Report to Congress

Anadromous Fish Habitat Assessment

January 1995

United States Department of Agriculture
Forest Service
Pacific Northwest Research Station
Alaska Region

R10-MB-279

TABLE OF CONTENTS

Introduction 1

Objective 1

Scope of Assessment 1

Perspectives on Salmonid Habitat 2

- Marine Ecology 2
- Freshwater Habitat 2
- Habitat Disturbance 3
- Habitat Management 4
- Hatcheries 4

Methods 5

Results 6

- Directive 1 - Effectiveness of Current Procedures 6
  - The Literature Review 7
  - The Expert Field Review 7
  - Watershed Analysis 8
  - Monitoring on the Tongass 9
  - Summary of Results Pertaining to Directive 1 9
- Directive 2 - Additional Needs 10

Recommendations 11

- Improvements Recommended for Examination in the Tongass Land Management Plan 11
- Improvements Recommended for Strengthening Habitat Protection Under Current Direction 12

Conclusions 14

Information Base 19

INTRODUCTION

The Conference Committee Report on the Fiscal Year 1994 Congressional Appropriations Act (Appendix A) directs the USDA Forest Service to respond to the following two directives on fish habitat management in the Tongass National Forest:

> **Proceed with stream analyses and studies and review procedures related to the PACFISH strategy in 1994 in order to study the effectiveness of current procedures** [for protecting the habitat of anadromous salmonids].
>
> **Determine if any additional protection** [for anadromous fish habitat] **is needed.**

Numerous species and discrete spawning populations (stocks) of Pacific salmon, steelhead trout, and anadromous cutthroat trout represent outstanding natural resources in Southeast Alaska. The Alexander Archipelago and the mainland of Southeast Alaska support one of the most productive and highly valued salmon fisheries in the world. The commercial salmon fisheries yield 160 million pounds (average annual production from the Tongass) worth about $250,000,000 annually and provide over 5,000 direct jobs in the Southeast Alaska economy. The sport fishing industry is smaller in economic and employment effects, but this sector is growing at an average of 10 percent per year. Sport fishing now provides over 1,200 direct full-time job equivalents with over $28,000,000 in earnings and 250,000 angler days. Sport fishers spend more than $90 for each salmon caught. The subsistence harvest of salmon is in excess of 1.2 million pounds annually. Harvesting salmon in traditional areas is important to sustaining the Tlingit, Haida, and Tsimshian cultures. Activities associated with salmon produce the most natural resources jobs annually in Southeast Alaska. The long-term conservation of a harvestable surplus of salmon and steelhead across the Tongass is essential to the economic future of Southeast Alaska.

Objective

The objective of this assessment is to provide a technical response to the two Congressional directives contained in the Conference Committee Report.

Scope of Assessment

(1) A broad temporal and spatial perspective was used to respond to the two Congressional directives.

(2) The assessment is a joint product of the Forest Service Alaska Region and Pacific Northwest Research Station.

(3) The assessment was a technical and scientific analysis directed specifically to respond to the two Congressional directives.

(4) The assessment is not a direction-setting document nor does it imply or suggest applying, or not applying, PACFISH to the Tongass National Forest.

(5) The recommendations are not intended to apply on lands other than those on the Tongass National Forest.

(6) The information applies to the habitat of all anadromous salmonids on the Tongass National Forest, with emphasis on Pacific salmon and steelhead and their habitats.

(7) The assessment was directly focused on current timber harvest and associated procedures, and their implementation, for managing anadromous fish habitat--that is, since passage of the Tongass Timber Reform Act of 1990.

Perspectives on Salmonid Habitat

Pacific salmon and steelhead in Southeast Alaska have complex life histories that depend on both marine and freshwater environments. Reproduction is in freshwater streams, primarily in forested watersheds, where adults must reach spawning grounds, eggs hatch, and juveniles rear for a variable period before they migrate downstream to the sea. Juvenile fish in the sea feed voraciously, grow and mature into adults over one or more years, and then return, generally to the same freshwater streams, to reproduce. Maintaining salmon and steelhead stocks and populations, then, depends on favorable conditions in both freshwater and marine environments. Salmon and steelhead populations can become stressed if either marine or freshwater habitat quality declines. Rapid movement towards extinction is possible if both marine and freshwater habitat productivity decline simultaneously.

Marine Ecology. The productivity of marine waters in the Gulf of Alaska, and thus the survival of salmon and steelhead in Southeast Alaska, are both highly variable and cyclic. Productivity is heavily influenced by the subarctic boundary current flowing into the eastern Pacific Ocean along the west coast of North America. Over cycles of about 20 to 30 years, the current flows predominantly north into the Gulf of Alaska, or alternatively south along the coast of British Columbia, Washington, Oregon, and northern California. When the current flows north, salmon and steelhead from Southeast Alaska enjoy exceptional marine survival. That favorable condition has persisted in Alaska for about the past 15 years and is currently reflected in high commercial, sport, and subsistence catches of salmon. Oceanographers indicate that the cycle is likely to reverse again within the next decade, leaving Alaskan marine waters less productive than now. Salmon and steelhead populations and catches will probably decline, and maintaining the freshwater habitats in good condition during these periods of unfavorable ocean conditions is essential to maintain viability and productivity of salmon and steelhead populations. Based on Alaska catch records (1900-present), the low point of the last current cycle was in the mid-1970s, and the high point appears to have been reached in the early 1990s.

The number of salmon and steelhead harvested in one year, or for a few consecutive years, is not by itself a measure of the health of individual stocks or of freshwater habitat conditions. Salmon harvests in any one year are determined by many factors, including number of salmon successfully hatched and reared in freshwater, salmon survival at sea, hatchery releases and their survival at sea, fish harvest regulations, weather, number of fishers participating in the fishery, and successful returns to freshwater spawning habitats. It is critical to recognize that populations fluctuate on a long-term-cyclical basis and therefore future fluctuations can be anticipated.

Managing fishery harvest can affect the status of salmon and steelhead stocks. The traditional goal of fish harvest management is to keep catches at or near the maximum yield that populations can sustain. Inherent in that goal is maintaining a harvestable surplus of fish well above what is needed to sustain stock viability. If stocks are overharvested, they can recover when harvest is reduced if both marine and freshwater habitats are healthy and productive.

