APPENDIX C.2

EXPERT FIELD REVIEW

Appendix 2. EXPERT FIELD REVIEW

INTRODUCTION

In this study, we used experts in a structured analysis process to assess the effects on fish habitat resulting from current timber management procedures. This expert analysis also assessed the potential effect of additional timber management activities that are possible under the preferred alternative in the proposed revision of the Tongass Land Management Plan. The study was designed following a modification of the Delphi technique.

The Delphi technique was conceived in the mid-1950s to estimate the probable effects, without traditional measuring criteria, of a massive atomic bombing attack on the United States by the Soviet Union (Linstone and Turoff 1979, Martino 1983). One of the keys to the technique is maintaining anonymity of the expert opinions to improve the chances of getting an honest assessment untainted by deference to another 'more noted' expert or the 'accepted current thinking' within the discipline.

Since the defense study, the Delphi technique has been modified and applied in a wide range of situations; however, its principal area of application has been in technological forecasting. Variations of the technique have found their way to government, industry, and academia. Very few studies are conducted following the exact protocol of the original, however. For our study, we intended to retain the benefits of the Delphi approach, but did not follow the exact format, and thus it is a modified Delphi study that we call the "expert field review."

Our Team allowed individual experts to observe procedures being used to protect fish habitat and record their judgments about the current condition of the watersheds and projections for the future. The goal was to obtain anonymous expert opinions, not to reach consensus among experts on any of the findings. The rationale for this structure was that differences in professional opinions and ratings are to be expected, and we wanted to compare the experts' professional judgments.

METHODS

Study Design

The major modifications we made study design compared to a pure Delphi technique were:

- The group of experts and Team members traveled together, touring the same watersheds and sharing transportation and accommodations throughout. The experts were in contact with the other participating experts and Team members. In the pure Delphi technique, experts conduct their evaluations independently and without knowledge of the names or credentials of other experts.

- Data were collected for a series of watersheds, followed by an evaluation by the same group of experts (except as noted below). In the pure Delphi technique, one evaluation is made, the results are examined by the moderating panel, and the information is shared with the experts in a limited way. The same experts are then given an opportunity to submit additional comments

or modify their first comments. The pure Delphi technique is also conducted without face-to-face discussions among the moderating panel or with the other experts.

- In the expert field review, the period between successive watershed evaluations was short (essentially overnight). No attempts were made to interpret results before all of the evaluations were completed. The data forms were examined by the moderators to clarify possible misinterpretations in meaning, numerical notation, or indecipherable handwriting. In those instances, the appropriate expert was questioned privately for clarification.

The information experts were given in advance of the field work included the *Channel Type User Guide, Tongass National Forest Southeast Alaska* (Paustian 1992), a description of the tentatively suitable timber determination process on the Tongass, and a summary of background materials and maps for the specific watersheds from the Tongass Land Management Plan and the Forest Service Area specialists. Specially produced GIS maps and overlays identifying value comparison units (VCUs), watershed boundaries, private lands, 100-foot contour lines, stream classes, stream channel types and classes, tentatively suitable timber, wetlands, unstable slopes, very unstable slopes, harvest units and their sizes, and specified roads were provided to each expert as that watershed was being reviewed. Unit cards, contained in the EIS documents or from files maintained by area personnel, were made available to review-team members while they were at each watershed. Area or District personnel were on-hand during the field reviews to guide the team to specific locations and answer questions about the watersheds. Overflights of the watersheds were made before ground visits.

Opinions were collected from the experts systematically. The method relied heavily on a data collection form (attachment 1) the experts completed for each watershed and again for all the watersheds in summary. We also provided the experts brief explanations of the terms used on the form and established some assumptions for them to use in responding to the data items (attachment 2). To document clarifications made during a pre-field review discussion between the Team and the experts, these assumptions and definitions were supplemented further (attachment 3), resulting in refinement of the form. The experts were encouraged to consider all items on the data form, but to answer only those that they felt comfortable addressing in their role as expert. They were also encouraged to provide a written record indicating what clues or rationale led to that rating, to aid us in interpreting the results.

The experts were directed to assess the increase in risk (above natural risk) to fish habitat in field review watersheds. The effects of management activities on other elements, such as terrestrial species habitat and long-term timber yield, were not considered. The only exception was upslope processes, which were evaluated independently of increased risk to fish habitat. The effects of upslope processes on fish habitat were integrated into the increased risks in the hydrology and habitat portions of the field review form.

The topographic features of a watershed combine to effect the relative risk (above natural) that can result from management activities. One expert noted it this way: "By examining increase in risk (above natural) rather than risk directly, similar numerical assessments [1 to 5, see form] of risk increases do not necessarily correspond to similar absolute risks. For example, on a steep unit with a narrow valley, the background risk (natural) may be quite high and even without an increase in risk the absolute risk may be greater than a lower gradient unit with a wide flat valley with a high (5) increase in risk."

The experts were directed to evaluate risk for three time intervals: now (present and near term), in 30 years, and in 100 years. Direct observations could be used for evaluating the period from harvest to the present. Future risk was determined based on professional judgment of how the experts expected the landscape to evolve. Inferences could be drawn by observing the adjacent undisturbed terrain and other unmanaged areas visited by the experts.

Our Team performed the role of moderators, receiving the information, answering the experts' questions, obtaining clarification of the experts' comments where needed, and summarizing the results. None of the results were shared among the experts or outside our Team before this report was written. Neither the experts nor our Team discussed opinions and judgments about the effect of forest management activities on fisheries habitat at any time during the field work or close-out interviews. Voiced opinions and judgments from one expert at a time were accepted in a controlled setting during close-out interviews. At no time were judgments shared between experts.

Precautions were taken to protect anonymity of the individual experts' responses. These precautions included: Cautioning the experts not to put their names or otherwise indicate authorship on the forms. Forms were individually coded before they were given to each expert to assist with the above step, then the code record was destroyed. Handwritten forms were typed as soon as possible and the original handwritten forms destroyed.

Selection of Experts

Our Team established several criteria to define and recruit experts for this study. The criteria were as follows:

- Professional credentials: Professionally and academically established scientists with a national reputation in their respective fields relating closely to the health of fish habitat. Competence in this arena was judged according to the number and type of research publications, professional reputation, and educational accomplishments.

- Objectivity: Of individuals judged as meeting the professional credential standard, the second criterion was that they have little or no vested interest in the guidelines for protecting fish habitat now used in Tongass National Forest management. Expertise with Pacific Northwest forest ecosystems was desired, however. The experts needed to be already familiar with the northern coastal rainforest and what could be expected as 'typical' and 'within the normal range of variation' for watersheds in this type of ecosystem. Whether the nominated individuals met this criterion was a value judgment.

- Availability: Because of logistical constraints in this type of evaluation, all the experts had to visit the chosen watersheds on specific dates in the company of Team members and other Forest Service guides. The field work took nine days. If candidates had otherwise been determined to meet the expert criteria but were not available during June 8-16, 1994, they could not participate. We wanted all the experts to evaluate all the watersheds, but because of some scheduling conflicts, not all of the experts did. Half of the experts evaluated all seven watersheds and the other half evaluated three or four of the seven watersheds. Part of preserving the anonymity of the experts requires that we do not state which experts participated in which evaluations.

- Discipline representation: Final selection of the group of experts was to balance by discipline the number of fisheries biologists with the number of geomorphologists.

- Remuneration: As a clarifying note, the experts that participated were not to benefit financially for their opinions or be otherwise beholden to the Forest Service Alaska Region for their jobs. The experts that participated are salaried staff of either Forest Service research stations, universities, or private companies. Travel expenses were reimbursed by the Forest Service, Alaska Region.

Our Team nominated candidates to the expert group. We listed potential candidates during a group brainstorming session and later used an iterative process with those candidates to narrow the list according to the individual's relative accomplishments and the total balance of the group. We were assisted in the recruitment process by Fred Everest, Program Manager, Pacific Northwest Research Station, who was designated as one of the officials responsible for the assessment. Dr. Everest made many of the phone calls to expert candidates soliciting their participation.

Experts selected were Alan Barta, Robert Bilby, Peter Bisson, C. Andrew Dolloff, David Montgomery, and Richard D. Woodsmith. Standardized resumés for them are contained in attachment 4.

Selection of Watersheds

The watersheds evaluated during the review were selected by the Team and included those used for pilot watershed analysis studies. As we collected information to answer the questions posed, we learned that, of all the watersheds in the Tongass National Forest subject to timber harvest subsequent to November 1990 (Tongass Timber Reform Act (post-Reform Act)), only a small subset were receiving their first timber management activities. To avoid the complications associated with also evaluating the effects from pre-Reform Act guidelines for managing timber harvest, the expert field review was focused on watersheds with mostly or only post-Reform Act timber harvest. Of those watersheds, time and access constraints limited the field evaluation to the following seven: Old Franks Creek and Upper Thorne River on Prince of Wales Island, Kadake Creek on Kuiu Island, Frosty Creek near the Bradfield Canal, and Buckhorn, Game, and Seagull Creeks on Chichagof Island (fig. 2A). Gypsum Creek was also selected for review, but access was not possible because of windthrown trees on the roads.

Even though these watersheds had post-Reform Act management guidance in common at the time of actual timber harvest, harvest planning had been underway for years spanning periods in which different sets of forest management guidance were in place. After the Reform Act was past, the as-yet unharvested units were reviewed and changed to bring them into compliance with current guidance. Unique aspects of harvest layout remain in each watershed, however, because of the influences of management guidance at the time environmental documents were written, resource inventories were performed, or road and timber harvest was laid out. The timber harvest planning history of the watersheds are summarized (attachment 5).

