Soil and Water

Goals: Maintain soil productivity and minimize soil erosion from land-disturbing activities. Minimize sediment transported to streams from land-disturbing activities. Maintain and restore the biological, physical, and chemical integrity of Tongass National Forest waters.

Objectives: Attain Alaska Region (R-10) Soil Quality Standards. Attain State of Alaska Water Quality Standards.

Background: Implementation of Soil and Water standards and guidelines is necessary to maintain soil productivity and water quality. The Soil and Water standards and guidelines are implemented as Best Management Practices (BMPs) described in FSH 2509.22. Region 10 Soil Quality standards are documented in FSM 2554. Methods for effectiveness monitoring of Soil Quality standards are also referenced in FSM 2554. Soil conservation practices are practices used to ensure that ground-disturbing activities will meet the R-10 Soil Quality standards. Typical soil conservation practices include log suspension requirements in timber harvest units and the use of full-bench and end-haul road construction techniques on landslide-prone terrain. Implementation monitoring evaluates whether or not soil conservation practices were required and implemented. Effectiveness monitoring determines whether or not the soil conservation practice used kept the ground-disturbing activity within the R-10 Soil Quality standard.

The State of Alaska Water Quality Standards set standards for chemical, physical, and biologic parameters of waters on National Forest System Lands. The Forest Service in Region 10 uses Best Management Practices and site-specific prescriptions to meet State of Alaska Water Quality Standards when implementing ground-disturbing activities on National Forest System lands.

Soil and Water Question 1: Are the standards and guidelines for Soil Disturbance being implemented?

The Best Management Practices (BMPs), described in the Soil and Water Conservation Handbook (Forest Service Handbook 2509.22, October 1996), define practices that protect soil and water resources. The Soil and Water standards and guidelines define site-specific measures to protect the resources. These standards and guidelines were monitored following a methodology described in the Tongass Monitoring Strategy. The strategy was developed to provide direction for Tongass Land and Resource Management Plan (Forest Plan) implementation monitoring.

The FY 2004 BMP Monitoring Report provides details on how the monitoring was conducted. Interdisciplinary Team Review trip reports detail individual reviews. These reports are included in the appendix. Additional information on the implementation monitoring is described in Soil and Water Question 3. A summary of the findings for the soil resources relative to disturbance is given below.

BMPs Applicable to Soil Disturbance

BMP 12.17 Revegetation of Disturbed Areas
BMP 13.5 Identification & Avoidance of Unstable Areas
BMP 13.9 Yarding Systems to Protect Soil/Water Resources
BMP 13.10 Landing Location & Design
BMP 14.7/ 14.12 Measures to Minimize Mass Failures/Control of Excavation & Sidecast
BMP 14.18 Control Rock Pit Sediment

Monitoring Context

Planning for some of the roads and units was completed before the Soil and Water Conservation Handbook was revised in October 1996 and new Forest Plan Standards and Guidelines were approved in May 1997. Both documents included many improvements for protecting soil and water resources. Several important changes in the 1996 Soil and Water Conservation Handbook included improving wetlands management direction, considering stream buffer windthrow, and generally making Forest Service BMPs consistent with State Forest Practices Regulations. A number of the units monitored were planned, laid out, and harvested under pre-1997 Forest Plan Standards and Guidelines. The concepts of the Forest Plan standards and guidelines were incorporated into most of these timber sales. Implementation of the Forest Plan standards and guidelines occurred in most of the units.

Monitoring Overview

Reviewing the timber sales and respective environmental documents associated with the monitoring this Fiscal Year, most of the units were harvested under contracts that were included in environmental documents that were signed before the 1997 Tongass Land and Resource Management Plan. The units and roads in the FY 2004 monitoring pool are listed below with their respective environmental impact statement (EIS) and environmental assessment (EA) or contracts. The small sales and public works contracts were all implemented under the Forest Plan Standards and Guidelines.

Soil and Water 1. Units Monitored in FY 2004 through BMP Implementation Monitoring Process

Units	Timber Sale; EIS/EA (decision year)
624-230, 622-266, 622-265, 622-264, 622-255, 622-254	Fusion TS; Polk EIS (1995)
Vestal Small Sale	Polk Small Sales; Polk EA (2000)
74A, 74B	Last Twin TS; Twin Creek EA (1998)
71A, 71B, 71C, 62	Bowen TS; South Lindenberg EIS (1996)
439-35, 439-39, 439-41, 439-42, 439-32	South Lindy TS; South Lindy EIS (1996)
439-37	South Park Resale TS; South Lindy EIS (1996)
439-146	South Sand Reoffer TS; South Lindy EIS (1996)
597-416, 597-418	Rio Beaver TS; Control Lake EIS (1998)
113*, 141*, 143*, 145	Orion South TS; Sea Level EIS (1999)
23B*, 23C	Mop Point TS; Mop Point/91 Knot EA (2001)
26B	King George; King George EIS (1996)
17A*, 17B*, 28*, 42*, 44A*, 44B*, 44C*	Situk Salvage TS; Yakutat Salvage Sale EA (2003)
540-206 (006), 540-210 (010), 540-224 (024), 540-225 (025), 533-248 (348), 533-251 (351), 534-218 (418), 535-204 (504), 535-209 (509), 537-208 (708), 539-210 (910), 539-222 (922)	Summore Change TS; Lab Bay EIS (1996)

*Monitored by IDT and 100% monitoring groups

Soil and Water 2. Roads Constructed/ Reconstructed and Monitored in FY 2004 through BMP Implementation Monitoring Process

Roads	Road Contract/ Timber Sale
3030350-2*, 3030356*, 3030361*, 3030351*, 3030360	Twin Bridges TS; Luck Lake EIS (2000)
9951 (assoc with units 17, 28 ,42 ,44)	Situk Salvage TS; Yakutat Salvage Sale EA (2003)
6235	2004 Mitkof Maintenance Contract
8410000, 8400000	Orion South TS; Sea Level EIS (1999)
8430200*, 8400000*	Mop Point TS; Mop Point/ 91 Knot EA (2001)
8400000*	Shoal Cove Running Plank Replacement
8000000 MP 30.2- 34.21; 8050000 MP 0-1.82; 8060200 MP 0-2.71	Fire Cove Reconstruction
8400000 MP 0-7.6*; 8430100, 8430000 MP 0-3.7; 8444000 MP 0-3.1; 8444600 MP 0-5.5	Licking Creek Reconstruction

*Monitored by IDT and 100% monitoring groups

Soil and Water 3. Roads with Culverts replaced for Fish Passage Improvement and Monitored in FY 2004 through BMP Implementation Monitoring Process

Roads	Road Contract/ Timber Sale
7540 MP 6.827*, 7.267, 7.755, 7.981*, 8.143, 8.184, 8.980, 10.368, 14.008; 7542 MP 0.027*, 0.109*, 0.236, 0.314, 1.887; 7551 MP 0.168; 7624 MP 0.106	Corner Bay Fish Passage Improvement; Construct (2002)
8530 MP1.222, 16.394	Hoonah Fish Pass Improvements

*Monitored by IDT and 100% monitoring groups

Quality Control IDT Monitoring

The IDT monitoring was completed on a sample made up of more than 10 percent of units and stratified sample roads monitored during the 100 percent monitoring effort. This IDT monitoring was conducted as a quality control effort on the 100 percent monitoring as well as an effort to conduct interdisciplinary review of the implementation of the standards and guidelines. Further details on the IDT monitoring can be found in the BMP Monitoring Report and individual trip reports in the appendix.