Freshwater Ecology. Salmon and steelhead have exacting freshwater habitat requirements and are vulnerable to human-caused changes in habitat quality. The fish have adapted to the variable conditions in stream environments along the Pacific coast and in the Gulf of Alaska since the last major period of

deglaciation. As a result, steelhead and the five species of Pacific salmon are now segregated into stocks that are specifically adapted to local landscapes, and many stocks, presumably, to local watersheds. The quality of fish habitat in any stream depends on the condition of the area that it drains. Thus, watersheds are the basic active unit of forested landscapes; they control the quality of salmon and steelhead habitat and, to a large extent, the populations of anadromous fish present and numbers of fish that can be sustainably harvested.

The Alexander Archipelago contains many islands with small watersheds and short stream systems that together are believed to contain numerous stocks of salmon and steelhead. A stock can be recognized under the Endangered Species Act, and can therefore be listed as either threatened or endangered if population size and trend, or threats to habitat, warrant. The populations of individual stocks in these short stream systems are small, making them highly vulnerable to watershed disturbances that affect the quality of freshwater habitat. Significant disturbance of habitat in these watersheds, coupled with poor marine conditions and continued intense fish harvest, can quickly place stocks with small populations at high risk of extinction.

Habitat Disturbance. Watersheds in Southeast Alaska are disturbed by both natural events and human activities, but the effects of these disturbances on fish habitat are generally different. The primary differences are related to the frequency and extent of disturbances across forested landscapes, and the potential for recovery of disturbed landscapes and fish habitats.

Natural disturbances (e.g., floods, landslides, windthrow of trees, insect outbreaks, earthquakes) that create spatial and temporal variability in fish habitats across forested landscapes can cause negative effects to fish habitat. These disturbances, however, are infrequent and sporadic so that whole watersheds are rarely affected by a single event. Also, the recurrence interval for large natural disturbances such as earthquakes and glaciation is often in the range of centuries to millenia for any given site. Because usually only a small area of the landscape is affected at any one time, and disturbances are infrequent, refuges are usually available to assure survival of salmon and steelhead stocks until the disturbed area recovers naturally, which might take a century or more. Salmon and steelhead stocks have evolved adaptive strategies to cope with the effects of natural disturbances, and consequently, are rarely placed at risk of extinction from natural events.

Human disturbances are typically more frequent and widespread than natural disturbances. The most common forms of human disturbance in forested watersheds of Southeast Alaska are logging and road construction. Projected harvest schedules on the Tongass National Forest would mean that most forested acres in any watershed classified as suitable-available under the Tongass Land Management Plan would be harvested during a timber rotation cycle, if allowable sale quantity was maintained throughout the rotation. Because logging is projected for all watersheds containing suitable-available acres during a rotation, and could be planned to recur over the entire area for repeated rotations, the disturbance could be relatively frequent in both time and space across the entire landscape subject to timber harvest. The cumulative effects[1] of frequent disturbances in the Pacific Northwest have been

---

[1] "Cumulative effects" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably forseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ Guidelines, 40 CFR 1508.7, issued 23 April 1971). Effects and impacts as used in these regulations are synonymous (1508.8 (b)).

shown to substantially reduce the quality of freshwater fish habitats resulting in negative consequences for species, stocks, and populations of fish that depend on them, even if coniferous cover is left in buffer strips along the fish-bearing streams. Fish-bearing streams represent only a small portion of stream mileage in any watershed. Because recovery of fish habitat from the effects of extensive logging in a watershed may take a century or more, recovery may never be complete if forests are clearcut harvested and watersheds are disturbed extensively on rotation cycles of about 100 years. Few refuges remain in a watershed that fish can use during such widespread, intense, and recurrent disturbances. Because extensive large clearcuts have no analogue in natural disturbance regimes of Southeast Alaska, salmon and steelhead most likely have not developed adaptive strategies to cope with such unnatural disturbances.

Should freshwater habitats be degraded for long periods, salmon and steelhead stocks will eventually be confronted simultaneously with low marine productivity and degraded freshwater habitat. The likely result of such double jeopardy could be high, long-term risk of extinction. Although the double jeopardy risk to individual stocks may be watershed by watershed, the overall risk to Southeast Alaska fisheries and the people who depend on them is determined in part by the total number of watersheds degraded.

Habitat Management. Because fluctuating ocean conditions are beyond human control, long-term viability and productivity of salmon and steelhead stocks on the Tongass National Forest depend heavily on maintaining high-quality freshwater habitats in forested watersheds. Regulation of fish harvest is beyond the control of the Forest Service, but one of our responsibilities is to conserve the quality of freshwater habitats on the National Forests. To do so requires that landscape disturbances, both natural and human-caused, be evaluated in a watershed context.

Natural and human disturbances have additive effects on freshwater fish habitat, so analysis of effects and planning for activities that cause disturbance should be at large spatial and temporal scales. Many management plans and protective measures for fish habitat on public and private land, however, are still applied on a smaller project area basis (e.g., for a single timber sale). Although project-level analyses are important, more attention should be given to larger spatial and temporal analyses so as to improve cumulative effects analyses. Watershed-scale planning, analysis, and implementation of management activities (such as logging) can better place fish habitat protection in the proper context.

Mixed assemblages of wild anadromous fish in watersheds complicate habitat management. Most watersheds on the Tongass National Forest contain five or more species of anadromous salmonids--a common mix includes coho, chum, and pink salmon, steelhead trout, sea-run cutthroat trout, and Dolly Varden char. These species may all reside together in the same watershed, but each uses available habitat in a slightly different way. Management disturbances in such watersheds can have severe effects on some stocks and species and little effect on others. Management plans should be designed to protect habitat for all stocks, but special consideration should be given to the most vulnerable species or stocks. The most vulnerable are often those whose juveniles stay in freshwater for the longest time (e.g., steelhead and sea-run cutthroat trout) before migrating to sea. Vulnerability can be assessed through watershed analysis. National Forest Management Act regulations provide for managing habitat to maintain the viability of existing native and desired non-native fish species on the Tongass, including non-anadromous fish. The Endangered Species Act extends protection to all species, subspecies, or distinct population segments once listed under terms of the Act.

Hatcheries. Salmon hatchery operations in Southeast Alaska have been successful in increasing salmon harvest in the past 10 years. Hatcheries have added millions of salmon to commercial, sport, and subsistence fisheries. An abundance of fish from hatchery supplementation, however, provides no assurance that wild stocks in natural habitats will be maintained. On the contrary, intense fishing pressure on hatchery fish, which are almost always mixed with wild stocks at sea, has been shown to result in depletion of wild stocks in the Pacific Northwest. Also, hatchery stocks generally experience lower

survival in the ocean than wild stocks, especially when ocean habitats decline on a cyclic basis as discussed earlier under Marine Ecology.

