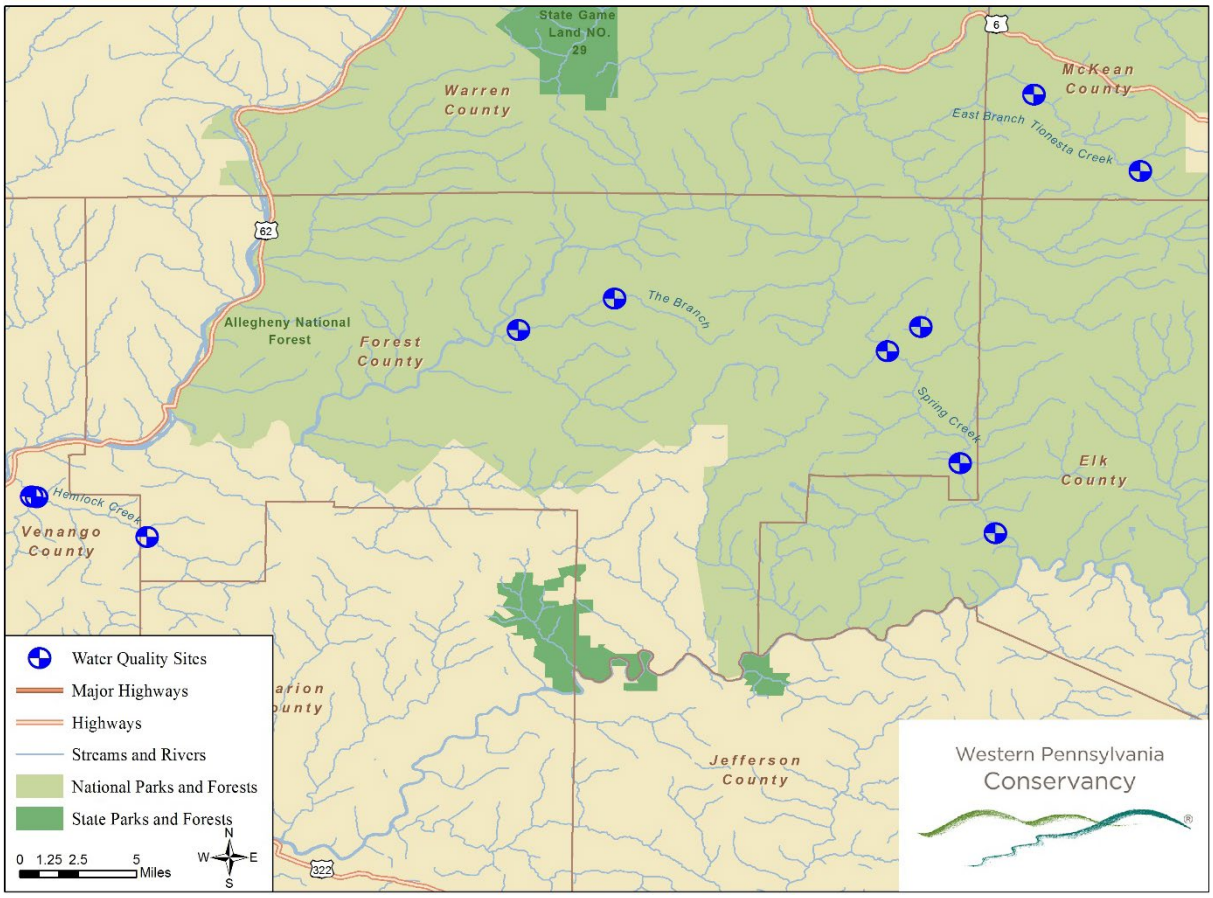


Figure 51. Study locations for WPC water quality monitoring on the ANF

Allegheny Reservoir Water Quality – The New York State Department of Environmental Conservation (NYS DEC), PA DEP, USACE, and SNI all collect and evaluate Allegheny Reservoir water data. These water data are used to determine if water quality is being maintained to protect the primary water uses of recreation and aquatic health.

WINs Coalition partners – The development of Marcellus extraction activities on public lands prompted WINs coalition partners to initiate a three-tiered program to help monitor activities and protect important water resources where needed. The first effort (Tier I) in the initiative was the deployment of TU trained Coldwater Conservation Corps volunteers to monitor local watershed activities in the region. In addition, more intensive water quality monitoring was conducted in the ANF through the operation of a network of stations in smaller sub-watersheds using data loggers (Tier II) and in larger basins using permanent multi-parameter real-time stations (Tier III) in areas targeted for Marcellus development. The monitoring approach was based on the successful network currently in use in the Susquehanna River watershed by the Susquehanna River Basin Commission.

In support of these efforts, the Colcom Foundation provided grants to the Iron Furnace Chapter of Trout Unlimited (IFTU), ECCD, and McKean County Conservation District (MCCD) to continue monitoring water quality in at-risk watersheds. In FY 2013, IFTU began working with the West Virginia Water Research Institute via the Three Rivers Quest Program to sample at ten locations in the Upper Allegheny Basin. The Three Rivers Quality Useful Environmental Teams (QUEST) initiative, given the acronym 3QR, is a water quality monitoring and reporting program for the Northern Allegheny River Basin. These data will supplement data collected by Duquesne University in the Lower and Middle Allegheny and by Wheeling Jesuit University in the Monongahela Basin. This project is also funded by the Colcom Foundation.

The 3QR program is split into four geographical regions: Northern Allegheny, Southern Allegheny, Upper Ohio, and Monongahela. In each region a mini-grant program was established to help facilitate the routine collection and sharing of water quality data by nonprofit organizations. The purpose of this program was to facilitate a regimented and continuous collection and sharing of water quality data in the Upper Ohio River Basin. MCCD applied for and was awarded a 3QR QUEST mini-grant administered by IFTU. Water quality data loggers were deployed in streams where drilling operations were occurring and/or were planned, including headwaters located on the ANF (Figure 52):

- MCCD currently has 16 Solinst data loggers with 10 deployed throughout McKean County.
- IFTU collected 3RQ grab samples at 11 locations in FY 2013, but only five in or nearby the ANF (Allegheny River at West Hickory, Tionesta Creek at Lynch, Tionesta Creek at Tionesta, Clarion River at Ridgway, and Clarion River at Cooksburg).
- Satellite Stations: IFTU has four of these within the ANF (Millstone Creek, Salmon Creek, Spring Creek, and Tionesta Creek). ECCD set up 11 real-time monitoring stations in municipal drinking water watersheds, including Big Mill Creek on the ANF, and 12 data loggers throughout Elk County.

- Streams with logger deployments: IFTU and the mini-grant partners (ECCD, MCCD, and WCCD) have loggers throughout ANF.

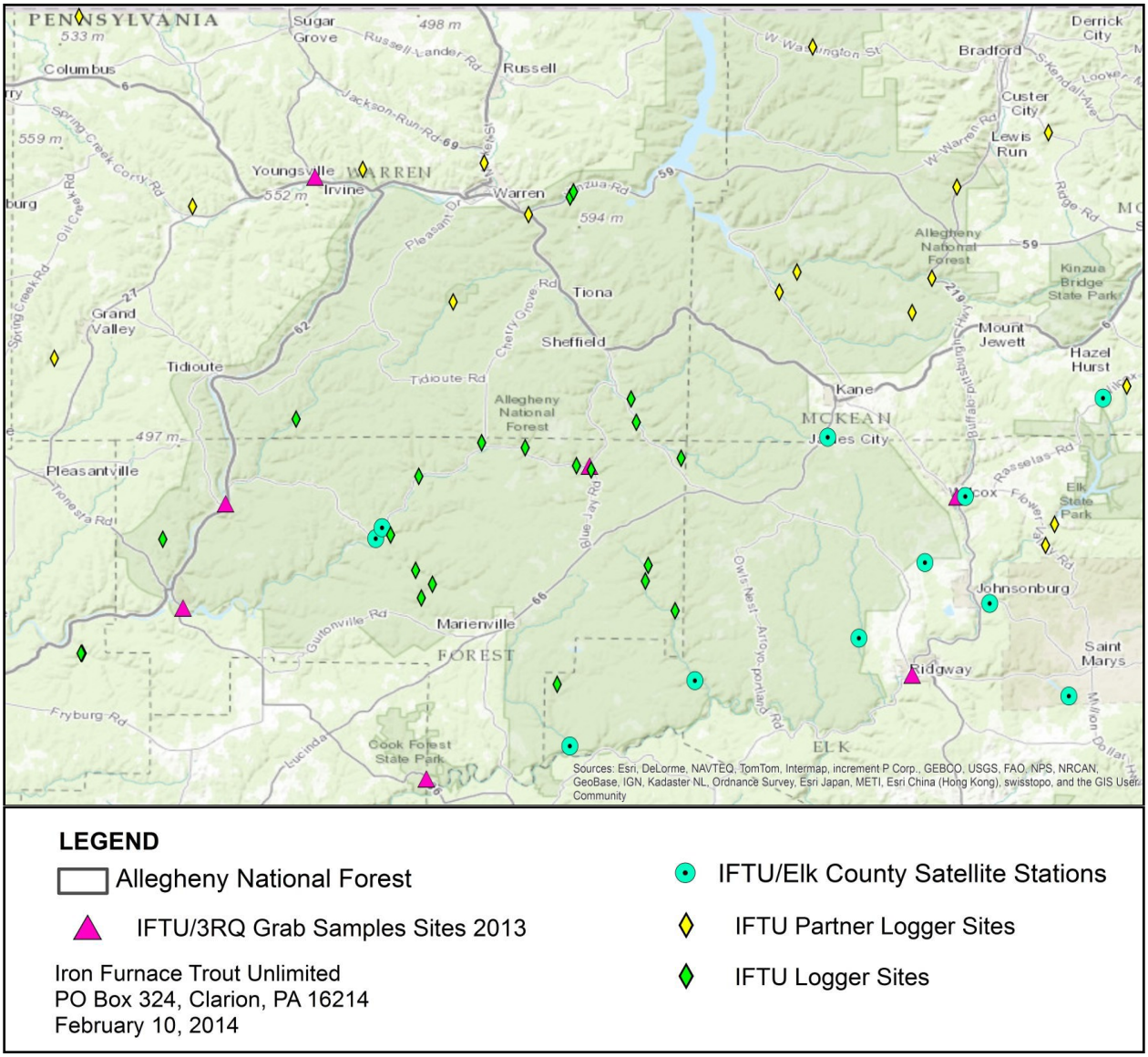


Figure 52. Location of water quality monitoring completed by partners in or near the ANF (IFTU)

Currently, these data are reviewed for indicators of pollution events, but not all of the data have been summarized or analyzed. When problem sites were identified, e.g., spikes in conductivity values or significant storm flow pH declines, follow-up occurred with the PA DEP and PFBC. These data will eventually be stored in the appropriate database (e.g., EPA Storet) so that it can be used for baseline data. In addition, the Forest Service has a database for water temperature data that will be used for analysis of effects from climate change.

Elk County acid precipitation water quality study – In the spring of 2008 and 2009, chemistry, habitat, and macroinvertebrate sampling was completed by PA DEP on 20 streams located in the

Clarion River Watershed (located in the Ohio River Basin) in Elk County, Pennsylvania. In the fall of 2012, 17 of those sites were resampled by PA DEP and ECCD to determine if the acidification present in many of the streams sampled is caused by acid precipitation or from another source. Sites with an IBI (see *3.8.3.2 Monitoring indicator 2 - macroinvertebrate sampling*) score of 63 or less (or close to it) both in the spring and in the fall samples were further examined by analyzing for dissolved aluminum. If the samples contained dissolved aluminum in concentrations over 150 mg/L, acid precipitation can be accredited for the source of the acidification problem.

All of the streams sampled but one (Lost Run) are located in the ANF. The following streams sampled are located in:

- Spring Creek Township: Cole Run (Stream Code 50178), Crow Run (Stream Code 50177), UNT to Bear Creek (Stream Code 50208), Davidson Run (Stream Code 50199), Crooked Run (Stream Code 50198), and Little Otter Run (Stream Code 50206).
- Millstone Township: Millstone Creek (Stream Code 49935), Winlack Run (Stream Code 49938), Wyncoop Run (Stream Code 50012), Steck Run (Stream Code 49998), Jakes Run (Stream Code 49988), Log Run (Stream Code 49979), Sugarcamp Run (Stream Code 49977), and East Branch Millstone Creek (Stream Code 49974).
- Ridgway Township: Pine Run (Stream Code 50437).
- Highland Township: Three Mile Run (Stream Code 50144).
- Fox Township: Lost Run (Stream Code 50397 for Sawmill Run UNT to 102667563).

Clarion University of Pennsylvania (oil and gas development effects on similar, adjacent watersheds) – In 2010, a study was conducted to compare the benthic macroinvertebrate communities in the Hedgehog Run and Grunder Run watersheds. While these two adjacent watersheds are similar in size and topography, the Hedgehog Run watershed has very little OGM development and the adjacent Grunder Run watershed has extensive development. Monthly kick-net samples were collected from slow and fast riffles at two sites from April to October. Water quality parameters, including pH, conductivity, temperature, dissolved oxygen, alkalinity, and total hardness were also collected. Turbidity measurements were collected by USGS water gauging stations in Grunder and Hedgehog every 15 minutes from June through October.

In addition to the 2010 sampling, this study reviewed previous surveys to provide insight on the history of the trends in water quality and the macroinvertebrate community of Grunder Run.

US Geological Survey sediment study – The Forest Service received funding from the National Energy Technology Laboratory in 2009 to fund various studies on the ANF. One of these projects funded the USGS to analyze sediment load in Grunder Run and Hedgehog Run. While these two adjacent watersheds are similar in size and topography, the Hedgehog Run watershed has very little OGM development and the adjacent Grunder Run watershed has extensive development (Table 24).

Grunder Run is located in a 3,171-acre watershed and has extensive OGM development, dirt and gravel roads, and off-highway vehicle trails. Approximately 84% of the drainage (2,657 acres) is

managed by the Forest Service. At the time of the study, there were 5.4 miles of mapped streams, one stone pit, and 412 recorded oil and gas wells (based on GIS data) in the drainage and there had been no timber harvest activity on NFS land since 2000. Many of the non-system roads in the Grunder Run watershed used for OGM development were constructed in the early 1980s by private oil and gas operators.

Hedgehog Run is primarily located in the Allegheny National Recreation Area and has almost no land-disturbing activity where NFS land is located in the 2,758-acre watershed. At the time of the study, this watershed had 6.8 miles of perennial and intermittent streams and 27 oil and gas wells (based on GIS).

Table 24. Comparison of total road mileage and road density within the Grunder Run and Hedgehog Run drainages, based on GIS

Drainage	Year	Acres	All Roads on all Ownerships		All Roads within 300' of a Stream on all Ownership		Forest Service Roads on all Ownership (Miles)	Forest Service roads within 300' of a stream (Miles)
			Total Miles	Road density (Miles/Mile^2)	Total Miles	Road density (Miles/Mile^2)		
Grunder Run	Oct. 2006	3,171	44.0	8.9	4.5	0.9	0.9	0.0
	April 2009		52.4	10.6	5.2	1.1	4.2*	0.0
	Nov. 2010		55.7	11.3	6.4	1.3	4.5	0.0
Hedgehog Run	Oct. 2006	2,758	9.0	2.1	0.2	0.1	1.0	0.0
	April 2009		8.6	2.0	0.1	0.1	1.0	0.0
	Nov. 2010		10.1	2.4	0.2	0.1	1.0	0.0

*This was not the result of new road construction between October 2006 and April 2009, but the result of a recalculation of miles in GIS.

The Forest Service collected 60 water samples in Grunder Run and 59 samples in Hedgehog from 2000-2007 (an average of six to seven samples per year) during high flow periods of which there were 52 sample pairs from the same storm event. USGS sampling began May 2010 and ended December 2010. They established two streamflow gages to measure continuous discharge and turbidity, and conducted manual and automatic sediment sampling. Due to a loss in project funds, USGS sampling did not continue past December 2010.

Results

Pennsylvania Department of Environmental Protection

Stream designation evaluations – Since 2007, the PA DEP has changed the water quality existing use designation of Wolf Run (Elk County, 14.5 miles) from a High-Quality (HQ) Cold Water Fishes (CWF) to an Exceptional Value (EV) stream, and Messenger Run (Warren County, 1.7 miles) and Porcupine Run (Forest County, 5.5 miles) from CWF to EV streams.

The DEP determines a list of streams that are not attaining water quality status every two years. The amount of impaired stream miles on the Forest has increased since 2007, but most of these miles of impaired streams were not caused by direct human activities on the ANF (Table 25). Atmospheric deposition was the cause of 35.8 miles of streams with acidic pH and high levels of metals, of particular concern to aquatic health is the concentration of aluminum. The streams include Big Mill Creek, Bear Creek, Crow Run, and East Branch of Millstone Creek. Previously listed (2003) streams included West Branch Millstone and East Branch Millstone Creek and the cause was natural sources of pH. It is more than likely that atmospheric deposition also contributed to this impairment. The Allegheny River and Tionesta Creek continue to be listed as impaired for fish consumption due to mercury deposition.

Table 25. Streams on the PA DEP impaired list within the ANF boundary

Stream Name	Year Listed	Water Use Impaired	Cause of Impairment	Stream Miles Impaired
East Branch Millstone Creek	2003	Aquatic Life	Natural Sources - pH	5.1
West Branch Millstone Creek	2003	Aquatic Life	Natural Sources - Metals ; Natural Sources - pH ; Natural Sources - Siltation	7.8
East Branch Millstone Creek	2013	Aquatic Life	Atmospheric Deposition - pH ; Atmospheric Deposition - Metals	14.2
Bear Creek	2013	Aquatic Life	Atmospheric Deposition - pH ; Atmospheric Deposition - Metals	9.3
Big Mill Creek	2013	Aquatic Life	Atmospheric Deposition - pH ; Atmospheric Deposition - Metals	8.4
Bump Run	2013	Aquatic Life	Petroleum Activities - Siltation ; Petroleum Activities - Oil and Grease	3.03
Crow Run	2015	Aquatic Life	Atmospheric Deposition - pH ; Atmospheric Deposition - Metals	3.9
Bobbs Creek	2015	Fish Consumption	Source Unknown - Mercury	0.02
Kingsley Run	2015	Fish Consumption	Source Unknown - Mercury	0.7
Phelps Run	2015	Fish Consumption	Source Unknown - Mercury	0.18
Tionesta Creek	2006	Fish Consumption	Source Unknown - Mercury	38.3

Stream Name	Year Listed	Water Use Impaired	Cause of Impairment	Stream Miles Impaired
Allegheny River	2006	Fish Consumption	Source Unknown - Mercury	87
Dutchman Run	2006	Aquatic life	Package plants, removal of vegetation, on-site wastewater	3.6

Aquatic Biology Investigation – Six streams had dissolved aluminum concentrations greater than 150 ppb during spring snow melts and rain events. Five of these six streams (Rocky Run, Cherry Run, an upper reach of Big Mill Creek, Bloody Run, and Pine Run) have been added to Category 5 of the Integrated Water Quality Report (IWQR) in need of a total maximum daily load for the source and causes of "Atmospheric Deposition - pH" and "Atmospheric Deposition - Metals". Additionally, the source of impairment for Gurgling Run, which was added to Category 5 of the IWQR in 2003, was changed from "Natural Sources" to "Atmospheric Deposition", with the causes of "pH" and "Metals".

While the other 18 streams are likely impacted by acidification to varying degrees, they were not enough to be considered impaired. They will be added to Category 1 or 2 of the IWQR as attaining their designated aquatic life uses.

An additional PA DEP survey in the Clarion River basin indicates that seven additional streams on the ANF will likely be listed as impaired due to acid deposition once data collection is complete. Most of these streams have alkalinity of < 2 and pH < 5.0 in the spring.

See *3.8.3.2 Monitoring indicator 2 – macroinvertebrate sampling* for additional results from the macroinvertebrate sampling conducted.

Western Pennsylvania Conservancy Shale Gas Study – WPC sampled water quality in streams quarterly from 2013 to 2015. Macroinvertebrates were collected twice a year during spring and fall visits from 2013 to 2014.

The grab samples collected assessed potential pollution from shale gas by looking at specific chemicals associated with development impacts such as barium, strontium, and chloride. The findings of the water quality samples showed that the sites on the ANF met EPA safe drinking water standards (EPA 2009). Results and findings are presented in *Assessment of High Value Ecological Areas in Pennsylvania's Shale Region* (WPC 2015). WPC will continue monitoring these sites over the next two years.

Macroinvertebrate communities were evaluated at each site using a variety of statistical indices. These indices allow for a general assessment of the health of a stream based on the results of the evaluation.

The Pollution Tolerance Index (PTI) measures the likelihood of pollution by assigning a PTI value to an organism or group of organisms. SPC4, in the Spring Creek Focal Area in the Allegheny National Forest, showed variation in PTI scores compared to other sites in the focal area. SPC4 was ranked "fair" in fall 2013, and "good" in both 2014 samples, where all other

Spring Creek sites were consistently ranked excellent. SPC4 lacked dragonflies as well as Elmidae and Psephenidae beetles, lowering the PTI for this site.

Hilsenhoff (B), a measure of organic pollution in a waterbody, was generally in good health across monitoring sites with a few exceptions. Five sites in their evaluation area were ranked "fair" (10 percent), suggesting somewhat significant organic pollution. These included East Branch Tionesta Creek (EBTC3) on the ANF. However, the town of Kane is in the headwaters of this watershed and may be contributing this condition.

Following two years of study, most sites had expected values when habitat and water quality data were evaluated together; lower scores in indices for aquatic quality, such as the PTI and Hilsenhoff (B) ranks were associated with lower habitat value scores. There were no correlations between water quality indices (e.g., PTI) and the presence of shale gas wells upstream.

Allegheny Reservoir Water Quality – The NYS DEC has reviewed data regarding the water quality of the Allegheny Reservoir. The reservoir has been listed as impaired in New York for nutrients (phosphorus), harmful algal blooms (HAB), and algal plant growth (native). Another potential pollutant identified by New York is mercury deposition. Pennsylvania has the reservoir listed for fish consumption due to mercury deposition, but does not have an impairment for nutrients. The fish consumption advisory in Pennsylvania recommends limiting consumption of small mouth bass to no more than two meals per month due to mercury levels; this advisory is more restrictive than the New York State advisory.

In response to the HAB, the USACE, in coordination with the SNI, initiated the HAB Response Plan. This plan requires weekly algae sample collection during the summer months, compliance with World Health Organization (WHO) Cyanobacteria or blue-green algae (BGA) cell count guidelines, and signage at reservoir access points to protect those recreating in the reservoir throughout the duration of the bloom.

Sampling by the USACE from 2012 through 2016 showed the reservoir has a high susceptibility for HAB. Specifically, high levels of BGA were found in several locations in New York and the northern section of the reservoir in Pennsylvania. The HAB problem seems to decrease significantly starting at Sugar Run Bay as sampling occurs from the north to the south. In addition, Wolf Run, near State Route 59, rarely had high levels of HAB.

BGA can produce cyanotoxins that are harmful to humans, pets, and aquatic life with exposure. The WHO Advisory level for exposure to BGA is 20,000 cells/ml, the Caution level is 100,000 cells/ml, and the Extreme Caution level is >10,000,000 cells/ml. In response to these findings, land managers have posted HAB Advisory and Caution level signs at lake access points during periods of the summer.

WINs Coalition partners – Figures 53 – 55 represent water chemistry data from 11 stream locations. Differences in alkalinity were observed between sites in watersheds draining glaciated land types verses sites in watersheds draining unglaciated land types (Figure 53). Sulfate levels were low in most streams except in the Clarion River which may be due to acid mine drainage

located in the watershed but off the ANF (Figure 54). Specific conductivity values were low for the sites in Tionesta Creek, but much higher on the Clarion River (Figure 55).

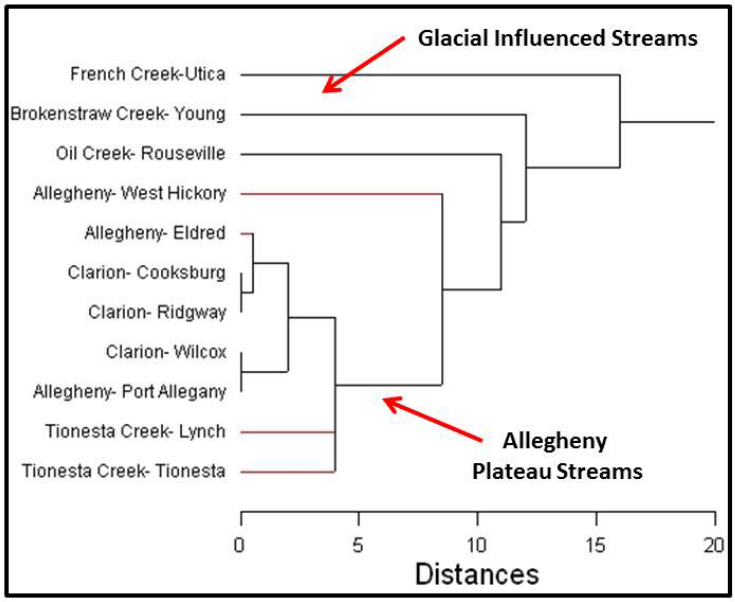


Figure 53. Comparison of alkalinity (mg/l as $CaCO_3$) at 11 sites in the upper Allegheny basin (January – December 2013; Bruce Dickson, IFTU)

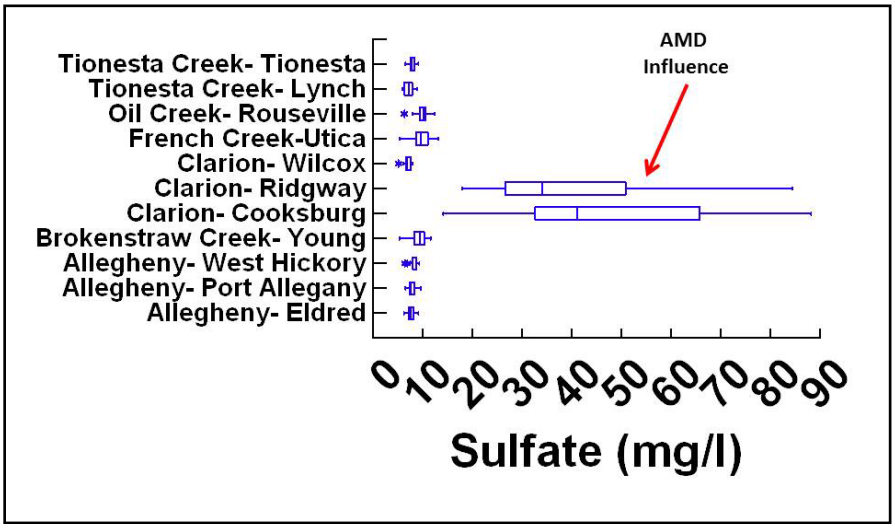


Figure 54. Comparison of sulfate values (mg/l) at 11 sites in the upper Allegheny basin (January – December 2013; Bruce Dickson, IFTU)

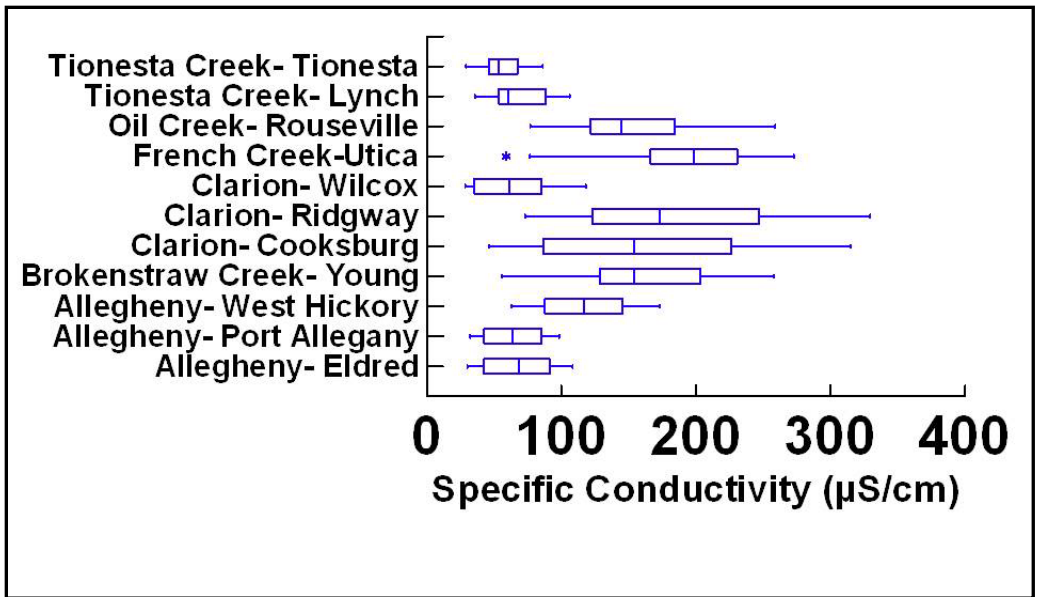


Figure 55. Comparison of specific conductivity (µS/cm) at 11 sites in the upper Allegheny basin (January – December 2013; Bruce Dickson IFTU)

A stream pollution event was documented on Hunter Creek in July 2012 during routine site evaluation for a large wood project. American Refining Group has a waterflood project in this area and one of their lines began discharging brine into the stream. PA DEP followed up to test the discharge behind well WT 3664 07 (047-21912) from the pipe/line on July 18, 2012. Specific conductivity exceeded water quality standards at 2640.00 µS/cm. Total dissolved solids was 2,064 ppm, chloride was 817.3 ppm, and manganese was 240 ppb. Methane was 12.0 ppb, ethane 12.4 ppb, and propane was 14.2 ppb.

Hunter Creek was sampled again on August 30, 2012, at 12:30pm (water temp-14.4ºC, pH-6.9, conductivity- 679 µS/cm). On this date, ECCD placed a continuous meter in this stream to monitor fluctuations in conductivity. Streams in this area usually have a conductivity value less than 100 µS/cm, but this stream was much higher. The water quality standard for conductivity is 1,000 µS/cm. This stream had a short exceedance of this value for four days in October 2012 (Figure 56). Sometime in late October, it appeared the problem was corrected. By January, conductivity was measuring 104 µS/cm. Site reviews conducted during the course of the sampling noted sediment covering the bottom of Hunter Creek.

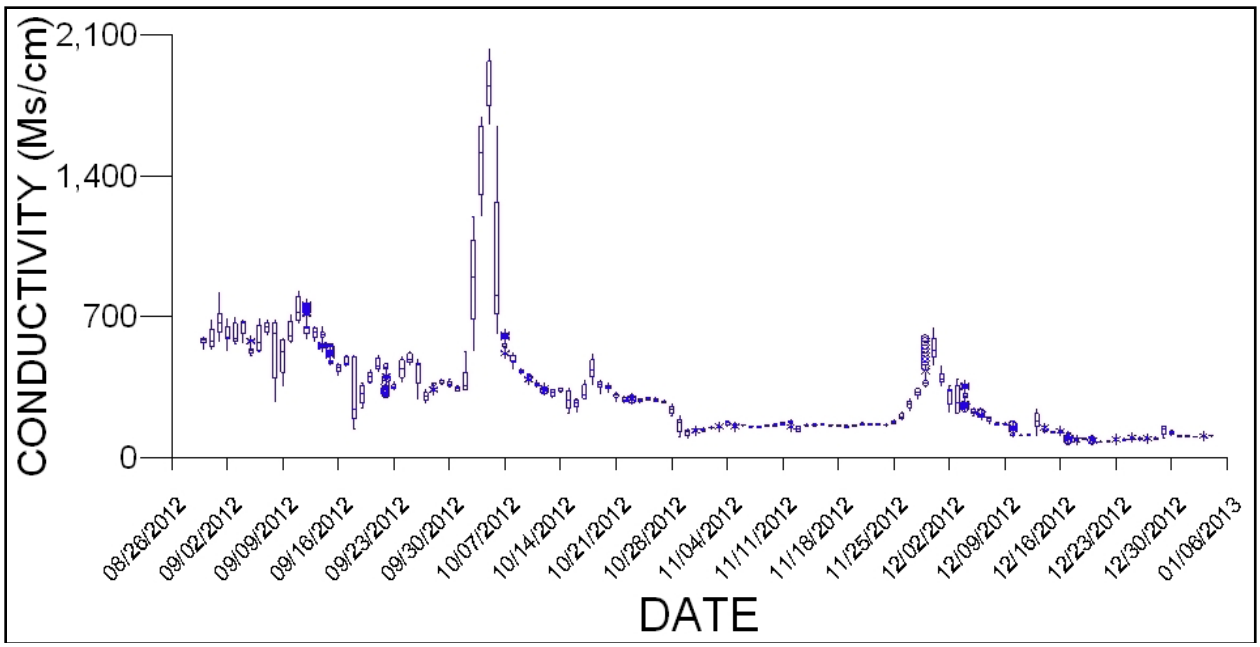


Figure 56. Specific conductivity (µS/cm) in Hunter Creek (August 28, 2012-January 8, 2013; ECCD)

Elk County acid precipitation water quality study – Of the 17 streams sampled in the Clarion River Watershed, 71% of the streams were found to be impacted by acidification with another 12% found to be partially impacted by acidification (Table 26). All of the affected streams (83%) lie within the ANF. In the 2008-09 sampling, the pH ranged from 4.8 to 6.5 with an average of 5.3. In the 2012 follow-up sampling, the pH ranged between 4.79 and 7.30 with an average pH of 5.8. Only four of the streams in both studies showed a neutral pH while all others were acidic in both the spring and fall. Water chemistry readings from both biological assessments indicated low alkalinity concentrations (0-10 mg/l) and low conductance values (26-130 µS/cm). Habitat sampling showed 14 sites were optimal and 3 sites (Three Mile Run, Crooked Run, and Little Otter Run) were suboptimal (Bonfardine 2014).

Table 26. Number of streams in the Elk County water quality study impacted by acidification

	# of Streams	Percent of Streams Sampled
Not Impaired	2	12
Impacted by Acidification	12	71
May be Impacted	1	6
Somewhat/partially Impacted	2	12
Total	**17**	**100**

Clarion University of Pennsylvania (oil and gas development effects on similar, adjacent watersheds) – Between the 1982 and 1984, water quality as well as macroinvertebrate abundance and diversity surveys showed great improvement, "the macroinvertebrate community is more diverse, has higher abundance, and contains more sensitive taxa such as Trichoptera than when compared to the 1982 survey" (Harris 2011b). Hardness and conductivity had decreased from

an average hardness of 107 ± 7ppm to 62 ± 3ppm and an average specific conductivity of 630 ± 28µS/cm to 268 ± 21µS/cm (Harris 2011b).

The 1993 and 1994 survey reports showed Grunder Run showed continued, but slight improvement with a few more taxa and slightly higher abundances (Harris 2011b). Surveys completed by Clarion University of Pennsylvania in 2008 found considerably more taxa with much higher abundances; however, this study also had a much higher sampling effort than the previous studies, thus they could not directly compare them (Harris 2011b). Water quality measurements showed an average alkalinity of 32 ± 4mg/L and an average specific conductance of 112.5 ± 30.3µS/cm, which is much reduced from the 1985 study (Harris, 2011b). Also, a much greater richness and abundance of taxa was identified, most likely due to the increased sampling effort.

The 2010 surveys measured a slightly higher average hardness (47 ± 27mg/L) and average specific conductance (136 ± 47.3µS/cm). These slightly higher levels did not exceed limits that are harmful to aquatic life. See *3.8.3.2 Monitoring indicator 2 - macroinvertebrate sampling* for additional results from the macroinvertebrate sampling conducted in 2010.

