ALASKA REFERENCES

Alaska—FRPA Region I
(Coastal Sitka Spruce/Hemlock Forest)

1) **Allan, J.D., M.S. Wipfli, J.P. Caouette, A. Prussian, and J. Rodgers. 2003. Influence of streamside vegetation on inputs of terrestrial invertebrates to salmonid food webs. Canadian Journal of Fisheries and Aquatic Sciences. 60: 309-320. (C)**

Author abstract: Salmonid food webs receive important energy subsidies via terrestrial in-fall, downstream transport, and spawning migrations. We examined the contribution of terrestrially derived invertebrates (TI) to juvenile coho (*Oncorhynchus kisutch*) in streams of southeastern Alaska by diet analysis and sampling of TI inputs in 12 streams of contrasting riparian vegetation. Juvenile coho ingested 12.1 mg·fish^{-1} of invertebrate mass averaged across all sites; no significant differences associated with location (plant or forest type) were detected, possibly because prey are well mixed by wind and water dispersal. Terrestrial and aquatic prey composed approximately equal fractions of prey ingested. Surface inputs were estimated at ~80 mg·m^{-2}·day^{-1}, primarily TI. Direct sampling of invertebrates from the stems of six plant species demonstrated differences in invertebrate taxa occupying different plant species and much lower TI biomass per stem for conifers compared with overstory and understory deciduous plants. Traps placed under red alder (*Alnus rubra*) and conifer (mix of western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*)) canopies consistently captured higher biomass of TI under the former. Management of riparian vegetation is likely to influence the food supply of juvenile coho and the productivity of stream food webs.

2) **Bartos, L. 1989. A new look at low flows after logging. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources, 21-23 March 1989, Juneau, Alaska. E.B. Alexander, Editor. USDA Forest Service, Alaska Region, R10-MB-77. Pages 95-98. (G)**

Author abstract: On the west side of Prince of Wales Island, a 51.6 square mile drainage basin was used to systematically evaluate low flow trends, before and after timber harvest. Both yearly flow duration curves and the 2 and 20 year recurrence low flow derived by Log Pearson Type III analysis, showed significantly greater low flows after timber harvesting 35 percent of the drainage area.

3) **Bartos, L.R. 1993. Stream discharge related to basin geometry and geology, before and after logging. In: Proceedings of Watershed '91: A Conference on the Stewardship of Soil, Air, and Water Resources, 16-17 April 1991, Juneau, Alaska. T. Brock, Editor. USDA Forest Service, Alaska Region, R10-MB-217. Pages 29-32. (G)**

Author abstract: Utilizing available U.S.G.S. hydrologic data on five watersheds in SE Alaska with different intensities of logging and two watersheds for a no harvest control; a composite analysis was done to determine the degree of hydrologic change caused by harvesting. The possible controlling basin parameters effecting a streams regimen, i.e., water yield, peak flood flows and mean seven day low flows other than drainage area and amount of timber harvest are geologic makeup, mean basin side slope gradient and basin shape. When considering these basin parameters (excepting basin shape) on floods before and after timber harvest, it was found that in all cases they were significant in S.E. Alaska.

4) Bjornn, T.C., S.C. Kirking, and W.R. Meehan. 1991. Relation of cover alterations to the summer standing crop of young salmonids in small southeast Alaska streams. Transactions of the American Fisheries Society. 20: 562-570. (K)

Electronic abstract: Summer abundance of young coho salmon *Oncorhynchus kisutch*, steelhead *O. mykiss* , and Dolly Varden *Salvelinus malma* was assessed in small streams on Prince of Wales Island, Alaska, in an attempt to measure the response of these fish to various types of cover alterations. The standing crop of subyearlings decreased during summer, but none of the decrease could be attributed to the changes in cover we made. Subyearling coho salmon (about 75% of the fish present) did not respond either to the removal of natural riparian vegetation or to the addition of simulated riparian canopy, large boulders, woody debris, or simulated undercut banks. Localized movements within the streams were sufficient to provide relatively rapid recolonization of the experimental habitat units. The forms of cover we evaluated were relatively unimportant in regulating abundance of young coho salmon in small streams.

5) Brabets, T.P. 1995. Application of surface geophysical techniques in a study of the geomorphology of the Lower Copper River, Alaska. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Resources Investigations Report 94-4165. 47pp. (A, G, I)

Electronic abstract: The Copper River, located in southcentral Alaska, drains an area of more than 24,000 square miles. About 30 miles above its mouth, this large river enters Miles Lake, a proglacial lake formed by the retreat of Miles Glacier. Downstream from the outlet of Miles Lake, the Copper River flows past the face of Childs Glacier before it enters a large, broad, alluvial flood plain. The Copper River Highway traverses this flood plain and in 1996, 11 bridges were located along this section of the highway. These bridges cross parts or all of the Copper River and in recent years, some of these bridges have sustained serious damage due to the changing course of the Copper River. Although the annual mean discharge of the lower Copper River is 57,400 cubic feet per second, most of the flow occurs during the summer months from snowmelt, rainfall, and glacial melt. Approximately every six years, an outburst flood from Van Cleve Lake, a glacier-dammed lake formed by Miles Glacier, releases approximately 1 million acre-feet of water into the Copper River. At the peak outflow rate from Van Cleve Lake, the flow of the Copper River will increase an additional 140,000 and 190,000 cubic feet per second. Bedload sampling and continuous seismic reflection were used to show that Miles Lake traps virtually all the bedload being transported by the Copper River as it enters the lake from the north. The reservoir-like effect of Miles Lake results in the armoring of the channel of the Copper River downstream from Miles Lakes, past Childs Glacier, until it reaches the alluvial flood plain. At this point, bedload transport begins again. The lower Copper River transports 69 million tons per year of suspended sediment, approximately the same quantity as the Yukon River, which drains an area of more than 300,000 square miles. By correlating concurrent flows from a long-term streamflow-gaging station on the Copper River with a short-term streamflow-

gaging station at the outlet of Miles Lake, long-term flow characteristics of the lower Copper River were synthesized. Historical discharge and cross-section data indicate that as late as 1970, most of the flow of the lower Copper River was through the first three bridges of the Copper River Highway as it begins to traverse the alluvial flood plain. In the mid 1980's, a percentage of the flow had shifted away from these three bridges and in 1995, only 51 percent of the flow of the Copper River passed through them. Eight different years of aerial photography of the lower Copper River were analyzed using Geographical Information System techniques. This analysis indicated that no major channel changes were caused by the 1964 earthquake. A flood in 1981 that had a recurrence interval of more than 100 years caused significant channel changes in the lower Copper River. A probability analysis of the lower Copper River indicated stable areas and the long-term locations of channels. By knowing the number of times a particular area has been occupied by water and the last year an area was occupied by water, areas of instability can be located. A Markov analysis of the lower Copper River indicated that the tendency of the flood plain is to remain in its current state. Large floods of the magnitude of the 1981 event are believed to be the cause of major changes in the lower Copper River.

6) Brownlee, K. 1991. Prey consumption by juvenile salmonids on the Taku River, southeast Alaska. M.S. Thesis, University of Alaska, Fairbanks. 166pp. (C)

Author abstract: Stomach contents were collected from juvenile salmonids (genus *Oncorhynchus* and *Salvelinus*) from habitats on the Taku River in 1987. Differences were defined between groups on fry. A linear discriminant function (LDF) analysis was applied to prey frequencies grouped by species, habitat, and period. The analysis discriminated between: fish in beaver ponds; sockeye in side-slough sites and fish from other mainstem sites; and beaver ponds and mainstem sites. An exclusion experiment was established in a beaver pond. The diet of sockeye (*O. nerka*) and coho (*O. kisutch*) fry was sampled from allopatric and sympatric treatment enclosures. LDF analysis applied to prey categories assigned group membership between species, treatment, and period factors. A log-linear analysis yielded significant interaction effects between the treatment, habitat, and period explanatory variables and the response, prey, confirming the influence of the presence of cogenerics on prey consumed.

7) Bryant, M.D. 1980. Evolution of large, organic debris after timber harvest: Maybeso Creek, 1949 to 1978. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-101. 30pp. (A, D)

Author abstract: The Maybeso Creek valley was logged from 1953 to 1960. Stream maps showing large accumulations of debris and stream channel features were made in 1949 and updated to 1960. The objectives of this paper are to document the effects of natural and logging debris on channel morphometry and to examine the fate of logging debris during and after logging. Map sections from 1949 through 1963 are examined and compared with a ground survey in 1978 of debris accumulations.

Natural conditions before logging revealed sparse accumulations of large debris scattered throughout the stream; these accumulations increased in number and density during logging. Natural material appeared to be well controlled and stable; whereas, logging debris was floatable. Year-to-year changes in accumulations were noted throughout the period of logging from 1953 to 1969. Fewer accumulations were observed in 1978 than in 1949, before the start of logging. Further studies are needed to quantify physical changes and to relate these changes to salmon habitat.

8) Bryant, M.D. 1981. Evaluation of a small diameter baffled culvert for passing juvenile salmonids. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Forest Service Research Note PNW-384. 8 pp. (K)

Electronic abstract: Poorly constructed road crossings of small streams can block upstream movement of juvenile salmonids. Where gradients are more than 1%, baffled culverts may facilitate fish passage to nursery areas above road crossings. The baffles create a series of short high velocity runs between the baffles and a series of low velocity backwater areas behind the baffles. These areas allow the fish to swim in short bursts and then rest. A 90-cm diameter culvert with off-set baffles was set at a 10% gradient in an artificial stream channel on Admiralty Island, Alaska. Juvenile coho salmon, Dolly Varden, and cutthroat trout used in the study were taken from two nearby streams. All fish, with the exception of a few larger (110 to 120 mm) Dolly Varden, were less than 100 mm fork length. All three species were able to negotiate the culvert, but more Dolly Varden than Coho salmon or Cutthroat trout were successful. Within the range of discharges commonly examined between 10 1/S and 16 1/S, discharge did not appear to affect fish movement up the culvert. Two potential problems with baffled culverts may occur at the outlet: outlet velocity; and scour of the stream bottom. Both can be avoided by proper design.

9) Bryant, M.D. 1984. Distribution of salmonids in the Trap Bay Basin, Tenakee Inlet. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 17-31. (K)

Author abstract: Because land management may affect a stream system at various points along its progression to the sea, it is important to identify zones used in the watershed by juvenile salmonids. This 2-year study examined the distribution of juvenile salmonids in an undisturbed, old-growth forest drainage. The purpose of the study was to determine the distribution of juvenile salmonids in a small stream basin from the main stream through the upper tributaries. Differences in density, species ratios, and size among juvenile salmonids in main-stream zones, lower tributary zones, and upper tributary zones were observed. Upper reaches of tributaries were used by age-0 coho, cutthroat trout, and Dolly Varden. Lower reaches of tributaries were extensively used by juvenile coho of all age-classes and Dolly Varden up to about 120 mm in length. Main-stream zones were sparsely populated by all species, but where off-channel rearing areas were available, coho were more abundant. Differences in density occurred from early summer to early fall.

10) Bryant, M.D. 1985. Changes 30 years after logging in large woody debris, and its use by salmonids. In: Riparian ecosystems and their management: Reconciling conflicting uses. R.R. Johnson, C.D. Ziebell, D.R. Paton, P.F. Ffolliot, and R.H. Hamre, Coordinators. Rocky Mountain Forest and Range Experiment Station, General Technical Report GTR RM-120. Pages 329-334. (D)

Electronic abstract: Changes in large woody debris in fourth and fifth-order salmon streams with logged, unlogged, and partially logged riparian zones are documented from maps--for 1949 to 1960--and from field surveys done in 1983 and 1984. Over the 30-year period, most changes in the amount of large woody debris occurred in the logged systems. During and immediately after logging large increases were noted, but in 1984 the amount of large woody debris in the logged systems was less than that observed before logging in most categories. Amounts of large woody debris in the other streams remained relatively stable. Thirty years after logging, habitat formed as a result of large debris provides important rearing areas for juvenile salmonids.

11) Bryant, M.D., and F.H. Everest. 1998. Management and condition of watersheds in southeast Alaska: The persistence of anadromous salmon. Northwest Science. 72: 249-267. (K)

Electronic abstract: In contrast to most of North America and Europe, numerous intact or lightly disturbed watersheds are present throughout southeast Alaska. These watersheds support abundant and diverse populations of anadromous salmonids. While the watersheds throughout the northern hemisphere have been exposed to human disturbance from millennia to centuries, significant human disturbance to the watersheds of southeast Alaska did not begin until the 1950's with the start of industrial logging. Although management of watersheds has evolved to reduce risks to aquatic habitat, the most intensive logging occurred during the first 20 years of timber harvest when few restraints were placed on timber harvest in watersheds. As a result, a legacy of streams with deteriorating habitat remains. While few salmon stocks in southeast Alaska appear to be in decline, escapement records on specific watersheds, particularly those most severely affected by management are non-existent or qualitative. The present status of salmon stocks may be attributed to abundant intact watersheds, high marine survival, and escapement levels that fully seed most watersheds. The numerous intact watersheds throughout southeast Alaska are a critical factor in maintaining sustainable salmon stocks in southeast Alaska.

12) Bryant, M.D., B.E. Wright, and B.J. Davies. 1992. Application of a hierarchical habitat unit classification system: Stream habitat and salmonid distribution in Ward Creek, southeast Alaska. USDA Forest Service, Pacific Northwest Research Station, Research Note PNW-RN-508. (A)

Electronic abstract: A hierarchical classification system separating stream habitat into habitat units defined by stream morphology and hydrology was used in a pre-enhancement stream survey. The system separates habitat units into macrounits, mesounits, and microunits and includes a separate evaluation of instream cover that also uses the hierarchical scheme. The paper presents an application of the system to a pre-enhancement survey of habitat and salmonid populations. Application of the method accompanied by snorkel counts of fish allowed us to determine habitat area, salmonid densities within habitat units, and an estimate of the total salmonid population by species. The method is useful to rapidly describe and stratify stream habitat to determine salmonid distribution and abundance during stream surveys.

13) Bryant, M.D., J.P. Caouette, and B.E. Wright. Evaluating stream habitat survey data and statistical power using an example from southeast Alaska. Draft manuscript. First author address: USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Juneau, Alaska. (A)

Author abstract: Stream habitat surveys and watershed assessments have been developed and used as monitoring tools for decades. Most rely on type I error as the primary criterion with minor consideration of statistical power and effect size. We test for statistical differences in fish habitat condition between harvested and non-harvested watersheds from habitat survey data collected in Southeast Alaska. We apply statistical power analysis to judge whether non-significant results could be interpreted with confidence. None of the fish habitat variables we examined were significant at $P = 0.05$; however, several p-values were less than 0.10 and consistent differences between harvested and unharvested reaches were observed among channel types. Statistical power is low and the probability of not detecting differences is high when the effect size, scaled to the standard deviation of the measurement, is small to medium. For large effect sizes the ability to detect differences increased but did not exceed 85% for any measurement. Statistical power, effect size and biological significance of the outcome are important considerations when the results are interpreted and can lend additional information to managers making decision with less than perfect data.