METHODS

The assessment included a comprehensive examination of existing information, collection of new field data, professional field observations and evaluations, and consensus among consulting Federal professionals (Appendix C). Principal tasks included

- Technical analyses in the field of three Tongass watersheds and a Regional synthesis of the findings (Appendix C.3).
- Field evaluations by scientists of four additional Tongass watersheds (Appendix C.2).
- Comprehensive literature review on Pacific salmon and steelhead habitat characteristics, processes, uses, and management interactions in Alaska and the Pacific Northwest (Appendix C).
- Completion of reports on monitoring the implementation and effectiveness of fish-habitat protection on the Tongass and recommendations for improvement (Appendix D).
- Review of reports on the status and uniqueness of salmon and steelhead genetic stocks in Southeast Alaska (Appendix C).
- Evaluation of the Alaska Region database on stream-channel-type attributes (Appendix C.1).
- Evaluation of the proposed PACFISH Pacific salmon and steelhead initiative (Appendix C).
- Peer review of draft reports by additional scientists and Tongass Area fish biologists (Appendix C).
- Review of draft reports by Forest Supervisors, Regional Staff Directors, and Tongass Area staff officers (Appendix C).

More than 50 scientists, resource specialists and managers were directly involved in completing the assessment. These participants represented the Alaska Region, Pacific Southwest Research Station, Pacific Northwest Research Station, Intermountain Research Station, Southeastern Research Station, Washington Office, Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, Weyerhaeuser Company, National Marine Fisheries Service, Environmental Protection Agency, Oregon State University, and the University of Washington. Non-federal participants were excluded from the final analysis of information, and from formulation of conclusions and recommendations.

Definitions of **current procedures**, **implementation**, and criteria used to evaluate **effectiveness** were needed before studies could be designed and completed to respond to the directives.

- **Current procedures** were defined as the set of requirements used in commercial timber harvest operations since passage of the Tongass Timber Reform Act. Procedures used to protect fish habitat in 1994 are better than those used immediately after passage of the Reform Act, but no activities planned in 1994 have yet been implemented. Post-Reform Act procedures and

applications that were applied to projects planned prior to the Reform Act but retrofitted to conform to Reform Act direction were used as our baseline for evaluating effectiveness.

- **Implementation** was defined as how well current procedures are carried out on the ground.

- **Effectiveness** was evaluated against two criteria: (1) a goal established by the Tongass Land Management Plan Environmental Impact Statement (1979) and, (2) Department of Agriculture direction (Departmental regulation 9500-4).

    1. The Tongass Land Management Plan includes a goal to "...preserve the biological productivity of every fish stream on the Tongass."

    2. Departmental regulation 9500-4 directs the Forest Service to manage "habitats for all existing native and desired non-native plants, fish, and wildlife species in order to maintain at least viable populations of such species" and avoid actions "which may cause a species to become threatened or endangered."

If current procedures achieve the criteria listed above, then they would be defined as effective. If they fail to achieve these criteria, then the identifiable deficiencies in effectiveness would be addressed under directive-2 on page 10 of this report.

RESULTS

The concurrent studies and accomplishments described in the Methods section of this synthesis of the assessment provided sufficient information for us to respond definitively to both of the directives in the FY 1994 Conference Committee Report (Appendix B). The responses and our reasoning are summarized below.

Directive 1 - Effectiveness of Current Procedures

Current procedures and their application have improved the way fish habitats on the Tongass are managed, compared to past protective procedures. Protection of streams and riparian zones has improved rapidly since the late 1980s and has continued to improve since passage of the Tongass Timber Reform Act. Improvements are:

- Use of Best Management Practices as authorized by Section 208 and required by Section 319 of the Clean Water Act for protecting beneficial uses of water, and some monitoring of their effectiveness.

- Active protection of class I and II streams post-Tongass Timber Reform Act.

- Some investment in stream inventory, including some basin-scale analyses.

- Development and application of a state-of-the-art channel-type classification and geographic information system.

- A willingness to increase protection measures for fish habitat as new information reveals deficiencies in previous procedures.

Despite large advances in protecting salmon and steelhead habitats in recent years, current procedures as presently applied on the Tongass have not fully achieved either of the criteria used to evaluate effectiveness. Current practices on the Tongass do not meet either the goal of the Tongass Land Management Plan to "preserve the biological productivity of every fish stream on the Tongass," or the long-term goal of avoiding the possible need for listing of salmon and steelhead stocks under the Endangered Species Act. Due to freshwater habitat conditions, timber harvest practices on the Tongass observed as part of this study were found to increase risk over natural risk levels to both habitat productivity and to individual stocks of salmon and steelhead. The degree of risk varies with the way timber harvest is planned and implemented.

Two types of deficiencies in current practices were found: (1) incomplete implementation of current procedures, and (2) need for additional direction for fish habitat protection. Current procedures were not fully implemented on all sites in any of the timber sale projects reviewed. Results of the analyses, however, indicated that even completely implementing current procedures would not be fully effective in protecting anadromous fish habitat productivity and salmon and steelhead stocks over the long term. Additional procedures were deemed necessary to reduce risk.

Long-term application of current procedures could lead to, or in some cases continue, declines in habitat productivity and eventual loss of stocks or need for listing of salmon and steelhead stocks as endangered or threatened. The primary evidence for arriving at this conclusion is summarized below:

The Literature Review (Appendix C). A thorough literature review of more than 1,540 publications addressing the effects of logging and other forest management activities on Pacific salmon and steelhead habitat revealed the following significant conclusions:

- No research studies of the effectiveness of post-Tongass Timber Reform Act procedures (procedures in effect since 1990) and their application for protecting fish habitats have been completed in Southeast Alaska because the site-specific effects of new procedures cannot be fully assessed for at least several years.

- Pre-Tongass Timber Reform Act studies showed that streams in Alaska respond to disturbances (e.g., loss of channel complexity, sedimentation, harvest of streamside trees, and disturbance of headwater streams and basins) like streams in similar coastal landscapes and conditions of the Pacific Northwest.

- Procedures similar to those currently used to protect fish habitat on the Tongass National Forest (especially buffer strips along fish-bearing streams), after being applied for nearly two decades to similar landscapes and conditions in coastal Washington and Oregon, failed to prevent declines in fish habitat capability, and resulted in increasing and now significant risk to the viability of salmon and steelhead stocks there.

