Fish Habitat

Goal: Maintain or restore the natural range and frequency of aquatic habitat conditions on the Tongass National Forest to maintain the abundance and diversity of resident and anadromous fish.

Objective: Determine if our best management practices (BMPs) and 1997 Tongass Land and Resource Management Plan (Forest Plan) Standards and Guidelines have been implemented and if they are effective in protecting fish habitat and fish populations. Monitor key stream channel characteristics and representative fish populations to determine if trends attributable to forest management are evident.

Background: Fish and aquatic resources on the Tongass National Forest provide major subsistence, commercial, and sport fisheries. Abundant rainfall and watersheds with high stream densities provide a high number and diversity of freshwater fish habitats. The Tongass National Forest provides spawning and rearing habitats for the majority of fish produced in Southeast Alaska. Maintenance of this habitat and high water quality is of concern to the public, State and Federal natural resource agencies, and Native organizations.

In FY 2004, major emphasis was placed on monitoring resident fish populations, fish passage conditions at road culverts, BMP implementation, and stream habitats. Work continued to develop a synthesized approach for all aspects of fish habitat monitoring. A technical team of Forest Service specialists continued to work with the Pacific Northwest Forest Experiment Station on development of a plan for synthesizing the aquatic monitoring.

Fish Habitat Question 1: Are population trends for Management Indicator Species (MIS) and their relationship to habitat changes consistent with expectations?

An annual monitoring program for trends in the populations of resident cutthroat trout and Dolly Varden char and their habitat was established in 1999. In 2004, abundance estimates and habitat surveys were completed for 21 of 23 previously identified monitoring streams. Two new sites were established and monitored in the case-study watersheds.

The protocol incorporates a design that requires monitoring of streams before and after timber harvest. Timber harvest has begun in the watersheds of two streams (Tunehean and Salty Creeks) and harvest may begin within the next several years for nine additional streams. Predicting the year of future timber harvest is difficult and is controlled by many variables including appeals and litigation of National Environmental Policy Act (NEPA) documents, the market value for timber, and changes in laws and policy affecting timber harvest in Southeast Alaska.

Alaska Department of Fish and Game (ADF&G) commercial harvest and escapement data are reported for coho and pink salmon for 1997 through 2004. A project is under way to develop and evaluate a stream-specific protocol for juvenile coho. Additionally, a project to help determine if pink salmon will be a sensitive indicator species is also in progress.

Monitoring Results for Resident Cutthroat Trout and Dolly Varden Char

Fiscal year 2004 was the sixth year for resident fish MIS monitoring. This year an additional control stream (Chanterelle Creek) was identified and monitored. Chanterelle is the long-term reference stream for the set of three case-study watersheds. Scary Creek, a previously harvested

stream and also one of the case-study watersheds, was also monitored, but Scary Creek data cannot be used for the resident fish MIS project as the watershed doesn't meet the site selection criteria. Both data sets will be valuable to help interpret the wide range of monitoring data being collected from the case-study watersheds.

Power analysis has suggested 16 treatment streams will be necessary for an 80 percent chance of detecting a decline in fish populations of 0.80 of the standard deviation of the samples. Existing long-term data sets for resident cutthroat trout in Oregon and for Dolly Varden char in Southeast Alaska indicate that a decline of approximately 20 percent of the mean annual population could be detected.

Even though the power analysis indicated 16 streams would be sufficient for the minimum monitoring program, 20 treatment streams have been selected. We will continue identifying and adding treatment streams for a more robust program. Doing so will compensate for potential fall-down in the planned timber harvest that will likely reduce the sample of treatment streams.

Control streams were added to the design following a recommendation from the Interagency Monitoring and Evaluation Group. Control streams are not required for the planned paired-t test, but will help to explain changes in the fish abundance that might not be related to timber harvest.

Twenty treatment streams and four control streams have been identified that meet the site selection criteria (Table Fish-1).

These criteria include:

Populations of resident cutthroat trout (Cut) and/or Dolly Varden char (DV);

Migration barriers to prevent interaction with anadromous fish;

FP3, MM1, or closely related channel types;

No previous logging, but with planned future logging; and

Not connected to lakes.

The control streams meet the same criteria except there is no planned future logging.

Photo Fish-1. Cutthroat Trout

Table Fish-1. Summary of Stream Reaches for Resident Fish Monitoring in 2004

Ranger District	Stream Name	Year of Timber Harvest	Channel Type	Fish Species	Population Estimate	Habitat Survey
Craig	Drinking Water Cr	2005	MM1	Cut, DV	Yes	Yes
	N Perkins Cr	2005	MM1	Cut, DV	Yes	Yes
	Keg Cr	Control	FP4	DV	Yes	Yes
Hoonah	S Fork Freshwater Cr	2006	MM1	Cut, DV	Yes	Yes
Juneau	Dry Bay Upper	2006	FP3	DV	No	No
	Dry Bay Lower	2006	FP3	DV	No	No
Ketchikan-Misty	Montana Cr	2005	MM1	Cut	Yes	Yes
	Packer Cr	2006	MM1	Cut, DV	Yes	Yes
	Gun Sight Cr	2006	MM1	DV	Yes	Yes
	Salty Cr	2001	MM1	Cut	Yes	Yes
	Emerald Cr	2005	FP3	Cut	Yes	Yes
Petersburg	Farragut Cr	2005	FP3	Cut, DV	Yes	Yes
	Tunehean Cr	2002	MM1	Cut, DV	Yes	Yes
	Lower Zim Cr	2006	MM1	Cut, DV	Yes	Yes
	Upper Zim Cr	2006	FP3	Cut, DV	Yes	Yes
	Upper Ohmer	Control	FP3	DV	Yes	Yes
Sitka	Corner Bay Tributary	2006	MM1	Cut	Yes	Yes
Thorne Bay	Oxbow Cr	Control	MM1	Cut, DV	Yes	Yes
	Chanterelle Cr	Control	MM1	DV	Yes	Yes
Wrangell	Gypsy Mainstem	2005	MM1	Cut	Yes	Yes
	Gypsy Tributary	2005	MC1	Cut	Yes	Yes
	West Fork Hoya Cr	2004	FP3	DV	Yes	Yes
	Vial Cr	2006	MM1	DV	Yes	Yes
	Jenkins Cr	2005	MM1	Cut	Yes	Yes

The density of cutthroat trout and Dolly Varden char varies widely among the sampled streams (Appendix A). For streams with only Dolly Varden, densities generally range from five to 35 fish per 100 m^2, and streams with only cutthroat from two to over 35 per 100 m^2. In streams with both species, the total fish density generally ranges from three to almost 50 per 100 square meters. Of the 24 monitoring streams, eight have only Dolly Varden, four only cutthroat, and 12 have both species. Abundance of Dolly Varden and cutthroat in the monitoring reaches generally tracks the density and generally ranges from less than 20 to almost 400 fish (Appendix A).

We also annually monitor physical stream habitat features important to fish. These include the number of pieces of large woody debris, pool area, number of pools, average residual pool depth, length of undercut banks, and the D50 substrate size (Appendix A). Differences in the amount of these habitat features are apparent between streams. For example, large woody debris ranges from just over 20 in Packer Creek to almost 100 pieces in Gun Sight Creek. For pool area, the range is from less than 100 m^2 for Gypsy Tributary to over 600 m^2 for Gun Sight Creek. Complete data on reach lengths and additional descriptions of the large woody debris, the pools, and the substrates are in the project files.

A crew of two or three people completed the monitoring for each stream. A Supervisor's Office employee traveled to many of the districts and worked with district representatives. This approach provided training for the often-newer district employees. Experienced Ketchikan Ranger District employees monitored streams on their district and assisted Thorne Bay District. Both approaches helped insure consistency and will be used next year.

Evaluation of Results

Annual variation in estimated fish abundance is evident for all monitored streams (Figures Fish-1 and Fish-2). This variation will affect our ability to detect change in the mean abundance of fish following timber harvest. The preliminary sample size of 16 streams was based on annual variations for fish populations found in the literature. We now have six consecutive years of cutthroat and Dolly Varden abundance data from many of our own streams. Based on the annual variation calculated for these streams, we will likely be able to detect a change in mean abundance of 20 to 35 percent if the stream has more than 30 fish and approximately 30 to 50 percent if the populations are less than 30 fish. Annual abundance estimates are more variable for streams with fewer fish.

Annual measurements of habitat features important to fish are also variable. Annual variation for pool area (Figure Fish-3) is often less than the estimated variation for fish, but variation for other habitat features, for example number of pieces of large woody debris, is generally greater (Figure Fish-4).

Figure Fish - 1. Cutthroat trout abundance estimates for streams with 6 years of data.

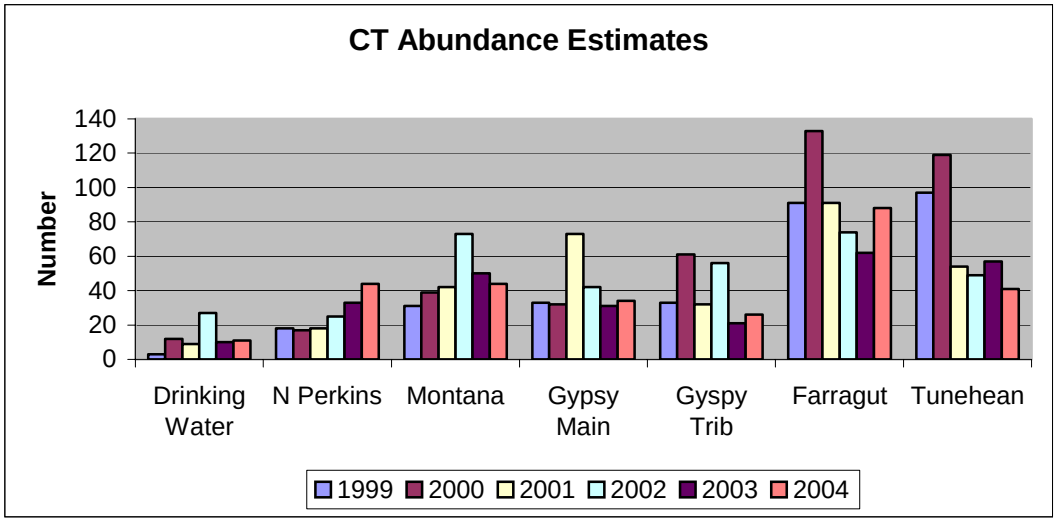


Figure Fish - 2. Dolly Varden char abundance estimates for streams with 6 years of data.

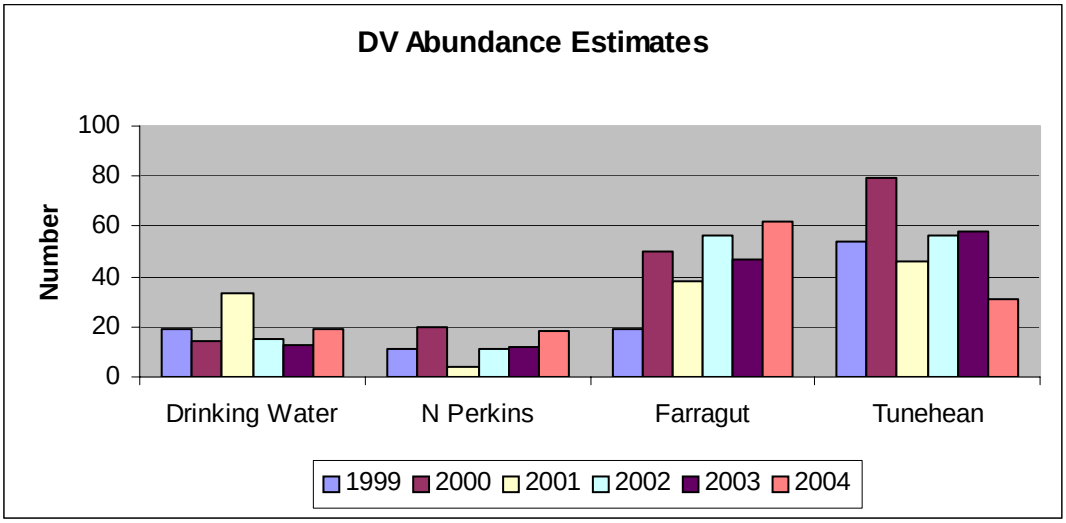


Figure Fish - 3. Measured pool area for the streams with 5 or 6 years of data.

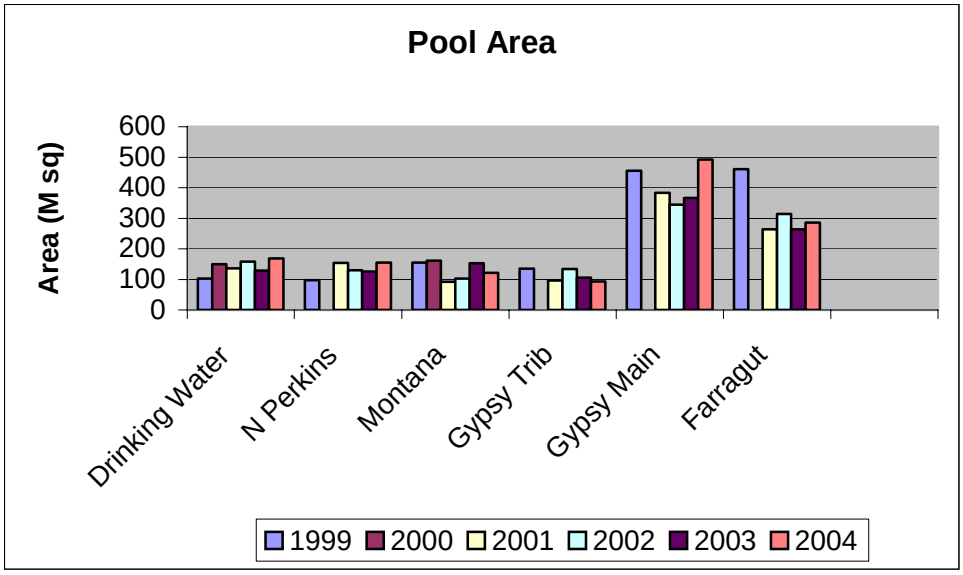
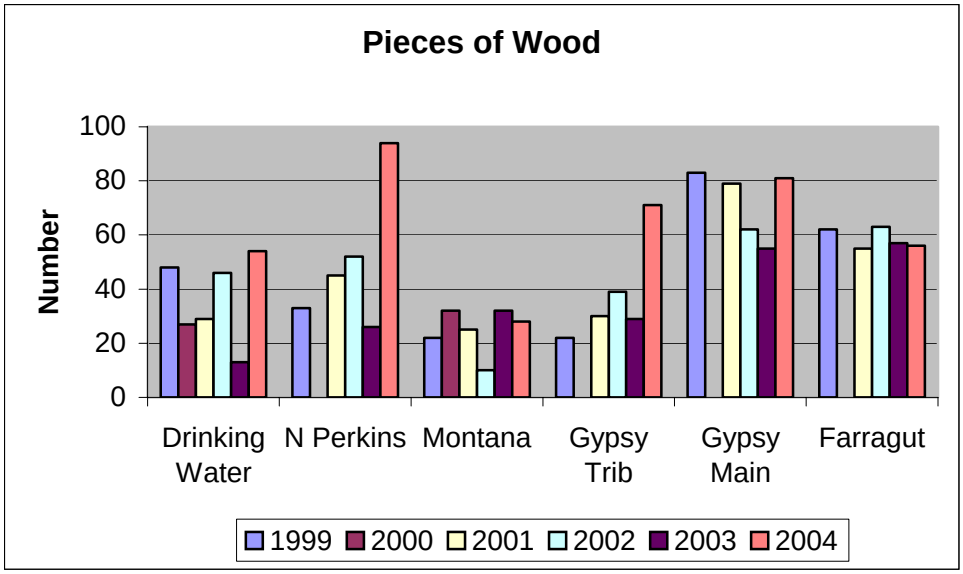


Figure Fish - 4. Pieces of wood for the streams with five or six years of data.



