Soil Resource

Introduction

Monitoring and evaluation are critical elements in determining whether the Forest is meeting its obligation for protection of the soil resource. It is only through monitoring and evaluation that we can determine effects that may be occurring to soils from management activities and other influences, and we can adjust our management practices accordingly to keep those effects within acceptable levels and ensure that we maintain or improve soil quality and productivity.

2007 Accomplishments

The Program accomplishments for 2007 included:

- Budget and work planning, including out-year planning.
- Analyzing effects for a variety of Forest projects.
- Completing scheduled soil surveys.
- Additional projects described below.

SOIL DISPLAY TRANSFERRED TO WEST VIRGINIA UNIVERSITY

In 2006, the Forest created a new interpretative soil display at the Seneca Rocks Discovery Center. However, Forest managers later decided not to keep the display at the Center. Therefore, the Forest moved the display to the Plant and Soil Science Department at West Virginia University. A new showcase is now being created to house the display and provide an educational outreach tool to college students.

SOIL SAMPLING WITH THE USDA-NRCS SOIL SURVEY DIVISION

In 2006-2007, the Soil Resource Inventory was updated by an additional 6,200 acres through the Tucker County Soil Survey Update, conducted by the USDA Natural Resource Conservation Service (NRCS). The focus of the mapping update was located in the Timberline Ski Resort area in Canaan Valley. The purpose of the mapping update was to verify soil lines, map units, and interpretations given to the landscape in the original mapping. This effort led to the planning of a soil investigation of the map unit RS, Rubbleland.

The benefit of this inventory update is two-fold to the Forest. One, the Forest is able to update mapping conducted in the 1940s that did not incorporate forest soil information. Two, the Forest can "piggy-back" soil sampling efforts on important soil types in the area where there is currently very little soils information. The Forest sends split samples off to university labs for special forest soil chemistry analyses. The soil chemistry data can be compared with the air quality monitoring and water chemistry monitoring conducted in the area. The air monitoring program annually collects data about deposition of pollutants, monitors visibility, and other parameters of air science (See the Air Quality Report for details). This information should

ultimately help identify relationships between acid deposition, soil chemistry, water chemistry, and aquatic habitat.

Accomplishments also included the monitoring and evaluation efforts described below.

Monitoring and Evaluation

FOREST PLAN MONITORING FOR THE SOIL RESOURCE

The 2006 Forest Land and Resource Management Plan (Forest Plan) has two monitoring items/questions in the Chapter IV Monitoring Matrix that are directly related to soils:

> *28. Is soil detrimental disturbance associated with land management activities below the 15% soil productivity loss threshold?*
>
> *29. Is acid deposition affecting soil productivity loss, and if so, is it affecting land sustainability?*

These monitoring questions, in turn, can be used to show how the Forest is meeting management direction in Chapter II of the Forest Plan. Specifically, that direction includes Goals SW01 and SW02, Standards SW03, SW04, SW06, SW07, and SW08, and Guidelines SW10, SW11, SW12, SW13, SW14, SW15, SW16, and SW18.

Monitoring activities in FY 2007 related to Questions 28 and 29 are described below.

Monitoring Question 28. Is soil detrimental disturbance associated with land management activities below the 15% soil productivity loss threshold?

This monitoring item was addressed in FY 2007 by looking at the implementation and effectiveness of management activities and Forest Plan standards in three Forest projects: the Desert Branch Timber Sale, the Upper Williams Timber Sale, and the Coles Run Prescribed Burn. The monitoring results from these projects should also help answer Monitoring Item 41 in the Forest Plan: To what extent is Forest management affecting soil erosion and stream sedimentation processes? Monitoring and evaluation related to Items 28 and 41 are reported for each project below.

Desert Branch Timber Sale

Unit 25 and Associated Landing Monitoring. In FY 2005, the implementation of the Desert Branch Timber Sale began on the Gauley Ranger District. In October of FY 2006, the Forest Soil Scientist was called in by the project's Timber Sale Administrator for a specialist opinion and to conduct a short monitoring trip to review implementation and effectiveness of mitigations applied to areas where new soil disturbance was occurring (2006 MNF Monitoring Report). In 2007, the Forest Leadership Team conducted a review of the sale with Gauley Ranger District staff. Various resource items were reviewed including soil disturbance, road reconstruction,

landing conversion to wildlife opening, and the Water Table Monitoring Project (2007 On-going status).