During the IDT review, a number of units and roads were visited in Fiscal Year 2004 as noted by district below:

Sitka Ranger District: October 5, 2004; Chichagof Island; Corner Bay Fish Passage Improvement Sites; Road 7540 MP 6.827; Road 7540 MP 7.981; Road 7542 MP 0.027; and Road 7542 MP 0.109;

Thorne Bay Ranger District: November 8, 2004; Prince of Wales Island; Twin Bridges Timber Sale; Roads 3030350-2, 3030356, 3030361, 3030351 and Coffman Cove LTF;

Yakutat Ranger District: October 13-14, 2004; Situk Blowdown Salvage Sale; Units 17, 28, 42, 44 and Saw Mill Creek LTF;

Ketchikan Ranger District: September 30, 2004; Revillagio Island; Orion South Timber Sale; Units 113, 141, 143, Road 8410, and Elf Point LTF; and

Ketchikan Ranger District: October 7, 2004; Revillagio Island; Mop Point Timber Sale; Unit 23B and Roads 8430200, 8400000, and Shoal Cove LTF.

Monitoring Results

Evaluation of the BMP monitoring for Fiscal Year 2004 shows that 53 units (49 unit monitoring forms) were in the unit pool, 45 roads/road segments, including 22 culvert replacement sites (noted on 45 road monitoring forms). The IDT monitored 8 units, 9 road construction segments including 4 fish pass improvement culvert replacements (located on 2 roads) and 4 log transfer facilities. The 10% quality control threshold was exceeded through the IDT monitoring in 2004. Of the 1130.4 acres of harvested units, 188.6 acres were monitored by the IDT during the review. Details of the Best Management Practices monitoring reviewed by the Interdisciplinary Teams are included in the IDT trip reports that are included in the appendix.

The monitoring showed that the Tongass National Forest is implementing the Standards and Guidelines for protection of Soil and Water Resources. There were two departures but no corrective actions reported as implemented relative to soil disturbance. The table below illustrates the BMP implementation ratings relative to soil disturbance.

Soil and Water 4. BMPs Implemented: Recorded on Unit and Road Forms

BMPs Applied	Number of Times the BMP was Appropriate for Use	Number of Departures from Full BMP Implementation	Number of Times Corrective Action Implemented
12.7/ 14.5/ 14.8 Measures to Minimize Surface Erosion	82	2	0
12.17 Revegetation of Disturbed Areas	11	0	0
13.5 Identification & Avoidance of Unstable Areas	15	0	0
13.9 Yarding Systems to Protect Soil/ Water Resources	39	0	0
13.10 Landing Location & Design	42	0	0
14.7/ 14.12 Measures to Minimize Mass Failures/ Control of Excavation & Sidecast	72	0	0
14.18 Control Rock Pit Sediment	75	0	0
Totals	**336**	**2**	**0**

Summary details on the departures by BMP are listed in the BMP Summary Report included in the appendix. In order to comply with the standards and guidelines, corrective actions were taken during timber sale administration although most were not significant enough to be noted on the forms. These corrective actions are also described in the individual BMP trip reports.

Review of the departures noted relative to soil disturbance shows that the notation was inappropriately designated and the departure relative to soil disturbance did not apply to the situations at these sites. Two fish improvement construction sites had pump failures during construction where the dewatering pump stopped working for a short period. At these sites, sediment from the construction site was transported downstream from the road crossing. This was noted as a departure from full BMP implementation at both sites for the soil erosion BMP. This departure would have been better noted under the Culvert and Bridge installation BMP.

Evaluation of Results

Generally 10 percent quality control monitoring completed by the IDT showed agreement with the monitoring completed by the sale administrators and engineering representatives. Monitoring showed that Best Management Practices (BMPs) were implemented. The numerical rating system that summarizes BMP use, number of departures, and corrective actions worked sufficiently. This numerical rating served to clarify the split between the ratings and help the group rate the BMP implementation more consistently. The numerical rating system facilitated reflecting on the significance of the departure and the impact on the soil, water, and timber resources.

During the IDT monitoring, the group identified strengths associated with BMP implementation and a few BMPs that need continued emphasis.

Identified strengths of BMP implementation relative to soil disturbance included:

BMP 13.5 Identification and Avoidance of Unstable Areas
BMP 13.9 Yarding Systems to Protect Soil/Water Resources
BMP 13.10 Landing Location and Design

Identified emphasis items relative to soil disturbance included:

BMP 12.17 Revegetation of Disturbed Areas

During the IDT review, there was discussion of the soil disturbance BMP application in units on South Orion timber sales where a small area (5 feet x 10 feet) showed barred soil. The vegetation was scrapped off during yarding and the Sale Administrator directed the contractor to seed the area.

High quality work on the part of the sale administrators and layout crews was noted. Particularly, they worked to limit soil disturbance and achieve the prescribed suspension. The sale administrators deleted over steep areas in the units to limit potential landslide issues particularly in areas where the operator could not achieve the prescribed suspension. The IDT review of the Orion South Timber Sale highlighted an example of these deferrals. In most cases, the over steep areas and areas that show unstable soils were identified prior to the environmental assessment and a soils prescription for the areas was developed. If these units were evaluated today under the 1997 standards and guidelines, many of the unstable areas and over steep slopes would have been deleted. The sale administrators requested review by the soil scientists of the steep areas (>72% slope gradient) that showed instability. The sale administrators worked with the Timber Management Assistant to implement deferral of the steep portions of the units for helicopter harvest.

Action Plan

Examining trends in the BMP implementation, less emphasis items and discussion topics related to soil disturbance were noted this year. This can be attributed to the specific harvest of units monitored and the fact that many of the units were helicopter logged. New emphasis has been placed in recent years on deleting areas of potential instability from the units and helicopter yarding the steep areas.

General recommendations on the BMP monitoring process include moving toward a smaller sample set for monitoring. The selection should be based upon random selection and monitoring conducted by an IDT. The district soil scientists need to continue to be involved with the prescription of suspension and harvest limitations in the units relative to defining unstable slopes. The district specialists should continue to work with the layout and sale administrators on implementation of the Best Management Practices on a routine basis.