- Timber harvest on unstable slopes and near small headwater streams in coastal zones of the Pacific Northwest resulted in simplified and degraded fish habitats regardless of geographic location.

- Buffer strips of conifers in the Pacific Northwest and Alaska that are prescribed for fish habitat protection during logging operations tend to lose trees subsequently because of windthrow during major storm events. Where buffer strips blew down in the Pacific Northwest, most of their effectiveness for long-term habitat protection was lost.

The Expert Field Review (Appendix C.2). The expert field review identified several items of concern with the application of current management procedures for protecting anadromous fish habitat. Those

items, in combination, result in increasing long-term risk to salmon and steelhead stocks, populations, and habitats on the Tongass National Forest. The most significant concerns are summarized below:

- Aquatic inventory data are incomplete and inconsistent across the administrative units of the Tongass National Forest. The result is inconsistent application and sometimes misapplication of current procedures for fish habitat protection.

- Timber harvest and road management activities have not been monitored or studied enough to assess their effects on fish habitat capability and populations and to measure effectiveness of current procedures and help guide and improve future management procedures and strategies.

- Stream buffers of coniferous trees along some class I streams (salmon and steelhead streams), though wider than 100 feet on each side of the stream, were observed to be too narrow to fully protect fish habitat against sedimentation and habitat simplification in two of the seven watersheds examined (Appendix C.2).

- Stream buffers along some class II streams (important for resident fish and water quality) were too narrow to fully protect fish habitat against sedimentation and habitat simplification in three of the seven watersheds examined (Appendix C.2).

- Perennial non-fish-bearing streams (class III streams important for water quality) were not given enough protection to fully control sedimentation and prevent probable long-term degradation of fish habitat in downstream waters in all watersheds examined.

- Clearcut timber harvesting was observed on some steep and unstable slopes, creating an increased risk of landslides and subsequent unacceptable amounts of sedimentation in salmon and steelhead habitats.

- A few roads were constructed on unstable soils, increasing risk of mass erosion and sedimentation in salmonid habitats. Some roads which were constructed on wetlands caused re-routing of water and increased sedimentation.

- Some drainage culverts did not appear to provide adequate upstream passage for adult and juvenile salmon and steelhead.

- Deficiencies in maintaining road drainage systems and in closeout of temporary roads were frequently identified as potential causes of road failure and thus likely sources of excessive sediment delivery to salmon and steelhead habitats.

- Current guidelines for protecting salmon and steelhead habitat were inconsistently applied across the Tongass, resulting in highly variable habitat protection on similar site conditions.

Watershed Analysis (Appendix C.3). The watershed analysis effort revealed that more comprehensive planning for fish habitat protection at the watershed scale should reduce the risk to fish habitat and populations resulting from timber harvest activities. This reduction is possible because the current condition of salmon and steelhead habitat can be better assessed, and the risk to habitat from future human-caused disturbances, or natural events like storms, can be better estimated. Current procedures for fish habitat protection are now applied primarily on a project area basis; consequently, the much more important cumulative effects of timber harvest on fish habitat in a watershed are not fully assessed.

In comparing protection measures that the watershed analysis teams would have designed on the three watersheds under a PACFISH-like habitat conservation strategy with management procedures

currently being applied on the Tongass National Forest (as defined in the Methods section), the three Tongass Area Watershed Analysis Teams found these differences:

- A considerable percentage of the area harvested in the three watersheds fell within the proposed Riparian Management Areas; total area of overlap is 6 percent for Kadake Creek, 27 percent for Game Creek, and 52 percent for Old Franks Creek watershed. Some portion of the overlap would probably not have been harvested.

- Riparian Management Area delineation identifies the sensitive riparian areas, wetlands, and sediment source areas in watersheds more clearly and completely than current procedures do.

- The riparian habitat conservation strategies developed by the Teams would have provided for more scrutiny of, and emphasis on, riparian-dependent resources and stream processes than do current procedures, especially resource protection needs adjacent to class III streams.

- With watershed analysis, some management prescriptions for timber harvest within the Riparian Management Areas would probably have been different from the management prescriptions that were implemented.

- Most class III streams are not currently being buffered to prevent negative effects of timber harvest and roads, such as loss of woody debris and changes in energy sources and nutrients, that can degrade downstream fish habitats.

- Some unstable soils and wetlands are currently being subjected to timber harvest and road construction. These activities increase risk to fish stocks and populations, and no measurements are being taken to assess these risks.

- Concerns about potential cumulative effects of timber harvest and other disturbances are unresolved and increasing rapidly where timber harvest is most intensive and extensive.

- Aquatic habitat inventory information is insufficient for development of protection that meets either definition of effectiveness; information is essentially lacking in many areas and inaccurate in others.

Monitoring on the Tongass (Appendix D). Monitoring is useful for assessing both the implementation of procedures and the effects of logging and other disturbances on fish habitat. The results of effectiveness monitoring are an important component of adaptive management; monitoring results can be quickly used to guide and improve the procedures for protecting fish habitat. Implementation and effectiveness monitoring on the Tongass since passage of the Reform Act is in an expansion phase: monitoring efforts have begun to assess the effectiveness and stability of buffer strips; yarding effects on soil disturbance; prescriptions for protecting class III streams; effects of roads on sedimentation and fish passage; landslide frequency and mitigation in relation to logging; and aspects of cumulative effects. Definitive results from effectiveness monitoring are not yet available, however.

The Tongass National Forest produces an annual monitoring and evaluation report. In 1993, fish and riparian standards and guidelines were successfully implemented in more than 90 percent of the situations examined Forest-wide. Minimum stream buffer widths (post-Reform Act) were achieved in more than 90 percent of the situations examined. Also, Best Management Practices for protecting beneficial uses of water were successfully implemented in about 90 percent of the situations examined. In all cases, only a small percentage of activities were monitored.

More implementation and effectiveness monitoring is needed to better assess the effects of logging on fish habitats. Monitoring needs to occur on more timber harvest and road disturbances and over longer time periods on individual sites. Effectiveness monitoring needs major improvement in both design and implementation. More research guidance would improve both design and interpretation of the monitoring program. Although some controversy is evident, current procedures appear to have been well implemented in the sample of activities that were monitored. The effectiveness of these procedures, however, has not been established through monitoring or research.