Evaluation, Conclusions, and Recommendations. In 2006, the landing area (Figure SL-9 in the 2006 MNF Forest Wide Monitoring Report) looked highly disturbed into the O and A horizons and surface of the subsoil; however this was to be expected. In 2007, the area was rehabilitated, ripped, and seeded with an appropriate wildlife mixture. In the center of the landing, a watering hole was constructed (Figure SL-1, below). Although this soil is mapped as the well-drained Gilpin series, there are areas within the ridge line that pond water and have subsurface water flows. This is apparent in Figure SL-2, which is a landing located just down slope on the other side of Forest Road 946. This photo depicts subsurface flow ponding on site from the top of the B horizon. The entrance to the landing was heavily stoned and holding well during use in 2006. In 2007, the entrance was actively being ripped by an excavator during the field review. The ripping appeared to be deep enough to break apart the compaction in the soil. It is recommended that the post-treatment condition of the landing be checked during a future monitoring visit.

Figure SL-1. Rehabilitation of Disturbed Soil in Unit 25 Landing

Figure SL-2. Landing Located Opposite of Unit 25 on Forest Road 946

Upper Williams – Big and Little Timber Sales

Language in the Decision Notice of the Upper Williams EA stated the need to have skid road systems reviewed in specific harvest units within the Day Run South watershed of the project. The purpose of the review was to monitor concerns with soil disturbance on steeply sloping units (average slopes of 30 percent) that were adjacent to or had stream channels located in them. The soils within the harvest area are mostly the Shouns series (colluvium located on backslopes and in coves), and Cateache series (residuum forming on ridge tops and on benches.) These soils form from the Mauch Chunk geologic formation. They are rated severe for erosion hazard, and they are susceptible to mass wasting, compaction, and ponding of water. In 2007, field visits were made to the sale area to document effects discussed in the EA, and to monitor implementation effectiveness. Visits to three harvest pay units are described below.

Pay Unit #2 Monitoring. The Timber Sale Administrator called for Specialist consultation on Pay Unit 2 in December 2006. Harvesting had already commenced. Operations were occurring outside the Normal Operating Season (contract provisions stated that the end of the season was November 30, 2006.). Temperatures and weather conditions were mild for the season. Considerable time had passed since the last precipitation event. Skid roads were for the most part adequately spaced (200 feet apart). Existing skid roads were used as available, as directed by the EA and contract.

Evaluation, Conclusions, and Recommendations. Some overland skidding on steep slopes had occurred. The operator indicated that the roads were too far apart to reach logs in some cases. The main haul road was an existing old skid road and averaged 20 to 23 percent slope, with long sustained grades. Waterbars will be needed during rehabilitation; seeding and

mulching would also help reduce accelerated erosion. The landing was adequately shaped, and the access road into it was stoned. Soil concerns from the field trip are as follows:

- Soil moisture was excessively high resulting in seepage onto skid roads which was not being drained off into undisturbed soil (Figure SL-3).

Figure SL-3. Seepage onto Skid Road in Pay Unit 2

- Rutting was occurring throughout the unit and in places was as much as 2 feet deep (Figure SL-4).

Figure SL-4. Monitoring Crew Measuring Depth of Rut in Pay Unit 2

- Compaction was occurring; however it was expected to occur during operations and should be mitigated at the end of the sale.

The culvert between the landing and road was not draining the ditchline and should be repositioned to function properly. This caused some ponding on the upslope ditch side.

Soon after the December field visit, operations were suspended by the District until field conditions could allow the conventional ground-based operations without detrimental soil disturbance. Also, a buncher-feller was used in the unit to harvest timber on the less steeply sloping areas (less than 20 percent of the unit). Figure SL-5 displays the soil disturbance caused within the unit by the buncher-feller, whereas Figure SL-6 shows soil disturbance caused by the use of tradition skidder/dozer operation.