14) Bryant, M.D., N.D. Zymonas, and B.E. Wright. 2004. Salmonids on the fringe: Abundance, species composition, and habitat use of salmonids in high gradient headwater streams, southeast Alaska. Transactions of the American Fisheries Society. 133: 1529-1538. (A)

Author abstract: We evaluated the species distribution, abundance, and habitat relationships of salmonids in small, 1st to 2nd order headwater streams in Southeast Alaska. Streams were separated into three zones based on gradient and sampled during the spring, summer, and fall. Dolly Varden (*Salvelinus malma*) were found in all streams where fish were present. They were the dominant species in moderate (mean gradient 5.5 %) and high gradient (mean gradient 12.9 %) zones. Coho salmon (*Oncorhynchus kisutch*) fry and parr were dominant species in the low gradient zone (mean gradient 3.1 %), but were present in higher gradient zones. Small numbers of steelhead parr (*O. mykiss*) were present in all three zones in the spring and fall. Few were captured during the summer. Coastal cutthroat trout (*O. clarki*) were found primarily in one stream and in all three zones. Density of all species decreased as gradient increased. Anadromous Dolly Varden in spawning condition were observed in the fall up to the highest accessible locations in four streams. Salmonids use high gradient reaches when pools are present and accessible. Headwater tributaries comprise a large proportion of most Southeast Alaska watersheds and the combined contribution from all of these tributaries to the fish community may be large. Results from this study underscore the importance of maintaining access for fish throughout watersheds and into small high gradient streams.

15) Bryant, M.D., D.N. Swanston, R.C. Wissmar, and B.E. Wright. 1998. Coho salmon populations in the karst landscape of North Prince of Wales Island, southeast Alaska. Transactions of the American Fisheries Society. 127: 425-433. (E, I)

Electronic abstract: Karst topography is a unique and distinct landscape and its geology may have important implications for salmon productivity in streams. The relationship between salmonid communities and water chemistry and the influence of habitat was examined in a set of streams on north Prince of Wales Island, southeast Alaska. Streams in karst landscapes showed higher alkalinities (1,500-2,300 mu eq/L) than streams not influenced by karst landscapes (750-770 mu eq/L). A significant, positive relationship was observed between alkalinity and density of coho salmon parr *Oncorhynchus kisutch*. Backwater pools supported higher densities of coho salmon than did other habitat units. Both coho salmon fry and parr tended to be larger in most karst-influenced streams than in nonkarst streams. Although past timber harvest practices in the riparian areas of several of the streams appeared to influence stream habitat and water temperature, streams flowing through karst landscapes had distinct water chemistry. Furthermore, these streams appeared to support more fish than nonkarst streams.

16) **Buffington, J.M., and D.R. Montgomery. 1999. Effects of hydraulic roughness on surface textures of gravel-bed rivers. Water Resources Research. 35: 3507-3521. (A, B, D, G)**

Electronic abstract: Field studies of forest gravel-bed rivers in northwestern Washington and southeastern Alaska demonstrate that bed-surface grain size is responsive to hydraulic roughness caused by bank irregularities, bars, and wood debris. We evaluate textural response by comparing reach-average median grain size (D_{50}) to that predicted from the total bank-full boundary shear stress ($t_{0_{bf}}$), representing a hypothetical reference condition of low hydraulic roughness. For a given $t_{0_{bf}}$, channels with progressively greater hydraulic roughness have systematically finer bed surfaces, presumably due to reduced bed shear stress, resulting in lower channel competence and diminished bed load transport capacity, both of which promote textural fining. In channels with significant hydraulic roughness, observed values of D_{50} can be up to 90% smaller than those predicted from $t_{0_{bf}}$. We find that wood debris plays an important role at our study sites, not only providing hydraulic roughness but also influencing pool spacing, frequency of textural patches, and the amplitude and wavelength of bank and bar topography and their consequent roughness. Our observations also have biological implications. We find that textural fining due to hydraulic roughness can create usable salmonid spawning gravels in channels that otherwise would be too coarse.

17) **Buffington, J.M., T.E. Lisle, R.D. Woodsmith, and S. Hilton. 2002. Controls on the size and occurrence of pools in coarse-grained forest rivers. River Research and Applications. 18: 507-531. (A, D)**

Electronic abstract: Controls on pool formation are examined in gravel- and cobble-bed rivers in forest mountain drainage basins of northern California, southern Oregon, and southeastern Alaska. We demonstrate that the majority of pools at our study sites are formed by flow obstructions and that pool geometry and frequency largely depend on obstruction characteristics (size, type, and frequency). However, the effectiveness of obstructions to induce scour also depends on channel characteristics, such as channel gradient, width:depth ratio, relative submergence (ratio of flow depth to grain size), and the calibre and rate of bed material supply. Moreover, different reach-scale channel types impose different characteristic physical processes and boundary conditions that further control the occurrence of pools within a catchment. Our findings indicate that effective management of pools and associated aquatic habitat requires consideration of a variety of factors, each of which may be more or less important depending on channel type and location within a catchment. Consequently, strategies for managing pools that are based solely on single-factor, regional target values (e.g. a certain number of wood pieces or pools per stream length) are likely to be ineffective because they do not account for the variety of local and catchment controls on pool scour and, therefore, may be of limited value for proactive management of complex ecosystems.

18) Campbell, A.J., and R.C. Sidle. 1985. Bedload transport in a pool-riffle sequence of a coastal Alaska stream. Water Resources Bulletin. 21: 579-590. (I)

Electronic abstract: A Helley-Smith pressure differential bedload sampler was used to measure bedload transport at consecutive riffle sections of a riffle-pool-riffle sequence on Bambi Creek, a small (154 ha), second-order stream on Chichagof Island, Alaska, during four storms over a 2-year period. Maximum bedload transport rate measured was 4920 kg/h at a streamflow of 2.35 m^3/s corresponding to a storm having a 5-year return interval. Transport of larger sediment (> 8 mm) varied systematically with streamflow at the two sampling locations. At flows up to approximately bankfull, transport of large sediment was greatest at the upstream site; at flows above bankfull, transport of large sediment was greatest at the downstream site.

19) Chaloner, D.T., and M.S. Wipfli. 2002. Influence of decomposing Pacific salmon carcasses on macroinvertebrate growth and standing stock in southeastern Alaska streams. Journal of the North American Benthological Society. 21: 430-442. (C, E)

Author abstract: We compared macroinvertebrate growth rates and standing stock in the absence and presence of meat from Pacific salmon (*Oncorhynchus* spp.) carcasses in microcosm and natural stream rearing experiments in southeastern Alaska. In microcosm experiments, the presence of salmon meat increased growth rates and standing stock for the shredder *Zapada cinctipes* and the collector *Psychoglypha subborealis*, but not the predator *Rhyacophila* sp., or the scraper *Cinygmula* sp. In natural stream experiments, the presence of salmon meat increased the growth rate and standing stock of *P. subborealis*, but increased only the growth rate of *Z. cinctipes*. Macroinvertebrate responses to inputs of salmon-derived organic material can vary by species, which may reflect their feeding ecology. Macroinvertebrate taxa belonging to the collector functional-feeding group are likely to be important in transferring the effects of spawning salmon to the rest of the food web in southeastern Alaska streams.

20) Chaloner, D.T., M.S. Wipfli, and J.P. Caouette. 2002. Mass loss and macroinvertebrate colonisation of Pacific salmon carcasses in south-eastern Alaskan streams. Freshwater Biology. 47: 263-273. (C, E)

Author abstract: 1. We examined the spatial and temporal dynamics of pink salmon (*Oncorhynchus gorbuscha*) carcass decomposition (mass loss and macroinvertebrate colonisation) in south-eastern Alaskan streams. Dry mass and macroinvertebrate fauna of carcasses placed in streams were measured every two weeks over two months in six artificial streams and once after six weeks in four natural streams. We also surveyed the macroinvertebrate fauna and wet mass of naturally occurring salmon carcasses.

2. Carcass mass loss in artificial streams was initially rapid and then declined over time (k =-0.033 day^{-1}), and no significant differences were found among natural streams.
3. Several macroinvertebrate taxa colonized carcasses, but chironomid midge (Diptera: Chironomidae) and *Zapada* (Pleceoptera: Nemouridae) larvae were found consistently and were the most abundant (on average 95 and 2%, respectively, of the invertebrates found). Chironomid abundance and biomass increased over time, whereas *Zapada* abundance and biomass did not. Significant differences in abundance were found among natural streams for *Baetis* (Ephemeroptera: Baetidae) and *Sweltsa* (Plecoptera: Chloroperlidae) larvae, while no significant differences were found for chironomid and *Zapada* abundance or biomass.
4. Our results suggest that salmon carcasses initially undergo a high rate of mass loss that tapers off with time. Chironomid and *Zapada* larvae are likely to be important in mediating nutrient and energy transfer between salmon carcasses and other components of the freshwater-riparian food web in south-eastern Alaskan streams.

21) Chaloner, D.T., K.M. Martin, M.S. Wipfli, P.H. Ostrom, and G.A. Lamberti. 2002. Marine carbon and nitrogen in southeastern Alaska stream food webs: Evidence from artificial and natural streams. Canadian Journal of Fisheries and Aquatic Sciences. 59: 1257-1265. (C, E)

Author abstract: Incorporation of marine-derived nutrients (MDN) into freshwater food webs of southeastern Alaska was studied by measuring the natural abundance of nitrogen and carbon stable isotopes in biota from artificial and natural streams. Biofilm, aquatic macroinvertebrates (detritivores, shredders, and predators), and fish (coho salmon, *Oncorhynchus kisutch*, and cutthroat trout, *Oncorhynchus clarki*) were sampled from streams in which Pacific salmon (*Oncorhynchus* spp.) carcasses had been artificially placed or were present naturally. In the presence of carcasses, all trophic levels incorporated marine-derived nitrogen (range, 22–73% of total N) and carbon (range, 7–52% of total C). In general, chironomid midges assimilated more marine-derived nitrogen and carbon than did other consumers. The assimilation of MDN by aquatic organisms and subsequent isotopic enrichment (5–6‰ for ^{15}N, 3–4‰ for ^{13}C) were similar in experimentally and naturally carcass-enriched streams. For specific taxa, however, percent assimilation for marine nitrogen and carbon were often dissimilar, possibly because of fractionation or transfer inefficiencies. These results suggest that pathways of MDN incorporation into stream food webs include both consumption of salmon material by macroinvertebrates and fish and uptake of mineralized MDN by biofilm. Incorporation of MDN into multiple trophic levels demonstrates the ecological significance of annual returns of anadromous fishes for sustaining the productivity of freshwater food webs.

22) Chaloner, D.T., G.A. Lamberti, R.W. Merritt, N.L. Mitchell, P.H. Ostrom, and M.S. Wipfli. 2004. Variation in response to spawning Pacific salmon among three south-eastern Alaska streams. Freshwater Biology. 49: 587-599. (C, E)

Author abstract: 1. Pacific salmon are thought to stimulate the productivity of the fresh waters in which they spawn by fertilizing them with marine-derived nutrients (MDN). We compared the influence of salmon spawners on surface streamwater chemistry and benthic biota among three southeastern Alaska streams. Within each stream, reaches up- and downstream of barriers to salmon migration were sampled during or soon after spawners entered the streams. 2. Within streams, concentrations of dissolved ammonium and soluble reactive phosphorus (SRP), abundance of epilithon (chlorophyll *a* and ash-free dry mass) and biomass of chironomids were significantly higher in reaches with salmon spawners. In contrast, biomass of the mayflies Epeorus spp. and Rhithrogena spp. was significantly higher in reaches lacking spawners. 3. Among streams, significant differences were found in concentrations of dissolved ammonium, dissolved organic carbon, nitrate and SRP, abundance of epilithon, and the biomass of chironomids and Rhithrogena. These differences did not appear to reflect differences among streams in spawner density, nor the changes in water chemistry resulting from salmon spawners. 4. Our results suggest that the 'enrichment' effect of salmon spawners (e.g. increased streamwater nutrient concentrations) was balanced by other concurrent effects of spawners on streams (e.g. sediment disturbance). Furthermore, the collective effect of spawners on lotic ecosystems is likely to be constrained by conditions unique to individual streams, such as temperature, background water chemistry and light attenuation.

23) Deal, R.L. 1997. Understory plant diversity in riparian alder-conifer stands after logging in southeast Alaska. USDA Forest Service, Pacific Northwest Research Station, Research Note PNW-RN-523. 8pp. (D)

Author abstract: Stand structure, tree height growth, and understory plant diversity were assessed in five mixed alder-conifer stands after logging in southeast Alaska. Tree species composition ranged from 7- to 91-percent alder, and basal area ranged from 30 to 55 m^2/ha. The alder exhibited rapid early growth, but recent growth has slowed considerably. Some conifers have been suppressed, but some spruce are now nearly as tall as the overstory alders. The four stands with the most alder had high species richness of shrubs, herbs, ferns, and mosses, but the predominantly spruce stand had slightly fewer species of shrubs and ferns, and considerably fewer herbs. Mixed alder-conifer stands have maintained species-rich understories for 45 years after logging, and stands with conifers and alders of relatively equal stocking contained the largest diameter conifers. Riparian alder-conifer stands maintain plant diversity and also will provide some large-diameter conifers for large woody debris for streams.

24) Deal, R., M. Wipfli, A. Johnson, T. De Santo, P. Hennon, and T. Hanley. 2002. Does red alder enhance wildlife, aquatic, and fisheries resources in young-growth western hemlock-Sitka spruce forests of southeast Alaska? In: Beyond 2001: A Silvicultural Odyssey to Sustaining Terrestrial and Aquatic Ecosystems. Proceedings of the 2001 National Silviculture Workshop, 6-10 May, Hood River, Oregon. S. Parker and S.S. Hummel, Compilers. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-546. Pages 93-102 (C, D, F)

Author abstract: Red alder (*Alnus rubra* Bong.) appears to influence the productivity and community composition of young growth conifer forests and affect the major resources (timber, wildlife, and fishes) of forested ecosystems in southeast Alaska. We propose that landscapes may be managed to concurrently enhance these resources. Historically, red alder has often been regarded as an undesirable species by forest managers and has been thinned from riparian and upland forests. We present an integrated approach to study the function of young-growth forest ecosystems and to understand how alder influences selected trophic linkages and processes in managed landscapes. We will assess the physical disturbances that are associated with alder establishment. We will also investigate mixed red alder-conifer forests and determine if these forests provide a greater biomass of understory vegetation and forage for herbivores (e.g., deer) and invertebrates than young-growth conifer forests. We will determine the effect of mixed red alder-conifer forests on the abundance of aquatic, riparian, and terrestrial invertebrates that provide food for fish, bats, and birds. We will also determine if most red alder trees die standing (as opposed to uprooting or bole snapping), and assess woody debris and sediment input in streams. We will investigate whether red alder in mixed stands may enhance conifer growth and total wood production. The inclusion of red alder in young-growth stands may allow clearcutting in areas where purely even-aged conifer forests would compromise wildlife, fish, and aquatic resources.