No consistent trends are evident in the annual fish abundance data. Some streams appear to have an increasing trend, for example cutthroat in North Perkins Creek and Dolly Varden in Farragut River (Figures Fish-1 and Fish-2). Other streams, like Tunehean Creek, have a decreasing trend for both Dolly Varden and cutthroat trout. Many streams demonstrate no apparent trend.

Is the decline in fish in Tunehean Creek likely related to forest management? A large culvert was being installed just upstream from the monitoring site during the 2002 abundance estimate and upstream timber harvest had also occurred. The fish populations were reduced in 2002, 2003, and 2004. It must be noted that the population declined in 2001 (before forest management). It is likely the decline in Tunehean Creek and the annual variation in the unmanaged streams are from a combination of sampling error and natural variation in fish

numbers. It is too early to speculate on the effects of forest management until all the streams are harvested and the analysis is completed.

There are no consistent trends in the habitat data. For example, the area of pools appears to be relatively uniform for streams with 5 or 6 years of habitat data (Figure Fish-3). An increasing trend of wood is apparent for North Perkins and Gypsy Tributary (Figure Fish-4).

The difference in abundance and density of fish between streams is intriguing. It was anticipated that there would be more fish in FP3 channels compared to the slightly steeper MM1 channels. While it is generally true that FP3 channels have high numbers of fish, the stream with the most fish is an MM1 channel. This stream, Gunsight Creek, has only Dolly Varden char and the estimated number in the monitoring reach for the last three years has been over 350. Density of Dolly Varden in Gunsight Creek is also the highest for any stream with a single species. Density of the combined populations of Dolly Varden and cutthroat in Emerald Creek is consistently greater than for the Dolly Varden population in Gunsight Creek (Appendix A). Even though the differences in abundance and density of fish between streams is intriguing and likely caused by multiple factors including watershed geology, elevation, stream productivity, and physical habitat, we have to remember that the number of fish in individual streams is not as important as the eventual comparison of the number of fish in each stream before and after timber harvest.

Actions Recommended for FY05

It is recommended that annual fish population and stream habitat monitoring continue in FY05. The monitoring program will be complete when at least 16 treatment streams have been logged and the amount of the post-logging data is approximately equal to the amount of pre-logging data. This suggests the resident fish monitoring project will continue for at least 10 years.

It is also recommend to continue monitoring resident fish populations in the case-study watersheds, and to assist in identifying a suitable case-study stream with resident fish that is currently unlogged, but with planned future logging.

The Forest Plan states we will monitor Dolly Varden char and cutthroat by annually evaluating the ADF&G's harvest statistics and completing population surveys on a sample basis, if necessary. We have found the harvest statistics to be only available for the larger and more popular sport fishing streams. Many of these streams are anadromous and do not have planned future logging.

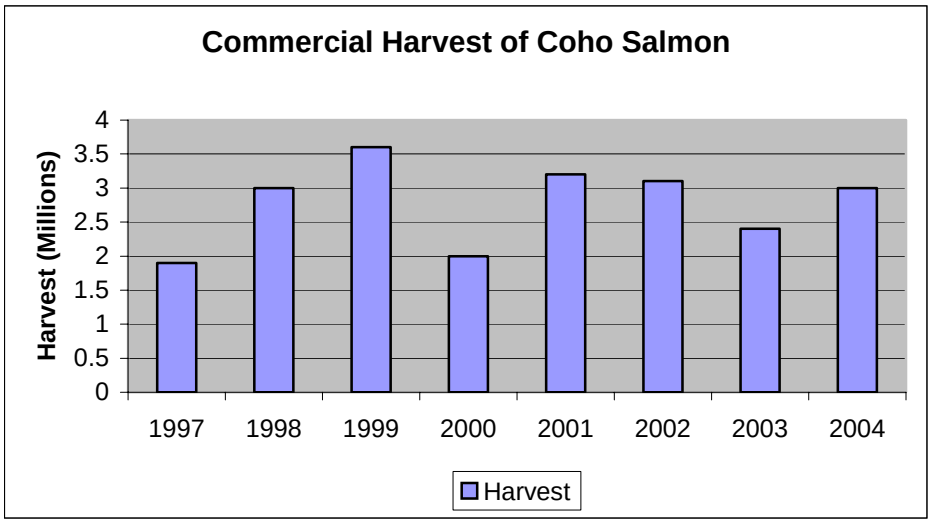
The Forest Plan should be amended to de-emphasize reliance on ADF&G's harvest statistics and emphasize monitoring the abundance and habitat of resident Dolly Varden and cutthroat that spend their entire lives in the freshwater, have relatively simple life history patterns, and are not subject to potentially variable competition with salmon.

Monitoring Results for Coho Salmon

Annual commercial harvest of coho salmon is reported by the ADF&G, and the Forest Service evaluates these estimates to see if long-term trends are evident (Figure Fish-5). No trends are evident. After reviewing ADF&G's entire data set that extends back to the late 1800's, it was interesting to note that the commercial harvest of coho salmon were high in 1999. It was the eighth highest on record. Harvest of coho in 2004 was over 1 million greater than the average annual harvest since 1960.

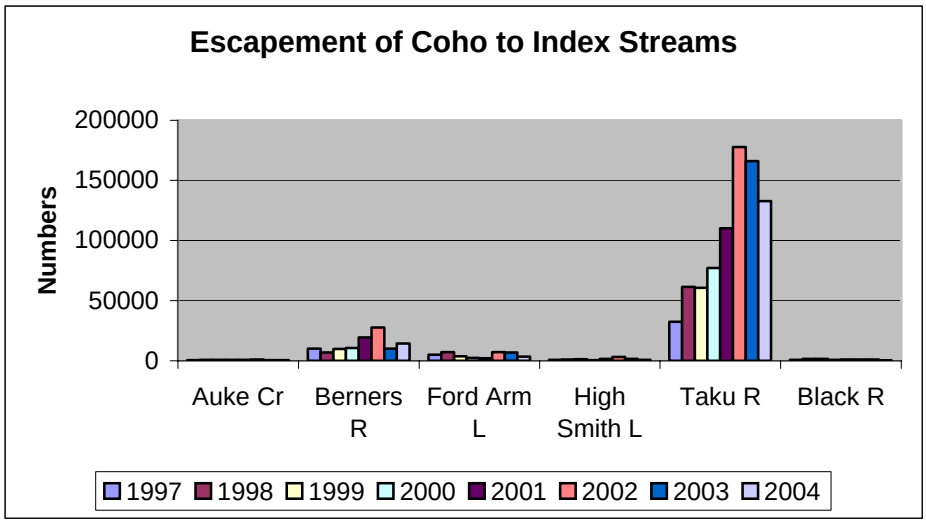
An ADF&G coho research biologist reports the mean wild coho abundance in SE Alaska from 1982 through 1997 was 3.7 million, and the mean from 1998 through 2004 was 3.8 million. This tends to indicate there are no major differences in wild coho abundance following completion of the Forest Plan in 1997.

Figure Fish - 5. Annual commercial harvest of coho salmon in Southeast Alaska from 1997 through 2004, Data provided by ADF&G



Estimates of coho escapement are difficult to collect as coho enter the streams during the fall when flows are often high and coho routinely distribute throughout the watersheds including into small tributary streams. The ADF&G has selected a small number of representative streams across Southeast Alaska to carefully (and expensively) count or estimate escapement. Data from these streams and rivers are the best available for the Forest Service to review for long-term trends (Figure Fish-6).

Figure Fish - 6. Annual escapement of coho salmon in six index streams from 1997 through 2004, Data provided by ADF&G



No consistent long-term trends are evident in the eight years of data from 1997 through 2004. A pattern of high escapement in 2002 is evident for Berners River and the Taku River. ADF&G attributes this to reduced commercial fishing effort and harvest due to low selling prices for wild salmon. Compared to 2002, escapements in 2003 and 2004 are reduced for all index streams.

Evaluation of Results

The region-wide harvest data and escapement data from index streams are good indicators of the annual abundance and potential trends of coho returning to Southeast Alaska. Since juvenile coho normally spend one or two years rearing in freshwater, coho abundance is likely affected by changes in the quality of stream habitat. Research in the Pacific Northwest and in Southeast Alaska has shown that forest management affects coho salmon on a stream-by-stream basis. Coho are also affected by the severity of winter weather and the cyclical productivity of the marine environment.

Development of Monitoring Protocols Using Juvenile Coho Salmon

The Forest Sciences Laboratory is developing and testing a protocol to use juvenile coho abundance in tributary streams as an indicator of potential effects of forest management. Part I of the study is field oriented and in 2004, 26 study stream segments from across the Forest were sampled for fish populations and stream habitat. Four-pass removal estimates were made of the number of juvenile coho, and modified Tier III stream habitat surveys were completed. The sample set presently includes nine old-growth, nine post-Forest Plan, and eight pre-Forest Plan sites. See Appendix A for a map of the monitoring sites and a more complete description of the field studies.

In part II, the review of existing monitoring protocols has been completed by the University of Washington and the paper has been submitted for publication as a PNW General Technical Report. Additionally, a draft report describing a long-term protocol to monitor Forest Plan prescriptions using coho salmon is nearing completion.

Analysis of the 2003 and 2004 field data indicated that more coho fry were found in most streams in 2003 than in 2004. When study streams were grouped by island, significant differences in densities of fry and parr were evident. Chichagof Island had higher fry densities in 2004 and Prince of Wales and Kuiu Islands had higher densities of parr. Sizes of juvenile coho sampled in 2004 were smaller than in 2003, and fish captured on Chichagof Island tended to be smaller than those on the other islands. See Appendix A for more description of juvenile coho abundance and size.

Above the watershed scale, geographic and physical variables were significant in explaining differences in juvenile coho abundance. Fry abundance was positively related to latitude and pH, and parr abundance was positively related to pH and inversely related to elevation.

The preliminary results of the field studies illustrate the complexity in monitoring fish response to management activities. However, as differences are identified they can be used to account for natural variation. An important outcome of the analysis to this point is that large scale features can have an important influence on salmonid abundance.

The developing long-term monitoring protocol is designed to detect a linear trend over a period of 10 years using least squares estimation. It will detect a trend in reduced annual fish abundance over time of approximately 5 percent (a 50 percent reduction in 10 years). The estimated sample

size would be nine streams to detect this change in post-Forest Plan streams. See Appendix A for a more complete discussion of the assumptions used for the power analysis.

Actions Recommended for FY05

The Forestry Sciences Laboratory successfully completed the third year of a 4-year study to develop a monitoring protocol for juvenile coho in tributary streams. This study should continue to completion in FY05. If an effective and affordable monitoring protocol can be developed, the Forest Service should request funding for implementation.

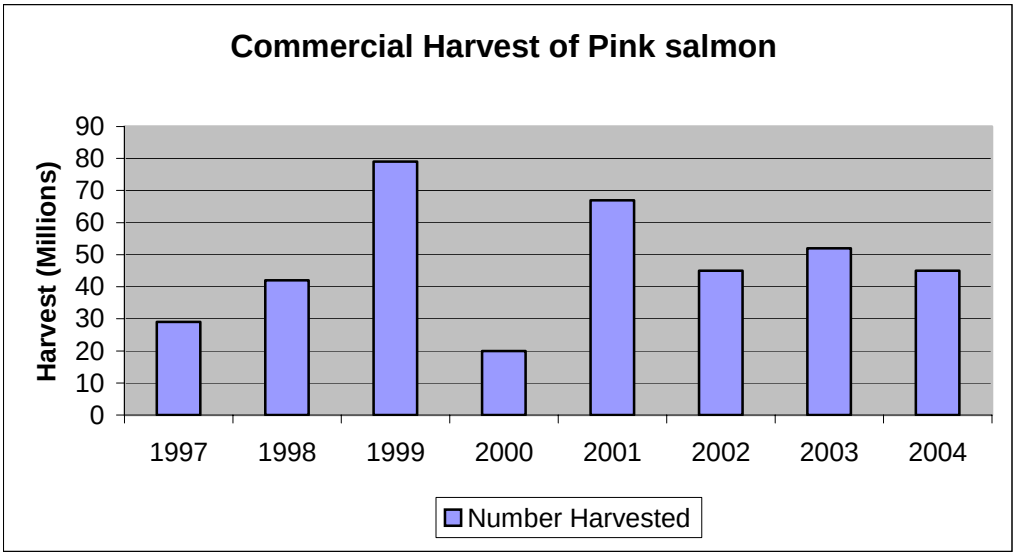
The Forest Plan states we will annually evaluate the ADF&G's commercial harvest and escapement statistics. In FY05, we recommend continuing to evaluate those comprehensive databases. There is a concern that the region-wide coho databases are insensitive to National Forest management.