US Geological Survey sediment study - The USGS estimated sediment loads and yields combined Forest Service and USGS data. Greater sediment load and yield occurred at Grunder Run (Figure 57 and 58). The limited data suggest sediment yields at both sites are indicative of predominately forested basins when compared to other sediment load data throughout Pennsylvania (Figure 59); however, the sediment yield in Grunder Run is the highest when compared against other forested watersheds.

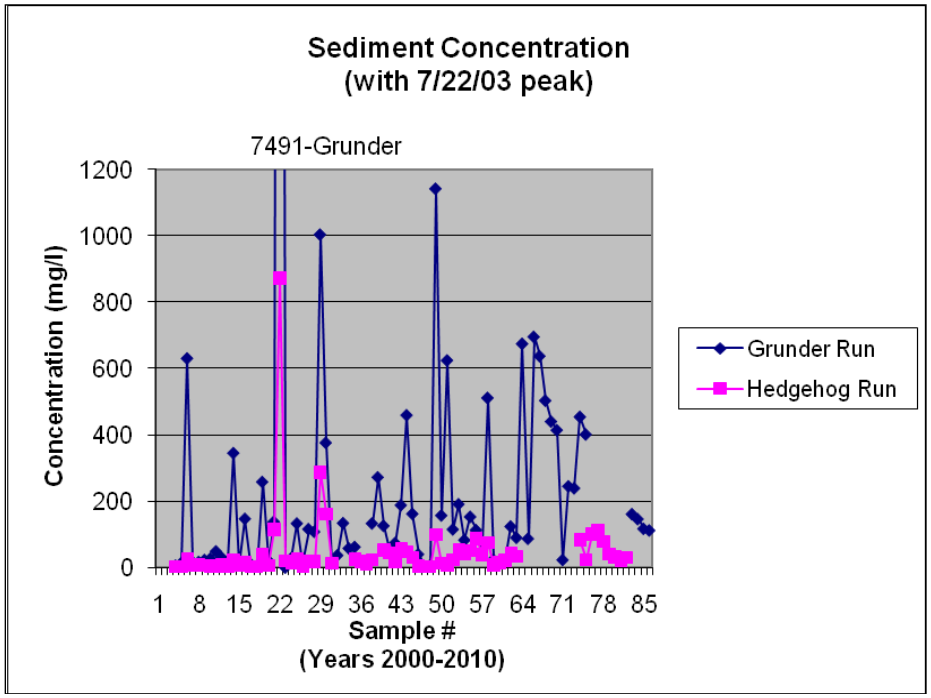


Figure 57. Sediment concentrations from water samples taken from Grunder Run and Hedgehog Run (2000-2010)

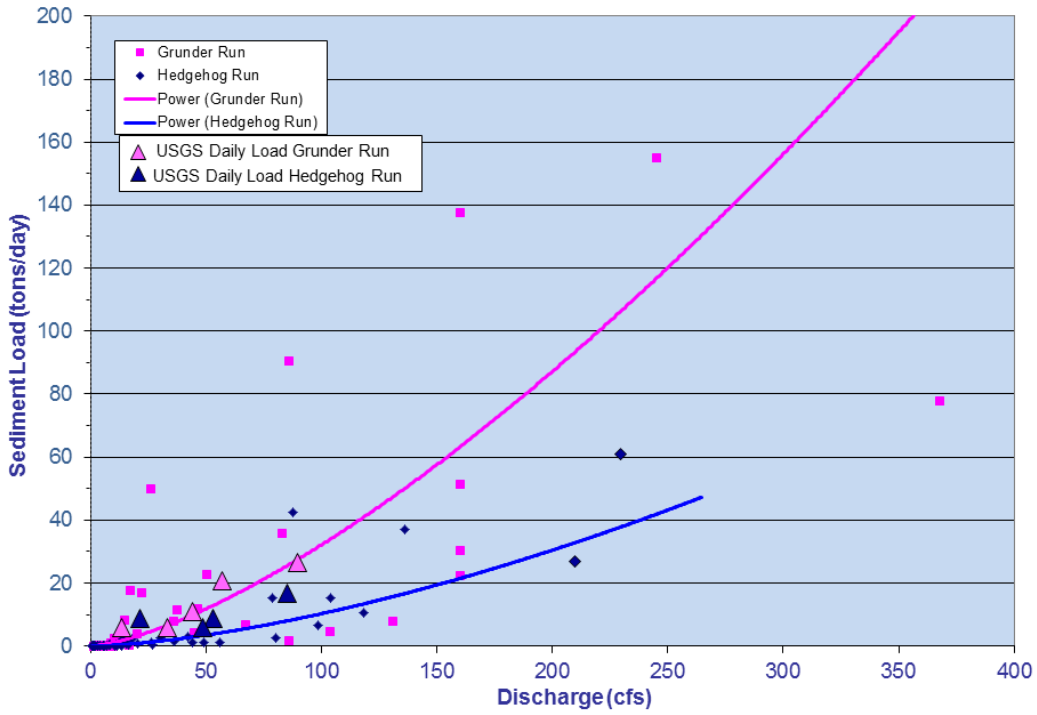


Figure 58. Comparison of sediment load in Grunder Run and Hedgehog Run

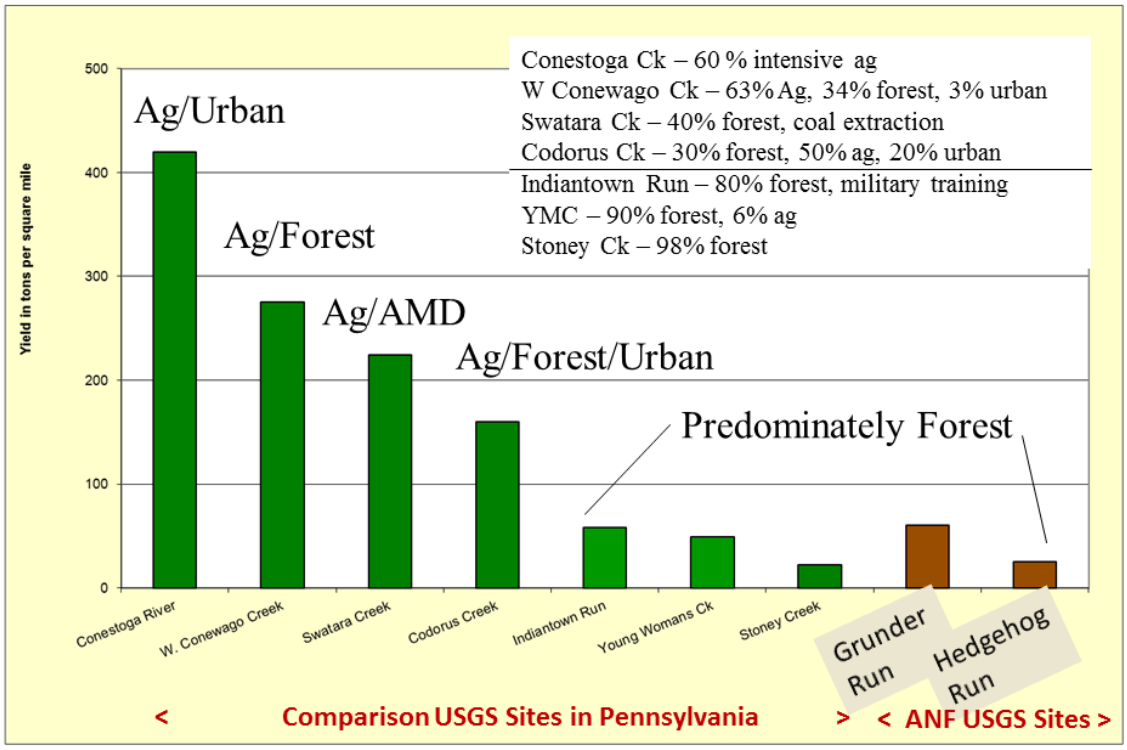


Figure 59. Comparison of sediment yield in drainages with various levels of disturbance throughout Pennsylvania

Discussion – The majority of streams on the ANF are meeting state water quality standards. This is shown by the number of miles of high-quality streams and recent upgrades in water quality class. Impairments are most frequently related to acid deposition or acidity from natural sources. This is typically only causing impairments on 1st or 2nd order streams, while the mainstem of streams have reduced productivity, they are not impaired. Larger streams are lower on the landscape and likely are recharged by groundwater with more buffering capacity. Additional pH and alkalinity data collection will provide supporting information for the evaluation of water quality.

Since 2007, no streams have been removed from the impaired list within the ANF, however conditions are likely to have improved in some impaired watersheds. The DEP is expected to conduct follow-up studies to determine if streams have improved or to develop plans to improve the stream water quality. Impairments related to oil spills, such as Chappel Fork and Bump Run are expected to return to normal levels once the oil deposits are flushed from the stream system. Dutchman Run is impaired due to septic discharges, but now that the Warren wastewater treatment has extended into Clarendon, this nutrient loading should cease, and water quality and macroinvertebrates are expected to return to normal levels. Dutchman Run is also listed for lack of riparian vegetation. The removal of the fire pond dam on Dutchman Run in 2016 should help improve water quality conditions by restoring a flowing stream channel lined with riparian vegetation. This will reduce stream temperatures and improve dissolved oxygen.

WPC found that the baseline of chemical and biological parameters demonstrates that streams within the focal areas of this study were of relatively high quality. Future monitoring conducted by WPC should be reviewed to identify trends in the data or areas of concern that require additional monitoring. Obtaining baseline data is critical to assess the extent of impacts, if any, or conversely recovery, and to inform policies and regulations to avoid impacts to other areas and minimize them through adaptive management.

The algal blooms and nutrient loading of the Allegheny Reservoir will require reductions in phosphorus and sediment in order for water quality improvements to be observed. Specifically, a waterbody-specific nutrient reduction and allocation strategy, known as a Total Maximum Daily Load (TMDL) plan, will need to be developed by NYS DEC to determine the specific sources of phosphorus in the reservoir. A nutrient reduction plan for the reservoir watershed will be complex because the watershed is fed by more than 1,608 square miles across multiple landowners and land management activities in Pennsylvania and New York. In addition, other conditions such as weather, stream flow, sunlight, sediments, and ecological attributes can all affect the growth of algae into blooms. Possible measures to reduce nutrient supplies to the reservoir include the following: a comprehensive stormwater program focuses on reducing runoff from urban areas and construction activities; improvements to wastewater treatment plant discharges and onsite septic systems will help reduce phosphorus levels; and nutrient management from agricultural sources, which is the focus of the Concentrated Animal Feeding Operations program (NYSFOLA 2009). More information will need to be collected in order to determine the most effective measures for reducing the occurrence of algal blooms.

Data collected by TU and Conservation County District partners indicate that Tionesta Creek and Clarion River have low levels of alkalinity related to the unglaciated geology in the watershed.

The sulfate and conductivity levels in the Clarion River are still impacted by acid mine drainage, but water quality is much improved compared to historic levels. The monitoring of conductivity has proven to be a valuable tool for the identification of brine leaks from OGM development.

Water chemistry readings from biological assessments conducted in Elk County showed low alkalinity concentrations (0-10 mg/l) and low conductance values (26-130 µS/cm); both characteristics are typical for streams on the ANF. The reduced buffering capacity of the surface water makes the entire watershed vulnerable to sporadic low pH values stemming from large rain events and runoff from spring snowmelt. Continual acidification and low alkalinity are certainly a threat to these streams and will have toxic effects on the aquatic life, primarily in the headwaters. Water chemistry is and will be the most probable future stressor to the health of the streams and watersheds.

The main issue for the slightly lower habitat scores at Three Mile Run, Crooked Run, and Little Otter Run in Elk County were low scores in embeddedness and sediment deposition. This sedimentation is likely related to roads depositing silt and sediment in streams. Overall physical habitat scores were slightly better than overall IBI scores for macroinvertebrates indicating that aquatic habitat is not the limiting factor in streams. Water quality is more limiting for macroinvertebrates in numerous streams due to low pH and alkalinity.

The study of Grunder Run and Hedgehog Run watersheds revealed that sedimentation is higher in the oil and gas impacted watershed compared to a watershed with very low development; however, the macroinvertebrate studies did not detect a negative impact to water quality from this development. Due to the increased sediment load in Grunder Run compared to Hedgehog Run, remediation of roads in this watershed would reduce sediment loads.

Recommendations

1. Treatment facilities for streams impacted by acid deposition should be implemented in additional watersheds and monitored.
2. Continue to monitor HAB in the Allegheny Reservoir and post signs at access areas when WHO values are exceeded.
3. Water quality data collected by partners should be stored in the appropriate depository so that it can be used for baseline data.
4. Continue to monitor conductivity at various sites to identify problems that occur from OGM development.
5. Address sedimentation problems identified in Elk County on the following streams: Three Mile Run, Crooked Run, Steck Run and Little Otter Run. In addition, sedimentation was observed in the Hunter Creek watershed and the roads in this watershed should be reviewed.
6. Mitigation of roads in the Grunder Run watershed is needed to reduce the sediment loads. The monitoring of sediment loads should continue at Grunder Run and Hedgehog Run as funding permits.

3.8.3.2 Monitoring indicator 2 – macroinvertebrate sampling

Protocol – Data were gathered from benthic macroinvertebrate surveys completed by the Clarion University of Pennsylvania, PA DEP, and USACE. All three utilized the EPA's Rapid Bioassessment Protocols or a modification there of.

Clarion University of Pennsylvania (potential impacts of oil and gas development) – In 2008, Clarion University of Pennsylvania completed a study to assess the potential impact of OGM development on aquatic macroinvertebrates on the ANF. Macroinvertebrates were collected at three seasonal intervals (early summer, late summer, and fall/winter) from 26 sites located on 18 streams on the ANF. Sampling sites were situated in areas of active OGM development, in areas of little or no development, and in areas where future development was anticipated. At the same time as biological sampling, water quality parameters, including pH, conductance, alkalinity, hardness, dissolved oxygen, and temperature were measured at each site. Physical parameters, such as stream width and stream depth, were also recorded at each site.

Clarion University of Pennsylvania (Chappel Fork oil spill) – Over the weekend of August 16-17, 2008, there was an intentional discharge of crude oil into Chappel Fork by disgruntled employees of an oil and gas company. Approximately 45,000 gallons were released from storage units, about half of which made it through containment facilities into Indian Fork and the lower reaches of Chappel Fork. Approximately six miles of Chappel Fork upstream from Chappel Bay and two miles of Indian Fork were contaminated with the released oil.

As part of their assessment of the potential impacts of OGM development, Clarion University had established a sampling site within the area heavily polluted by the oil release. They had collected two sets of samples prior to the oil spill, on May 30 and August 5, 2008, and one set of samples following the spill on December 30, 2008.

Pennsylvania Department of Environmental Protection (Chappel Fork oil spill) – In response to the Chappel Fork oil spill, PA DEP conducted an aquatic biology investigation of the Chappel Fork watershed on September 16-18, 2008. The survey in part involved macroinvertebrate sampling at nine stations within the watershed on Indian Run, North Fork Chappel Fork, and Chappel Fork. PA DEP also conducted a second aquatic biology investigation of the basin in September 2009.

Pennsylvania Department of Environmental Protection (Instream Comprehensive Evaluation surveys) – Section 303(d) of the federal Clean Water Act (CWA) requires Pennsylvania to identify all waters within the Commonwealth whose water quality limited segments require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. Water quality limited segments are defined as waterbodies that do not meet water quality standards even after the application of technology-based treatment requirements to point and nonpoint sources of pollution. To investigate and determine possible sources and causes of impairment, biological, physical and chemical data are collected and analyzed.

PA DEP routinely samples benthic macroinvertebrates as part these surveys and follows the Instream Comprehensive Evaluation (ICE) Surveys sampling methodology (PA DEP 2013a). An Index of Biotic Integrity (IBI), used as part of the ICE surveys, measures the extent to which

anthropogenic activities compromise a stream's ability to support healthy aquatic communities through direct quantification of biological attributes along a gradient of ecosystem conditions. Each of the six IBI metrics exhibits a strong ability to distinguish between relatively pristine and heavily impacted conditions. In addition, each metric measures a different aspect of the benthic macroinvertebrate community. Taken together as the IBI multi-metric index, they provide a solid foundation for assessing the biological condition of benthic macroinvertebrate assemblages in Pennsylvania's wadeable, freestone, riffle-run stream ecosystems. An aquatic life use impairment threshold has been defined as an IBI score less than 63.

As part of a statewide effort from 2008 to 2016, PA DEP collected macroinvertebrate data at 252 streams in 37 watersheds partially or entirely overlain by the ANF. These tabular data were received from PA DEP in 2013.

U.S. Army Corps of Engineers (macroinvertebrate surveys on tributaries to Allegheny Reservoir) – In 2006, the USACE began collecting macroinvertebrate and water quality data from streams tributary to Allegheny Reservoir. Each year they continued to sample 5-10 streams with the goal of obtaining baseline information for each of the named streams. Most have no historical data that could be used for reference should future impacts occur (e.g., Chappel Fork oil spill in 2008). A second, equally important goal is the identification of possible sources and causes of impairment from point or non-point source pollutants.

Clarion University of Pennsylvania (oil and gas development effects on similar, adjacent watersheds) – In 2010, a study was conducted to compare the benthic macroinvertebrate communities in the Hedgehog Run and Grunder Run watersheds. While these two adjacent watersheds are similar in size and topography, the Hedgehog Run watershed has very little OGM development and the adjacent Grunder Run watershed has extensive development. Monthly kick-net samples were collected from slow and fast riffles at two sites from April to October. Water quality parameters, including pH, conductivity, temperature, dissolved oxygen, alkalinity, and total hardness were also collected. Turbidity measurements were collected by U.S. Geological Survey (USGS) water gauging stations in Grunder and Hedgehog every 15 minutes from June through October.

In addition to the 2010 sampling, this study reviewed previous surveys to provide insight on the history of the trends in water quality and the macroinvertebrate community of Grunder Run.

Pennsylvania Department of Environmental Protection (Aquatic Biology Investigation) – In 2013, PA DEP examined 24 streams from six drainages across a variant of geologic formations to determine if they are impacted by natural acidification or acid deposition. Spring and fall macroinvertebrate surveys were conducted along with aluminum concentration sampling.

Results

Table 27. Aquatic invertebrate surveys completed on the ANF (2008-2013)

Year	Assessor (Study)	Objective	Conclusions
2008	Clarion University of Pennsylvania (Harris 2011a)	Assess potential impacts of OGM development	No observable differences between populations from sites located in areas of active OGM development and those of undeveloped areas
2008	Clarion University of Pennsylvania (Harris 2011a)	Assessment of oil spill in Chappel Fork	Clear detrimental impacts to the macroinvertebrate fauna of the stream
2008-2013	PA DEP (Pulket pers. comm. 2013)	ICE Surveys-assess the extent to which anthropogenic activities compromise a stream's ability to support healthy aquatic communities	80% of the 252 streams sampled on the ANF are meeting or exceeding their water quality standards based on this IBI. Impairments are most frequently related to acid deposition or acidity from natural sources. Other impairments are related to the Chappel Fork oil spill or nutrient impairments.
2008-2013	USACE (Reilly pers. comm. 2014)	Macroinvertebrate surveys on tributaries to Allegheny Reservoir	No major issues detected; "most have beautiful bugs"
2010	Clarion University of Pennsylvania (Harris 2011b)	OGM development effects on similar, adjacent watersheds	No significant differences in macroinvertebrate communities
2013	PA DEP (PA DEP 2013b)	Aquatic Biology Investigation-acidification study on 24 streams in six drainages	37.5% failed to attain threshold; 25% had episodic dissolved; aluminum >150 ppb; Six streams added or changed to Category 5 of the Integrated Water Quality Report for "Atmospheric Deposition - pH" and "Atmospheric Deposition - Metals"; Two streams listed as impaired from "natural sources".

Clarion University of Pennsylvania (potential impacts of oil and gas development) – Results indicated that all sampled streams are within the bounds of water quality established by the PA DEP. Results of the biological sampling suggest that differences in macroinvertebrate populations in the sampled streams appear to be related to watershed location and stream size, with no observable differences between populations from sites located in areas of active OGM development and those of undeveloped areas.

Clarion University of Pennsylvania (Chappel Fork oil spill) – In terms of water quality before and after the oil spill, there was no detectable difference in the parameters measured. However, there was a significant difference in the aquatic macroinvertebrates collected before and after the oil spill. In most streams sampled, the greatest number of individuals and taxa were collected in the early summer and fall/winter collections, but in Chappel Fork, macroinvertebrate diversity and abundance were lowest in the fall/winter collection following the oil spill.

Although the total numbers were similar to those of the late summer collections, the number of taxa was reduced from 26 to 16, with the oligochaetes being the dominant taxa following the spill. The substrate during this collection was still oily and it is not surprising that the tolerant worms were the only group prospering. A comparison of the biotic indices from before and after the spill reinforces these observations. The Shannon-Wiener Diversity was markedly decreased while the Shannon Index tripled indicating most organisms were in only a few taxa. The Hisenhoff Index increased to 7.6 following the spill, a number which is indicative of a poor aquatic ecosystem. Interestingly, the proportional composition of functional feeding groups for the site was little changed following the oil spill, although the numbers comprising each group were reduced.

When the macroinvertebrate data were clustered in terms of presence or absence a definite pattern emerged. Based on the early and late summer collections, Chappel Fork was most similar to Four Mile Run, a stream not impacted by OGM development, but in the fall/winter collection Chappel Fork was separated from all other sampled streams with no similarity. In the final analysis where similarities were compared across all dates, Chappel Fork again clustered separately from all other streams.

Pennsylvania Department of Environmental Protection (Chappel Fork oil spill) – The results of PA DEP's 2008 investigation showed that the oil spill caused significant damage to the benthic macroinvertebrate community within approximately 2.6 miles of the North Fork, 1.4 miles of Indian Run and 2.2 miles of Chappel Fork. Macroinvertebrate mortality was extremely high and aquatic insects were found in various degrees of decomposition. This indicated that macroinvertebrate mortality was still occurring after a month from when the oil spill first occurred (PA DEP 2009b).

The results of the 2009 investigation showed improvement in the benthic macroinvertebrate community. The density of aquatic insects had increased when compared to the 2008 investigation; however, scores remained below the threshold of 63.0 (PA DEP 2011).

Pennsylvania Department of Environmental Protection (Instream Comprehensive Evaluation surveys) – The preliminary results from this monitoring show that 80% of the 252 streams sampled on the ANF are meeting or exceeding their water quality standards based on IBI.

U.S. Army Corps of Engineers –(macroinvertebrate surveys on tributaries to Allegheny Reservoir and River) – The streams surveyed by the USACE from FY 2008 through FY 2013 are listed in Table 28. Analysis of the results and calculation of IBI scores is forthcoming; however, per Rose Reilly, USACE, no major issues have been detected and "most of the streams have beautiful bugs".

Table 28. USACE macroinvertebrate collections from tributaries to the Allegheny Reservoir and River (2008-2013)

Location	Date Sampled	Station Code
Allegheny River, Billies Run	05/22/08	2240
Brothwell Run	05/22/08	2244
Pigeon Run	05/22/08	2246
Wolf Run	05/22/08	2202
Allegheny River, Hemlock Run	05/19/09	2214
Allegheny River, Morrison Run	05/19/09	2212
Cornplanter Run	05/19/09	2260
Johnny Cake Run	05/19/09	2258
North Branch Hodge	05/19/09	2256
Campbell Run	05/20/10	2204
Dewdrop Run	05/20/10	2206
Dutchman Run	05/20/10	2210
Mud Lick Run	05/20/10	2226
South Branch Hodge Run	05/20/10	2254
Nelse Run	05/21/10	2248
North Branch Tracy Run	05/21/10	2264
Polly's Run	05/21/10	2242
Tracy Run	05/21/10	2262
Peters Run	05/17/11	2277
South Branch State Line Run	05/17/11	2270
Chappel Fork	04/04/12	2220
Kinzua Creek	04/04/12	2233
Meade Run	04/04/12	2234
South Fork Kinzua Creek	04/04/12	2231
Willow Creek	04/04/12	2268
Brothwell Run	04/05/12	2244
Pigeon Run	04/05/12	2246
Wolf Run	04/05/12	2202
Total Collections (2008-2013)	**39**	

Clarion University of Pennsylvania (oil and gas development effects on similar, adjacent watersheds) – Grunder Run had generally higher overall abundance, overall taxa richness, EPT (Ephemeroptera-mayfly, Plecoptera-stonefly, and Trichopera-caddisfly) richness, EPT abundance, percent EPT, and EPT vs. Chironomidae abundance for most months and for the year. Hedgehog Run generally had a higher percent composition of Chironomidae and Chironomidae abundance for most months and for the year. Hedgehog Run had higher Shannon-Wiener diversity index values, Shannon's Equitability values, and Simpson's Reciprocal index values for most months and for the year. The Hilsenhoff Biotic Index values for Grunder and Hedgehog Run were variable, while the Sorensen's Quotient indicated that the communities in

Hedgehog and Grunder Run were similar. Functional feeding group and habitat group examinations showed slight differences between the two streams but were inconclusive.

Comparisons to previously completed surveys indicated improvement in macroinvertebrate communities since the initial OGM development in the 1980s. The overall improvement in water quality and macroinvertebrate communities from the 1980s to 2010 is likely due to the fact that most of the initial development and road construction was done in the 1980s, sites have stabilized, and the community has had time to adjust and recover. Nearly all of the taxa identified in the previous surveys were collected in the 2010 survey.

For additional results from the water quality parameter and USGS turbidity measurement collections, as well as comparisons to previous surveys of Grunder Run, see *3.8.3.1 Monitoring indicator 1 - water quality monitoring*.

Pennsylvania Department of Environmental Protection (Aquatic Biology Investigation) - Nine streams had both spring and fall IBI scores less than the aquatic life use impairment threshold of 63.0.

See *3.8.3.1 Monitoring indicator 1 - water quality monitoring* for additional results from the aluminum concentration sampling conducted.

Discussion

Clarion University of Pennsylvania (potential impacts of oil and gas development) – The Clarion University studies did not detect substantial differences between the macroinvertebrate communities of streams within watersheds with differing levels of OGM development. This may be a result of an insufficient number of collections. Likewise, sampling was not long enough in duration to detect changes within individual streams. Each of the Clarion studies took place over a single season. Changes to macroinvertebrate communities are cumulative in nature, and only become evident after several years of collecting. As an example, sedimentation in the streams within development areas may reach a threshold after which aquatic fauna decreases rapidly. It may be that they simply have not reached that threshold as yet.

Another possible explanation for a lack of detectable difference in benthic fauna may be related to sampling localities in the streams. Samples were taken within fast riffles and slower riffle/glides which are located in higher gradient portions of the streams. Since the majority of streams on the ANF are high gradient, sediment may have been rapidly flushed through the streams during periods of high water. Had pools and lower gradient portions of the streams, where sediment is more likely to be deposited been included the studies they may have detected more of a difference in faunal composition. Although sampling in pools is typically more qualitative than that in riffles and glides, it should be considered in any additional follow-up study.

While sampling efforts did not detect faunal differences related to OGM development, the impact of the August 2008 oil spill in Chappel Fork was clear. Based on the early and late summer collections, Chappel Fork was most similar to Four Mile Run, a stream not impacted by

OGM development, and Morrison Run; however, based on fall/winter collections, Chappel Fork separated out from all other sampled streams with no similarity, indicating the oil spill impacted the macroinvertebrate fauna of the stream. The spill's immediate impact on benthic communities was also reflected in PA DEP's 2008 macroinvertebrate sampling within the Chappel Fork watershed; however, 2009 surveys concluded that while the benthic communities were still impacted a year after the oil spill, recovery was occurring.

Pennsylvania Department of Environmental Protection (Instream Comprehensive Evaluation surveys) – The preliminary results from this monitoring showed that 80% of the 252 streams sampled on the ANF are clearly meeting or exceeding their water quality standards based on the IBI (> 63) for the determined water use. While the other 50 streams may have not met the IBI threshold during one sampling period, they will not all be listed as impaired by PA DEP if they only have one sampling period that falls below the IBI standard. Per PA DEP, aquatic life use impairment occurs when aquatic life appears to be depressed in a stream year-round.

Sites that fell below the attainment IBI score are most frequently depressed due to acid deposition (see *3.8.3.1 Monitoring indicator 1 - water quality monitoring*). Many of these sites fall below the IBI threshold in the spring due to snowmelt and acidic storm flow, but then improve later in the year during baseflow when groundwater improves water quality. Other streams not attaining IBI scores are related to point sources such as the Chappel Fork oil spill or nutrient impairments from sewage discharge to streams.

Pennsylvania Department of Environmental Protection (Aquatic Biology Investigation) – In nine of the 24 streams sampled, impacts from acid deposition were evidenced by year-round IBI scores less than the aquatic life use impairment threshold of 63.0. Of those nine, six had dissolved aluminum concentrations greater than 150 ppb during spring snow melts and rain events indicating acidification is from precipitation, not due to natural conditions (see *3.8.3.1 Monitoring indicator 1 - water quality monitoring*).

Recommendations – PA DEP recommends that future acid deposition projects and funding should be focused on treatment of the six streams (Rocky Run, Cherry Run, an upper reach of Big Mill Creek, Bloody Run, Pine Run, and Gurgling Run) revealed not to be in attainment of their designated aquatic life use during the Aquatic Biology Investigation study. Alkalinity is nearly or completely absent in the majority of these six streams. Assuming proper construction, maintenance, and operation, passive treatment systems could raise alkalinity and pH in these streams, leaving them less susceptible to dissolved aluminum toxicity. The remaining streams examined during this study should continue to be monitored, particularly in the fall, to document possible degradation of macroinvertebrate assemblages and other aquatic life.

Clarion University of Pennsylvania recommends the sampling of macroinvertebrates in pools if additional surveys are conducted as follow-up to their assessments of OGM development, and PA DEP recommends resurvey of the Chappel Fork watershed macroinvertebrate community is completed until full recovery is documented.

USACE recommends the sampling of tributaries to the Allegheny Reservoir and Allegheny River should continue.

Overall, macroinvertebrate surveys should continue as they can provide an early warning of hazardous changes in water quality, detect episodic events such as pollution spills, evaluate recovery from disturbed conditions, and reveal trends and cycles. It is also recommended that the ANF inventory watersheds identified with sediment sources and apply or improve BMPs at the areas of concern. The ANF should continue surveying roads for sediment contributions to water ways so that these sediment sources can be mitigated. Additionally, habitat improvement projects should be focused on projects where water quality is suitable for aquatic organisms.

3.8.4 Effect of management activities, natural events, and other disturbances on soils

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How are management activities, natural events, and other disturbances affecting soils?	Discussion of soil quality standard monitoring	Annual	2 years	FY 2013

Background – In FY 2016, the ANF updated the protocol for monitoring soils based on national direction regarding how to conduct soil quality standards monitoring and changes in regional guidance. The protocol moves away from using a Regional soils disturbance threshold (from superseded directive: FSH2509.18 – Soil Management) and toward a suite of soil quality standards based on local conditions with monitoring of soil property changes from management activities and the ecosystem responses to those changes (current directive: FSM 2550 - Soil Management). As such, the associated monitoring question (*Is detrimental soil disturbance exceeding regional thresholds?*) was modified to the current question (*How are management activities, natural events, and other disturbances affecting soils?*).

This monitoring questions addresses the Forest Plan goal to:

> Maintain, restore, or improve soil quality, productivity, and function. Manage soil disturbances from management activities such that they do not result in long-term loss of inherent soil quality and function (USDA-FS 2007, p. 14).

This monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the:

- Progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities, and
- Effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 U.S.C. 1604(g)(3)(C)).

Protocol – During FY 2008-2015, soil disturbance and soil productivity loss in timber sales was to be monitored annually to show compliance with Regional soil disturbance guidelines. Boundaries, along with areas of major soil disturbance and areas of lowered productivity were

recorded. Soil disturbance in this study refers to any area where soil has been detrimentally disturbed in any way (i.e., severe compaction, displacement, puddling, rutting, burned, eroded, or mass movement). The level of disturbance for each soil criteria (i.e., severe compaction, displacement, puddling, rutting, burned, eroded, or mass movement) to be detrimental is found in USDA-FS 2012b.

Soil disturbance monitoring occurred in FY 2008 (two timber sale payment units), FY 2009 (16 randomly selected timber sale payment units), and FY 2010 (one timber sale payment unit). The payment units were checked on the ground for skid trails, landings, and other impacts, which could be considered a form of detrimental disturbance to soils. All disturbed areas were inventoried using GPS and/or orthophotographs and the acreage of disturbance was recorded.

In FY 2015, soil compaction was evaluated at 14 plugged well sites. Each site was evaluated by inserting a sharp-shooter shovel into the soil at several locations throughout the plugged well site and compared to undisturbed soil a distance from the site.

In FY 2016, the ANF updated the protocol for monitoring soils based on National direction. This soil quality standards monitoring protocol has not been implemented on the Forest, but evaluates compaction, rutting, exposed mineral soil, hydrophobic soil, increased soil temperature, soil displacement, nutrient loss, and litter layer loss. These data are then assessed to determine how the physical and biological functions at the site may have been affected.

Results – See *3.1.1 Effects of management practices* for results from the FY 2008 (Forest Road 230 timber sale) and FY 2010 (Mud Lick and Chappel 2003 blowdown salvage sales) soil disturbance monitoring.

Over the 16 units (308 acres) monitored in FY 2009, all skid trails with compacted soils were measured and recorded. Skid trails averaged 0.9 acres of disturbance (Table 29) while log landings with compacted soils were measured and recorded with an average 0.5 acres of disturbance. The major disturbance factor in these units was compaction. Total detrimental soil disturbance averaged 8% of the activity area, well below the Regional standard of 15%.

Table 29. Post-harvest soil monitoring of timber sale payment units (FY 2009)

Sale	Payment Unit	Unit Acres	Skid Trail (Feet)	Skid Trail (Acres)	Landing (Acres)	Total Acres Disturbed	Percent Disturbance
Clarendon	2	2	1,000	0.3	0.1	0.38	19%
Fire-Tower	9	36	5,800	1.6	0.9	2.51	7%
Fire-Tower	8	36	5,000	1.4	0.9	2.29	6%
Fire-Tower	6	26	1,100	0.3	0.2	0.47	2%
Fire-Tower	10	10	1,300	0.4	0.5	0.81	8%
Fire-Tower	5	13	1,500	0.4	0.0	0.44	3%
Rock Run	3	13	3,800	1.0	0.9	1.96	15%
Rock Run	1	23	7,122	2.0	0.1	2.07	9%
Rock Run	5	12	3,200	0.9	0.0	0.90	8%
East Lewis	4	11	2,000	0.6	0.5	1.00	9%
East Lewis	5	10	1,100	0.3	0.5	0.75	8%
East Lewis	6	18	2,517	0.7	0.5	1.14	6%
Sheriff West	18	17	4,195	1.2	0.3	1.50	9%
Sheriff West	16	29	5,300	1.5	0.1	1.57	5%
Sheriff West	11	13	2,870	0.8	0.7	1.47	11%
Sheriff West	4	39	3,652	1.0	0.8	1.78	5%
Average		**19.25**		**0.9**	**0.5**		**8%**

Of the 14 plugged oil and gas well sites that evaluated for compaction in FY 2015, two were compacted, five were moderately compacted, and seven were not compacted.

Discussion – During FY 2008-2015, the ANF had a goal to limit detrimental soil disturbance to 15% of an activity area. After a year of recovery after a timber sale, the only disturbance areas found were usually in skid trails and landings. Key detrimental soil conditions resulting from ground-based timber sale activities include detrimental compaction, detrimental puddling, severe rutting, and accelerated surface soil erosion, and detrimental displacement. One of the stands monitored exceeded the 15% detrimental disturbance threshold. One possible reason for why this stand exceeded the threshold is most likely related to the small size of the unit – there were too many skid trails within this small two-acre payment unit.