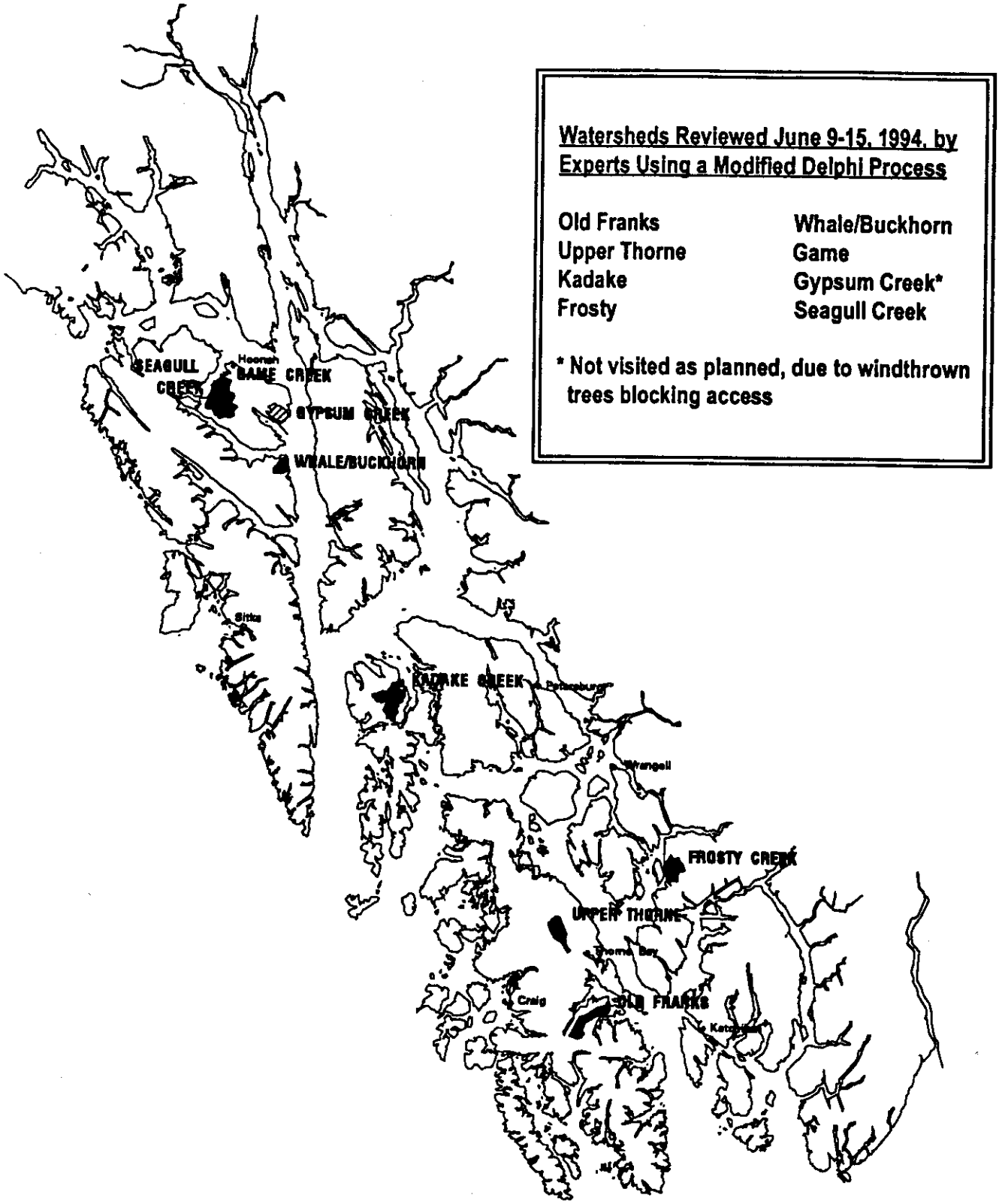
Expert Comments About the Rating System

The experts were questioned in their exit interviews about how they ended up viewing their use of the 1-5 rating system on the data forms. The following comments represent the full range of opinions expressed.

"On Kadake Creek, I was truly blanking out the pre-TTRA entries, and previous cuts, in my ratings. I also assumed low probability that some of the tentatively suitable timber (the yellow on the field maps) would be cut, in part due to statements by District staff that it would be a long time before any more entries (10-20 years). I also assumed a maximum take of 55% of the tentatively suitable timber over a 100-year period."

"I was uncomfortable with the use of numbers; unable to distinguish difference between evaluating risk of an event occurring and risk to fish habitat."

Figure 2A--Tongass map showing watersheds visited, or planned for visit, by the expert review group



"My comments incorporate observations on all of the sites visited within a watershed on the effects to fish habitat within the areas harvested post-TTRA. In no way are my comments an attempt to evaluate the cumulative effects of fish habitat throughout a watershed."

"In regards to the 100-year view, I assumed a 100-year rotation which is probably not long enough. I figure we were trying to calculate recovery rates and felt more comfortable evaluating the 100-year without logging than with logging. The assumption that TTRA guidelines would be in place in 100 years is no doubt wrong."

"I thought of 0 as pristine and 5 as catastrophic. An increase in risk from 2 to 4 means something pretty serious...I am predicting more risk for mass failures during future harvest because it looks like future harvest is in even higher risk sites and probable lack of stabilization and regeneration in existing (now) mass failure sites."

"My rationale behind high risk ratings for accelerated mass wasting was because of terrain and activity in the watersheds would lead to inevitable increase in debris and slide occurrences. If I perceived it would go as far as class II and I, then the increased risk rating is also reflected in channel morphology/ stability rating."

"Key observations during the watershed tour were used to assess potential sources of increased risk to fish habitat under current management practices. Note that combinations of factors and observations related to each of the following categories were used to assess the risk associated with each of the categories on both the individual watershed and summary evaluation forms. The following observations were drawn from the entire tour; only some of the following observations apply to each watershed. The aggregated regional risk assessment reflects the full range of practices occurring under current management."

RESULTS AND RECOMMENDATIONS

As described previously, experts used a form prepared by our team to rate each watershed. Scores are summarized as composite tables for each watershed showing experts' ratings for each category in attachment 6a-6g. Experts also prepared a summary form showing their ratings after review of all the watersheds they visited. Their ratings, as well as an average rating for each category, are in chapter 3 of the main body of this report.

At the end of the field review, five of the six experts were available for exit interviews. The following sections represent either comments made by the experts at these exit interviews or on their summary evaluations. These comments do not represent an even treatment by each of the experts: some prepared their summary statements on a computer and wrote expansively, but others made short, succinct statements on the form we gave them. Also, some experts had more time than others at their exit interviews because of airplane connections.

Comments from forms and interviews do not necessarily represent all observed situations because the experts were primarily considering management procedures that were not effective in protecting fish habitat. Some experts volunteered comments on good procedures they observed, and these comments are included. Readers should avoid generalizing these comments to the whole Forest (for instance, several fish passage problems were observed in the field, but by far the majority of structures passed fish adequately). Comments were selected from the exit interviews and experts' summary forms to represent the range of opinions they expressed. The comments are compiled by topic; the topics are not arranged in order of priority, nor are the comments under each topic. Similar comments made by

the same expert may be repeated--once in the section from exit interviews and again in the section on written summary statements. This could result in readers placing twice as much weight on an opinion of a single expert when this was not the intent. Our Team's interpretation of the weighting of concerns is presented in the section on the expert field review of Chapter 3.

Answers to question 1: "Are current management procedures on the Tongass National Forest effective in protecting fish habitat?"

Exit Interviews

Five of the experts who were available for an exit interview were asked this question: "Are current management procedures on the Tongass National Forest effective in protecting fish habitat on the Tongass?" They all indicated that additional protection measures were necessary to fully protect fish habitat. The experts generally believe that current management measures were effective in protecting some of the habitat some of the time.

Current management practices were generally judged effective for protecting fish habitat where the minimum requirements were exceeded both in terms of buffer design and avoidance of roading and logging in areas of higher risk of mass wasting. The experts generally agreed, however, that current management decisions resulted in less protection than they judged was needed to maintain the biological productivity of fish habitat where minimum requirements were met but the hydrological and geomorphological forces of a particular landscape did not determine the road and harvest-unit design.

The experts were concerned about the extent of forested land currently considered tentatively suitable for commercial harvest and roading. Some of the experts commented that adverse effects on salmonid habitat on the Tongass would be significant if the logging specified in the preferred alternative of the Supplement to the Draft EIS for the Tongass Land Management Plan Revision was done under the current management requirements.

The experts generally agreed that the lack of buffers on class III and some unclassified channels is a significant problem that will adversely affect fish habitat through the loss of a long-term supply of large woody debris. One expert was most concerned with the perennially flowing class III streams close to fish-bearing waters and increases in sediment debris torrents derived from mass wasting. Another expert said that, because class III streams are open conduits to downstream fish habitat, sediment will flush down to fish habitat during big events and affect fish habitat. Still another expert observed that people do not recognize that a 60% filled culvert on a class III stream may plug and fail during high flows.

Harvesting timber on unstable slopes--those rated either high or very high by the mass movement index used in the Tongass--will generally accelerate mass wasting and transport sediment to fish streams via the small colluvial channels and V-notches. One expert mentioned that he did not see anything indicating that unstable areas are being treated more gently than other terrain. Road building and cutting were observed across active hollow terrain. Seeing the transport of active debris flows in these channels was described as "a real red flag." Another expert said that sediment-delivery routing processes are clearly a threat to fish habitat given current management. A third expert said harvest units larger than 40 to 50 acres bring up risk to fish habitat, but 25-acre units would not greatly increase the risk.

Current up-slope and mid-slope road practices will cause changes in channel morphology and substrate; surface erosion of roads and cut-banks causing chronic and acute sediment delivery to streams; surface drainage problems; road failures; and culvert problems. For example, roads cutting across active hollows

(V-notch ravines) transport sediment into fish streams, especially the fines. One expert expects roads to fail, especially when they cross drainages mid-slope.

Widespread culvert problems will cause adverse effects to the productivity and accessibility of fish habitat. Problems noted by the experts included undersized culverts that did not ensure fish passage, movement of additional bedload and large woody debris, improper road drainage, round pipes instead of bottomless arches or bridges, perched culverts blocking fish passage, sediment accumulation above culverts that will be flushed down into fish streams during high-flow events, and inadequate monitoring and maintenance.

Some experts indicated that the buffers on class I and II streams need to exceed the minimum 100 feet, particularly on large floodplain channel types. One person stated that site topography and windfirmness must be matched or proper shading for microclimate control, nutrients, and long-term recruitment of large woody debris will be lost. Significant windthrow was observed in many of the areas visited that had been logged within the last 1 to 3 years. Some experts said that the risk to fish habitat from windthrow in a buffer was directly related to the stream's ability to flush the large woody debris out of the system and the importance of nurse logs for conifer regeneration in riparian zones.

Some experts observed the inadequate design and maintenance of roads through wetlands has resulted in roads intercepting down-slope drainage, which causes channelization of water flow and increases the frequency of peak flows in class I and II streams influenced by the affected wetlands.

Several experts were struck by the variability in interpreting similar guidance. They suggested that sale administrators and biologists should be assisted by geomorphologists and soil scientists.