No changes in the Forest Plan are recommended at this time. Future recommendations may be developed following completion and testing of the juvenile coho monitoring plan.

Monitoring Results for Pink Salmon

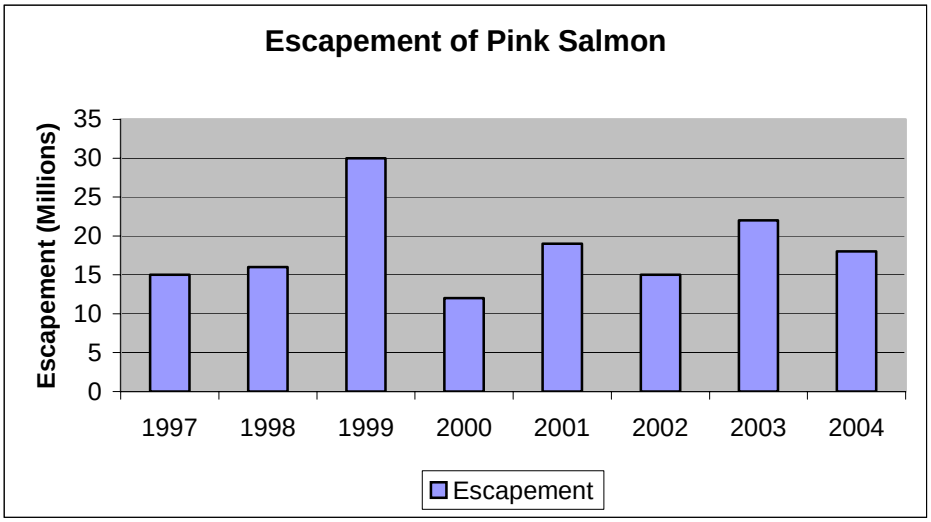
Annual commercial harvest of pink salmon is reported by the Alaska Department of Fish and Game. The Forest Service evaluated these estimates to see if long-term trends are evident. Annual commercial harvest is an indicator of population abundance. Harvest data from 1997 through 2004 are presented in Figure Fish-7.

Figure Fish - 7. Annual commercial harvest of pink salmon in Southeast Alaska from 1997 through 2004, Data provided by ADF&G



Another indicator of pink salmon abundance is the number of adult fish that return to spawning streams. ADF&G biologists fly over the streams and count pink salmon concentrated on broad spawning riffles. ADF&G annually reports this spawning-survey data (commonly and hereafter called "escapement" data) for a series of index streams across Southeast Alaska. The Forest Service evaluates the escapement data for long-term trends (Figure Fish-8). The reported data is the sum of the peak escapement counts for approximately 850 index streams across Southeast Alaska.

Figure Fish - 8. Annual escapement of pink salmon in Southeast Alaska from 1997 through 2004, Data provided by ADF&G



No long-term trends are apparent in the eight years of harvest and escapement data from 1997 through 2004. After reviewing the entire data set for commercial harvest of pink salmon, it is interesting to note that the harvests in 1999 and 2001 were the highest and second highest recorded. The estimated harvest of 45 million pink salmon in 2004 is approximately twice the average long-term harvest since 1960.

Evaluation of Results

The combination of annual harvest and escapement is a good indicator of the annual abundance and potential trends for the pink salmon returning to Southeast Alaska. It is generally believed, that pink salmon abundance is controlled by several factors including freezing in the winter when eggs are incubating in stream gravels and the cyclical productivity of the marine environment when juvenile pink salmon are rearing in the estuaries and the North Pacific Ocean. Quality of the freshwater habitat, mainly the percentage of fine sediment in the spawning gravel, is also important and may be affected by forest management, but is likely overshadowed by the influence of winter freezing and ocean productivity.

Commercial harvest of both pink and coho salmon was high in 1999. The synchrony of high commercial harvest of both species suggests a strong influence of ocean productivity on the abundance of these species.

A study to see how sensitive pink salmon escapement has been to previous forest management is currently in the design phase. Part of the plan is to review the approximately 30 years of spawning escapement data that have been collected in over 800 watersheds and the timber harvest history for the same watersheds.

Kuiu Island was selected as a pilot for this study. Eighty-one streams were identified for Kuiu that have long-term escapement records, and a strategy has been developed to quantify the logging history for each watershed. Information was gathered on the percent of the watersheds harvested each year, the percent harvested on slopes greater than 72 percent, the percent harvested in riparian areas, the road density, the amount of road on slopes greater than 35 percent, and the amount of road within riparian areas and on wetlands. Searching for

relationships between escapement and timber harvest slowed in 2002 as the pink salmon escapement data is not currently in a form suitable for use in this project. The data is being upgraded by ADF&G.

Actions Recommend for FY05

Looking for relationships within the existing pink salmon escapement data and the logging history should continue. If relationships are detectable, we should initiate monitoring looking forward to see if they continue with logging conducted under the current standards and guidelines. If relationships are not evident, we should discontinue monitoring pink salmon beyond reviewing ADF&G's annual harvest and escapement data. It is assumed that older logging was less fish friendly than logging planned under the current standards and guidelines.

No changes are recommended for the Forest Plan until the evaluation of the existing pink salmon escapement data and the timber harvest history data is complete.

Fish Habitat Question 2: Are Fish and Riparian standards and guidelines being implemented?

Best Management Practices (BMPs) described in the Soil and Water Conservation Handbook (Forest Service Handbook 2509.22, October 1996) define practices that provide protection for soil and water resources. The Fish Riparian 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 Forest Plan implementation monitoring. Refer to the *Tongass Best Management Practice Implementation Monitoring Report: Fiscal Year 2004* in the appendix for details on how the monitoring was conducted. A summary of the findings for the fish and riparian resources relative to BMP implementation follows.

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. The 100 percent monitoring was primarily conducted by Forest Service sale administrators and engineering representatives with assistance from resource specialists in a few circumstances. A team of Forest Service employees and other Federal and State agency representatives conducted the IDT monitoring. Included were sale administrators, engineers, foresters, planners, and resource specialists from soils, water and fisheries. The IDT monitoring was conducted on all the units ready for IDT review and a stratified random sample of more than 10 percent of roads monitored during the 100 percent monitoring effort.

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 few of the significant changes included in the 1997 Forest Plan Final Environmental Impact Statement and the Forest Plan Standards and Guidelines resulted in new stream class definitions and stream protection measures required for each stream class and channel type. Buffer protection of Class III streams was entirely new. A number of the units monitored were planned,

laid out, and harvested under pre-1997 Forest Plan Standards and Guidelines. The concepts of the new standards and guidelines were incorporated into most of these timber sales. Implementation of the new standards and guides occurred in most of the units, although Class III stream buffers were not implemented in all cases.

Monitoring Overview

The data summarized in the table and discussed below reflect results from the total units and roads monitored in the 100 percent and IDT monitoring efforts. This monitoring covered 1130.4 acres in 53 harvest units, 45 road segments and 22 culvert replacement sites. Details of the Best Management Practices monitoring can be found in the Tongass report in the appendix. Details on specific units and roads reviewed by the Interdisciplinary Teams are included in the IDT trip reports that are included in the appendix.

Review of the timber sales and respective environmental documents associated with the monitoring this fiscal year, showed that most of the units were harvested under contracts that were included in environmental impact statements (EISs) or environmental analyzes (EAs) signed before the 1997 Forest Plan. The units and roads in the FY2004 monitoring pool are listed below with their respective environmental document or contracts. The small sales and public works contracts were all implemented under the 1997 Forest Plan Standards and Guidelines.

Table Fish-2. 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

Table Fish-3. 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

Table Fish-4. 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

Monitoring Results

A total of 53 units and 45 roads/road segments (22 culvert replacement sites) were monitored this year through the 100 percent implementation monitoring process. The IDT monitored 8 units, 9 road construction segments including 4 fish pass improvement culvert replacements (located on 4 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 tables presented below reflect results from the total units and roads monitored in the 100 percent and IDT monitoring efforts. Summary of this effort are included in Soil and Water Question 3 and additional details are included in *Tongass Best Management Practice Implementation Monitoring Report: Fiscal Year 2004.*

BMPs Applicable to Fish and Riparian Management that were included in the monitoring suite for FY 2004 include:

BMP 12.6 Riparian Area Designation and Protection
BMP 12.6a Buffer Design and Layout (TTRA and other buffers)
BMP 13.16 Stream Channel Protection
BMP 14.6 Timing Restrictions for Construction Activities
BMP 14.14/ 14.17 Bridge and Culvert Design and Installation (fish passage, etc.)
BMP 14.15 Diversion of Flows Around Construction

As part of the Best Management Practices implementation monitoring, information is collected on the streams monitored in the harvest units. The following tables show the number of linear feet of stream channel protected and the approximate stream buffer acres retained in the areas in and adjacent to harvest units monitored. Since some of the units monitored were planned, laid out, and harvested under pre-1997 Forest Plan Standards and Guidelines, some Class III streams were not buffered and some Class IV streams were not designated as "Class IV streams" but designated live streams.

Significant lengths of stream channels were reported as protected during unit harvest in the implementation monitoring effort in FY 2004 as shown in the table below. These stream lengths and associated buffer areas show that the stream protection measures are being implemented. Comparison of the stream data collected during the IDT monitoring effort and the total implementation monitoring effort illustrated on tables that follow shows that a number of the protected streams were checked during the IDT quality control monitoring process. In the quality control monitoring, roughly 9.5 percent of the streams lengths protected were reviewed by the IDT.

Table Fish-5. Linear Feet/ Acres of Stream Channel Protected and Lakes/ Wetlands Effected in FY 2004 monitored through implementation monitoring effort

	100 % Monitoring Effort		**IDT Monitoring Effort**	
Stream Class	**Linear feet of Stream Channel Protected**	**Approximate Acres Retained as Streamside/ Beach/Wetlands/ Buffer**	**Linear feet of Stream Channel Protected**	**Approximate Acres Retained as Streamside/ Beach /Wetlands Buffer**
Class I	8900 feet	55.03 acres	1500 feet	34.63 acres
Class II	10150	29.23	4450	11.38
Class III buffered	8730	12.8	750	0.5
Class III un-buffered*	16460		0	
Class IV	34540		750	
Beach buffer		0		0
Wetlands		103.5		90.5

* Un-buffered Class III streams in units planned, laid out, and harvested under pre-1997 Forest Plan Standards and Guidelines

The BMP implementation monitored relative to road construction and reconstruction related primarily to culvert replacement sites in FY 2004, although some culverts and bridges were installed on roads constructed for transportation (public works and specified roads) and timber harvest (specified and non-specified roads). Culvert installation included sites at 8 Class I streams, 7 Class II streams, 15 Class III streams and 26 Class IV streams. Also installed were bridges and composite structures (combinations of weirs, arches and multi-plates/pipes). These sites included bridges constructed to cross 3 Class I streams and 5 Class II streams. The IDT monitored 2 Class I culverts, 1 Class II culvert, 4 Class III streams and 6 Class IV streams as well as 4 bridges that span Class II stream crossings.

Comparison of the number of times the IDT applied the BMP relative to the 100% monitoring effort shows that the IDT monitoring was conducted on a high percentage of the sites where

BMPs relative to riparian areas were applied. Best Management Practice 12.6/12.6a Riparian Area Designation & Protection/Buffer Zone Design and Layout and BMP 13.16 Stream Channel Protection were applied in timber unit harvest. BMPs 14.6 Timing Restrictions for Construction Activities/Fisheries Prescription and 14.14/14.17 Design & Installation of Bridges and Culverts were applied in road construction/reconstruction.

The corrective actions on the Best Management Practices relative to riparian areas, streams and buffers are shown in the table below. These corrective actions were implemented to achieve BMP standards. The table also shows some departures noted relative to full BMP implementation. However, most of these notations were actually erroneous since the incidents were corrected and the BMPs implemented.

Table Fish-6. BMPs Relative to Riparian Areas, Streams, and Buffers Implemented as Tracked through Implementation Monitoring Effort

BMPs Applied	Number of Times the BMP was Appropriate for Use	Number of Times Corrective Action Implemented	Number of Times Departure from Full BMP Implementation
BMP 12.6 Riparian Area Designation and Protection/ BMP 12.6a Buffer Design and Layout (TTRA and other buffers)	29	1	1
BMP 13.16 Stream Channel Protection	39	0	1
BMP 14.6 Timing Restrictions for Construction Activities	20	0	0
BMP 14.14/ 14.17 Bridge and Culvert Design and Installation (fish passage, etc.)	29	3	5
BMP 14.15 Diversion of Flows Around Construction	15	0	1
Totals	**132**	**4**	**8**

Corrective actions and departures associated with riparian areas, streams and buffers were reported during implementation in FY 2004. Corrective actions in BMP 12.6/12.6a and departures in BMP 12.6/12.6a and BMP 13.16 occurred in the Summore Change timber sale on one unit. In this unit, classification errors during environmental assessment were noted during sale administration. Reconnaissance was completed before harvest; corrections were made on the stream prescriptions before and during layout. Implementation of the stream prescriptions was completed through changes in the unit configuration during sale administration. An additional corrective action was required but not implemented until after the monitoring forms were turned in and compiled relative to an Orion South unit where stream clean out in a Class IV stream had not been completed. A third incident that occurred but was not reported as a corrective action involved felling in a buffer on the Situk Salvage Sale. There was one unit where a few trees were felled into the buffer, the contractor was reprimanded, and stream buffer integrity was still intact.

The three corrective actions were implemented and five 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. The departures noted relative to the BMPs were related to the lack of Forest inspection, turbidity measurements, and turbidity measurements that exceeded the State standards for suspended sediment 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. These departures were erroneously noted and the ratings should have showed some incidents but eventual full BMP implementation since the incidents were corrected and actual inspection was delegated to the contractor.

Two fish improvement construction sites had pump failures during construction where the dewatering pump stopped working for a short period, which contributed to two of the three noted corrective actions on the culvert sites. 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 third corrective action was at a culvert site where the measured level of suspended sediment, measured with turbidity, exceeded the State Water Quality standards for a period of 72 hours following initial construction in the channel. Mitigation included application of additional straw bales in the channel to attenuate the dispersion of sediment. The COR and ADEC were notified of the problem and no notice of violation was issued.

The IDT reviews of the units and roads were quite extensive this year and provide overview of the implementation status of the Best Management Practices. Summary of this work as well as the individual trip reports can be found in the appendix. Details are provided on Riparian Standards and Guidelines, Stream Identification/Classification, Class IV Stream Protection, Culvert/Bridge Installation & Design, and Culvert Fish Passage Improvement Projects.