25) Dolloff, C.A. 1983. The relationships of wood debris to juvenile salmonid production and microhabitat in small southeast Alaska streams. Ph.D. Thesis, Montana State University, Bozeman. 109pp. (D)

Author abstract: Many small streams in Southeast Alaska contain both wood debris deposited by natural causes and/or logging and populations of juvenile salmonids. Resource managers have assumed that large amounts of wood debris were detrimental to fish populations and have recommended debris removal. This study was initiated to describe the effects of wood debris and debris removal on populations of juvenile coho salmon and Dolly Varden in four tributary streams of Staney Creek, Prince of Wales Island, Alaska during the summers of 1979-1981. Three streams were located in clearcuts and had debris removed from selected subsections by manual labor. A fourth stream was located in an uncut forest stand and provided information on fish populations under natural conditions. Population densities and production of both species were typically higher in subsections having debris accumulations intact. Production during the June-September period for age 0+ and age 1+ coho combined ranged from 0.464-2.496 g/square meter. Dolly Varden production ranged from 0.106-0.879 g/square meter. For coho, debris provided visual isolation, permitting larger numbers of fish to live together without excessive territorial interactions. Greater Dolly Varden numbers were related to increased cover provided by debris. There was little apparent competition between the species. An examination of microhabitat preferences showed that each of two coho and three Dolly Varden age classes was found in distinct areas. Coho occupied midwater positions that they defended from other fish. Dolly Varden were found on the stream bottom in dense cover. Analysis of stomach contents showed that coho selected most dietary items from the drift whereas Dolly Varden primarily exploited benthic prey. Discriminant analysis showed that depth of focal point, depth of water, distance to nearest fish and distance to nearest cover were the most important variables accounting for separation of the five species-age class groups. Discriminant analysis using species as groups and incorporating the proportion of diet from terrestrial sources as an independent variable revealed that dietary differences also contributed to group separation. Stream cleaning in streams similar to those studied will likely be detrimental to anadromous juvenile fish populations.

26) Dolloff, C.A. 1986. Effects of stream cleaning on juvenile Coho salmon and Dolly Varden in southeast Alaska. Transactions of the American Fisheries Society. 115: 743-755. (D)

Author abstract: The effects are described of selective removal of woody debris on populations of juvenile Coho salmon *Oncorhynchus kisutch* and Dolly Varden *Salvelinus malma* in two small streams on Prince of Wales Island, Alaska, during the summers of 1979-1981. These streams contained debris left when surrounding forests were clear-cut in the late 1960s. Debris smaller than 60 mm in diameter and larger debris not embedded in the stream channel were manually removed from half of the study reach on each stream in 1979 by state-of-the-art techniques. Immigration and emigration of fish from the study sections and intrastream movements were very limited after an initial period of population adjustment in the spring regardless of treatment. Population densities and production of both species were typically higher in sections where debris accumulations had not been removed. Production of age-0+ and age-1+ Coho salmon and age-1+ and age-2+ Dolly Varden during the June-September period ranged from 0.70 to 2.22 g/sq m in the cleaned sections and from 0.84 to 2.10 g/sq m in the uncleaned sections. Carrying capacities for both species were lower in cleaned sections despite the use of selective techniques for removing woody debris.

27) Duncan, W.F.A., and M.A. Brusven. 1985. Energy dynamics of three low-order southeast Alaskan streams: Autochthonous production. Journal of Freshwater Ecology. 3: 155-166. (K)

Electronic abstract: Physical and biotic processes of three low-order southeast Alaska streams located on Prince of Wales Island were studied. These streams drained an undisturbed watershed representing a coniferous climax forest, a recently logged watershed with little riparian regeneration, and a logged watershed with heavy riparian growth. Community respiration and production were measured in closed, recirculating 12-L Plexiglas metabolism chambers using the dissolved oxygen method. Gross production among the streams varied from 0.1-2.7 g $O_2/m^2/d$; respiration varied from 0.1-1.0 g $O_2/m^2/d$. Highest rates of production and respiration occurred in the recently logged stream; lowest rates were measured in the mature, climax forest stream. Seasonal differences in production and respiration were apparently influenced by logging.

28) Duncan, W.F.A., and M.A. Brusven. 1986. Benthic macroinvertebrates in logged and unlogged low-order southeast Alaskan streams. Freshwater Invertebrate Biology. 4: 125-132. (C)

Electronic abstract: The benthic macroinvertebrate communities of three low-order streams in southeast Alaska exhibiting pre- and post logging conditions were examined. The logged watersheds had the highest densities and biomass of benthic macroinvertebrates, while an unlogged coniferous climax forest watershed had the lowest. Benthic macroinvertebrate community composition was similar for key species among the three streams. Collector-gatherers were generally the most abundant functional group comprising up to 80% of the insect community; predator-engulfers were the second most abundant functional group. Salmonid fishes greatly altered the macroinvertebrate community composition during spawning because of mass disturbance of the streambed. Gravels disturbed during spawning were most rapidly recolonized by mayflies and stoneflies, especially *Alloperla* spp.

29) Duncan, W.F.A., M.A. Brusven, and T.C. Bjornn. 1989. Energy-flow response models for evaluation of altered riparian vegetation in three southeast Alaskan streams. Water Research. 23: 965-974. (C)

Electronic abstract: First approximation production-response models to riparian vegetation alteration for low-order southeast Alaskan streams are presented. The models reflect negative and positive production responses with respect to estimated maximum production values (kcal). Using the models we predict the response of autochthonous of allochthonous production, benthic and terrestrial macroinvertebrate production, and potential salmonid tissue elaboration to variation in riparian cover, riparian composition and stream nutrients. Higher amounts of net usable allochthonous input are predicted with increasing riparian cover and percentage deciduous composition. Autochthonous production and net usable allochthonous production form the primary energy base of the stream ecosystem and are linked via energy transfer coefficients to higher trophic levels, e.g., benthic macroinvertebrate (BMI) production. Like the energy transfer coefficients derived for autochthonous and allochthonous production, the terrestrial invertebrate and salmonid production estimates are first approximations and require validation. These models provide resource managers with criteria to assess probable consequences of different riparian management strategies on fisheries resources in S.E. Alaska.

30) Edgington, J. 1976. Study of land use - salmon problems and planning in southeastern Alaska. Alaska Department of Fish Game, Compliance Report No. 5-31-R. (B)

Electronic abstract: During the period 1973-1976 detailed stream inventories have been completed for Southeastern Alaska salmon Districts 2 and 4 and published in Technical Report No 23. A total of 438 streams have been surveyed and accounts for a total of 3,119,433 m^2 of available spawning gravel. The effects of logging study of Kadashan Creek has established the pre-logging data base describing the average pink salmon escapements as {approx} 53,300 for the even-yr cycle and {approx} 44,200 for the odd-yr cycle. Chum salmon have averaged 16,700 escapements. Fry production and survival have been greatest in the intertidal sample area although other sample areas had high values also. Gravel particles < 0.833 mm diam have fluctuated at approx the 8% level of a mix of other gravel sizes. All sample areas show normal levels of intra-gravel dissolved oxygen. The project awaits the logging phase for continued sampling

31) Edgington, J.R. 1984. Some observations of fine sediment in gravels of five undisturbed watersheds in southeast Alaska. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 109-114. (B, I)

Author abstract: Analysis of gravel samples is reported for five streams in southeast Alaska. A 10-cm diameter cylinder sampler was used, with sieve analysis presented as percent fines, by weight. No consistency was apparent in the levels of fines, which was less than 0.833 mm, from stream to stream. The monitoring standard of percent of fines less than 0.833 mm detected wide variations in fines, and demonstrated long-term trends in the Kadashan River. The highest percentage of fines was approximately 13 percent for three streams.

Increased escapement goals are advocated for streams suspected of having increased amounts of fines.

32) Elliot, S.T. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Transactions of the American Fisheries Society. 115: 392-400. (C, D)

Electronic abstract: Logging debris resident for five or more years in small streams of southeastern Alaska is frequently removed to improve salmonid habitat. This practice was evaluated for its effects on juvenile anadromous Dolly Varden *Salvelinus malma* and macrobenthos populations in a small spring-fed stream during 1973-1981. Debris, consisting of limbs, needles, and fragmented logs, was removed by hand from the entire stream in July 1976. The surface area, number, and size of pools were reduced thereafter, and the water velocity increased. Macrobenthos density and invertebrate drift decreased 60-90% immediately after debris removal but returned to pretreatment levels in 1977. The Dolly Varden population decreased from 900 to less than 100 fish by 1978 and then fluctuated sharply between late 1978 and 1981. Removal of old logging debris does not improve habitat and can result in smaller rearing populations. Old debris should not be removed unless a block to migrating adult spawners or impairment of water quality can be demonstrated.

33) Estep, M.A., and R.L. Beschta. 1985. Transport of bedload sediment and channel morphology of a southeast Alaska stream. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Research Note PNW-430. 15pp. (A, D, G, I)

Author abstract: During 1980-81, transport of bedload sediment and channel morphology were determined at Trap Bay Creek, a third-order stream that drains a 13.5-square kilometer watershed on Chichagof Island in southeast Alaska. Bedload sediment was sampled for 10 storms: peak flows ranged from 0.6 to 19.0 cubic meters per second, and transport rated ranged from 4 to 4400 kilograms per hour. Peak transport rates typically occurred during peak streamflow. Transport of bedload sediment at a riffle over 1600 meters upstream from the mouth of the watershed was greater for most storm events than that measured at another riffle 22 meters downstream. Transport was greatest at the downstream riffle, however, during the most severe storm of the season and during another storm 1 week later. Both magnitude of storm and availability of sediment appeared to determine the transport of bedload sediment in Trap Bay Creek. Regression relationships were developed between streamflow (independent variable), several transport variables, and particle sizes in two diameter classes (D_{50} and D_{90}). Analysis revealed that total bedload discharge was positively correlated with streamflow; transport of either diameter class, however, had no consistent relationship with streamflow from one storm to the next. Relationships between particulate organic matter and streamflow were also highly variable from storm to storm. Observations indicated that large organic debris, especially fallen trees, played a major role in determining channel morphology; tidal action was an important factor affecting channel characteristics in the lower 1300 meters of the channel.

34) Fish Habitat Analysis Team. 1994. Appendix C: An evaluation of the effectiveness of current procedures for protecting anadromous fish habitat on the Tongass National Forest. In: Report to Congress: Anadromous Fish Habitat Assessment (January 1995). USDA Forest Service, Pacific Northwest Research Station, Alaska Region, R10-MB-279. 63pp. plus Appendices (A, B, D, F, I, J)

Compiler abstract: The Fish Habitat Analysis Team (FHAT) used three interrelated investigations to respond to a Congressional request to study the effectiveness of current procedures in protecting fish habitat on the Tongass National Forest:

1. Assessment of existing literature and data (published and unpublished) related to forest management effects on fish in southeast Alaska;
2. Convening of a group of experts in watershed science and fish habitat that examined a group of managed watersheds and determined the effectiveness of current management practices on protecting fish habitat; and
3. Analyses of a pilot project of three watersheds representing a range of management conditions on the Tongass.

The literature review resulted in 1,542 citations related to land management effects on anadromous fish habitats. No studies directly evaluated BMPs as practiced on the Tongass National Forest. Studies in landscapes similar to southeast Alaska, however, demonstrated that salmonid habitat declined when >25% of a watershed was harvested.

The watershed and fish habitat experts determined that under current management practices, two watersheds were at a low risk of experiencing adverse changes to fish habitat and water quality, five watersheds were at moderately low risk, and one watershed was at moderate risk. Future fish habitat risk was rated moderate or moderately high because of an expectation of continued timber harvest and road building. The experts expressed concerns regarding some buffers that were too narrow, streams without buffers, timber harvest on unstable slopes, and road-related problems.

The analyses of the pilot watershed project resulted in the determination that existing fish habitat is in relatively good condition in the two watersheds with the least amount of timber harvest activity (5-6%). The third watershed with 15% timber harvest may be an exception to this conclusion.

The overall conclusion of the FHAT was that current BMPs, although an improvement from previous procedures, are not entirely effective at protecting fish habitat over the long term.

35) Flory, E.A., and A.M. Milner. 1999. Influence of riparian vegetation on invertebrate assemblages in a recently formed stream in Glacier Bay National Park, Alaska. Journal of the North American Benthological Society. 18: 261-273. (C)

Electronic abstract: Influence of the development of riparian vegetation on benthic invertebrate assemblages was analyzed in a recently formed stream in southeast Alaska. Several features of riparian interaction were documented: 1) invertebrate use of willow catkins entering streams in summer, 2) invertebrate use of submerged alder roots as a substrate for attachment and as a source of building material for caddisfly cases, and 3) retention of leaf litter by salmon carcasses. The development of riparian vegetation markedly influenced colonization of the stream by certain invertebrate taxa and thereby played an important role in the successional sequence of macroinvertebrates and overall assemblage development in this new stream.

36) Flory, E.A., and A.M. Milner. 2000. Macroinvertebrate community sucession in Wolf Point Creek, Glacier Bay National Park, Alaska. Freshwater Biology. 44: 465-480. (C)

Author abstract: Macroinvertebrate community development in Wolf Point Creek in Glacier Bay National Park, Alaska formed by ice recession was investigated from 1991 to 1994 as part of a long-term study of colonization now exceeding 20 years. Chironomidae, the first taxon to colonize the stream, still dominated the community comprising 75–95% by number, but species succession was apparent. 2. Species richness in August increased from five species in 1978 to 11 in 1991 and 16 in 1994. 3. *Diamesa* species, abundant in 1978 at densities exceeding 2 750 m^{-2}, were not collected in 1994, while *Pagastia partica* dominated the community with densities exceeding 10 000 m^{-2}. 4. Sixteen taxa, never previously collected, colonized the stream between 1991 and 1994 including representatives of Coleoptera, Muscidae, Trichoptera, and the first noninsect taxon, Oligochaeta. Colonization by new taxa was associated with an increase in summer water temperature and the development of riparian vegetation. 5. Inter-specific competition is suggested as a possible factor in species succession and is incorporated into a taxa richness model of community development in postglacial streams incorporating stable and unstable channels.

37) Gende, S.M., T.P. Quinn, M.F. Willson, R. Heintz, and T.M. Scott. 2004. Magnitude and fate of salmon-derived nutrients and energy in a coastal stream ecosystem. Journal of Freshwater Ecology. 19: 149-160. (C, E)

Electronic abstract: We quantified the energy and mineral (nitrogen, phosphorous) composition of live pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*), their eggs, and carcasses, and tracked the fate of chum salmon spawning in a small Alaskan coastal stream. On average, salmon entered streams with 5.3 $kJ \cdot g^{-1}$, 3.3% N, 0.48% P. Much of the energy in female salmon was stored in the gametes because the gonads were both large (20% of their wet body mass) and high in energy density (11 kJ/g). Carcasses following senescent death had lower mass-specific energy and N (but not P) compared to fish at stream entrance. Bears removed nearly 50% of the salmon-derived nutrients and energy from the stream by capturing salmon and dragging the carcasses from the stream. Much of the salmon biomass was made available to riparian scavengers because bears partially consumed the fish. Nutrients bound in salmon tissue at senescent death were quickly exported to the estuary after only a few days because of periodic high flows and low rates of scavenging by bears.