Emphasis needs to be placed on removing over steep sections and areas that indicate unstable soils from the units during initial planning, and layout phases. Emphasis on training people as to the BMPs and the actual reference for the BMPs and form guidelines is necessary. The importance of a strong understating of the BMPs and the mechanism for tracking implementation is necessary to continue integrity in the monitoring program as well as for implementation of the Standards and Guidelines that protect soil and water resources.

Soil and Water Question 2: Are the standards and guidelines effective in meeting Alaska Regional Soil Quality Standards?

Soil and water effectiveness monitoring is completed through monitoring the soil quality standards as described in Forest Service Manual 2554, and is addressed in two parts: 1) Soil Disturbance, and 2) Landslide frequency.

Soil Disturbance

The effectiveness of Forest Plan Standards and Guidelines and BMPs in preventing excessive soil disturbance due to timber harvest activities has been monitored on the Tongass National Forest since the Regional Soil Quality Standards were established in 1992. A statistical review of two sets of this data taken on Prince of Wales Island was completed in 1999, and was summarized in the Year 2000 Forest Plan Monitoring Report.

Status

The data collected on Prince of Wales Island is in general agreement with similar data collected on the Wrangell and Petersburg Ranger Districts. It clearly indicates that all timber harvest units, including cable, helicopter and shovel yarding systems, are within the established standard of less than 15 percent detrimental soil disturbance.

The forest plans to collect soil quality monitoring data on the northern portion of the forest, specifically the Yakutat area and if possible, portions of the Sitka Ranger District.

Landslide Inventory

The objective of this inventory effort is to provide a database that will assist in determining the extent of landslides on the Tongass. The inventory will assist forest managers in the identification and management of potentially unstable slopes.

Status

A forest-wide inventory to identify, delineate, and digitize all landslides was initiated in 2001. Landslides are being digitized as an independent layer in GIS. In 2004, landslide inventory was conducted on additional areas, typically coincident with timber sale EIS project areas. Currently, approximately 2.9 million acres of landslide inventory have been completed on the Ketchikan, Petersburg, Sitka and Wrangell Ranger Districts.

Progress on the Landslide Inventory is typically about 600,000 acres per year and is constrained by soil scientists available to do the work. If all Wilderness and National Monument Land Use Designations are excluded, there are approximately 10.9 million acres of Tongass National Forest lands to map. There are approximately 8 million acres of forest left to inventory.

Soil and Water Question 3: Are Best Management Practices being implemented?

The Best Management Practices (BMPs) were monitored on the Tongass National Forest, using guidelines described in the Tongass Monitoring Strategy. The strategy was developed to provide direction for Forest Plan implementation monitoring. An interagency team of representatives from the Forest Service and Alaska Department of Environmental Conservation selected specific BMPs to be monitored, based upon potential risk factors to soil and water resources. Members of the Monitoring and Evaluation Group (IMEG) then reviewed their selection. The BMPs evaluated are included in the Soil and Water Conservation Handbook (Forest Service Handbook 2509.22, October 1996). Soil and water effectiveness monitoring is completed through monitoring the soil quality standards as described in Forest Service Manual 2554, and is summarized in this report.

The BMP implementation monitoring included two distinct efforts: (1) 100 percent monitoring of the units closed out and roads completed, and (2) interdisciplinary team (IDT) monitoring. These monitoring efforts are briefly described in Soil and Water Question 1 and described in more detail in the Tongass Best Management Monitoring Report in the appendix.

BMPs Monitored and Reported

BMP 12.5 Wetlands Protection Measures
BMP 12.6/ 12.6a Riparian Area Designation & Protection/Buffer Zone Design and Layout
BMP 12.7/ 14.5/14.8 Measures to Minimize Surface Erosion
BMP 12.8/ 12.9 Oil Pollution Control Measures
BMP 12.17 Revegetation of Disturbed Areas
BMP 13.5 Identification and Avoidance of Unstable Areas
BMP 13.9 Yarding Systems to Protect Soil/ Water Resources
BMP 13.10 Landing Location and Design
BMP 13.11/ 13.14/ 14.5 Erosion Control Measures for Units & Temporary Roads
BMP 13.16 Stream Channel Protection
BMP 14.6 Timing Restrictions for Construction Activities/ Fisheries Prescription
BMP 14.7/14.12 Measures to Minimize Mass Failures/ Control of Excavation & Sidecast
BMP 14.9 Drainage Control Structures to Minimize Erosion & Sedimentation
BMP 14.14/ 14.17 Design & Installation of Bridges and Culverts
BMP 14.15 Diversion of Flows Around Construction Sites
BMP 14.18 Control Rock Pit Sediment
BMP 14.20/ 14.22 Road Maintenance Access Management
BMP 14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan

Monitoring Overview

The monitoring overview section for Soil & Water Question 1 should be referenced for a description of the units and roads monitored. This overview also provides details on the units and roads monitored during the quality control IDT process. Additional information describing the IDT monitoring is included in the appendix in the individual BMP trip reports.

Monitoring Results

Evaluation of the BMP monitoring for Fiscal Year 2004 shows that 53 units (49 unit monitoring forms) were in the unit pool, 45 roads/ road segments, including 22 culvert replacement sites (noted on 45 road monitoring) forms. The IDT monitored 8 units, 9 road construction segments including 4 fish pass improvement culvert replacements (located on 2 roads) and 4 log transfer facilities. The 10% quality control threshold was exceeded through the IDT monitoring in 2004. Of the 1130.4 acres of harvested units; 188.6 acres were monitored by the IDT during the review.

The monitoring showed that the Tongass National Forest is implementing the Standards and Guidelines for protection of Soil and Water Resources in most cases. There were only a few departures from full implementation that were noted involving fish passage culvert inspection and design, minor oil leaks, unit design where streams were not located properly and unit layout changes were required as well as seeding of road corridors and road cuts adjacent to units. In the cases involving unit layout, corrective actions to modify the unit configuration were implemented during unit layout and sale administration. Some corrective actions were carried out during public works construction of fish passage culverts to mitigate sediment transport and clean up leaking equipment. In a number of the situations involving sites where seeding was not completed during the seeding window, direction to comply with the seeding were conveyed. Action plans were developed to fully implement the BMPs, although seeding at some of these sites had not been completed.

The number of times corrective actions were implemented is summarized in the table below as well as departures from full BMP implementation. Corrective actions are actions completed to mitigate situations that occur during implementation. In some cases, corrective action was taken so that the BMP was fully implemented before the unit or road was approved by either the sale administrator or contracting officers representative. Some of the corrective actions were emphasis notes relative to BMP implementation but action activity is not warranted. In a few cases, the monitoring resulted in action plans being drawn up to complete additional work so the BMPs would be fully implemented. Some monitoring showed departures from full BMP implementation due to misinterpretation of the protocol and guidelines for filling out the BMP forms.