Evaluation of Results

Best Management Practices are being successfully implemented on the Tongass National Forest. The high quality work of the individuals involved with preliminary site investigations, layout, unit and road design, environmental assessment, contract preparation, and contract administration has been reflected in the successful identification of streams and implementation of protective measures in units and effective culvert installations.

The diligent work of the sale administrators with other specialists to correct stream identification problems has contributed significantly to successful implementation of the fish habitat Best Management Practices. Emphasis needs to continue on correcting any improperly identified or missed streams. Specific focus should be placed on correctly identifying streams during the early stages of planning, site investigation, and layout.

The effective work of the engineers has contributed to the successful implementation of the Best Management Practices associated with culverts and bridges. Significant emphasis needs to be

focused on reviewing the designs relative to the specific sites, minimizing turbidity and collecting turbidity measurements. This turbidity data is significant water quality data that can be used to evaluate our compliance relative to the ADEC water quality standards. This data also provides important information as to whether corrective action needs to be taken to comply with State water quality standards. Emphasis needs to continue on site-specific designs for construction and evaluation of the designs after the initial high flows of the fall.

The linear feet of stream channels protected and buffers implemented (and documented in the implementation monitoring process) were less than the amounts reported in FY 2003 for Class I, II, III and IV streams. In part, this change can be attributed to the relative location of the units to streams. The only increase noted was relative to Class IV streams protected. The increase in the stream lengths and monitored lengths can also be related to the increased emphasis on stream identification. The 1997 Standards and Guidelines have been incorporated into much of the layout of the pre-1997 Forest Plan units. Incorporation of the standards and guidelines into most of the timber sales has resulted on a clear emphasis on identification and prescription relative to the streams.

Action Plans

Recommendations include modification of the monitoring process to transition away from a 100 % monitoring of the implementation of the Best Management Practices to a review of a selected set of a random generated subset of units and roads by an IDT team. Focus on an improved understanding of the guidelines on how to fill out the forms is necessary to improve the consistency of the ratings. Recommendations also follow to modify the Forest Service Handbook to better address the fish passage culvert sites. Modification of the form to include only applicable BMPs for culvert replacement sites is also recommended. A pilot form has been developed for culvert replacement site tracking and monitoring. Further detail on the recommended action is included in the interdisciplinary team reports in the appendix.

Stream Buffer Stability

The vegetation inherent in riparian areas is recognized as an important controlling factor and component in maintaining the natural range and frequency of aquatic habitat conditions. The Forest Plan contains several Riparian Standards and Guidelines that are intended to retain the integrity of riparian management areas. These standards specifically intend to: 1) maintain natural and beneficial quantities of large woody debris over the short and long term, 2) maintain stream banks and stream channel processes, 3) provide for the beneficial uses of riparian areas by maintaining water quality, and 4) maintain optimum salmon stream temperatures. By retaining riparian vegetation in a condition found within the range of natural variability, it is anticipated that these Riparian Standards and Guidelines can largely be achieved.

Windthrow is a natural and important phenomenon of Southeast Alaska. It recycles forest stands, and maintains and renews the forest ecosystem. However, timber harvest has the potential to exacerbate the rate of windthrow in adjacent forest stands, including riparian management areas, beyond that found within the natural range of variability. Monitoring the incidence of windthrow in riparian management areas and comparing that to windthrow found in control riparian areas will assess whether the buffers are retained in a condition found within the natural range of variability.

Monitoring Results

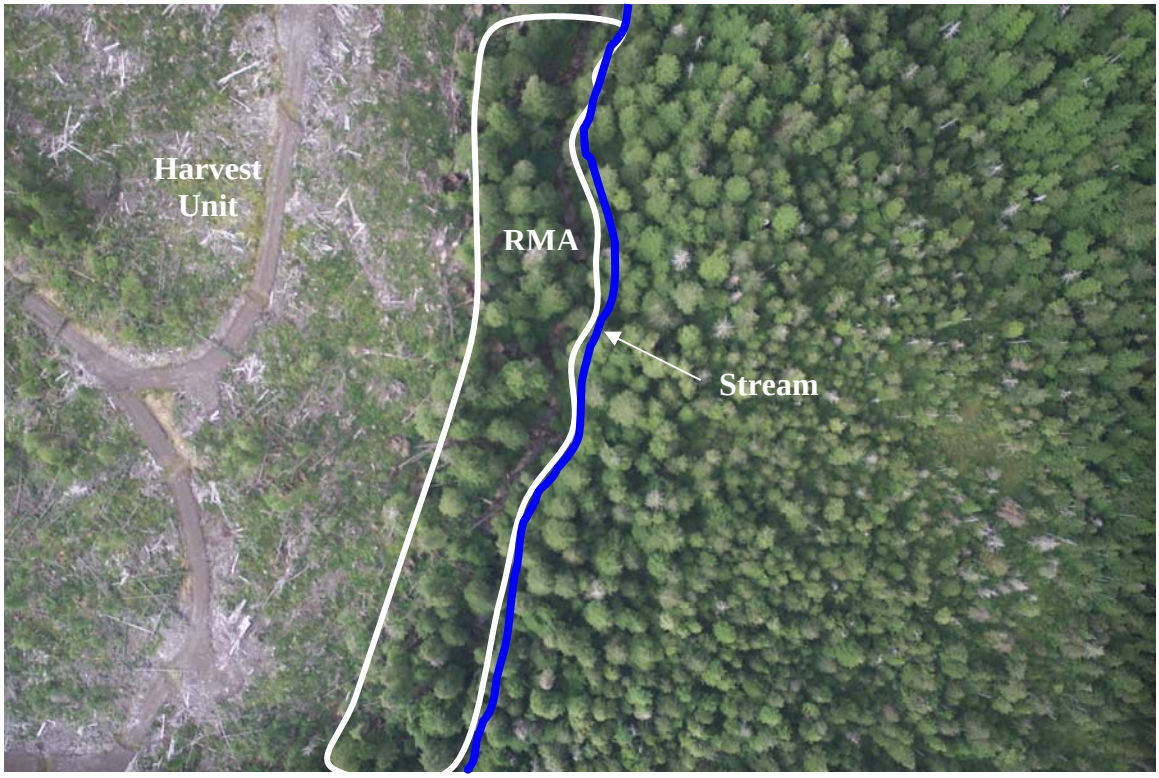
A protocol to monitor the incidence of windthrow in Riparian Management Areas (RMAs) is described in the *Forest Plan Monitoring and Evaluation Guidebook.* This protocol monitors the incidence of windthrow in all riparian buffers of Class I, II and III streams on the Tongass National Forest that are associated with timber sales consistent with the Forest Plan. The number of trees felled and the change in canopy cover, due to windthrow, is documented and measured using low-altitude digital still aerial photographs (Figure Fish-9).

First, pre-windthrow baseline conditions are obtained after harvest of a unit but before the windthrow prone months of the year, which are typically the winter months, beginning in October. Repeated measurements of canopy loss due to windthrow are then obtained annually for the first five years after harvest and then again 10 and 15 years after harvest.

The full range of variables are represented in this monitoring effort since it strives to include all of the stream buffers associated with timber sales that are intended to be consistent with the Forest Plan. There are currently 104 RMAs monitored and they are located on 5 Ranger Districts and are associated with 22 timber sales and 51 harvest units. Twenty-eight of the monitored RMAs are associated with harvest units harvested in 2000, 27 are associated with 2001 harvest, 11 are associated with 2002 harvest, 32 are associated with 2003 harvest activity and 6 of the RMAs monitored are associated with units harvested during 2004. Approximately 66 percent of the RMAs are adjacent to Class III streams (non-fish bearing, water quality streams). The remaining 34 percent of the RMAs are adjacent to Class I or II streams (anadromous and resident fish bearing streams). Approximately 43 percent of the RMAs are associated with harvest units that have been clearcut and have single age management structure. The remaining 57 percent of the RMAs are associated with harvest units that have some form of partial harvest silvicultural management structure. Retention of trees within the harvest units varies from none to approximately 75 percent.

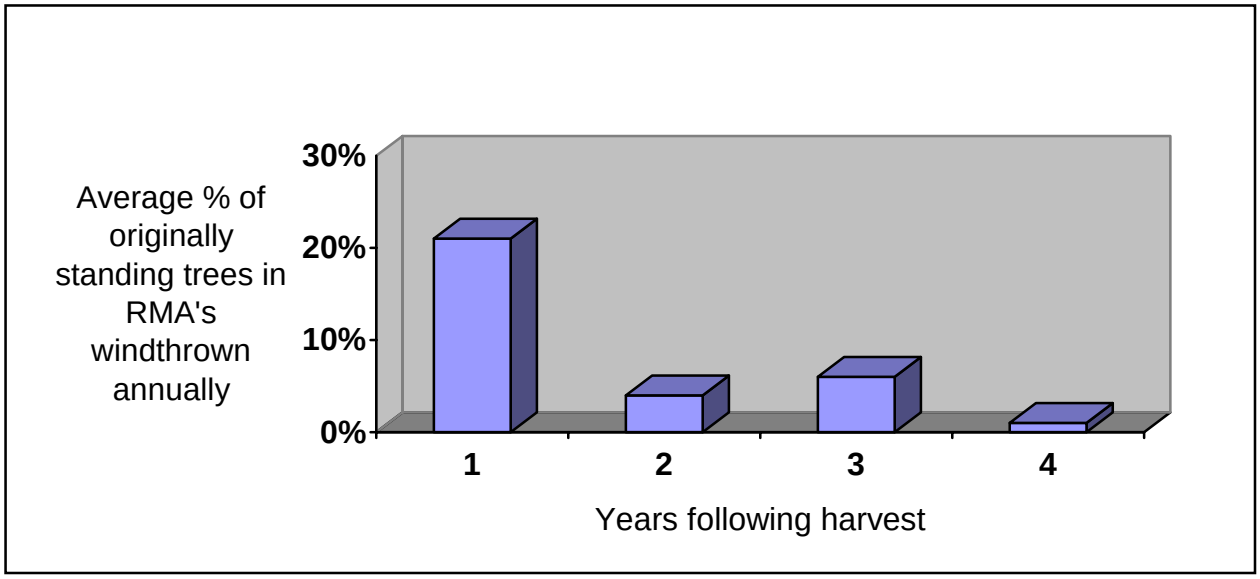
Monitoring results have shown that post harvest windthrow is present in 12 (12%) of the 98 RMAs associated with harvest units harvested during the 4 years from 2000 through 2003. The incidence of windthrow, within these 12

Figure Fish - 9. Low Altitude Aerial Digital Image of Riparian Management Area



RMAs, ranged from 3 percent to 91 percent (average 31%) of the total number of trees initially within the RMA (Table Fish-7). The majority of the windthrow occurred during the first year following harvest. The average percent loss of originally standing trees, in RMAs that had windthrow, is 21% after the first year following harvest. The average rate of windthrow is reduced in subsequent years following harvest to 4% after 2 years, 6% after 3 years and 1% after 4 years (Figure Fish-10). Generally, if windthrow did not occur within the first year following harvest then windthrow did not occur in subsequent years. Only two of the 12 RMAs with windthrow, did not have windthrow occur during the first year following harvest. The majority (82%) of the RMAs with windthrow are associated with harvest units harvested in 2000 while only 27% of all the RMAs monitored are from that year.

Figure Fish - 10. The rate of windthrow within riparian management areas that have had occurrences of windthrow.



Evaluation of Results

Monitoring the incidence of windthrow in control areas and comparing that to the incidence of windthrow within the RMAs associated with timber harvest will assess whether the RMAs are retained in a condition found within the natural range of variability. Cursory review of the incidence of windthrow in control and treatment riparian areas indicates that windthrow has been exacerbated within the RMAs associated with timber harvest. Therefore, current windthrow management prescriptions established to maintain the RMAs within the natural range of variability have not been 100 percent effective.

The assessment of the incidence of windthrow within control riparian areas is currently incomplete. The amount of windthrow is currently expressed only in terms of the number of trees felled by windthrow. The amount of windthrow will also be eventually defined by the change in canopy cover. Calculating the change in canopy cover requires the low elevation digital images of the RMAs be registered to existing orthographic images so image scale can be calculated. Mid-elevation digital images are required as an intermediate step in this process. Mid-elevation images have been obtained for a few of the RMAs.

This is the fourth year of results of this multi-year study. In addition to the need to monitor windthrow over time, it is also important to represent the complexities of the multitude of spatial variables. To represent the spatial variables, this study strives to include in its sample population all RMAs associated with timber sales consistent with the 1997 Forest Plan. For the most part, this has been achieved but with exceptions. To date, the sample population does not include several potential and eligible RMAs that were not included for a host of reasons. The RMAs currently excluded from monitoring include:

1. Those with harvest units that had not been completely felled by late September or were felled over multiple years.

2. Those where digital images were not obtained due to weather.
3. Those that experienced technical difficulties in processing the digital images.
4. Those that were not distinguishable on the low elevation digital image due to the streams narrow width, slight incision depth and large percent of tree retention within the harvest unit.

A better understanding of the complex relationship between spatial and structural variables and riparian windthrow is expected through the continuation of this monitoring effort. This better understanding will provide more effective windthrow abatement prescriptions and management will move closer toward desired riparian conditions.