Figure SL-5. Ground Disturbance with Feller-Buncher in Pay Unit 2

Figure SL-6. Ground Disturbance with Skid Road in Pay Unit 2

The unit was closed out after the silvicultural prescription had been completed in the following spring of 2007. In addition to soil quality monitoring, water resource monitoring also occur by the Forest Hydrologist, Aquatic Specialist, and staff.

Pay Unit #4 Monitoring. Chris Neal, purchaser, Amy Mullins, TSA, and I walked over a portion of pay unit 4 on Thursday May 3, 2007. This unit had not yet been harvested, so we looked at the unit in terms of how it was laid out for harvest and what restoration would be

needed for skid roads and landings. We discussed site-specific conditions including soil series, subsurface flow, cove areas, surface runoff concerns, and soil moisture conditions.

Evaluation, Conclusions, and Recommendations. Several items were agreed to during our pre-harvest discussion:

1) The operator would need to install two additional skid roads into the unit for the purpose of reaching each tree with 100 feet of cable and for safety concerns.
2) Minimal to no skid road blading would occur on bench areas; however blading would need to occur on steeper side slopes.
3) There may also be a need for a short spur off of the middle existing road.

Wet soil conditions were noted in existing skid roads, and the depth at which these seeps occur (18 inches) was also noted. The location of the extremely rocky areas would be used to determine skid road spacing; therefore some spacing may be closer than 200 feet. The purchaser indicated that mitigation such as ditching, installing a culvert, in sloping with trenching, and using tops as mats in the seeps could all be done to minimize effects once these wet areas were encountered. These mitigations are all suitable to address the soil wetness with the optimum goal to prevent ponding (water sitting for an extended period) in the skid road. The purchaser also agreed that timing would be important for entering this unit. September and August were the best times to harvest this unit to avoid encountering wet soil moisture conditions.

Pay Unit #1 Monitoring. In June 2007, the Timber Sale Administrator asked for specialist input for Pay Unit #1. Similar to Pay Unit 4 discussed above, this unit had not yet been harvested, so we looked at the unit in terms of how it was laid out for harvest and what restoration would be needed for skid roads and landings.

Evaluation, Conclusions, and Recommendations. Recommendations were provided similar to those for Pay Unit #4, above. Harvesting began 2 to 3 weeks later. It is recommended that post-harvest conditions of the unit be checked during a future monitoring visit.

Summary. This area of the Upper Williams watershed was identified in the EA analysis as being sensitive for the effects observed in the pictures above. Other alternatives in the analysis looked at using no ground-disturbing methods (i.e. helicopter) to harvest the timber. In future projects on similar soils, more consideration should be given to how we can operate on these soils with minimal impacts. The risk is high for detrimental soil disturbance in units where strict oversight of operations does not occur and operations occur outside of the growing season. Another option would be to consider more use of tracked overland equipment such as feller-bunchers. This use would minimize soil disturbance as shown in the photo below and lessen the risk for operating on sensitive soils.

Coles Run Prescribed Burn

Coles Run Monitoring. The purpose of the soil monitoring conducted in the Coles Run Prescribed Burn project (CE) was to monitor for Item #28 (soil quality) and for Item #41 (soil erosion). The units were observed post burn in April, 2007.

Evaluation, Conclusions, and Recommendations. The burns were light and scattered across the units (Figure SL-7). Overall, no signs of erosion were present in the burned areas. The O horizon was burned to varying degrees across the project area (Figure SL-8). In some areas, the burn did not seem to be hot enough to meet the prescription objectives. This discrepancy was verified by the Forest's Fire Management Officer.

Figure SL-8. Ephemeral Channel Burned on 4/16/07
(Notice patch burning and O horizon still intact in much of the area)

Figure SL-7. Soil profile (O horizon, A horizon, B horizon) in colluvium in ephemeral stream within burned unit 4/16/07

Firelines were created either: 1) by hand, 2) by using existing cleared linear features such as system roads, and/or 3) by disking of the soil in order to break up and bury the fuel. There did not appear to be any soil movement along the lines (Figure SL-9). This may be because disking of the soil allowed for high infiltration of precipitation and because the soils are classified as well-drained. Soil textures also tend to be sandier, ranging from loams to sandy loams.