Mitigating factors noted by the experts included valley bottom benches and slope breaks, forgiving soils, rapid regeneration of vegetation after harvest, and harvest methods that disturb little soil.

Tongass-Wide Summary Forms

Comments from the experts' summary forms are compiled here by topic; the topics are not arranged in order of priority, nor are the comments under each topic.

General comments--"The field review of the post-TTRA (Tongass Timber Reform Act) watersheds raised concerns about present management practices. Perhaps the most basic is large differences in interpretation and implementation of management practices under the Reform Act."

"While the basic processes creating and maintaining fish habitat in Southeast Alaska are similar to those operating in the lower 48 states, the spatial context of each watershed dictates the potential impacts of particular management practices. The wide range of landforms in southeast Alaska leads to great spatial variability in potential management impacts, controlled in part by differences in the glacial activity that sculpted the present landscape. Areas of low relief, abundant wetlands, and meandering floodplain channels have risks that differ from areas with narrow, steep, u-shaped valleys with relatively steep, confined, alluvial channels. The following comments attempt to synthesize observations collected across a range of local conditions into a single regional framework. While many of the individual resource scientists and sale administrators in the watersheds that we visited were making effective local resource management decisions, for the purposes of this assessment I had to project potential regional resource impacts forward in time on the basis of the full range of practices and conditions observed during the watershed tours."

Accelerated mass wasting--"Current management practices for steep slopes (i.e., split yarding and partial suspension) are based on concerns about acceleration of surface erosion processes such as rain splash and overland flow. Such processes may be important in locations where short hillslopes drain directly into small colluvial channels [most likely intermittent v-notches in the local vernacular] and avoiding direct soil disturbance is a good practice. However, shallow mass wasting is the dominant process likely to deliver significant amounts of sediment to downstream channels from most of the steep slopes that we observed during our tour. Many of these slopes are finely dissected by small unchanneled valleys, often referred to in the lower 48 as colluvium-filled swales or hollows and subsumed in Alaska under the more general term v-notch. These topographic features are areas of high, shallow, mass-wasting potential, whether they are formed under Holocene conditions and processes (my preferred hypothesis) or are relict features formed rapidly after deglaciation."

"Management-induced acceleration of shallow land slides from steep hillslopes and hollows involves either a time-dependent reduction in root strength or changes in canopy interception that alters the hillslope hydrologic regime. There are many studies that document both the contribution of root strength to the soil and significantly increased rates of land slides after timber harvest on steep slopes in forested regions. Current management practices for steep slopes do not directly address this mechanism. This should be a major concern in this region; in our field review we observed complete harvest of timber on undissected slopes and hollows with gradients in excess of 100%; clearcutting was common on slopes between 70 and 100% and local resource personnel related examples of recent harvest on slopes up to 140%. Clearcutting is not the best management practice on steep slopes where root strength is a major factor affecting slope stability."

"An increased risk of accelerated mass wasting is attributable to a loss of soil strength due to root decay and harvesting activities on steep unstable slope. This risk will increase after harvest as the roots decay and until new root systems replace them (5-40 yrs). Once the slopes begin to fail, a positive feedback is set-up making continued slope failures likely. Evidence of increased mass-failure risk may be found in the many slump, debris flow, and snow avalanche scars in areas adjacent to and upslope of harvest units. The slope angle of many harvest units was near the angle of repose for soils with little cohesive strength. Other soils were judged unstable based upon accelerated mass wasting at road cuts."

"Clearcutting on slopes that are significantly greater than the friction angle of the soil and that are dissected by topographic hollows will accelerate mass wasting."

"Significant slumping of road cut material was observed."

"Unstable slopes are being harvested and roaded, particularly in the Chatham Area where steep, unstable terrain is abundant. A particular concern is the increased use of mid-slope roads and associated stability problems."

"It seems likely that in-unit landslides will increase after clearcutting and that some of these landslides will initiate debris torrents that could cause loss of fish habitat."

"Shallow landslides were observed in some units on steep slopes after harvesting in areas where failures were not observed on unharvested slopes."

"Clearcutting on slopes that are significantly steeper than the friction angle of the soil and that are dissected by topographic hollows" was noted as being of particular concern, as was "harvesting on deep-seated slump/earthflows located on the outside of channel meanders." Also observed was "significant slumping of road cut material in some locations."

"Harvesting on steep unstable slopes should not occur. It contributes to a general unraveling of the landscape and even though its impact on fish habitat will not be felt immediately, in part due to mid-slope storage, eventually most of that colluvium will make its way to the channel (100 years +) and a few slides and debris flows will find their way to fish-bearing streams."

"Future `tentatively suitable' timber base is often located in portions of the watershed that may pose greater risks to fish habitat than areas already harvested. Initial harvest units appear to be in the most accessible and easiest to harvest areas. The harvesting of many of the areas designated 'tentatively suitable' (yellow on GIS map) are on even more unstable slopes; thus, I would expect future harvests to pose an even greater risk to fish habitat (all else being equal)."

Palustrine wetland function--General observations included that wetland drainage will be altered by adjacent roads and sediment loads from road run-off to small channels. Water tables will also be increased by harvesting the adjacent forests. Both changes may affect nutrient cycling and therefore aquatic organisms. Roads dissecting wetlands may also cause increased peak flows in some streams, disrupt groundwater transport characteristics, and divert flow from other channels, thereby reducing water delivered to wetlands.

Channel morphology/stability--"Channel morphology and stability are adjusted to the water, sediment, and woody debris supply imposed upon the channel. The timber harvesting activities observed will increase the water and sediment supply and reduce the woody debris supply (in the long term; in the short term, woody debris loading may increase due to blowdown and accelerated bank cutting). The increased water supply will come from increased channel flow through unbuffered smaller streams and the loss of evapotranspiration due to the removal of vegetation. Increased sediment supply will occur due to increased water and sediment inputs into small channels, and increased surface wash from roads. In the long term, the decreased supply of woody debris will totally change the character of the stream channels. Woody debris is responsible for most of the pool (rearing habitat) in the streams we visited in the Tongass." "Risk is from aggradation and channel widening caused by increased mass wasting. Reduced large woody debris supply from unbuffered tributaries may alter the distribution of channel units. Channel stability may be affected by increased peak flows."

Channel substrate--"Concentration of flow in locations other than natural channels can cause increased sediment production and delivery to fish-bearing streams. The grain size distribution and embeddedness of channel substrate greatly affects its value as fish habitat. Increased fine sediment loads (from accelerated bank erosion and upslope channels) will degrade spawning gravels by reducing permeability and blocking fry emergence. If sediment loads are especially high, rearing habitat may be reduced by pool filling. The extent of gravel-size material suitable for spawning in many of the steeper class I channels and class II channels is associated with large woody debris loading."

Water quality--"Production of fine sediment from road cuts and surfaces is a significant issue in some of the watersheds that we visited (Frosty and Seagull, in particular). Especially in steeper areas, road-side ditches are routed directly to small streams from where the sediment eventually is routed to downstream fish-bearing channels."

"The water quality indicators of increased risk to fish habitat are temperature, suspended sediment, and nutrients." Several experts expect "suspended sediment loads to increase from road surface, fill, and cutslope surface wash and from unbuffered tributaries." They also predict "a loss of nutrient supply to downstream fish habitat due to the unbuffered tributaries. Temperature effects will generally be minor, but may be more important in areas with abundant, slow-moving, dark surface water."

"Alterations of drainage patterns by roads and culverts that divert water out of natural water courses and concentrate it at relief culverts may also impact fish habitats."

"Frequent road-surface grading along highly used haul roads in areas with fine sediment production from road surfaces serves to increase erosion of fine sediment by refreshing the road surface with finer material. While overall road densities are relatively low, and fine sediment production does not appear to be a significant problem in some areas, the production and delivery of fine sediment from road surfaces to channels appears to be an important process in some localities in Southeast Alaska."

"Best Management Practices are not always applied or monitored. Examples include trees felled in class III channels and unseeded, highly erodible road cuts at a stream crossing hemorrhaging sediment into channels. Best Management Practices may not be enough, but they do need to be used and monitored."

"Road drainage maintenance and monitoring is a concern. Culverts on active roads are not always maintained. The problem is worse for out-of-use roads without regular monitoring. Abandoned roads are often not carefully water-barred. Road construction should be limited to summer, followed by effective seeding of road cuts and fills to avoid sediment production."

Habitat diversity/accessibility--"The two most apparent factors related to increased risk of fish habitat degradation are lack of consistent protection for class III streams and fish passage problems from culverts" and "road drainage blockages."

"The diversity of habitat is closely related to channel morphology/stability and substrate. Fish need a wide range of flow depths, velocities, and sufficient cover for different life stages. As wood debris recruitment is limited and channel morphology is altered, this diversity of habitat will be lost. Also, accessibility is a concern, especially with respect to culverts and road drainage. Sometimes class I streams were diverted to a roadside ditch which is likely to dry out and adversely impact (i.e. kill) young fish."

"Risk is from decreased diversity caused by sedimentation from mass wasting and road failures. Also altered channel unit distribution caused by reduced supply of large woody debris from unbuffered tributaries. Also unbuffered tributaries may not provide suitable refuge habitat during high flows."

"No buffers were observed on some small class I channels."

Buffer function/integrity--"The decision of where to start a buffer varied from VCU [value comparison unit] to VCU. The most conservative buffers we saw started at the edge of the flood plain and went out 100 feet. The least conservative buffers had side channels that were not within the buffered area."

"As an example, consider the main branches of Kadake. One hundred feet would not suffice over a long time period due to the dynamics of flood plain and stream channel interactions. The decision to stay away at least 200-300 feet ensured that large woody debris and dynamic equilibrium will be maintained. In contrast, timber on parts of the natural flood plain on portions of Upper Frosty was harvested, thereby decreasing potential channel/flood plain interactions in those sections over the long term."

"Several buffers on class I and class II systems we viewed (notably unit Y on Game Creek) had buffers that were narrow for the terrain. In these situations, the buffer should be extended beyond the 100 feet to a logical topographic boundary (e.g., slope break)."

"Many of the TTRA buffers we observed showed sufficient windthrow to jeopardize their long-term effectiveness. When combined with lateral channel migration in alluvial channels, there may be no functionality to some of the observed buffers in 50 to 100 years."

"Portions of recent buffers in many of the watersheds had greater than 50% of the width of the buffer blown down."