38) Gillilan, S.E. 1989. Storage dynamics of fine woody debris for two low-order coastal streams in southeast Alaska. M.S. Thesis, Oregon State University, Corvallis. (C, D)

Author abstract: The characteristics and associated storage dynamics of approximately 2000 pieces of fine woody debris (FWD; 2.5 cm < diameter < 10 cm and 0.3 m < length < 10 m) was evaluated over a three-year period in two undisturbed salmonid nursery streams in southeast Alaska. To index a given reach propensity to capture and store FWD over time, 100 survey stakes (diameter = 2.9 cm, length = 44 cm) were introduced at one-year intervals to the head of four reaches with distinct coarse woody debris (CWD; diameter > 10 cm, length > 1 m) loadings, and their downstream dispersal monitored.

Between 1987 and 1989, storage of FWD was temporally and spatially variable and not suggestive of steady-state conditions. In the 1987-1988 stormflow period, the total resident FWD volume (cm^3 per meter of reach) declined 43%. This was followed by a resident volume increase of 9% in the 1988-1989 period. These changes in FWD storage occurred despite maximum peak flows which differed between periods by only 10%. These annual changes in FWD storage indicate that factors and processes in addition to magnitude of peak flow were important in FWD storage dynamics. Factors important in describing the observed storage fluctuations might include the effects of an unusually low peak flow regime (20% of nine-year average) in the year prior to the study's commencement, as well as variable rates of FWD recruitment from the riparian environment.

The majority of FWD was shorter (66-102 cm) than bankfull width (3.8-5.6 m), approximately 4.7 cm in diameter, geometrically simple in form, and in moderate to advanced states of decay. Shorter pieces were generally entrained more frequently than longer pieces, resulting in selective retention of longer pieces through time. The data strongly suggest FWD loadings are positively correlated with the amount of CWD in the reach.

Retention of stakes was generally highest in a reach with high CWD loading (0.47 m^3/m), intermediate in two reaches with moderate CWD loading (0.13 m^3/m and 0.11 m^3/m), and lowest in a reach with low CWD loading (0.0082 m^3/m). Distinct spatial and temporal stake dispersal patterns were noted between reaches. The retention of stakes declined most dramatically during the first stormflow (1.31 m^3/m) following their introduction, while succeeding storms of equal or greater magnitude had less of an effect.

39) Glass, R.L., and T.P. Brabets. 1988. Summary of water resources data for the Girdwood-Alyeska area, Alaska. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Open-File Report 87-678. 24pp. (G, I)

Electronic abstract: Surface water, groundwater and water quality data for the Girdwood-Alyeska area are presented in graphs, tables, and maps. Surface water data include streamflow measurements and water quality analyses from three streams. Groundwater data include descriptions of 106 wells, with lithologic and water quality data from selected wells. The report also contains a map depicting the geology of the area.

40) Gomi, T., R.C. Sidle, and D.N. Swanston. 2004. Hydrogeomorphic linkages of sediment transport in headwater streams, Maybeso Experimental Forest, southeast Alaska. Hydrological Processes. 18: 667-683. (B, D, F, I)

Author abstract: Hydrogeomorphic linkages related to sediment transport in headwater streams following basin wide clear-cut logging on Prince of Wales Island, southeast Alaska, were investigated. Landslides and debris flows transported sediment and woody debris in headwater tributaries in 1961, 1979, and 1993. Widespread landsliding in 1961 and 1993 was triggered by rainstorms with recurrence intervals (24 h precipitation) of 7.0 years and 4.2 years respectively. Occurrence, distribution, and downstream effects of these mass movements were controlled by landform characteristics such as channel gradient and valley configuration. Landslides and channelized debris flows created exposed bedrock reaches, log jams, fans, and abandoned channels. The terminus of the deposits did not enter main channels because debris flows spread and thinned on the unconfined bottom of the U-shaped glaciated valley. Chronic sediment input to channels included surface erosion of exposed till (rain splash, sheet erosion, and freeze-thaw action) and bank failures. Bedload sediment transport in a channel impacted by 1993 landslides and debris flows was two to ten times greater and relatively finer compared with bedload transport in a young alder riparian channel that had last experienced a landslide and debris flow in 1961. Sediment transport and storage were influenced by regeneration of riparian vegetation, storage behind recruited woody debris, development of a streambed armour layer, and the decoupling of hillslopes and channels. Both spatial and temporal variations of sediment movement and riparian condition are important factors in understanding material transport within headwaters and through channel networks.

41) Gomi, T., R.C. Sidle, M.D. Bryant, and R.D. Woodsmith. 2001. The characteristics of woody debris and sediment distribution in headwater streams, southeastern Alaska. Canadian Journal of Forest Research. 31: 1386-1399. (B, C, D)

Author abstract: Large woody debris (LWD), fine woody debris (FWD), fine organic debris (FOD), and sediment deposition were measured in 15 steep headwater streams with five management and disturbance regimes. Clear-cut channels logged in 1995 contained large accumulations of logging residue that initially provided sites for sediment storage. Half of the LWD in clear-cut channels was recruited during and immediately after logging. Woody debris from logging activities remains in young growth conifer channels 37 years after logging. Numbers of LWD in clear-cut and young conifer channels were significantly higher than in old-growth channels, although numbers of FWD pieces were not significantly different because of higher recruitment from old-growth stands. Channels that experienced recent (1979 and (or) 1993) and earlier (1961 and (or) 1979) scour and runout of landslides and debris flows contained less LWD and FWD, although large volumes of LWD and FWD were found in deposition zones. The volumes of sediment stored in young alder and recent landslide channels were higher than in the other channels. Because of the recruitment of LWD and FWD from young alder stands, the ratio of sediment stored behind woody debris to total sediment volume was higher in young alder channels compared with recent landslide channels. Numbers of LWD and FWD pieces in all streams were significantly correlated with the volumes of sediment stored behind woody debris. Timber harvesting and soil mass movement influence the recruitment, distribution, and accumulation of woody debris in headwater streams; this modifies sediment storage and transport in headwater channels.

42) Gomi, T., R.C. Sidle, R.D. Woodsmith, and M.D. Bryant. 2003. Characteristics of channel steps and reach morphology in headwater streams, southeast Alaska. Geomorphology. 51: 225-242. (A, D)

Author abstract: The effect of timber harvesting and mass movement on channel steps and reach morphology was examined in 16 headwater streams of SE Alaska. Channel steps formed by woody debris and boulders are significant channel units in headwater streams. Numbers, intervals, and heights of steps did not differ among management and disturbance regimes. A negative exponential relationship between channel gradient and mean length of step intervals was observed in the fluvial reaches (<0.25 unit gradient) of recent landslide and old-growth channels. No such relationship was found in upper reaches (≥0.25 gradient) where colluvial processes dominated. Woody debris and sediment recruitment from regenerating riparian stands may have obscured any strong relationship between step geometry and channel gradient in young alder, young conifer, and recent clear-cut channels. Channel reaches are described as pool–riffles, step–pools, step–steps, cascades, rapids, and bedrock. Geometry of channel steps principally characterized channel reach types. We infer that fluvial processes dominated in pool–riffle and step–pool reaches, while colluvial processes dominated in bedrock reaches. Step–step, rapids, and cascade reaches occurred in channels dominated by both fluvial processes and colluvial processes. Step–step reaches were transitional from cascades (upstream) to step–pool reaches (downstream). Woody debris recruited from riparian corridors and logging activities formed steps and then sequentially might modify channel reach types from step–pools to step–steps. Scour, runout, and deposition of sediment and woody debris from landslides and debris flows modified the distribution of reach types (bedrock, cascade, and step–pool) and the structure of steps within reaches.

43) Grotefendt, R.A. 1996. A pilot study utilizing low-altitude fixed base aerial photography for monitoring riparian and channel habitat conditions. Report written by Forest Consulting and Photogrammetry, North Bend, Washington. Written for Sealaska Corporation, Juneau, Alaska. 15pp. plus maps and photo plates. (A, D, F)

Compiler abstract: The purpose of this pilot study was to investigate the potential of low altitude aerial photography as a means to enhance the monitoring of riparian buffers and stream channel habitats on Sealaska Corporation lands in southeast Alaska. Monitoring of riparian habitats is normally conducted through ground surveys. However, obtaining large sample sizes and quantifying the complexity of riparian and channel habitats is difficult with ground surveys. Therefore, in 1995, low altitude aerial photographs (420 to 750 ft. flying heights) were obtained for about 3 miles of Cabin Creek, Prince of Wales Island, Alaska and for 2 miles of Sandstone Creek, Canyon River, and Wildcat Creek in Washington. The imagery was expected to: 1) provide multiple measurements of many riparian attributes, 2) document stream changes for historical review, 3) obtain detailed photographs to show the effectiveness of land management practices, and 4) provide the ability to repeat the measurements that were taken. Thirty riparian and stream characteristics were investigated using low altitude photos, including (but not all inclusive): diameter of downed trees, heights of standing trees, cut bank erosion volume, down tree count, down tree decay class, geomorphic zones, channel gradient (%), treefall direction, canopy closure (%), channel width, stem map, sand bar map, channel bank map, log debris position map. Results showed that photo measurements were accurate at quantifying many riparian characteristics, however, overhanging vegetation can obscure some dimensions. Therefore, low altitude photography may be used in conjunction with ground survey techniques to more fully quantify riparian area characteristics.

44) Halupka, K.C., M.F. Willson, M.D. Bryant, F.H. Everest, and A.J. Gharrett. 2003. Conservation of population diversity of Pacific salmon in southeast Alaska. North American Journal of Fisheries Management. 23: 1057-1086. (K)

Author abstract: We analyzed intraspecific variation in selected biological characteristics of five species of Pacific salmon *Oncorhynchus* spp. in southeast Alaska and adjacent areas of Canada with a particular interest in describing the variation among populations and suggesting conservation priorities to preserve existing variation. We identified traits that showed high levels of among-population variation, evaluated the interspecific consistency of variation patterns, and noted the relationship of these traits to potential adaptive variation. In addition, we graphically identified populations with distinctive phenotypic and demographic characteristics as outliers from the distribution of mean values of traits taken from populations throughout the region. We also reviewed allozyme surveys to identify populations that differed in terms of the geographic clustering patterns of allele frequencies. Approximately 9,000 salmon populations occur in the study area, and sufficient data were available from 2,062 (23%) of them to analyze at least one characteristic. We identified 47 populations represented by adequate data sets that have distinctive characteristics. An additional 35 populations, represented by limited samples or unusual nominal traits, may be regionally distinctive. Of the 47 adequately sampled, distinctive populations, 22 met our criteria for conservation consideration: (1) high potential for adaptive variation (including distinctive run timing), (2) a distinctive trait combined with high spawner abundance or allozyme frequencies that diverge from geographic clustering patterns, and (3) more than one distinctive characteristic or freshwater habitat shared with other distinctive populations. Freshwater habitats for 6 of those 22 populations are located in watersheds that do not have restrictive land use designations and warrant the highest conservation priority.

45) Harding, R.D. 1993. Abundance, size, habitat utilization, and intrastream movement of juvenile coho salmon in a small southeast Alaska stream. M.S. Thesis, University of Alaska, Fairbanks. 109pp. (A, D)

Author abstract: Aquatic habitat was measured, and juvenile coho salmon *Oncorhynchus kisutch* abundance and intrastream migrations were monitored in Kake Bake Creek, Alaska, between 1985 and 1986. Fry densities averaged 0.88, 0.33, and 0.11 fish/m^2 during August, November, and March, respectively; parr densities averaged 0.15, 0.09, and 0.05 fish/m^2, during August, November, and March respectively. Fry were distributed evenly between riffle, glide, and pool habitat types during August, but not during November or March. Parr were distributed evenly in riffle and glide habitats during August, November and March. Stream areas containing pools and large woody debris tended to have higher coho densities; habitat was generally a significant predictor of juvenile abundance despite low R^2 values.

Fall immigrants totaled 1,434 coho, with 764 immigrating into beaver ponds. Fall immigrants were bright silver in color and several had sea-lice *Calugus spp.* attached near their anal fins. Between April 1 and June 2, 1986, 586 coho smolts emigrated from Kake Bake Creek; 172 had been fall immigrants.

46) Harris, A.S., and W.A. Farr. 1974. The forest ecosystem of southeast Alaska. 7. Forest ecology and timber management. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-25. 109pp. (K)

Author abstract: Large-scale use of the timber resource of southeast Alaska began in 1953 after long efforts to establish a timber industry. Development and present status of the industry and present management of the timber resource are summarized, stressing the biological basis for timber management activities in southeast Alaska today. Ecological and silvicultural considerations related to timber harvest, reforestation, and stand development are discussed.

Published and unpublished information are brought together. Current management practices are discussed as a basis for a better understanding of how this information can be helpful in managing the timber resource and to point out where research is needed.

47) Heifetz, J., M.L. Murphy, and K.V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaskan streams. North American Journal of Fisheries Management. 6: 52-58. (A, D)

Electronic abstract: Effects of logging on preferred winter habitats of juvenile salmonids in southeastern Alaskan streams were assessed by comparing the area of preferred winter habitat in 54 reaches of 18 streams. Three types of streams were sampled at each of six locations: a stream in a mature, undisturbed forest; a stream in a clear-cut area but logged on at least one bank; and a stream in a clear-cut area with strips of forest (buffer strips) along the stream bank. To identify preferred winter habitats, we classified stream areas in 12 of 18 streams into discrete habitat types and compared the density of salmonids within these habitat types with average density of the entire reach. Most wintering Coho salmon (*Oncorhynchus kisutch*), Dolly Varden (*Salvelinus malma*), and steelhead (*Salmo gairdneri*) occupied deep pools with cover (i.e., upturned tree roots, accumulations of logs, and cobble substrate). Riffles, glides, and pools without cover were not used. Seventy-three percent of all pools were formed by large organic debris. Reaches in clear-cut areas without buffer strips had significantly less area of pool habitat than old-growth reaches. Buffer strips protected winter habitat of juvenile salmonids by maintaining pool area and cover within pools. In some cases, blowdown from buffer strips added large organic debris to the stream and increased the cover within pools.