The average percent disturbed of the 16 payment units was 8% detrimental soil disturbance, which is well below the threshold of 15%. This is very similar to the results found in previous year of disturbance monitoring (see *3.1.1 Effects of management practices* for results from the FY 2008 soil disturbance monitoring).

The monitoring of plugged well sites indicated that 50% of the sites were being restored properly, while 36% had moderate compaction and 14% of sites were very compacted. The seven sites that had little to no compaction are expected to revegetate very quickly, and new natural growth was found at several of these sites. The compacted sites are expected to take 50 or more years to reach natural levels of compaction.

Although dedicated soil disturbance monitoring has not occurred on an annual basis, the ANF still conducts surveys before projects to avoid or mitigate sensitive areas on every stand where vegetation management is planned. These surveys identify soils with poor drainage, water resources (e.g., streams and wetlands), rocky areas, and steep slopes that should be avoided or require additional mitigations. Timber sale administrators work with harvesters to layout skid trails so to minimize disturbance and impacts to resources. Other standards and guidelines also improve the health of soils such as avoiding whole-tree harvesting, leaving tops and branches on site, leaving larger-sized down woody debris, avoiding rutting, and promoting rapid revegetation at the site.

Recommendations – To help identify sensitive soils and protect areas of concern, the new soils quality standards monitoring protocol should be implemented in FY 2017 and conducted annually on a variety of sites. Specifically:

- The Forest expects to hold a training on soil disturbance monitoring in the fall of 2017 to teach employees how to conduct this monitoring. This training will also improve the understanding needed to identify areas to avoid and minimize impacts to soils.
- Soil monitoring should occur in post-harvest stands on each District to ensure the number of disturbed areas is minimized and soil compaction reduced so that soils have the capacity to sustain herbaceous and woody plant growth.
- Soil compaction should be evaluated when oil and gas operators are plugging wells and decommissioning roads so that conditions do not prevent natural reestablishment of trees and shrubs.

By the next evaluation report, the ANF expects to have more data from soil surveys to analyze that will help assess the effect of management activities and other disturbances on the soil resource.

The Forest Plan still contains references to the superseded directive FSH 2509.18 – Soil Management and was not updated with the changes in monitoring protocol. To align with changes in the national and regional direction, the Forest Plan should be updated to remove the references to the superseded documents and reflect the updated guidance.

3.8.5 Effect of management activities, natural events, and other disturbances on quality, cold-water ecosystems

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How are management activities, natural events, and other disturbances affecting quality, cold water ecosystems?	Presence/absence of brook trout	Annual	2 years	N/A

Background – The 2012 Planning Rule requires the Monitoring Program of all Forest Service units to monitor the status of focal species to assess the ecological conditions required under 36 CFR 219.9. In that context, a focal species is "[a species] whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the [forest] plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area" (36 CFR 219.19). During the monitoring transition, the ANF selected the brook trout to serve as a focal species for the ecological integrity (composition, structural, function, and connectivity) of quality, cold water ecosystems.

Protocol – Brook trout monitoring has not occurred as of 2016. The ANF intends to use environmental DNA (eDNA) sampling to monitor the presence/absence of brook trout. This monitoring will be conducted with the assistance of the Forest Service National Genomics Center for Wildlife and Fish Conservation (NGCWFC) who will provide sampling supplies, processing, interpretation, and technical advice. The protocol for brook trout eDNA monitoring is being developed.

3.9 Wildlife, fish, and sensitive plant habitat monitoring

3.9.1 Status of cerulean warbler

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the cerulean warbler on the ANF?	Number of individuals documented	Annual	2 years	FY 2013

Background – The original Monitoring Program included monitoring questions addressing five Management Indicator Species (MIS), one of which was the cerulean warbler (*Setophaga cerulea*). Monitoring of MIS was a requirement of the 1982 Planning Rule to gauge the effects of the Forest Plan on ecological communities of management interest. The emphasis in the 2012 Planning Rule is placed on monitoring focal species as indirect indicators of the ecological integrity of select ecological conditions.

Focal species were identified during the monitoring transition and the cerulean warbler was not selected. It is also not currently listed as a Regional Forester Sensitive Species; however, there

are Forest Plan objectives addressing cerulean warbler breeding habitat (USDA-FS 2007a, p. 20). For this reason, during the monitoring transition, the monitoring questions related to the cerulean warbler were recommended for modification into two questions: one focused on the status of the species on the ANF and one focused on the availability of nesting habitat on the ANF. The latter (*How much cerulean warbler nesting habitat does the ANF provide?*) will be monitored and evaluated every six years.

Protocol – Annual songbird survey driving routes were completed in project areas and chosen so a variety of habitats were traversed. Routes were completed between dawn and 0930 with stops made every ½ mile. All singing birds were documented for five minutes. The number of routes completed varied from year to year.

In FY 2011, callback surveys were conducted during Pennsylvania Breeding Bird Safe Dates (June 1 – July 31) between dawn and 0930. Survey points were approximately 200 meters apart. The call was played for 60 seconds and the surveyor then listened for 90 seconds before playing the call for another 60 seconds and then moving on to the next survey point.

In addition to the songbird survey drive routes and callback surveys conducted by ANF staff, several research projects have been conducted by NRS staff to address interior forest bird species using audible point counts or mist netting.

Finally, the Second Atlas of Breeding Birds in Pennsylvania was reviewed (Wilson et al. 2013) for the status of the cerulean warbler across the state.

Results – Table 30 documents cerulean warbler observations from FY 2008 and FY 2016. Observations were made during the breeding season unless otherwise noted. The majority of warbler observations are associated with an established research project, either an audible point count or a netting capture. Differences among years reflect highly varying intensities, focus, and geographic scope of research efforts. Observations in FY 2012 and FY 2013 were incidental and made during work on research projects not conducted on cerulean warblers or in preferred cerulean habitat.

Table 30. Cerulean warbler observations (FY 2008-2016)

YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cerulean Warblers Observed	53	154	42	17	4	3 7[1] 3[2]	50 1[3] 61[4]	53 65[4]	41 64[4] 13[5]

[1] Non-reproductive (outside of breeding season)
[2] Non-reproductive (outside of breeding season during migration period)
[3] Incidental observation made between point counts
[4] State Game Lands
[5] Songbird survey drive route

The possible, probable, and confirmed breeding behavior by cerulean warblers documented state-wide changed by 35%, -36%, and -22%, respectively between the first breeding bird atlas

(1983-1989) and the second (2004-2009; Figure 60). This represented a 7% decrease overall across the three status categories; however, point counts conducted on the ANF as part of the second Pennsylvania Breeding Bird Atlas found NFS lands along the Allegheny Reservoir to support some of the highest densities of cerulean warblers in the state (Wilson et al. 2013).

Cerulean Warbler (number of blocks)

Status	first Atlas 1983 - 1989	second Atlas 2004 - 2009	Change %
Possible	324	437	35
Probable	430	275	-36
Confirmed	82	64	-22
Total	836	776	-7

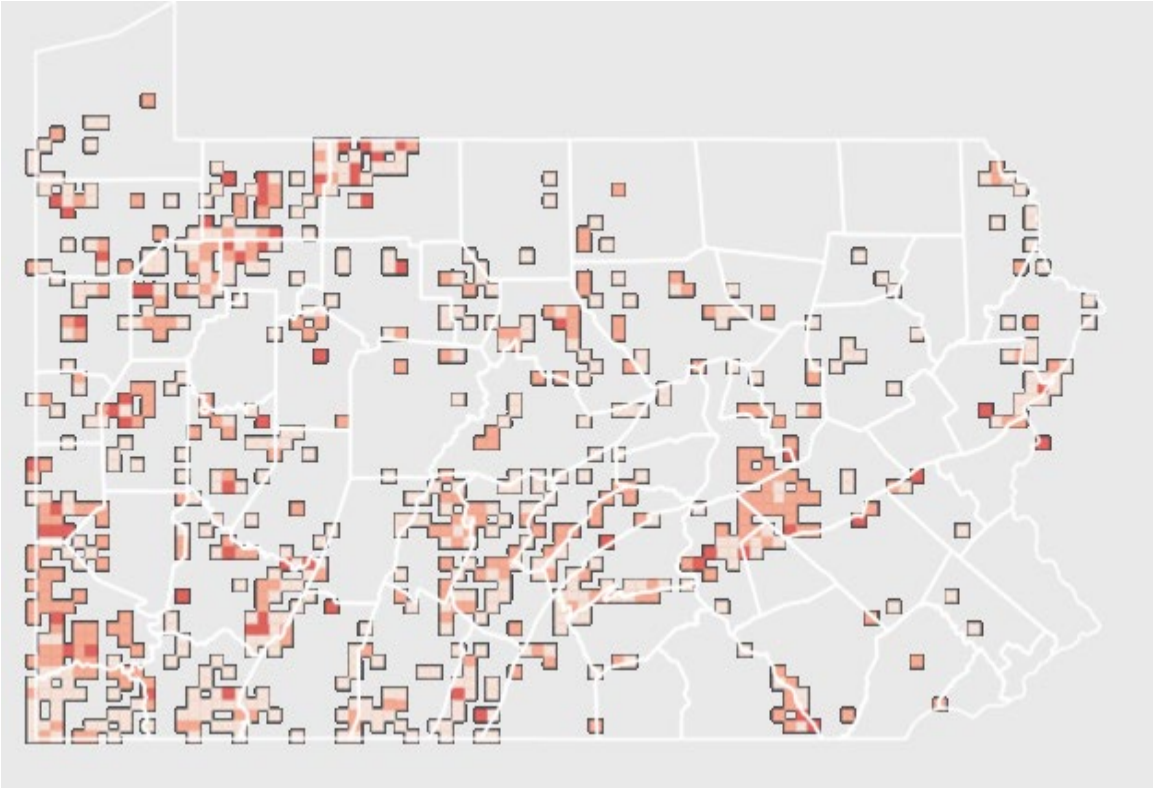


Figure 60. Pennsylvania-wide breeding status of cerulean warblers from the Second Atlas of Breeding Birds in Pennsylvania

Discussion – Based on documented occurrences from songbird routes, callback surveys, NRS research projects, and the second Pennsylvania Breeding Bird Atlas, the ANF population of cerulean warblers appears to be relatively stable, and not be suffering the decline reported in other parts of the state.

Recommendations – Continue to survey cerulean warbler preferred nesting habitat during songbird survey routes.

3.9.2 Status of northern goshawk

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the northern goshawk on the ANF?	Number of active territories	Annual	2 years	FY 2013

Background – The original Monitoring Program included monitoring questions addressing five MIS, one of which was the northern goshawk (*Accipter gentilis*). Monitoring of MIS was a requirement of the 1982 Planning Rule to gauge the effects of the Forest Plan on ecological communities of management interest. The emphasis in the 2012 Planning Rule is placed on monitoring focal species as indirect indicators of the ecological integrity of select ecological conditions.

Focal species were identified during the monitoring transition and the northern goshawk was not selected; however, it is currently listed as a Regional Forester Sensitive Species and there is a Forest Plan objective addressing active northern goshawk territories (USDA-FS 2007a, p.19). For this reason, during the monitoring transition, the monitoring questions related to the northern goshawk were recommended for modification into one question focused on the status of the species on the ANF. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – In 2001, the ANF partnered with Dave Brinker of the Central Appalachian Goshawk Project (CAGP) and he has led the effort to monitor and determine the success of northern goshawk territories in the ANF since. In 2013, in addition to completing the annual territory status and success monitoring, CAGP piloted the video monitoring of select active territories on the Forest with the objective to obtain data on the cause of nest failure in northern goshawks. Video monitoring by the CAGP continued annually after 2013 as resources allowed.

Results – Measures of northern goshawk population monitoring and reproductive parameters documented by the CAGP are presented in Figures 61 and 62. Since 2004, 25 distinct northern goshawk territories have been documented with the number of occupied territories (defined as some evidence of breeding activity, i.e., at least one adult present) per year averaging 5.5 (range = 3-11 territories; Figure 61). Annual nesting success (proportion of active territories – defined as having active nests with incubating females that fledged at least one chick) since 2004 has averaged 53% (range = 0-100%; Figure 62). The average annual number of chicks fledged per occupied territory since 2004 has been 0.9 (range = 0-1.6 chicks). The average annual number of chicks fledged per successful territory (fledged at least one chick) since 2004 has been 2.1 (1.0-3.0 chicks).

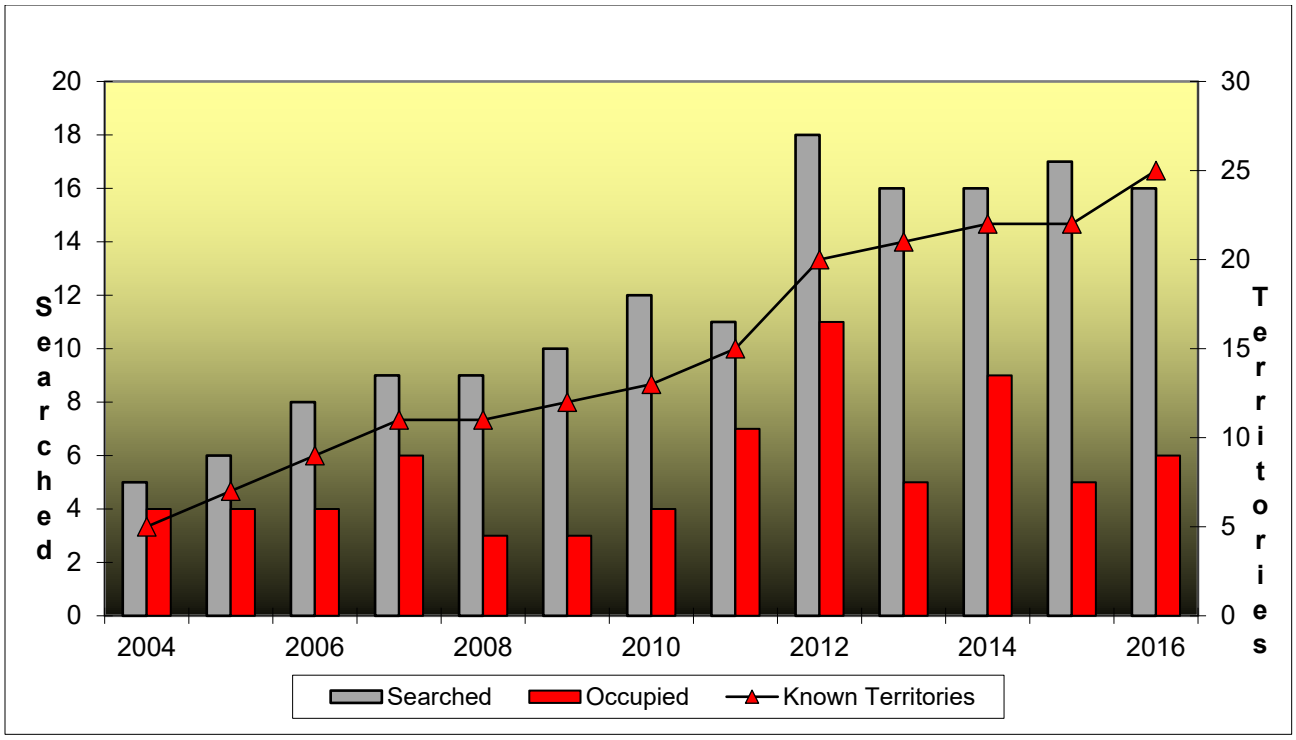


Figure 61. Northern goshawk territory monitoring on the ANF as monitored by the Central Appalachian Goshawk Project (Brinker 2016).

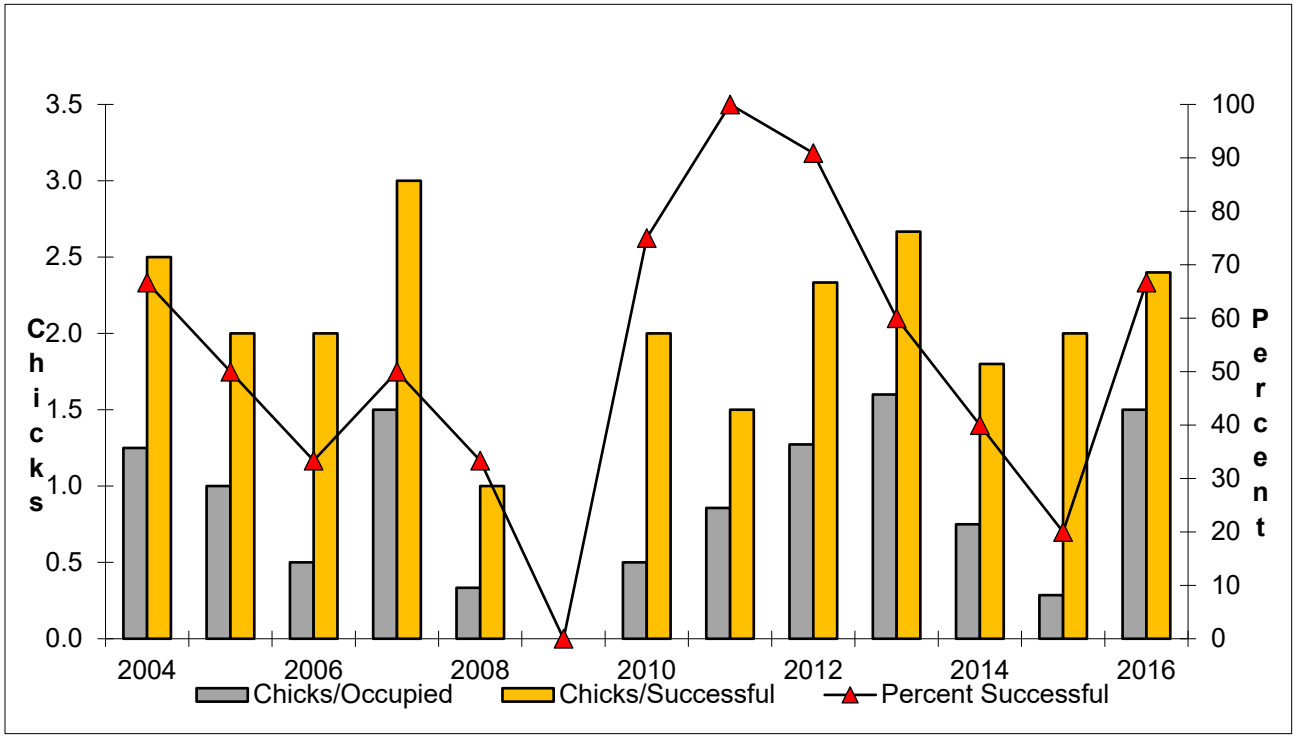


Figure 62. Northern goshawk reproductive success on the ANF as monitored by the Central Appalachian Goshawk Project (Brinker 2016)

Video monitoring of select active territories was completed in 2013, 2015, and 2016. Two active territories were monitored in 2013 and both were successful. One of the territories monitored in 2013 was also the only territory monitored in 2015 and failed due to fisher depredation. One t territory was monitored in 2016 and it was successful.

Discussion – The CAGP began in 1994 with the monitoring of recently discovered northern goshawk territories in the high elevations of the Monongahela National Forest in West Virginia (Buckelew 1991). During the 1990s, northern goshawk populations in the Northeast and Central Appalachians (WV-MD-PA) were considered by most eastern raptor biologists to be in good condition and increasing. From 1990 through 2000, nesting pairs expanded from the very rare occurrence in Maryland (1980, 1988, and 1996) to several pairs documented each summer during the period 2002-2006 (Brinker 2010). Nest success during the 1990-2001 period at territories monitored by the CAGP was 80-100%.

This situation changed dramatically in the early 2000s when the population trajectory of northern goshawks in the central Appalachians reversed itself. From 2003-2010, nesting success averaged 48% (range 17-71%) with three years below 50% and three years at 50% (Brinker 2013). All nesting territories in West Virginia and Maryland were vacated while in Pennsylvania known territories in the southern portion of the state also gradually went vacant. During this period, Pennsylvania and New York completed second atlas projects and both recorded declines in northern goshawks (Crocoll 2008, Brinker 2012). This decline occurred while regional habitat conditions were relatively stable.

The exact cause of the poor reproductive success from 2003-2010 is unknown. The eight-year period of low reproductive output is the most likely factor responsible for the observed retraction of northern goshawk breeding in the Central Appalachians (Brinker 2013). Two potential hypotheses that could explain the poor reproductive success and breeding retraction are increased nest predation and West Nile Virus related change in adult survival rates (Brinker 2013). Perhaps the most likely explanation is a combination of both hypotheses acting synergistically on population demographics to reduce overall population reproductive success (Brinker 2013). A healthy growing population from Pennsylvania northward that can serve as a source for dispersing juveniles, and most importantly sub-adults, is essential to maintaining northern goshawk breeding populations in Maryland and West Virginia.

On the ANF, the northern goshawk has been considered an uncommon species. Between 1986 and 2006, 74 nests were identified Forest-wide collectively representing 43 distinct territories (USDA-FS 2007b, p. 3-196). Seven of those territories were known to be active between 1986 and 1990, 15 territories were documented as active between 1991 and 1999, and 12 territories were documented as active between 2000 and 2006. From 2004 through 2016, the number of active territories remained relatively stable (4.7 per year on average; range = 3-11 territories); however, this is fewer territories than were active during the previous period (1986-2006) suggesting northern goshawk populations on the Forest have declined over the long-term (since 1986).

During the same period (2004-2016), ANF territories had a similar reproductive success rate to the CAGP overall with an annual average of 53% successful. Reproductive success started and ended the period at 67%, but was not stable in between, experiencing two periods of decline

(2004-2009 and 2012-2015) on either side of a sharp increase (2010-2011). A combination of increased nest predation (presumably by fisher) and West Nile Virus is also the likely explanation for the reduced overall population and reproductive success on the ANF.

Recommendations – In cooperation with the CAGP and Pennsylvania Game Commission (PGC), continue to monitor known and historic northern goshawk territories and conduct surveys for new territories where effort has been minimal in the past when resources allow. Habitat analysis should be completed in an effort to correlate habitat preferences and quality with nesting activity and success. Continue to maintain the integrity of northern goshawk habitat by implementing the management emphasis outlined in the Forest Plan FEIS (USDA-FS 2007b, p. 3-197).

3.9.3 Status of timber rattlesnake

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the timber rattlesnake on the ANF?	Number of known and historic dens	Annual	2 years	FY 2013

Background – The original Monitoring Program included monitoring questions addressing five MIS, one of which was the timber rattlesnake. Monitoring of MIS was a requirement of the 1982 Planning Rule to gauge the effects of the Forest Plan on ecological communities of management interest. The emphasis in the 2012 Planning Rule is placed on monitoring focal species as indirect indicators of the ecological integrity of select ecological conditions.

Focal species were identified during the monitoring transition and the timber rattlesnake was not selected; however, it is currently listed as a Regional Forester Sensitive Species and there is a Forest Plan objective addressing known and historic den locations (USDA-FS 2007a, p.19). For this reason, during the monitoring transition, the monitoring questions related to the timber rattlesnake were recommended for modification into one question focused on the status of the species on the ANF. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Potential and confirmed timber rattlesnake dens were monitored at least once a field season between April and October every year. When monitoring a den site during the spring and fall, the number of snakes observed, the sex, age, weather conditions and status of vegetation were documented when possible.

In FY 2008, the ANF and PFBC entered into a cooperative agreement to monitor timber rattlesnakes in an attempt to locate new den locations and confirm potential den sites. ANF and PFBC staff capture timber rattlesnakes in areas where there is a historic den site, or no dens are known. PFBC personnel surgically implant a radio transmitter in each captured snake and staff from both the ANF and PFBC tracked the movement of tagged snakes on a weekly basis until it is determined they are no longer migrating, which usually occurs around the second week of

October. Each time a snake is tracked, a GPS location is recorded. At the beginning of subsequent field seasons, attempts are made to recapture snakes near these potential den sites in hopes of documenting new dens. The transmitter is removed from recaptured snakes and the snakes are released. A separate gestation site study began in FY 2016 for which gravid females were collected, implanted with a transmitter, and tracked through the season. This project resulted in identifying two additional den sites.

Results – Radio telemetry monitoring resulted in the capture and tagging of 63 timber rattlesnakes and confirmation of 35 dens across the ANF (Table 31). The number of active den sites documented by monitoring ranged from two in FY 2009 to twelve in FY 2011.

Table 31. Timber rattlesnake den monitoring and PFBC telemetry program (FY 2008-2016)

Fiscal Year	Rattlesnakes Captured and Tagged	Dens Confirmed	Mortalities
2008	5	2	1 – illegally poached
2009	3	2	1 – on ATV trail
2010	5	3	1 – vehicle and 1 – natural predation
2011	5	5	0
2012	6	6	0
2013	7	3	0
2014	6	3	2 – poached/shot
2015	6	3	1 – illegal ATV use on railroad grade
2016	20[1]	8[1]	2 – unknown 1 – natural causes
Total	63	35	9

[1] – includes nine rattlesnakes captured and tagged, and two dens confirmed as part of gestation site study

Discussion – Prior to the agreement, the PFBC was in the process of visiting all historic records of timber rattlesnake dens on the ANF to document rattlesnake activity. Survey data indicated that many den sites were no longer active and rattlesnake populations were declining on the ANF. The dens that were considered active were assumed so based on documented observations of individuals, particularly neonates. While the observation of neonates is a good indication of a den, it does not serve as a conclusive identifier. Through the telemetry program, 35 dens were confirmed on the Forest, including three on the Bradford Ranger District which did not have any potential timber rattlesnake dens identified prior. Given that den sites are the focal point of rattlesnake activity and snakes show a high fidelity to their dens, this information is important for developing project mitigations and buffers to protect known dens, particularly as populations statewide are still believed to be in decline (NatureServe 2014).

Timber rattlesnakes utilize a variety of habitat conditions throughout their life, from rocky crevices for hibernating, traversing forested settings, under rotting logs for shade and openings for basking and foraging. The most notable trend to habitat that affects populations, is the condition of the den. When surrounding vegetation becomes too dense at a den site, the gravid females must travel further distances to bask and gestate their young. This would make them

more susceptible to predation, human encounters and vehicle mortalities. Losing one gravid female each year from a den, where numbers are already below historic numbers, could result in localized extirpation at that den. Also, if a den fails, males from other dens may have to travel further or in different directions to seek out females for mating. If they repeatedly fail to mate, populations at dens could become isolated and eventually extirpated. With information from the gestations site study, the ANF will gain an improved understanding of the optimum overstory conditions for basking habitat at den sites and overall habitat needs.

Recommendations – Continue to work with PFBC on the telemetry program and researchers on the gestation site study to identify timber rattlesnake dens. Also, maintain the integrity of den sites by reducing or removing human activities that have a high risk of causing rattlesnake mortality. Consider manipulating vegetation at den sites where basking and foraging habitat has become limited.

3.9.4 Manage deer density

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the deer density across the landscape?	Estimate of deer per square mile	Annual	2 years	FY 2013

Background – Forest Plan objectives include the management of white-tailed deer populations at 10 to 20 deer per square mile to sustain herbaceous and woody species diversity across the landscape (USDA-FS 2007a, p. 20). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – White-tailed deer (*Odocoileus virginianus*) density is estimated in the spring using the deer pellet-group count technique (deCalesta 2013). There are 26 deer pellet-group count transects completed annually on the KQDC (www.kqdc.com), a 74,000-acre collaborative area, of which two-thirds is ANF, where private landowners and the ANF have implemented an adaptive management program with the goal of improving the quality of hunting and habitat. Outside of KQDC, transects are completed within District-level project areas, research study areas, and Deer Management Assistance Program (DMAP) units.

Results – Deer density estimates from deer pellet-group count transects ranged from 1.0 to 51.4 deer per square mile between FY 2008 (spring 2008) and FY 2016 (spring 2016; Table 32). Average deer densities fluctuated annually on both the KQDC and outside the KQDC with KQDC density peaking at 17.2 deer/mi^2 in FY 2011 and density outside the KQDC peaking at 19.7 deer/mi^2 in FY 2016.

Table 32. Average deer density (deer per square mile) estimates and the range of estimate from spring deer pellet-group count transects, both within KQDC and outside of KQDC

	Fiscal Year								
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
KQDC (Deer/Mi²)									
Average (# of Transects)[1]	14.9 (26)	15.3 (26)	15.2 (26)	17.2 (24)	9.7 (26)	13.8 (25)	13.4 (25)	14.0 (25)	11.4 (26)
Range	3.0-29.3	2.7-27.4	1.0-37.0	5.4-51.4	2.8-21.9	2.4-34.3	4.4-28.3	2.1-31.7	4.0-29.7
Outside KQDC (Deer/Mi²)									
Average (# of Transects)	12.5 (8)	8.3 (4)	14.3[2] (8)	12.2[2] (7)	11.3 (8)	17.3 (13)	18.3 (17)	17.0 (16)	19.7 (12)
Range	3.1-27.8	3.0-8.2	6.6-40.7	5.7-21.4	5.0-25.8	8.7-29.4	4.5-36.4	6.2-38.5	4.0-36.6

[1] Due to rounding adjustments, results are different than what was reported the last time this question was updated.
[2] Additional deer pellet-group counts were taken into account since the last time this question was updated.

Discussion – Forest Plan objectives include managing deer populations to sustain herbaceous and woody species diversity across the landscape (10 to 20 deer per square mile). This objective has been met as average deer density estimates across the ANF, both within and outside the KQDC, fell within this range from FY 2008 through FY 2016.

The range of deer density estimates illustrates the importance of continuing to use DMAP as a management tool for targeting high deer densities. DMAP has been integral to the ANF's continued success in providing quality hunting; protecting its investment in healthy forest habitat and regeneration; and actively engaging the hunting community in the sustainable management of their public lands. During the first four years of the program, the ANF made judicious annual adjustments of DMAP permit requests and realized reductions in deer density and subsequent deer impact levels. These changes translated to a drastic reduction in the need for the ANF to fence and fertilize regeneration harvests and that decline has been sustained since FY 2007.

Recommendations – Continue to monitor estimates of deer density across the ANF, both within and outside the KQDC, and adaptively use DMAP. Outside of the KQDC, focus monitoring on a DMAP unit basis rather than by District-level project area.

3.9.5 Status of great blue heron

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the great blue heron on the ANF?	Number of active colonies	Annual	2 years	FY 2013

Background – During the monitoring transition, the monitoring questions associated with the status and productivity of great blue heron (*Ardea herodias*) colonies on the ANF (*How many great blue heron colonies are known to be active? How many active nests are there? How many*

colonies have become abandoned?) were recommended for modification into one question focused on the status of the species on the ANF. Forest Plan objectives include ensuring a stable or increasing population trend for active great blue heron colonies on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Known great blue heron rookeries are observed in the field each year to record occupancy. Reports of new nests are field verified. Searches for new nests are occasionally conducted in high potential nesting habitat. Surveys are completed from a distance in order to minimize disturbance.

Results – Table 33 summarizes the results of great blue heron rookery monitoring completed from FY 2008 through FY 2016.

Table 33. Great blue heron rookery occupancy and size (FY 2008-2016)

Fiscal Year	Results
2008	1 rookery with 8 nests active. 6 adult birds were observed.
2009	1 rookery with 1 nest, activity unknown, no birds observed.
2010	3 rookeries were monitored. One was inactive and nest was noted as gone. One had 1 nest and 1 adult was noted as incubating. One had 2 active nests and 3 adults observed.
2011	5 rookeries were monitored. Three no longer existed from the previous year. One had 15 nests, no activity was noted. One had 4 active nests with 2 adults and 4 chicks observed.
2012	6 rookeries were monitored. Three no longer existed from the previous year. One had 2 active nests with 4 adults and 1 chick observed. One had 2 nests, activity unknown, no birds observed. One had 29 nests with 9 active with 13+ adults and 4 chicks observed.
2013	5 rookeries were monitored. One no longer existed from the previous year. One had 3 active nests with 4 adults observed and 6-8 egg shells. One had 4 active nests with 1 adult observed and multiple young of year. One had possibly 3 active nests, no birds observed. One rookery had 29 nests with 5 active with 9 adults and 4 chicks observed.
2014	Rookery monitoring was not completed.
2015	8 rookeries were monitored. One was still not rebuilt since it was last monitored. Two no longer existed since they were last monitored. Two were active with 4 nests and 5 birds, and 3 nests and 6 birds. Three were inactive – 1 with 9 nests and 2 with 2 nests.
2016	9 rookeries were monitored. One was still not rebuilt since it was last monitored and the other eight no longer existed since they were last monitored.

Discussion – Since FY 2008, 13 rookeries have been abandoned or relocated on the ANF. Although habitat for the great blue heron is widespread, this species is very sensitive to disturbance and there are few known or historic rookeries on the ANF.

Recommendations – Continue to investigate reports of new nests and search for new rookeries in high potential nesting habitat. Continue annual monitoring of known rookeries and implement guidelines to protect known rookeries.

3.9.6 Status of northern flying squirrel

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the northern flying squirrel on the ANF?	Number of occupied nesting sites	Annual	2 years	FY 2013

Background – During the monitoring transition, the monitoring questions associated with the status and productivity of the northern flying squirrel on the ANF (*How many northern flying squirrel nest sites are known to exist? How many are occupied?*) were recommended for modification into one question focused on the status of the species on the ANF. Forest Plan objectives include ensuring a stable or increasing population trend for occupied northern flying squirrel nesting sites on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Establish northern flying squirrel (*Glaucomys sabrinus*) nest box transects in suitable habitat and monitor nest box use annually.

Results – There are two known nesting occurrences of the northern flying squirrel within the ANF proclamation boundary. One is on State Game Lands 29 and the other is within Chapman Dam State Park.

In 2007, 70 nest boxes were placed in suitable habitat for the northern flying squirrel. Monitoring of these boxes has not documented use by northern flying squirrels. Two nest boxes had either confirmed or suspected use by southern flying squirrels (*Glaucomys volans*). In 2016, 25 of the nest boxes on the Bradford Ranger District were moved to more suitable habitat, following recommendations from the PGC. In addition, the Marienville Ranger District installed 26 new nest boxes during FY 2014-2016. Two boxes were found to have use by flying squirrels, but the species could not be determined.

Discussion – The northern flying squirrel is a Regional Forester Sensitive Species on the ANF. In Pennsylvania, it is listed by the state as an endangered species and is listed as a priority species in the state's Wildlife Action Plan (PGC-PFBC 2015).

Northern flying squirrels prefer old-growth boreal forests that contain a heavy coniferous component, moist soils, and lots of downed woody debris. Pennsylvania's forests do not provide the old-growth conifer stands that are optimum habitat for northern flying squirrels and most remaining old-growth and appropriate hemlock/spruce habitat exists only in small, isolated fragments. As a result, Pennsylvania northern flying squirrels use forests that contain a mix of coniferous and deciduous trees that often are second-growth age class and associated with a

water source. This is the case with the two nesting occurrences of the species that have been documented within the ANF proclamation boundary.

According to PA's Wildlife Action Plan, habitat factors influencing the northern flying squirrel's decline in Pennsylvania include loss of older conifer and mixed forest stands to development, especially in the Pocono Region (PGC-PFBC 2015). Limiting factors in younger, highly managed forests include both a reduced quantity of natural cavities and lower production of desired fungi for food as northern flying squirrels rely on specific fungi that are dependent on hemlock and spruce trees. Another factor considered is the declining health of hemlock forest stands due to the hemlock wooly adelgid. Lastly, although smaller in size, the more numerous southern flying squirrel appears to be an aggressive competitor for tree cavities as well as food resources. It also carries a parasite that may be debilitating or lethal to the northern flying squirrel.

Management proposed in the PA Wildlife Action Plan for the northern flying squirrel includes: determining its precise range, regularly tracking population and reproductive trends, and documenting patterns of habitat and space use by northern flying squirrels as well as southern flying squirrels (PGC-PFBC 2015). The document also recommends statewide efforts to protect older hemlock and mixed-stand forests and development of guidelines for forest protection within a five-mile radius of known northern flying squirrel populations.