Soil and Water 5. Summary of BMP Implementation Monitoring for Harvest Units, Roads Constructed/ Reconstructed, Road Segments with Culverts Reconstructed for Fish Passage Improvement

BMPs Applied	Number of Times BMP was Appropriate for Use	Number of Times Corrective Action Noted & Implementation Initiated	Number of Times Departure from full BMP Implementation Noted
12.5 Wetlands Protection Measures	47	0	1
12.6/ 12.6a Riparian Area Designation & Protection/ Buffer Zone Design and Layout	29	1	1
12.8/ 12.9 Oil Pollution Control Measures	82	2	1
12.17 Revegetation of Disturbed Areas	15	0	0
13.5 Identification and Avoidance of Unstable Areas	16	0	0
13.9 Yarding Systems to Protect Soil/ Water Resources	41	0	0
13.10 Landing Location and Design	43	0	0
13.11/ 13.14/ 14.5 Erosion Control Measures for Units & Temporary Roads	22	0	0
13.16 Stream Channel Protection	39	0	1
12.7/ 14.5/ 14.8 Measures to Minimize Surface Erosion	35	0	2
14.6 Timing Restrictions for Construction Activities/ Fisheries Prescription	20	0	0
14.7/ 14.12 Measures to Minimize Mass Failures/ Control of Excavation & Sidecast	26	0	0
14.9 Drainage Control Structures to Minimize Erosion & Sedimentation	39	0	1
14.14/ 14.17 Design & Installation of Bridges and Culverts	29	3	5
14.15 Diversion of Flows Around Construction Sites	15	0	1
14.18 Control Rock Pit Sediment	29	0	0
14.20/ 14.22 Road Maintenance Access Management	31	0	1
14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan	49	1	1
	607	7	11

Corrective Action Summary

Comparison of the data that is summarized in the previous tables shows that corrective actions were taken relative to the following BMPs:

12.5 Wetland Protection Measures,
12.6/ 12.6a Riparian Area Designation & Protection/ Buffer Zone Design and Layout, 12.8/ 12.9 Oil Pollution Control Measures,
13.9 Yarding Systems to Protect Soil/ Water Resources,
13.16 Stream Channel Protection,
12.7/ 14.5/ 14.8 Measures to Minimize Surface Erosion,
14.14/ 14.17 Design & Installation of Bridges and Culverts,
14.20/ 14.22 Road Maintenance Access Management, and
14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan.

Details outlining some of the corrective actions are summarized in the Tongass BMP Report and IDT trip reports included in the appendix.

The corrective actions included:

- modifying the unit configuration and boundaries to minimize impact to wetlands,
- identification and prescription of protection measures on streams during unit harvest,
- clean up of a minor equipment leaks and oil spills,
- additional seeding prescribed and implemented in a few cases prior to the end of the seeding window,
- modification of designs to provide water flow and improve fish passage in adapting the office plans to the field sites,
- use of mitigation measures to minimize sediment transport and attenuate suspended sediment in stream courses, and
- grading of log transfer facilities (LTF) surfaces and maintenance of settling ponds to minimize sediment transport.

Departure from Full BMP Implementation Summary

In FY 2004, the corrective actions contributed to the BMP implementation in most cases so there were some departures from full implementation noted. Departures from full BMP implementation occurred on 11 events in 6 roads, 1 LTF, 4 harvest units that are associated with two timber sales and one fish passage culvert replacement contract. The best management practices that showed the departures follow:

BMP 12.5 Wetland Protection Measures,
BMP 12.6/ 12.6a Riparian Area Designation & Protection/Buffer Zone Design and Layout,
BMP 12.8/ 12.9 Oil Pollution Protection Measures,
BMP 13.16 Stream Channel Protection,
BMP 12.7/ 14.5/ 14.8 Measures to Minimize Surface Erosion,
BMP 14.14/ 14.17 Design and Installation of Bridges and Culverts,
BMP 14.20/ 14.22 Road Maintenance Access Management, and

BMP 14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan.

The departures noted relative to wetlands protection, riparian area designation/buffer zone design and layout as well as stream channel protection occurred on the Summore Change Timber Sale. On this sale, unit design showed harvest proposed on muskeg and numerous streams were not designated. The sale administrator worked with the resource specialists to modify the unit configuration to drop the acreage in the muskegs, develop stream prescriptions and implement stream buffers and other protection measures.

Departure relative to oil pollution measures was noted relative to a fish passage replacement site on the Corner Bay Fish Passage Improvement Contract where oil was spilled due to equipment failure. Working with the Forest hazardous materials team, the site was cleaned up and the contaminated materials hauled off site and disposed in an approved facility.

Numerous departures were noted relative to the design and installation of culverts on the Corner Bay Fish Passage Improvement Contract. At some of the sites, the culverts designed for the crossings were short relative to the road width so the rip rap along the slope to the creek was stacked near vertical. The modified installations will have higher maintenance needs but will provide fish passage and transport water as long as the structures are maintained. This contract utilized contractor inspection which contributed to a departure rating since the COR was not present and turbidity measurements were not completed. The contract required only quality control inspection of a representative number of the sites and mitigation to provide water quality in accord with State water quality standards.

Two fish improvement construction sites had pump failures during construction where the dewatering pump stopped working for a short period. At these sites, sediment from the construction site was transported downstream from the road crossing. This was noted as a departure from full BMP implementation at both sites for the soil erosion BMP. This departure would have been better noted under the Culvert and Bridge installation BMP.

The road maintenance and access management departure was noted due to the contractor leaving the roads on the Orion South Timber sale without seeding the road cuts. The sale administrator and contracting officer has written the operator notices of noncompliance on seeding associated with this sale. The Forest is continuing to pursue contract action to direct the contractor to complete the seeding.

The LTF surface erosion control plan, storm water pollution prevention departure was noted in relation to the Summore Change Timber Sale where the operator had a hydraulic leak and an oil spill at the LTF facility. The sale administrator notified the operator that clean up of the spill was required and the operator cleaned up the contaminated soil material. The contaminated material was disposed in an approved facility.

Corrective actions mitigated the incidents in some of the situations that were designated as departures, so in some cases the overall outcome contributed to no net loss of implementation of the Standards and Guidelines.

Evaluation of Results

Generally, 10 percent quality control monitoring completed by the IDT was in agreement with the monitoring completed by the sale administrator and engineering representative, and showed that the BMPs were being implemented. The variation occurred in differences of degree of BMP implementation. Evaluation of these ratings shows the sale administrators and contracting officer's representatives were more stringent in their ratings than the IDT and more precise in measuring stream lengths/buffers. There were some inconsistencies in interpretation of how to apply the guidelines and the specific BMPs that the forms were referencing.