Table Fish-7. Riparian Management Areas

District	Timber Sale	Riparian Management Area (RMA)	Harvest Year	Stream Class	Initial Number of Trees in RMA	Incidence of Windthrow Number of annual windthrow trees and cumulative windthrow % of initial number of trees within RMA				
						2000	2001	2002	2003	2004
Petersburg	Dakota	DK138A	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		DK138B	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Crane	CR46A	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CR48aA	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CR48bB	2000	III	132	0(0%)	31 (23%)	6 (28%)	0(28%)	0(28%)
		CR49aA	2000	III	102	0(0%)	4(4%)	0(4%)	0(4%)	0(4%)
		CR49bB	2000	III	81	0(0%)	0(0%)	0(0%)	7(9%)	0(9%)
		CR51aA	2000	III	456	0(0%)	11(2%)	8(4%)	3(5%)	6(6%)
		CR51bB	2000	III	43	0(0%)	26(60%)	7(77%)	6(91%)	0(91%)
		CR51aB	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CR51bA	2000	III	232	0(0%)	6(3%)	0(3%)	0(3%)	0(3%)
		CR51bB	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Twin Creek	TW41A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41B	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41C	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41D	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41E	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41F	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		TW41G	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
	East Fork	EF3aA	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		EF1aA	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		EF1A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		EF1B	2001	II	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)

District	Timber Sale	Riparian Management Area (RMA)	Harvest Year	Stream Class	Initial Number of Trees in RMA	Incidence of Windthrow Number of annual windthrow trees and cumulative windthrow % of initial number of trees within RMA				
						2000	2001	2002	2003	2004
	South Pass	SP148A	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		SP148B	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
	South Saddle	SS60A	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		SS60B	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
	Last Twin	LT74aA	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		LT74aB	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		LT74bA	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
Wrangell	Nemo	NL9aA	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		NL9aB	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		NL9aC	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		NL9bA	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		NL9bB	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		NL13A	2000	III	26	0(0%)	14 (54%)	0 (54%)	5 (73%)	0 (73%)
		NL13B	2000	III	33	0(0%)	11 (33%)	0 (33%)	5 (48%)	3 (58%)
	Turn	TN2A	2000	II	26	0(0%)	2 (8%)	3 (19%)	0 (19%)	(19%)
		TN3B	2000	III	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Kuakan	KK31A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK31B	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK31C	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK31D	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK31E	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK32A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK32B	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)

District	Timber Sale	Riparian Management Area (RMA)	Harvest Year	Stream Class	Initial Number of Trees in RMA	Incidence of Windthrow Number of annual windthrow trees and cumulative windthrow % of initial number of trees within RMA				
						2000	2001	2002	2003	2004
		KK32C	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK32D	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK33A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK33B	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK33C	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK35A	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK35B	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK35C	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
		KK35D	2001	III	not counted	no harvest	0(0%)	0(0%)	0(0%)	0(0%)
Thorne Bay	North Thorne	CL401A	2000	I	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CL401B	2000	I	387	0(0%)	110 (28%)	0 (28%)	0 (28%)	0 (28%)
		CL404A	2000	I	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CL404bB	2000	I	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		CL404aB	2000	I	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Rio Roberts	CL417A	2000	I	not counted	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Alder	AL202A	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
	Abandon	AB204A	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		AB204B	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
	Ridge	RD249A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
	Pepper	PP403A	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP403B	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP403C	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP405A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)

District	Timber Sale	Riparian Management Area (RMA)	Harvest Year	Stream Class	Initial Number of Trees in RMA	Incidence of Windthrow Number of annual windthrow trees and cumulative windthrow % of initial number of trees within RMA				
						2000	2001	2002	2003	2004
		PP405B	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP405D	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP406A	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP406B	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP406C	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP412A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP412B	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP413A	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP413B	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP414A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP414B	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		PP414C	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
	Rio Beaver	CL416A	2004	I	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
		CL416A	2004	III	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
		CL418A	2004	II	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
	Change	LB206A	2004	I	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
		LB222A	2004	I	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
		LB222B	2004	I	not counted	no harvest	no harvest	no harvest	no harvest	0(0%)
Craig	Fork	FKA	2002	II	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
	Rolling Rock	RRA	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
	South Arm	SA265A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	No data
		SA265B	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		SA301A	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)

District	Timber Sale	Riparian Management Area (RMA)	Harvest Year	Stream Class	Initial Number of Trees in RMA	Incidence of Windthrow Number of annual windthrow trees and cumulative windthrow % of initial number of trees within RMA				
						2000	2001	2002	2003	2004
		SA303A	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		SA303B	2003	I	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		SA310A	2003	II	113	no harvest	no harvest	no harvest	0(0%)	16 (14%)
		SA312A	2003	II	not counted	no harvest	no harvest	no harvest	0(0%)	0(0%)
		SA316A	2003	III	not counted	no harvest	no harvest	no harvest	0(0%)	No data
Ketchikan	Upper Carroll	UC8A	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		UC8B	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		UC17A	2002	III	94	no harvest	no harvest	0(0%)	0(0%)	5 (5%)
		UC17B	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		UC18A	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)
		UC9A	2002	III	not counted	no harvest	no harvest	0(0%)	0(0%)	0(0%)

Fish Habitat Question 3: Are Fish and Riparian Standards and Guidelines effective in maintaining or improving fish habitat?

Fish Passage

Upstream Passage of Juvenile Fish at Road Crossings

FISH112 IV.G, Class I: Maintain, restore or improve the opportunities for fish migration.

FISH112 IV.G, Class II: Maintain, restore or improve the opportunities for the natural fish migration of resident fish where feasible.

Upstream migration is essential for many fish species in the Tongass National Forest. Anadromous fish (fish that migrate from the ocean to freshwater to spawn) require access to spawning habitat. Juvenile anadromous fish migrate during their freshwater life stage, seeking seasonal habitats. Resident fish (fish that spend their entire life in freshwater) also may migrate seasonally in response to food, shelter and spawning needs.

Providing for fish passage at stream and road intersections to ensure fish migration is an important consideration when constructing or reconstructing forest roads. Improperly located, installed or maintained stream crossing structures can restrict these migrations, thereby adversely affecting fish populations. These structures can present a variety of potential obstacles to fish migration. The most common obstacles are excessive vertical barriers, debris blockages, and extreme water velocities that can inhibit fish passage, especially smaller or juvenile fish.

The Tongass National Forest strives to incorporate an adaptive management process to achieve the desired management goals and objectives for the fish passage at road crossings program. The adaptive management approach includes a continuous process of using, or developing, state-of-the-art assessment and restoration techniques followed by monitoring and adjustment of the techniques accordingly.

Designing the crossing structure to fit the stream is the key for attaining fish passage objectives and avoiding many unintended and undesirable impacts. Culverts that constrict the stream channel may cause excessive water velocity, excessive bedload deposition or rapid change in water surface profile at the inlet. Culverts installed at a gradient significantly different than the natural stream grade can induce stream head cutting upstream or excessive deposition of bedload at the culvert inlet. Culverts that do not retain adequately sized bedload may lead to excessive water velocities within the culvert. Culverts with excessive water velocities within them may release energy by eroding the outlet control, leaving the outlet perched.

Commonly used techniques to provide fish passage across roads include:

1. Maintaining the natural streambed through the use of bridges, and bottomless arch culverts.
2. Installing culverts that mimic and retain the natural stream characteristics of stream width, gradient, substrate and pool depth and spacing.
3. Installing culverts that are countersunk and at a flat gradient. This technique has limited application and is only effective where the natural stream grade is also flat and the water is pooled and backwatered, as is found in palustrine, estuarine and occasionally floodplain channels

4. Installing culverts equipped with a system of weirs or baffles. The complex hydraulics and poor bedload transport associated with baffled culverts require very careful design considerations if fish passage is to be retained over time.
5. Removing culverts and restoring the natural stream channel.

Monitoring Results

Fish Passage Standards and Guidelines including drainage structure design criteria have evolved over time and are still evolving as information on fish swimming performance, fish movement patterns and culvert hydraulics is improved. Therefore, the assessment of the effectiveness of the Standards and Guidelines contained in the Forest Plan can only be meaningfully conducted on drainage structures designed since the effective date of the Forest Plan (1997). Forest Plan Standards and Guidelines acknowledge the need to restore and improve the opportunities for fish passage through drainage structures regardless of when they were designed and installed. This report includes an assessment of all fish stream crossings across the Tongass regardless of installation date (pre and post 1997), followed by an assessment of just recent culvert installations (post 1997 Forest Plan).

Pre and Post 1997 Forest Plan Results

An intensive survey of the Tongass road system has been conducted to identify the location and fish passage conditions of all fish stream crossings. This inventory is part of the Alaska Region Road Condition Survey (FSH 7709.58). This survey is aproximatley 99% complete on the approximately 3,600 miles of classified roads (roads determined to be needed for long-term motor vehicle access) and approximately 60% complete on the 1,500 miles of unclassified roads (roads not intended, or not yet determined, to be part of the forest transportation system and include temporary, unclassified and decommissioned roads). This survey, has to date, identified 3,070 fish stream crossings along classified roads and 253 fish stream crossings along unclassified roads.

An analysis of the fish passage capability at these stream crossings has been done and involves comparing existing conditions to today's standards. The vast majority of the drainage structures surveyed were installed before the implementation date of the Forest Plan. Forest Plan standards stipulate that juvenile fish will have unrestricted upstream passage within a defined range of stream flows. The stream flow at the upper end of this range is the stream flow that exists two days before and two days after a peak flow. The peak flow that is used is the flow that statistically recurs about once every two years and is known as the mean annual flood. This upper limit stream flow, or "fish passage design flow," is unique for each stream since it is based upon the specific hydrologic characteristics of that stream. It has been estimated that streams in Southeast Alaska have flows at or below this design flow approximately 98% percent of any given year. Therefore, in effect current fish passage standards stipulate that juvenile fish be able to successfully swim through culverts approximately 98% of the year.

The basic challenge of evaluating fish passage capability at culverts is to determine and compare fish swimming performance against culvert hydraulic conditions across a range of stream flows. Analytical software, entitled "FishXing", has been developed by the Forest Service to assist with these calculations. This software is designed to allow the user to input various criteria important to fish passage and estimate the effects on the fish's ability to move through the culvert at

different stream flows. Some of the input variables are fish swimming ability, culvert dimensions, roughness within the culvert and various streambed and culvert elevations.

To improve assessment efficiency, a Juvenile Fish Passage Evaluation Criteria Matrix was developed by a group of interagency, interdisciplinary professionals. The matrix increases assessment efficiency by creating a coarse sieve that quickly separates out the culverts that have conditions that can be assumed to meet standards from those that do not. It is then only necessary to do the more time intensive FishXing analysis on the culverts with less obvious fish passage conditions. The evaluation matrix stratifies culverts by type and establishes criteria thresholds for culvert gradient, stream constriction, debris blockage, and vertical barrier at the culvert outlet (perch) specific to each culvert type. Each culvert is placed into one of the three juvenile fish passage capability categories.

- GREEN Category: conditions that have a high certainty of meeting juvenile fish passage at all desired stream flows.
- RED Category: conditions that have a high certainty of not providing juvenile fish passage at all desired stream flows.
- GRAY Category: conditions are such that additional and more detailed analysis is required to determine their juvenile fish passage ability. This additional analysis includes use of the FishXing analytical software.

The fish passage evaluation criteria in the matrix are not culvert design criteria, because additional fish passage considerations may be required.

Culvert outlet perch is defined as the difference in elevation between the water surface at the hydraulic control located downstream of the culvert and the elevation at the bottom surface of the culvert outlet. This approach provides a flow dependent assessment of culvert perch. Previous calculations of culvert outlet perch on the Tongass used the difference in elevation between the hydraulic control located downstream of the culvert and the elevation at the bottom surface of the culvert outlet. Although this latter approach provides a flow independent estimate, it was found with field visits to often provided un-realistic over-estimates of perch height.

The gradient of a culvert, its perch and its width to streambed ratio were not used as criteria for determining fish passage capability if the culvert was backwatered. A culvert was determined to be backwatered in palustrine channels if the bottom surface of the culvert inlet was lower than the water surface downstream of the culvert. This exception to the standard assessment protocol was implemented after site visits to palustrine channels containing culverts with the afore-mentioned conditions indicated no fish passage concerns. However, since culverts in palustrine channels are often blocked by beaver debris, any blockage was identified as a concern. A culvert in non-palustrine channels was considered backwatered if the bottom surface of the culvert inlet was more than 3 inches lower than the hydraulic control located downstream of the culvert.

Across the forest, there are about 80 miles of Class I (anadromous fish) streams and 300 miles of Class II (resident fish) streams above Red Culverts. This includes the miles above Gray Culverts. About 50% of the Gray's will be classified as Red and 50% as Green. A minimum estimate of the miles of streams above the Green Culverts is approximately 150 miles (589 Green culverts x 1/4 mi/culvert = 147.25 mi).

The Tongass has approximately 16,093 total miles of Class I and 9,281 miles of Class II streams according to the most current GIS stream layer. The Red Culverts are affecting approximately 0.5% of the length of Class I's and 3.2% of the length of Class II's. Additionally, the Red Culverts are often on the smaller Class I and II streams as engineers traditionally avoid or cross larger streams with bridges.

A Forest Plan-related pilot study conducted in 1989 indicates that the GIS data provides an under estimate of the true lengths of both Class I and II streams. This has been further validated by recent timber recon and road condition surveys. The most recent road condition survey data from a sample of 12 watersheds show that for all of the fish streams, the GIS under estimates the number (not the length) of streams by about 13%. Interestingly for that sample, the GIS over estimates the number of Class I's and under estimates the number of Class II's. Again, the total for both stream classes was under estimated by 13%. So the true percentage of length of fish streams above Red Culverts is likely somewhat less than stated above.

Table Fish-8 provides the status of juvenile fish passage capability by structure type for all currently identified Class I fish streams (mainly salmon streams) and Class II fish stream crossings (resident fish streams) which have been completely surveyed along both classified and unclassified roads. The assessed fish stream crossings include culverts, bridges, fords and locations where the crossing structures have been removed. This survey is ongoing and not all fish stream crossings have been located nor have critical measurements required for fish passage assessments been completed on all identified fish stream crossings. In summary, of the 3,106 fish stream crossings, on both classified and unclassified roads, that have all necessary assessment measurements available, 53% are classified as “GREEN”, 40% as “RED” and 7% as “GRAY”. Approximately 36% of the crossings are Class I streams while the remaining 64% are Class II streams.