The ANF's monitoring is consistent with this information as the focus of monitoring is in areas with the best suitable habitat where cavities are available, either natural or man-made.

Recommendations – Continue to place nest boxes in suitable habitat and monitor annually. Consider a conifer replacement strategy in the event there is a loss of hemlock to HWA.

3.9.7 Manage known locations of plant species with viability concerns

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many locations of plant species with viability concerns are known on the ANF?	Number of individuals/populations	Annual	2 years	FY 2013

Background – Forest Plan objectives include ensuring a stable or increasing population trend for known locations of plants species with viability concerns on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Survey and element occurrence data are entered into the Natural Resource Manager Threatened, Endangered, and Sensitive Plants – Invasive Species (NRM TESP/IS). The protocols for surveys and element occurrence data collection are contained in USDA-FS 2014b and USDA-FS 2015a.

Results – There were 140 known sites for plant species with viability concerns in the 2008-2013 monitoring and evaluation period. During the 2014-2016 reporting period, 40 additional sites were documented for four plant species with viability concerns, bringing the total to 180 known sites on the ANF with at least one plant species with viability concern. Some sites have more than one species at that location, e.g., rich site habitats where base cations are high in toe slope positions with yellow-birch-ash-sugar-maple overstories.

Discussion – Surveys conducted by ANF staff, contractors, and WPC Natural Heritage Program staff have successfully located plant species with viability concerns. Survey work is typically focused where ground-disturbing and vegetation management activities occur, not necessarily where the most suitable habitat for plant species with viability concern occurs. As such, we do not know how much suitable or occupied habitat occurs within the planning area for some species.

Recommendations – Continue surveys and data entry into to NRM-TESP/IS. To assess the amount of suitable habitat for species with the fewest known occurrences, develop another agreement with WPC to conduct surveys in suitable habitat for select species that have the highest likelihood of being impacted by ground and canopy altering activities. Monitoring of known locations is needed to determine if sites are being impacted by non-native invasive species.

3.9.8 Status of red-shouldered hawk

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the red-shouldered hawk on the ANF?	Number of active territories	Annual	2 years	FY 2013

Background – During monitoring transition, the monitoring question associated with the status and productivity of the red-shouldered hawk on the ANF (*How many red-shouldered hawk active territories are known to exist?*) was recommended for modification into one question focused on the status of the species on the ANF. Forest Plan objectives include ensuring a stable or increasing population trend for active red-shouldered hawk territories on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Known red-shouldered hawk nests are observed in the field each year to record occupancy. Reports of new nests are field verified. Searches for new nests are occasionally conducted before leaf out in high potential nesting habitat. Also, the Second Atlas of Breeding Birds in Pennsylvania was reviewed (Wilson et al. 2013) for the status of the red-shouldered hawk across the state.

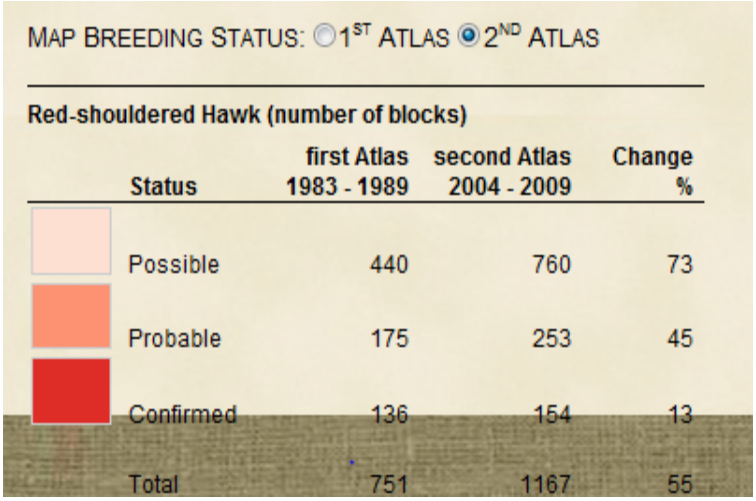
Results – Monitoring results indicate the red-shouldered hawk population on the ANF is stable or increasing.

Table 34 summarizes the results of red-shouldered hawk monitoring completed from FY 2008 through FY 2016.

Table 34. Red-shouldered hawk nests monitored and status (FY 2008-2016)

Fiscal Year	Territories Monitored	Active Territories (Female Incubating)
2008	3	3
2009	1	1
2010	5	5
2011	8	6
2012	10	6
2013	6	6
2014	9	5
2015	15	11
2016	12	12

The possible, probable, and confirmed breeding behavior by red-shouldered hawks documented state-wide increased by 73%, 45%, and 13%, respectively between the first breeding bird atlas (1983-1989) and the second (2004-2009; Figure 63). This represented a 55% increase overall across the three status categories. Similarly, red-shouldered hawk active territories increased on the ANF between 2008 and 2016.


MAP BREEDING STATUS: ○ 1ST ATLAS ◉ 2ND ATLAS

Red-shouldered Hawk (number of blocks)

Status	first Atlas 1983 - 1989	second Atlas 2004 - 2009	Change %
Possible	440	760	73
Probable	175	253	45
Confirmed	136	154	13
Total	751	1167	55

Figure 63. Pennsylvania-wide breeding status of red-shouldered hawk from the Second Atlas of Breeding Birds in Pennsylvania

Discussion – The Second Atlas of Breeding Birds in Pennsylvania indicated the species is distributed over a relatively broad area and may be declining in response to habitat alteration in some areas within the state, although the ANF did not appear to be one of them. Sixty-nine nests were monitored between FY 2008 and FY 2016, with the number of active nests increasing over that same period (Table 34). Although fledgling success is not tracked closely, at least 15 of the active nests were observed to have produced at least one chick (nestling or fledgling). Monitoring results indicate the red-shouldered hawk population on the ANF is stable or increasing.

Recommendations – Continue to monitor known nests and field-verify reports of new nests.

3.9.9 Status of osprey

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the osprey on the ANF?	Number of occupied nesting sites	Annual	2 years	FY 2013

Background – During monitoring transition, the monitoring questions associated with the status and productivity of ospreys on the ANF (*What is the status of known nests? How many young are produced?*) were recommended for modification into one question focused on the status of

the species on the ANF. Forest Plan objectives include ensuring a stable or increasing population trend for occupied osprey nesting sites on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Known osprey (*Pandion haliaetus*) nests are observed in the field each year to record occupancy and number of chicks fledged. Nests are checked often during mating season and less frequently when the chicks have hatched. Reports of new nests are field-verified. Also, the Second Atlas of Breeding Birds in Pennsylvania was reviewed (Wilson et al. 2013) for the status of the osprey across the state.

Results – Osprey populations on the ANF are increasing and are likely to continue to increase on the ANF. Table 35 summarizes the results of osprey monitoring completed from FY 2008 through FY 2016.

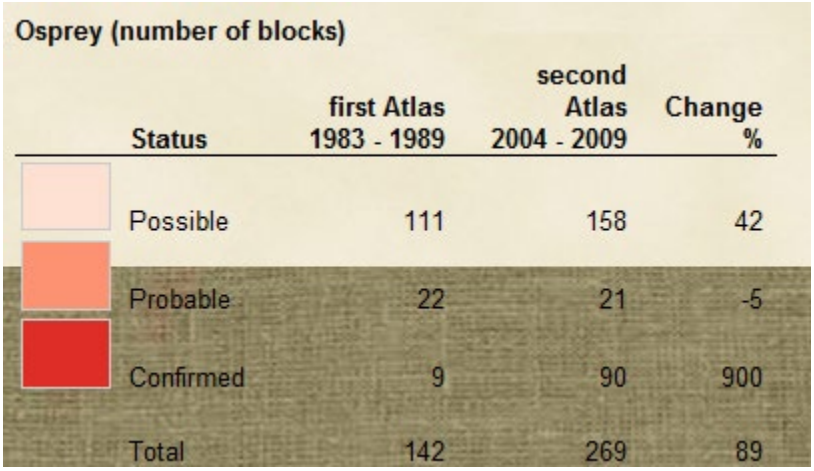
Table 35. Osprey nest occupancy and fledgling success (FY 2008-2016)

	Fiscal Year Active (Y, N, or UNK[1]) Young Fledged								
Nest	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	N	Retired	Retired	Non-Extant					
2					N	N	UNK	Y 2	Y 2
3		Y 0	Y 3	Y 0	Y 0	Y 2	Y 0	Y 2	Y UNK
4		Y 0	UNK	UNK	UNK	Retired			
5			Y 1	Y 1	Y 0	Y 3	Y UNK	Y 2	Y UNK
6			Y 3	Y 1	Y 3	Y 3	Y UNK	Y 3	Y 2
7		N	UNK	UNK	Retired				
8			Y 2	Y 0	N	N	N	N	N
9				N	N	Retired			
10					Y 1	Y 1	Y UNK	Y UNK	Y 2
11				Y 0	Y 0	Y 2	Y UNK	Y UNK	Y 2
12								Y UNK	Y UNK
13								Y 0	Y 2
14									Y 0

	Fiscal Year Active (Y, N, or UNK[1]) Young Fledged								
Nest	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total Active Nests	**0**	**2**	**4**	**5**	**5**	**5**	**5**	**8**	**9**
Total Fledged	**0**	**0**	**9**	**2**	**4**	**11**	**0**	**9**	**10**

[1] – UNK = Unknown

The possible, probable, and confirmed breeding behavior by osprey documented state-wide changed by 42%, -5%, and 900%, respectively between the first breeding bird atlas (1983-1989) and the second (2004-2009; Figure 64). This represented an 89% increase overall across the three status categories. Similarly, active nests on the ANF increased from 2008-2016.



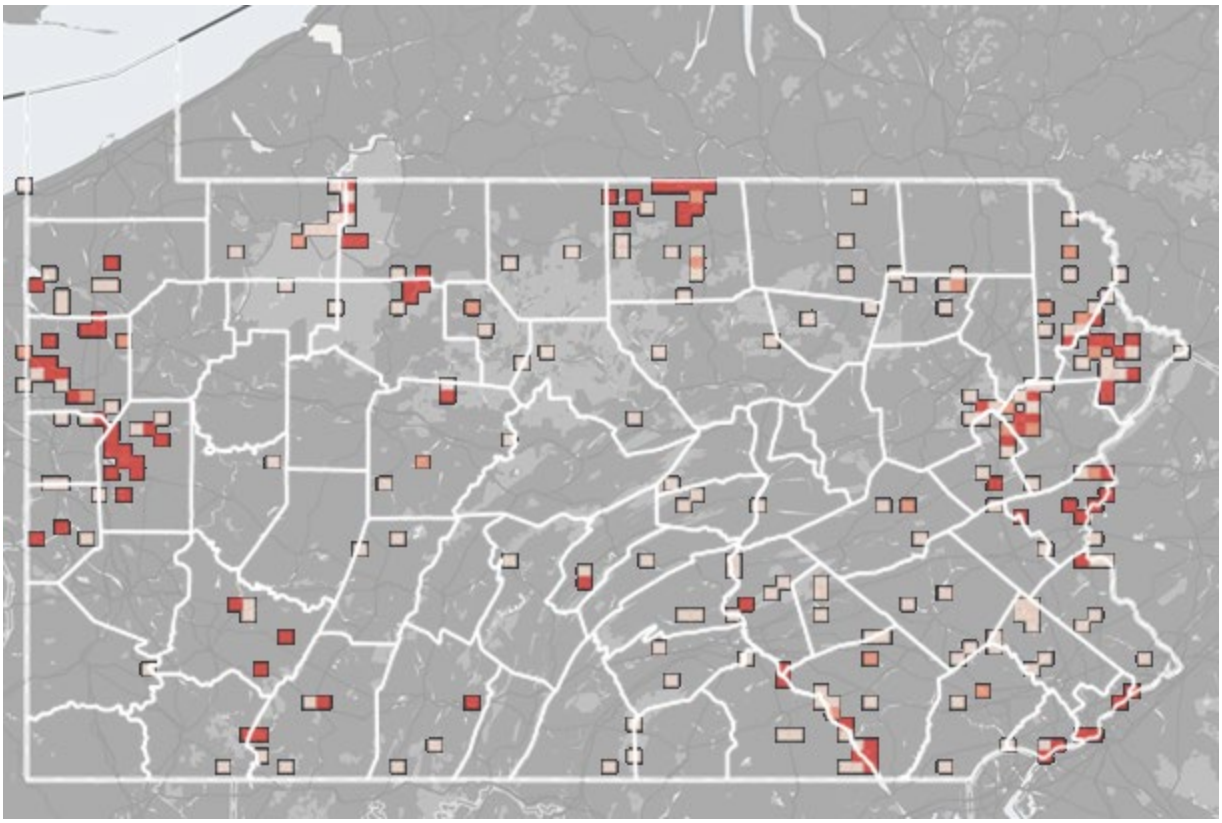


Figure 64. Pennsylvania-wide breeding status of osprey from the Second Atlas of Breeding Birds in Pennsylvania

Discussion – In FY 2016, there were nine active osprey nests on the ANF. The well-established osprey pairs of nests 3, 5 and 6 usually successfully fledge at least one chick per year, with nest 6 fledging three chicks during three consecutive years (Table 35). The overall number of active nests has increased from 2 in FY 2009 to 9 in FY 2016. Osprey populations on the ANF increased between 2008 and 2013 and are likely to continue to increase.

As of the end of the evaluation period (FY 2016), the osprey was listed as state threatened in Pennsylvania. Pennsylvania's nesting osprey population has been on the rise in recent years. During the Second Atlas of Breeding Birds in Pennsylvania, confirmed nests were reported in at least 90 atlas blocks, and were widely distributed across the Commonwealth.

Recommendations – Continue to monitor the activity of known osprey nests.

3.9.10 Minimize risk of aquatic invasive species introduction

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are aquatic invasive species (AIS) present in the Allegheny Reservoir and Allegheny River? What is the risk of AIS introduction from Forest Service boat launches?	AIS documented in the Allegheny Reservoir and Allegheny River and risk of AIS introduction from Forest Service boat launches	Annual	2 years	FY 2013

Background – The section of the Allegheny River managed by the ANF is home to some of the healthiest populations of clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*) mussels over their entire range (USDI-FWS 2008). Recognizing the importance of these populations and the threat posed to them by invasive zebra mussels (*Dreissena polymorpha*), the original Monitoring Program included the monitoring question: *Are zebra mussels in the Allegheny Reservoir and what is the risk of zebra mussel introduction from Forest Service boat launches?*

Since then, although zebra mussels present the most significant risk for ecological disturbance, there are numerous other invaders and potential invaders that pose a threat to the ecological health of the Allegheny River and Reservoir. This resulted in the monitoring question being updated during the monitoring transition and broadened in scope in the updated Monitoring Program to include any aquatic invasive species (AIS) and their risk of introduction. As such, this monitoring question addresses the 2012 Planning Rule requirement of monitoring the status of a select set of ecological conditions that contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

Protocol – The original protocol established to determine the presence of zebra mussels in the Allegheny Reservoir was composed of shoreline surveys on each side of Forest Service boat launches. The surveys were carried out after the reservoir dropped to a pool elevation of at least 1,318' mean sea level (msl), or a drop of at least 10' from summer pool elevation in the fall. The surveys were performed by walking a minimum ¼-mile to visually determine the presence of zebra mussels. If a dock was present at the launch, it was also inspected for zebra mussels. The assessments were conducted by ANF employees.

Following suggestions from ANF staff for improved detection ability, dive surveys for invasive mussels were used in the Allegheny River and Reservoir in 2015 and 2016. Dive surveys were performed by staff from the ANF scientific dive team and survey likely areas for the establishment of invasive mussels.

As part of the conservation measures implemented for the clubshell and northern riffleshell (see also *3.9.14 Implement conservation measures for federally endangered mussels*), boat screenings and trailer inspections were conducted by the concessionaires managing launches under special

use permit. The overall goals of the screenings and inspections were to determine the level of risk of zebra mussel introduction to the Allegheny Reservoir and Allegheny River posed by use of Forest Service boat launches and minimize the risk over the life of the Forest Plan. Boat screenings included a series of predetermined questions that were asked of boaters before they launched their watercraft. The objective was to screen (through personal interviews) at least 500 boats for the risk assessment. Launch sites that typically received the highest use were targeted first. The assessment was primarily conducted during the recreational boating season from Memorial Day to Labor Day. In addition to the questionnaire, boat trailers parked at launch sites were visually inspected for the presence of aquatic vegetation and/or zebra mussels. The objective was to visually inspect at least 1,000 trailers.

Results

Mussel surveys

During the FY 2008-16 period no live or dead invasive mussels were located in the Allegheny River or Reservoir.

Reservoir shoreline surveys were planned in FY 2008 to occur sometime in early-mid November, but a large snowfall occurred that prevented the survey from occurring. No surveys were carried out in FY 2009. The FY 2010 surveys were conducted when the pool elevation was higher than 1318' msl (when surveys are normally completed) due to the potential for snow to cover the shoreline if delayed. In addition to the survey of shorelines, courtesy docks at Elijah, Kiasutha, Webbs Ferry, Willow Bay, and Wolf Run were inspected as follows:

- Elijah – shoreline survey conducted on each side of launch on 10-21-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.
- Kiasutha – shoreline survey conducted on each side of launch on 10-21-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.
- Roper Hollow – shoreline survey conducted on each side of launch on 10-20-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.
- Webbs Ferry – shoreline survey conducted on each side of launch on 10-20-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.
- Willow Bay – shoreline survey conducted on each side of launch on 10-21-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.
- Wolf Run – shoreline survey conducted on right side (north) of launch on 10-21-2009 at a pool elevation of 1320.4' msl. No evidence of zebra mussels was detected.

In FY 2011, the shoreline adjacent to all seven developed boat launches on the ANF was surveyed for evidence of zebra mussels. These included:

- Dewdrop – shoreline survey conducted on each side of launch on 10-13-2011 at a pool elevation of 1313.8' msl. No evidence of zebra mussels was detected.
- Elijah – shoreline survey conducted on each side of launch on 9-29-2011 at a pool elevation of 1313.4' msl. No evidence of zebra mussels was detected.

- Kiasutha – shoreline survey conducted on each side of launch on 9-29-2011 at a pool elevation of 1313.4' msl. No evidence of zebra mussels was detected.
- Roper Hollow – shoreline survey conducted on each side of launch on 10-12-2011 at a pool elevation of 1313.8' msl. No evidence of zebra mussels was detected.
- Webbs Ferry – shoreline survey conducted on each side of launch on 10-12-2011 at a pool elevation of 1313.8' msl. No evidence of zebra mussels was detected.
- Willow Bay – shoreline survey conducted on each side of launch on 9-22-2011 at a pool elevation of 1314.7' msl. No evidence of zebra mussels was detected.
- Wolf Run Marina – shoreline survey conducted on each side of launch on 10-13-2011 at a pool elevation of 1313.8' msl. No evidence of zebra mussels was detected.

In addition to the survey of shorelines, courtesy docks at Elijah, Kiasutha, Webbs Ferry, Willow Bay, and Wolf Run were also inspected in FY 2011. No evidence of zebra mussels were found on the docks that were exposed at the time of the survey from the drawdown of the reservoir.

As a result of staff shortages, no shoreline surveys were conducted during FY 2012-2014. Following the introduction of dive surveys in FY 2015 (Table 36), shoreline surveys did not occur in 2015 or 2016.

Table 36. Dive surveys conducted for invasive mussels (FY 2015-2016)

Date	Location	AIS Present	Notes
7-31-2015	Allegheny Reservoir, Casey Bridge SR59	No	Surveyed piers 1 and 2 (west)
9-4-2015	Allegheny River, Hickory St. Bridge	No	Surveyed two piers
7-20-2016	Allegheny Reservoir, Roper Hollow Boat Launch	No	Surveyed submerged rock face opposite side of inlet
7-20-2016	Allegheny Reservoir, Webb's Ferry Boat Launch	No	Surveyed submerged rock face south of launch
7-20-2016	Allegheny Reservoir, Devil's elbow SR59 Bridge	No	Surveyed two piers

Risk assessment

Watercraft screening – 5,438 watercraft were screened for zebra mussel introduction risk during the FY 2008-2016 period (Table 37). Of the vessels screened, 91 were determined to be at medium risk for zebra mussel introduction into the reservoir and 19 were high risk.

Table 37. Summary of watercraft at risk based on personal interviews with boaters (FY 2007-2016)

Fiscal Year	Screened Watercraft	Medium & High Risk Watercraft	Percent of Medium & High Risk Watercraft
2007-2008[1]	635	12	1.9%
2009	999	29	2.9%

Fiscal Year	Screened Watercraft	Medium & High Risk Watercraft	Percent of Medium & High Risk Watercraft
2010	879	28	3.2%
2011	825	10	1.2%
2012	690	5	0.7%
2013	522	11	2.1%
2014	315	7	2.2%
2015	435	5	1.1%
2016	246	3	1.2%
Total	**5,438**	**110**	**2.0%**

[1]FY 2007 and FY 2008 were combined since FY 2007 was a shortened season and only 96 watercraft were screened.

Boat trailer inspections – Of the 12,365 trailers inspected in the parking lots (Table 38), only one was found with vegetation and none had visible zebra mussels.

Table 38. Boat trailers inspected at Forest Service boat launches (FY 2008-2016)

Fiscal Year	Trailers Inspected	Trailers with Vegetation	Trailers with Visible Zebra Mussels
2008	1,139	0	0
2009	1,606	1	0
2010	1,390	0	0
2011	1,749	0	0
2012	1,897	0	0
2013	2,041	0	0
2014	1,201	0	0
2015	1,134	0	0
2016	208	0	0
Total	**12,365**	**1**	**0**

Discussion

Mussel surveys

As called for in the ANF's Conservation Program for threated and endangered freshwater mussels (*Implement conservation measures for federally list mussels*), shoreline surveys were carried out in FY 2010 and FY 2011. Due to staff shortages and uncooperative weather, surveys were not carried out in FY 2008-2009 and FY 2012-2016. In 2015 and 2016, dive surveys to identify invasive mussels occurred in the Allegheny River and Reservoir. The dive surveys are not limited by the reservoir drawdown and divers are able to survey portions of the reservoir that are below the normal lower pool limit, making this a more effective survey method than shoreline surveys. During the FY 2008-16 period no live or dead invasive mussels were located in the Allegheny River or Reservoir.

Risk assessment

There has been a generally decreasing trend in the frequency of medium or high-risk watercraft (MHRW) launched into the reservoir over the FY 2008-2016 period. The decrease in the number of MHRW is despite of the fact that in FY 2013 the designation of the reach of the Allegheny River from Warren to Franklin was reclassified as a risk factor for zebra mussels. This reclassification was due to the Pennsylvania Fish and Boat Commission's finding of zebra mussels in Conewango Creek in Warren in 2009. This change in classification, while not indicative of an actual change in user-ship, should have resulted in a higher number of boats being classified as MHRW.

Trailer inspections carried out throughout the FY 2008-2016 period found only a single trailer carrying remnants of aquatic vegetation despite the screening of over 12,000 trailers. While screenings carried out at ANF boat launches were targeting zebra mussel risk, the screening of trailers and watercraft for aquatic vegetation also serves as a screening for many other potential invasive species. The data gathered from the watercraft and trailer screenings over the FY 2008 to FY 2016 period indicates that there were few users of ANF boat launches whose equipment posed a risk for zebra mussel introduction and it can then be inferred that few user's equipment posed a risk of AIS introduction in general.

FY 2016 was the final year in which watercraft and trailer screenings were included in concessionaire special use permit. Because most watercraft and trailers at ANF boat launches have been low risk for AIS introduction, and concessionaires will no longer carry out watercraft and trailer screenings, it may be beneficial for the ANF to focus its resources on the goal of minimizing the risk of AIS introduction from the use of Forest Service boat launches rather than assessing the level of risk. Members of the public using Forest Service boat launches have an immediate interest in preventing the introduction of AIS because of the negative effects on recreational opportunities of AIS introduction. Public education about the risks posed by AIS introduction is equally important as the screening of watercraft, perhaps more so.

Recommendations – The following recommendations are made regarding the monitoring of AIS introduction risk:

- Continue watercraft and trailer screenings by ANF ecosystem or recreation staff as possible.
- During watercraft and trailer screenings, focus on educating members of the public on the risk posed by AIS introduction and the actions they can take to minimize risk.
- Print educational materials on the risks of AIS introduction on the ANF to hand out to the public.
- Consider replacing the shoreline surveys from the ANF Conservation Program with dive surveys.
- Paint "Clean, Drain, & Dry" messaging on the pavement at the approaches to ANF boat launches.

3.9.11 Status of bald eagle

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
What is the status of the bald eagle on the ANF?	Number of active nests and their productivity	Annual	2 years	FY 2013

Background – During the monitoring transition, the monitoring questions associated with the status and productivity of bald eagle nests on the ANF (*What is the status of known bald eagle nests on the ANF? How many young are produced?*) were recommended for modification into one question focused on the status of the species on the ANF. Forest Plan objectives include maintaining or increasing productivity of bald eagles on the ANF (measured by the number of chicks that successfully fledge; USDA Forest Service 2007a, p. 20). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Known nests are observed in the field each year to record occupancy and number of chicks fledged. Nests are checked often during mating season and less frequently when the chicks have hatched. Reports of new nests are field verified. Searches for new nests are occasionally conducted before leaf out in high potential nesting habitat. Drive routes through suitable habitat are also conducted during the nesting season.

Results – Annual productivity during the last evaluation period (FY 2008-2013) remained above the USFWS national recovery objective of 1.0 young per active nest every year except FY 2009. During the nesting season from FY 2014 through FY 2016, staff availability did not allow for multiple visits; therefore, failure rates and nest productivity could not be determined for all active nests.

Table 39 summarizes the results of bald eagle monitoring completed from FY 2008 through FY 2016.

Table 39. Nest success of monitored bald eagle territories (FY 2008-2016)

Fiscal Year	Territories Monitored	Active Territories (Female Incubating)	Failed Territories	Young of Year	Young Per Active Nest
2008	10	5	0	8	1.6
2009	20	12	5	10	0.8
2010	19	12	3	13	1.1
2011	24	15	3	19	1.3
2012	20	10	1	19	1.9
2013	17	12	2	19	1.6
2014	12	10	UNK[1]	3	UNK[1]
2015	15	9	UNK[1]	11	UNK[1]
2016	15	14	UNK[1]	2	UNK[1]

[1] Staff availability did not allow for multiple nest visits. Failure rates and nest productivity could not be determined for all active nests.

Discussion – The number of active nests on the ANF increased from five in FY 2008 to 14 in FY 2016, with a peak in FY 2011 of 15.

Recommendations – Continue to monitor nest success.

3.9.12 Implement bald eagle conservation measures

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are bald eagle conservation measures being implemented?	Status of conservation measure implementation	Annual	2 years	FY 2013

Background – Although the bald eagle was removed in 2007 from the Endangered Species Act's (ESA) list of federally endangered and threatened species, the conservation measures developed for the 2007 Forest Plan have been maintained because the species is: 1) afforded protections from "taking"[2] under the Bald and Golden Eagle Protection Act (BGEPA); and 2) a Regional Forester Sensitive Species on the ANF. As such, this monitoring question addresses the 2012 Planning Rule requirement of monitoring the status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

Two sets of bald eagle conservation measures were developed for the 2007 Forest Plan. The first set is included in Appendix C of the Forest Biological Assessment (BA) that was completed during Forest Plan revision and submitted to the USFWS. This set represents the ANF's Conservation Program for the bald eagle. There are six conservation measures in the Conservation Program applicable to the bald eagle, in addition to two conservation measures applicable to all federally listed species. The second set was issued by the USFWS in their concurrence letter as conservation measures to implement in order to reach a "not likely to adversely affect" determination (USDI FWS 2007). There are 11 measures included in this second set.

As stated in the Approval and Declaration of Intent section of the FY 2008-2013 Monitoring & Evaluation Report, NTPs associated with outstanding and reserved mineral development are being evaluated under the 1986 Forest Plan standards and guidelines. As a result, the conservation measures that would apply to private oil and gas are not applicable. The ANF may negotiate mitigation measures with operators consistent with the conservation measures and

[2] The Bald and Golden Eagle Protection Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturb" means: "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

2007 Forest Plan standards and guidelines, and uses collaborative approaches to avoid, mitigate, or remedy resource concerns associated with OGM development.

Protocol and Results
Bald eagle conservation measures were implemented when applicable and management activities did not occur in suitable nesting, foraging, and roosting habitat within buffers established around active nests. The integrity of active eagle nest sites is being maintained and reproduction is continuing at a steady rate on the ANF.

Conservation Program (all species)

1. Measure: Secure subsurface rights (e.g., mineral, oil, and gas rights) within areas on the ANF identified as important endangered and threatened species habitats.

   Protocol/Results: See *3.11.1 Acquire subsurface ownership*.

2. Measure: Continue to cooperate with other agencies and organizations to support inventory and monitoring efforts on the ANF to gain a better understanding of the occurrence and distribution of threatened and endangered species.

   Protocol/Results: See *3.9.11 Status of bald eagle*.

Conservation Program (bald eagle)

1. Measure: The likelihood of bald eagle death or injury due to fishing-associated activities shall be reduced by the monthly cleanup of discarded fishing line and lures at developed fishing access sites on and near the Allegheny Reservoir.

   Protocol/Results: As Forest Service personnel and concessionaires that manage Forest Service boat launches come across fishing line and lures, they were collected and properly disposed of. In addition, there is an annual Allegheny River and Allegheny Reservoir cleanup. News releases were distributed to educate hunters and to inform landowners of the need to protect bald eagle nests, foraging, and roosting habitat.

2. Measure: Predator guards will be installed and maintained on bald eagle nest trees, in cooperation with PGC.

   Protocol/Results: The ANF worked with PGC when new predator guards needed to be installed or existing predator guards needed maintenance or replacement.

3. Measure: In cooperation with PGC, monitor known eagle nests and search for new ones. Provide monitoring data to PGC and USFWS, annually, at the end of each nesting season.

   Protocol/Results: See *3.9.11 Status of bald eagle*.

4. Measure: All reports of dead eagles on the ANF will be investigated by ANF or PGC personnel and reported to local PGC Conservation Officers and the USFWS.

   Protocol/Results: All reports of dead eagles found on or near the ANF were forwarded to the appropriate Regional PGC office.

5. Measure: Signs and/or news releases shall be displayed or distributed to educate hunters and to inform landowners of the need to protect bald eagle nests, foraging and roosting habitat.

   Protocol/Results: News releases were distributed to educate hunters and to inform landowners of the need to protect bald eagle nests, foraging, and roosting habitat.

6. Measure: In order to protect the bald eagle and maintain suitable habitat if it is de-listed, bald eagle management guidelines consistent with those identified in the BGEPA will be implemented upon de-listing.

   Protocol/Results: Conservation measures have been maintained since the bald eagle was delisted in July 2007.

Concurrence Letter

1. Measure: Around each nest, a 660-foot, no-disturbance buffer will be in place year-round. No activities that may disturb eagles or alter habitat (e.g., timber harvest, land clearing, OGM development, road construction and maintenance, trail construction, habitat improvement) will be undertaken within this buffer. The buffer will remain in place for five years after a nest has been abandoned. A larger buffer will be implemented as necessary.

   Protocol/Results: Project-level documents and Plans of Operation (private OGM development) were reviewed. No Forest Service activities that may have disturbed eagles or altered habitat were proposed or occurred within the year-round 660-foot buffer applied to active nests. The ANF did not need to negotiate mitigation measures with private oil and gas operations as no developments were proposed within the year-round 660-foot buffer. The 660-foot nest buffer was maintained where nests remained in active status (for five years after a nest was determined abandoned).

2. Measure: Recreational activities within 660 feet of active bald eagle nests will be avoided. The buffer will be established and maintained through the use of buoys, signs, road closures, or other appropriate measures when necessary. The Forest Service will establish a larger buffer when this is necessary to avoid adverse effects. If monitoring indicates a smaller buffer will result in no adverse effects, the Forest Service may establish a smaller buffer following consultation with the Fish and Wildlife Service.

   Protocol/Results: On-the-ground monitoring of recreational activities near actives nests was completed. The Cornplanter nest was vulnerable to boating and camping traffic.

Signs were placed along the shoreline to warn people not to camp there. In FY 2013, this nesting pair successfully fledged two young. Since nesting began long before the boating season was in full swing, this pair of eagles seem to tolerate the boat traffic. The nest was checked in March of 2014 with no activity documented; status was unknown in 2015. In 2016, the nest was checked in May and was active, with one nestling identified. It is unknown if the young successfully fledged.

3. Measure: From January 15 to July 31, the following activities will not take place within 1,320 feet of bald eagle nests: road and trail construction and maintenance, timber-cutting and hauling, OGM development, and low-level flights by Forest Service aircraft.

   Protocol/Results: Project-level documents and Plan of Operations Review (private OGM development) were reviewed. No Forest Service activities occurred within the seasonal 1,320-foot buffer applied to active nests. The ANF did not need to negotiate mitigation measures with private oil and gas operations as no developments were proposed within the seasonal 1,320-foot buffer.

4. Measure: Local roads will be closed to public use where active nests are located on a case-by-case basis.

   Protocol/Results: On-the-ground monitoring of active nests was completed to indicate changes in eagle behavior. The non-system road near the Grove Run nest was closed; however, the nest tree blew over and this site was not active thereafter. The trail near the Kiasutha nest was closed in FY 2008 and has remained closed since then. The Kiasutha nest fledged two young in FY 2013. It was active again FY 2014-2016; it is unknown if any young were produced or fledged.

5. Measure: To maintain suitable roosting and nesting habitat, scattered white pines and other potential nest trees will be maintained along the slopes of the Allegheny Reservoir, Allegheny River, Tionesta Creek, Clarion River, Kinzua River, and Salmon Creek. Federal activities that may result in the degradation of habitat should be avoided within 300 feet of the Allegheny Reservoir, Allegheny River, and Tionesta Creek.

   Protocol/Results: On-the-ground observation as well as review of project-level documents and Plan of Operations (private OGM development) were completed. White pine and other potential nest trees were maintained and no degradation of suitable roosting or nesting habitat occurred within 300 feet of the Allegheny Reservoir, Allegheny River, and Tionesta Creek.

6. Measure: A burn plan will be prepared prior to implementation of any prescribed burning, and any burning within primary bald eagle habitat will include smoke considerations or mitigation measures to reduce smoke-related impacts to bald eagles.

   Protocol/Results: A burn plan was completed for the fields near the Hall Barn. Smoke considerations were included to reduce potential impacts to the nearby eagle nest (Trunkeyville nest). The field was burned in FY 2008. A wildlife biologist monitored

the Trunkeyville nest during the burn. No visible smoke reached the nest site and the eagles remained on the nest. No signs of stress to the eagles were observed. No additional prescribed burn units have been completed in this area or at any others of a known bald eagle nest since FY 2008.

7. Measure: If the bald eagle is removed from the federal list, existing standards and guidelines will remain in effect for five years, after which management guidelines identified in association with the BGEPA will be adopted.

   Protocol/Results: See the Protocol/Results for conservation measure 6 under the Conservation Program.

8. Measure: When non-federal activities, such as OGM development, are proposed within 1,320 feet of active bald eagle nests, the Forest Service will notify the developer of the presence of a federally listed species and the need to contact the USFWS. The Forest Service will concurrently notify the USFWS of the project.

   Protocol/Results: Plans of Operation (private OGM development) were reviewed. No oil and gas activities were proposed within the 1,320-foot buffer applied to active nests; therefore, the USFWS was not contacted.

9. Measure: Power lines will be installed in a manner consistent with the most current version of the Avian Protection Plan Guidelines, including submission of a site-specific plan that will identify and reduce hazards to the bald eagle.

   Protocol/Results: Power line proposals and special use permits were reviewed. Two special use permits were issued for power lines; however, these permits were renewals for existing lines.