"Blow down of 100-foot buffers is a significant problem in some places. Together with the observation that trees from beyond a 100-foot buffer could be recruited to a channel, this implies potential for long-term reductions in large woody debris recruitment even in channels that occupy stable positions. Since large woody debris is the dominant pool-forming agent in many class I and II channels, short-term blow down potential locally translates into a potential for long-term impacts to channel morphology. Long-term reductions in large woody debris loading will directly lead to reductions in pool habitat, especially in channels with gradients between 1 and 4%. Maintaining large woody debris loading also is important for maintaining gravel-size substrate in steeper channels where large woody debris provides significant roughness; decreased large woody debris loading in these channels may result in coarser bed surfaces that are unsuitable for spawning."

"Buffers of class I and class II streams were, generally, sufficient to protect much of the interactions which ran between the stream and the adjacent terrestrial system."

"In many cases, the buffers on class I streams were well beyond the 100-foot requirement. If this policy continues, then I think the buffers on class I's are generally adequate."

"In some cases 100 feet may not be enough to totally protect the zone that contributes large woody debris, governs nutrient transformations and cycling, and provides nurse logs to the riparian area. Risks to fish habitat are increased at these locations."

Other concerns included observations of "Complete harvest across unclassified or misclassified alluvial step-pool channels that may provide habitat for resident species," and "harvest across small class I channels (side channels) that did not appear on planning maps."

Buffers function/integrity class III and unclassified streams--If the desirable condition is retention of conditions similar to those in unmanaged watersheds, then all experts agreed that larger buffers are needed on class III streams, at least where they are close to fish habitat or in sensitive areas. "It seemed clear that in some areas, thin buffers on small headwater channels are vulnerable to blowdown. This will have complex and unpredictable effects on fish habitat in the long term."

One of the "two most apparent factors related to increased risk of fish habitat degradation was lack of consistent protection for class III streams. Much buffer function is lost by not buffering class III tributaries, e.g., shading and nutrient supply. Also, bank stabilization from roots is lost, as well as large woody debris supply to the tributary and to downstream areas."

Variability in classifying streams--"A major concern involves recognizing and classifying stream channels for buffer protection. Of particular concern is that many significant channels (some of which were observed to contain fish) are not designated as channels: they do not appear on planning documents (EIS, GIS) and sometimes not even on implementation documents (unit cards). There is a wide range of practices for recognizing and updating management plans based on field work. Some Districts only deal with channels designated during planning (It's not a class I channel because it's not on the map), whereas others actively modify unit and buffer boundaries based on field reconnaissance. Defining the upper bound to class III channels (in essence, defining what is and is not a channel) also is neither clearly nor uniformly applied. Many small alluvial channels, especially steep cascade channels, are not recognized as channels; in some Districts, yarding occurs across these small channels; in others, split yarding and/or partial suspension are practiced. A number of these small channels are perennial, as are many of the even smaller colluvial channels that also are not recognized as channels. Since approximately 50% of the total channel length in a channel network is composed of first-order channels, then the

channel networks defined by the current application of the class I, II, and III designations include less than half of the total channel network present in the landscape. While few of the smallest, steepest channels will provide fish habitat, these channels are still an important component of the channel network, especially in regard to water quality issues such as water temperature and delivery of sediment produced in harvest units and from roadways to downstream channels."

"A parallel issue involves distinguishing class II from class III channels. The morphology of class III channels I observed during the watershed tour ranged from small (less than 1 meter in width) steep colluvial channels to larger (up to 4 meters width) step-pool channels that may provide habitat for resident fish. The practice of defining class II channels based on the presence of fish during (usually) a single site visit is inadequate for determining whether a channel actually provides habitat because seasonal use may vary and because of the difficulty inherent in finding fish if the population density is not high. Resource specialists questioned during the tour indicated that the harder they look at many of these smaller channels the more of them they find fish in, a comment virtually identical to others I have received from fisheries biologists working on steep streams in the lower 48. While this issue is most pertinent to the less commercially attractive resident populations, it potentially applies to a significant proportion of their habitat."

Variability in measuring buffers--"The point from which buffers should be defined also is subject to significantly different interpretations under current management practices. During the trip we encountered three distinct variations on the interpretation of where to start the minimum 100-foot buffers. The narrowest definition was that of the bankfull or active channel margin; an alternative used in some Districts involved the margin of any side or high-flow channels; the third definition was to start buffers from the edge of the floodplain. These definitions result in very different buffer widths along low-gradient floodplain channels that generally provide the best anadromous fish habitat; differences may be largely irrelevant in confined channels. Moreover, these differences in buffer width along floodplain channels make a significant difference to both short- and long-term resource protection. In the short term, defining 100-foot buffers from the margin of the bankfull channel in floodplain, or unconfined, channels may not protect high-quality side-channel habitat. Over longer time scales (e.g., 20-100 years), unconfined channels migrate across their floodplain, and side channels are created and destroyed by a number of processes. Provision of narrow buffer strips along such channels may be of little value when the channel moves beyond the extent of the buffer zone. This is also a problem for channels on alluvial and debris flow fans; they also migrate across the fans. If maintenance of processes such as large woody debris recruitment is desired over the long-term, then buffer designs must take channel dynamics into account in a manner that does not rely on the initiative of individuals to continually maintain sufficient buffers. Finally, some Districts view 100-foot buffers as a minimum; some view them as the maximum; implementation problems also occur that result in encroachment and narrow buffers."

Large woody debris--"The primary concern is eventual loss of large woody debris due to unbuffered tributaries. This will result in large quantities of sediment being moved downstream into class I and class II streams. It is likely that, as large woody debris in tributaries decays and is moved, debris flows will be generated, damaging tributary and mainstem ecosystems and habitat. Also, loss of large woody debris supply from tributaries will affect class I and class II morphology. Massive blowdown on class I and class II streams will eliminate the sustained supply of large woody debris. This may be most important between 75 and 200 years following blowdown."

"The recruitment of large wood debris is dependent upon the supply in the riparian zone. Minimal adverse impact was observed in the 0-3 years since harvest at the sites visited. Most of the impact now observable is a loss of wood debris in unbuffered small channels that were classified as class III based on the absence of fish. In fact, some of these streams might be class II if more attempts were made to sample fish."

Several experts observed that the height of riparian trees often exceeded the minimum 100-foot buffer width and indicated "this implied that the natural rate of recruitment would not be maintained by 100-foot buffers even if they did not blow down soon after the adjacent unit was harvested."

Inadequate evaluation by physical scientists--"The involvement of physical scientists such as geomorphologists, hydrologists, and soil scientists in the laying out of cut units in the field appears to be minimal. Although well intentioned, the evaluation of mass failure risk and sediment routing risks are often beyond the expertise of the sale administrators and fisheries biologists who lay out cut units. In addition the layout personnel often are faced with mutually exclusive objectives which cannot all be successfully met."

Comments from Individual Watershed Field Forms

In this section, results are presented as summarized remarks made by the experts for each watershed. Watersheds are presented in the order visited. Field forms, with the experts exact ratings and remarks, are available on request. The experts also prepared summary ratings based on what they observed during the entire field review. Comments included in the summary ratings are incorporated elsewhere in this appendix.

Old Franks Creek--Existing Old Franks Creek timber harvest and roading activities were given a moderately low risk of affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years would drop to low. With further harvest and roading in Old Franks Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderate. All areas of risk to fish habitat were fairly evenly identified as sources of risk (channel morphology/stability, channel substrate, water quality, habitat diversity and accessibility, buffer function and integrity, and large woody debris), although the range in the experts' opinions was great (for instance channel morphology/stability rated between low and moderately-high risk).

Accelerated mass wasting was rated as a moderate risk now, and a high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was inconclusive, rated from high to low by the various experts.

Some of the concerns and comments expressed by the experts were:

- Class III streams need buffers; streams smaller than class III streams don't need them.
- Mass wasting is a concern. More protection is needed of high-hazard soils (related to smaller than class III streams too; one expert noted that it is not a "really serious problem in this watershed, but could contribute to the extirpation of small populations in class II streams"). Maximum mass wasting is at the time of maximum root decay before new rooting strength develops.
- Culvert problems require additional maintenance.
- Class II streams may need wider than minimum buffers.
- Erosion concerns from roads, hollows, and other slope failures were noted.
- Some streams were misclassified.
- Minor temperature concerns were expressed about some streams.

Upper Thorne Creek--Existing Upper Thorne River timber harvest and roading activities were given a low risk of affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years continue to be low. The one area of immediate concern is

buffer function/integrity which was rated as a moderately low risk. With further harvest and roading in the Upper Thorne, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to between moderate and moderately low. All areas of risk to fish habitat were fairly evenly identified as sources of risk (channel morphology/stability, channel substrate, water quality, habitat diversity and accessibility, buffer function and integrity, and large woody debris).

Accelerated mass wasting was rated as a moderate risk now, and a moderately high risk in the long term with additional timber harvest and roading. The concern for increased mass-wasting risk, however, does not result in a commensurate concern for fish habitat. Risk to palustrine wetland function was inconclusive, rated from high to low by the various experts.

Some of the concerns and comments discussed by the experts were:

- Increased risk of mass wasting is likely, especially over the rotation, as more difficult areas are entered.
- Concern was expressed about windthrow in class I, II and III buffers; 25 feet is not enough (50 to 100 feet is).
- Stream classes I, II, and III are inadequate for designing buffers.
- The District was congratulated on going well beyond the minimum buffer requirements. Buffers were well tailored to site characteristics, and generally class I and II buffers were sufficient.
- Some concern was expressed for buffers on intermittent streams.
- Temperature concerns were mentioned as perhaps being a problem and also as not being a problem
- Abandoned roads should be better prepared to provide drainage.
- Some class II streams had more than adequate buffers (e.g. 200 feet); 100 feet would have been sufficient.
- Wider buffers on class III streams are needed to provide shade and large woody debris retention.

Kadake Creek--The experts generally were pleased with the management activities observed in the Kadake Creek watershed. One expert said, "This watershed is a good example of Tongass Timber Reform Act protection fully implemented. Buffers on class I and class II streams are uniformly 100 feet or greater; and Best Management Practices have been followed well."

In the scoring, existing Kadake Creek timber harvest and roading activities were given a low to moderately low risk of affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years would drop to low. With further harvest and roading in Kadake Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderate to moderately low. The primary area of current risk to fish habitat was water quality (including sediment and temperature), although this risk drops to low without further activities. Water quality is also the greatest long-term risk with additional activities, although the range of experts' opinions was from low to moderately high.

Accelerated mass wasting was rated as a moderate risk now, with a moderately high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was inconclusive, rated from high to low by the various experts.