Figure SL-9. Disked Fireline around Unit 4/16/07

In summary, this prescribed fire did not cause any noticeable soil resource damage. However, the desired effects of the burn were only partially accomplished across the project area. A good contrasting project is the Shock Run Prescribed Fire from 2005. That fire burned hot, burned to the mineral soil in many patchy areas, and may have had areas that were susceptible to post-burn erosion. The desired effects should be somewhere between the projects. These effects can be difficult to achieve on the MNF because of environmental factors such as topography, burn windows, climate, and fuel variations.

Monitoring Question 29. Is acid deposition affecting soil productivity loss and if so, is it affecting land sustainability?

Soil water and stream acidification are real phenomena that have been shown to occur in West Virginia. Long-term, increasing losses of base cations to stream water due to ambient acid deposition have been documented in stream water on a control watershed in the Fernow Experimental Forest, which is located in the Monongahela NF (Edwards and Helvey 1991).

Other watersheds on and near the Fernow Experimental Forest, which have been artificially acidified with sulfur and nitrogen to determine effects on soils and stream water, have shown mobilization of base cations in soil and consequent leaching to stream water and substantial reductions in the acid-neutralizing capacity of soil and water (Edwards et al. 2002a, 2002b).

Since 1995, intensive soil data collection has occurred in various locations across the Forest, including comprehensive studies in the Otter Creek Wilderness, North Fork of Cherry River watershed, and Lower Williams River watershed. These efforts began to establish baseline soil chemistry data across the Forest, especially in areas assessed by the Soil Nutrient Sensitivity Map to be highly sensitive to acidification (Connolly et al. 2007). Through 2006, more than 600 soil samples have been collected across varying soil types, landscape positions, and aspects, and they have been analyzed for physical and chemical characteristics. Preliminary results show that soils in sensitive areas are affected adversely by acid deposition. Base saturation values are often below 15 percent in areas where base-poor geologies exist (Jenkins 2002, Schnably 2003, Desert Branch EA Soil Resource Report 2003, Cherry River EA Soil Resource Report 2004, Lower Williams River EIS, unpublished), and Calcium to Aluminum (Ca:Al) ratios are less than 1.0 for soils found on ridge tops and benches of these same areas (Desert Branch EA Soil Resource Report, Cherry River EA Soil Resource Report, Lower Williams River Soil Resource Report). Some south-facing cove soils have soil aluminum levels that might indicate possible toxicity for vegetation.

In FY 2007, additional soil chemistry data collection and monitoring occurred in the Red Spruce Study Area, in the Anthony Creek Watershed, and in the Lower Williams River Project Area. These three efforts are described below.

Anthony Creek Watershed

Background. The Anthony Creek watershed is located in Pocahontas and Greenbrier Counties, West Virginia. It is identified as a 5th level Hydrologic Unit (HUC 0505000305), which is further delineated into five 6th level units. The Anthony Creek watershed is an estimated 148 miles^2 in size and has a southwest-facing orientation. It ranges in elevation between 1,795 feet at the downstream extent of the watershed to about 3,600 feet along Meadow Creek Mountain at the headwaters of Anthony Creek and Sevenmile Run. The Anthony Creek watershed receives between 44.3 inches and 54.2 inches of average annual precipitation at various locations, but averages about 48.1 inches across the watershed.

Almost 52% (77 miles^2) of the Anthony Creek watershed is composed of surficial geology (mostly of the Pocono Group and Brallier Formation) that is rated high for sensitivity to acid deposition. This geology is widely distributed throughout the watershed. Surficial geology in the remaining portion of the watershed consists primarily of the Chemung Group that is rated medium for sensitivity to acid deposition. An estimated 53% (208 miles) of streams in the watershed drain from geology with high sensitivity to acid deposition. Currently, no stream segments in the watershed are listed as pH impaired (Section 303d of the Federal Clean Water Act) by the State of West Virginia. However, given the arrangement and composition of the different geologies in the watershed, some streams are likely experiencing varying degrees of acidification and others are expected to possess acid-neutralizing capacities (ANC) capable of

buffering pH to levels that support aquatic biota. More than 14 miles (4%) of streams in the watershed are listed as benthic macro-invertebrate impaired, and more than 4 miles (1%) of streams are listed as aluminum impaired. This information suggests aquatic communities that inhabit Meadow Creek or the Greenbrier River may be at risk due to water quality and habitat related concerns. These concerns warranted soil monitoring within the watershed related to Monitoring Item 29 in the Forest Plan.