10. Measure: The Forest Service will continue to monitor bald eagle nest sites, nest productivity, and foraging and roosting areas on the ANF, and will report findings to the USFWS. Any potential impacts will be immediately eliminated with larger buffers in consultation with USFWS.

    Protocol/Results: See the Protocol/Results for conservation measure 3 under the Conservation Program.

11. Measure: To reduce mortality, discarded fishing line and lures will be cleaned up monthly from May through September at developed fishing access sites around the Allegheny Reservoir. Signs and news releases will be displayed and distributed to educate hunters not to shoot eagles, not to use lead shot or lead sinkers, and inform landowners of the needs to protect bald eagle nests and habitat.

    Protocol/Results: See the Protocol/Results for conservation measures 1 and 5 under the Conservation Program.

Discussion –Bald eagle conservation measures were implemented when applicable and management activities did not occur in suitable nesting, foraging, and roosting habitat within buffers established around active nests.

Recommendations – Continue to monitor the implementation of eagle conservation measures.

Publish annual news releases advising Forest visitors not to disturb eagles, asking them to pick up discarded fishing line, and consider not using lead ammunition or fishing gear.

Determine how management guidelines identified in the BGEPA differ from the conservation measures already implemented.

3.9.13 Implement conservation measures for federally listed bats

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are conservation measures being implemented for bat species listed, proposed, or candidate for protection under the Endangered Species Act?	Status of conservation measure implementation	Annual	2 year	FY 2013

Background – The basis of this monitoring question is to review the action the ANF is taking to fulfill its 7(a)1 (ANF Conservation Program) and 7(a)2 (USFWS concurrence letter conservation measures) responsibilities under the Endangered Species Act (ESA) with respect to the threatened and endangered bat species that occur within the ANF proclamation boundary. As such, this monitoring question addresses the 2012 Planning Rule requirement of monitoring the status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

Two sets of Indiana bat conservation measures were developed for the 2007 Forest Plan. The first set is included in Appendix C of the Forest BA that was completed during Forest Plan revision and submitted to the USFWS. This set represents the ANF's Conservation Program for the Indiana bat. There are six conservation measures in the Conservation Program applicable to the Indiana bat, in addition to two conservation measures applicable to all federally listed species. The second set was issued by the USFWS in their concurrence letter (USDI-FWS 2007) as conservation measures to implement in order to reach a "not likely to adversely affect" determination. There are seven measures included in this second set.

Between 1998 and 2015, substantial sampling effort was taken on the ANF to document the presence and distribution of Indiana bat. One male was captured in the southeast portion of the ANF in 1998 (Jones Township, Elk County; Gannon and Blackburn 2002a) and another male was captured on private land adjacent to the northeast corner of the Forest in 2001 (McKean County; Gannon and Blackburn 2002b). These data suggested the ANF likely only supported a low density of adult male Indiana bats whose presence on the ANF was transient (USDI-FWS 2007). Research corroborated this finding by concluding the ANF is not preferred summer

habitat for reproductive female bats due to the latitude, elevation, and relatively short, cool summers with high precipitation (Brack et al. 2002). In terms of winter habitat, the ANF has four hibernacula within or immediately adjacent to its boundary and the Indiana bat has not been documented at any of these sites. Based in part on the ANF's Indiana bat summer and winter habitat survey efforts, the USFWS revised the Indiana bat range map for Pennsylvania to reflect that the distribution of potential Indiana bat summer and winter habitat does not include the ANF (Figure 65; Turner personal communication 2014).

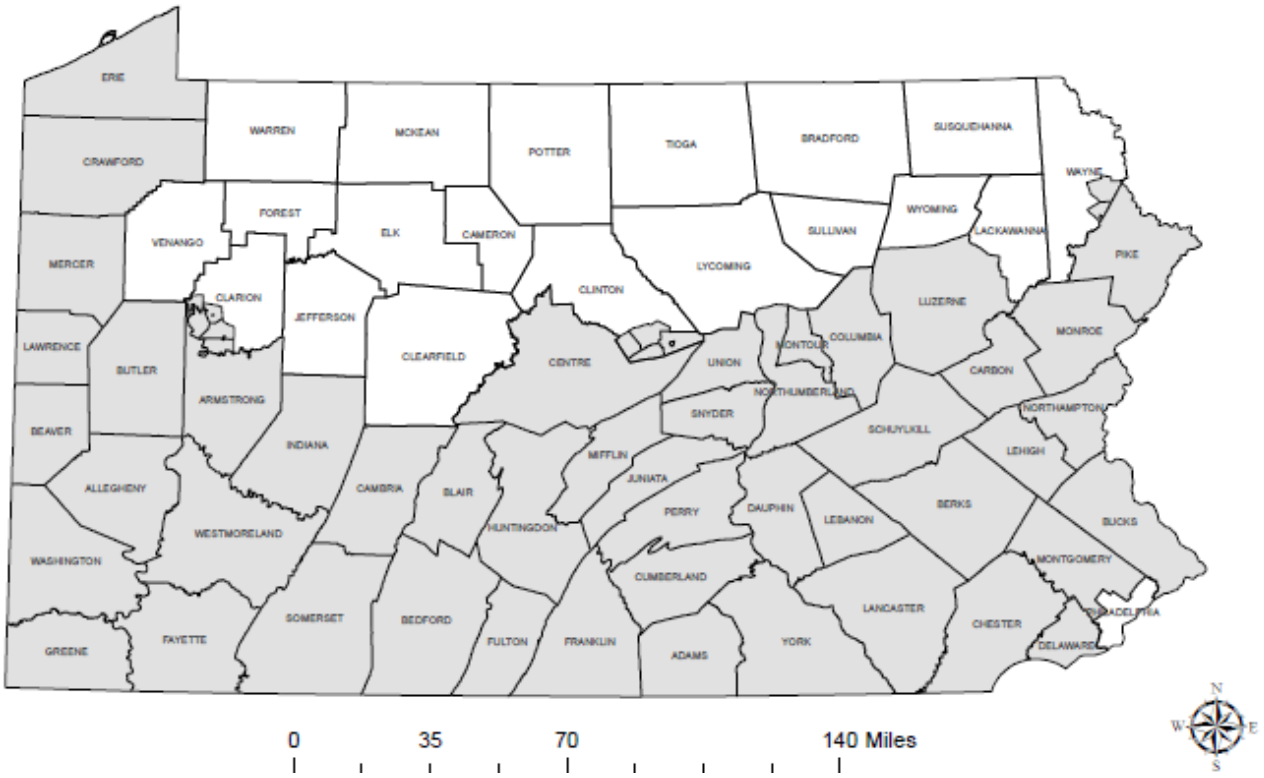


Figure 65. Counties in grey reflect Indiana bat range in Pennsylvania

Since the completion of the 2007 Forest Plan and the issuance of the USFWS concurrence letter, the northern long-eared bat (NLEB) was Federally listed as Threatened on April 2, 2015. The ANF has maintained implementation of the conservation measures developed for the Indiana bat as they are expected to benefit the NLEB as well as other sensitive bat species. The ANF also implements the six conservation measures developed for the Northern long-eared Bat Programmatic B for Land and Resource Plans of the Forest Service Eastern Region (USDA-FS 2015b).

As stated in the Approval and Declaration of Intent section of the FY 2008-2013 Monitoring & Evaluation Report, NTPs associated with outstanding and reserved mineral development are being evaluated under the 1986 Forest Plan standards and guidelines. As a result, the conservation measures that would apply to private oil and gas are not applicable. The ANF may negotiate mitigation measures with operators consistent with the conservation measures and 2007 Forest Plan standards and guidelines, and uses collaborative approaches to avoid, mitigate, or remedy resource concerns associated with OGM development.

Conservation Program (all species)

1. Measure: Secure subsurface rights (e.g., mineral, oil, and gas rights) within areas on the ANF identified as important endangered and threatened species habitats.

   Protocol/Results: See *3.11.1 Acquire subsurface ownership*.

2. Measure: Continue to cooperate with other agencies and organizations to support inventory and monitoring efforts on the ANF to gain a better understanding of the occurrence and distribution of threatened and endangered species.

   Protocol/Results: See Protocol/Results for conservation measures 2, 5, and 6 under the Conservation Program.

Conservation Program (Indiana bat)

1. Measure: Maintain bat interpretive display at Hall Barn and continue to provide bat educational opportunities to the public (public presentations and displays).

   Protocol/Results: The interpretive display at the Hall Barn was maintained and is now a geocache site where participants must read the interpretive panels and answer questions on bats to find the coordinates of the cache.

2. Measure: Maintain three bat condos at Hall Barn, Buzzard Swamp, and Camp Cornplanter. Erect additional bat condos and install additional bat boxes where needed. Maintain the Hall Barn and the baffles inside. Monitor bat use within these structures every two or three years.

   Protocol/Results: Condos at the Hall Barn, Buzzard Swamp, and Camp Cornplanter were maintained. Additional condos were constructed at the Bean Fields and Birdsell Edey. Also, in partnership with the National Wild Turkey Federation, bat boxes were installed across the Forest.

   Vegetation was removed annually from the sides of the Hall Barn and away from the foundation. The area around the barn and parking lot is also mowed annually as well as a path to the Hall Barn Condo. Vegetation is removed from the base of the condo and guano is periodically removed to prevent buildup. Boards were added as internal support to stabilize the front barn doors. Repairs were also completed as necessary to the downspout, louvers, trim, roof, and paint.

   Annual emergence counts were conducted, and results were shared with PGC as part of the Appalachian Bat Count (https://www.pgc.pa.gov/InformationResources/GetInvolved/Pages/AppalachianBatCount.aspx).

3. Measure: Provide training opportunities to ANF biologists that include bat identification, biology, habitat requirements, and sampling techniques.

   Protocol/Results: As mist net surveys are not completed in-house, ANF staff did not receive training on these survey techniques; however, training opportunities were made available on acoustic sampling techniques.

4. Measure: Complete 10-year snag longevity study started in FY 2000.

   Protocol/Results: Results of the completed snag longevity plots need to be analyzed and summarized.

5. Measure: Between 20 and 30 bat survey mist net sites will be implemented once every third year to monitor bats on the ANF.

   Protocol/Results: Mist net surveys were conducted at 31 sites in FY 2010, 26 sites in FY 2013, 24 sites in FY 2014, and 27 sites in FY 2015 (Figure 66). The 2014 and 2015 surveys were conducted with the specific objective to net, transmitter, and track NLEB to locate maternity roosts. As a result, four NLEB roosts trees have been identified on the ANF, three of which are known, occupied maternity roosts per USFWS definitions (Turner personal communication 2016).

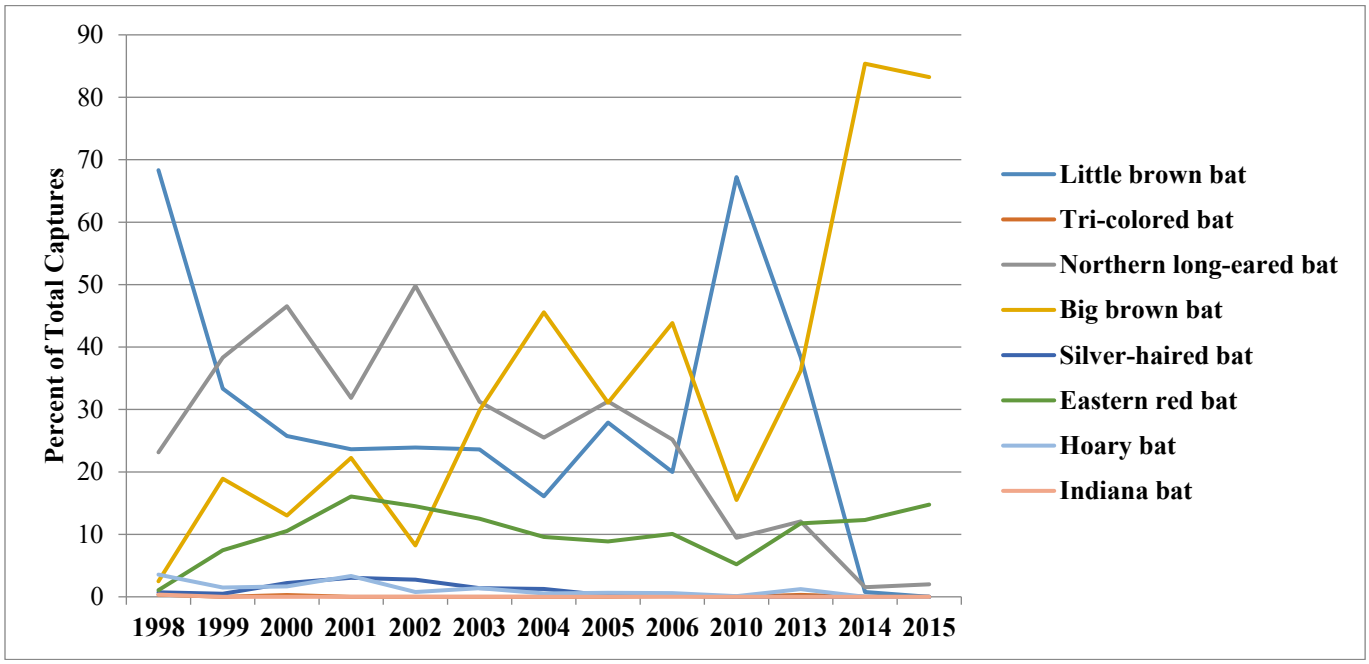


Figure 66. Percent of total captures by species in mist net surveys completed on the ANF (FY 1998-2015)

Also, acoustic surveys were conducted from FY 2008 through FY 2016 along four driving routes to determine pre- and post-WNS population trends. These data have not yet been analyzed for trends.

6. Measure: Coordinate with PGC to conduct bat monitoring at caves on or in the vicinity of the ANF.

   Protocol/Results: There are four known NLEB hibernacula within or near the ANF boundary. In coordination with PGC, surveys were conducted through fall swarm trapping at one of these sites (McKean County Cave) in 2013 and 2014. One NLEB was documented during the 2014 survey.

Concurrence Letter

1. Measure: In all timber harvest units:

   - One-quarter acre within each five acres of harvest should be set aside as reserve areas. Layout of reserve areas should emphasize the following: vernal ponds, wet depressions, unique plant communities, rock complexes, den trees, snags, conifers, mast producing species, and tree and shrub species that are a minor component of the stand. Additional live and dead trees scattered throughout the harvest unit should be retained.

   - Retain trees with characteristics of suitable roosts (dead or dying trees with flaking or exfoliating bark) whenever possible.

   - Retain all shagbark hickory.

   - Retain at least nine snags per acre, greater than 10 inches DBH (where available).

   - Retain at least three live trees per acre ≥ 20 inches DBH (or largest trees available) of preferred roost tree species (e.g., hickories oaks, maples, elms, black locust, or green and white ash). Where possible, these trees should be located in areas of the stand where thick regeneration which occurs after a final harvest, will not shade or obstruct bat flight to the tree. Retain an additional 6 live trees per acre > 10 inches DBH.

   Protocol/Results: ANF marking guidelines require that one-quarter acre, within each five acres of final harvest, are set aside as reserve areas; trees with characteristics of suitable roosts are retained whenever possible and all shagbark hickory are retained.

   Marking tallies completed pre-harvest for final harvest units cut in FY 2008-2016, were reviewed for snag and live tree retention (Table 40). An average of 4.2 snags per acre > 10 inches DBH, 7.3 live trees per acre > 10 inches DBH, and 1.2 live trees per acre ≥ 20 inches DBH were retained in final harvest units.

Table 40. Final harvest unit marking tallies (FY 2008-2016)

Sale Name/Payment Unit # (Conservation Measure)	Snags/Acre > 10" DBH (at least 9)	Live ≥ 20" DBH/Acre (at least 3)	Live > 10" DBH/Acre (at least 6)
LMC Salvage Removals/1	7.0	Unknown*	8.6
LMC Salvage Removals/5	7.7	Unknown*	10.8
CHSP FR 237 Stewardship/1	7.4	Unknown*	7.4
CHSP FR 237 Stewardship/2	4.7	Unknown*	8.2
FR 473 Removals/1	5.1	Unknown*	10.2
Timberdoodle/7	4.3	Unknown*	4.0
Long Road/10	1.6	Unknown*	2.0
Turnup Run/9	6.4	Unknown*	7.0
Turnup Run/10	1.2	Unknown*	12.0
Reagan Run/2	0.5	Unknown*	9.0
Silver Slide IRTC/1	6.1	Unknown*	5.5
Silver Slide IRTC/3	7.6	Unknown*	20.0
Silver Slide IRTC/4	7.8	Unknown*	8.4
FR 150B Removals/1	7.2	Unknown*	7.5
FR 150B Removals/3	6.3	Unknown*	6.0
Phillips County Line/2	2.3	1.4	1.4
Phillips County Line/3	6.0	1.9	6.0
Elijah Run/5	3.4	0.7	3.2
Little Arnot/9	3.9	1.6	5.6
Mudlick/5	3.0	1.0	5.0
FR 744 Removal/1	8.7	Unknown*	6.0
FR 744 Removal/2	10.4	Unknown*	6.5
FR 340 Salvage Removal/1	6.0	Unknown*	11.3
FR 340 Salvage Removal/4	6.8	Unknown*	13.7
FR 340 Salvage Removal/8	5.3	Unknown*	11.6
Bobbs Fork/3	1.4	0.8	2.2
Bobbs Fork/6	2.2	1.2	4.3
Bobbs Fork/8	3.7	0.7	4.3
West Sugar/1	3.4	6.7	8.7
West Sugar/7 & 8	5.7	7.0	18.0
Log Run/5	4.7	Unknown*	21.2

Sale Name/Payment Unit # (Conservation Measure)	Snags/Acre > 10" DBH (at least 9)	Live ≥ 20" DBH/Acre (at least 3)	Live > 10" DBH/Acre (at least 6)
Brush Creek/12	5.1	Unknown*	8.4
Brush Creek/13	5.1	Unknown*	8.8
Mead/5	3.6	0.2	3.4
Mead/12	6.3	1.3	6.7
Slater Run/10	3.4	2.0	9.0
Slater Run/12	1.7	5.0	11.0
Mead/11	4.0	0.2	2.4
Indian Run/7	4.4	0.5	2.1
Hemlock Run/6	3.6	Unknown*	4.3
Hemlock Run/7	4.4	Unknown*	5.0
Sleeping Bear/1	2.7	Unknown*	5.7
Sleeping Bear/2	2.1	Unknown*	5.8
CHSP Little Seek Stewardship/1	4.7	0.5	6.7
CHSP Little Seek Stewardship/2	2.5	2.6	5.4
CHSP Kemp Run Stewardship/1	4.6	2.6	6.7
CHSP Kemp Run Stewardship/2	7.7	2.9	12.6
BHSP Iron Quad Stewardship/1	2.6	1.6	6.7
FR 216 B Removal/1	5.0	1.3	2.6
Little Hunter Removals/1	3.7	1.4	2.7
Evil East Removals/1	4.8	0.8	9.0
Evil East Removals/5	6.5	1.6	12.8
Evil East Removals/7	5.1	1.5	6.9
CHSP Pomegranate Hollow IRTC/4	2.6	0.9	2.7
Rocketline Removals/2	1.8	2.4	9.8
Rocketline Removals/3	2.7	1.1	3.1
Rocketline Removals/4	3.8	0.3	5.7
Rocketline Removals/6	5.5	5.5	11.5
CHSP Pearsall IRTC/7	2.5	1.1	2.3
CHSP Pearsall IRTC/8	1.8	1.5	3.6
CHSP Pearsall IRTC/11	3.3	3.0	6.0
FR 580 Salvage Removals Re-Ad/6	4.7	3.0	6.0
Salmon Trails Re-Ad/5	4.5	3.0	10.8

Sale Name/Payment Unit # (Conservation Measure)	Snags/Acre > 10" DBH (at least 9)	Live ≥ 20" DBH/Acre (at least 3)	Live > 10" DBH/Acre (at least 6)
Browns Run/2	4.1	2.9	2.0
Browns Run/7	3.8	2.3	15.3
Browns Run/8	3.8	2.3	15.3
Lick Run/1	0.3	Unknown*	3.9
Lick Run/2	0.2	Unknown*	4.5
Coal Knob/1	4.6	2.1	4.4
Coal Knob/2	4.3	1.9	4.0
Coal Knob/3	5.0	2.3	4.8
LR Removals/1	3.1	1.5	6.0
LR Removals/2	2.6	1.2	5.0
West Tuna/4	3.3	1.5	5.4
West Tuna/5	3.3	1.5	5.4
Sheriff Removals/3	1.4	1.5	10.2
Sheriff Removals/4	4.3	2.8	12.1
Sheriff Removals/5	3.0	2.5	9.2
Average	**4.2**	**1.2**	**7.3**

*The diameter of live trees was not recorded. Trees recorded in the > 10" category may be ≥ 20" DBH.

2. Measure: For partial/intermediate harvests in healthy stands, retain canopy closure at optimal roosting and foraging habitat levels (> 50%).

   Protocol/Results: Marking checks completed pre-harvest, for partial harvests cut in FY 2008-2016, were reviewed for residual relative density (Table 41; 43% residual relative density = 50% canopy closure). Residual relative density in partial harvest units averaged 54%, 43%, 52%, 45%, 46%, and 58% in, thinnings, shelterwood seed cuts, shelterwood preparation cuts, single tree selection cuts, group selection cuts, and thinnings to accelerate mature forest conditions, respectively.

Table 41. Partial harvest (thinnings, shelterwood seed and preparation cuts, selection cuts, and thinnings to accelerate mature forest conditions) unit marking checks (FY 2008-2016)

Treatment	Average Residual Relative Density	Units	Units > 43% Residual Relative Density
Thinning	54%	58	47
Shelterwood Seed Cut	43%	70	29
Shelterwood Preparation Cut	52%	3	2
Single Tree Selection Cut	45%	7	5

Group Selection Cut	46%	1	1
Thinning to Accelerate Mature Forest Conditions	58%	2	2

3. Measure: All known roost trees on the ANF will be protected until they no longer serve as a roost. In the event that it becomes absolutely necessary to remove a known Indiana bat roost tree, removal will be conducted through consultation with USFWS, and during the time period when the bats are likely to be in hibernation (October 15 to March 31).

   Protocol/Results: There are no Indiana bat roost trees on the Forest. Four NLEB roost trees have been identified on the ANF, three of which are known, occupied maternity roosts per USFWS definitions. The ANF will protect them per the Eastern Region Conservation Measures (see *Eastern Regional Conservation Measures* section below).

4. Measure: During the review of OGM development Plans of Operation, if known occurrences of federally-listed or candidate species are located in the vicinity of a proposed OGM development, this will be documented in a letter to the operator and copied to the USFWS Field Office in State College, Pennsylvania. The letter will direct the operator to contact the Service to resolve issues related to threatened and endangered species prior to proceeding with any tree-cutting or earth disturbance.

   Protocol/Results: The Plans of Operation were reviewed, and no Indiana or northern long-eared bat occurrences were located in the vicinity of proposed OGM development.

5. Measure: If Indiana bat maternity roost trees are discovered, protect the trees from physical disturbance and designate an area of use based on site conditions, radio-tracking or other survey information, and best available information regarding maternity colony needs. Maintain or enhance the site by maintaining an adequate number of snags, including known roost trees; maintaining large live tress to provide future roosting opportunities; and maintaining optimal roosting and foraging habitat.

   Protocol/Results: There are no Indiana bat maternity roost trees on the Forest. Four NLEB roost trees have been identified on the ANF, three of which are known, occupied maternity roosts per USFWS definitions. The ANF will protect them per the Eastern Region Conservation Measures (see *Eastern Regional Conservation Measures* section below).

6. Measure: Conduct prescribed burning, within any maternity colony, only during the hibernating season.

   Protocol/Results: There are no Indiana bat maternity colonies on the Forest. Four NLEB roosts trees have been identified on the ANF, three of which are known, occupied maternity roosts per USFWS definitions. The ANF will protect them per

the Eastern Region Conservation Measures (see *Eastern Regional Conservation Measures* section below).

7. Measure: Demolition or removal of buildings or other man-made structures that harbor bats should not occur between April 15 and August 15. Bat boxes will be installed near the building prior to demolition. If the building must be removed when bats are present, a bat expert will survey the building to determine whether Indiana bats are present; if they are, consultation with USFWS will be necessary.

   Protocol/Results: No buildings containing bats were demolished.

Eastern Region Conservation Measures

The following six conservation measures developed for the Northern long-eared Bat Programmatic Biological Assessment for Land and Resource Plans of the Forest Service Eastern Region (USDA-FS 2015b) have been implemented on the ANF where applicable.

1. Designate caves and mines that are occupied by bats as smoke-sensitive targets. Avoid smoke entering these caves and mines any time of the year when Threatened, Endangered, or Sensitive (TES) bats are present.
2. Within 0.25 miles of known, occupied NLEB hibernacula, timber harvest will be designed to maintain, enhance, or restore swarming, staging, roosting, and foraging habitat. The future desired condition is that these areas will feature structurally complex, resilient forest communities with a continuous supply of snags, culls, cavities, and other quality roosts.
3. Application of herbicides and other pesticides will be planned to avoid or minimize direct and indirect effects to known, occupied TES bat hibernacula and maternity roosts.
4. Before old buildings, wells, cisterns, bridges, and other man-made structures are structurally modified or demolished, they will be surveyed for bats. If TES bat roosting is found, demolition or modification of these structures will not occur when bats are present and the need for alternative roosts will be evaluated.
5. Avoid cutting or destroying known, occupied NLEB maternity roost trees unless they are an immediate safety hazard.
6. Where needed to provide drinking sources for bats, create small wetlands or water holes.

Discussion – When applicable, conservation measures were implemented with the exception of the snag retention and one of the live tree retention measures in final harvest units.

Only one of the final harvest payment units monitored met the standard for retaining nine snags per acre > 10 inches DBH. These stands likely did not have a level of mortality that created an abundance of snags to retain; however, these tallies do not take into consideration the reserve areas left in units (at least one-quarter acre within each five acres of harvest), which retain additional snags as well as conifers and other unique features. Additionally, newer forest health

stressors (e.g., insects and disease such as beech bark disease and emerald ash borer) will more than likely recruit more snags in a variety of age classes across the ANF.

The first live tree guideline calling for the retention of three live trees per acre ≥ 20 inches DBH was only met in seven units monitored. Each year this guideline will be easier to implement as the forest continues to mature. The second live tree guideline, which calls for the retention of six live trees per acre > 10 inches DBH, was met or exceeded in most units. Again, these tallies do not take into consideration the reserve areas left in units (at least one-quarter acre within each five acres of harvest), which retain additional snags as well as conifers and other unique features such as wildlife trees.

As demonstrated in the last evaluation period (see *Standing and downed woody debris* in USDA-FS 2014a), FIA data indicate that an abundance of standing dead trees of all sizes and stages of decay is present across the ANF, although individual stands may contain more or fewer snags than the averaged FIA sample. Standing dead trees in the least decayed classes indicate that snag recruitment is occurring. The higher volume of trees in the more advanced decay classes indicate that standing dead trees are persisting as snags for some time.

Recommendations – Continue to implement conservation measures with emphasis on retaining snags > 10 inches DBH and live trees ≥20 inches DBH. Retaining trees that may become snags during the first entry (partial harvest) may result in more snags available for retention in the final harvest.

Analyze and summarize snag longevity study data.
Update the Forest Plan to incorporate conservation measures specific to the NLEB (e.g., Eastern Region Conservation Measures) and remove those specific to the Indiana bat.

Evaluate acoustic survey trend data for bat species.

3.9.14 Implement conservation measures for federally listed mussels

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are conservation measures being implemented for mussel species listed, proposed, or candidate for protection under the Endangered Species Act?	Status of conservation measure implementation	Annual	2 years	FY 2013

Background – The basis of this monitoring question is to review the action the ANF is taking to fulfill its 7(a)1 (ANF Conservation Program) and 7(a)2 (USFWS concurrence letter conservation measures) responsibilities under the ESA with respect to the threatened and endangered species of freshwater mussels that occur or have suitable habitat within the ANF proclamation boundary. As such, this monitoring question addresses the 2012 Planning Rule requirement of monitoring the status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

Two sets of mussel conservation measures were developed for the 2007 Forest Plan with extensive overlap between the two sets. The first set is included in Appendix C of the Forest BA (and its December 2006 supplement) that was completed during Forest Plan revision and submitted to the USFWS. This set represents the ANF's Conservation Program for threatened and endangered freshwater mussels, including the clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*). There are nine conservation measures in the Conservation Program applicable to threatened and endangered freshwater mussels, in addition to two conservation measures applicable to all federally listed species. The second set was issued by the USFWS in their concurrence letter (USDI-FWS 2007) as conservation measures to implement in order to reach a "not likely to adversely affect" determination. There are 25 measures included in this second set.

Since the completion of the 2007 Forest Plan and the issuance of the USFWS concurrence letter, four additional freshwater mussel species with documented occurrence or suitable habitat within the ANF have been federally listed as threatened or endangered. The addition of these new species has resulted in the original monitoring question, which addressed only clubshell and northern riffleshell mussels, being modified during the monitoring transition and broadened to address all federally listed, proposed, or candidate mussels, including: rabbitsfoot (*Quadrula cylindrica cylindrica*), rayed bean (*Villosa fabalis*), sheepnose (*Plethobasus cyphus*), and snuffbox (*Epioblasma triquetra*). At the end of the evaluation period (FY 2016), there were no proposed or candidate mussel species present on the ANF.[3]

As stated in the Approval and Declaration of Intent section of the FY 2008-2013 Monitoring & Evaluation Report, NTPs associated with outstanding and reserved mineral development are being evaluated under the 1986 Forest Plan standards and guidelines. As a result, the conservation measures that would apply to private oil and gas are not applicable. The ANF may negotiate mitigation measures with operators consistent with the conservation measures and 2007 Forest Plan standards and guidelines, and uses collaborative approaches to avoid, mitigate, or remedy resource concerns associated with OGM development.

Protocol and Results

This monitoring question focuses on monitoring and evaluating Conservation measures for listed mussel species. Overall, our monitoring indicates that relatively little ANF timber harvest has occurred over the FY 2008-2016 period in the 13% Area. Of the sales that did occur, all were designed with appropriate riparian buffers intended to mitigate any impact that could result from the basal area reduction. During the FY 2008-2016 period, no permanent or temporary roads or trails were constructed by the ANF in the 13% Area and significant efforts were made to decommission or improve roads in order to have a positive impact on water quality.

There was an increase in total roads in the 13% Area during the FY 2008-2016 period as well as surface disturbance, due the development of well pads associated with oil and gas extraction

[3] On September 29, 2020, the USFWS proposed listing of the longsolid mussel and designation of a critical habitat unit within the ANF proclamation boundary (https://www.federalregister.gov/documents/2020/09/29/2020-17015/endangered-and-threatened-wildlife-and-plants-12-month-finding-for-purple-lilliput-threatened). As of June 2021, the USFWS had not published a final rule in the Federal Register.

efforts by private mineral owners. The ANF coordinates with the operators and regulatory agencies (e.g., PA DEP) to remedy identified concerns. OGM development activities have been relatively limited in the 13% Area over the period considered in this report.

Conservation Program (all species)

1. Measure: Secure subsurface rights (e.g., mineral, oil, and gas rights) within areas on the ANF identified as important endangered and threatened species habitats.

   Protocol/Results: See *3.11.1 Acquire subsurface ownership*.

2. Measure: Continue to cooperate with other agencies and organizations to support inventory and monitoring efforts on the ANF to gain a better understanding of the occurrence and distribution of threatened and endangered species.

   Protocol/Results: In FY 2013, the ANF partnered with WPC through a Challenge Cost Share Agreement developed to conduct surveys and collect data on mussel distribution and abundance on the ANF. Prior to these surveys, this information was limited outside of the Allegheny River.

   Mussels were sampled by hand by divers or snorkelers. All mussels found were identified to species and then replaced. In total, 54 sites were surveyed across the Forest between FY 2014 and FY 2016. ANF and WPC biologists selected survey sites based on their potential as habitat for threatened and endangered mussels. Surveys sites included locations on the Allegheny Reservoir as well as along the Clarion River, Tionesta Creek, and numerous ANF streams. Five hundred forty-five individual mussels from 16 common species were identified; no individuals of threatened or endangered species were located.

Conservation Program (federally listed freshwater mussels)

1. Measure: Educational materials will be made available to the public about the threats that zebra mussels present, how they are transported, where they currently occur, and procedures to decontaminate watercraft. This material will be available as handouts, as well as signs posted at the marina and boat launches on the Allegheny Reservoir and at Buckaloons Recreation Area.

   Protocol/Results: Signs with information about the prohibition of launching watercraft that may contain zebra mussels or AIS and the methods to be used to decontaminate a watercraft are posted at all Forest Service boat launches. In the past, prior to the beginning of the boating season (Memorial Day weekend), educational materials were made available to various venues, such as concessionaires that manage campgrounds and boat launches, Forest Service offices, bait shops, sporting goods stores, marinas, and visitor centers. Educational materials are available in Forest Service offices but, due to personnel changes, the practice of handing out of educational materials to private businesses or concessionaires was not maintained over the FY 2014-2016 period.

2. Measure: Signs will be posted at the marina and boat launches on the Allegheny Reservoir, and at Buckaloons prohibiting the launching of vessels that may be carrying zebra mussels, unless such vessels have been decontaminated.

   Protocol/Results: See the Protocol/Results for Conservation Measure 1 under the Conservation Program.

3. Measure: At canoe access sites and the boat launch at Buckaloons, the Forest Service shall establish educational displays and/or provide educational materials explaining the same items listed in the first conservation measure above.

   Protocol/Results: See the Protocol/Results for Conservation Measure 1 under the Conservation Program.

4. Measure: The Forest Service will coordinate with other agencies in developing and implementing contingency plans and protocols for zebra mussel control and/or native mussel species protection in the event of zebra mussel incursion.

   Protocol/Results: A contingency plan has not been discussed or developed by other agencies as no zebra mussels have ever been documented in those portions of the Allegheny River adjacent to the ANF, according to the USGS Aquatic Invasive Species database and Pennsylvania Sea Grant who track such occurrences and are annually reviewed by ANF staff. Zebra mussels were collected in Conewango Creek, upstream of the Allegheny River, in 2009 by the PA Fish and Boat Commission during a dam removal.

5. Measure: The collection of dead, injured, or sick endangered mussels will be reported to USFWS.

   Protocol/Results: No dead, injured, or sick endangered mussels have been documented during mussel surveys conducted at 60 sites by the WPC and the Forest Service during the 2014-2016 period.

6. Measure: Surveying the Allegheny Reservoir shoreline for ¼ mile on each side of ANF boat launches for the presence of zebra mussels, occurring after the reservoir has been drawn down at least 10-15 feet when possible. Zebra mussel detection surveys will be conducted along the shoreline for ¼ mile on each side of Forest Service developed boat launches within the Allegheny Reservoir (approximate pool elevation 1318 – 1313 feet or less (mean sea level)) conditions permitting.

   Protocol/Results: No occurrences of zebra mussels have been documented in the Allegheny Reservoir. Substrate samplers placed on three docks (Wolf Run Marina, USACE dock at Kinzua Dam, Onoville Marina in New York) by the USACE did not harbor any mussels when retrieved near the end of the 2008 through 2012 recreational seasons. As of FY 2015, because of the possibility of zebra mussels becoming established below the low water mark of the reservoir, the Forest Service switched to

using dive surveys in the Allegheny Reservoir. Three sites in the Allegheny Reservoir were surveyed in FY 2015 and three sites were surveyed in FY 2016; no live or dead zebra mussels were found.

See also *3.9.10 Minimize risk of aquatic invasive species introduction*.