Some of the concerns and comments expressed by the experts were the following:

- Concern about increase in mass wasting because of harvest on steep slopes (>40 degrees).
- High density of roads in some locations can lead to increased sediment sources. (Low-density was noted in other locations.)
- Unbuffered class III streams are a concern.
- Road surface erosion in some locations is a problem. Better rock should be used.
- Small tributaries to mainstems (loss of accessibility to under-classified streams) are a concern.
- Managers could experiment with leaving wood sources in small headwater streams.
- Generally buffers on class I and II streams are well laid out.
- Loss of buffers on class III streams is a problem.

Frosty Creek--Scores given by the experts for Frosty Creek ranged widely. Some seemed to take into consideration that almost no fish use the system because of very low productivity caused by the sterile granitic substrate.

Scores in Frosty Creek ranged from a low to moderately high current risk of activities affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years shifts to moderately low to low. With further harvest and roading in Frosty Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderate to moderately high. All areas of risk to fish habitat were fairly evenly identified as sources of risk (channel morphology/stability, channel substrate, water quality, habitat diversity and accessibility, buffer function and integrity, and large woody debris).

Accelerated mass wasting was rated as a moderate risk now, and a moderately high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was inconclusive, rated from high to low by the various experts.

Some of the concerns and comments discussed by the experts were the following:

- Lack of buffers on streams is a concern, partly because many streams were not even classified.
- Channels were often missed from inventories and unit cards.
- More consistency is needed in classifying streams across the Tongass.
- Buffers should be designed based on site observations, not on inventory.
- Harvest on steep slopes (40 degrees +) and colluvium-filled hollows is a concern.
- Movement of fine granitics into fish habitat is a concern, especially if a large landslide occurs.
- Because buffers were often minimum size, any windthrow would be cause for concern.
- Managers appeared to address the minimum requirements, not real protection needs.
- Class III streams need buffers.
- The soil survey is incomplete or inaccurate for assessing mass-movement hazard.
- Larger buffers are needed on uncontained streams, like Frosty.
- The limiting factor for fish here is likely granitic geology; logging could perhaps increase secondary production by temporarily increasing nutrients (the narrow buffers are all right; management-related disturbance might be good for nutrients and increasing solar radiation).
- Adequacy of road maintenance is doubtful.
- Better training is needed on channel identification to increase consistency.
- A problem exists with the stream classification system: the main stem had no anadromous fish, but if it did not have two major falls, it could be a major fish stream.

(Note: two experts left the group after Kadake Creek, and one additional expert joined the group at this watershed.)

Whale/Buckhorn Creeks--Whale/Buckhorn Creeks were given a wide range of risk scores, from a low to a moderate risk of activities now affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 years becomes moderately low and in 100 years drops to low. With further harvest and roading in Old Franks Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderate to moderately high. All areas of risk to fish habitat were fairly evenly identified as sources of risk (channel morphology/stability, channel substrate, water quality, habitat diversity and accessibility, buffer function and integrity, and large woody debris), although the range in experts' opinions was great (for instance, water quality was rated from a low to moderately high risk).

Accelerated mass wasting was rated as a moderate risk now, and a moderately high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was rated as less than in most other watersheds (generally a low to moderate risk).

Some of the concerns and comments expressed by the experts were the following:

- Risk of increased mass wasting from harvest on 40 degree + slopes and hollows is a concern.
- Buffers are at risk because they are undersized.
- Buffers are lacking on class III streams.
- Minimal buffers produce high windthrow potential,
- Roads have possible fish passage problems, largely because of the use of round culverts).
- A more flexible buffering method is needed. Continuous buffers on class I to III streams are not always necessary.
- Class I to III streams need consistent buffering.
- Roads are at risk of erosion.
- Risks will increase because roads must be constructed midslope.
- Drainage on abandoned roads is inadequate.

Game Creek--Game Creek had the widest range of ratings of all the watersheds evaluated by the experts. Ratings for existing Game Creek timber harvest and roading activities ranged from low to high risk of affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years would drop to moderately low. With further harvest and roading in Game Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderately high. Areas of risk to fish habitat with the highest ratings were buffer function/integrity and channel morphology/stability.

Accelerated mass wasting was rated as a moderate to high risk now, and a high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was inconclusive, rated from high to low by the various experts.

Some of the concerns and comments expressed by the experts were the following:

- Class III and some intermittent streams need to be buffered.
- Mass wasting is a concern because of harvest on steep (>35 to 40 degree) slopes, high mass movement-hazard soils, and hollows.
- Split yarding on steep slopes either side of drainages helps prevent surface erosion, but does not address the potential for shallow landsliding.

- Debris flows cause risk to road crossings and culverts.
- Maintenance (or closure) of out-of-use roads is inadequate. Waiting for a failure is a poor approach; recycling roads is a good approach.
- The percentage of fines on roads will contribute sediment to streams.
- Better training is needed to recognize unstable terrain.
- Generally, class I and II streams are buffered adequately (except where the stream is completely missed), with some risk of windthrow. One expert thought some buffers were inadequate, and suggested about 200 feet (one site potential tree) to ensure full loading of large woody debris. Another expert stated that this was a good example of Reform Act protection fully implemented.
- A key restoration need is to deal with some channels that are blocked for fish passage by culverts/roads; too many round pipes are used on small fish streams.
- Riparian zones should be better matched to conditions. Some streams may migrate out of their buffers.
- Risk to fish habitat is higher at steep sites than at lower relief.

Seagull Creek--The experts rated Seagull Creek as having the highest risk to fish habitat, accelerated mass wasting, and palustrine wetland function of any of the watersheds observed during the review. Ratings for existing Seagull Creek timber harvest and roading activities ranged from a moderately low to high risk of affecting the health and condition of the watershed and fish habitat. With no further activity in the drainage, the risk in 30 and 100 years would drop to moderately low. With further harvest and roading in Game Creek, however--as anticipated by assuming harvest of most of the tentatively suitable timber--the risk to fish habitat would increase to moderately high. Areas of risk to fish habitat with the highest ratings were channel morphology/stability, channel substrate, and water quality.

Accelerated mass wasting was rated as a moderately high risk now, and a high risk in the long term with additional timber harvest and roading. Risk to palustrine wetland function was rated moderately high (a higher rating than in any of the other watersheds).

Some of the concerns and comments expressed by the experts were:

- Harvesting class III streams and major hollows and their effect on sediment production are concerns; class III streams need buffers.
- Mid slope roads result in significant sediment production.
- Road drainage on abandoned roads is not well done.
- Harvest on steep and unstable slopes is a concern.
- An increase in peak flows is a risk.
- Loss of large woody debris on class III streams will result in loss of sediment storage capacity.
- Stream capture by drainage ditches is a concern.
- Seagull Creek buffers did a better job (than at Game Creek) of following topographic relief--the "lay of the land."
- Roads are the most significant problem; a key restoration need is to repair the road drainage system or put the road to bed as rapidly as possible.
- Risk of mass failure on steep slopes is greatly increased.
- Coho rearing is increasingly risky because of road construction and drainage patterns.
- Insufficient input into planning from physical scientists is a concern.
- Implementing Best Management Practices needs to be more closely monitored.
- Large quantities of fine sediment are produced from roads.
- Buffer integrity is a concern because of windthrow.
- Regrading roads every 10 days and mobilizing more fines is a concern.

Answers to question 2: "If you do not consider current Tongass management to be effective for the protection of fish habitat, what additional management practices do you recommend to reduce the risk to fish habitat?"

Experts' Responses in Their Individual Exit Interviews

To prevent the acceleration of mass wasting and maintain channel morphology/stability--To fully protect fish habitat, roading or logging should be avoided in high-risk upper basins, in the fringes of conifers between avalanche chutes, in any terrain classified by the Tongass as very high mass-movement index, or in much of the high mass-movement index terrain.

If some risk to fish habitat is acceptable, the Forest Service could monitor the effectiveness of experimental small patch cuts using helicopters and taking up to 10% of the suitable timber in unstable areas or selective logging of a low percentage of the trees between the hollows on unstable slopes by using helicopters (i.e., maintain an interwoven, live-tree root system to hold the soil onto the steep slope). Slopes less than 26 degrees were generally considered stable with proper roading and logging practices.

To maintain wetland functionality--Improved road drainage and maintenance are needed to prevent changes in local hydrology and the input of fine sediments to wetlands adjacent to roads.

To maintain water quality--Better enforcement of Best Management Practices is needed to ensure they are implemented.

Although all experts agreed buffers were needed on some class III streams and unclassified channels, the opinions as to the width and locations needed differed. Several recommended that a continuous vegetated (forested, where naturally occurring) buffer along class III and unclassified channels is needed to prevent them from becoming open conduits for sediment transfer and to help reduce the increase in water flow down the channels because of the evapotranspiration from the trees in the buffer.

Some experts indicated that perennially flowing class III and unclassified streams need continuous forested buffers, perhaps 100 feet, to provide sources of large woody debris that will either move down into fish habitat or remain as a debris dam helping to reduce transport of sediment to fish streams from up-slope areas being harvested. As soon as the existing large woody debris in these channels decays or gets flushed out, if a long-term source is not available to replace it, the channel will lose its ability to trap sediment. Existing large woody debris may function as sediment trap for 20 to 30 years, so this time lag before the adverse effects to fish habitat can be documented in the fish streams will be long.

One expert was primarily concerned with buffering perennially flowing class III streams close to fish-bearing waters. In Oregon and Washington, biologists suggested class III streams be buffered 500 feet linearly upstream from fish-bearing waters, with the buffer width tailored to the landform. He also thought that intermittently flowing class III and unclassified streams only need forested buffers at the most sensitive locations, including deeply incised areas, head walls, unstable hillsides, and tributary junctions. He recommended leaving buffers in sites that will probably not blow down, and feathering the buffer edge.

Other experts recommended continuous forested buffers be retained along all intermittent alluvial channels.

Most experts recommended that roads should be closed to vehicular traffic after timber harvest is completed to reduce the production of sediments from use of the roads. Road closure should ensure adequate drainage under low or no maintenance, and seeding during the spring or early summer to

ensure that herbaceous vegetation takes hold before the autumn rains and the end of the growing season.

To maintain habitat diversity and accessibility to fish--Some experts advocated a better match between buffers for class I and II habitat and the topography of the site. The entire floodplain needs to be included in planning for the buffer, which should continue to the slope break. Planning for nurse logs in riparian floodplains is thought to be very important for getting future conifer regeneration.