During IDT monitoring, the group identified strengths associated with BMP implementation and a few BMPs that need continued emphasis. Identified strengths of BMP implementation included: riparian area designation and implementation of buffers, stream channel protection, identification and avoidance of unstable areas, yarding systems to protect soil and water resources, landing locations and design, timing restrictions for construction activities/fisheries prescription, design and installation of culverts, erosion control measures and plans, oil pollution control measures, and LTF surface erosion control/storm water pollution prevention.

In the harvest units, continued emphasis is focused on consistent identification of streams and prescription/implementation of protective measures (buffers) as well as avoidance of unstable areas and associated mitigation covering bared soil with vegetative debris and seeding. Emphasis is also being placed on BMPs specific to seeding of roads, and cross drain function. Additional details on the emphasis items that contributed to departures can be found in the appendix in the BMP report.

During completion of the roads, continued emphasis is being placed on rock pit sediment control and development, seeding soil exposed in road cuts, providing required fish passage at culvert sites, and development of the settlement ponds and ditches to minimize transport of sediment at LTF structures.

Focus on the design of the culverts/bridges specific to the site will be emphasized on sites where structures are being replaced or removed. At these sites, detailed survey and investigation should focus on maintaining the original stream course as well as providing fish passage. The structures and sites should be surveyed after construction completion and the initial high flows to ensure fish passage is provided. Particular focus should be placed on monitoring stream turbidity for compliance with State Water Quality Regulations. At the culvert replacement sites, inspection notes, monitoring, and implemented mitigation measures ensure water quality and response to equipment failures when necessary. Inspection of equipment prior to work daily for equipment leaks and maintenance needs is suggested.

Overall, the sale administrators and engineering representatives demonstrated diligence in implementing appropriate protection of the stream courses, as well as prescribed suspension, effective culvert/water bar installation, and limiting sediment transport. The terrain in some of these units was excessively steep, requiring extensive efforts on the part of the sale administrators to implement the BMPs. The sale administrators worked carefully to identify streams missed during the environmental assessments and during layout, and implemented the appropriate stream protection measures.

There were numerous cases where the IDT identified strengths and a few cases of concerns. Brief overview of the situations that related to departures from full BMP implementation is included in the BMP report in the appendix.

The IDT identified strengths associated with the following BMPS:

BMP 12.5 Wetlands Protection Measures
BMP 12.6/ 12.6a Riparian Area Designation & Protection/ Buffer Zone Design and Layout
BMP 12.7/ 14.5/14.8 Measures to Minimize Surface Erosion
BMP 12.8/ 12.9 Oil Pollution Control Measures
BMP 13.5 Identification and Avoidance of Unstable Areas
BMP 13.9 Yarding Systems to Protect Soil/ Water Resources
BMP 13.10 Landing Location and Design
BMP 13.16 Stream Channel Protection
BMP 14.6 Timing Restrictions for Construction Activities/ Fisheries Prescription
BMP 14.14/ 14.17 Design & Installation of Bridges and Culverts
BMP 14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan

Emphasis items were associated with the following BMPs:

BMP 12.6/ 12.6a Riparian Area Designation & Protection/ Buffer Zone Design and Layout
BMP 12.7/ 14.5/14.8 Measures to Minimize Surface Erosion
BMP 12.17 Revegetation of Disturbed Areas
BMP 13.11/ 13.14/ 14.5 Erosion Control Measures for Units & Temporary Roads
BMP 13.16 Stream Channel Protection
BMP 14.14/ 14.17 Design & Installation of Bridges and Culverts
BMP 14.26/ 14.27 LTF Surface Erosion Control Plan, Storm Water Pollution Prevention Plan

Summary

The results show that the Tongass has successfully implemented the Best Management Practices and is continuing to improve on implementing the BMPs as well as documenting the BMP monitoring. Specific details on the situations that were associated with the departures as well as corrective actions taken in response to efforts to implement the BMPs are detailed in the BMP Summary Report included in the appendix.

Overall, the monitoring showed that the Tongass National Forest is implementing the Best Management Practices successfully. There was general agreement between the 100 percent monitoring effort and the IDT monitoring effort. There were eleven departures from full BMP implementation noted. These departures involved isolated instances of site related problems. The departures also indicated there is a lack of understanding on what constitutes a departure and the difference between a corrective action and a departure rating.

Generally, the sale administrators and engineering representatives have a strong understanding of the Best Management Practices (BMPs) and work to implement these BMPs on the ground. The sale administrators, engineering representatives, and contracting officer's representatives have responsibilities for implementation of many of the BMPs through the

contract administration. Through the hard work and diligent efforts of the sale administrators, engineering representatives and contracting officer's representatives, the BMPs are implemented on the ground.

Action Plans

The IDT monitoring of the Tongass this year shows that the sale administrators, engineering representatives, and contracting officer's representatives are consistently implementing these BMPs fully and monitoring the same criteria as the IDT. This is a trend that has continued to generally improve over the past five years; however, showed a downturn this year. The departures noted this year identify some focal points for Fiscal Year 2005. Examining the IDT review relative to the departures and emphasis items, evaluation of the data shows that review of a subset of the data could be used to identify if BMP implementation was occurring.

Particular action plans have been developed to improve consistency of stream identification and prescription relative to riparian streams as well as water quality streams. A lecture and field training program were conducted across the Tongass to promote consistency in stream classification. Continual emphasis on review of any questionable stream prescriptions and locations should be a focal point of the layout crews.

Field participation by the district soil scientists, hydrologists, and fish biologists throughout the environmental assessment and layout is necessary. Emphasis on detailed field review of contract developed environmental assessment as well as layout is necessary. Numerous of the discrepancies between the environmental documents, layout and timber that could be harvested with maintaining BMP implementation was related to errors or oversights in the contract work.

The IDT recommends focusing on emphasis items rather than the specific rating for the BMP. The group feels that this trip should be a communication opportunity to discuss interpretation of implementation of the BMPs. The group does not feel that it is significant to focus on the specific ratings. The orientation of the group is toward interpretation and implementation rather than a rigorous inspection of detail. Follow through on a feedback system has been initiated to get information from monitoring back to the planning, design, layout, and contract preparation groups.

Specific action is recommended to develop specific monitoring forms for the culvert installation sites and the road decommissioning. A pilot form for road decommissioning/closure has been developed. Further review of this form and development to cover road obliteration and trench roads is underway. The road decommissioning/closures have not been routinely monitored for BMP implementation. Inclusion of road closure sites on the IDT monitoring is recommended.