7. Measure: Survey potential sources of water pollution from activities that may be occurring or will occur on the ANF. This includes assessing specific projects or types of projects, monitor water quality of tributaries to the Allegheny River, and remediate suspected causes of sedimentation through implementation of the terms and conditions below.

    - Existing trails shall be visually surveyed to determine which trails or trail segments are contributing sediment to perennial or intermittent streams. Appropriate erosion and sedimentation controls shall be implemented to correct identified problem areas.
    - Existing roads shall be visually surveyed to determine which roads or road segments are contributing sediment to perennial or intermittent streams.
    - Appropriate erosion and sedimentation controls shall be implemented to correct identified problem areas.
    - Tree harvesting/removal techniques shall continue to be visually monitored to ensure that standards and guidelines are in fact implemented and do in fact result in only insignificant amounts of transported sediment compared to areas where no earth disturbance takes place.
    - OGM development activities (including individual Pollution Prevention and Spill Response Plans) shall continue to be visually monitored to ensure that guidelines for federally-owned leases are adhered to, and guidelines for privately-owned rights are adhered to. Appropriate action (e.g., reporting known or suspected violations to the EPA and/or PA DEP) will be taken when guidelines are not followed.
    - The Forest Service shall periodically visually monitor private OGM development (abandoned and active) on the ANF to determine whether or not pollutants (e.g., oil, gas, brine, sediment, etc.) are being properly contained to avoid contamination of the soil, water, or air. If any contamination is detected, suspected, or likely to occur, the Forest Service shall work with the developer who will remediate the situation; and/or report the incident to the appropriate federal and state authorities (i.e., EPA, PA DEP). Any known or suspected take of federally listed species resulting from such activities shall be immediately reported to the USFWS.
    - Water quality monitoring stations (i.e., locations) shall be established on several tributaries to the Allegheny River immediately before those tributaries empty into the Allegheny River, with emphasis on determining sediment budgets for watersheds with varying degree of activities. The design of the study and placement of the stations should be coordinated with the USFWS. A depth-integrated sampler will be used to collect water samples that will then be sent to a lab for analysis.

Protocol/Results: Visual monitoring of projects is conducted by Forest personnel, such as engineers, trail managers, oil and gas administrators, biologists, and soil and water resource personnel, during their normal work in the field and with scheduled visits to areas where the potential for water quality concerns could occur.

- Transportation monitoring – A field visit or a discussion with the Contracting Officer Representative upon completion of any road or trail surfacing work is done to determine if the work meets the surfacing guidelines that have been prescribed to address runoff concerns. During the FY 2008-2016 period, road improvement work was carried out in the 13% area in order to reduce issues with sedimentation and runoff (Table 42).

Table 42. Transportation activities in the 13% area (FY 2008-2016)

Year	Activities
2016	Drainage structures and road surface repaired and multiple culverts replaced on 1.4 miles of FR156.
2015	0.1 miles FR160 reconditioned, 0.3 miles FR323 reconditioned and multiple culverts replaced, 1.1 miles of FR204 reconditioned, 1.2 miles of FR550 reconditioned and multiple culverts replaced.
2014	None
2013	300 feet of road decommissioned and one stream crossing decommissioned on Ott Run, 5,000 feet of private oil and gas road decommissioned with two stream crossings decommissioned, one stream crossing replaced with an AOP crossing and the approaches surfaced with DSA limestone
2012	Several miles of FR160, 0.2 miles of FR362, 0.4 miles of FR362B surfaced with DSA limestone
2011	None
2010	0.14 miles of FR245, 0.52 miles of FR245C, 0.02 miles of FR524 surfaced with DSA limestone
2010	0.02 miles surfaced with DSA limestone
2009	None
2008	None

- Timber harvest monitoring – During the FY 2014-2016 period, seven timber sale units, totaling 156 acres were harvested in the 13% Area. Four of the harvest units were shelterwood seed cuts totaling 115 acres. The remaining three harvest units were overstory removal cuts totaling 41 acres. Post-harvest field reviews of these units were not carried out due to a lack of personnel.

  For the FY 2008-2013 period, the following timber harvest activities were carried out in the 13% Area. One stand originally harvested as a shelterwood seed cut in 1997 had a final harvest done in FY 2008 as part of the Stonehill Removal, thus completing the prescription for this stand. This unit was located high on the plateau with no water concerns. The Little Hammer timber sale, located partially in the 13% Area, had two units harvested; however, these units were both outside the 13% Area. There was no active harvesting by the ANF in FY 2009 or FY 2010. In FY 2011, there was one active timber sale. This sale, Grunder East, had

two payment units (8 and 9) harvested totaling 32 acres. In FY 2012 and FY 2013, there were four active timber sales. The sales included Grunder East, Grunder West, and Sill Run (all part of the Meads Mill project area) as well as a fourth active sale part of the Beaver Run Stewardship project. Review of LiDAR stream data prompted monitoring of one payment unit (14) within the Sill Run sale. A field review by the Forest Silviculturist and Forest Fisheries Biologist found no stream present and thus buffers were not required.

- Private oil and gas monitoring – From FY 2008 through FY 2016, the review of well packages issued a NTP were completed as possible based on available resources by ANF oil and gas administrators, the Forest Fisheries Biologist, and biological technicians (Table 43).

During the FY 2008-16 period, no cases were noted where oil, gas, or brine were being improperly stored; however, during the FY 2008-2013 period some containment pits appeared too small to capture the fluids from the largest tank at a tank battery should it drain completely.

Table 43. Private OGM development reviewed in the 13% Area for water resource concerns (FY 2008-2016)

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
209	8-21-2009	yes		Sill Run road crossing installed with 45"x35" culvert and 50-year flow should be 58"x36". Road surface has larger commercial stone, but still lot of fines. Approximately 900' of runoff reaching Sill Run.
277	8-21-2009	yes	pipeline	Significant erosion and runoff occurring from a pipeline constructed across several springs and an unnamed tributary to Grunder Run. There were no temporary or permanent erosion control measures in place to help stabilize the site. After the review, the developer was notified by an ANF oil and gas administrator of the concern.
276	5-3-2010	in progress	0	At time of visit, lots of initial development activity occurring. Did not review on this day, but will need to be monitored.
277	5-3-2010	yes	pipeline	This was a follow-up review from 8-21-2009. Some water bars put in on west side of unnamed tributary to Grunder Run, but some runoff still reaching stream. No water bars on east side of stream where runoff is reaching stream in a couple locations. Lots of springs

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
				intercepted by the pipeline on the east side (as well as the west side)
B-002	5-5-2010	yes	11	Wells are upslope of any water resources. Noted commercial stone on roads. Drill cuttings sprayed on cutslope at well 470-14.
B-003	5-4-2010	yes	4	Road built into wells 111 and 112 looked good except that two 6" casings used for minor crossings between well 111 and 112 were significantly undersized and do not meet any BMP or road standard. Cutslopes well-seeded. Well pad 112 up against a stream and should be monitored regularly. A pile of drill cuttings in the woods was discovered adjacent to well site 126. This material has the potential to move off-site and into a nearby tributary to Browns Run.
B-004	5-4-2010	yes	6	No concerns with runoff and water resources.
B-006	5-3-2010	to 2 wells	2	Road leading to wells 24 and 25 in very bad shape. Road is downcutting from runoff. May reach a drainage that leads to Dale Run, but did not walk it out to check. Wells 22 and 23 weren't drilled at time of visit, but road leading to wells will need careful placement of culverts to avoid impacting springs located just downslope.
B-012	5-3-2010	yes	1	This is a deep well. No concerns. Located high on the plateau.
B-019	5-4-2010	NTP not issued at the time of review		Layout and marking of timber done. Will need to ensure runoff is not directed to existing springs and live drainages.
B-020	5-4-2010	NTP not issued at the time of review		No work had begun
B-037	5-2010	to 8 wells	0	No water related concerns with roads built to wells 19-22 and 26-29. Road layout done for wells 23-25 and 30-32; lots of potential water resource concerns that need followed up, including many springs and wetlands.
B-050	5-7-2010 and 5-12-2010	cleared only	15, although not drilled since wells not	Serious erosion and runoff into the Sill Run drainage was occurring throughout the development, where little to no erosion and sediment control measures

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
			permitted yet	were in place. Numerous small streams and springs were heavily laden with sediment.
B-052	5-6-2010	cleared only	6, although not drilled on day of review	All wells high and dry, so no water concerns. However, within the lease, ATV trails are established going straight up and down the slopes below this well package.
B-054	5-5-2010	yes	9; 1 was in progress	Roads built well. Most cutslopes seeded and sloped nicely; some reseeding needed. Drilling pits piled high against some trees which may lead to damage. Big pile of drill cuttings on cutslope at well 470-18. Potential runoff to Morrison Run that needs additional monitoring. Road leading to an old well to be plugged had significant runoff to ditch along FR156 and then to Morrison Run.
B-086	5-7-2010	cleared only	0	Did not review well sites. Appear to be upslope of any water resource. A follow-up should be conducted.
B-020	1-24-2011	yes	4	Wells 5, 6, 7, 8, and tank battery 100% complete; all Inspection Items are 'Satisfactory'
B-019	4-15-2011	yes	7	Road templates need to be reworked to permit the water to run off instead of running down the 2-track. Pipelines that were dug across the roadway have settled considerably and need to be filled in. Follow-up inspection planned within the next 14 days.
B-006	7-7-2011	to 2 wells	2	Road leading to wells 24 and 25 still in very bad shape as was the case during the 2010 visit. Road is downcutting from runoff. Two plastic cross drains are collapsed and likely not functioning properly. The site does not look very active. Wells 22 and 23 still not drilled at time of visit, but existing woods road leading to wells will need careful placement of culverts to avoid impacting springs located just downslope. There is a corrugated plastic pipe under road entrance (before gate) that leads to

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
				a tributary to Dale Run. This pipe drains the ditch line. It is highly likely that runoff from the entrance is also reaching the outlet end which then connects to the tributary. Roads need work and gate kept closed.
B-151	7-27-2011	NTP not issued at the time of review		Layout of wells and flagging of roads complete.
277	8-30-2011	yes	pipeline	This was a follow-up review from 2009 and 2010 of a pipeline that crosses a tributary to Grunder Run. The waterbars put in on west side of unnamed tributary are working properly, and the pipeline is very well vegetated. No further concerns at this point. On east side of crossing, the pipeline is now very well vegetated, but no water bars to disrupt water that is flowing down well-defined scoured channels. Need several water bars on the east side of crossing as this section is steep and lengthy and captures numerous springs and runoff during rain events.
B-019	9-9-2011	yes	7 (3 drilled)	No water resource concerns with two of the drilled wells (40-8 and 40-9) or roads. Doesn't appear there will be any concerns with roads built to other wells, except for 40-11. Well 40-11 is drilled and road built beyond well 40-6 (from a previous well package). This road crosses a small drainage (located between FR160D and well 40-6) and is contributing excessive runoff. This needs corrected. No runoff concerns at the well pad for 40-11, but will need to monitor runoff as it works its way around the backside of the well pad in the coming years. There is heavy runoff at the intersection of the road leading to wells 40-6 and 40-

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
				11, and FR160D. Need better water control; road is downcutting.
B-020	9-9-2011	yes	4	No water resource concerns. High and dry.
B-149	6-25-2012	yes	2	Well 24: well established drainage flows along west side of well pad as close as 25'. Well pad appears slightly sloped away from stream; grass coming in nicely. Need to monitor. Well 25: new road within approximately 40' of stream at the closest, near the road entrance; filter strip should be OK. Disturbed soils well seeded; grass coming in nicely. Nice runoff control at culvert inlet on FR 323 at the entrance to the OGM development road. Need to monitor. The LiDAR stream originates just north of well pad 24 at an existing OGM development road. The culvert on this older road is ~90% plugged and needs corrected. At the end of this road is an illegal ATV trail, most likely associated with the OGM development; heavy damage to soils; steep. The culvert on FR 323 at entrance road to well 25 is now too short (18"x~18') and is rusted (C condition). Sediment from road overtopping outlet. Stream is heavily laden with sediment. Would recommend either decommissioning this short section of FR 323 from well 25 to the private line, or replacing existing culvert with longer one.
B-151	6-25-2012	yes	7	Looked at well sites 15-21. Wells drilled but not fracked. No pump jacks yet. All high and dry. No water concerns. Very low priority to monitor.
B-149	4-4-2013	yes	2	Minor rutting of Forest Service road, will monitor during spring break-up; all Inspection Items are 'Satisfactory'
B-52	7-18-2013	yes	6	Small amount of stripped material remaining against boundary trees at wells 2 and 4; all other work completed as required.

Case #	Date Reviewed	Roads Built	Well Sites Reviewed	Observations Made
				ATVs are no longer running the pipelines as these have been adequately blocked with boulders. Vegetation is catching nicely and is about 90% overall. Scarification completed as requested. All Inspection Items are 'Satisfactory'
B-050	1-13-2014	yes	9 wells in production; 13 remain undrilled	Ditches appear stable with varying amounts of vegetation present; all Inspection Items are 'Satisfactory'
B302	5-7-2014	yes	3	Site inspected to insure road slope not a runoff concern.
B303	5-7-2014	yes	4	Site inspected to insure road slope not a runoff concern.
B304	2-14-2014	no	stone pit	No concerns identified during inspection.
B306	4-23-2014	yes	6	One well pad and one access route location shifted during layout because of potential runoff issues.
B308	5-20-2014	yes	11	Two well pads and one access route moved during layout because of potential runoff issues due to slope.
B318	7-23-2014	yes	6	No concerns identified during review.
B331	1-29-2015	yes	5	No concerns identified during review.

- Water quality monitoring – Two streams, Hedgehog Run and Grunder Run, have been monitored for sedimentation issues by both the USGS and ANF, and were also included in a study by Clarion University comparing the water quality in the two watersheds (see *3.8.3 Status of water quality*).

8. Measure: A portable wash station will be made available at one of the boat launches (most likely Wolf Run Marina where there is security 24 hours/day) during the boating season in the event boat(s) at risk need decontaminated.

   Protocol/Results: The ANF has not provided staff dedicated to operating a portable wash station to decontaminate vessels. Data gathered from watercraft and trailer screenings over the evaluation period indicate that there were few users of ANF boat launches whose equipment posed a risk for zebra mussel introduction (see *3.9.10 Minimize risk of aquatic invasive species introduction*).

9. Measure: To continue the educational aspect of the zebra mussel prevention program, and to determine the risk of zebra mussel introduction to the Allegheny Reservoir from Forest Service boat launches, at least 500 watercraft will be screened at launch sites by Forest

Service personnel and at least 1,000 trailers will be inspected for potential zebra mussel contamination.

Protocol/Results: See *3.9.10 Minimize risk of aquatic invasive species introduction*.

Concurrence Letter

1. Measure: Educational materials (handouts, signs, educational displays) will be made available to the public about zebra mussels, measures to reduce their spread, and decontamination methods. Information will be made available at boat launches, the marina, and the Buckaloons Recreation Area.

   Protocol/Results: See the Protocol/Results for conservation measure 1 under the Conservation Program.

2. Measure: Signs will be posted at the marina, boat launches, and Buckaloons prohibiting the launching of vessels that may be carrying zebra mussels.

   Protocol/Results: See the Protocol/Results for conservation measure 1 under the Conservation Program.

3. Measure: A portable wash station for the decontamination of vessels for zebra mussels will be made available at one the boat launches during the boating season.

   Protocol/Results: See the Protocol/Results for conservation measure 8 under the Conservation Program.

4. Measure: The Forest Service will continue to survey the Allegheny Reservoir for zebra mussels during the annual drawdown.

5. Protocol/Results: See the Protocol/Results for conservation measure 6 under the Conservation Program.

6. Measure: To continue the education aspect of the zebra mussel prevention program, and to determine the risk of zebra mussel introduction to the Allegheny Reservoir from the operation of Forest Service boat launches, at least 500 watercraft will be screened at launch sites by Forest Service personnel and at least 1,000 trailers will be inspected for potential zebra mussel contamination annually.

   Protocol/Results: See the Protocol/Results for conservation measure 9 under the Conservation Program.

7. Measure: During project-level planning and implementation, riparian corridors will be defined on the basis of soils, vegetation, and hydrology (surface and groundwater) that will maintain the ecological functions and values associated with the riparian area. Riparian corridors will vary by water feature, but at a minimum will be defined by the

fixed width distances in the Forest Plan (USDA-FS 2007a, p. 75). Within the defined riparian corridors identified in the Forest Plan:

- Construction of new facilities, roads, motorized trails, OGM development, landings, and buildings will be avoided.
- Streams, wetlands, and their riparian corridors will be kept free of logging debris, sawdust, equipment, oil, and other materials or obstructions.
- Cable yarding that crosses streams should avoid impacts to the stream channel. Crossings should be at a right angle, with full suspension.
- When management activities occur, special attention will be given to riparian dependent resources.
- In riparian corridors within the 13% Area, herbicides will only be used for management activities necessary to control invasive exotic plant species.
- In riparian corridors within the 13% Area, timber harvesting should not occur.

Protocol/Results: All project-level planning is subject to review by the Forest Aquatic Ecologist, Fisheries Biologist, and/or Hydrologist. All project-level actions during the FY 2008-2016 period, including Coalbed Run Project (2011), Southwest Reservoir Project (2010), and Meads Mill Project (2008), comply with the above listed standards and guidelines. See the Protocol/Results for conservation measure 7 under the Conservation Program.

8. Measure: Proposed management activities shall be planned, evaluated, and implemented consistent with measures developed to protect the clubshell and northern riffleshell including those recognized to maintain, improve, or enhance their habitat. These measures include, but are not limited to, implementing standards and guidelines in the Forest Plan.

   Protocol/Results: See the Protocol/Results for conservation measure 7 under the Conservation Program and concurrence measure 1 under the Concurrence Letter.

9. Measure: Maintain watershed health and water quality by following guidelines contained in the current versions of Timber Harvest Operations Field Guide for Waterways, Wetlands, and Erosion Control, and Erosion and Sediment Pollution Control Program Manual, PA DEP.

   Protocol/Results: The guidelines of the 2007 Forest Plan include provisions for all ANF management activities to follow the PA DEP's Timber Harvest Operations Field Guide for Waterways, Wetlands and Erosion Control and their Erosion and Sediment Pollution Control Program Manual (USDA-FS 2007a, p. 74).

   See also the Protocol/Results for conservation measure 7 under the Conservation Program.

10. Measure: Woody material naturally occurring in streams should only be removed when fisheries habitat is being degraded or when damage is likely to infrastructure such as

bridges and culverts or private property. When a river is impassable due to woody debris, remove only the portion necessary for safe passage of boats; the need will be determined on a case-by-case basis.

Protocol/Results: Wood removal from streams is only done according to the guideline in the Forest Plan and is assessed through discussion with engineers on the Forest on whether this action occurred. No specific incident of wood removal was noted in the FY 2008-2016 period.

11. Measure: Firewood should not be collected from streams, wetlands, springs, seeps, and vernal ponds.

    Protocol/Results: Firewood permits include terms prohibiting the taking of firewood from streams. People cutting firewood are periodically checked by Forest personnel to ensure they are in compliance with language in the permit. No specific incident of wood removal from streams, springs, seeps or vernal pools was noted in the FY 2008-2016 period.

12. Measure: The drafting of water from a stream should maintain existing uses such as fish and aquatic life, including threatened and endangered species and their habitat.

    Protocol/Results: The drafting of water is not monitored continuously, but when Forest personnel see a concern with maintaining existing uses, PA DEP will be notified. No concerns with maintaining existing uses were identified by Forest Service personnel in the FY 2008-2016 period.

13. Measure: Glyphosate shall not be applied to surface waters or within 10 feet of standing or flowing water. This buffer should be adjusted based on field conditions at the time of spraying, in order to account for moister or drier conditions.

    Protocol/Results: See *3.7.6 Effectiveness of herbicide design criteria*.

14. Measure: Any roads constructed or reconstructed within 300 feet of a stream, as well as existing roads located within 300 feet of a stream, shall use a high-quality surfacing material to minimize sediment delivery. In the event that this cannot be achieved, the USFWS will be consulted.

    Protocol/Results: See the Protocol/Results for conservation measure 7 under the Conservation Program.

15. Measure: Any motorized trails constructed or reconstructed within 300 feet of a stream, as well as existing motorized trails located within 300 feet of a stream, shall use a high-quality surfacing material to minimize sediment delivery. In the event that this cannot be achieved, the USFWS will be consulted.

Protocol/Results: No new Forest Service motorized trail crossings were constructed during the FY 2008-2016 period.

See also the Protocol/Results for conservation measure 7 under the Conservation Program

16. Measure: Permanent and temporary road and trail crossings of streams shall be limited, and will be designed to minimize erosion. A high quality, non-erosive surfacing material, binding material, or other suitable material or methods should be used to control sediment delivery where vegetative cover is either inappropriate or expected to be inadequate for effective erosion control. Pit run sandstone is only appropriate for stream crossings as a subgrade material.

    Protocol/Results: No new Forest Service road or trail crossings (permanent or temporary) were constructed during the FY 2008-2016 period.

    See also the Protocol/Results for conservation measure 7 under the Conservation Program.

17. Measure: Where natural revegetation is unlikely, or sedimentation and erosion are concerns, plant native or desirable non-native species immediately after road or trail construction or reconstruction.

    Protocol/Results: See the Protocol/Results for conservation measure 10 under the Concurrence Letter.

18. Measure: Where stream crossings are needed, bridges and bottomless arches should be favored rather than culverts and should be utilized to maintain fish and aquatic passage, stream channel structure, erosion control, bank stability, and stream gradient. Structures that properly distribute flood flow, bankfull flow, and sediment transport capacity should be used.

    Protocol/Results: In FY 2013, Otter Resources installed a new crossing on lower, mainstem Ott Run. That same year, the Pennsylvania Department of Transportation replaced an existing crossing on Morrison Run. In both instances, the culvert was set too high in the channel and each crossing is now at least a partial aquatic organism barrier. The ANF is working with both parties to correct the situation.

    See also the Protocol/Results for conservation measure 7 under the Conservation Program and Protocol/Results for conservation measure 10 under the Concurrence Letter.

19. Measure: Permanent stream crossing structures should be designed and constructed to withstand a minimum of 50-year storm event and should not constrict the channel width.

Protocol/Results: See the Protocol/Results for conservation measure 7 under the Conservation Program and Protocol/Results for conservation measure 10 under the Concurrence Letter.

20. Measure: Temporary stream crossings should be constructed to accommodate a minimum of bankfull flow.

    Protocol/Results: See the Protocol/Results for conservation measure 10 under the Concurrence Letter.

21. Measure: Roads constructed for OGM development shall meet Forest Service standards for local roads.

    Protocol/Results: The ANF may negotiate mitigation measures with operators consistent with the conservation measures and 2007 Forest Plan standards and guidelines. The number of wells permitted within the 13% Area from FY 2008 through FY 2016 is summarized in Table 44, and road construction is associated with each well package (0.1 mile of road construction per well; USDA-FS 2010).

Table 44. Private oil and gas proposals in the 13% Area issued a Notice to Proceed (NTP; FY 2008-2016)

Fiscal Year	NTP Issued	PA DEP Permitted Wells
2008	7	70 (including 1 deep well)
2009	5	58
2010	11	71 (including 1 test well)
2011	13	145
2012	4	45 (including 1 Marcellus)
2013	15	75, 3 stone pits, and 1 road
2014	6	30, 1 stone pit
2015	1	5
2016	0	0

22. Measure: During the review of OGM development Plans of Operation, if known occurrences of federally-listed or candidate species are located in the vicinity of a proposed OGM development, this will be documented in a letter to the operator and copied to the USFWS Field Office in State College, Pennsylvania. The letter will direct the operator to contact the Service to resolve issues related to threatened and endangered species prior to proceeding with any tree-cutting or earth disturbance.

    Protocol/Results: There were no instances where a known federally listed species was located within an area of a proposed OGM development, and thus notification to the USFWS was not required.

23. Measure: Oil and gas operators will implement and maintain their submitted Soil Erosion and Sedimentation Control Plan and Spill Prevention Plan.

Protocol/Results: See the Protocol/Results for conservation measure 7 under the Conservation Program.

24. Measure: Monitor or survey potential sources of water pollution, including trails, roads, timber harvests, and OGM development, to ensure 1) standards and guidelines are implemented, 2) only minimal sediment is produced from these activities, and 3) appropriate erosion and sedimentation controls are implemented to correct any identified problems.

    Protocol/Results: See the Protocol/Results for conservation measure 7 under the Conservation Program.

25. Measure: Conservation measures specific to the Wild and Scenic River Corridor (MA 8.1) include the following:

    - Timber harvest associated with forest management will be limited to address recreation and scenery management activities, user safety, wildlife concerns, forest health, or catastrophic events. Vegetation management is infrequent and may take place to 1) improve habitat for species of concern, restore ecosystems, or maintain existing unique or important wildlife features or plant communities; 2) maintain or expand of existing facilities or trails; 3) carry out conservation, research, or education around heritage sites; and 4) conduct timber salvage and associated reforestation.
    - Existing roads or aerial harvest methods will be used for salvage harvests.
    - Roads will not be constructed on islands and will be limited to those needed for public access, or service and maintenance. New road construction will be limited to that required for designated special uses or by law to provide access to non-federal land or valid existing mineral rights
    - Mitigate or decommission roads that are causing environmental damage, degrading outstandingly remarkable values, or to manage visitor use and access.

    Protocol/Results: An evaluation by the Forest Aquatic Ecologist will be made of any proposed activities within the Wild and Scenic River corridor to insure they comply with this measure. None of the activities were proposed within the Wild and Scenic River corridor.

Discussion – The purpose of the monitoring addressed in this section is to review the action the ANF is taking to fulfill its responsibilities under the ESA to 1) carry out programs for the conservation of federally listed freshwater mussels, and 2) ensure its management actions are not negatively impacting the continued viability of threatened and endangered freshwater mussel populations that occur on the Forest.

The primary threat to freshwater mussels on the ANF is sedimentation caused by runoff from roads and trails and from erosion resulting from basal area reduction during timber harvest. The next most significant threat to freshwater mussels on the ANF would be from the establishment of invasive zebra or quagga mussels.

Our monitoring indicates that relatively little ANF timber harvest has occurred over the FY 2008-2016 period in the 13% Area. Of the sales that did occur, all were designed with appropriate riparian buffers intended to mitigate any impact that could result from the basal area reduction. Although relatively little timber harvest occurred, post-harvest monitoring by ANF personnel for hydrological issues was lacking. While limiting timber harvest within the 13% Area has a positive impact on water quality by limiting basal area reduction, there is a drawback in that because there are then relatively few projects being undertaken in the 13% Area to improve water quality, i.e., through the replacement of existing road-stream crossings with AOP crossings or placement large wood addition in streams.

During the FY 2008-2016 period, no permanent or temporary roads or trails were constructed by the ANF in the 13% Area and significant efforts were made to decommission or improve roads in order to have a positive impact on water quality.

The increase in roads in the 13% Area during the FY 2008-2016 period as well as surface disturbance from the development of well pads is due to extraction efforts by private mineral owners. The ANF uses collaborative approaches to avoid, mitigate, or remedy resource concerns for processing OGM development proposals and administering existing developments. The ANF coordinates with the operators and regulatory agencies (e.g., PA DEP) to remedy identified concerns. OGM development activities have been relatively limited in the 13% Area over the period considered in this report.

While the shoreline surveys for invasive zebra mussels have not been carried as described in the Forest Plan Conservation Program since FY 2011, in 2015 and 2016, six dive surveys specifically for zebra mussels, as well as numerous other general mussel surveys, were conducted on the ANF. These surveys represent a more effective protocol for detecting the presence of invasive mussels than the shoreline survey method.

Recommendations – The following recommendations are made regarding the monitoring of conservation measures for threatened and endangered freshwater mussel species:

1. During future planning and implementation of ANF projects in the 13% Area, efforts should be made to include the replacement of existing road-stream crossings with AOP crossings.
2. During future planning and implementation of ANF projects in the 13% Area, efforts should be made to include large wood additions to streams.
3. Consider replacing the shoreline surveys with annual dive surveys for zebra mussels.
4. Monitoring of oil and gas roads and well pads in the 13% Area should be undertaken by ANF aquatics staff as time allows.
5. Post-harvest monitoring of timber sales in the 13% Area for hydrological issues should occur as needed.

3.9.15 Effectiveness of mitigation measures for plant species with viability concerns

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Are project mitigation measures effectively reducing impacts to existing locations of plant species with viability concerns?	Number and type of mitigations	Annual	2 years	FY 2013

Background – Forest Plan objectives include ensuring a stable or increasing population trend for known locations of plants species with viability concerns on the ANF (USDA Forest Service 2007a, p. 20). As such, the monitoring question addressing the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired condition and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Survey and element occurrence data are entered into NRM TESP/IS. The protocols for surveys and element occurrence data collection are contained in USDA-FS 2014b and USDA-FS 2015a.

Results – Monitoring plots have not been established in which mitigation measures could be assessed to determine their effectiveness of reducing impacts to existing locations of plant species with viability concerns.

Discussion – A monitoring protocol has been drafted based on agency and literature review, but funding and staffing have not been adequate to complete this monitoring. Other National Forest monitoring efforts of buffers in similar conditions (closed canopy vs. removal) and reference literature for canopy retention distance have been used to inform mitigate measure recommendations; however, this is not enough to completely evaluate effects to species.

Currently there are several areas being treated for NNIP where plant species with viability concerns also occur. Seasonal timing and type of treatments are successfully being used to limit impacts, and without NNIP treatment suitable habitat would be degraded or lost.

Recommendations – Consider what resources may be available to field-test, finalize, and implement the draft monitoring protocol.

3.9.16 Implement conservation measures for federally listed plants

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
If federally listed plants have been identified, what conservation measures are being implemented?	Status of conservation measure implementation	Annual	2 years	FY 2013

Background – The basis of this monitoring question is to review the action the ANF is taking to fulfill its 7(a)1 (ANF Conservation Program) and 7(a)2 (USFWS concurrence letter conservation measures) responsibilities under the ESA with respect to the threatened and endangered plants species of freshwater mussels that occur within the ANF proclamation boundary. As such, this

monitoring question addresses the 2012 Planning Rule requirement of monitoring the status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

As stated in the Approval and Declaration of Intent section of the FY 2008-2013 Monitoring & Evaluation Report, NTPs associated with outstanding and reserved mineral development are being evaluated under the 1986 Forest Plan standards and guidelines. As a result, the conservation measures that would apply to private oil and gas are not applicable. The ANF may negotiate mitigation measures with operators consistent with the conservation measures and 2007 Forest Plan standards and guidelines, and uses collaborative approaches to avoid, mitigate, or remedy resource concerns associated with OGM development.

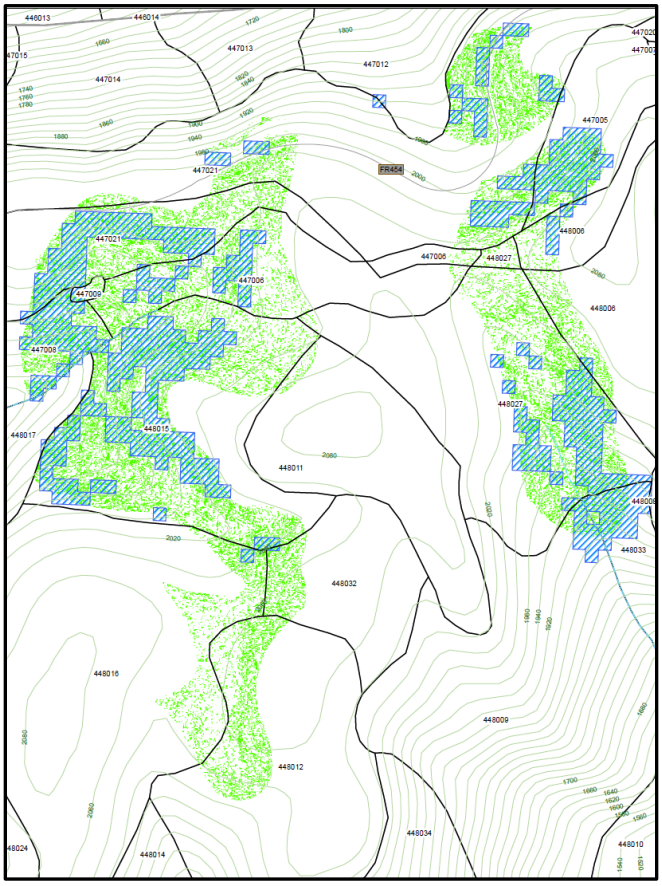
Protocol – Survey and element occurrence data are entered into NRM TESP/IS. The protocols for surveys and element occurrence data collection are contained in USDA-FS 2014b and USDA-FS 2015a.

Results – Above-project and project-level surveys for federally listed small whorled pogonia (*Isotria medeoloides*) and northeastern bulrush (*Scripus ancistrochaetus*)[4] have been conducted in areas proposed for management activities such as, but not limited to: timber harvest, road construction, and wildlife opening construction. Surveys to date have not documented federally listed plant species on the ANF.

Discussion – Survey work is focused where ground disturbing or vegetation management activities occur and not necessarily where the most suitable habitat for the small whorled pogonia and northeastern bulrush occurs. If federally listed plants are documented, follow Forest Plan direction (USDA-FS 2007a, p. 84). Conservation measures found in the Biological Assessment and the USFWS Concurrence Letter (USDI-FWS 2007) completed for the 2007 Forest Plan would also apply.

A re-analysis of the small whorled pogonia habitat GIS model was completed in 2010 and has a better representation of characteristics than the previous model of individual/groups of pixels (Figure 67). The new model better reflects the conditions on the landscape in terms of gradations versus distinct pixels. One must remember that the small whorled pogonia model is used as an overlay to assist in narrowing down field survey areas for some key, but not all, habitat features for this plant. The model does not take into account more recent changes in overstory conditions (e.g., opening of canopy from insect and disease outbreaks, change in land use, impacts from NNIP species, etc. The model also cannot take into account the mychorrhiza (fungal) associates needed by this plant to germinate and survive.

[4] On August 28, 2019, the USFWS completed a 5-year review for the northeastern bulrush (https://ecos.fws.gov/docs/five_year_review/doc6123.pdf) which recommended the species be delisted due to recovery. As of June 2021, the USFWS had not published a proposed delisting rule in the Federal Register.



Recommendations – The GIS model should be used as an overlay with other available GIS data to evaluate habitat suitability followed up by field surveys to detect suitable habitat and/or plants. Continue to use/refine the GIS model in areas of key habitat.

3.10 Minerals and geology monitoring

3.10.1 Establish and maintain an oil and gas development inventory

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Has an inventory of all oil and gas development been established and is it being maintained?	Status of oil and gas development inventory	Annual	2 years	FY 2013

Background – Ninety-three percent of the subsurface mineral rights on the ANF are privately held. There is already substantial infrastructure associated with the development of these rights

and further development is expected. One of the Forest Plan objectives is to establish and maintain an inventory of all oil and gas development on the ANF. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.

Protocol – The ANF establishes and maintains inventories of OGM development and infrastructure using GIS technology. GIS layers have been initiated and updated using multiple sources with varying levels of accuracy – GPS technology, interpretation of aerial photography, interpretation of manually created maps, digitized state data, etc. The most reliable data sources typically are features identified and recorded using GPS technology or high-resolution aerial photography. The main OGM GIS layers that have been maintained are wells (shallow wells, i.e., conventional wells, are differentiated from unconventional wells, i.e., Marcellus wells) and associated roads in the ANF's corporate road layer (i.e., TravelrouteLn), stone pit layers (both point and area features), and major pipeline infrastructure (i.e., utilities). These GIS layers have been maintained on the ANF for decades.