Table Fish-8. Juvenile Fish Passage Evaluation Criteria Matrix

STRUCTURE TYPE	GREEN CATEGORY Conditions assumed to meet passage standards for juvenile fish					GRAY CATEGORY Additional analysis required to determine status					RED CATEGORY Conditions assumed not to meet passage standards for juvenile fish				
	CRITERIA	Class I Crossings		Class II Crossings		CRITERIA	Class I Crossings		Class II Crossings		CRITERIA	Class I Crossings		Class II Crossings	
ROAD STATUS: (classified or unclassified)		Classified	Un-classified	Classified	Un-classified		Classified	Un-classified	Classified	Un-classified		Classified	Un-classified	Classified	Un-classified
Bottomless pipe arch or countersunk[1] pipe arch or countersunk cmp.	Culvert span to bed width ratio >= 0.9 AND no blockage OR backwatered[2] AND no blockage.	31	0	37	0	Culvert span to bed width ratio of 0.5 to 0.9 OR blockage >0% but <=10%.	7	0	16	0	Culvert span to bed width ratio <0.5 OR blockage >10%	7	0	19	1
Pipe arch or cmp with span greater then 48" and are not countersunk.	Culvert gradient <0.5% AND no perch AND no blockage AND culvert span to bed width ratio > 0.75 OR backwatered AND no blockage.	81	0	97	0	Culvert gradient between 0.5% - 2.0% OR perch >0.0' but <=4" OR blockage >0% but <=10% OR culvert span to bed width ratio between 0.5 to 0.75.	36	0	33	0	Culvert gradient >2.0% OR >4" perch OR blockage >10% OR culvert span to bed width ratio <0.5.	72	0	163	1
CMP with span less then or equal to 48" and are not countersunk.	(Culvert gradient <0.5% AND no perch AND no blockage AND culvert span to bed width ratio > 0.75) OR (backwatered AND no blockage)	77	0	110	1	Culvert gradient between 0.5% - 1.0% OR perch >0.0' but <=4" OR blockage >0% but <=10% OR culvert span to bed width ratio between 0.5 to 0.75.	21	0	59	2	Culvert gradient >1.0% OR >4" perch OR blockage >10% OR culvert span to bed width ratio <0.5.	134	2	800	7
Hydraulic Design Baffled Culverts	Hyrdraulic design baffled culverts with current design criteria	3	0	0	0	Hydraulic design baffled culverts with unknown design criteria	8	0	19	0	Not Applicable	0	0	0	0
Total Culvert Crossings		192	0	244	1		72	0	127	2		213	2	982	9
Bridges, fords or removed structures	No road fill caused blockage	549	79	452	135	Not Applicable	0	0	0	0	Road fill causing blockage. Water piping through road fill	6	4	28	9
Total Crossings		**741**	**79**	**696**	**136**		**72**	**0**	**127**	**2**		219	6	1010	18

[1] For a culvert to be considered countersunk it must have 100% bedload coverage within it and have an average bedload coverage depth of equal or greater then 20% of the culvert rise.

[2] For a culvert to be considered as backwatered the hydraulic control located downstream of the culvert must be at least 3" higher in elevation then the upstream invert of the culvert. If the downstream channel is palustrine then the water surface directly downstream of the culvert must be higher in elevation then the upstream invert of the culvert for it to be considered as backwatered.

Figures Fish-11 and Fish-12 illustrate the status of juvenile fish passage assessments for both Classified and Unclassified roads. In addition to culvert crossings, these figures include fish streams crossed by bridges, fords, crossings where the structures have been removed and those that have an incomplete set of assessment measurements available for them.

Along classified roads (Figure Fish-11), 3,070 fish crossings have been identified; 35% of these are Class I streams and 65% are Class II streams. Approximately 40 percent of the crossings are assumed not to meet juvenile fish passage standards. This mostly includes the Red culverts but several removed culverts and log bridges were a barrier to juvenile fish passage due to bridge collapse and improper structure removal. A bridge collapse or improper structure removal resulted in the stream flowing subsurface through the course roadfill especially at lower flows. The majority (82%) of the Red crossings are located in Class II streams. Approximately 47 percent of the crossings are assumed to meet juvenile fish passage standards. This includes Green culverts and almost all of the bridges,fords and removed structures. Approximately 6 percent of the crossings are Gray culverts and require more extensive analysis. Approximately 7 percent of the crossings have incomplete measurements.

Along unclassified roads (Figure Fish-12), 253 fish crossings have been identified; 35% of these are Class I streams and 65% are Class II streams. Approximately 9 percent of the crossings are assumed not to meet juvenile fish passage standards. One-half of the crossings assumed not to meet passage standards are culverts while the other one-half are collapsed log bridges or improperly removed structures. The majority (75%) of the crossings assumed not to meet passage standards are located in Class II streams. Approximately 85 percent of the crossings are assumed to provide juvenile fish passage. This includes Green culverts and most fords, removed structures and bridges. Less than 1 percent of the crossings are Gray culverts that require more extensive analysis. Approximately 5 percent of the crossings are culverts that have incomplete measurements.

Figure Fish - 11. Juvenile Fish Upstream Passage Assessment - Percent of Various Stream Crossing Types in Class I and II Streams along Classified Roads

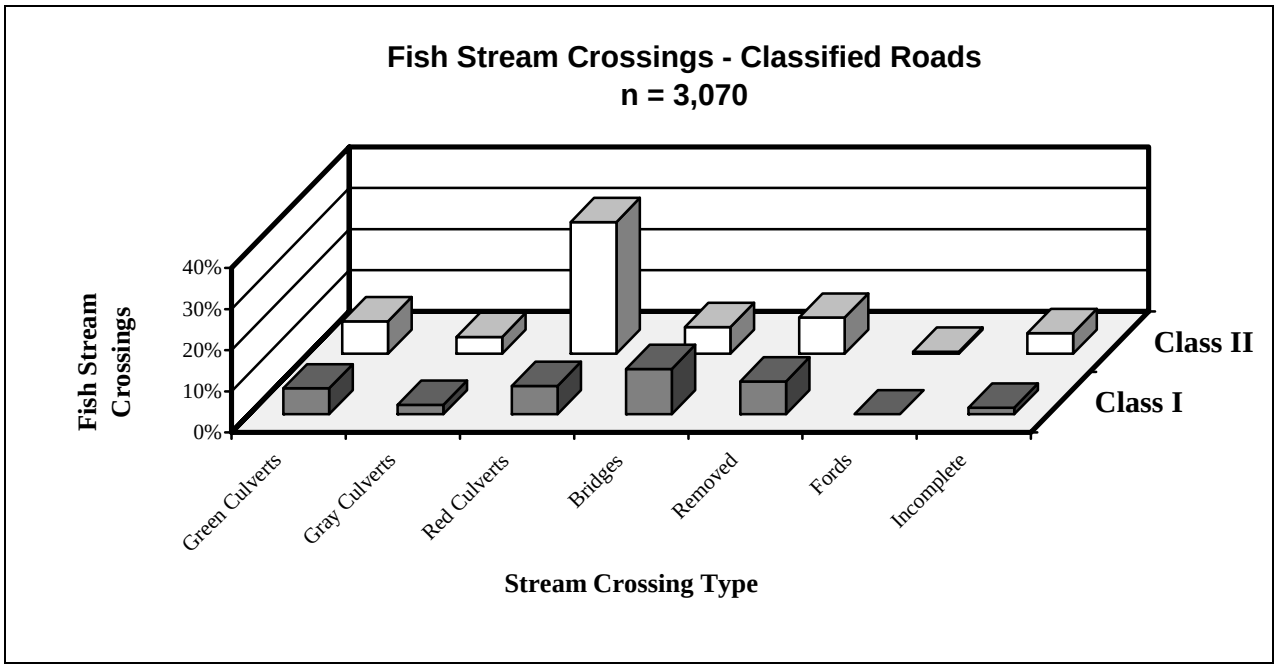
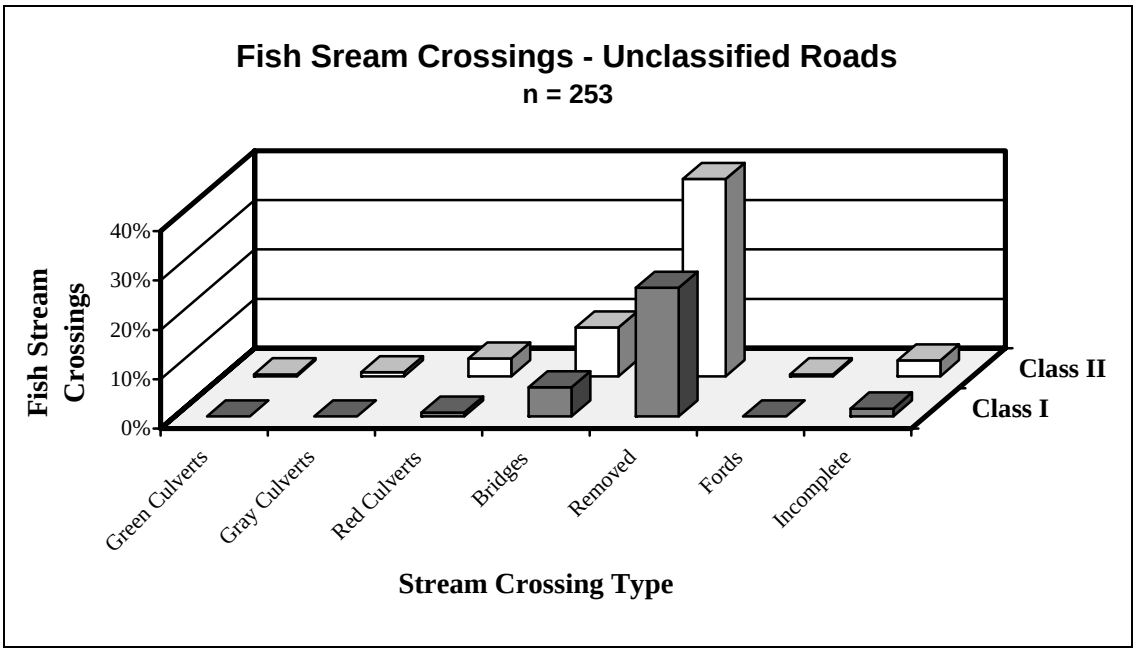


Figure Fish - 12. Juvenile Fish Upstream Passage Assessment - Percent of Various Types Stream Crossing in Class I and II Streams along Unclassified Roads



Post 1997 Forest Plan Results

An evaluation of juvenile fish passage capability was completed on 163 stream crossings that have been identified as meeting the criteria of being recent installations subject to current Fish Passage Standards and Guidelines. The evaluation consisted of design review and/or post installation measurements of the physical characteristics of the culverts with respect to the stream morphology. The evaluated culverts were installed from 1997 through 2004 on 7 different Ranger Districts.

The results indicate that 138 (85%) of the stream crossing structures have been installed in a manner that meets current juvenile fish passage standards, 18 (10%) of the stream crossing structures are assumed not to meet current juvenile fish passage standards and 5 (3%) of them require additional analysis to determine their fish passage capability.

During 2004, 19 stream crossings that were not meeting juvenile passage standards were replaced. A review of the designs of the replaced structures indicate that juvenile passage standards were achieved. Fifteen of the 19 stream crossings were replaced with culverts that simulated natural stream conditions (i.e., stream width, gradient, substrate and pool depth and spacing). The remaining 4 fish stream crossing structures were replaced with bridges.

The evaluation of post 1997 drainage stuctures was a cursory review and requires additional more refined assessment to more accurately determine if juvenile passage standards have been met at new culvert installations. The cursory evaluation utilized, in part, the Juvenile Fish Passage Evaluation Criteria Matrix, which is intended only as a coarse assessment process. It is not known if all the culverts assessed in this review were designed with current design criteria, or

if they were, if the design was implemented. Therefore, this evaluation only assessed if existing culvert conditions were present which would provide for juvenile fish passage and does not necessarily assess the effectiveness of current design criteria.

Evaluation of Results

There is currently a strong initiative toward maintaining, restoring and improving fish passage along Tongass National Forest Roads. The initial inventory and survey of all fish streams and their passage conditions along Forest roads continues and is nearing completion. The number of fish stream crossings identified and completely assessed has increased from 304 in 1998 to 2,666 in 2004 (Figure Fish-13). The completely assessed crossings are fish crossings at which all required measurements for analysis has been collected and the analysis has been completed. Therefore, the completely assessed crossings do not include Gray crossings or those that are missing some or all the measurements required for analysis. Through the cooperation of an interagency group, a state-of-the-art fish passage assessment model has been developed and is being continuously improved. A set of interim design criteria for drainage structures in fish streams has been developed. Education and training opportunities are available for Forest personnel responsible for ensuring fish passage at road crossings. A research study that seeks to better understand the movement patterns, thus the passage needs, of headwater populations of cutthroat trout and Dolly Varden char is in progress. Results from this fish movement study will be used to evaluate the current fish passage standards. A process to establish a prioritized remediation action plan is currently being developed by an inter-agency group. Over 1,400 surveys that identify the quality and quantity of fish habitat upstream of impaired crossings have been completed. These surveys indicate that the average length of habitat upstream of Red crossings is approximately 450 meters and the median length is approximately 250 meters (Figure F-6). An improved approach to data management and project tracking is being developed. Fish passage remediation projects have been implemented. This includes removal of culverts along roads no longer required to remain drivable and the replacement of passage impaired culverts with state-of-the-art culvert installations.

It is important to emphasize that fish are assumed to be able to pass through most of the culverts identified in the Red and Gray categories most of the year. Most of these culverts do have fish located upstream of them. Specialists are mostly concerned that passage may not be possible for juvenile fish during periods of high stream flow. The results presented are for juvenile fish passage, and it is likely that stronger swimming adult fish are not restricted in most of the structures. Field measurements are being used for the *FishXing* Software to analyze questionable streams and determine if adequate fish passage is provided.

The drainage structures assessed for their consistency with current juvenile fish passage standards in the section of the report entitled Pre and Post 1997 Forest Plan Results include drainage structures installed at various times with various fish passage design standards under the Forest Plan. Therefore, the results should not be necessarily interpreted to conclude that the reason for a specific structure not meeting the current standards is due to negligent structure design. The results do provide a baseline of current but preliminary fish passage conditions that can be used to track the commitment and progress toward maintaining, restoring or improving the opportunities for fish migration on the Tongass National Forest (Figure Fish-14).