Additional fish habitat biologists, hydrologists, and geomorphologists need to be involved in the design and layout decisions for roads, harvest units, and buffers.

Training in hydrology and geomorphology is needed for existing staff so they can predict the potential constriction of channel flow from improperly designed culverts.

One expert--is experienced in the design of stream crossing structures--said that all fish-bearing streams need bottomless arch or box culverts or bridges instead of the round culverts being installed. Culverts should be installed to be <1% grade, with no fall at the outfall, and with >6 inches deep of water flowing through the culvert to maintain fish passage. Log sills should be placed below culverts more frequently than observed to prevent scour, perched culverts, and blockage to fish passage.

To maintain functional integrity of the buffer, including the long-term recruitment of large woody debris to fish habitat--Because of the frequency of windthrow in newly established buffers and because it compromises the functional integrity of these buffers by reducing the recruitment of large woody debris into the channel, one expert recommended that the functional buffer should be made windfirm by leaving trees for a distance equal to 25% of the width of the functional buffer. Also, commercial salvage harvest or personal-use harvest of the buffer trees that windthrow should not be allowed because they break up the force of the wind as it approaches the remaining buffer wall.

Wider buffers than 100 feet should be retained on class I and II channels. One expert recommended the width should equal the height of the dominant mature trees in the buffer plus 25% of this distance to accommodate the loss of the buffer to windthrow

Another expert recommended that mainstem channels should have forested buffers at least 300 feet wide, measured from where trees are established on the floodplain, and another said that the buffer should extend 100 feet out from the outer edge of the floodplain (as determined by alluvial soils and slope break).

One expert suggested that buffers are needed on class III channels and unclassified, perennial channels (from 0.33 to 0.5% of the height of mature trees in the buffer plus 25% of this width to ensure that the buffer will become windfirm after the outer portion of it blows down). Where the resultant buffer would be very narrow, some multiple of the channel width should be maintained and effectiveness monitoring conducted to determine the minimum buffer width needed in these types of channels.

The least conservative recommendation was that class III and perennial unclassified channels need a continuous, 25-foot-wide forested buffer for the first 500 feet up-slope from class I or II channels into which they flow.

Most experts indicated that when the minimum width buffer is used (whether the current 100-foot or a future requirement), the buffer should be measured starting from the outer bank of the outermost side channels.

One expert advocated leaving the dead and downed trees in the riparian area to serve as nurse logs to speed the regeneration of riparian trees because probably 85% of conifer seedlings in riparian areas are on nurse logs.

Another expert stated that the classification of streams for the buffer requirements should be based on fish-habitat characteristics, not a one-time field observation of the presence or absence of fish. Some class II streams the experts observed should have been class I.

Written Recommendations

Changes in the design of stream buffers--One expert wrote, "The decision of which channels require buffers is critical. These distinctions should be based upon habitat, and water and sediment routing considerations rather than the presence or absence of specific fish species. In the class I and II channels, a buffer of about 330 feet would be about the height of mature trees and make a small allowance for increased windthrow. Rapidly migrating meandering channels would need even wider buffers but that should be evaluated on a site-specific basis. Similarly, some channels might be adequately protected by narrower buffers, but that should also be evaluated on a site-specific basis. The approval of buffers narrower than 330 feet should require the approval of an interdisciplinary team of physical and biological scientists."

One expert recommended:

- Unconfined alluvial floodplain channels (generally class I): floodplain width as minimum buffer width.
- Confined alluvial channels (generally class I and class II): minimum buffer width of 200 feet or site-potential tree height.
- Confined cascade alluvial channels and colluvial channels (generally class III and no class): minimum buffer width of 100 feet.
- Potentially unstable areas: Alternative silvicultural approaches (i.e., no clearcutting) on slopes steeper than 40° (84%) and in topographic hollows steeper than 35° (70%).

Most experts thought class III streams should be buffered. One expert wrote that "100-foot buffers are probably not adequate because blowdown directly impacts the channel in many cases through episodic, rather than chronic, loading of large woody debris, and altered shading and nutrient delivery." Another expert wrote: "I don't think it's necessary to buffer all class III streams, but it might be wise to place buffers on those in steep, unstable areas. It may be possible to cluster these close to one another to keep windthrow to a minimum. The idea is to provide some natural riparian vegetation in some headwater areas that can deliver fine particulate organic matter over time, and ultimately fall in the channels."

One expert noted "It seemed clear that in some areas, thin buffers on small headwater channels are vulnerable to blowdown. This will have complex and unpredictable effects on fish habitat in the long term."

Another expert recommended that "smaller upslope channels (generally class III and unclassified perennial) could be adequately protected with narrower buffers (than required on class I and II) because mature trees are generally shorter and woody debris recruitment is often less important because the protection of water quality rather than spawning and rearing habitat is the primary objective. For these streams, I suggest a buffer width of 30 to 50 meters."

"Blowdown will occur in a buffer of any width. To protect the integrity of the buffer, it is essential that no salvage logging be done from buffer or near-buffer blowdown. The blowdown provides topographic roughness to extract momentum and lessen a given gust's impact."

Recommendations for training--Two recommendations by experts emphasized the need for training.

"Training is needed for personnel responsible for sale and road locations in recognizing unstable soils and terrain and in understanding hydrology and geomorphology in order to lay out buffers that will function as intended over the long term."

"I believe the Region must sponsor a series of workshops designed to educate ALL potential practitioners (especially anyone who deals with layout) in the art of buffer design. For fish habitat to benefit, it should be made clear to all that 100 feet is the starting point--sometimes sufficient, but frequently minimal."

Recommendations for road management--"To minimize adverse impact to fish habitat, logging roads should be closed and seeded as soon as possible after the harvest."

"Several issues relating to road construction and maintenance are of concern. First, road maintenance in general appears to be done only when problems arise and does not continue once harvest activity slows down within a catchment. Funding also needs to be available for fixing road-drainage-related problems not associated with keeping the road open, such as stream and wetland drainage diversions and fish passage blockage resulting from scouring below culverts."

"More frequent culverts discharging onto undissected hillslopes would reduce this problem; sediment produced from road surfaces should not be routed directly to stream channels as an intentional design. The practice of frequent road grading should be reconsidered in areas where this is a problem."

"Round culverts should only be used on those fish-bearing streams where they can be installed with very little risk of forming a fish blockage."

Restoration recommendations--"Restoration should focus on identifying, prioritizing, and correcting culverts presenting fish-passage problems and correcting and maintaining drainage from and through road systems."

"Restoration of abandoned roads is needed. "Recycling" of roads with appropriate ground treatment is recommended. Otherwise, careful drainage design and seeding is recommended."

Monitoring recommendations based on the watersheds visited--"Implementation of a sustained monitoring effort is necessary to assess the long-term performance of management practices. Current monitoring in most Districts seems to focus primarily on buffer integrity: Did it blow down? More emphasis is needed on the type of channel monitoring that Steve Paustian is developing involving stratifying channels and collecting detailed data on a number of reaches within a watershed. Other concerns include the need to monitor more than 1 or 2 reaches in a watershed and to incorporate event-based monitoring of event-driven processes (e.g., suspended sediment loads) if a monitoring program is to see a response signal. Establishment of baseline studies or at least data for before/after comparisons should be vigorously pursued. Training and methodology concerns are of course an issue, but were not discussed extensively during this tour. It is crucial that monitoring methods be scientifically based and tested; ad hoc methods that work will be of little use in the long run. All monitoring programs, however, run into problems with maintaining funding and institutional commitment; institutions in particular like to look forward not backward. Perhaps the most important long-term contribution to monitoring programs would be to predicate future management decisions on evaluations of past management performance. In other words, make monitoring of performance a key component of planning future activity."

Specific monitoring recommendations made by one or more of the experts include the following:

- Implementation and effectiveness of Best Management Practices;
- Changes in morphology and substrate of all channel types in response to harvesting, including everything from small ephemeral upslope channels to mainstems;
- Buffer effectiveness and integrity;
- Woody debris recruitment;
- Mass failure occurrence, timing, size, mechanism, etc.;
- A regional network of reference sites for buffer windthrow to better understand conditions influencing vulnerability;
- Stream discharge;
- Suspended sediment;
- Response of class III streams to current practices;
- Assessing channel stability of the class III system with and without buffers;
- Delivery rate of materials to downstream systems to provide some means of identifying those class III systems needing buffers; and
- Road maintenance and culvert inspection/rehabilitation program in every watershed.

Attachments

Attachment 1--Forms developed by the Team to collect opinions during the expert field review

Review of Post-TTRA Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: _____ **Date:** June/__/1994 **Form Number:** ____

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES	-	-	-	-	-
Accelerated Mass Wasting					
Palustrine Wetland functionality					
HYDROLOGY	-	-	-	-	-
Channel Morphology					
Channel Substrate					
Channel Stability					
Water Quality (inc. temp, sed,etc.)					
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity					
Buffer Integrity					
Buffer Functionality					
Large Woody Debris					
OVERALL RISK TO FISH HABITAT					

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

(Use the Other Side of this Form to Elaborate on the Probable Causes for Increased Risk)

Attachment 1--Forms developed by the Team to collect opinions during the expert field review (continued)

(Individual Expert Survey Questionnaire Continued)

Provide comments on the PROBABLE CAUSES of any areas of INCREASED RISK noted on the previous page:

Based on this review, do you have: 1) concerns about management practices you've seen in the watershed, 2) specific restoration needs identified, 3) recommendations for monitoring, or 4) any other areas of particular concern.

Would you have designed the stream buffers in a different manner (such as narrower or wider)? If so, please describe how the buffer(s) would differ, and indicate the harvest unit to which you are referring.

(use continuation sheets as necessary)

Attachment 1--Forms developed by the Team to collect opinions during the expert field review (continued)

CONTINUATION SHEET NO. __

Individual Expert Survey Questionnaire

Watershed: _____ **Date:** June/__/1994 **Form Number:*** ___

* Please show the same Form Number as given to you on the first page of your questionnaire sheet for this watershed.

Attachment 2--Assumptions developed by the Team for use by the experts.

Assumptions

The following list of assumptions was handed to the experts at the beginning of the field review.

The following assumptions will be used in evaluating the "risk" of current practices to fish habitat in Alaska.