During FY 2011-2016, the ANF used digital photography to digitize other oil and gas infrastructure throughout the ANF, such as tank batteries, compressor stations, buildings, structures, meter stations, and other OGM related equipment, as well as previously unidentified pipelines, roads, and wells. GIS information is typically updated on a project-level basis and undergoes a detailed quality control review before it is incorporated in the ANF's corporate GIS data. The quality control step is performed in order to maintain accuracy and completeness of the ANF's corporate GIS data.

Results

Non-system roads and wells

During FY 2009 and FY 2010, two Forest-wide projects took place (the SEIS and TEIS projects). Through the reviews for these projects, existing GIS layers associated with roads and oil and gas wells were completed. From these reviews, estimated non-system road mileages and existing wells (i.e., active or inactive wells) were made. From these reviews and NTPs issued since then, there is an estimated 13,000 active and inactive oil and gas wells on NFS land. No unconventional well development occurred on the ANF since the last evaluation period.

Oil and gas roads are considered to be non-NFS roads, or non-system roads. For clarification, a portion of non-system roads may not be related to OGM (e.g., unauthorized trails/roads); however, this mileage makes up a small portion of the non-system road mileage total. There is an estimated 2,000 miles of non-system roads used for oil and gas activities.

Stone pits and pipelines

The ANF typically updates stone pit GIS layers when performing watershed-level project analyses. In addition, OGM-related pit development was digitized for OGM-specific projects during FY 2012-2016 and is stored in project-level data. GIS spatial data sources associated with major distribution/transmission pipelines have been updated during FY 2008-2016. The

vast majority of pipelines installed are gathering lines which serve a specific OGM project. Gathering lines are typically digitized and documented in OGM project-level data and are not incorporated into ANF GIS corporate data.
Other OGM related infrastructure (tank batteries, compressor stations, structures, etc.)

During FY 2010-2016, the ANF used digital photography to digitize other oil and gas infrastructure throughout the ANF, and established a new infrastructure GIS feature class. This dataset contains information for tank batteries, compressor stations, buildings, structures, meter stations, and other OGM-related equipment. This dataset is currently being updated.

Discussion – The ANF spent a considerable amount of resources during FY 2008-2016 to update existing OGM-related GIS layers (wells, non-system roads, stone pits) and to establish a new OGM infrastructure feature class, which includes data on tank batteries, compressor stations, building structures, meter stations, and other OGM-related equipment. Due to extensive private OGM development on the ANF, baseline OGM GIS data still has informational gaps which may be addressed using various existing data sources. Using aerial photography and readily available DEP data, it is estimated that there are over 25,000 oil and gas wells on the Forest including active, inactive, orphaned, abandoned, plugged, and well sites that have been built, but not drilled. These locations need to be ground-truthed to determine what their actual status is and if they are being double counted across the various sources of information. As we continue to collect more data, it is expected that this number could increase

Recommendations – Continue to update and revise OGM-related GIS datasets using existing resources, including, but not limited to: GPS collected data, aerial photography, LIDAR data, state digitized data, data provided by OGM operators, and ANF digitized data. When informational gaps still are noted, develop strategies on how best to close these gaps using available resources. Implementation should be driven by priorities.

3.10.2 Federal oil and gas developments meeting Forest Plan design criteria

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
To what extent are new Federal oil and gas developments meeting Forest Plan design criteria?	Level that federal oil, gas, and mineral development(s) are meeting Forest Plan design criteria	Annual	2 years	FY 2013

Background – This question is the result of a modification made during the monitoring transition. As stated in the Approval and Declaration of Intent section of the FY 2008-2013 Monitoring & Evaluation Report, NTPs associated with outstanding and reserved mineral development are being evaluated under the 1986 Forest Plan standards and guidelines. The ANF may negotiate mitigation measures with operators consistent with the conservation measures and 2007 Forest Plan standards and guidelines, and uses collaborative approaches to avoid, mitigate, or remedy resource concerns associated with OGM development. As a result, the monitoring question in the original Monitoring Program (*To what extent are new oil and gas developments meeting Forest Plan design criteria?*) was modified to the current question in the updated

Monitoring Program (*To what extent are new Federal oil and gas developments meeting Forest Plan design criteria?*).

As stated in the 2007 Forest Plan (USDA-FS 2007a, p. ROD_42), leasing may occur periodically when parcels with federally owned oil and gas rights are nominated to the BLM Eastern States Office. The BLM Eastern States Office will then forward the nominated parcel(s) to the Forest Service Regional Office for processing. Each parcel is subject to 36 CFR 228.102(e). The ANF will ensure that appropriate NEPA compliance exists before nominated parcels are forwarded to BLM with final Forest Service consent to leasing. Site-specific analysis in compliance with NEPA and other federal law and regulations is required prior to approving ground-disturbing activities, such as the Forest Service's approval of a permit to drill at a specific location. The intent of the new question in the updated Monitoring Program is to evaluate whether the applicable Forest Plan standards and guidelines were followed during development of new federal oil and gas leases and whether mitigations achieved the desired outcomes.

Protocol – The ANF assists the BLM in compliance inspections of federal oil and gas developments periodically throughout the year.

Results and Discussion – Though there are several active leases on federally owned oil and gas rights, no new leases have been issued since the last evaluation period. Implementation and effectiveness monitoring was completed on an existing lease in FY 2014 (see *3.1.1 Effects of management practices: Federal oil and gas development – Tract 13*).

Recommendations – Continue to work with BLM to evaluate and monitor oil and gas leases of federally owned oil and gas rights.

3.11 Land ownership monitoring

3.11.1 Acquire subsurface ownership

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
Have subsurface rights been acquired in Management Areas 5.1, 5.2, 7.1, 7.2, 8.1, 8.2, 8.3, 8.4, 8.5, and 8.6? To what extent have these rights been withdrawn?	Acres of subsurface acquired/withdrawn	Annual	2 years	FY 2013

Background – One of the Forest Plan objectives is to work with partners to acquire subsurface ownership of lands in MAs 5.1, 5.2, 7.1, 7.2, 8.1, 8.2, 8.3, 8.4, 8.5, and 8.6. As such, this monitoring question addresses the 2012 Planning Rule monitoring requirements of monitoring the progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.

No Federal mineral activities shall be conducted in areas withdrawn or MAs identified as not available for mineral leasing. Other MAs have stipulations for no surface occupancy. All areas

available for mineral leasing within 1,300 feet of the Allegheny Reservoir have stipulations for no surface occupancy. Federal mineral leasing outside of the above named areas will be designed, constructed, and operated in a manner that is compatible with the surface resource objectives of the MA. Federal oil/gas lease operations are managed by the Bureau of Land Management in cooperation with the surface management agency. Standards for Federal leases are contained in the Bureau of Land Management "Surface Operating Standards for Oil and Gas Exploration and Development Gold Book."

Protocol – The ANF works with partners when a potential opportunity arises to acquire subsurface ownership of lands in MAs where all Federal minerals (including oil and gas) shall not be available for leasing. These MAs are as follows:

- 5.1 (Designated Wilderness Areas)
- 5.2 (Wilderness Study Area)
- 7.1 (Developed Recreation Areas)
- 8.1 (Wild and Scenic River Corridor)
- 8.2 (National Recreation Area)
- 8.3 (Scenic Area)
- 8.4 (Historic Area)
- 8.5 (Research Natural Area)
- 8.6 (Kane Experimental Forest)

Results – Since the last evaluation period, no partners have approached the ANF with the intent to convey mineral rights.

During the last evaluation period, the ANF worked with partners who expressed interest in conveying mineral rights in a couple special areas. These partners, however, did not acquire the mineral rights from the subsurface owners, or the ANF was not able to accept these rights. These examples are noted below.

Rimrock Area

WPC contacted the ANF when oil and gas operators proposed wells and roads along Rimrock road and near the Rimrock Overlook, in FY 2007-2008. The Rimrock area is in MA 2.2 (Late Structural Linkages), however, it is a very popular recreation area on the ANF. The Western Pennsylvania Conservancy, therefore, was interested in discussing potential options of acquiring the subsurface rights in the area from the subsurface owner(s). The ANF and WPC discussed the value of the area, potential resource concerns, and various options. WPC contacted the subsurface owner(s) and was not able to acquire the mineral rights at the time.

Allegheny Front Region

The Northern Allegheny Conservation Association contacted ANF about donating the OGM rights under 969 acres within the National Recreation Area in Watson Township. Due to difficulties in obtaining title insurance and the inability to find an appraiser to determine the market value, this conveyance was not completed.

Discussion – The ANF has not had any opportunities to acquire mineral rights since the last evaluation period.

Recommendations – Continue to work with partners who approach the ANF to discuss options for acquiring mineral rights in MAs 5.1, 5.2, 7.1, 8.1, 8.2, 8.3, 8.4, 8.5, and 8.6. In addition, collaborate with parties who may be interested in acquiring mineral rights in other areas of the ANF that may have similar site-specific management objectives as the aforementioned MAs.

3.12 Transportation system monitoring

3.12.1 Maintain roads

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many miles of road maintenance have been accomplished?	Miles of road maintenance	Annual	2 years	FY 2013

Background – A Forest Plan goal is to "…provide a safe, efficient, and economical [transportation] system responsive to public and administrative needs…" (USDA-FS 2007a, p. 16). A major component of providing this is to complete road maintenance at an appropriate level and frequency. This monitoring question addresses the specific aspect of routine road maintenance – grading, brushing, cleaning ditches and culverts – by measuring the miles of road that have had these activities completed as well as the associated Forest Plan objective: on an annual basis, road maintenance activities will occur on a minimum of 150 miles of passenger car roads (OML 3 to 5) and a minimum of 100 miles of high clearance vehicle roads (OML 2; USDA-FS 2007a, p. 21). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Accomplishment of these items was reported in the Roads Accomplishment Report (RAR) for FY 2008-2012, in WorkPlan in FY 2013-2015, and in INFRA-Travel Routes for FY 2016. Mileage is based on contract miles or as measured on the ground for work accomplished by force (user-generated) account. The majority of this work is accomplished by contract. If multiple activities are completed on the same mile, the mileage is only counted once. For example, if a ten-mile section of road is graded and brushed, only ten miles of accomplishment are counted.

Results – Annual miles of road maintenance for high clearance vehicle roads and passenger car roads are shown in Table 45. Maintenance is broken down into operational maintenance level 1-2 (OML 1-2) and operational maintenance level 3-5 (OML 3-5) for reporting at the national level because OML 1 and 2 are closed to passenger cars, while OML 3-5 are open to passenger cars. OML 2 roads are typically maintained for administrative, timber and OGM traffic, whereas OML 3-5 are maintained for the general public, hunting, fishing, recreationists and commercial uses.

Table 45. Miles of road maintenance for high clearance vehicle roads (OML 1-2) and passenger car roads (OML 3-5; FY 2008-2016)

Fiscal Year	OML 1-2 Maintenance Miles	OML 3-5 Maintenance Miles
2008	62.1	395.1
2009	75.5	385.9
2010	149.9	353.6
2011	142.9	388.9
2012	121.2	395.7
2013	95.8	357.5
2014	92.0	411.0
2015	101.3	451.2
2016	144.6	353.0
Total	**985.3**	**3,491.9**
Average	**109.5**	**388.0**

Discussion – The Forest Plan objective was exceeded as an average of 379.45 miles of OML 3-5 roads and 107.9 miles of OML 1-2 roads were maintained annually (Table 45). The level of annual accomplishment is dependent on the miles of road needing routine maintenance each year. For some roads, their use is light, and they may be able to go 2-3 years between routine maintenance. Others do not receive routine maintenance because they are being reconstructed in a given year. It should be noted that as deer browsing impacts have declined, the need for brushing along roads has increased.

There is greater variation in the accomplishment of OML 1-2 roads. Maintenance on these roads is dependent on specific resource needs (timber sales, OGM activity, hunting, etc.). As resource activity increases, more OML 1 and 2 roads require maintenance.

These actions support the Transportation System Goal included in the Forest Plan. During this evaluation period, road maintenance occurred in support of the general public utilizing the Forest, providing for a safe transportation system, and protecting soil and water resources from adverse effects attributed to runoff.

Recommendations – Continue performing road maintenance activities as needed.

3.12.2 Decommission roads no longer needed

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many miles of road have been decommissioned?	Miles of road decommissioning	Annual	2 years	FY 2013

Background – A Forest Plan goal is for the ANF's transportation system is to have "…minimal adverse effects on ecological processes and ecosystem health…and is in balance with needed

management actions" (USDA-FS 2007a, p. 16). A component of providing this is to complete decommissioning of roads that are no longer needed or were never authorized. This monitoring question addresses the specific aspect of eliminating those unneeded roads by measuring the miles of road that have been made unusable by removing drainage and surfacing and effectively blocking access for use. It also addresses the Forest Plan objective to evaluate road benefits and risks and decommission two miles of roads that are no longer needed, annually (USDA-FS 2007a, p. 21). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Accomplishment of this item was reported in the RAR for FY 2008-2012, in WorkPlan in FY 2013-2015 and in INFRA-Travel Routes for FY 2016. Mileage is based on contract miles or as measured on the ground for work accomplished by force (user-generated) account. The majority of this work is accomplished by contract. Mileage includes both system and non-system roads, i.e., Forest Service roads (system) that are no longer needed and user created roads (non-system) that were never authorized and a legitimate use doesn't exist. If a legitimate use exists, a NEPA analysis would have been undertaken to allow these roads to be added to the system rather than being decommissioned. System roads need a NEPA analysis prior completed to decommissioning.

Results – Annual miles of road decommissioning are shown in Table 46. While the Forest Plan recognizes several levels of decommissioning (USDA-FS 2007a, p. 98), the typical level accomplished on the ANF is removing culverts, and the fills associated with them, removing road surfacing, and scattering slash on the roadbed.

Table 46. Miles of decommissioned roads (FY 2008-2016)

Fiscal Year	Decommissioned Miles
2008	0.0
2009	0.0
2010	2.2
2011	2.6
2012	1.0
2013	0.0
2014	8.0
2015	0.0
2016	0.5
Total	**14.3**
Average	**1.6**

Discussion – The Forest Plan objective of 2 miles per year was not met as an average of only 1.6 miles of road was decommissioned annually (Table 46). The level of annual accomplishment is dependent on the miles of road available for decommissioning each year. The ANF is typically

assigned a target of five miles of road to be decommissioned each year. Due to the nature of the use of the transportation system on the ANF (active timber program and OGM activity), only limited opportunities exist for decommissioning roads. For a complete discussion of road uses on the ANF, see Subpart A: Executive Summary Report, September 2015 available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd527634.pdf.
These actions support the Transportation System Goal listed in the Forest Plan. During this evaluation period, road decommissioning occurred in support of reducing the size of the transportation system and protecting soil and water resources from adverse effects attributed to runoff.

Recommendations – Continue monitoring the road system for opportunities to decommission unneeded roads.

This question is already adequately addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.5 Transportation activities*). As such, it is recommended to remove this question from the Monitoring Program to reduce redundancy.

3.12.3 Surface roads with limestone

Monitoring Question	Monitoring Indicator	Monitoring Frequency	Evaluation Frequency	Last Updated
How many miles of road have been surfaced with limestone?	Miles of road surfaced with limestone	Annual	2 years	FY 2013

Background – A Forest Plan goal is for the ANF's transportation system is to be "…minimal adverse effects on ecological processes and ecosystem health…" (USDA-FS 2007, p. 16). A major component of providing this is to maintain the surface of the road with a material that is harder and reduces degradation compared to the typical pit run surfacing material. This monitoring question addresses the specific aspect of resurfacing roads with a harder, more durable surfacing material that will reduce long-term maintenance costs and reduce the potential impact of the road on water quality. It also addresses the Forest Plan objective to surface an additional five miles of roads with limestone to minimize sediment delivery to streams, annually. (USDA-FS 2007, p. 21). As such, this monitoring question addresses the 2012 Planning Rule monitoring requirement of monitoring the progress toward meeting the desired conditions and objectives in the Forest Plan, including for providing multiple use opportunities.

Protocol – Accomplishment of these items was reported in the RAR for FY 2008-2012, in Work Plan in FY 2013-2015 and in INFRA-Travel Routes for FY 2016. Mileage is based on contract miles or as measured on the ground for work accomplished by force (user-generated) account. The majority of this work is accomplished by contract. Contract documents were reviewed to determine the specific length of each road that had an improved surfacing material applied to it.

Results – Annual miles of road surfacing are shown in Table 47, including the various categories of improved surfacing material currently in use as well as the average cost per ton average cost per mile by surface type.

Table 47. Miles of road surfacing (FY 2008-2016)

Fiscal Year	DSA Limestone (Miles)	1" Minus (Miles)	PA 2A (Miles)	Paving (Miles)	Contract Cost
2008	4.368	-	0.074	-	$1,184,218
2009	16.300	-	0.038	11.300	$3,187,900
2010	13.140	11.610	-	0.269	$2,963,573
2011	8.837	3.802	-	-	$1,749,946
2012	0.534	2.981	0.787	-	$646,140
2013	2.975	0.406	0.628	-	4677,340
2014	3.447	1.128	5.803		$1,448,062
2015	2.013		6.834		$1,515,088
2016	2.589		4.713		$1,451,250
Total	**54.203**	**19.927**	**18.877**	**11.569**	**$18,823,517**
Average Miles	**6.023**	**2.214**	**2.097**	**1.285**	
Average Cost/Mile	**$40**	**$27**	**$26**	**$50**	
Average Cost/Ton	**$120,000**	**$81,000**	**$78,000**	**$150,000**	

Discussion – The Forest Plan objective of 5 miles per year was met as an average of 6.023 miles of road were surfaced with limestone, annually (Table 47). ARRA funding resulted in increased surfacing in FY 2009 and FY 2010. As an example, the paving shown in the table above is all the result of ARRA funding. For FY 2009, this paving was accomplished on township roads and in FY 2010 the paving was on Forest Service roads, primarily leading to parking areas.

The Forest Plan includes the guideline: where new or existing permanent roads are within 300 feet of perennial and intermittent streams, a high quality non-erosive surfacing material, binding material, or other suitable material should be used to control sediment delivery (USDA-FS 2007a, p. 75)." Since development of the Forest Plan, the Forest has utilized several surfacing materials to reduce the potential for erosion and sedimentation control, as presented in Table 47.

Driving Surface Aggregate (DSA) is a specific gradation of material that was developed for use as a surfacing material on dirt and gravel roads to reduce potential erosion and sedimentation. More information about DSA is available from the Center for Dirt and Gravel Road Studies at Penn State University here: https://www.dirtandgravel.psu.edu/general-resources/driving-surface-aggregate-dsa. Studies conducted on the ANF have indicated that DSA limestone has approximately 10% of the sediment production potential of pit run (Bloser and Scheetz 2012; the complete report is available here: https://www.dirtandgravel.psu.edu/center-info/research/anf-sediment-quantification-study). Due to the high cost of this material ($40/ton, $120,000/mile), however, use of it is limited to critical road-stream intersections.

DSA originally was only available as a limestone aggregate, but a sandstone version has been approved. 1" minus is a DSA sandstone surfacing. It has the same gradation as DSA limestone,

but is made with sandstone rather than limestone. It is available from local pits rather than needing to be trucked in from State College or Buffalo. It is not as hard as limestone and has different characteristics as a surfacing material. The Forest has surfaced approximately 20 miles of road with 1" minus. We have concluded that this surfacing material requires extra effort in placement, moisture content control, and compaction. For these reasons, we have discontinued use of this material.

PA 2A is also available locally. It has a coarser gradation than DSA and is used where riding comfort is not as important. It typically is slightly less expensive than 1" minus and is also easier to apply. This material meets the criteria for a non-erosive surfacing material, but not to the degree of DSA limestone.

A new non-erosive surfacing material has recently been developed – 4A modified limestone. This material has a maximum 3 ½" size and therefore needs to be put down in minimum of 6" layers (the other materials can be 4" layers). The costs quoted for this material are approximately the same as PA 2A, but it is a limestone material, thus harder and more durable. The Forest has initiated placement of this material on several sections of roads to determine its applicability and durability as a non-erosive surfacing material.

As initially noted in the FY 2008-2013 Monitoring & Evaluation Report (USDA-FS 2014a), the ANF no longer uses pit run material from on-Forest as a road construction material. As a result of this, road costs have increased from an average of $50,000 per mile to over $150,000 per mile for new construction and from $25,000 per mile for resurfacing with pit run to a minimum of $78,000 per mile for 4" of PA 2A. This has increased funding needed to maintain the road system, with fewer miles being resurfaced with DSA limestone.

Recommendations – Continue monitoring the road system for opportunities to surface roads with improved surfacing materials. Typically, available funds limit the amount of improved surfacing materials that can be used. Emphasis should be given to higher priority projects (roads within 300' of streams) or roads where the existing pit run surfacing is failing.

4.0 Monitoring questions removed during the 2016 update

As a result of the monitoring transition (*2.0 Forest Plan Monitoring Program*), a number of monitoring questions were removed from the Monitoring Program as they were either no longer relevant to the management of resources on the ANF, resulted in redundancy in our monitoring and evaluation efforts, or are expected to be addressed through other efforts. This section identifies the questions included within the original Monitoring Program that were removed and provides a rationale for why they were removed.

4.1 – Monitoring questions removed to reduce redundancy

Table 48 displays the 12 questions removed from Monitoring Program with the aim of reducing redundancy. Each question was removed because it can be adequately addressed by another question already in the Monitoring Program.

Table 48. Monitoring questions removed during the monitoring transition to reduce redundancy within the Monitoring Program

Original Monitoring Program Question	Now Addressed in Updated Monitoring Program Here
Have destructive insects and diseases increased to potentially damaging levels after management activities?	*3.7.5 Changes in forest health*
How many acres of invasive plant treatment have occurred?	*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*
Are the following stewardship elements being addressed: fire, noxious/invasive plants, air quality, education, recreation use impacts, outfitter/guides, opportunities for solitude or primitive and unconfined recreation? Are wilderness areas being managed to standard?	*3.1.2.1 Recreation activities*
Have equestrian trails been designed and developed for equestrian use?	*3.1.2.1 Recreation activities*
How many acres of even-aged regeneration harvest and uneven-aged harvest have occurred?	*3.1.2.6 Timber harvest management practices by Management Area*
How many acres have been treated with pre-commercial thinning or release?	*3.1.2.3 Reforestation activities*
How many acres have been treated with prescribed fire?	*3.1.2.2 Prescribed burning by resource objective*
How many and what type of terrestrial habitat enhancements have been implemented?	*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*
How many acres of fish habitat improvements have been implemented?	*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*
How many miles of stream restoration or enhancement have been completed?	*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*
How many acres have been treated to increase plant species diversity (with site preparation, herbicide application, and fencing)?	*3.1.2.3 Reforestation activities*
How many acres of hazardous fuels reduction treatments have occurred?	*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*

4.2 – Monitoring questions no longer relevant

4.2.1 – Management Indicator Species

The original Monitoring Program included monitoring questions addressing five MIS: northern goshawk, timber rattlesnake, cerulean warbler, mourning warbler, and aquatic invertebrates.

Monitoring of MIS was a requirement of the 1982 Planning Rule to gauge the effects of the Forest Plan on ecological communities of management interest. The emphasis in the 2012 Planning Rule is placed on monitoring focal species as indirect indicators of the ecological integrity of select ecological conditions. Focal species were identified during the monitoring transition (*pileated woodpecker* and *brook trout*) and none of the five MIS were selected.

The northern goshawk and timber rattlesnake are currently listed as a Regional Forester Sensitive Species and there are Forest Plan objectives addressing active northern goshawk territories and known and historic timber rattlesnake den locations. There are also Forest Plan Objectives addressing cerulean warbler breeding habitat. For these reasons, the monitoring questions related to the northern goshawk, timber rattlesnake, and cerulean warbler were recommended for modification into a single question per species that focused on the status of the species and, for the cerulean warbler, also the availability of nesting habitat on the ANF.

The mourning warbler is not a Regional Forester Sensitive Species and there are not Forest Plan objectives that address its status on the ANF. The mourning warbler was selected as a MIS to serve as an indicator of early structural, or young forest, habitat which it uses for foraging, reproduction, and/or hiding cover. This age class (0-20 years) is already monitored directly and addressed by other monitoring questions in the updated Monitoring Program (*3.7.4 Provide vegetation diversity*). For these reasons, the mourning warbler monitoring questions were removed from the Monitoring Program.

As a taxa, aquatic invertebrates were selected as a MIS to serve as an indicator of indicator of stream quality important for a diversity of fish, dragonflies, mussels and other aquatic species. Aquatic invertebrates are excellent indicators of water quality and biological monitoring of surface waters serves several purposes. It provides an early warning of hazardous changes in water quality, detects episodic events such as pollution spills, evaluates recovery from disturbed conditions, and reveals trends and cycles. As such, aquatic invertebrate population trends, diversity and relative abundance, and their relationship to aquatic habitat conditions have and will continued to be addressed, as appropriate, by the question in the updated Monitoring Program addressing water quality (*3.8.3 Status of water quality*).

4.2.2 – Indiana bat status on the ANF

Based in part on the ANF's Indiana bat summer and winter habitat survey efforts, the USFWS revised the Indiana bat range map for Pennsylvania to reflect that the distribution of potential Indiana bat summer and winter habitat does not include the ANF (see *3.9.13 Implement conservation measures for federally listed bats*). As such, the monitoring questions associated with the status of the Indiana bat as well as the Forest Plan objective to provide optimum and suitable vegetative habitat (5-year monitoring frequency; USDA-FS 2007a, p. 20) were removed from the Monitoring Program. It is recommended the objective addressing provision of Indiana bat habitat be removed from the Forest Plan for the same reason.

4.2.3 – Oil and gas working group

The Forest Plan includes the objective to establish a formal, multi-agency working group, including representatives from the ANF, PA DEP, and other state and Federal agencies, to coordinate policies and processes regarding the management of oil and gas resources and infrastructure on the ANF (USDA-FS 2007a, p. 20). The associated monitoring question was removed from the Monitoring Program because such a working group does not promote collaboration with key stakeholders, e.g., oil and gas industry representatives. It is recommended this objective be removed from the Forest Plan for the same reason.

4.2.4 – Resource concerns associated with oil and gas development

The Forest Plan includes an objective to identify areas of resource concern associated with oil and gas development (USDA-FS 2007a, p. 20). The associated monitoring question was removed for several reasons. First, various other monitoring questions address the intent of this question. For example, by addressing the implementation of bald eagle conservation measures (*3.9.12 Implement bald eagle conservation measures*), the ANF is addressing potential resource concerns with the bald eagle from all activities, including OGM development. In this instance, a specific "bald eagle resource concern" question only for OGM development would be redundant and is impractical. This is also true for other resource concerns.

Secondly, resource concerns are documented qualitatively on a site-specific, project level basis. The mitigation, avoidance, or resolution of resource concerns associated with OGM development are qualitatively documented in case-specific project records, personal communications (e.g., inspection reports, communication records, e-mails), and similar assessment documents. Mitigation, avoidance, and resolution of resource concerns are negotiated with the oil and gas operator and coordinated with regulatory agencies and other stakeholders. Given the inventory of OGM development on the ANF (*3.10.1 Establish and maintain an oil and gas development inventory*), to quantitatively evaluate or even qualitatively summarize resources concern for OGM development on the ANF is difficult.

Lastly, private mineral development on the ANF is not subject to NEPA. As stated in the Approval and Declaration of Intent of the FY 2008-2013 Monitoring & Evaluation Report (USDA-FS 2014a):

> Legal cases specific to severed mineral estate development on the ANF have been decided since the 2007 Forest Plan was affirmed with instructions. In context of these cases, the Third Circuit Court of Appeals provided, among other things, that the Forest Service "does not have the broad authority it claims over private mineral rights owners to access surface lands. […] Although the Service is entitled to notice from owners of these mineral rights prior to surface access, and may request and negotiate accommodation of its state- law right to due regards, its approval is not required for surface access. Minard Run Oil Co. v. U.S. Forest Service, 670 F.3d 236, 254 (3rd Cir. 2011).

Consistent with the Minard Run decisions, NEPA analyses documenting direct, indirect, and cumulative effects are not being performed prior to processing private mineral projects. The

Forest is analyzing the effects from OGM development when it performs NEPA analyses for its projects, and the monitoring and evaluation of these effects is incorporated into various other monitoring questions as previously discussed.

4.2.5 – Wildfire Fire Use Plan

The Forest Plan includes the objective that a Wildland Fire Use Plan for managing naturally ignited fires within specific MAs will be developed, implemented, and incorporated into the ANF Fire Management Plan (USDA-FS 2007a, p. 21). Wildland Fire Use is the application of the appropriate management response to naturally-ignited wildland fires to accomplish specific resource management objectives in pre-defined designated areas outlined in Fire Management Plans (i.e., Wildland Fire Use Plan) (USDA-FS 2007b, p. 6-27). Due to the low frequency of naturally caused fires in northwest Pennsylvania, having a Wildland Fire Use Plan would be impractical. Almost all of the fires are human-caused fires on the Allegheny with 100% suppression as the appropriate management response. As such, the associated monitoring question was removed from the Monitoring Program.

4.3 – Monitoring questions addressed by other efforts

One question was removed during the monitoring transition because it was expected to be addressed through other efforts: *Have lands that are not suited for timber production become suited?* This question addresses the NFMA requirement to review lands classified as unsuited for timber production at least every 10 years. Lands considered suited for timber production have remained static since the 2007 Forest Plan revision. In the absence of technological advancement in ground-based harvest equipment or additional soil design criteria that would affect suitability for timber production, lands considered suitable for timber production remain unchanged. When the Forest Plan is revised again, a thorough consideration of growing site conditions, slope, soil characteristics, and equipment capabilities would be undertaken to revisit lands considered suitable for timber production.

5.0 Recommendations

Evaluation of monitoring information has resulted in the recommendation of adjustments to improve the implementation and/or effectiveness of management and/or monitoring practices, as well as a number of changes to the Forest Plan and Monitoring Program (Table 49).

Table 49. Recommendations by monitoring question

Description	Recommendations
Cross-program monitoring	

3.1.1 Effects of management practices	FR 230 timber sale: There are no findings to recommend changes to standards and guidelines in the Forest Plan at this time.
	
	Tract 13:
	• Continue use of implementation folder on future federal minerals.
	• Direct oil and gas administrators to reference Erosion and Sedimentation Control Plan requirements and the decision mitigations (Conditions for Approval) in inspections.
	• When waivers for road construction work are issued in the NTP, include timeframes for completion. State the need for final inspection acceptance of all required items.
	• Multiflora rose should be treated and monitored.
	
	2003 Blowdown salvage sales:
	
	• Bench cut skid trails should be avoided due to the disturbance to soils and alteration of hydrology.
	
	• In future blowdown or broad scale mortality assessments:
	  ○ Consider providing field crews with consistent thresholds to categorize damage.
	  ○ Where heavy and moderately heavy blowdown occurs, map reserve areas using a GPS unit that can record coordinates of reserve areas.
	
	Smoke monitoring: Continue smoke monitoring during selected prescribed burns.
	
	National BMP monitoring:
	• Provide oil and gas companies with information on resource concerns to consider during planning process and layout. This exchange of information was actually occurring with two of the larger oil and gas operators on the Forest around the time of the FY 2013 review.

	• Per the FY 2013 minerals management review:
	  ○ To reduce the changes in water temperature around the wetland, trees should be planted to provide shade around the wetland.
	  ○ Instead of controlling all the site drainage at one infiltration basin, it may be better to distribute the outflows over multiple locations.
	• BMPs need to be designed and implemented so that they will hold up to trail and road use for the length of time between maintenance (e.g., use of more durable materials at rolling dips, which will hold up to ATV/motorcycle traffic).
	• On roads and trails, particular attention to surfacing, road shape, and drainage near water body crossings should be made.
	• When project oversight is not present, plans need to adequately describe the level of restoration needed at stream crossings during road decommissioning.
	• Grading contracts should be written to address the removal berms on the edge of the road and restore connection to the ditches for road surface runoff.
	• For timber sales, it was observed that the undisturbed forest floor effectively traps sediment and slows runoff. The only locations where sediment was reaching water resources was where skid trails crossed streams or wetlands. Water resource buffers were effective at minimizing the potential for sediment or herbicides to reach streams.
	• Skid trails should be covered with a sufficient amount of branches and debris as to reduce erosion on steep slopes.
	• Follow-up maintenance, on the stored section of FR 209, is required to remove a failing culvert.

3.1.2 Comparison of projected and actual outputs and services	Plan and implement larger landscape prescribed burns to better utilize limited resources and funding to capture the limited weather burn windows that occur in northwest Pennsylvania. Continue and expand the use of stewardship authority and FCI McKean prison crews for the treatment of NNIP. Expand the chemicals and treatment techniques available for NNIP treatment through, for example, amendment of the Forest Plan. Additionally, there are MAs on the ANF that have not been included in project-level analyses and are not anticipated to be included in the near future in which NNIP treatment is needed, for example the west side of the Allegheny Reservoir. Where proposals for improvements to riparian areas are in hemlock stands, implementation should consider the risk of attracting HWA to these stands. Where thinning treatments of hemlock stands occurs, these areas should be monitored for HWA. Track aspen regeneration treatments that occur in riparian areas.

	Increase implementation rates in order to better meet landscape level Forest Plan desired conditions, goals, and objectives, with a particular emphasis on increasing final harvest rates within MA 3.0. Continue monitoring outputs and services designed to move the Forest towards desired landscape-level vegetation conditions.
3.1.3 Comparison of actual and estimated costs	Continue to monitor expenditures with the objective to efficiently and effectively spend the Forest's allocated budget to meet the needs of Forest Plan implementation.
3.1.4 Length and timing of growing season	Continue to annually collect data on frost-free season length. Update the Monitoring Program to evaluate the data at a more appropriate (longer) frequency, e.g., 10-year intervals, rather than every two years.
Noxious weeds monitoring	
3.2.1 Establish seed and mulch mixes that limit spread of invasive species	Refine seed mixes for timber sales and road work so that desirable cover is met. Continue working with Timber Sale Administrators and Engineering staff. Continue to work with native seed suppliers to produce genetically appropriate seed that is readily available for use on the ANF.
3.2.2 Effectiveness of non-native invasive plant controls	Continue monitoring select locations for year-after treatment effectiveness in terms of resprouts, seed banks, or missed plants. It is recommended to have at least one seasonal dedicated to NNIP treatment per District whose sole responsibility is NNIP contract administration, treatment and monitoring. Expand the chemicals and treatment techniques available for NNIP treatment through, for example, amendment of the Forest Plan.
Recreation monitoring	
3.3.1 Manage dispersed sites and concentrated use areas to prevent resource damage	Continue to inventory and evaluate dispersed sites during project-level planning Continue to utilize FPO and LEO patrols in areas where investments have been made to prevent overcrowding during peak seasons, minimize health and safety concerns, and resource degradation.

3.3.2 Resource damage occurring from motorized and non-motorized use in authorized areas	Continue to provide, and update as needed, information to Forest-users through sources identified in the Discussion section of this monitoring question. Ensure informational and interpretive signage in the field is checked and maintained on a routine basis, including the replacement of worn out/damaged signs. Develop a sign plan for trails/areas experiencing unauthorized use. Continue FPO and LEO patrols and maintain collaborative efforts with user groups, local businesses, and tourism bureaus. Maintaining effective communication with OGM development operators and conducting annual compliance inspections of permitted ROWs are critical to identifying and addressing unauthorized ATV use in ROWs.
Trails monitoring	
3.4.1 Management of trails	A Trail Maintenance Plan should be developed to provide a schedule for basic trail maintenance needs. The plan would incorporate a list of basic trail maintenance tasks to be performed according to Forest Service trail guidelines in Forest Service Handbook 2309.18. Trail maintenance should then be completed in accordance with the standards established for each trail based on its Trail Management Objectives and would be consistent with the management direction provided in the trail class matrix.
3.4.2 Evaluate ANF road system for suitable snowmobile use	The Forest is required by law, in the Travel Management Rule, to evaluate and update a motor vehicle use map on an annual basis. The Forest will also adhere to any changes and/or new directives regarding travel management planning for OHVs, including over-the-snow vehicles. Specific to over-the-snow vehicles, the Forest will continue to maintain a Snowmobile Trails Map to show where it is legal for the public to ride.
3.4.3 Facilitate regular grooming of designated snowmobile trail system	The ANF should evaluate options for leveraging resources that most effectively maintain the snowmobile trail system.
Heritage monitoring	
3.5.1 Develop management plans for preservation of cultural resources	To extent funding, staffing, and workload levels allow, the ANF should address development of heritage management plans for the eligible and potentially eligible sites within the ANF.