Turbidity Compliance Monitoring

Background

The Clean Water Act establishes regulatory authority for water quality within the Environmental Protection Agency (EPA) and Alaska Department of Environmental Conservation (ADEC). ADEC has established numeric criteria for water quality as Water Quality Standards (ADEC, 1999). The Forest Service must apply Best Management Practices that are consistent with the Alaska Forest Resources and Practices Regulations to achieve Alaska Water Quality Standards. The site-specific application of BMPs, with a monitoring and feedback mechanism, is the approved strategy for controlling nonpoint source pollution as defined by Alaska's Nonpoint Source Pollution Strategy (ADEC, 2000).

Monitoring Context

Stream turbidity monitoring during road construction activity is a simple, low-cost observation of a water quality standard that responds to routine BMP implementation monitoring outlined in the USDA Forest Service Memorandum of Agreement with the Alaska Department of Environmental Conservation (1992). Turbidity is specifically referenced as an erosion control measure in BMP 14.5 Road and Trail Erosion Control Plan which was developed as an administrative and preventative practice. The objective of turbidity sampling is to determine if the erosion control measures are achieving State water quality criteria for turbidity. If turbidity exceeds water quality criteria, corrective action(s) are taken. If turbidity continues to exceed water quality criteria despite corrective actions, the Alaska Department of Environmental Conservation is consulted.

The waters within the Tongass National Forest are classified for multiple beneficial uses (water supply, water recreation, and growth and propagation of fish, shellfish, and other aquatic life and wildlife (Alaska Water Quality Standards 18 AAC 70.020,1999 as amended, 2002). If water bodies are protected for more than one use class, the most stringent water quality criteria for all included use classes apply. The most stringent criteria for turbidity is that samples,

> *"…may not exceed 5 NTU (nephelometric turbidity units) above natural conditions when the background turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU." (AK Water Quality Standards (WQS) Tables, 2004)*

Actual uses for these affected waterways are related to the growth and propagation of fisheries (Alaska Water Quality Standards 18 AAC 70.020(c), Table A, as amended, 2002), therefore a second criteria for turbidity important to the forest management is that samples,

> *"…may not exceed 25 NTU above natural conditions. For all lake waters, may not exceed 5 NTU above natural conditions."*

Monitoring Methods

Turbidity protocols require sampling before construction, within 48 hours of the beginning of construction, and subsequent sampling as necessary. Grab samples and a portable turbidity meter were used in all cases. Some sites received pre-sampling background data gathering and some received post-impact sampling for several days after construction was completed.

Turbidity measured upstream of the drainage structure site was assumed to reflect natural or background conditions for evaluating the achievement of water quality criteria downstream of the drainage structure where construction has occurred. The difference in the paired upstream and downstream data is evaluated against the State water quality criteria standard that compares the disturbed site data against the natural conditions. By collecting both upstream and downstream data in the same period, natural variations in the turbidity due to precipitation, stream flow and upstream events are negated.

Site conditions play a substantial role in determining the nature of the turbidity readings. Stream discharge varies depending upon the bed load deposits, channel shape, stream size, and drainage area. For example, smaller streams sampled below road crossings that are located within alluvial areas are very dynamic and change rapidly.

Turbidity is measured in nephelometric turbidity units (NTUs). Turbidity increases occur in response to natural channel processes as well as forest management activities. Spikes in turbidity levels may be due in part to increased precipitation, level of flow, changes in watershed conditions or construction/ timber harvest. Measuring changes in turbidity with grab samples only reflects the conditions of the stream at the time the sample was collected and does not provide the data necessary to predict longitudinal change.

Monitoring Results

Twelve new or replaced drainage structures were monitored in FY 2004 per criteria for turbidity monitoring protocol (*Tongass National Forest Turbidity Monitoring Protocols, as revised, 2004*). These structures were identified in the road condition survey process and prioritized for replacement. The construction and replacement of culverts to improve fish passage frequently involves multiple phase construction of structures designed to provide fish passage. Diversion of water flow or “dewatering” from the immediate zone of construction, through cofferdams and diversion pipes is typically required. The stream gradients are then constructed specifically to provide fish passage. The stream banks are reconstructed to near their original contours.

The twelve locations monitored in FY 2004 included 39 episodes for turbidity after construction started. One site showed a restart of construction work. Consultations with ADEC occurred at each site where turbidity levels were elevated and no violations of the State Water Quality standards were issued. Ten of the twelve sites met State water quality criteria for drinking water within 48 hours of initial construction start time and eleven of the twelve sites met the criteria for propagation and growth of fish within the 48 hour criteria. In each of the cases where the water criterion was interpreted to not exceed, the data shows that the water had cleared within 48 hours of construction initiation or restart. The data shows that the water quality returned to less than 5 NTUs in most cases shortly after construction completion. Specific data summary and results are included in the appendix.

Turbidity Summary of Results for 2004 tables by geographic area:

- Chichagof Island: 6 sites monitored (1 site had restarts); 2 sites showed no samples exceeded 5 NTU at any point, 2 sites showed incidental periods of exceedances of 5 NTU, 2 sites monitored indicated the water quality may have exceeded the 5 NTU criteria, 1 site showed incidental period of exceedances over 25 NTUs
- Revillagigedo Island: 4 sites monitored; no exceedances reported
- Mitkof Island: 2 sites monitored; no exceedances reported

Evaluation of Results

Turbidity data reported in FY 2004 demonstrates compliance with State water quality criteria. Compliance was achieved in a period less than 48 hours after construction was initiated to over 100 hours after construction was completed.

Turbidity exceedances were determined by the difference between the averages from the upstream and downstream sample sites. Four sites had instances where NTUs exceeding 5 NTUs but below 25 NTUs were recorded; of these four only two may have showed elevated levels for a period of over 48 hours. One site showed exceedances over 25 NTUs but the turbidity level at this site lasted less than 5 hours and decreased below the 5 NTU level within 48 hours. At both sites that showed longer periods of higher turbidity levels, there were problems with the pumps used to divert water from the site. Notices of non-compliance were issued to the contractor and mitigation measures were taken to limit the transport of sediment to the streams.

Conclusion:

- There were no violations of state water quality standards for turbidity issued by the State. The Forest responded to temporary exceedances with corrective actions and consultation with ADEC according to our MOA.
- The Forest will continue dialogue with ADEC and EPA on the application of numeric turbidity criteria and appropriate corrective actions and monitoring protocols.
- Conclusive evaluation on whether we aversely affected the growth and propagation of fish or contributed to any long term effect is not possible from the current grab sample monitoring.

Action Plans

Continued turbidity monitoring for compliance with the BMP 14.5 requiring erosion Plans for construction activities is recommended. We can use the grab sample turbidity monitoring to indicate compliance with the State Water Quality Standards. Continued emphasis is necessary to follow the protocol in collecting up stream and down stream samples is necessary. Focus on collecting samples that show recovery of the site following construction end is imperative. Additional training and focus on inspection and monitoring of the fish passage improvement sites is recommended.