48) Hennon, P., M. Wipfli, R. Deal, A. Johnson, T. De Santo, M. Schultz, T. Hanley, E. Orlikowska, G. Takashi, M. Bryant, and R. Edwards. 2002. Mixed alder-conifer forests: Managing upland ecosystems in southeast Alaska for wood products, wildlife, and fish. In: Congruent Management of Multiple Resources: Proceedings From the Wood Compatibility Initiative Workshop, 4-7 December 2001, Stevenson, Washington. A.C. Johnson, R.W. Haynes, and R. A. Monserud, Editors. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-563. Pages 51-58. (C, D)

Author abstract: Historically, red alder (*Alnus rubra*) Bong. has been viewed as an undesirable tree species and has been actively removed from managed forests. Several recent studies suggest that the presence of red alder may help alleviate some of the problems associated with fish and wildlife habitat that develop in the dense conifer-dominated young-growth forests that typically grow after clearcutting. Our study uses an integrated approach to evaluate to what extent red alder may influence trophic linkages and processes in managed young-growth ecosystems. Key components of this study include how logging and natural disturbance favor the regeneration of alder and how different mixtures of alder are associated with timber productivity, woody debris recruitment, terrestrial and aquatic invertebrate abundance, and fish and wildlife habitat. By using one independent variable in all components of this study (i.e., amount of red alder), we simultaneously contrasted many possible responses across this gradient to develop a general response model. Managers may use this model to choose a desirable level of red alder in a particular landscape to meet simple or multiple resource objectives. Both compatibility and tradeoffs among resources will be clearly evident. Active management (i.e., thinning with species bias or planting) can be used to achieve different amounts of alder in managed forests.

49) Hetrick, N.J., M.A. Brusven, W.R. Meehan, and T.C. Bjornn. 1998. Changes in solar input, water temperature, periphyton accumulation, and allochthonous input and storage after canopy removal along two small salmon streams in southeast Alaska. Transactions of the American Fisheries Society. 127: 859-875. (C, E, H, J)

Electronic abstract: Changes in solar radiation, water temperature, periphyton accumulation, and allochthonous inputs and storage were measured after we removed patches of deciduous, second-growth riparian vegetation bordering two small streams in southeast Alaska that produce Coho salmon *Oncorhynchus kisutch*. Solar radiation and leaf litter input were measured at the water surface at random locations dispersed through six alternating closed- and open-canopy stream sections. Water temperature, periphyton, and stored organic samples were collected near the downstream end of each section. Solar radiation intensity was measured with digital daylight integrators and pyronometers, periphyton biomass and chlorophyll a were measured on red clay tile substrates, allochthonous input was measured with leaf litter baskets, and benthic organic matter was measured with a Hess sampler. Average intensity of solar radiation that reached the water surface of open-canopy sections was significantly higher than in closed-canopy sections of two streams measured during daylight hours in summer 1988 and of one stream measured day and night in summer 1989.

50) Hetrick, N.J., M.A. Brusven, T.C. Bjornn, R.M. Keith, and W.R. Meehan. 1998. Effects of canopy removal on invertebrates and diet of juvenile Coho salmon in a small stream in southeast Alaska. Transactions of the American Fisheries Society. 127: 876-888. (C)

Electronic abstract: We assessed changes in availability and consumption of invertebrates by juvenile Coho salmon *Oncorhynchus kisutch* in a small stream in southeast Alaska where patches of dense second-growth riparian vegetation bordering the stream had been removed. Benthic invertebrate populations were assessed during summer 1988 and 1989 with a Hess sampler. Aerial invertebrates were sampled during summer 1989 with wire-mesh sticky traps hung just above the water surface and with floating clear-plastic pan traps. Invertebrate drift was assessed during summer 1989 with nets placed at the downstream end of closed- and open-canopy stream sections. Diets of age-0 and age-1 Coho salmon were sampled by flushing stomach contents of fish collected from closed- and open-canopy stream sections. Abundance and biomass of benthic invertebrates were larger in open- than in closed-canopy stream sections and were primarily Dipterans, Ephemeropterans, and Plecopterans. More insects were caught on sticky traps in open than in closed sections on two of four dates sampled, and composition of the catch was primarily dipterans (74% in both closed- and open-canopy sections).

51) Johnson, A.C., and P. Wilcock. 2002. Association between cedar decline and hillslope stability in mountainous regions of southeast Alaska. Geomorphology. 46: 129-142. (K)

Author abstract: Old-growth forests experiencing widespread decline of yellow-cedar (*Chamaecyparis nootkatensis*) in southeast Alaska have a 3.8-fold increase in the frequency of landslides. We report here on an investigation of the cause of this increased slope instability. Time since death of cedar was assessed using surveys around landslide sites. Root decay on dead trees was used to estimate the decline in the apparent soil strength provided by roots. Changes in soil hydrology were measured with 120 piezometers located in areas of healthy cedar, healthy spruce/hemlock, and sites with cedar decline. Relative influences on slope stability by changes in soil moisture and root strength were evaluated with a simple stability model. At most sites, soil depth is <0.7 m, and the loss of root strength has an important and possibly dominant influence on slope instability. In soils deeper than 1 m, changes in pore pressure have a proportionately larger influence on slope stability. Landslides appear most likely when cedar decline reaches snag class IV (approximately 50 years after tree death), when most of the cedar root strength is lost and root strength from secondary growth has yet to develop.

52) Johnson, A.C., and R.T. Edwards. 2002. Physical and chemical processes in headwater channels with red alder. In: Congruent Management of Multiple Resources: Proceedings From the Wood Compatibility Initiative Workshop, 4-7 December 2001, Stevenson, Washington. A.C. Johnson, R.W. Haynes, and R. A. Monserud, Editors. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-563. Pages 101-108. (E)

Author abstract: We investigated links between physical disturbance processes, vegetation type (alder or conifer), and stream nitrate concentrations in headwater streams in young-growth stands and old-growth forests within mountainous terrain in southeast Alaska. Alder coverage in upland headwater zones (areas with slopes > 15^{o}, or 27%) associated with landsliding was more extensive within young-growth stands than within old-growth forests. The highest nitrate concentrations occurred in streams within alder dominated young-growth forest. However, some streams with high alder coverage had low nitrate concentrations. These streams were larger and originated within alpine zones or ridge tops, suggesting that landform and source area may be important factors regulating nutrient concentrations. An understanding of the relationship among disturbance patterns, tree species establishment, and nutrient cycling may help managers better predict the effect of harvest practices on stream productivity.

53) Johnson, A.C., D.N. Swanston, and K.E. McGee. 2000. Landslide initiation, runout, and deposition within clearcuts and old-growth forests of Alaska. Journal of the American Water Resources Association. 36: 17-30. (K)

Electronic abstract: More than 300 landslides and debris flows were triggered by an October 1993 storm on Prince of Wales Island, southeast Alaska. Initiation, runout, and deposition patterns of landslides that occurred within clearcuts, second-growth, and old-growth forests were examined. Blowdown and snags, associated with cedar decline and "normal" rates of mortality, were found adjacent to at least 75 percent of all failures regardless of land use. Nearly 50 percent of the landslides within clearcuts occurred within one year following timber harvest; more than 70 percent of these sites had hydrophytic vegetation directly above failures. In following the runout paths of failures, significantly more erosion per unit area occurred within clearcuts than in old-growth forests on slopes with gradients from 9 to 28 degree (16 to 54 percent). Runout length, controlled by hillslope position within deglaciated valleys, was typically longer in old-growth forests than in second growth and clearcuts (median values were 334, 201, and 153 m, respectively). Most landslides and debris flows deposited in first- and second-order channels before reaching the main stem channels used by anadromous fish. Slide deposits in old-growth forests were composed of a higher proportion of woody debris than deposits derived from slides in second growth or clearcuts.

54) Johnson, S.W., and J. Heifetz. 1985. Methods for assessing effects of timber harvest on small streams. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Alaska, NOAA Technical Memorandum ABFL/NMFS. (A, C, E, G, I)

Electronic abstract: The methods used by the Northwest and Alaska Fisheries Center's Auke Bay Laboratory in assessing the effects of clear-cut logging on salmonid habitat and the effectiveness of buffer strips in protecting fish habitat during and after logging are described in detail. The methods have been used by the laboratory since 1982 to study fish populations and habitat in three different categories of streams in southeastern Alaska. The methods described include measurements of fish, periphyton, benthos, preferred fish habitats, and stream physical characteristics, such as discharge gradient, substrate, and water quality.

55) Johnson, S.W., J. Heifetz, and K.V. Koski. 1986. Effects of logging on the abundance and seasonal distribution of juvenile steelhead in some southeastern Alaska streams. North American Journal of Fisheries. 6: 532-537. (K)

Electronic abstract: Eighteen streams in six locations in Southeastern Alaska were examined for the effects of logging on juvenile steelhead (*Salmo gairdneri*) populations. Three types of streams were examined at each location: a stream in undisturbed old-growth forest; a stream in a clear-cut area with strips of forest (buffer strips) along the stream bank; and a stream in a clear-cut area logged on at least one bank. Within each stream type, three reaches were sampled. Few juvenile steelhead were found in reaches where juvenile cutthroat trout (*Salmo clarki*) were present, and no juvenile steelhead were found in streams with a low-flow discharge (<0.06 m^3/s). Only two study sites, Prince of Wales Island and Mitkof Island, had juvenile steelhead in all three stream types. Fry (age 0) and parr (age 1 and older) were sampled in summer and winter at the Prince of Wales Island site; parr were sampled in summer at the Mitkof Island site. Logging appeared to affect the growth of steelhead fry and the abundance and distribution of both fry and parr. On Prince of Wales Island, fry were more abundant and larger in the clear-cut reaches than in the old-growth or buffered reaches. Parr density in summer was highest in the clear-cut reaches at both sites but, by winter, had decreased 91% in the clear-cut reaches and had increased 100 and 400%, respectively, in the old-growth and buffered reaches. Parr were migrating during fall and winter; therefore, the effects of logging on their growth could not be assessed.

56) Jones, S.H., R.J. Madison, and C. Zenone. 1978. Water resources of the Kodiak-Shelikof Subregion, south-central Alaska. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Hydrologic Investigations Atlas HA-612. (I)

Electronic abstract: Hydrologic data for the Kodiak-Shelikof subregion of south-central Alaska are summarized to provide a basis for planning water resources development, identifying water problems and evaluating existing water quality and availability. Average annual precipitation, measured at a few coastal locations in this maritime climatic zone, ranges from 23 to 127 inches. Mean annual runoff for the Kodiak Island group ranges from 4 to 8 cfs/sq mi. A maximum instantaneous runoff of 457 cfs/sq mi has been determined from a small basin on Kodiak Island. Lowest measured stream discharges range from no flow to 0.91 cfs/sq mi. Surface water is the primary source of water supplies for the city of Kodiak and other communities. The geology of the subregion is characterized by metamorphosed sedimentary and volcanic rocks with only a thin mantle of unconsolidated material. A few small, alluvium-filled coastal valleys offer the most favorable conditions for ground-water development, but moderate yields (50-100 gal/min) have been obtained from wells in fractured bedrock. Water in streams and lakes generally has a dissolved-solids concentration less than 60 mg/L, and the water varies from a calcium-bicarbonate type to a sodium-chloride type. The chemical composition of ground waters has a dilute calcium-bicarbonate type in unconsolidated materials and a sodium-bicarbonate type in bedrock. The dissolved solids in the groundwater ranges from 170 to 250 mg/L.

57) Keith, R.M., T.C. Bjornn, W.R. Meehan, N.J. Hetrick, and M.A. Brusven. 1998. Response of juvenile salmonids to riparian and instream cover modifications in small streams flowing through second-growth forests of southeast Alaska. Transactions of the American Fisheries Society. 127: 889-907. (D)

Electronic abstract: We manipulated the canopy of second-growth red alder *Alnus rubra* and instream cover to assess the effects on abundance of juvenile salmonids in small streams of Prince of Wales Island, southeast Alaska, in 1988 and 1989. Sections of red alder canopy were removed to compare responses of salmonids to open- and closed-canopy sections. At the start of the study, all potential instream cover was removed from the study pools. Alder brush bundles were then placed in half the pools to test the response of juvenile salmonids to the addition of instream cover. Abundance of age-0 Coho salmon *Oncorhynchus kisutch* decreased in both open- and closed-canopy sections during both summers, but abundance decreased at a higher rate in closed-canopy sections. More age-0 Dolly Varden *Salvelinus malma* were found in open-canopy sections than in closed-canopy during both summers. Numbers of age-1 and older Coho salmon and Dolly Varden were relatively constant during both summers, and there was no significant difference in abundance detected between open- and closed-canopy sections. Abundance of age-0 Coho salmon decreased in pools with and without additional instream cover during both summers. Abundance of age-1 and older Coho salmon and age-0 Dolly Varden did not differ significantly in pools with or without added cover during either summer. Abundance of age-1 and older Dolly Varden was higher in pools with added instream cover than in pools without cover during both summers. Age-0 Coho salmon decreased in abundance throughout the summer in both years. Emigration was measured in 1989 and accounted for most of the decrease in abundance. Age-0 Coho salmon emigrants were significantly smaller than age-0 Coho salmon that remained in the stream

58) Kessler, S.J., S.J. Paustian, and S. Russell. 1989. Modeling fish habitat and stream class using channel classifications. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources, 21-23 March 1989, Juneau, Alaska. E.B. Alexander, Editor. USDA Forest Service, Alaska Region, R10-MB-77. Page 101. (A)

Author abstract: Channel type inventories of Tongass National Forest streams are used in a number of ways in the Revision of the Tongass Land Management Plan and other planning and implementation activities across the Forest. For the fish resource, three major uses of the channel type inventories are employed in conjunction with the ARC/INFO Geographical Information system (GIS). These uses are: 1) to model the quantity of timber available from riparian areas as

a result of application of different land management prescriptions, 2) to model the fish habitat capability of Forest streams, and to predict effects on the fish resource resulting from different land management allocations, and 3) to predict stream class, or display the extent of anadromous and resident fish habitat. We presented detailed information for the second two uses, while Wilsona and Kessler addressed the quantity of timber available in riparian areas in their presentation.

59) Kirchhofer, D.A. 1984. A stream ecosystem in an old-growth forest in southeast Alaska. Part III: Standing crop and drift of invertebrates in Porcupine Creek. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 71-79. (C)

Author abstract: Abundance and composition of benthos and drift in Porcupine Creek, a small undisturbed stream in southeast Alaska, was sampled over a period of two years. Abundance of aquatic insects varied greatly from year to year. The density (number per sq m) was three to six times greater in 1978 than in 1977, ranging from a low of 307 insects/m^2 to a high of 48,418 insects/m^2. For freshwater reaches of Porcupine Creek, four taxa, two mayfly genera, *Baetis* and *Cinygmula*, one stonefly taxa, *Alloperla* complex, and the diteran family Chironomidae made up 64-81 percent of all insects in the benthos. The stream/estuary ecotone of Porcupine Creek, which as influenced by tides, had a greater density of macroinvertebrates than the freshwater reaches. Isopods and amphipods accounted for 93 percent of the benthos in the ecotone.

Drift was composed of the same major taxa as the benthos, but in different proportions. For the third-order section, two taxa, *Baetis* and Chironomidae, made up 66-98 percent of the total drift. *Baetis* was a greater percentage of drift than benthos at both second- and third-order reaches, whereas *Alloperla* made up a greater percentage of benthos than drift and did not drift in any numbers except during spring emergence.