Summary of the Results Pertaining to Directive 1. The cumulative information resulting from the literature review, the expert field review, the three watershed analyses, peer review, and other sources provides a consistent message that current procedures and their implementation on the Tongass National Forest to protect fish habitat are not fully effective to prevent habitat degradation or fully protect salmon and steelhead stocks over the long term. The largest deficiencies in current procedures are related to protecting headwater streams and their watersheds (class III streams, unclassified intermittent and ephemeral streams, and unstable soils), which to a large degree determine the productivity of downstream fish habitats. The results of these studies, and other information, provide an early diagnosis of symptoms indicating that fish habitat is in decline in some areas as a result of logging, and that longer term application of current procedures could lead to stock declines.

Directive 2 - Additional Needs

Additional needs were identified to help reduce the risk to anadromous fish habitat. These needs fall into two categories: (1) information and analyses to better understand the ecology and conditions of anadromous fish habitats, and (2) the implementation of activities to directly protect habitat once the analyses are complete. The most important needs identified are:

- Quantitative and measurable objectives for anadromous fish habitats should be developed for watersheds where timber harvest and other disturbances have and/or will occur. Future aquatic inventory procedures should include these habitat objectives.

- A formal watershed analysis procedure should be implemented for watersheds with salmon and steelhead populations on the Tongass National Forest. The more timber harvest activities in a watershed or the more unstable the soils, the higher the priority for completing watershed analyses. Watershed analyses that are completed before planned disturbances can more effectively assess potential cumulative effects and risks to fish habitat.

- Riparian management areas should be identified for long-term fish habitat protection on all classes of streams in watersheds where timber is harvested and roads constructed.

- A new class of streams that includes intermittent and ephemeral channels should be defined, inventory standards written, and these areas provided with more protection to minimize cumulative effects on salmon and steelhead habitats downstream.

- Forest-wide definitions, inventory standards, and interpretations of mass-movement-hazard areas should be developed, and a full inventory and analysis of high-hazard and very high-hazard soils should be conducted.

- Specific procedures for analyzing cumulative effects on watersheds producing salmon and steelhead and containing suitable-available acres for timber should be developed for the Tongass National Forest, and included in watershed analysis procedures.

- Best Management Practices for protecting water quality should be more fully implemented, monitored, and improved as necessary, specifically focusing on anadromous salmonid habitats, landscape and temporal scales, and cumulative effects of watershed disturbances on habitat capabilities.

- Implementation monitoring of Best Management Practices should continue, and effectiveness monitoring should be accelerated.

- Additional information should be gathered as soon as possible on life histories, distributions, site-specific habitat requirements, and genetic attributes of salmon and steelhead stocks on the Tongass.

- Repeatable, long-term baseline research measurements should be established as soon as possible on some salmon and steelhead streams across the Tongass for research on habitat attributes and capabilities. These measurements can be used to track changes in the structure of anadromous fish habitats that have resulted from human and natural disturbances. Both disturbed and undisturbed habitats should be sampled.

- Salmon and steelhead habitat capability models should be developed for field use in assessing habitat capability conditions and projected changes after timber harvest.

RECOMMENDATIONS

Current direction for anadromous fish habitat protection on the Tongass National Forest is less than fully effective, and additional protection is needed to make timber harvest more compatible with maintaining high-quality fish habitat and long-term conservation of anadromous fish stocks. The highest risks to fish habitat productivity and viability are in watersheds already intensively logged. The strength of the concern resulting from these findings warrants improving fish habitat protection efforts under current procedures prior to completion of the Tongass Land Management Plan Revision. The needs for additional improvements in fish habitat protection, described in the response to Directive 2, can be divided into two categories:

(1) those that should be examined during the Tongass Land Management Plan Revision because they may have socioeconomic impacts, and public disclosure and participation are needed; and,

(2) those activities relevant to current direction in the Tongass Land Management Plan that should be strengthened prior to completing the revision.

Improvements Recommended for Examination in the Tongass Land Management Plan Revision

- **Increased protection on headwater areas--steep slopes, high-hazard soils, and class III and IV streams.** Headwater areas greatly influence downstream fish habitat capabilities. They serve as sources and conduits for sediment from natural and human-caused disturbances. Currently these areas are not fully classified, and it is vitally important that new management direction be developed and applied to minimize long-term downstream impacts.

- **Modification of streamside buffers on flood plains and confined alluvial channels.** Establishing site-specific buffers on flood plains and confined alluvial channels should be through watershed

analysis and subsequent project design. The purpose is to provide for protection for small off-channel streams associated with flood plain streams, and to provide for long-term sources of woody debris.

- **Clarification of the current Tongass plan direction of "...preserve biological productivity of all fish streams on the Tongass."** This direction is interpreted inconsistently across the Tongass and has caused confusion. It can be interpreted that productivity of all fish streams must be maintained at 100 percent, allowing for no reduction due to human-caused disturbances. This is a difficult goal to meet, while allowing for the other multiple uses of the Forest. The Tongass plan revision should clarify this and define appropriate goals for fish habitat productivity on the Tongass between the 100 percent level and the level needed to conserve fish stocks for continued use by Alaska fisheries, as well as addressing acceptable levels of risk or probability of attaining goals.

- **Establish quantitative objectives for fish habitat capability.** Without quantitative measures of fish habitat attributes, it is very difficult to identify habitat capability changes resulting from human-caused activities in a watershed. Project planning and evaluations are currently not quantitative regarding anadromous fish habitat capability, and therefore, are less effective in achieving habitat capability goals.

Improvements Recommended for Strengthening Habitat Protection Under Current Direction

- **Begin implementing watershed analysis.** Use of watershed analysis comparable to that employed in PACFISH would move the Forest an important step toward the agency goal of ecosystem management and long-term sustainability of all forest resources by helping managers make better decisions. It would provide large-scale analyses of how best to manage watersheds with steep unstable areas, highly productive fisheries, productive timber lands, important and sensitive wildlife resources, high-value recreation and visual resources, cultural resources, and other considerations. It would address many of the concerns about effectiveness of current procedures for protecting fish habitats, including more protective prescriptions for stream classes, high-hazard soils, steep slopes, wetlands, road location and design, timber sale layout, logging, fish passage, and cumulative effects of watershed disturbances over time. Watershed analyses would also provide for assessments and management direction better founded on natural disturbance ecology, including management approaches more consistent with site-specific ecological processes and functions, resulting in a systems approach to management.

  Initial application of watershed analysis could begin conservatively, aimed at the highest priority watersheds based on the highest risks to anadromous fish.

  Because aquatic habitats and fish populations are subject to the continuing effects of all previous disturbances in a watershed, the effects of additional planned management activities should be viewed as additive to existing effects. Analysis procedures for cumulative effects are needed to examine these additive effects, and would be key components of watershed analysis.