The elevated turbidity levels documented at numerous sites typically recovered to background levels within 48 hours. At the sites where this did not occur, additional mitigation was applied to decrease the turbidity levels. Explanation for why elevated turbidity occurred relates to the pumping of water to dewater the sites and the size of the backfill materials. Recommendations

follow to tighten the contract provisions for the specification of backfill and application of mitigation measures in response to the compliance turbidity monitoring. As mentioned above, dialogue with ADEC and EPA on the application of numeric turbidity criteria and appropriate corrective actions and monitoring protocols will continue.

Soil and Water Question 4: Are Best Management Practices effective in meeting water quality standards?

Goal: Maintain and restore the biological, physical, and chemical integrity of Tongass National Forest waters.

Objective: Attain State of Alaska water quality standards forest-wide.

Background: The Clean Water Act establishes regulatory authority for water quality within the Environmental Protection Agency (EPA) and Alaska Department of Environmental Conservation (ADEC). ADEC has established numeric criteria for water quality as Water Quality Standards (ADEC 2003). The Forest Service must apply Best Management Practices that are consistent with the Alaska Forest Resources and Practices Regulations to achieve Alaska Water Quality Standards. The site-specific application of BMPs, *with a monitoring and feedback mechanism*, is the approved strategy for controlling nonpoint source pollution as defined by Alaska's Nonpoint Source Pollution Strategy (ADEC 2000).

Attainment of state water quality standards is a specific Forest Plan objective driving the Aquatic Synthesis. Continuous water quality and stream stage (water depth) instruments have been installed in a set of three case study watersheds (Thompson 2004) to monitor stream turbidity and temperature as Forest Plan implementation proceeds.

Monitoring Results and Evaluation

We are within a calibration period for evaluating reference water quality in the case study watersheds. Results and evaluation presented in this report should be considered provisional and subject to revision as additional data are collected and analyzed.

Turbidity

Continuous stream turbidity monitoring before, during, and after new road construction in Upper Shaheen Creek in 2004 provides some preliminary results with respect to BMP effectiveness (Thompson 2005). The complete report is included in the appendices. The monitoring objectives were to compare turbidity up and downstream of the road and to evaluate the attainment of Alaska Water Quality Standards for turbidity at the watershed scale. No drinking water use occurs in Shaheen Creek. However, data are compared to the most stringent criteria applicable in accordance with Alaska Water Quality Standards. For turbidity this is drinking water:

> *"Turbidity may not exceed 5 nephelometric turbidity units (NTU) above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU."* (ADEC 2003)

The location and design of Road 2050000 (especially the use of bridges for most stream crossings) through Upper Shaheen—and dry weather during construction-- provided ideal

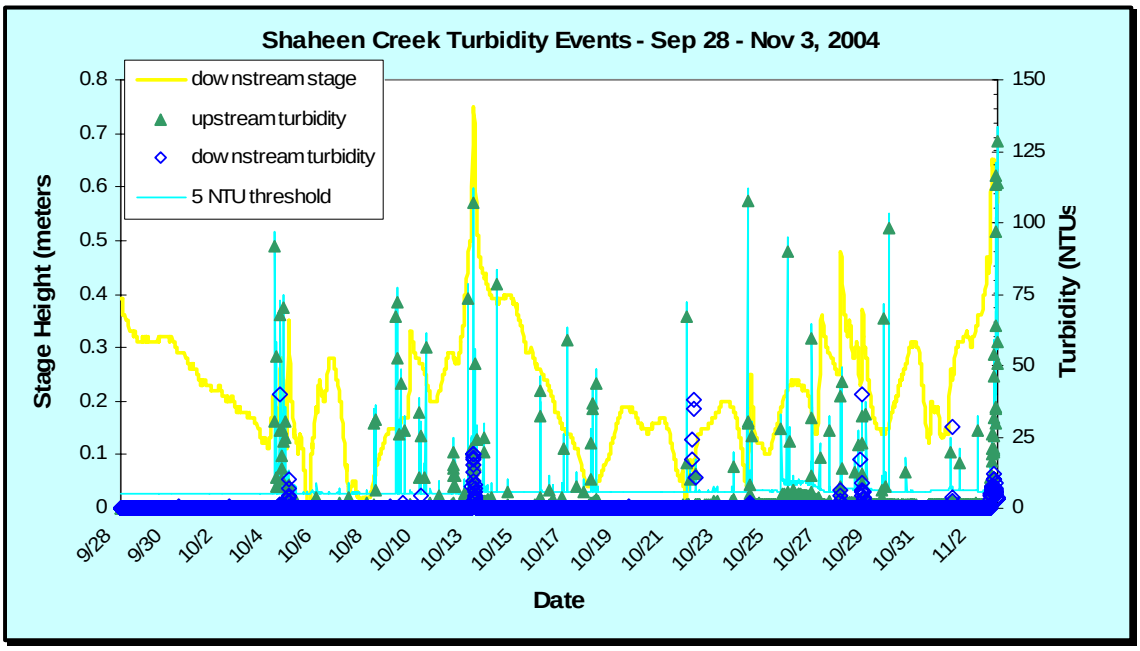
conditions for minimal water quality impacts. Road construction began on July 13 and was substantially complete within the watershed by July 27.

Photo: Upper Shaheen Mainstem Bridge, Road 2050000, shortly after installation.

Provisional data indicate that baseline turbidity in Upper Shaheen Creek is usually at or near 0 NTU between storms. Events of elevated turbidity occurred both upstream and downstream of the road during storms, and also for brief intervals that were not clearly associated with storms.

Loss of some data from the turbidity instrument upstream of the road limits our interpretation of “natural” turbidity with respect to the numeric criteria of the Alaska Water Quality Standards. For the 50 days with comparable upstream and downstream data, eleven downstream records exceeded 5 NTU over natural (upstream). Nine of the records represent isolated spikes of fifteen minutes or less. Two are contiguous records implying a total duration of up to thirty minutes. Figure Soil and Water-1 displays the period of matching up and downstream data post-road construction. This also corresponds to the stormiest weather of the season. The upstream instrument recorded more elevated turbidity readings than the downstream instrument. Additional data will bolster these comparisons.

Figure Soil and Water -1. Shaheen Creek Turbidity Events- Sep 28- Nov. 3, 2004



Events exceeding 5 NTU over natural downstream of the road were temporary and short term for the period during and up to three months after road construction. These data, coupled with observations of appropriate BMP implementation on site, provide assurance of compliance with Alaska Water Quality Standards for turbidity in Upper Shaheen Creek. Additional data will be collected to evaluate turbidity during timber hauling and, eventually, road storage activities.