Figure Fish - 13. Number of Fish Stream Crossings Assessed for Fish Passage Capability on Classified Roads as Reported Over Time

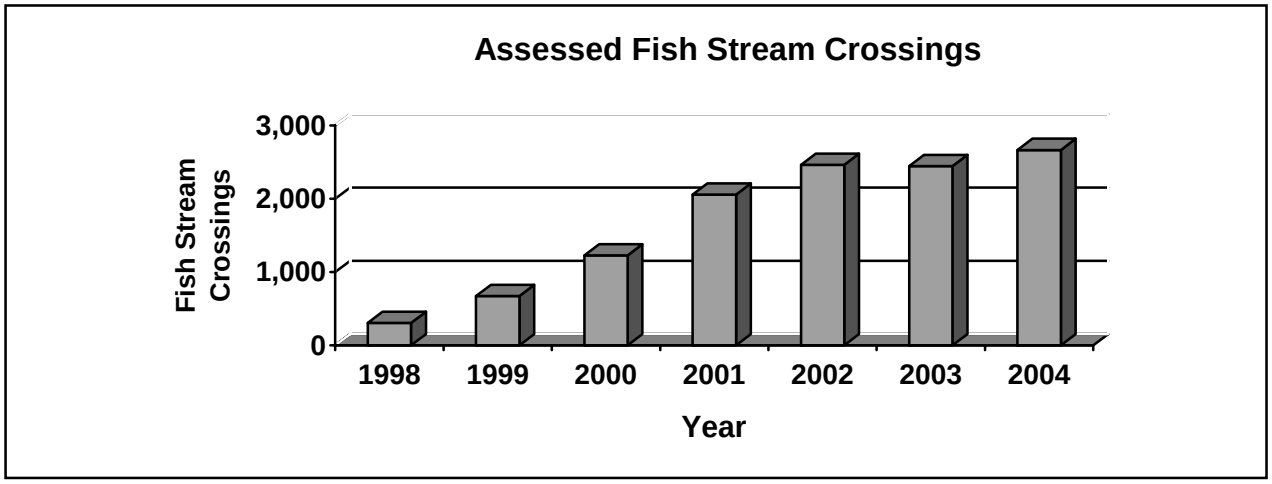


Figure Fish - 14. Percent of Assessed Fish Stream Crossings on Classified Roads that Meet Juvenile Fish Passage Standards as Reported Over Time

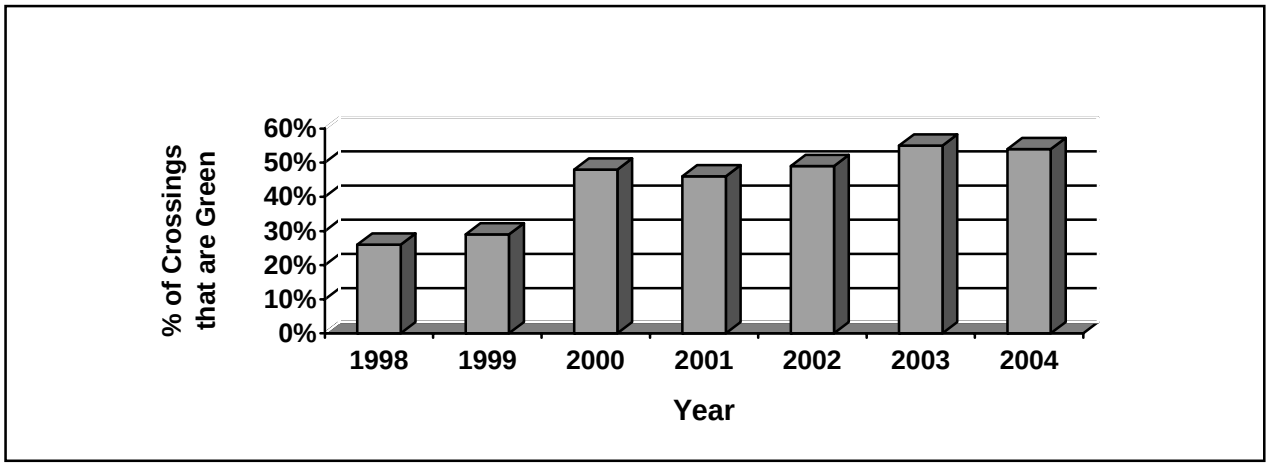
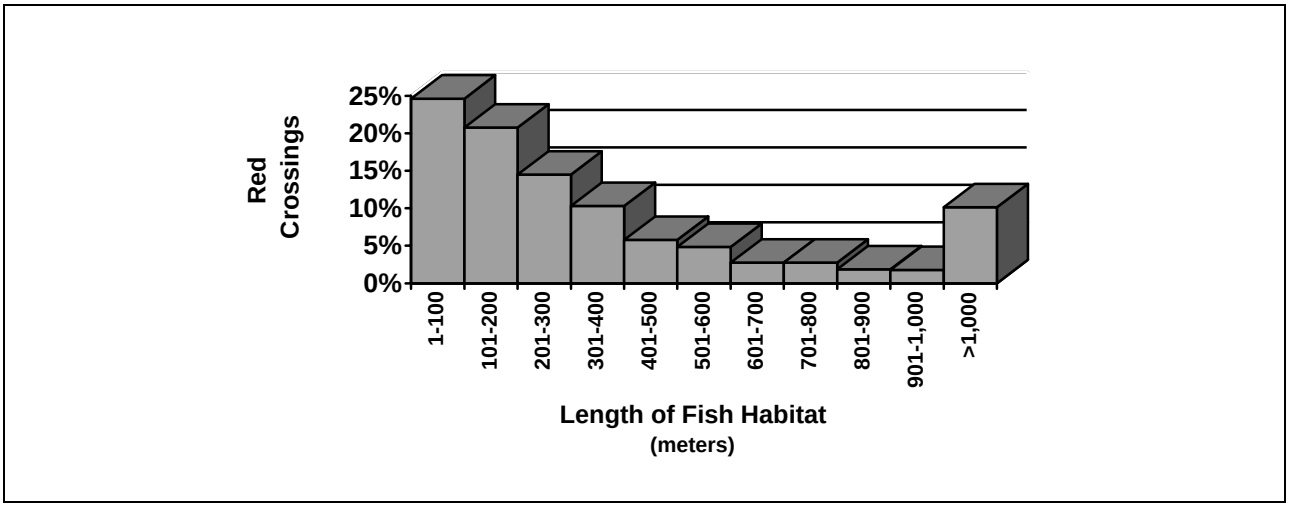


Figure Fish - 15. Length of Fish Habitat Upstream of Fish Crossings not Meeting Juvenile Fish Passage Standards



The assessment of fish passage capability through culverts installed in fish streams since the effective date of the 1997 Forest Plan indicates a dramatic improvement from previous installations. Of the 163 culverts identified as post Forest Plan, 138 or 85% of the culverts have been installed in a manner that meets current juvenile fish passage standards. An evaluation of 1,572 culverts identified as pre Forest Plan installations indicate that 271 or 17% of the culverts meet juvenile fish passage standards.

Fifteen of the 18 post 1997 Forest Plan culverts identified as potentially not meeting juvenile passage standards were installed before 2001. More recently installed culverts have a greater tendency to have conditions that meet juvenile fish passage standards. This improvement is attributed to a greater awareness and incorporation of improved culvert designs. In recent years, a set of interim culvert design criteria have been developed, which better ensure that juvenile fish passage will not be impaired. These design criteria better recognize the importance of designing a drainage structure to fit the characteristics of the stream. More recently, a greater emphasis has been placed on using stream simulation concepts in culvert design. Stream simulation includes embedding a culvert at natural stream grade, sizing it to the streams bank full width and backfilling it with streambed and riprap material to mimic stream characteristics. An advantage of stream simulation designs is that these designs are not dependent on the validity of assumptions pertaining to fish performance, stream hydrology and culvert hydraulics, as are hydraulic designs. Successful stream simulation provides the assurance that all aquatic species and life stages present are able to pass through the culvert with the same level of difficulty as that found in the natural stream channel.

An occasional problem with new culvert installations in fish streams has been applying “typical” or standard designs without fully considering stream conditions. To provide fish passage, typical designs attempt to minimize culvert gradient. Several of the culvert installations inappropriately applied typical designs that resulted in the channel responding occasionally with severe stream head cutting upstream of the culvert.

Fish streams not identified as fish streams requiring passage prior to new road construction were also determined to be a reason for post Forest Plan crossings not meeting passage standards. The identification of crossings requiring fish passage prior to construction is thought to have improved but the ability to consistently identify those with very marginal habitat conditions remains challenging.

In summary, monitoring results indicate an encouraging trend toward improved fish passage at culvert installations. This trend is attributed to the application of improved inventory, design concepts, and criteria.

Fish Passage at Road Crossings Recommendations

The Tongass National Forest strives for an adaptive management approach to achieve the goals and objectives of the fish passage at road crossings program. Adaptive management is essential to assure that the assumptions that are prevalent in the assessment and restoration of the crossings are correct and that our actions are functional. The knowledge and tools to assess fish passage capability at road crossings and the design of crossing structures are evolving. The fish passage analysis model currently is based upon assumptions on stream hydrology, culvert hydraulics, fish swimming abilities, and fish migration needs. These assumptions need to be tested for verification and against the Forest Plan fish passage criteria. Work on testing these assumptions and better defining the criteria used in the model is under progress. Expanded application of the model has been initiated and additional data continues to be collected and analyzed annually. In an effort to learn additional information about resident fish migration patterns, an administrative study was initiated in fiscal year 2001. This ongoing study investigates the migratory behavior of Dolly Varden char and cutthroat trout in headwaters. This study will provide a better understanding of the stream flow conditions and season that these fish naturally move during. Although this study is ongoing some preliminary results are emerging. Spring and fall are the periods when most upstream movement occurred and most fish appeared to move less then 100 meters with more of the fish moving downstream than upstream. Analysis of fish movement as related to stream stage is very preliminary but data is becoming available that defines the upper and lower stream stages during which fish are capable or desire to move upstream. Upon completion of this study, the fish passage analysis model and additional field trials, modification of the design flow Standards for culverts to provide unimpeded passage for these species may be required. This information will eventually allow culverts to be designed appropriately.

Recommendations follow that monitoring of hydraulic and structural conditions continue at culverts recently installed (i.e., designed and installed under the direction of the Forest Plan) in fish bearing streams. This monitoring effort is necessary to assess the achievement of fish passage and will assist in the evaluation of the success of design, maintenance and other management actions. Monitoring the structural and hydraulic conditions of new culverts installed in fish bearing streams is especially important as the Forest applies innovative design concepts and criteria in its aggressive program to restore and improve fish passage.

Proposals include development of a task group to review the current content, approach and evaluation criteria for monitoring the effectiveness of Forest Plan Fish Passage Standards and Guidelines. The task group would consult with the Interagency Monitoring and Evaluation Group (IMEG) and may recommend changes to the Monitoring and Evaluation Plan contained in the Forest Plan. Issues for discussion include: 1) Refining effectiveness monitoring objectives

and protocol. 2) Providing better integration of fish passage implementation and effectiveness monitoring. 3) Improving the process for the identification and reporting of drainage structures installed or reinstalled in fish streams on an annual basis so effectiveness monitoring sample populations can be better defined. 4) Relating contract as built drawings to record baseline conditions to provide for improved follow-up effectiveness monitoring.

There is currently substantial funding available to correct fish passage problems identified through the survey and analysis process. In FY 2005, survey, design and construction of additional structures to improve fish passage will be ongoing.

The Forest Plan directs us to use fish habitat objectives to evaluate aquatic habitat health. These objectives were developed from physical stream attributes (channel morphology, pools, wood, substrate, etc.) measured in harvested and unharvested watersheds (USDA Forest Service 1995). The attributes are stratified by stream channel process group (Paustian et al 1992) and displayed as percentiles to reflect the natural variability of habitat features. Table Fish-9 displays the current Tongass National Forest fish habitat objectives for Floodplain (FP) and Moderate Gradient Mixed Control (MM) streams.

Table Fish-9. Tongass National Forest Fish Habitat Objectives, November 2003. (Bryant et al in press)

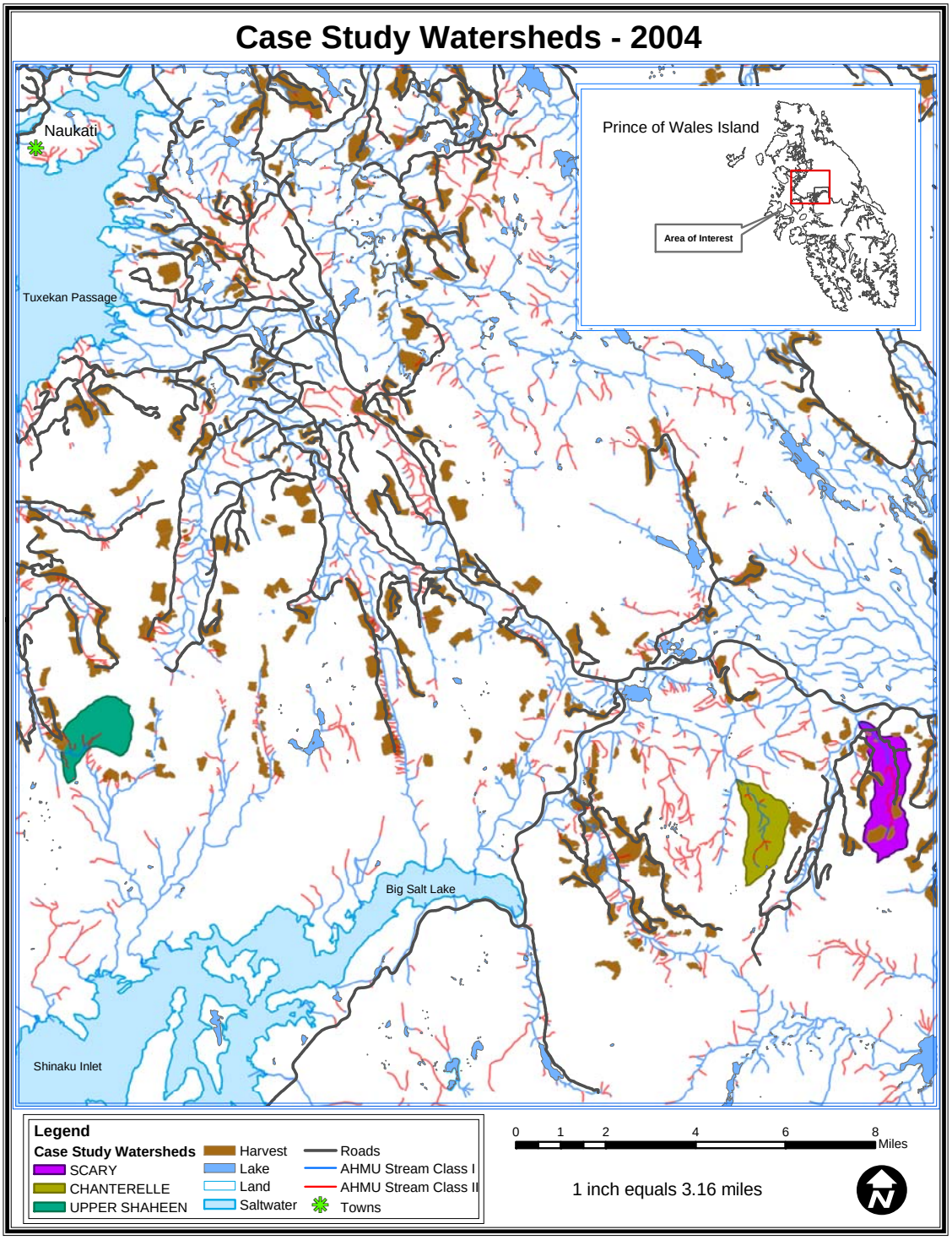
Habitat Attribute (units in meters unless otherwise specified)	Percentiles	Process Group=FP		Process Group=MM	
		Harvested		Harvested	
		NO	YES	NO	YES
Channel bankfull width/depth ratio	25	18.0	18.6	5.8	13.9
	50	23.5	23.8	10.7	18.4
	75	33.6	38.4	16.1	23.7
Total large wood pieces / stream length surveyed	25	.23	.16	.21	.19
	50	.33	.25	.30	.25
	75	.47	.49	.47	.29
Total key pieces large wood / stream length surveyed	25	.04	.07	.04	NA
	50	.09	.10	.10	NA
	75	.19	.13	.12	NA
Number of pools / stream length surveyed (kilometers)	25	24.6	21.4	41.7	24.5
	50	41.0	28.3	51.0	34.9
	75	52.7	36.2	68.4	44.9
Pool spacing (stream length surveyed / channel bed width) / total number of pools	25	.46	.22	.20	.45
	50	1.84	.57	.37	.62
	75	5.49	4.52	.71	2.22
Average residual pool depth / average channel bed width	25	.039	.035	.066	.048
	50	.045	.042	.075	.056
	75	.060	.046	.098	.076
Median particle size (D50) (millimeters)	25	20	20	25	32
	50	29	30	49	43
	75	50	51	83	143
Total pool length / stream length surveyed	25	.32	.32	.17	.35
	50	.48	.50	.29	.38
	75	.56	.66	.37	.55