- **Develop a Forest-wide restoration strategy for degraded watersheds.** The Alaska Region should develop a watershed restoration strategy to identify and address its watershed restoration needs. The strategy should incorporate the principles of ecosystem management and the concepts of watershed restoration planning (including watershed analyses) into an orderly and coordinated process for developing and carrying out a comprehensive restoration program in

the Alaska Region. The program would accelerate recovery of selected priority watersheds whose function and productivity have been impaired by natural and human disturbances.

- **Inventory anadromous fish habitats and fish communities.** Aquatic inventory information on both habitat and fish provides important data for habitat protection and watershed analyses. If inventory procedures are quantitative and replicable, they become powerful tools for monitoring trends in habitat condition over time and assessing whether timber harvest affects anadromous fish habitats and populations. Aquatic inventories are a high priority and should be institutionalized on the Tongass, just as timber stand and soils inventories have been. Initial inventory should be aimed at the highest priority watersheds based on highest risk to anadromous fish.

- **Develop Forest-wide definitions, inventory standards, and interpretations of mass-movement-hazard areas, and conduct full inventory and analysis of high-hazard and very high-hazard soils.** Timber harvest operations on unstable soils at any location in a watershed present risk to fish habitat. Accelerated mass erosion often results when unstable soils are disturbed. The processes of mass erosion can transport sediments for long distances before deposition--usually in low-gradient streams supporting anadromous fish. Improved management and protection of unstable soils will help control risk to fish habitats.

- **Increase monitoring on implementation and effectiveness of procedures for anadromous fish habitat protection.** More long-term monitoring is needed to answer questions like, "Did protective measures like buffer-strips persist after many years, or after large storm events?" Research studies should be key components of effectiveness monitoring. Highest priority risks to habitat loss should be studied. Watersheds subject to pilot watershed analysis for this assessment are high priority for long-term monitoring.

- **Ensure that management direction for habitat protection is consistently applied.** Examination of watersheds revealed some inconsistencies in the way timber sale procedures for protecting aquatic habitats were implemented. Additional resources should be made available to ensure more complete and consistent application of management direction for protecting anadromous fish habitats.

- **Classify streams draining intermittent and ephemeral channels.** Intermittent and ephemeral headwater channels often represent more than 50 percent of the total stream mileage in a watershed. These channels are conduits for routing sediment, nutrients, and debris downstream to fish-bearing waters and therefore are key components of anadromous fish habitats. Logging disturbs these streams and can cause reductions in fish habitat capability downstream. Most often, these headwater channels which should be included in a class IV designation, currently receive little or no protection during logging. Once these channels are defined and mapped during project reconnaissance, their needs for protection can be examined during watershed analysis.

- **Further develop the process for setting quantitative objectives for fish habitat.** The goal of quantitative objectives for salmon and steelhead habitat protection is to maintain desired habitat capabilities on a sustained basis. The team recommends that managers should quantitatively define the features of desirable salmon and steelhead habitat that are attainable in a given geomorphic setting and that they hope to maintain. This effort is currently underway on the Tongass.

- **Examine and improve Best Management Practices.** Best Management Practices have never been fully implemented, and thus have never fully protected fish habitats. Review and update

of Alaska Region Best Management Practices and their direction for application is important as new information from research and monitoring becomes available.

- **Accelerate acquisition of research information.** The assessment revealed large gaps in knowledge important to manage and protect the habitats and stocks of anadromous fish on the Tongass. An accelerated and sustained research effort is recommended to provide additional information for management. At least one long-term watershed study, like the Alsea Watershed study in Oregon, or the Carnation Creek watershed study in British Columbia, should be performed on the Tongass to assess the long-term cumulative effects of timber management on anadromous fish stocks and their habitats. Research should address the role of class III and class IV streams in maintaining anadromous fish habitat capability on the Tongass. Research priorities should be set jointly by the Alaska Region and the Pacific Northwest Station.

CONCLUSIONS

Freshwater habitat for wild fish should be carefully managed within individual watersheds and with a long-term watershed perspective to ensure needed fish habitat protection. The assessment concludes that current practices for timber harvest planning and application are not fully effective in protecting anadromous fish habitats on the Tongass National Forest. However, no significant risk is perceived to fish habitat from implementation of current procedures for timber harvest during the next one or two years while the Tongass Land Management Plan is being revised, if actions are taken to strengthen activities under current procedures. Increased headwater protection from timber harvest, increased buffers on flood plains and alluvial channels, and completion of cumulative watershed effects analyses to evaluate natural and human disturbances, are very important protective measures that are needed. As discussed in the Results section of this assessment, several other areas merit concern as well.

Protecting the salmon and steelhead resources of Alaska and the Pacific Northwest is truly a national concern. Extinct and declining stocks in California, Idaho, Oregon, and Washington have prompted development of fish habitat protection measures specified under the Pacific Anadromous Fish Strategy (PACFISH). Although these measures have not been applied to Alaska, the comparison requested in the Conference Committee Report is appropriate. A comparison among current procedures for fish habitat protection on the Tongass, procedures in the PACFISH Strategy, and recommendations of the Anadromous Fish Habitat Assessment Team can be found in Table 1.

Preventing the need to list species is established as a Federal policy by USDA Regulation 9500-4, the 2670 section of the Forest Service Manual, and a Memorandum of Understanding to conserve species tending toward listing signed by the Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, and National Marine Fisheries Service in January of 1994. Conservative approaches should be taken to avoid the need for listing anadromous fish stocks under the Endangered Species Act. Once stocks are listed, many resource management options are precluded and the resulting effects on local economies can be severe and immediate.

Management that uses disturbance ecology, and simulates the natural spatial and temporal range of forest disturbances consistent with ecological processes and functions, is currently believed to provide the highest probability of conserving the salmon and steelhead habitats needed to sustain stocks. The further management plans stray from natural disturbance ecology, the greater the risk to anadromous fish stocks.

The success of fish and wildlife conservation depends on a systems rather than species focus in forest plans. Comprehensive assessments of what is needed to conserve biodiversity and planning at the

landscape scale are emerging as common features of revised forest plans and of conservation biology. Because little information exists on individual salmon and steelhead stocks in Southeast Alaska, conserving fish habitat and stocks at the landscape scale must rely heavily on applying the best current principles of habitat management, landscape ecology, and conservation biology.