60) Kirkpatrick, B., T.C. Shirley, and C.E. O'Clair. 1998. Deep-water bark accumulation and benthos richness at log transfer storage facilities. Alaska Fishery Research Bulletin. 5: 103-115. (K)

Author abstract: A small, manned submersible was used to determine the extent of bark accumulation and its effects on the epifaunal macrobenthos at depths from 20-130 m at log transfer facilities (LTFs) and log rafting facilities (LRFs) in Dora Bay, Prince of Wales Island, Alaska. Continuous videotaping from an external fixed camera was conducted along 6 transects located near LTFs and LRFs and along 3 transects in a similar, adjacent area not used as an LTF or LRF. Bark and woody debris accumulation and kinds and numbers of organisms were recorded by depth for 3 general habitat types (steep, rocky; moderate incline; cobble; flat, silty) with and without bark. Bark accumulation was found to 40-m depth on 6 dives, and to 70-m depth on 3 dives. Of 91 taxa observed during the study, most (69 species) were found on rocky, bark-free habitat; significantly reduced species richness was found in all bark-dominated habitats. Bark and debris from LTFs appeared to be displaced down slope into adjacent, deeper area; this is the first published account of bark and woody debris accumulation below 20-m depth. In suitable habitats, manned submersibles or remotely operated vehicles appear to be useful tools for monitoring bark accumulation and investigating the effects of logging facilities.

61) Kline, T.C., Jr., J.J. Goering, O.A. Mathisen, P.H. Poe, and P.L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon: 1. d^{15}N and d^{13}C evidence in Sashin Creek, southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 47: 136-144. (E)

Electronic abstract: Value of δ^{15}N and δ^{13}C (the per mil deviation from the recognized isotope standard) from biota of a southeastern Alaska stream (Sashin Creek) that receives an annual run of 30,000 anadromous pink salmon (*Oncorhynchus gorbuscha*) were measured to determine sources of nitrogen (N) and carbon (C). Marine-derived nitrogen (MDN) is the predominant source of N for food webs found in the lower 1,200 m of the stream which, due to a waterfall, is the only portion of the stream available to salmon returning to spawn. Comparable spawning section biota were enriched by about 5 per mil relative to the salmon-free control section, corresponding to the difference between 0 and 100% MDN in a mixing model. Food webs of resident rainbow trout (O. *mykiss*), at the outlet of one of the source lakes, Sashin Lake, have very low δ^{13}C, suggesting the importance of a respired C pool in the lake.

62) Konopacky Environmental. 1996. Fish collections in twelve unnamed and USFS-designated Class III streams on Prince of Wales Island, southeast Alaska, during late-June 1996. Annual Report – 1995, Volume 2 of 2. Konopacky Project No. 002-7 report written by Konopacky Environmental, Meridian, Idaho. Written for Ketchikan Pulp Company, Ketchikan, Alaska. Submitted to Alaska Department of Fish and Game, Juneau, Alaska. (A)

Author abstract: Konopacky Environmental staff used a Coffelt Mark X backpack electrofisher, set at 300 volts and variable amperage, to sample a 60-m long reach in each of 12 small unnamed USFS-designated Class III streams (i.e., fishless) on Prince of Wales Island, southeast Alaska, on June 25-26, 1996. Three streams were located in each of four study-defined quadrants (i.e., north, west, east, south) on the island. All streams were used in an ongoing multi-year water-air temperature/timber harvest study, funded by Ketchikan Pulp Company, on the island. A total of three Dolly Varden char *Salvelinus malma* were collected from two streams. One char (i.e., 126 mm total length [TL], 15 g live weight [LW]), was collected from a stream, located at T66S, R80E, SE1/4, in the north quadrant on the island. Two char (i.e., 97 mm TL, 7 g LW and 107 mm TL, 10 g LW) were collected from a stream, located at T71S, R80E, S02, NW1/4, in the west quadrant on the island. No fish of any species were collected in the sampled reaches of the other ten study streams. Given the small number of fish found in the two streams via the electrofishing efforts, the USFS method of labeling Class III streams appears acceptable for planning purposes associated with timber harvest.

63) Koski, K.V. 1981. Utilization of estuarine areas by salmonids in southeastern Alaska and the potential impact from logging. Estuaries. 4: 286-287. (K)

Electronic abstract: Southeastern Alaska is a complex of mountainous islands and fiords. Most of this archipelago is in the Tongass National Forest which contains the largest stand of old growth forest in the United States. Over 250,000 acres of the Tongass have been clearcut and logging is continuing at a rate of about 18,000 acres annually. Over 2,500 identified salmon streams flow from this Forest into adjacent estuaries; these ecosystems produce about 30% of the Nation's salmon resource. Physical and biological characteristics of these estuaries are variable and dependent upon adjacent watershed topography and geology.

64) Koski, K.V., and D.A. Kirchhofer. 1984. A stream ecosystem in an old-growth forest in southeast Alaska. Part IV: Food of juvenile coho salmon, *Oncorhynchus kisutch*, in relation to abundance of drift and benthos. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 81-87. (C)

Author abstract: Stomach contents of juvenile coho salmon were collected from five study reaches in Porcupine Creek, southeast Alaska, using a flushing technique that did not injure the fish. The food consumed was compared with the apparent food availability as measured by samples of the invertebrate drift and benthos. The prey items found in the stomachs were ranked as to their relative dietary importance using the Index of Relative Importance (IRI). To determine what food was available or unavailable to coho salmon, the actual food consumed was compared with the apparent food availability using an Index of Food Selection (L). Total stomach contents were compared using a relative index of fullness. Food items with the highest values of IRI varied among all study reaches. Amphipods were the most important food in the stream / estuary ecotone, and Diptera was the dominant food in the freshwater reaches upstream. Pink salmon eggs were the most important food item in all reaches during September. Salmon eggs, amphipods, and Diptera were actively selected from the apparent availability of food, whereas Plecoptera, Ephemeroptera, and isopods were usually avoided or not available. The fullness of stomachs reflected the general abundance of food in the drift and benthos. Terrestrial insects were scarce in the diet and in the apparent food supply, possibly reflecting the low diversity of vegetation associated with old-growth forests in southeast Alaska. The stream / estuary ecotone is an important rearing habitat for coho salmon as shown by its higher density and growth as compared with areas upstream. Possible consequences of logging are discussed.

65) Koski, K.V., and M.L. Murphy. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management. 9: 427-436. (D)

Author abstract: Natural rates of input and depletion of large woody debris (LWD) in southeast Alaska streams were studied to provide a basis for managing streamside zones to maintain LWD for fish habitat after timber harvest. Debris was inventoried in a variety of stream types in undisturbed old- growth forest; 252 pieces of LWD were dated from the age of trees growing on them. Longevity of LWD was directly related to bole diameter: small LWD (10-30 cm diameter) was less than 110 years old, whereas large LWD (> 60 cm diameter) was up to 226 years old. Assuming equilibrium between input and depletion of LWD in streams in old-growth forests and exponential decay of LWD, input and depletion rates were calculated from mean age of LWD. Input and depletion rates were inversely proportional to LWD diameter and ranged from 1%/yr for large LWD in all stream types to 3%/yr for small LWD in large, high-energy, bedrock-controlled streams. A model of changes in LWD after timber harvest (which accounted for depletion of LWD and input from second-growth forest) indicated that 90 years after clear-cut logging without a stream-side buffer strip, LWD would be reduced by 70% and recovery to

prelogging levels would take more than 250 years. Because nearly all LWD is derived from within 30 m of the stream, the use of a 30-m wide, unlogged buffer strip along both sides of the stream during timber harvest should maintain LWD.

66) Landwehr, D. 1993. Soil disturbance monitoring transects: Thorne Bat Ranger District, Tongass National Forest. In: Proceedings of Watershed '91: Soil, Air, and Water Stewardship Conference, 16-17 April 1991, Juneau, Alaska. T. Brock, Editor. USDA Forest Service, Alaska Region, R10-MB-217. Page 58. (K)

Author abstract: One hundred ninety soil disturbance transects were completed in timber harvest units on the Thorne Bat Ranger District, Tongass National Forest in southeast Alaska. Mineral soil disturbance on individual transects varied from 0 to 39 percent of the transect. Average disturbance of all transects was 4.6 percent. Shovel yarding averaged slightly higher levels of disturbance, 5.1 percent, as compared to cable yarding systems which averaged 4.0 percent.

Comparisons were drawn between the Coffman Cove Administrative Area and the Thorne Bay Administrative Area. Shovel yarding on the Coffman Cove averaged 7.1 percent mineral soil disturbance whereas shovel yarding on the Thorne Bay Area averaged 3.3 percent.

Differences in mineral soil disturbance between the two administrative areas can be explained by differences in operator experience or awareness and differences in timber sale administration. Once operators on the Coffman Cove Area tried to reduce soil disturbance, conditions improved and total disturbance was reduced.

Shovel yarding appears to have the higher potential for exposing mineral soil. When done improperly, shovel yarding can result in high levels of disturbance. Standards and guidelines for overall mineral soil disturbance were met in all the units involved in the study. Three units are borderline on acceptable disturbance (i.e. Confidence intervals overlap the acceptable level). Most of the exposed [soil] in these areas resulted from rutting in shovel yarded areas and skid trails in the case of one downhill hi-lead unit.

67) Lisle, T.E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, southeast Alaska. North American Journal of Fisheries Management. 6: 538-550. (A, D)

Author abstract: The effects of woody debris on anadromous salmonid habitat in eight streams on Prince of Wales Island, southeast Alaska, were investigated by comparing low-gradient (1-9%) first- or second-order streams flowing through either spruce-hemlock forests or 6-10-year-old clearcuts, and by observing changes after debris was selectively removed from clear-cut reaches. Woody debris decreased the rate of shallowing as discharge decreased, thus helping to preserve living space for fish during critical low-flow periods. Debris dams were more frequent in clear-cut streams (14.9/100 m), which contained more debris, than in forested streams (4.2/100 m). As a result, total residual pool length (length when pools are filled with water but there is no flow) and length of channel with residual depth greater than 14 cm-the depth range occupied by 84% of coho salmon *(Oncorhynchus kisutch)*-were greater in clear-cut streams than in forested streams. Greater volumes of woody debris in clear-cut streams produced greater storage of fine sediment (<4-mm diameter) unless the stream gradient was sufficiently high to flush sediment from storage. One-half of the debris dams broke up or were newly formed over a

3-year period, which suggests that they usually released sediment and woody debris before the pools they formed were filled with sediment. Woody debris removal decreased debris-covered area, debris dam frequency, and hydraulic friction in some cases but, in others, these variables were unaffected or recovered within 2 years after erosion and adjustment of the streambed. No consistent differences in pool dimensions were found between treated and untreated clear-cut reaches. Comparisons of habitat in forested and clear-cut streams suggested that removing debris from clear-cut streams reduced salmonid carrying capacity. Retention and natural reformation of debris dams in cleared reaches prevented the expected deterioration of habitat. However, the removal and destabilization of existing woody debris may cause depletion of debris before riparian trees can regrow and furnish new material to the clear-cut streams.

68) Lohr, S.C., and M.D. Bryant. 1999. Biological characteristics and population status of steelhead (*Oncorhynchus mykiss*) in southeast Alaska. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-407. 20pp. (K)

Author abstract: We reviewed existing data to determine the range and distribution of steelhead (*Oncorhynchus mykiss*) in southeast Alaska, summarized biological characteristics, and determined population status of steelhead stocks. Unique or sensitive stocks that may require consideration in planning land management activities are identified within the data reviewed. Data sources were personal communications, reports, and unpublished data files of State and Federal agencies. Only eight winter-run stocks in southeast Alaska and two summer-run stocks in southwest Alaska had sufficient data to valuate biological characteristics. Age structure, sex ratio, incidence and frequency of repeat spawning, and body length were similar among winter-run stocks, and consistent with coastwide trends of increasing freshwater age and body size of steelhead stocks in the northern portion of their range. Winter-run stocks appeared to have a greater proportion of repeat spawners (kelts) than summer-run stocks, and juvenile steelhead in the summer-run stocks generally spent 1 year less in both fresh water and the ocean. Assessment of escapement trends, run timing, and stock status is hindered by lack of adequate data both in number of stocks with sufficient data and the number of years of data available. Incomplete weir counts during immigration and emigration of adult fish and low sample sizes of escapement indices, both within and among years, decrease the reliability of estimates. Although stocks with sufficient data are not at risk, small run sizes that are typical of most steelhead stocks may be more susceptible to poor land management practices and overharvest than larger stocks.

69) Lorenz, J.M., M.L. Murphy, and K.V. Koski. 1989. Classification and inventory of fish habitat in the Taku River, Alaska. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources, 21-23 March 1989, Juneau, Alaska. E.B. Alexander, Editor. USDA Forest Service, Alaska Region, R10-MB-77. Pages 113-115. (A, G)

Author abstract: A system for classifying fish habitat in large glacial rivers was developed and used in a 1986 study of salmon in the Taku River, Alaska. Twelve distinct habitat types -- 7 within the river channel and 5 off-channel -- were identified on the valley floor (Table 1). Aerial photographs were used to differentiate habitat types by their channel geometry, hydraulic characteristics, and water source. Over 1,900 ha of fish habitat in the lower river, between the Canadian border and the river mouth (29 km), were classified by habitat type and verified with aerial and boat surveys. Random samples of fish abundance and physical characteristics, stratified by habitat type, were used to estimate fish density and habitat quality for each habitat type in the lower river. The two most abundant types (main channels and braids) were in the river channel and made up over 90% of the area. However, the most important habitats for juvenile sockeye, coho, and Chinook salmon (Table 2), those with low water velocity and easy access to main channels, made up less than 10% of the area. The total population of juvenile salmon in the lower Taku River was estimated at about one million. Juvenile salmon density in main channel habitats was similar along the entire length of the river (60 km), but species composition changed as sockeye became less abundant and chinook more abundant upstream. Sockeye salmon spawned in many habitat types, keying on specific reaches with good intragravel flow. The habitat classification system described here provided a good framework for identifying juvenile fish habitat in the Taku River and may be applicable to other large glacial rivers.

70) Martin, D.J. 1993. Fish habitat and channel conditions of nine streams in forested lands of southeast Alaska and Afognak Island. Project No. 44-005 final report written by Pentec Environmental, Inc., Edmonds, Washington. Written for Sealaska Corporation, Juneau, Alaska and the Alaska Forest Association, Ketchikan, Alaska. 37pp. plus Figures, Tables, and Appendix. (A, B, D, F, H, J)

Compiler abstract: Sealaska Corporation and the Alaska Forest Association initiated a monitoring program to determine the effectiveness of the 1990 Alaska Forest Resources and Practices Act BMPs in protecting fish habitat and water quality during and after timber harvest in southeast Alaska. The monitoring program included unharvested, currently harvested, and previously harvested watersheds. This report presents the results of stream surveys conducted on nine streams in southeast Alaska and on Afognak Island in 1992:

- Four sites were previously logged from 1990-1992 and retained riparian buffers (two were harvested with variations);
- Three sites had logging initiated during 1992 and concurrent with the initiation of the monitoring program;
- Two sites had not experienced logging and were not scheduled to be harvested in the immediate future.