An analysis of channel condition assessment reaches across the forest concluded that very large sample sizes and/or long term data would be necessary to achieve sufficient statistical power to successfully discriminate habitat measurements in unharvested watersheds from those with management practices consistent with the current Forest Plan (Woodsmith et al in press). This finding supports the case study approach, where stream, riparian, and upland data are intensively evaluated in a few carefully selected locations over the long term in order to provide a watershed context to interpret fish habitat responses to Forest Plan implementation.

A set of three case study watersheds has been established as part of the Forest Plan aquatic monitoring synthesis (see Figure Fish-16 Case Study Watersheds). The goal of the Aquatic Synthesis is to evaluate the effectiveness of Forest Plan standards and guidelines in protecting

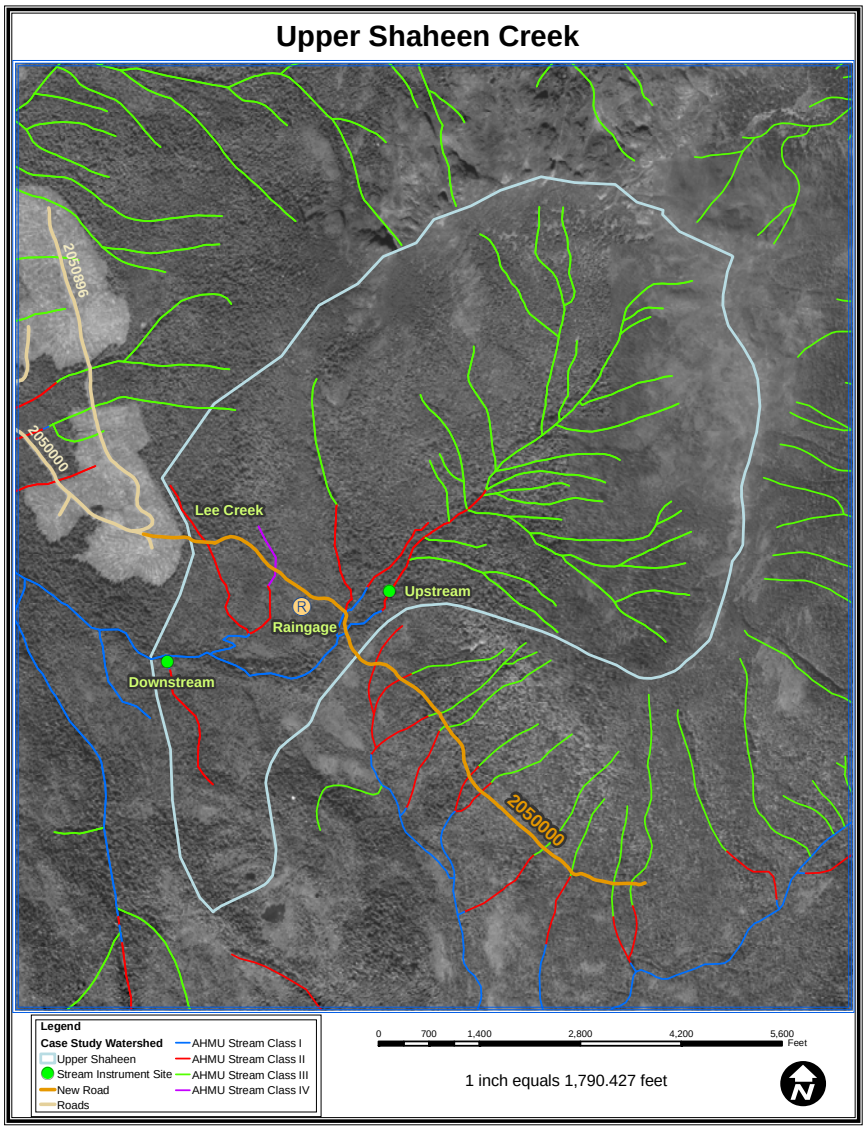
aquatic resources such as fish habitat at the watershed scale. The Aquatic Synthesis includes objectives for stream biota and habitat, water quality, stream flow, soils, wetlands, and riparian and upland vegetation (Thompson 2004).

Figure Fish - 16. Case Study Watersheds



The case study watersheds are small third-order watersheds, about 1000 acres each, within the Central Prince of Wales Volcanics Ecological Subsection (Nowacki et al 2001). Chanterelle Creek serves as a long term reference with no roads or timber harvest. Scary Creek is a cumulative effects treatment with existing timber harvest and road system. Upper Shaheen Creek reflects pre- and post-treatment conditions as roads and timber harvest progress according to the Forest Plan. We were unable to match fish population distributions in all three watersheds[2] as originally directed by the Interagency Monitoring and Evaluation Group (IMEG). This will require an adjustment of the case study watershed objectives to be described in a modified study plan. The study plan will be presented to IMEG for review and comment in 2005.

Figure Fish - 17. Upper Shaheen Creek



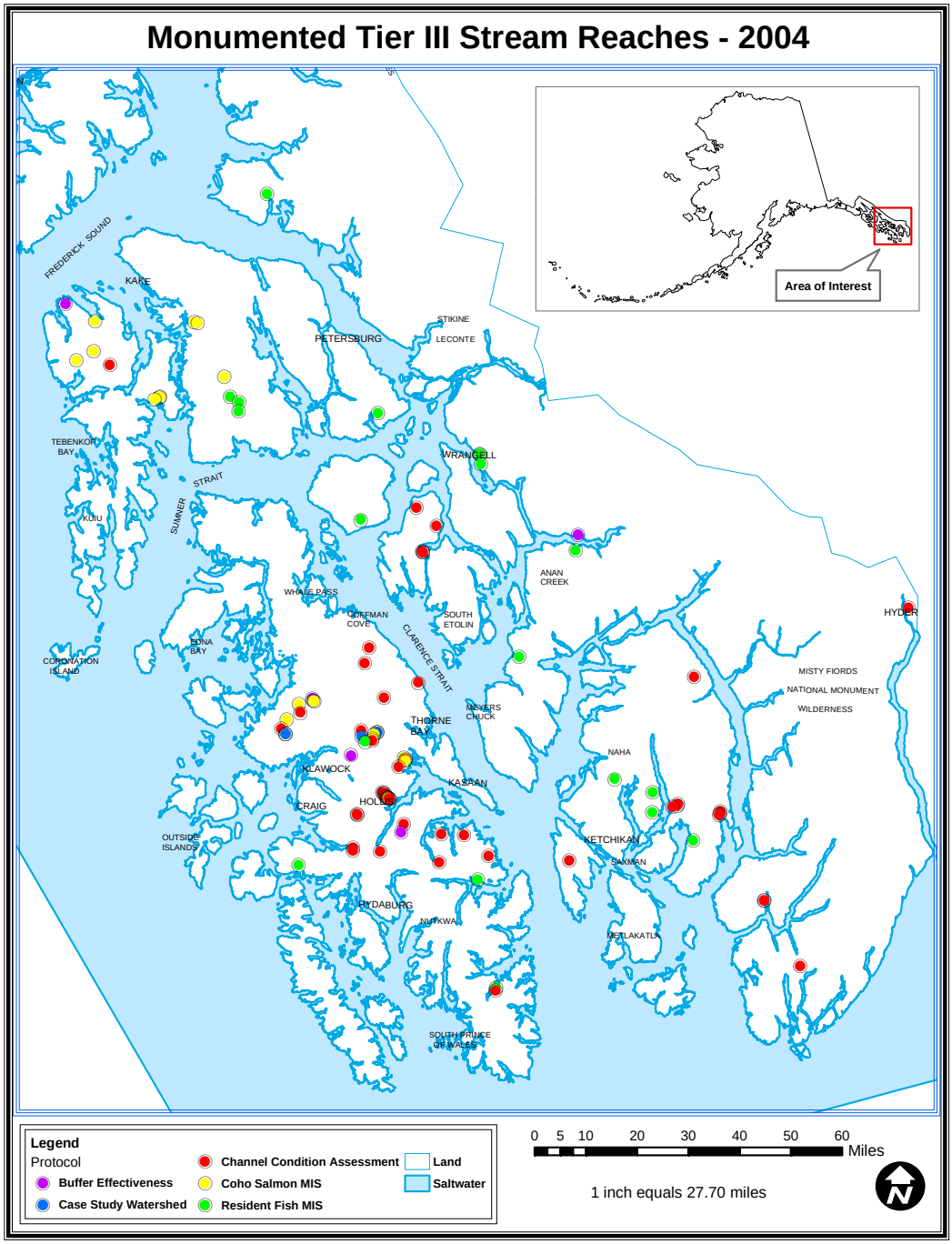
2 Chanterelle and Scary each have substantial barrier falls that isolate resident fish populations in headwaters from downstream anadromous fish. Upper Shaheen lacks a discrete barrier. Coho salmon populations in Chanterelle Creek are influenced by the Rio Roberts fish ladder constructed downstream in 1988.

In 2004, we established a total of six new stream habitat monitoring reaches in the case study watersheds. One reach near the mouth of each case study watershed has no specific fish population objectives. In addition to these, Chanterelle Creek has a new resident fish MIS reach, Scary Creek has a new resident fish reach (as well as a previously established coho salmon MIS reach), and a tributary to Upper Shaheen (Lee Creek) has a new coho salmon MIS reach. Habitat data from these reaches will be integrated with other watershed data, providing reference conditions to calibrate data from a forest-wide network of stream monitoring reaches. We will examine storm events, windthrow, and new landslides in the case study watersheds and evaluate responses to these disturbances. Stream channels will naturally respond to watershed disturbance. The types and magnitude of these responses must be considered during evaluation of monitoring results.

Figure Fish - 18. Tier III habitat survey, Scary Creek, 2004

More extensive fish habitat monitoring will proceed in concert with ongoing statistical analysis of data from a network of over 150 established stream habitat monitoring reaches across the Tongass National Forest (see Figure Fish-9). These data include physical stream attributes measured during stream buffer effectiveness, channel condition assessment, and coho salmon, resident cutthroat and Dolly Varden char MIS monitoring efforts. Measurements are compatible with survey procedures (generally Tier III) described in the Forest Service's Alaska Region Stream Survey (USDA Forest Service 2001). The objective of this analysis is to evaluate variability and trends in aquatic habitat conditions across the Tongass National Forest, continuing to update the fish habitat objectives in Table Fish-8 accordingly.

Figure Fish - 19. Stream Monitoring Reaches



Analysis of a subset of these data (the channel condition assessment reaches) successfully discriminated between unharvested and heavily harvested watersheds, implying that these data could be used to quantify cumulative watershed effects and focus watershed restoration planning efforts (Woodsmith et al in press). We are developing a decision support model that will eventually integrate reach-level habitat data with watershed scale data (landslides, road erosion, etc) to assess watershed condition across the Tongass National Forest. The Aquatic and Riparian

Effectiveness Monitoring Plan (AREMP) for the Northwest Forest Plan uses a similar approach (Reeves et al 2004).

Crew training, experience, and standard protocols for these surveys are critically important to minimize variability associated with measurement error (Woodsmith et al in press). In 2004, we reviewed quality assurance procedures and evaluated replicate data collected by crews monitoring habitat at fish MIS reaches. Our findings emphasize the need for continued use of experienced crews and close attention to documented standard operating procedures for data collection and data management for all aquatic habitat monitoring efforts.

Actions Recommended for 2005

We recommend no changes to Forest Plan standards and guidelines for protecting fish habitat at this time. The following specific actions are recommended for 2005:

1. Continue measurement of established Tier III stream habitat reaches associated with fish MIS efforts and locations with pre- and post-treatment monitoring objectives, including case study watersheds.
2. Complete baseline landslide inventory and analysis upstream of all resident fish MIS reaches, and any other long term Tier III stream monitoring reaches.
3. Maintain case study watershed data collection and analysis according to modified objectives in updated study plan, subject to IMEG review.
4. Continue emphasis on crew training and quality assurance procedures. Document standard operating procedures for Tier III surveys for aquatic monitoring.
5. Compile all compatible habitat data relevant to fish habitat objectives into a single database. The utility of stream habitat data for effectiveness monitoring in the Tongass National Forest awaits complete statistical analyses. This analysis will also help determine an appropriate distribution of reaches and measurement frequency.

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