The assessment concludes that providing for more anadromous fish habitat protection on the Tongass is necessary and practicable. More comprehensive watershed analyses comparable to those in the PACFISH Strategy, if just applied on priority watersheds where timber will be harvested, will provide for both timber harvest and anadromous fish habitat protection. This process will help define timber harvest that is sustainable over time. Additional protection procedures and improved application of all procedures will reduce risk to fish populations. Costs of timber harvest programs may increase with additional habitat protection, but sustained habitats for anadromous fish stocks and harvests, as well as a sustainable rate of timber harvest, are both important goals.

This assessment provides important information for use in considering new management direction and revising the Tongass Land Management Plan. Until more information is available, anadromous fish habitat protection should be both responsive and conservative.

Table 1--Current management procedures, PACFISH Strategy, and Fish Habitat Analysis Team: comparison of components

Component	Current management procedures	PACFISH	Team Recommendations
Buffers	The 1986 Aquatic Habitat Management Handbook directs the use of aquatic habitat management units (AHMU's) for managing streamside areas. The units are based on stream class and riparian vegetation, and--when available--land type, soils, and additional stream classification. Objectives and direction for management within the units are provided in the Handbook. A riparian management area is defined in the 1991 proposed revision of the Tongass Land Management Plan. The area includes minimum 100-foot buffers on all streams, 150-foot buffers on some channel types, riparian soils, and very high mass-movement hazard soils adjacent to streams and riparian soils. Management prescriptions (zoning ordinances) within the riparian management area are guided by stream class and channel type, and call for minimum 100-foot no-commercial timber harvest buffers adjacent to all class I streams and those class II streams that flow directly into a class I stream, as required by the 1990 Tongass Timber Reform Act; 100- to 500-foot buffers for lakes; 200-foot no-harvest buffers on most flood plains; and other stream- and channel-type-specific guidance. On class III streams, harvest is allowed on most channel types to the stream edge, but the harvest rate in a watershed is limited. No maximum buffer size is set for any stream. Most current projects have been incorporating the guidelines proposed by the Forest Plan Revision for managing by channel type and stream class, although using them is optional.	Interim widths of riparian habitat conservation areas in the absence of site-specific information are 300 feet for fish-bearing streams and lakes; 150 feet for permanently flowing non-fish-bearing streams, ponds, reservoirs, and wetlands greater than 1 acre; 100 feet in key watersheds and 50 feet in non-key watersheds for seasonally flowing or intermittent streams, wetlands less than 1 acre, and landslides and landslide-prone areas. Most commodity activities are permitted in Habitat Conservation Areas if they do not retard or prevent attainment of riparian management objectives.	We recommend following the process described in the proposed Tongass Plan revision, with the following changes: the riparian management area expands to include high mass-movement-hazard soils and wetland fens; before completing both watershed and project analyses, adopt no-harvest buffers for the entire flood plain for class I and II streams and no-harvest buffers of one site-potential tree for confined alluvial channels on class I and II streams; and plan for limited harvest buffers of 100 feet for class III streams. We propose a new stream class--class IV: it requires special consideration during timber harvest but typically no coniferous buffer strip. The proposed watershed analysis will recommend site-specific Riparian Management Areas that will modify those described in the Tongass Plan Revision process.
Riparian management objectives	The Aquatic Habitat Management Handbook describes some measurable objectives for: streambank and stream channel stability, temperature sensitivity, fish passage through stream crossings, special road-construction mitigative measures, water quality, and large woody debris. Qualitative objectives for primary and secondary aquatic production are also described.	Interim Riparian Habitat Management Objectives that provide quantifiable definition of desirable habitat conditions are being developed to guide land management decisions until watershed analysis is completed.	We recommend fish habitat objectives for large woody debris, width/depth ratio, and pool frequency based on currently undisturbed conditions. We also recommend further analysis and inventory to establish additional fish habitat objectives.

Component	Current management procedures	PACFISH	Team Recommendations
Key watersheds	Key watersheds are not directly addressed, but values are applied to watersheds through Value Comparison Units. Those with "high" fish ratings might be comparable to PACFISH.	Key watersheds are identified by selecting a subset of watersheds that are important to "at risk" stocks, currently are in "good" condition, or have a high potential for restoration.	No change from current management procedures is recommended.
Wetlands	Presidential Executive Orders 11988 and 11990 require that Federal agencies avoid undertaking or providing assistance for new construction (e.g. roads) in wetlands/flood plains unless the head of the agency finds no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands and flood plains. The proposed revised Tongass Land Management Plan states that all management activities under the proposed action will conform to these directives. Specific guidance is given for river, lake, and estuary wetlands.	River, lake, forested, and non-forested wetlands will have special standards and guidelines.	No change from current management procedures is recommended. The value of wetland fens would be emphasized, however, through their incorporation into the Riparian Management Area.
Stream class	Stream classes are mapping units that display specific identified values for aquatic resources. Class I is defined as "streams with anadromous or adfluvial fish habitat, plus reasonably enhancable habitat upstream of barriers." Class II is defined as "streams with resident fish and generally steep gradient (6-15%)." Class III is defined as streams with no fish populations but with potential water-quality influence on downstream aquatic habitat.	Specific stream classifications are not stated, but stream values are stratified as fish-bearing streams, permanently flowing non-fish-bearing streams, and seasonally flowing or intermittent streams.	We recommend adding a set of physical criteria to the determination of class II and III streams. In addition, we recommend adding a class IV stream category.
Upslope stability	Areas of very high mass-movement hazard are removed from the timber base in the 1991 proposed revision to the Tongass Land Management Plan.	Areas of high and very high mass-movement hazard are included in Habitat Conservation Areas and are not included in the land base used to determine the Allowable Sale Quantity.	Areas of very high mass-movement hazard are removed from the timber base. We recommend a reassessment of the rating systems for mass-movement hazard--consistent across the Forest--and no clearcut harvest on high mass-movement hazard areas before this reassessment.
Sensitive stocks	Identification and management of sensitive stocks is directed by Forest Service Manual 2670. The most recent Regional Forester's Sensitive Species List was updated in January 1994. Three fish stocks are on the list. The revised Tongass Plan collected information prioritizing categories of species associated with forests. Forest Service and Alaska Natural Heritage Program are currently cooperating to inventory potentially sensitive areas.	PACFISH recommends a comprehensive inventory of at-risk and unique stocks, and these stocks are currently being studied by the Forest Service and the Alaska Chapter of the American Fisheries Society.	We recommend research on stock identification, assessment, and viability.