Stream Temperature

The most stringent state water quality criteria for stream temperature are as follows: for aquatic life, stream temperatures:

> *"…may not exceed 20° C [68°F] at any time. The following maximum temperatures may not be exceeded, where applicable:*
>
> *Migration routes 15° C [59°F]*
> *Spawning areas 13° C [55°F]*
> *Rearing areas 15° C [59°F]*
> *Egg & fry incubation 13° C [55°F]*
>
> *For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms."* (ADEC 2003)

An analysis of legacy stream temperature data collected on Prince of Wales Island was completed in 2004 (Walters 2004). Because instruments were placed in deep pools, data were compared to the rearing area criteria (59°F). Continuous data were collected for various timeframes from 1997 to 2002. State water quality criteria for stream temperature were exceeded during warm weather in both harvested and unharvested watersheds. Linear

regression failed to identify any predictive relationships between harvest levels (watershed or riparian) and cumulative days of temperature exceeding 59°F, which ranged from five days to 165 days over the variable periods of record.

In the case study watersheds, stream temperature instruments were installed by late July 2004. The monitoring objectives are to determine baseline characteristics of stream temperature near the mouth of each case study watershed (Thompson 2004). Dry and warm weather prevailed throughout the summer of 2004 in Southeast Alaska. May through August is generally the period when streams are most likely to experience maximum temperatures. Total precipitation falling in Ketchikan during these months in 2004 was 57% of normal; in Yakutat precipitation was 44% of normal for the same period (NOAA NWS 2005, WRCC 2005). The Tongass National Forest experienced many sunny, rainless days and extended low stream flow.

All instrument sites can be described as spawning or rearing areas, so we have applied the most stringent state water quality criteria (55°F) to these data. In 2004, these criteria were exceeded in all three case study watersheds (Figure Soil and Water-2). For comparison, Figure Soil and Water-2 also displays stream temperature exceedances observed in the much larger watersheds of Staney Creek on Prince of Wales Island and Situk River near Yakutat for the same period as the data record for the case study watersheds (USGS 2005).

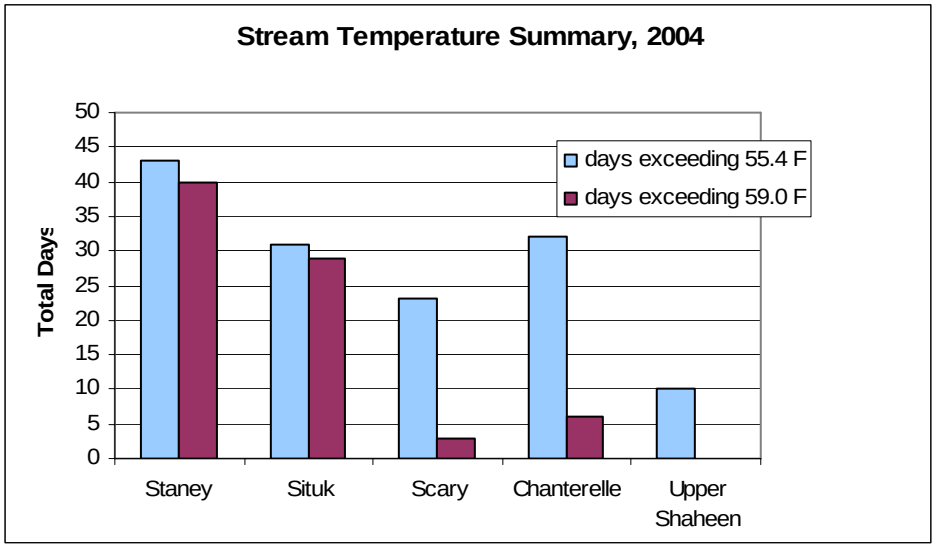


Figure Soil and Water-2. Cumulative days of stream temperature water quality criteria exceedances from selected watersheds, Tongass National Forest, July 21 through September 1, 2004.

Soil and Water 6. Summarizes watershed information relevant to Figure Soil and Water-2

Watershed	Basin Size (acres)	Percent Basin Harvest	Percent Riparian Harvest	Maximum Stream Temperature Jul 21 – Sep 1, 2004
Staney	31,415	43	35	74.3°F
Situk	23,040	16	<10	68°F
Scary	1300	25	<10	60°F
Chanterelle	1000	0	0	61°F
Upper Shaheen	1100	0	0	58°F

High stream temperatures in Southeast Alaska are likely to occur during warm, rainless weather and resulting low stream flow periods regardless of watershed harvest levels or extent of past riparian harvest. This confirms the importance of current riparian management practices of the Forest Plan. Shade provided by intact riparian forest moderates the effects of climate on stream temperature.

Fish kills were reported in Staney Creek and other streams on Prince of Wales Island in 2004. These fish kills corresponded with low rainfall, low stream flow, high air temperature, and large pink salmon returns, similar to past fish kills (Martin 2003). No fish kills were observed in the Situk River (Gillikin, personal communication), or the case study watersheds in 2004.

Macroinvertebrates

The Forest Plan's Monitoring Plan suggests the use of stream-dwelling macroinvertebrates to evaluate water quality effects of forest management activities. The Environment & Natural Resources Institute (ENRI) initiated a water quality assessment of Southeast Alaska watersheds using macroinvertebrates in 2002 (Rinella et al 2003). The Alaska Department of Environmental Conservation funds this multi-year project with a grant provided by the Environmental Protection Agency. The Tongass National Forest is a partner, providing suggestions for sampling sites, logistical support and review of progress reports.

ENRI concluded their fieldwork in 2004. One hundred and twenty-seven stream reaches have been sampled in Southeast Alaska, including the case study watersheds and many other streams within the Tongass National Forest. This pilot effort will set the stage for determining whether macroinvertebrates will be used as water quality monitoring indicators in the Tongass National Forest. A final report is anticipated in 2005.

Actions Recommended for 2005

We recommend no corrective actions to Forest Plan Standards and Guidelines for attaining State of Alaska water quality standards in the Tongass National Forest at this time. It is reasonable to continue focusing on BMP implementation and effectiveness monitoring, including the feedback mechanism, to meet the USFS responsibilities outlined in the 1992 Memorandum of Agreement between ADEC and the USFS, Alaska Region.

The following specific actions are recommended for 2005:

1. Engineering personnel will continue grab sample compliance monitoring as described in *Turbidity Protocols and Sampling Procedures* (Seitz Warmuth 2003). We will seek the advice

of ADEC and EPA on the appropriate application and reporting of numeric turbidity criteria in this context.

2. Hydrology personnel will continue collection and analysis of continuous turbidity and stream temperature data in case study watersheds as described in the *Aquatic Monitoring Synthesis Study Plan* (Thompson 2004).

3. Hydrology personnel will draft a study plan for continuous turbidity monitoring during culvert installation at up to two sites. Study plan will be reviewed by IMEG in 2005 in preparation for implementation in 2006.

3. Continue partnership with ENRI's water quality assessment of Southeast Alaska watersheds.

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