1) The following is excluded from the "tentatively suitable" timber shown on the watershed maps in yellow: 1) a minimum 100 foot buffer either side of Class 1 and most Class 2 streams, 2) 500 feet from the ocean, an area known as the beach fringe, and 3) 1000 feet from the ocean associated with estuaries. Of the remaining "tentatively suitable," a portion is unavailable for harvest due to the selected management plan. The timber left is called the "suitable available," and is not depicted on the maps. Of the "suitable available," assume that 90 percent may eventually be scheduled for harvest (proposed revised Tongass Land Management Plan, 1991). Definitions of "tentatively suitable," "suitable available," and "suitable scheduled" are located at the end of this document.

2) The amount of Forest-wide harvest of the "Suitable Available" lands over the next 100 years is shown in two ways: one column is the theoretical rate of harvest (allowed by the proposed revised Forest Plan), while the other column represents the actual average rate of harvest over the last 15 years. 70 years from now, essentially all harvest is anticipated to be second growth.

Years from Now	Theoretical Amount Harvested	Amount Based on Past History
0 (now)	15	15
5	21	18
10	26	21
35	53	35
70	90	55
100	90	55

3) 10 percent of the tentatively suitable timber has been harvested, which equates to roughly 15 percent of the suitable available timber (see definitions below).

4) We are now approximately 40 years into the Tongass timber harvest rotation, so maximum harvest would occur in each watershed within the next 70 years.

5) We will assume that the normal rate of tree mortality from insects/disease and windthrow will remain the same.

6) Best Management Practices are continually evolving, not always perfectly implemented, and not always effective.

7) Roads will continue to be constructed primarily using the rock overlay method. Rates of road construction could possibly go as high as 200 miles per year across the Forest, but are more likely to

be closer to the 53 miles of new and 101 miles of reconstruction per year, as evidenced by the average from 1987-1991. (Note: there are approximately 3,500 miles of roads on the Forest. Currently about 17 % of nonwilderness lands are roaded, or 1.9 million acres. This results in a road density of about 1.2 miles/square-mile.)

8) Assume that current harvest methods will be used during the current rotation (although, as shown, the distribution has been changing). The following general harvest methods, with their amount of use, are currently being used on the National Forests in Alaska.

Harvest Method	***Conditions***
High lead (46 %)	Decreasing in use. Historically this is the standard practice. 60 % of high lead is downhill. Avoids building side slope roads.
Shovel yarding (11 %)	Increasing in use. Used near roads, on flat land, and typically areas with low erosion susceptibility.
Skyline (42 %)	Increasing in use. Typically used in areas with soil problems.
Helicopter (10 %)	Increasing in use. Used to avoid building roads, access difficult locations, or where there are soil problems. Also used for unevenage management, such as group selections.

Definitions:

Tentatively Suitable: Forest land that is producing or is capable of producing crops of industrial wood and: a) has not been withdrawn by Congress, the Secretary of Agriculture, or the Chief of the Forest Service, b) existing technology and knowledge is available to ensure timber production without irreversible damage to soils productivity, or watershed conditions; c) existing technology and knowledge, as reflected in current research and experience, provides reasonable assurance that it is possible to restock adequately within 5 years after final harvest, and d) adequate information is available to project response to timber management activities.

Suitable Available: Lands which are determined to be tentatively suitable and which are available for harvest in the selected management plan.

Suitable Scheduled: That portion of the Suitable Available timber that is actually scheduled for harvest over the rotation.

Attachment 3--Additional assumptions, definitions, and form modifications developed jointly by the Team and the experts

Before visiting the first watershed of the review, the moderating panel and expert group met to discuss the evaluation process and to identify changes the experts deemed necessary in the field collection form. The moderating panel had agreed before this meeting that final evaluation items on the form would be established by the expert group. The following agreements were made.

- Wetland functionality and accelerated mass wasting will be evaluated by themselves. Their relation to fish habitat will be addressed using other issues on the form (e.g. habitat).
- We are to rate negative impacts on the form and describe positive impacts in the comments sections.
- Channel morphology and channel stability will be grouped into one item. The general definition will be: Dynamic stability, over time, of physical features of the stream and the resulting effect on fish habitat.
- Large woody debris will be rated as changes in wood loading detrimental to fish habitat.
- Buffer functionality and buffer integrity will be grouped into one item. Some factors affecting the rating of this item include: provision of nurse trees, shading, debris, protecting banks, root strength, nutrient changes, fine organic matter, microclimate (e.g. anchor ice).
- Habitat diversity and *accessibility* will be grouped into one item. Habitat diversity includes at the micro, meso, and macro scales. (Accessibility was a new item.)
- Water quality includes temperature, suspended sediment, chemistry; but **NOT** wood.
- Overall risk to fish habitat is an overall evaluation for the watershed; it does not need to be the sum or average of individual scores.

Attachment 4--Standardized resumés of experts

Fisheries biologists

Robert E. Bilby
Aquatic Ecologist

Weyerhaeuser Company
Technology Center 1A5
Tacoma, Washington 98477
(206) 924-6557 (office)
(206) 924-6970 (fax)

Education:
Cornell University, Ithaca, NY; Ph.D., ecology, 1979
University of Rhode Island, Kingston, RI; B.S., zoology, 1974

Expertise:
Structure and function of stream ecosystems; production, population dynamics, and community interactions of stream-dwelling fishes; ecological effects of land-use practices and non-point pollution on aquatic ecosystems; ecology of riparian ecosystems.

Peter A. Bisson
Aquatic Biologist

Weyerhaeuser Company
Technology Center 1A5
Tacoma, WA 98477
(206) 924-6329 (office)
(206) 924-6970 (fax)

Education:
Oregon State University, Corvallis, OR; Ph.D., fisheries and wildlife, 1975
University of South Florida, Tampa, FL; post-graduate student, zoology, 1971
Oregon State University, Corvallis, OR; M.S., fisheries and wildlife, 1969
University of California at Santa Barbara, CA; B.A., environmental biology, 1967
Ventura College, Ventura, CA; undergraduate student, biology, 1965

Expertise:
Structure and function of stream ecosystems; fish production, population dynamics and community structure; analysis of environmental data bases; environmental impacts of land-use practices and non-point source pollution; and zoogeography and systematics of freshwater fishes.

C. Andrew Dolloff
Project Leader, Assistant Professor

USDA Forest Service
Southeastern Forest Experiment Station
Department of Fisheries and Wildlife Science
Virginia Tech
Blacksburg, VA 24061-0321
(703) 231-4864 (office)
(703) 231-7580 (fax)

Education:
Montana State University, Boseman, MT; Ph.D., fisheries and wildlife, 1983
North Carolina State University, Raleigh, NC; M.S., zoology, 1979
University of Maine, Orono, ME; B.S., wildlife and fisheries, 1975

Expertise:
Structure and function of stream ecosystems; fish production, population dynamics and community structure; effects of land use (historical and contemporary) on distribution and abundance of stream fishes; and stream habitat survey and evaluation procedures.

Geomorphologists

Alan Barta
Research Geomorphologist

USDA Forest Service
Intermountain Research Station
316 East Myrtle Street
Boise, ID 83702
(208) 364-4406 (office)
(208) 364-4346 (fax)

Education:
The Johns Hopkins University, Baltimore, MD; Ph.D. candidate, geomorphology
International Association for Hydraulic Research, summer school on stability of river and coastal forms, Perugia, Italy, 1990
Hampshire College, Amherst, MA; B.A., geomorphology and hydrology, 1988
Colorado State University, Fort Collins, CO; visiting student, earth resources, 1986-87
Princeton University, Princeton, NJ; summer student, geology field camp, 1986

Expertise:
Hydraulics and sediment transport; numerical and physical modeling of hydraulics and sediment transport; magnitude, frequency, and effectiveness of geomorphic events; determination of stream flows to maintain and improve aquatic habitat; effects of changing land use on drainage basins and stream channels.

David R. Montgomery
Research Assistant Professor

Department of Geological Sciences, AJ-20
University of Washington
Seattle, WA 98195
(206) 685-2560 (office)
(206) 543-3836 (fax)

Education:
University of California, Berkeley, CA; Ph.D., geological sciences, 1991
Stanford University, Palo Alto, CA; B.S., geology, 1984

Expertise:
Channel initiation and landscape evolution; earth surface process modeling; fluvial processes and bedform organization in steep alluvial channels; and geomorphic disturbance regimes.

Richard D. Woodsmith
Research Hydrologist

USDA Forest Service
Pacific Northwest Research Station
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801-8545
(907) 586-8811 (office)
(907) 586-7848 (fax)
(Note: professional publications are under Richard D. Smith)

Education:
Oregon State University, Corvallis, OR; Ph.D., geology/geomorphology, 1990
Oregon State University, Corvallis, OR; M.S., geology/geomorphology, 1985
University of Oregon, Eugene, OR; B.S., geology, 1972

Expertise:
Fluvial geomorphology; fluvial sedimentology; sediment transport and channel morphology in forest channels; effects of land use on hillslope stability and fluvial processes in forest ecosystems; and sediment routing and budgeting in mountainous terrain.

Attachment 5--Timber harvest planning history of watersheds visited by the expert review group

Old Franks--Timber harvest along Old Franks Creek (Tongass VCU 613) was planned, and NEPA environmental disclosure documents were contained within the 1989-94 Operating Period for the Ketchikan Pulp Company Long-Term Timber Sale Area FEIS (USDA Forest Service 1989**a**). In the Record of Decision, Alternative 7 with modifications was selected as the harvest plan (USDA Forest Service ROD June 2, 1989, signed by the Regional Forester). The Forest Service (Ketchikan Area) said amending the environmental documents after passage of the Reform Act was not necessary. Ground layout for all the timber harvest units was completed in either 1991 or 1992. Timber harvest started in April 1992 and was completed in April 1993, with the majority of harvest in March and April of 1993.

Upper Thorne Bay--Timber harvest in Upper Thorne Bay (Tongass VCU 586) was planned and the NEPA environmental disclosure documents contained within the 1989-94 Operating Period for the Ketchikan Pulp Company Long-term Timber Sale Area FEIS (USDA Forest Service 1989**a**). In the Record of Decision, Alternative 7 with modifications was selected as the harvest plan (USDA Forest Service ROD June 2, 1989, signed by the Regional Forester). The Forest Service (Ketchikan Area) said amending the environmental documentation after passage of the Reform Act was not necessary. Ground layout for all the timber harvest units was completed in either 1991 or 1992. Some of the layout was modified as felling operations began. Timber harvest started in June 1991 and was completed by the end of 1992.