Monitoring for Item 29. In the summer of 2007, Anthony Creek watershed became the latest addition of areas and new geologies where soils were sampled. Two transects, dissecting geologies of the Ridge and Valley Province, were completed. One transect ran west to east up Beaver Lick Mountain in the Little Creek drainage near Sue. The other ran east to west up Beaver Lick Mountain in the Anthony Creek drainage near Neola. This sampling was done as a preliminary assessment for the upcoming 2008 Anthony Creek Watershed Assessment. Soils sampled were formed from multiple geologies comprised of acid shales and siliceous sandstones. Ten pits were excavated and sampled by horizon. Samples were sent to the University of Maine for general forest soil chemistry analysis and to the Soil Testing Lab at Pennsylvania University for the specific Aluminum Stress Test (Ca:Al ratio using a $SrCl_2$ extraction method).

Evaluation, Conclusions, and Recommendations. Sampling data is still being processed and interpreted. The 2008 Anthony Creek Watershed Assessment was originally going to be the vehicle used to discuss sampling results and provide general guidance for land management activities related to Monitoring Item 29. However, due to budget and personnel constraints, the assessment may be postponed or canceled. If this assessment does not occur, the results of this soil sampling should be used in whatever site-specific projects that are developed for this area.

Lower Williams River Terrestrial Liming Project

Monitoring for Item 29. The second area sampled was related to pre-monitoring work for the Lower Williams Terrestrial Liming Environment Assessment currently underway in 2008. This project is looking at soil chemistry levels in the watershed to evaluate the need for base cation restoration, particularly calcium. Samples were taken in units to be harvested in the upcoming Lower Williams Vegetation EIS project, and in areas adjacent to the units for additional restoration opportunities and as background or control areas. Five small pits were hand dug either in a linear transect 50 feet apart across the landscape or in a cardinal star pattern, depending on the shape of the unit selected. The O horizon, A horizon, and top of the B or transitional horizon were sampled, and samples were sent to the above mentioned labs for testing.

In conjunction with the soil sampling, foliar sampling was done at five of the sites. Twenty samples per site were taken. Two to three trees species were sampled, depending on the species available at each site. Sun side, top canopy leaves were shot from the uppermost branches and collected as they fell to the forest floor. These leaves were labeled, bagged, air-dried, and sent to the University of Maine Soil Testing Lab for foliar chemical analysis.

Evaluation, Conclusions, and Recommendations. Results of the 2007 sampling efforts are expected in the first quarter of FY 2008. Evaluation will occur as part of the Lower Williams Terrestrial Liming Project.

Red Spruce Study Area

Monitoring for Item 29. In 2005, a partnership was formed with Forest Service Research (Morgantown, WV), NRCS, and West Virginia University to monitor ten Forest Health Monitoring Plots set up in the red spruce ecosystem across the Forest some thirty years ago. These plots were established by researchers to look at growth trends in the red spruce related to decline or expansion of the ecosystem. However, no other data were collected over the time period to look at other parameters such as soil chemistry, foliar chemistry, and other biological indicators. Therefore, this follow-up project was designed to capture additional data and establish baseline numbers for the future comparison of data.

Evaluation, Conclusions, and Recommendations. Dr. Steve Stephenson and graduate student, Adam Rollins, produced a preliminary document that analyzes the data from the Red Spruce Monitoring Project. The report was reviewed by several USFS - NRCS and USFS State and Private Scientists. Based on that review and the desire to further investigate the data, a recommendation was put forth to intensify the analysis of the data with a more stringent statistical review. Funding has been set aside for this additional review in FY 2008.