Component	Current management procedures	PACFISH	Team Recommendations
Restoration	Restoration is addressed through the revised Tongass Plan project schedules and in the regional watershed-improvement-needs inventory.	Key watersheds receive priority for restoration. Restoration is guided by watershed analysis.	Watershed analysis guides restoration activities.
Watershed analysis	Screening, analysis, or both of cumulative watershed effects is required for projects with significant vegetation-removal or soil-disturbing activities to ensure that the project, considered with other activities, will not increase sediment or water yields beyond acceptable limits. No specific watershed-analysis guidelines have been developed.	Watershed analysis is required before implementation of some activities in Habitat Conservation Areas. It proposes measurable and repeatable indices of habitat quality. A Federal Agency Guide to Pilot Watershed Analysis (1994) has been issued as guidance.	Watershed analysis is recommended before timber harvest and other major land-disturbing activities. This recommendation is similar to PACFISH.
Monitoring	A memorandum of agreement (1992) between the Forest Service and the Alaska Department of Environmental Conservation commits the Forest Service to perform Best Management Practices (BMP) monitoring tasks as described in the Alaska Nonpoint Source Pollution Strategy (1990). Types of BMP monitoring required are implementation, effectiveness, and validation. Implementation monitoring programs were formally established on the Tongass in 1991. In April of 1994, the Regional Forester adopted an effectiveness monitoring strategy for the Tongass. The following issues will receive priority consideration: riparian buffer stability; buffer effectiveness in protecting fish habitat; the effects of roads on fish passage, stream flow, sedimentation, and channel stability; effectiveness of class III stream protection in minimizing erosion and downstream sedimentation; and soil mass movement in relation to roads and harvest units.	Requires watershed-specific monitoring of implementation standards and guidelines, and their effectiveness in achieving the Management Objectives.	The team recommends increased emphasis on monitoring. Most monitoring recommendations fall under the priority items shown in the current management procedures. Additional recommendations include an annual program of monitoring culverts and a monitoring program for fish habitat objectives.

INFORMATION BASE

The documents listed below were used to complete our assessment and report. The documents represent field work, Congressional Acts, anadromous fish conservation biology, gathering and analysis of additional information, team discussions and consensus of consulting technical professionals, and review by scientists, technical experts, and the Assessment Managers. We do not list all sources of information, but only the principal documents examined and used. Other important sources of information used to complete this report are on file in the Regional Office, Alaska Region, Juneau.

Alaska National Interest Lands Conservation Act. 1980. Public Law 96-487.

Endangered Species Act. 1973. Public Law 93-205.

Halupka, K.C., J. Troyer, M. Willson, and F. Everest. 1993. Identification of unique and sensitive chinook salmon stocks of Southeast Alaska. Report to Alaska Region, USDA Forest Service. 92 p.

Halupka, K.C., J. Troyer, M. Willson, and F. Everest. 1993. Identification of unique and sensitive coho salmon stocks of Southeast Alaska. Report to Alaska Region, USDA Forest Service. 141 p.

Halupka, K.C., J. Troyer, M. Willson, and F. Everest. 1993. Identification of unique and sensitive sockeye salmon stocks of Southeast Alaska. Report to Alaska Region, USDA Forest Service. 235 p.

Halupka, K.C., M. Willson, M. Bryant, and F. Everest. 1994. Biological characteristics and population status of anadromous salmon in Southeast Alaska, Chum Salmon. Report to Alaska Region, USDA Forest Service. 141 p.

Meehan, W., 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society. 751 p.

National Environmental Policy Act. 1970. Public Law 91-190.

National Forest Management Act. 1976. Public Law 94-588.

Pearcy, W. G. 1992. Ocean ecology of North Pacific salmonids. Washington Sea Grant Program, Books in Recruitment Fishery Oceanography. University of Washington Press. Seattle. 179p.

Reiman, B., D. Lee, J. McIntyre, K. Overton, and R. Thurow. 1993. Consideration of extinction risks for salmonids. Boise, ID: USDA Forest Service. Fish Habitat Relationships Technical Bulletin 14. 12 p.

Root, C., and L. Margolis, ed., 1991. Pacific salmon life histories. Vancouver, BC: University of British Columbia Press. 564 p.

Thorpe, J. F. 1993. Salmonid flexibility: Responses to environmental extremes. Trans. Am. Fish Soc. 123: 606-612.

Tongass Timber Reform Act. 1990. Public Law. 101-626.

USDA Forest Service. 1991. Forest Service Manual, Section 2670.12, Secretary of Agriculture's Policy on Fish and Wildlife 9500-4 (WO Amendment 2600-91-3).

USDA Forest Service. 1991. Forest Service Manual, Section 2670.22, Sensitive Species (WO Amendment 2600-91-3).

USDA Forest Service. 1992. Best Management Practices. Implementation Monitoring Report 1992. Unpublished. U. S. Department of Agriculture, Forest Service, Juneau, AK. 37 p.

USDA Forest Service. 1993. Best Management Practices. Implementation Monitoring Report 1993. Unpublished. U. S. Department of Agriculture, Forest Service, Juneau, AK. 40 p.

USDA Forest Service. 1994. Fish habitat analysis team report. An evaluation of the effectiveness of current procedures for protecting anadromous fish habitat on the Tongass National Forest. Anadromous Fish Habitat Assessment, USDA Forest Service. 63 p. plus appendices.

USDA Forest Service. 1994. Effectiveness monitoring team report. Report of the Effectiveness Monitoring Team, Anadromous Fish Habitat Assessment, USDA Forest Service. Letter dated 9/7/94 from R. Coleman to F. Everest and F. Norbury, 4 p.

USDA Forest Service. 1994. Interim report, Anadromous Fish Habitat Assessment, Alaska Region and Pacific Northwest Research Station. Letter dated 3/17/94 from M. Barton and C. Philpot to Chief, USDA Forest Service. 14 p.

USDA Forest Service. 1994. Draft watershed restoration strategy, Alaska Region. Juneau, AK. 21 p.

USDA Forest Service and USDI Bureau of Land Management. 1994. Environmental assessment for implementation of interim strategies for managing anadromous fish-producing watersheds in eastern Oregon and Washington, Idaho and portions of California. 68 p.

U.S. Government. 1994. A Federal Agency Guide for Pilot Watershed Analysis. Jan. 1994 (version 1.2) Washington, DC 140p.

U.S. Government. 1994. Memorandum of understanding between the USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, USDI National Park Service, and USDC National Marine Fisheries Service. Framework for cooperation for conservation of species tending toward Federal listing under the Endangered Species Act.