3.5.2 Evaluate heritage sites	The ANF should continue to look for opportunities to allocate more resources to complete evaluative work either through additional internal staffing (temporary or permanent) or contractors. The ANF should also continue and expand the Challenge Cost Share Agreement with the Pennsylvania SHPO summer intern program.
3.5.3 Develop inventory of culturally sensitive sites	The ANF should make a deliberate and concerted effort to reach out to all 14 Tribal nations and their THPOs in order to complete a comprehensive inventory of culturally sensitive sites to America Indian Tribes with ancestral ties to the ANF. This will involve formal invitation letters, sit-down meetings, on-site visits, and ethnographic research outside the normal Section 106 compliance consultation. This work will, however, require additional funding for permanent/temporary staff salary time or a contract, as well as counsels/meetings and field site visits. The ANF should continue to work with the SNI and other interested Tribal Nations in gathering ethnographic information on the Buckaloons Prehistoric Sites and the Earthworks Prehistoric Sites in order to develop the site management plans and determine their eligibility for the NRHP. Both these sites are well established culturally sensitive sites to the SNI. It is recommended the Forest Plan objective associated with this monitoring question be modified as the monitoring question was, i.e., work with appropriate representatives of American Indian Tribes with ancestral ties to the ANF landscape to develop a confidential inventory of culturally sensitive sites.
Scenery monitoring	
3.6.1 Maintain or exceed scenic integrity levels	Conduct monitoring from a sample of implemented vegetation management projects to evaluate the effectiveness of design criteria and project-specific mitigation measures in meeting SIL objectives. Continue to use SIL as a primary indicator for measuring effects in project-level scenery management analysis.
Vegetation monitoring	
3.7.1 Stocking within five years of regeneration harvest	Continue to monitor tree seedling development success and the need for additional reforestation treatments to assure timely and adequate tree seedling stocking in regeneration harvests. Continue to implement uneven-aged treatments through an adaptive management approach taking into account the direction noted in the 2007 Forest Plan.
3.7.2 Maximum opening size from even-aged management	Continue monitoring the size of temporary openings created through shelterwood removals, clearcuts, or two-aged harvests to ensure Forest Plan standards and guidelines are met.

3.7.3 Prescriptions and effects	Continue monitoring implementation of silvicultural prescriptions in all types of prescriptions. Continue utilizing relative density measures of stand crowding in silvicultural prescription development. Continue utilizing local guidelines for silvicultural prescription development in Allegheny Plateau hardwoods (Marquis, et al. 1994). Recognize the dynamic nature and changing health of forest stands on the ANF, and utilize adaptive management techniques when developing appropriate silvicultural prescriptions. Continue utilizing the standardized ANF silvicultural prescription template designed to ensure all measurable components of silvicultural prescriptions are addressed, including long-term objectives. Ensure that the inventory used to write a prescription accurately represents conditions on the ground. Collect updated inventory data in the following situations: • Existing data are older than 10 years old. • Original stand boundaries are significantly differently than actual treatment boundaries. • When stand composition, stocking, health, or distribution has changed since the last inventory (e.g. BBD, windthrow, general decline, etc.). Where clumpy stocking distribution occurs, or mortality such as BBD-caused mortality has impacted a stand, a shelterwood seed cut may require the residual relative density to fall below 50%. Account for sapling stocking in the prescription when it exceeds 5% of the total stand relative density. Assess prescription effectiveness on a frequent basis with marking crews, particularly inexperienced crews.
3.7.4 Provide vegetative diversity	Increase regeneration treatments in order to move forest age class and structural stage distribution toward desired conditions in the Forest Plan.
3.7.5 Changes in forest health	Continue insect and disease detection and monitoring activity as a cooperative effort with FHP. Maintain health of forest stands by maintaining adequate growing space and site resources through thinning. Enhance the diversity of forest vegetation in terms of composition and structure in order to improve resiliency of the forest and reduce level of impact from insects and diseases, particularly those that are introduced.

	Utilize ANF Forest Plan direction that provides for emphasizing integrated pest management methods to prevent or minimize pest problems using the most current science and available control methods. For those insects and diseases that present new threats to Forest tree species (such as EAB, HWA, and SWW), continue monitoring for their presence on the ANF, and develop and implement strategies and action plans for these pests that integrate newly identified or state-of-the-art pest control techniques. Continue monitoring overall health and status of affected tree species. Continue to assess the need for public education (firewood movement) and monitor effectiveness of education and outreach efforts.
3.7.6 Effectiveness of herbicide design criteria	Continue monitoring representative samples of herbicide treatment areas to ensure Forest Plan standards and guidelines relative to herbicide application are being implemented. Also, operationally: • Continue to ensure personnel laying out herbicide treatment boundaries and surveying sites for water or other sensitive features pay particular attention to less obvious water features that are dry at the time of treatment, such as intermittent streams, in order to ensure they are adequately buffered per Forest Plan standards. • Continue to provide training, if necessary, for contract inspectors in the identification and delineation of intermittent streams and other water resources. • Strive to lay out smooth treatment area boundaries without sharp corners that the equipment operator is unable to navigate. • Ensure adequate flagging is hung to indicate treatment area and buffer boundaries, particularly where heavy understory vegetation and brush is present. This includes hanging flagging as high as possible, with long streamers where heavy brush exists. • Reflag buffers prior to herbicide application, if necessary, following a wet weather event to ensure the distance to water feature compliance standards are met. • Layout personnel should strive to walk unit boundaries prior to vegetation leafing out in order to better see water features, pipelines, and other features that should be avoided during treatment. • Layout personnel need to survey for water features that fall within 100’ of the treatment area boundary, to ensure they are properly buffered even if they fall outside the treatment area boundary. • Ensure herbicide contract inspectors document condition of buffered water features at the time of treatment. Due to variable soil and climatic conditions, it is difficult to conclude whether a buffered feature was dry or contained flowing water at the time of treatment if not documented. • Clearly document decisions made on treatment day (based on weather, topography, etc.) on stand data sheet. • Do not assume that buffers designated during timber sale layout are adequate.

	• Label the purpose of reserve areas, especially when they contain water features. • Maintain maps showing movement of herbicide machine.
3.7.7 Effect of management activities, natural events, and other disturbances on large dead, damaged, or diseased trees	Discuss this monitoring question and indicator and reconsider its value to the Monitoring Program and management of the ANF. If this question is retained, finalize a formal monitoring protocol for pileated woodpecker including a methodology that incorporates scale for a meaningful analysis.
Watershed and air monitoring	
3.8.1 Complete soil and water restoration projects	Remove this question from the Monitoring Program to reduce redundancy as soil and water improvements are addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*).
3.8.2 Restore compositional/structural diversity to riparian corridors	Implement treatments that have been proposed and approved in projects. Where proposals for improvements to riparian areas are in hemlock stands, implementation should consider the risk of attracting HWA to these stands. Where thinning treatments of hemlock stands occurs, these areas should be monitored for HWA. Track aspen regeneration treatments that occur in riparian areas. Remove this question from the Monitoring Program to reduce redundancy as riparian corridor restoration treatments are addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.4 Fuels, non-native invasive plant, wildlife, fish and stream activities*).
3.8.3 Status of water quality	Monitoring indicator 1 – water quality monitoring: • Treatment facilities for streams impacted by acid deposition should be implemented in additional watersheds and monitored. • Continue to monitor HAB in the Allegheny Reservoir and post signs at access areas when WHO values are exceeded. • The water quality data collected by partners should be stored in the appropriate depository so that it can be used for baseline data. • Continue to monitor conductivity at various sites to identify problems that are occurring from OGM development. • Address sedimentation problems identified in Elk County on the following streams: Three Mile Run, Crooked Run, Steck Run and Little Otter Run. In addition, sedimentation was observed in the Hunter Creek watershed and the roads in this watershed should be reviewed.

	• Mitigation of roads in the Grunder Run watershed is needed to reduce the sediment loads. The monitoring of sediment loads should continue at Grunder Run and Hedgehog Run as funding permits. Monitoring indicator 2 – macroinvertebrate sampling: • PA DEP recommends that future acid deposition projects and funding should be focused on treatment of the six streams revealed not to be in attainment of their designated aquatic life use during the Aquatic Biology Investigation study. The remaining streams examined during this study should continue to be monitored, particularly in the fall, to document possible degradation of macroinvertebrate assemblages and other aquatic life. • Clarion University of Pennsylvania recommends the sampling of macroinvertebrates in pools if additional surveys are conducted as follow-up to their assessments of OGM development, and PA DEP recommends resurvey of the Chappel Fork watershed macroinvertebrate community is completed until full recovery is documented. • USACE recommends the sampling of tributaries to the Allegheny Reservoir and Allegheny River should continue. • Overall, macroinvertebrate surveys should continue as they can provide an early warning of hazardous changes in water quality, detect episodic events such as pollution spills, evaluate recovery from disturbed conditions, and reveal trends and cycles. It is also recommended that the ANF inventory watersheds identified with sediment sources and apply or improve BMPs at the areas of concern. The ANF should continue surveying roads for sediment contributions to water ways so that these sediment sources can be mitigated. Additionally, habitat improvement projects should be focused on projects where water quality is suitable for aquatic organisms.
3.8.4 Effect of management activities, natural events, and other disturbances on soils	To help identify sensitive soils and protect areas of concern, the new soils quality standards monitoring protocol should be implemented in FY 2017 and conducted annually on a variety of sites. Specifically: • Soil monitoring should occur in post-harvest stands on each District to ensure the amount of disturbed areas is minimized and soil compaction reduced so that soils have the capacity to sustain herbaceous and woody plant growth. • Soil compaction should be evaluated when oil and gas operators are plugging wells and decommissioning roads so that these areas are not prevented from naturally reestablishing trees and shrubs. The Forest Plan still contains references to the superseded directive FSH 2509.18 – Soil Management and was not updated with the changes in monitoring protocol. To align with changes in the national and regional direction, the Forest Plan should be updated to remove the references to the superseded documents and reflect the updated guidance.

3.8.5 Effect of management activities, natural events, and other disturbances on quality, cold-water ecosystems	Complete development of the protocol for brook trout eDNA monitoring.
Wildlife, fish, and sensitive plant habitat monitoring	
3.9.1 Status of cerulean warbler	Continue to survey cerulean warbler preferred nesting habitat during songbird survey routes.
3.9.2 Status of northern goshawk	In cooperation with the CAGP and Pennsylvania Game Commission (PGC), continue to monitor known and historic northern goshawk territories and conduct surveys for new territories where effort has been minimal in the past when resources allow. Habitat analysis should be completed in an effort to correlate habitat preferences and quality with nesting activity and success. Continue to maintain the integrity of northern goshawk habitat by implementing the management emphasis outlined in the Forest Plan FEIS (USDA-FS 2007b, p. 3-197).
3.9.3 Status of timber rattlesnake	Continue to work with PFBC on the telemetry program and researchers on the gestation site study to identify timber rattlesnake dens. Maintain the integrity of den sites by reducing or removing human activities that have a high risk of causing rattlesnake mortality. Consider manipulating vegetation at den sites where basking and foraging habitat has become limited.
3.9.4 Manage deer density	Continue to monitor estimates of deer density across the ANF, both within and outside the KQDC, and adaptively use DMAP. Outside of the KQDC, focus monitoring on a DMAP unit basis rather than by District-level project area.
3.9.5 Status of great blue heron	Continue to pursue reports of new nests and search for new rookeries in high potential nesting habitat. Continue annual monitoring of known rookeries and implement guidelines to protect known rookeries.

3.9.6 Status of northern flying squirrel	Continue to place nest boxes in suitable habitat and monitor annually. Consider a conifer replacement strategy in the event there is a loss of hemlock to HWA.
3.9.7 Manage known locations of plant species with viability concerns	Continue surveys and data entry into to NRM-TESP/IS. To assess the amount of suitable habitat for species with the fewest known occurrences, develop another agreement with WPC to conduct surveys in suitable habitat for select species that have the highest likelihood of being impacted by ground and canopy altering activities. Monitoring of known locations is needed to determine if sites are being impacted by non-native invasive species.
3.9.8 Status of red-shouldered hawk	Continue to monitor known nests and field verify reports of new nests.
3.9.9 Status of osprey	Continue to monitor the activity of known osprey nests.
3.9.10 Minimize risk of aquatic invasive species introduction	Continue watercraft and trailer screenings by ANF ecosystem or recreation staff as possible. During watercraft and trailer screenings, focus on educating members of the public on the risk posed by AIS introduction and the actions they can take to minimize risk. Print educational materials on the risks of AIS introduction on the ANF to hand out to the public. Consider replacing the shoreline surveys from the ANF Conservation Program with dive surveys. Paint “Clean, Drain, & Dry” messaging on the pavement at the approaches to ANF boat launches.
3.9.11 Status of bald eagle	Continue to monitor nest success.
3.9.12 Implement bald eagle conservation measures	Continue to monitor the implementation of eagle conservation measures. Publish annual news releases advising Forest visitors not to disturb eagles, asking them to pick up discarded fishing line, and consider not using lead ammunition or fishing gear.

	Determine how management guidelines identified in the BGEPA differ from the conservation measures already implemented.
3.9.13 Implement conservation measures for federally listed bats	Continue to implement conservation measures with emphasis on retaining snags > 10 inches DBH and live trees ≥20 inches DBH. Retaining trees that may become snags during the first entry (partial harvest) may result in more snags available for retention in the final harvest. Analyze and summarize snag longevity study data. Update the Forest Plan to incorporate conservation measures specific to the NLEB (e.g., Eastern Region Conservation Measures) and remove those specific to the Indiana bat.
3.9.14 Implement conservation measures for federally listed mussels	During future planning and implementation of ANF projects in the 13% Area, efforts should be made to include the replacement of existing road-stream crossings with AOP crossings and large wood additions to streams. Consider replacing the shoreline surveys with annual dive surveys for zebra mussels. Monitoring of oil and gas roads and well pads in the 13% Area should be undertaken by ANF aquatics staff as time allows. Post-harvest monitoring of timber sales in the 13% Area for hydrological issues should occur as needed.
3.9.15 Effectiveness of mitigation measures for plants with viability concerns	Consider what resources may be available to field test, finalize, and implement the draft monitoring protocol.
3.9.16 Implement conservation measures for federally listed plants	The GIS model should be used as an overlay with other available GIS data to evaluate habitat suitability followed up by field surveys to detect suitable habitat and/or plants. Continue to use/refine the GIS model in areas of key habitat.
Minerals and geology monitoring	

3.10.1 Establish and maintain an oil and gas development inventory	Continue to update and revise OGM-related GIS datasets using existing resources, including, but not limited to: GPS collected data, aerial photography, LIDAR data, state digitized data, data provided by OGM operators, and ANF digitized data. When informational gaps still are noted, develop strategies on how best to close these gaps using available resources. Implementation should be driven by priorities.
3.10.2 Federal oil and gas developments meeting Forest Plan design criteria	Continue to work with BLM to evaluate and monitor oil and gas leases of federally owned oil and gas rights.
Land ownership monitoring	
3.11.1 Acquire subsurface ownership	Continue to work with partners who approach the ANF to discuss options for acquiring mineral rights in MAs 5.1, 5.2, 7.1, 8.1, 8.2, 8.3, 8.4, 8.5, and 8.6. Collaborate with parties who may be interested in acquiring mineral rights in other areas of the ANF that may have similar site-specific management objectives as the aforementioned MAs.
Transportation system monitoring	
3.12.1 Maintain roads	Continue performing road maintenance activities as needed.
3.12.2 Decommission roads no longer needed	Continue monitoring the road system for opportunities to decommission unneeded roads. Remove this question from the Monitoring Program to reduce redundancy as road decommissioning is addressed in the monitoring question that compares projected outputs to actual outputs (*3.1.2.5 Transportation activities*).
3.12.3 Surface roads with limestone	Continue monitoring the road system for opportunities to surface roads with improved surfacing materials. Typically, available funds limit the amount of improved surfacing materials that can be used. Emphasis should be given to higher priority projects (roads within 300' of streams) or roads where the existing pit run surfacing is failing.

List of Acronyms

ALB	Asian longhorned beetle
AMPA	aminomethyl phosphoric acid
ANF	Allegheny National Forest
AOP	aquatic organism passage
APHIS	USDA-Animal and Plant Health Inspection Service
ARRA	American Recovery and Reinvestment Act
ASQ	allowable sale quantity
BA	Biological Assessment
BBD	beech bark disease
BGEPA	Bald and Golden Eagle Protection Act
BLM	USDI Bureau of Land Management
BMP	best management practice
CAGP	Central Appalachian Goshawk Project
CASTNET	Clean Air Status and Trends NETwork
CE	Categorical Exclusion
CFR	Code of Federal Regulations
CSSM	cherry scallop shell moth
CUA	concentrated use area
DASM	digital aerial sketch mapping
DBH	diameter at breast height
DCNR	Department of Conservation and Natural Resources
DCNR-BOF	Department of Conservation and Natural Resources-Bureau of Forestry
DEP	Department of Environmental Protection
DSA	driving surface aggregate
EAB	emerald ash borer
ECCD	Elk County Conservation District
EFETAC	Eastern Forest Environmental Threats Assessment Center
FACTS	Forest Service Activity Tracking System
FCI	Federal Correctional Institute
FDM	Forest Disturbance Mapper
FEIS	Final Environmental Impact Statement
FHM	Forest Health Monitoring
FHP	USDA-Forest Service Northeastern Area, State and Private Forestry, Forest Health Protection
FIA	Forest Inventory and Analysis
FR	Forest Road
FS Veg	Field Sampled Vegetation
FTC	forest tent caterpillar
FWW	fall webworm
FY	fiscal year
GIS	Geographic Information System
GPS	Global Positioning System
NRHP	National Register of Historic Places
HWA	hemlock woolly adelgid

IFTU	Iron Furnace Chapter of Trout Unlimited
KEF	Kane Experimental Forest
KQDC	Kinzua Quality Deer Cooperative
IRTC	Integrated Resource Timber Contract
MA	Management Area
MCCD	McKean County Conservation District
MDN	Mercury Deposition Network
MIS	Management Indicator Species
msl	mean sea level
MODIS	moderate resolution imaging spectroradiometer
NAAQS	National Ambient Air Quality Standard
NADP	National Atmospheric Deposition Program/National Trends Network
NDVI	normalized differential vegetation index
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NFS	National Forest System
NNIP	non-native invasive plants
NNIS	non-native invasive species
NTP	Notice to Proceed
NRM-TESP/IS	Natural Resource Manager Threatened, Endangered, and Sensitive Plants – Invasive Species
NRS	USDA Forest Service Northern Research Station
NYS DEC	New York State Department of Environmental Conservation
OGM	oil, gas, and mineral
OHV	off-highway vehicle
p.	page
pp.	pages
PA	Pennsylvania
PEC	Pennsylvania Equine Council
PFBC	Pennsylvania Fish and Boat Commission
PDA	Pennsylvania Department of Agriculture
PDSI	Palmer Drought Stress Index
PGC	Pennsylvania Game Commission
RAR	Roads Accomplishment Report
ROW	right-of-way
RTFD	Real Time Forest Disturbance
SCA	Student Conservation Association
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office
SIL	Scenic Integrity Level
SNI	Seneca Nation of Indians
SWW	sirex woodwasp
TCD	thousand canker disease
TEIS	Transitional Environmental Impact Statement
TIM	Timber Information Manager

TNC	The Nature Conservancy
TU	Trout Unlimited
USEPA	U.S. Environmental Protection Agency
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YCC	Youth Conservation Corps
WCCD	Warren County Conservation District
WPC	Western Pennsylvania Conservancy

Literature Cited

Bonfardine, K. 2014. Unpublished data. *Elk County acid precipitation and physical habitat study*.

Brack V, Jr, Stihler CW, Reynolds RJ, Butchkoski CM, Hobson CS. Effect of climate and elevation on distribution and abundance in the mideastern United States. In: Kurta A, Kennedy J, editors. The Indiana bat: biology and management of an endangered species. Austin, TX: Bat Conservation International; 2002. pp. 21–28.

Brinker, D. F. 2010. Northern goshawk. In: Ellison, W.G. (ed.). *Second atlas of the breeding birds of Maryland and the District of Columbia.* Baltimore, MD: The Johns Hopkins University Press. Pp. 110-111.

Brinker, D. F. 2012. Northern goshawk. In: Wilson, A.M., D. W. Brauning, and R. S. Mulvihill (eds.). *Second atlas of breeding birds in Pennsylvania*. University Park, PA: The Pennsylvania State University Press. Pp. 148-149.

Brinker, D. F. 2013. Unpublished data. *Proposal to the Pennsylvania Game Commission: Video monitoring of nesting northern goshawks (Accipiter gentilis) in the Central Appalachians*.

Brinker, D. F. 2016. Unpublished data. *Central Appalachian Goshawk Project – 2016 Summary*.

Brose, P.H., K.W. Gottschalk, S.B. Horsley, P.D. Knopp, J.N. Kochenderfer, B.J. McGuinness, G.W. Miller, T.E. Ristau, S.H. Stoleson, and S.L. Stout. 2008. *Prescribing regeneration treatments for mixed-oak forests in the Mid-Atlantic region*. GTR-NRS-33. Newtown Square, PA: USDA Forest Service, Northern Research Station. 100 pp.

Buckelew, A. R., Jr. 1991. Recent northern goshawk breeding records from the West Virginia highlands. *Redstart* 58(3): 74–75.

Crocoll, S. 2008. Northern goshawk. In: McGowan, K.J. and K. Corwin (eds). *The second atlas of breeding birds in New York State*. Ithaca, NY: Cornell University Press. Pp. 196–197.

deCalesta, D. S. 2013. Reliability and precision of pellet-group counts for estimating landscape-level deer density. *Human-Wildlife Interactions* 7(1): 60-68.

Federal Land Manager Environmental Database. 2017. Accessed July 21, 2017. http://views.cira.colostate.edu/fed/

Gannon, M and T. Blackburn. 2002a. Survey of bats at Allegheny National Forest with emphasis on the Indiana bat (*Myotis sodalis*). Altoona, PA: Penn State University. 109 pp.

Gannon, M and T. Blackburn. 2002b. Telemetry study of bats in Pennsylvania with emphasis on the Indiana bat (*Myotis sodalis*). Altoona, PA: Penn State University. 41 pp.

Hand, J.L., S.A. Copeland, D.E. Day, A.M. Dillner, H. Indresand, W.C. Malm, C.E. McDade, C.T. Moore, M.L. Pitchford, B.A. Schichtel, and J.G. Watson. 2011. *Spatial and seasonal patterns and temporal variability of haze and its constituents in the United States: report V*. Accessed July 21, 2017. http://vista.cira.colostate.edu/Improve/spatial-and-seasonal-patterns-and-temporal-variability-of-haze-and-its-constituents-in-the-united-states-report-v-june-2011/

Hanson, J.W. 2014. Unpublished thesis. *Assessing overstory and understory tree species communities and their similarity using data from the Pennsylvania Regeneration Study*. Syracuse, NY: SUNY College of Environmental Science and Forestry. 88pp.

Harris, S. 2011a. Unpublished manuscript. *Biomonitoring of aquatic macroinvertebrates in the Allegheny National Forest in areas of active oil and gas development*. Clarion, PA: Clarion University of Pennsylvania. 164 pp.

Harris, S. 2011b. Unpublished manuscript. *Impacts of sedimentation from oil and gas development on stream macroinvertebrates in two adjacent watersheds of the Allegheny National Forest of northwestern Pennsylvania*. Clarion, PA: Clarion University of Pennsylvania. 141 pp.

Houston, D.R., B.D. Rubin, M.J. Twery, and J.R. Steinman. 2005. Spatial and temporal development of beech bark disease in the northeastern United States. In: Evans, C.A., J.A. Lucas, and M.J. Twery. *Beech bark disease: proceedings of the beech bark disease symposium*. GTR-NE-331. Newtown Square, PA: USDA Forest Service, Northern Research Station. 149 pp.

Kimmel, J.T. and R.H. Yahner. 1994. *The northern goshawk in Pennsylvania: Habitat use, survey protocols, and status*. University Park, PA: The Pennsylvania State University Press. 466 pp.

Krist, F.J., Jr., J.R. Ellenwood, M.E. Woods, A.J. McMahan, J.P. Cowardin, D.E. Ryerson, F.J. Sapio, M.O. Zweifler, and S.A. Romero. 2014. *2013 – 2027 National Insect and Disease Forest Risk Assessment*. FHTET-14-01. Fort Collins, CO: USDA Forest Service, Forest Health Technology Enterprise Team. 199 pp.

Leung,Y.-F., J.L. Marion and S.K. Nepal. 2006. Monitoring trail conditions: new methodological considerations. *The George Wright Forum* 23(2): 36-49.

Linderholm, H. W. 2006. Growing season changes in the last century. Agricultural and Forest Meteorology. 137(1-2):1-14.

Marasco, T. and P. Weiss. Pennsylvania DCNR-BOF, Division of Forest Pest Management. PowerPoint Presentation: *DCNR Hemlock Management Strategy, BOF Forest Pest Management and BSP Resource Management*. Clarion, PA. January 28, 2013.

Marquis, D.A., ed. 1994. *Quantitative silviculture for hardwood forests of the Alleghenies*. GTR-NE-183. Radnor, PA: USDA Forest Service, Northeastern Forest Experiment Station. 376 pp.

NADP. 2017. National Atmospheric Deposition Program NADP/NTN. Accessed July 20, 2017. http://nadp.isws.illinois.edu/

NatureServe. 2014. NatureServe Explorer: An online encyclopedia of life. Version 7.1. Arlington, VA: NatureServe. Accessed May 30, 2014. http://explorer.natureserve.org

NYSFOLA. 2009. *Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management*. New York State Federation of Lake Associations, Inc.

PA DCNR-BOF, Division of Forest Pest Management. 2009. *Forest Insect and Disease Conditions in Pennsylvania*.

PA DCNR-BOF, Division of Forest Pest Management. 2010. *Pennsylvania Forest Health Report*.

PA DCNR-BOF, Division of Forest Pest Management. 2011. *Pennsylvania Forest Health Report*.

PA DCNR-BOF, Division of Forest Pest Management. 2012. *Pennsylvania Forest Health Report*.

PA DCNR-BOF. Pennsylvania Bureau of Forestry Planting and Seeding Guidelines. http://elibrary.dcnr.pa.gov/GetDocument?docId=1742696&DocName=sf-BOF_Planting-Seeding_Guidelines.pdf

PA DEP. 2009a. *An evaluation of the Pennsylvania Air Quality Program.* Accessed July 20, 2017. http://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Regulations%20and%20Clean%20Air%20Plans/attain/APCA%205-Year%20Report%20042209.pdf

PA DEP. 2009b. *Aquatic biology investigation/crude oil spill: Chappel Fork Watershed Survey (SC 56544)*. 18 pp.

PA DEP. 2011. *Aquatic biology investigation/crude oil spill: Chappel Fork Watershed Survey (SC 56544)*. 9 pp.

PA DEP. 2013a. *Instream Comprehensive Evaluation Surveys.* Harrisburg, PA: PA DEP, Bureau of Point and Non-Point Source Management. 71 pp.

PA DEP. 2013b. *Aquatic Biology Investigation-Acidification Study*. Meadville, PA: PA DEP, Northwest Regional Office. 25 pp.

Park, I.W., and Mazer, S.J. 2018. Overlooked climate parameters best predict flowering onset: Assessing phenological models using the elastic net. Global Change Biology. 2018: 1-13.

Pekney, N., G. Veloski, M. Reeder, J. Tamilia, E. Rupp, and A. Wetzel. 2014. *Measurement of atmospheric pollutants associated with oil and natural gas exploration and production activity in Pennsylvania's Allegheny National Forest*. Journal of the Air & Waste Management Association. Accessed July 21, 2017. https://www.ncbi.nlm.nih.gov/pubmed/25283004

PGC-PFBC (Pennsylvania Game Commission and Pennsylvania Fish & Boat Commission). 2015. Pennsylvania Wildlife Action Plan, 2015-2025. C. Haffner and D. Day, editors. Pennsylvania Game Commission and Pennsylvania Fish & Boat Commission, Harrisburg, Pennsylvania.

Romme, R., K. Tyrell, and V. Brack, Jr. 1995. Unpublished report. *Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat (Myotis sodalis)*. Bloomington, IN: Indiana Department of Natural Resources. 38 pp.

Sams, C.E. 2007. Methylmercury contamination: impacts on aquatic systems and terrestrial species, and insights for abatement. In: Furniss, M., C. Clifton, and K. Ronnenberg (eds). *Advancing the fundamental sciences: proceedings of the Forest Service National Earth Sciences Conference*, *San Diego, CA, October 18-22, 2004*. GTR-PNW-689. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 577 pp.

Smith, G.C., J.W. Coulston, and B.M. O'Connell. 2008. *Ozone bioindicators and forest health: a guide to the evaluation, analysis, and interpretation of the ozone injury data in the Forest Inventory and Analysis Program.* GTR-NRS-34. Newtown Square, PA: USDA, Forest Service, Northern Research Station. 100 pp.

Smith, G.C., R.S. Morin, and G.L. McCaskill. 2012. *Ozone Injury to Forests across the Northeast and North Central United States, 1994-2010*. GTR-NRS-103. Newtown Square, PA: USDA, Forest Service, Northern Research Station. 46 pp.

USDA-Forest Service. 1993. *Allegheny National Forest 1986 Land and Resource Management Plan*. Warren, PA: USDA, Forest Service, Allegheny National Forest. 405 pp.

USDA-Forest Service. 1993. *Allegheny National Forest Monitoring and Evaluation Report-Fiscal Year 1992*. Warren, PA: USDA, Forest Service, Allegheny National Forest. 69 pp.

USDA-Forest Service. 1997. *Allegheny National Forest Final Environmental Impact Statement for Vegetation Management Electric Utility Rights-of-way*. Warren, PA: Environmental Consultants Incorporated. 178 pp.

USDA-Forest Service. 2003. *Forest-wide Roads Analysis Report.* Warren, PA: USDA, Forest Service, Allegheny National Forest. 173 pp.

USDA-Forest Service. 2007a. *Allegheny National Forest 2007 Land and Resource Management Plan*. Warren, PA: USDA, Forest Service, Allegheny National Forest. 269 pp.

USDA-Forest Service. 2007b. *Final Environmental Impact Statement to Accompany the Allegheny National Forest 2007 Land and Resource Management Plan*. Warren, PA: USDA, Forest Service, Allegheny National Forest. 708 pp.

USDA-Forest Service. 2008a. *Allegheny National Forest FY 2008 Monitoring & Evaluation Report*. Warren, PA: USDA, Forest Service, Allegheny National Forest. 86 pp.

USDA-Forest Service. 2008b. *Threatened, endangered, and sensitive plants element occurrence field guide*. Washington D.C.: USDA, Forest Service, Rangeland Management Staff. 49 pp.

USDA-Forest Service. 2009. Forest Service Handbook, Allegheny National Forest 2409.17-Silvicultural Practices, Chapter 2-Reforestation. 12 pp.

USDA-Forest Service. 2010. *Site-specific effects of private oil and gas development on the Allegheny National Forest.* Warren, PA: USDA Forest Service, Allegheny National Forest. 96 pp.

USDA-Forest Service. 2012a *National Best Management Practices for Water Quality Management on National Forest System Lands Volume 1: National Core BMP Technical Guide*. FS-990a. Washington D.C.: USDA, Forest Service, Washington Office. 177 pp.

USDA-Forest Service. 2012b. Forest Service Manual 2500, Eastern Region (R9) Chapter 2550. 6pp.

USDA-Forest Service. 2014a. *Allegheny National Forest Monitoring and Evaluation Report-Fiscal Year 2008-2013*. Warren, PA: USDA Forest Service, Allegheny National Forest. 294 pp.

USDA-Forest Service. 2014b. *USDA Forest Service National Forest System data recording protocols and requirements for invasive species: survey, inventory, and treatment*. Washington, D.C.: USDA, Forest Service, Natural Resource Manager. 50 pp. http://fsweb.wo.fs.fed.us/invasivespecies/data.shtml

USDA-Forest Service. 2015a. *Threatened, endangered, and sensitive plants element occurrence protocol and field guide*. Washington D.C.: USDA, Forest Service, Rangeland Management Staff. 41 pp. http://fsweb.nrm.fs.fed.us/support/other_documents/tesp/other_document_tesp_Element_Occurrence.pdf

USDA-Forest Service. 2015. *Programmatic biological assessment: northern long-eared bat. For Land and Resource Management Plans of the Forest Service Eastern Region.* Milwaukee, WI: USDA Forest Service, Eastern Region Regional Office. 214 pp.

USDI-Fish and Wildlife Service. 2007. *United States Fish and Wildlife Service concurrence letter regarding determinations in the Revised Forest Plan Biological Assessment*. 21 pp.

U.S. Environmental Protection Agency. 2009. National Primary Drinking Water Regulations. EPA 816-F-09-004. https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf

U.S. Environmental Protection Agency. 2013. Clean Air Markets Division Clean Air Status and Trends Network (CASTNET). Accessed June 10, 2014. https://www.epa.gov/castnet

U.S. Environmental Protection Agency. 2016a. Clean Air Status and Trends Network (CASTNET). Accessed July 18, 2017. https://www.epa.gov/castnet

U.S. Environmental Protection Agency. 2016b. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators.

U.S. Environmental Protection Agency. 2016c. NAAQS Table. Accessed July 18, 2017. https://www.epa.gov/criteria-air-pollutants/naaqs-table

U.S. Environmental Protection Agency. 2017a. Nonattainment Areas for Criteria Pollutants (Green Book). Accessed July 21, 2017. https://www.epa.gov/green-book

U.S. Environmental Protection Agency. 2017b. Sulfur Dioxide. Accessed July 20, 2017. https://www.epa.gov/so2-pollution

USGPO. 2013. Federal Register Volume 78, Number 150. Accessed July 21, 2017. http://www.gpo.gov/fdsys/pkg/FR-2013-08-05/html/2013-18835.htm

WPC. 2015. *Assessment and Baseline of High Value Ecological Areas in the Shale Region*. Accessed June 4, 2021. https://waterlandlife.org/wp-content/uploads/2018/02/Assessment-of-High-Value-Ecological-Areas-in-PA-Shale-Region-2015.pdf

Wilson, A.M., D. W. Brauning, and R. S. Mulvihill (eds.). *Second atlas of breeding birds in Pennsylvania*. University Park, PA: The Pennsylvania State University Press. 586 pp.

Personal communication

Koch, Jennifer. 2013. USDA-Forest Service, NRS. Telephone conversation regarding potentially resistant American beech trees on the ANF.

McWilliams, Will. 2014. USDA-Forest Service, FIA. Email regarding FIA sampling conducted in FY 2013.

Morin, Randy. 2014. Email and telephone conversations regarding FY 2008-2012 FIA data summaries for the ANF.

Pulket, Molly. 2013. PA DEP. Excel spreadsheet of PA DEP macroinvertebrate data and station information.

Reilly, Rose. 2014. USACE. Email regarding aquatic invertebrate collections from tributaries to the Allegheny Reservoir and River.

Turner, Melinda. 2014. USFWS. Email regarding revised Indiana bat range in Pennsylvania.

Turner, Melinda. 2016. USFWS. Email regarding northern long-eared bat sites on the ANF.