Twenty parameters were characterized within each stream, including large woody debris (LWD), LWD source bank, pool depth, substrate composition, spawning area, cover type, total cover, bank erosion, shade, channel gradient, channel width, cobble embeddedness, and temperature. Monitoring results were presented for each surveyed creek. Potential BMP effectiveness was also discussed.

71) Martin, D.J. 1995. A preliminary assessment of fish habitat and channel conditions for streams on forested lands of southeast Alaska. Project 44-006 final report written by Pentec Environmental, Inc., Edmonds, Washington. Written for Sealaska Corporation, Juneau, Alaska and the Alaska Forest Association, Ketchikan, Alaska. 88pp. (A, B, D, F, G, I, J)

Compiler abstract: In 1992, Sealaska Corporation and the Alaska Forest Association initiated a monitoring program in southeast Alaska to evaluate the overall effectiveness of the BMPs specified by the revised 1990 Alaska Forest Resources and Practices Act (FRPA) with the intent to prevent significant adverse effects of timber harvest on fish habitat and water quality. The objectives of the monitoring program were to determine: (1) if fish habitat conditions changed following timber harvest, and (2) if fish habitat quality had been significantly affected (positive or negative) by timber harvest activities. This report presents results from the 1993 habitat survey and provides preliminary analyses of survey data collected in both 1992 and 1993.

Ten streams were surveyed in 1992 and 1993. Streams varied in size from 5.2 to 31.0 m wide. Streams were subdivided into reaches based on geomorphic channel types. Timber harvest activities in all watersheds except one had occurred or were planned to occur in accordance with the revised FRPA. Streams were surveyed beginning at the mouth and proceeding upstream until an anadromous fish barrier was encountered or to a point where fish utilization was known to be low. Fish habitat and channel conditions were characterized by measuring or characterizing reach length, channel type, channel bankfull width, channel gradient, streambed particle size, riparian vegetation, buffer width, buffer treatment (e.g. unmanaged, partial harvest, no buffer), channel disturbances (e.g. bank erosion, blowdown), channel depth, pool width and length, large woody debris (LWD), stream flows, water temperature. These data were used to calculate various factors known to be indicative of fish habitat and spawning habitat quality: relative amount of fast-water and slow-water habitat; relative amount of pool habitat; pool spacing; residual pool depth; LWD in channel; size distribution of the dominant substrate; dominant habitat cover type; and frequencies of occurrence of units with sand/gravel, gravel/sand, gravel/cobble, and cobble/gravel substrate. Comparisons of fish habitat and channel conditions for the various streams between 1992 and 1993 and between different timber harvest treatments are provided.

72) Martin, D.J. 1996. Fish habitat and channel conditions for streams on forested lands of coastal Alaska: An assessment of cumulative effects. 1995 Assessment. Project 51-002 review draft report written by Pentec Environmental, Inc., Edmonds, Washington. Written for Sealaska Corporation, Juneau, Alaska and the Alaska Forest Association, Ketchikan, Alaska. 37pp. plus Appendices. **(A, B, D, F, G)**

Author abstract (Author Summary of Current Findings): An experimental approach that uses comparisons of pre- and post-harvest conditions in multiple basins is proposed as the basis for testing the effectiveness of modern BMPs in protecting fish habitat. A suit of habitat measurements, which will provide measurement repeatability and are useful for documentation of habitat changes, have been tested and modified for this monitoring program. Power analyses have been performed on a number of habitat parameters to determine the level of detection of various statistical analyses. Sample sizes have been identified for most parameters that will enable an 80 percent level of power.

Some habitat conditions are changing more in the post-harvest basins than in the pre-harvest basins, and the changes are most likely a result of timber harvest activities. Recent LWD recruits to a stream and the percentage of recruits caused by blowdown show a definite response to timber harvest. Significant reductions in riparian canopy density may be associated with timber harvest in some basins. Changes in total LWD loading are difficult to interpret in terms assigning timber harvest effects except where blowdown is clearly documented. Large variability in LWD loading within a basin makes it difficult to test for differences between pre- and post-harvest conditions among groups of basins because not all of the basins are demonstrating the same

pattern under natural conditions. Following LWD trends within a basin over time is probably the best approach to detecting change. The substrate particle size analysis was the most sensitive analysis performed, yet the results do not provide any indication that timber harvest can be associated with the recorded changes. Changes in relative pool area and pool depth show no relationship to pre- or post- harvest conditions or anything else.

73) Martin, D.J. 2001. The influence of geomorphic factors and geographic region on large woody debris loading and fish habitat in Alaska coastal streams. North American Journal of Fisheries Management. 21: 429-440. (A, D)

Author abstract: Large woody debris (LWD) and channel data from three Alaska coastal regions with varying geomorphic channel types were analyzed to document regional variability in LWD abundance, define geomorphic characteristics affecting LWD abundance, and identify relationships between LWD abundance and the formation of pools and gravel bars in streams. Large woody debris abundance was significantly lower at the northern edge of the coastal coniferous forest than in Southeast Alaska and was significantly greater in alluvial gravel-bedded channels than in contained boulder-bedrock channels. More pools and gravel bars were formed by LWD in alluvial channels than in contained channels. Pool spacing (the number of channel widths between pools) decreased with increasing LWD abundance (pieces/km) and was significantly influenced by the interaction between LWD abundance and channel width. As channel width increased, pool spacing was more strongly influenced by changes in LWD abundance, but the relative change in pool spacing diminished with increasing LWD load. The percentage of stream area in pools was insensitive to changes in LWD abundance and was best predicted by channel type. The percentage of habitat units with gravel as the dominant substrate was positively related to LWD abundance and negatively related to stream gradient.

74) Martin, D.J., and A. Shelly. 2004. Status and trends of fish habitat condition on private timberlands in southeast Alaska: 2003 Summary. Alaska Clean Water Action Grant No. NA170Z2325 final report written by Martin Environmental and TerraStat Consulting Group, Seattle, Washington. Written for Sealaska Corporation and the Alaska Department of Natural Resources, Juneau, Alaska. 44pp. plus Appendices. (A, B, D)

Compiler abstract: In 2003 the Sealaska Corporation and the Alaska Department of Natural Resources initiated a habitat and channel conditions monitoring program through an Alaska Clean Water Action Grant. This project was a continuation from previous monitoring programs that were conducted from 1992-1997 and from 1998-2001. The objectives of the project were to expand the database for monitoring of streams on private lands in southeast Alaska and to examine trends in habitat condition using both previously gathered and newly gathered data. Analyses were conducted to identify factors besides logging that could be influencing habitat trends. A power analysis was also conducted to determine sample size for future monitoring. Results from this study were compared against habitat condition trends and data collected by the Tongass National Forest on streams without logging.

This study surveyed 19 stream reaches during 2003 that included 7 new reaches and 12 previously surveyed reaches. The surveyed reaches were located in three basins in the Hoonah area and in six basins in the Craig area. With the exception of four, all the reaches occurred in timber harvest units and most had buffer zones along both sides of the stream. Trend analysis was also conducted on 13 stream reaches from the historical data. Data were divided by those with only post-harvest data and those with both pre- and post-harvest data. Results of the analysis suggest that there were no significant regional trends in habitat conditions at the post-harvest sites for 11 years following logging. Also, there was no discernable difference between average habitat conditions before and after logging at the pre- and post-harvest reaches on private lands. Results showed that habitat variability was partially caused by different responses in habitat to changes in recruitment of wood that were related to wood loading and channel width. Additional years of reach monitoring are needed.

75) Martin, D.J., and J.A. Kirtland. 1995. An assessment of fish habitat and channel conditions in streams affected by debris flows at Hobart Bay. Project 16-004 report written by Pentec Environmental, Inc., Edmonds, Washington. Written for Goldbelt, Inc., Juneau, Alaska. 40pp. plus Appendix. (A, B, D, G)

Compiler abstract: In 1993, several debris flows occurred in two small basins that drain into Laura's Creek and Salt Chuck Creek of Hobart Bay. Three debris flows were initiated by forest practice activities, which then deposited silt, sand and some debris into Gypo Creek. Two large debris flows were initiated by natural causes that then passed through a clearcut unit and deposited large quantities of sediment and debris in Nancy and Salt Chuck Creeks. Laura's Creek, Salt Chuck Creek, and their tributaries were subsequently listed as DEC impaired water bodies because of channel modifications and sedimentation caused by the debris flows.

Field surveys of Gypo Creek, Nancy Creek, and lower Salt Chuck Creek were conducted to assess fish habitat, channel conditions, and landslide occurrence. Landslides were inventoried using aerial photographs taken in 1979 (pre-harvest) and 1989-90 (post-harvest). Fish habitat and stream channel inventories were conducted both upstream and downstream of the debris flow entry locations. Channel types were used to delineate stream reaches, and each reach was further delineated into channel geomorphic units (e.g. pools, riffles, cascades). Within each channel, the following were measured or characterized: stream discharge, channel gradient, channel depth, thalweg depth, pool tail crest depth, pool width and length, pool forming elements, cover elements (e.g. large woody debris [LWD], slash, undercut banks), and substrate particle size. From these variables, various habitat parameters were calculated, such LWD and undercut bank area, pool spacing, pool volume, frequency of occurrence of pool forming elements, frequency of dominant and subdominant substrates, and total and inchannel LWD loading.

Study results were as follows:

- A total of 26 landslides were identified, all of which were shallow-rapid failures of the thin, semi-cohesionless soils of the area;
- All landslides were either debris avalanches or debris flows;
- Thirteen of the 26 landslides delivered sediment to streams; six of these originated in timber harvest areas;
- The majority (69%) of the landslides occurred in steep inner gorges along stream channels;
- Forty-six percent of the landslides occurred in old-growth forest;
- Fifty-four percent of the landslides originated in harvest units or road fill;
- It was not possible to determine if forest management activities increased the frequency of landsliding;

- Landslides in the Gypo Creek and Nancy Creek watersheds were largely confined to small tributaries and did not transfer significant amounts of sediment to higher order channels;
- Channel characteristics and fish spawning and rearing habitat conditions were described;
- Channel modifications and sedimentation of Hobart Bay streams result from naturally occurring debris flows that create favorable and unfavorable fish habitat conditions that vary with the size and frequency of mass wasting events. Timber harvest may have influenced the timing and magnitude of some events.

76) Martin, D.J., and L.E. Benda. 2001. Patterns of instream wood recruitment and transport at the watershed scale. Transactions of the American Fisheries Society. 130: 940-958. (D)

Author abstract: A wood budget was constructed for the Game Creek basin (132 km^2) in southeast Alaska to identify spatial and temporal controls on the abundance and distribution of large woody debris (LWD). Field measurements of wood storage, size, and age were used to estimate volumetric rates of LWD recruitment and transport. Mortality recruitment did not follow a spatial pattern and ranged from 0.1 to 8.1 $m^3 \cdot km^{-1} \cdot year^{-1}$ (recruitment corresponded to forest mortality rates of 0.1 - 2.6% per year). Wood recruitment by bank erosion increased with increasing drainage area and ranged from 1 $m^3 \cdot km^{-1} \cdot year^{-1}$ at the smallest drainage areas to about 16 $m^3 \cdot km^{-1} \cdot year^{-1}$ at 60 km^2. Bank erosion recruitment exceeded the maximum mortality recruitment at a drainage area of approximately 20 km^2 (about 10-m-wide channel). Recruitment from land-sliding was only locally significant. The contribution of fluvial transport (flux) to total LWD storage increased with drainage area to an asymptotic maximum of 50% at about 50 km^2 (about 20-m-wide channel). Mean predicted transport distances for mobile LWD over the lifetime of individual pieces ranged from about 200 m in small, jam-rich streams to about 2,500 m in larger channels with fewer jams. Fluvial transport of LWD increased interjam spacing and jam size and decreased jam age with increasing distance downstream. Constructing LWD budgets at the watershed scale has numerous geomorphic and ecological implications, including identifying spatial controls on the abundance and diversity of aquatic habitats. In addition, information on LWD budgets may be useful for determining how and where to protect LWD sources to streams.

77) Martin, D.J., M.E. Robinson, and R.A. Grotefendt. 1997. Fish habitat and riparian stand composition for streams on forested lands of coastal Alaska: 1996 assessment. Review draft report written by Martin Environmental, Seattle, Washington, and Grotefendt Photogrammetric Services, Inc., North Bend, Washington. Written for Sealaska Corporation, Juneau, Alaska. 43pp. plus Appendices. (A, D, F, H)

Compiler abstract: The overall objective of this study was to document the effects of forestry practices on fish habitat. Specific objectives were to 1) determine if timber harvest is changing fish habitat, 2) determine if timber harvest is affecting habitat quality, and 3) identify the specific categories of best management practices that are not protecting fish habitat. Surveys of streams were conducted for 4 years in 20 stream systems in southeast Alaska. Comparisons were made among habitat features in pre- and post-harvest basins, as well as between pre- and post-harvest habitat features within each basin. Low-altitude aerial photographs were taken of the riparian zones and stream channels. Twelve sets of variables were measured from the photographs, including: channel area; length of stream reach; down tree decay; treefall direction; standing tree type (conifer, deciduous, snag); and distance from a stream to standing trees, down trees, and stumps. Fish habitat and channel morphology data were also collected, and included: channel depth, velocity, and width; channel surface gradient; channel cross-sectional area; channel type; pool spacing; sizes of stream bed substrates; numbers and types of large woody debris (LWD) structures; channel forming functions of LWD structures (e.g. pool scour, pool damming, bar stabilization, sediment storage, channel deflection); riparian canopy density; and location and length of unstable banks.

Results showed most LWD is recruited from areas immediately adjacent the streams. Comparisons at pre- and post- harvest basins showed that canopy density was not significantly different, the amount of change in LWD was larger in post-harvest reaches than pre-harvest reaches, and that there is an increase in LWD recruitment following logging in the post harvest basins. Pool depths changes were significant in 50% of the reaches in both pre- and post-harvest basins. Results also showed that pool habitat is strongly affected by channel type and that significant changes in the amount of LWD in streams can cause changes in pool habitat depending on channel type, LWD loading, and initial pool spacing.

78) Martin, D.J., M.E. Robinson, and R.A. Grotefendt. 1998. The \ for protection of salmonid habitat in Alaska coastal streams. Report written by Martin Environmental, Seattle, Washington, and Grotefendt Photogrammetric Services, Inc., North Bend, Washington. Written for Sealaska Corporation, Juneau, Alaska and the Alaska Forest Association, Ketchikan, Alaska. 85pp. plus Appendices. **(A, D)**

Compiler abstract: The purpose of this study was to evaluate the cumulative effectiveness of the Alaska Forest Resources and Practices Act by determine the effectiveness of 20 m wide riparian buffers for supplying LWD to streams and for protecting fish habitat. Low-elevation aerial photographs were used to identify potential large woody debris (LWD) sources in 15 watersheds (36 study reaches) in southeast Alaska. Annual channel survey data from 1994-1997 were used to monitor changes in LWD recruitment and to examine interactions between LWD, channel morphology, and fish habitat. Thirteen variables were measured from the aerial photographs, including: channel area, length of down trees, height of standing trees, treefall direction, and down tree decay class. Fish habitat and channel inventories were also conducted.