Frosty Bay--Timber sale analysis was initiated in 1983 for the Cleveland Peninsula including the Frosty Bay drainage. A Decision Notice was signed in 1984 for the timber sale (USDA Forest Service 1984). The log transfer site at Frosty Bay was evaluated separately and an environmental assessment was completed, but a decision on the location and design was not made. The sale was laid out in 1984, but the project was deferred before the sale because of poor market conditions. In 1987, a new environmental analysis was initiated since the 1983 EIS was considered inadequate. The Frosty Bay Timber Sale FEIS was prepared (USDA Forest Service 1990) and the Record of Decision was signed December 10, 1990. Sale layout was updated during the summer of 1990. To bring the sale up to Reform Act requirements, minimum 100-foot buffer zones were added to the main class II channels. Timber harvest started late in the season of 1992 and was completed in the fall of 1993.

Kadake--A modest amount of timber was harvested in the Kadake Creek watershed in the mid-1960s, and intensified in the 1970s and 1980s. Some of the harvest units in the Kadake watershed pre-date the National Environmental Policy Act, and consequently were not covered in an environmental impact statement. The units harvested between 1969 and 1989 were prepared under several different project analyses. The units harvested after 1989 were covered in the Alaska Pulp Corporation Long-Term Timber Sale Contract FSEIS for the 1981-86 and 1986-90 Operating Periods (Analysis Area 12: Kuiu Island) (USDA Forest Service 1989**b**). That Record of Decision was signed December 17, 1989, by the Regional Forester.

Timber harvest of the units visited by the expert review team were planned in the Alaska Pulp Corporation Long-Term Timber Sale Contract, North and East Kuiu FEIS (USDA Forest Service 1993). The planning effort was after passage of the Reform Act. Alternative 4 was chosen for implementation in the Record of Decision signed January 20, 1993. The harvest units in the Kadake watershed were laid out on the ground during the summer of 1993 and harvested in 1993 and 1994. Some harvesting was still being completed while the expert review team visited the Kadake watershed.

Whale/Buckhorn--The cutting units in Whale and Buckhorn Creek watersheds (Tongass VCU 238) have had a long planning history but very little timber was cut before the Reform Act was passed. Those units that were harvested are a consolidation of those planned for the Trap Bay Timber Sale and laid

out on the ground in July 1981. Roads were also located, surveyed, and staked in the early 1980s. Cutting was postponed, however, because of a court injunction. Cutting units were redesigned and evaluated in December 1986 and described in the Alaska Pulp Corporation Long-Term Timber Sale Contract Final Supplemental Environmental Impact Statement for the 1981-86 and 1986-90 Operating Periods (Analysis Area 6: Corner Bay) (USDA Forest Service 1989**b**). In 1989 when the cutting units were laid out, the old flagging, paint, and road stakes still present from the early planning efforts were confusing, so new color schemes and codes were established. After release from the court-ordered injunction, two cutting units were released and timber felled in 1990 before the Reform Act was passed.

After passage of the Reform Act and release from the injunction, additional changes were made to some of the cutting units as documented in unit records. Reading the old road stakes was difficult and road plans could not be reconciled with the terrain, so roads were re-staked and surveyed, culvert sizes were changed, and fish passage concerns were accommodated. The remaining units were harvested in 1991 and 1992. All final yarding and cutting unit closeout was completed in 1991 or 1992.

Game and Seagull Creeks--Timber harvest was laid out on paper for the Game and Seagull Creek watersheds as early as 1981, but plans did not extend to ground layout at that time. The NEPA documentation was in the Alaska Pulp Corporation 1981-1986 Long-term Timber Sale EIS (USDA Forest Service 1980), again in the Alaska Pulp Corporation 1986-1990 Long-Term Timber Sale EIS (USDA Forest Service 1986), and finally again in the Alaska Pulp Corporation Long-Term Timber Sale Contract Final Supplemental EIS for the 1981-86 and 1986-90 Operating Periods (USDA Forest Service November 1989**b**). Some timber was harvested in the north fork of Game Creek in 1986 and 1987, before a court-ordered injunction stopping additional harvest.

After release of the court-ordered injunction, additional harvest layout was completed before the Reform Act was passed. That layout, as well as the remaining harvest unit layout, was modified to conform to the Reform Act in 1991 and subsequent years as documented in unit records. Felling and yarding began in 1992, was completed in Game Creek in 1993, and continues in Seagull Creek in 1994.

Attachment 6a--Composite ratings by the experts for Frosty Creek

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Frosty Creek Composite **Date:** June 12, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	2334	2445	1233	3345	1123
Palustrine Wetland Functionality	1244	2255	1144	2255	1144
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	12224	23345	11233	13345	11113
Channel Substrate	11233	13334	11223	13334	11113
Water Quality (inc. temp, sed, etc.)	12224	12345	11123	12345	11113
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	11124	23335	12222	33335	11112
Buffer Functionality/Integrity	12334	23344	12223	23344	11123
Large Woody Debris	11124	22334	11223	22334	11112
OVERALL RISK TO FISH HABITAT	12224	23344	11223	23344	11113

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.

Attachment 6b--Composite ratings by the experts for Game Creek

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Game Creek Composite **Date:** June 14, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	145	355	224	355	124
Palustrine Wetland Functionality	34	25	24	35	14
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	1234	2345	2223	3345	1122
Channel Substrate	1234	2344	1222	3344	1112
Water Quality (inc. temp, sed, etc.)	1133	1334	1112	2334	1111
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	1144	3335	1223	3345	1222
Buffer Functionality/Integrity	1235	2345	2223	3345	2224
Large Woody Debris	1134	2335	1223	2335	1123
OVERALL RISK TO FISH HABITAT	123 ½	2345	2222	3345	1122

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.

Attachment 6c--Composite ratings by the experts for Kadake Creek

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Kadake Composite **Date:** June 11, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	2234	3455	1233	3355	1123
Palustrine Wetland Functionality	125	225	114	225	113
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	11122	12233	11122	22233	11112
Channel Substrate	11122	12233	11112	12223	11112
Water Quality (inc. temp, sed, etc.)	1223	12344	11122	12344	11112
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	11113	22233	11112	22233	11112
Buffer Functionality/Integrity	11112	22233	11112	22224	11112
Large Woody Debris	11112	12222	11112	22222	11112
OVERALL RISK TO FISH HABITAT	11 1½22	22333	111 1½2	22333	1111 1½

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.

Attachment 6d--Composite ratings by the experts for Old Franks Creek

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Old Franks Composite **Date:** June 9, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	3335	4555	2234	3555	1124
Palustrine Wetland Functionality	144	245	124	245	114
HYDROLOGY					
Channel Morphology/Stability	11223	22333	11122	12334	11113
Channel Substrate	1113	2333	1112	2334	1113
Water Quality (inc. temp, sed, etc.)	11223	22234	11123	22333	11112
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	11122	22234	11113	23334	11113
Buffer Functionality/Integrity	12233	23444	11223	22344	11122
Large Woody Debris	11123	22334	11122	23345	11123
OVERALL RISK TO FISH HABITAT	11223	23334	11123	23344	11113

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.

Attachment 6e--Composite ratings by the experts for Seagull Creek

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Seagull Creek Composite **Date:** June 15, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase In Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	345	555	344	555	234
Palustrine Wetland Functionality	34	45	33	45	23
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	2234	3445	2223	3445	1122
Channel Substrate	2245	3445	2223	3445	1112
Water Quality (inc. temp, sed, etc.)	2245	3445	1222	3445	1112
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	1224	3335	1224	2335	1122
Buffer Functionality/Integrity	1134	3335	1224	2335	1124
Large Woody Debris	1122	2234	1222	2235	1122
OVERALL RISK TO FISH HABITAT	2235	3445	2223	3445	1122

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.

Attachment 6f--Composite ratings by the experts for Upper Thorne River

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Upper Thorne Composite **Date:** June 10, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	2224	3445	1234	3345	1122
Palustrine Wetland Functionality	114	225	113	235	113
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	11111	23333	11112	22333	11112
Channel Substrate	11111	22233	11112	22223	11112
Water Quality (inc. temp, sed, etc.)	11112	12223	11111	12233	11111
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	11111	12233	11122	22333	11112
Buffer Functionality/Integrity	11222	22333	11122	22233	11122
Large Woody Debris	11111	22223	11122	22233	11122
OVERALL RISK TO FISH HABITAT	11112	22333	11112	22333	11112

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it means that an expert did not feel qualified in rating that indicator.

Attachment 6g--Composite ratings by the experts for Whale/Buckhorn Creeks

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Review of Post-Reform Act Activities and Assessment of Impacts on Fish Habitat

Individual Expert Survey Questionnaire

Watershed: Whale/Buckhorne Composite **Date:** June 13, 1994

The watershed you are viewing has had a timber sale in the past three years. Using your professional expertise and the background information provided to you, please complete the remainder of this form as a separate and independent assessment. Please do not indicate your identity anywhere on this form.

Rate the INCREASE in risk (over the natural background risk) for each of the following potential indicators of the health and condition of the watershed and fish habitat using a scale of 1-5. Note: in a pristine watershed, there would be NO increase in risk.

1 = Low (≤ 20%); 2 = Moderately Low (21-40%); 3 = Moderate (41-60%); 4 = Moderately High (61-80%); 5 = High (≥ 81%)

Increase in Risk Over the Natural Background Risk

INDICATOR	Now	In 30 Years*		In 100 Years*	
		With	Without	With	Without
UPSLOPE PROCESSES**	-	-	-	-	-
Accelerated Mass Wasting	234	445	133	345	123
Palustrine Wetland Functionality	123	124	112	124	112
HYDROLOGY	-	-	-	-	-
Channel Morphology/Stability	2233	2344	1123	2344	1123
Channel Substrate	1223	2333	1222	2333	1122
Water Quality (inc. temp, sed, etc.)	1234	2344	1122	2344	1112
HABITAT (Riverine/Lacustrine)	-	-	-	-	-
Habitat Diversity/Accessibility	1113	2223	1112	2223	1112
Buffer Functionality/Integrity	1234	2334	1123	2334	1113
Large Woody Debris	1124	2333	1122	2344	1113
OVERALL RISK TO FISH HABITAT	1233	3 3½44	1123	3 3½34	1112

* The WITH and WITHOUT columns refer to the evaluation of the potential future condition WITHOUT additional roading or logging beyond what has already taken place, and WITH additional roading and logging under current management practices given the general identification of areas (on your maps) considered tentatively suitable for commercial timber harvest.

** These upslope processes are evaluated independently of their affect on fish habitat.

Note: If there are fewer numbers in some blocks, it indicates that an expert did not feel qualified in rating that indicator.