Some of the study results were:

- LWD is important for pool formation and for retention of gravels for salmonid spawning habitat;

Relative effectiveness of LWD to form fish habitat is a function of stream channel type and the amount of LWD in the stream;

- Nearly all of the recruitable size trees occurred within 20 m of stream,
- Selective timber harvest in the buffers, in addition to windthrow following logging, did not significantly reduce the potential supply of LWD from the 0-10 m zone;
- A 20-m wide buffer zone is more effective for providing LWD than a wider buffer or an unlogged area;
- Windthrow may reduce potential long-term supply of LWD in a small percentage of riparian buffers;

- Quantity and quality of fish habitat in streams with naturally low supplies of LWD could be improved by planning buffer zones to increase the supply of LWD.

79) Martin, D.J., M.E. Robinson, S.J. Perkins, and R.A. Grotefendt. 1997. Monitoring the effects of timber harvest activities on fish habitat in streams of coastal Alaska 1992-1997. Project status report written by Martin Environmental, and S.J. Perkins, Seattle, Washington, and Grotefendt Photogrammetric Service, Inc., North Bend, Washington. Written for Sealaska Corporation, Juneau, Alaska. 13pp. (A, D, I)

Compiler abstract: Sealaska Corporation and the Alaska Forest Association initiated a monitoring program in 1992 to determine the short-term and long-term effects of modern forest practices on fish habitat and water quality. This report provides a summary of the monitoring program objectives, approach, and findings from 1992-1997.

The objectives of the monitoring program were to: (1) determine if fish habitat conditions have been altered by timber harvest; (2) determine if habitat quality has been significantly affected, positively or negatively, by timber harvest; and (3) identify specific types of BMPs, such as riparian buffers or roads, that are not protecting fish habitat.

Stream surveys were conducted from 1992 to 1997 in 32 basins located in coastal forests of southeast Alaska, on the Kenai Peninsula, and on Afognak Island. In order to determine if fish habitat conditions have changed due to timber harvest, two study approaches were used: (1) comparing pre- and post-harvest habitat conditions in multiple basins, and (2) comparing pre- and post-harvest habitat conditions in each of the basins. Conclusions are presented for the buffer zone and mass wasting studies.

80) Martin, D.J., W.M. Young, Jr., S.D. Edland, T.S. Lin, and R.B. Morrow. 1990. An inventory of fish habitat conditions on seven southeast Alaska streams identified by the EPA Section 304(I) Long List. Project No. 00044-001 interpretive report written by Pentec Environmental, Inc., Edmonds, Washington. Written for Sealaska Corporation, Juneau, Alaska. 14pp. plus Figures, Tables, and Appendix. (A, B, D, F, H)

Compiler abstract: Streams that are suspected of being degraded by timber harvest and other activities are listed as impaired water bodies by the Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (DEC). Water quality data for forested streams in southeast Alaska are almost non-existent, so the so called "long list" of degraded streams is developed primarily through professional judgment. As a result, EPA requested comments from all interested parties concerning the need for inclusion or deletion of specific streams from the "long list."

Seven streams on Sealaska Corporation land in southeast Alaska that appeared on the "long list" were measured in 1990 to assess the quality and quantity of salmonid spawning and rearing habitat, to determine if they met applicable water quality standards. Cobble embeddedness and stream bank stability were measured to infer conditions related to sediment loads and turbidity. Large woody debris (LWD) was quantified as an indicator of channel stability and habitat quality for rearing fish. Riparian tree frequency was measured as an index of stream shading and future LWD sources. Sixteen environmental parameters were measured or visually estimated in each study reach and along transects within each reach. Transect characteristics that were quantified were: habitat type, width and depth, pool size, pool depth, pool cover, pool quality, pool creator (bedrock, boulders, gravel/cobbles, LWD), substrate composition, cobble embeddedness, and potential LWD. Characteristics of stream reaches between transects that were quantified were: bank stability, riparian condition (old growth, buffer > or < 30 m, second growth, clearcut), large woody debris, spawning area, spawning quality, and gradient.

Study results indicated that general habitat characteristics of the seven streams were characterized as follows:

- Riffles and runs were the dominant habitat types;
- Pools were relatively small, shallow, and had limited cover;
- Riparian condition varied along all streams, with sections of clearcuts, riparian buffers, second growth, and old growth forest;
- Clearcut was the dominant riparian condition along all streams except Humpback and Gunnuck creeks;
- Stream bed substrate was predominantly gravel and cobble;
- Spawning area ranged from <500 m^2 to 10,000 m^2.

Cobble embeddedness, bank stability, LWD and potential LWD were discussed in detail. The relationships between environmental conditions and water quality standards were also discussed.

81) Martin Environmental. 1997. A summary of stream water quality monitoring data: South Fork Michael Creek, Admiralty Island, Alaska. Draft report written by Martin Environmental, Seattle, Washington. Written for Koncor Forest Products, Inc., Anchorage, Alaska, and the Alaska Department of Environmental Conservation and Alaska Department of Natural Resources, Juneau, Alaska. 10pp. plus Figures and Tables (I)

Compiler abstract: The South Fork of Michael Creek in the Lake Florence Watershed, Admiralty Island was monitored from 1993-1996 to determine the effect of 66 ft wide riparian buffer strips with variation treatments on water temperature and turbidity. The stream was monitored for two years prior to timber harvest, and continued during the logging phase (1995 and 1996). Stream stage, turbidity, and water temperature were monitored at five stations, and riparian canopy density was measured between stream monitoring stations. The partial-cut buffers and associated BMPs effectively maintained stream turbidity near pre-harvest levels. Pre-treatment canopy densities were not measured, but comparisons of canopy densities among treated and untreated areas suggested some places were affected by timber harvest. Canopy density was reduced in all sampled areas in the winter of 1995-1996 as a result of blowdown. The effectiveness of the partial-harvest buffers and associated BMPs on maintenance of water temperature was not clearly demonstrated.

82) Martin, J.R. 1993. Influence of roads on wetland vegetation in southeast Alaska. In: Proceedings of Watershed '91: A Conference on the Stewardship of Soil, Air, and Water Resources, 16-17 April 1991, Juneau, Alaska. T. Brock, Editor. USDA Forest Service, Alaska Region, R10-MB-217. Page 33. (K)

Author abstract: The Tongass is the largest National Forest (over 17 million acres) in the United States and encompasses most of southeast Alaska. Approximately, 1.6% of the land is classified as forested wetlands; 9.5% peatland, 3.7% scrub wetlands; 2.3% lacustrine wetlands;

0.2% estuarine wetlands; and 42,429 miles of riverine wetlands for a total of over 4.7 million acres. Road building has been a major activity since the early 1950's. Over 2,600 miles of forest roads currently exist on the Tongass N.F. It's been expected that this mileage will double over the next 50 years. Most of these roads are built by overlaying pit-run rock on organic soils generally on gentle to flat topography. Because of the high rainfall, much of this flat topography is dominated by wetland vegetation. Consequently, a large percentage of the roads have been built on peatland and forest wetlands and to a lesser extent estuarine wetlands. Vegetation response to this development is highly variable in both direction and rate depending on how the hydrologic function was disrupted. Previously wet areas have become dryer and are progressing towards forest conditions as indicated by increased tree growth and regeneration. Conversely, wet areas have become wetter and shifts are seen from Sphagnum and short sedge dominated peatlands with highly stagnant water towards tall sedge fresh water marsh communities. In alluvial riparian forests, where terrace building and degradation is an active process, roads have caused some sites to become more stable and other sites to degenerate to alder or gravel bar conditions. Roads built in estuaries which have reduced the extent of saltwater inundation have caused formally grass dominated communities to become forested. The importance of considering changes in hydrologic function and subsequent shifts in resource production in road management planning is emphasized. Opportunities to utilize these concepts in road management planning and restoration are discussed.

83) McGreer, D.J. 2000. Effects of forest harvesting and roads on streamflow processes and application to watersheds of southeast Alaska. Report written by Western Watershed Analysts, Lewiston, Idaho. Written for Sealaska Corporation, Juneau, Alaska. 10pp. (G)

Compiler abstract: Timber harvest and related road construction can have important effects on hydrologic processes such as total water yield, timing of yield, seasonal low flows, peak flows and floods. This paper presents a review of scientific studies of the potential effects of timber harvest and roads on hydrologic processes in cool, wet forests—mostly from the western slopes of the Pacific Northwest—similar to those typically found in southeast Alaska. The author concludes that clearcut harvesting of forests in southeast Alaska will result in increased annual streamflow as well as increased flows at all times of the year, including low flows. In addition, the author concludes that peak flows may potentially increase following extensive clearcut logging, with further increases due to forest roads. These effects can be minimized by regulating the amount of acreage harvested and by minimizing compacted road surfaces and the amount of road mileage that discharges water directly to streams or gullies that are linked to streams. Road system water discharge can be minimized by carefully locating roads and by designing road drainage systems to minimize discharge of road surface sediments.

84) McNeil, W.H. 1966. Effect of the spawning bed environment on reproduction of pink and chum salmon. University of Washington, College of Fisheries, Seattle, Fishery Bulletin. 65: 495-523. (G, I)

Electronic abstract: The pink *Oncorhynchus gorbuscha* and chum *O. keta* are the only Pacific salmon in North American streams using fresh water solely for spawning. The young of other species remain in fresh water for many months. Post work on spawning bed mortality and fieldwork in streams of the Kasaan Bay region of Prince of Wales Island in Southeast Alaska are reviewed. There was 75-99% mortality between spawning and fry emergence connected with low and high stream discharge, freezing air temperatures, low dissolved oxygen levels during and after spawning or movement of gravel.

85) Meehan, W.R. 1970. Some effects of shade cover on stream temperature in southeast Alaska. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Research Note PNW-113. 9pp. (H, J)

Electronic abstract: Water temperature differences measured with a precision resistance thermometer over 20-yard intervals show that on clear summer days, shade-producing streamside vegetation is important in cooling or maintaining coolness of small streams. The average temperature increase in unshaded reaches of streams in the Haines Juneau area was 0.071 deg c. and in the Petersburg Wrangell area it was 0.164 deg c. in shaded reaches the average temperature decrease was 0.060 deg c. and 0.081 deg c., respectively. Under overcast skies, the effects of shade were very small and the trend was for a slight temperature increase over 20-yard stream reaches--0.011 deg c. and 0.009 deg c., in the two areas. The reasons for the significantly different temperature responses in the two geographic areas are not yet known.

86) Meehan, W.R. 1971. Effects of gravel cleaning on bottom organisms in three southeast Alaska streams. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Program Fish Cultivation. 33: 107-111. (B, C)

Electronic abstract: Excessive sediment in the spawning gravels of salmon streams is believed to be a factor limiting salmon production. A riffle sifter designed for 'cleaning' streambed gravels is described. It is self-powered and amphibious, and stirs up streambed gravel sucking up fine materials and spraying them out onto the stream banks. The effects of using the riffle sifter in 3 streams in S.E. Alaska is evaluated. The 3 streams were Fish Creek, Slocum Creek and Lover's Cove Creek. Lover's Cove Creek was the best cleaned after development of the equipment. The bottom types and pre-treatment levels of sedimentation were similar. Samples were taken 3 days before, approx 3 days after, 3 months after and 12 months after treatment. All showed noticeable decreases in bottom fauna immediately after cleaning. There was a decrease of approx 30 percent in materials less than 0.4 mm in Slocum Creek and 65 percent less in Lover's Cove Creek which was the most thoroughly cleaned. In Lover's Cove Creek recruitment of bottom organisms was back to pre-treatment levels after 12 months and differences in fauna were negligible.

87) Meehan, W.R. 1974. The forest ecosystem of southeast Alaska. 3. Fish habitats. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-15. 41pp. (B, D, G, I, J)

Author abstract: The effects of logging and associated activities on fish habitat in southeastern Alaska are discussed, and fish habitat research applicable to southeast Alaska is summarized. Requirements of salmonids for suitable spawning and rearing areas are presented. Factors associated with timber harvest which may influence these habitats are discussed in detail; e.g., sediment, stream temperature, streamflow, logging debris, and chemicals. Recommendations for further research are made.

88) Meehan, W.R., F.B. Lotspeich, and E.W. Mueller. 1975. Effects of forest fertilization on two southeast Alaska streams. Journal of Environmental Quality. 4: 50-55. (I)

Electronic abstract: 4 streams in southeast Alaska were studied to determine the effects of forest fertilization with urea on basic productivity and water quality. An initial, short-term increase in ammonia-N_2 was observed in the treated streams, and nitrate-N_2 levels increased and remained high compared to control stream levels during the yr following treatment. Conclusions did not approach those considered toxic to aquatic life or unsafe for human consumption. Changes in biomass of periphyton and benthic fauna as a result of fertilization were not detected.

89) Milner, A.M. 1987. Colonization and ecological development of new streams in Glacier Bay National Park, Alaska. Freshwater Biology. 18: 53-70. (C, G, I, J)

Author abstract: Colonization and ecological development of post-glacial freshwater communities were investigated in Glacier Bay National Park, south-eastern Alaska, following the rapid recession of a Neo-glacial ice sheet within the last 250 years. Environmental variables shown to be most significant in stream development were temperature, flow regime and sedimentation. The Chironomidae (Diptera) were the pioneer invertebrate colonizers of newly emergent streams arising as meltwater from receding ice sheets and displayed a distinct pattern of succession with stream maturity. Ephemeroptera and Plecoptera colonized warmer clearwater streams, but Trichoptera had a minimal role in invertebrate community development. Establishment and production of salmonid fish populations in the new streams related principally to stream flow and sediment characteristics. Future pathways along which the streams may develop is probably dependent on the degree of large organic debris input. Stream development, structure and function are summarized including references to theories of ecosystem development, ecological succession and community stability.

90) Milner, A.M. 1996. Data analysis and summary of the use of rapid bioassessment metrics to evaluate the use of a partial buffer zone in timber harvest in a Lake Florence watershed, Admiralty, Island. White paper, Institute of Arctic Biology, University of Alaska, Fairbanks. 13pp. (C, I)

Compiler abstract: The report summarizes three years of macroinvertebrate data collected in Michael Creek to analyze the application of rapid bioassessment for evaluating timber harvest effects with a partial buffer strip on the macroinvertebrate community. The data represent a two year pre-harvest period (1993-1994), and the first year of post-harvest (1995). Four bioassessment metrics were used to determine possible differences in the macroinvertebrate community between a portion of the creek with a partial buffer and a control area. The four metrics were: 1) EPT genera (orders Ephemeroptera, Trichoptera, and Plecoptera); 2) EPT Individuals/Total Individuals Ratio; 3) percent dominant taxa; and 4) Family Biotic Index of Hilsenoff. Overall, no significant effects of timber harvest on the macroinvertebrate community were detected using the chosen bioassessment metrics. However, the bioassessment technique described may not detect timber harvest effects on aquatic systems that are not linked to macroinvertebrate community structure. Likewise, timber harvest effects that cause an overall decrease in macroinvertebrate populations, but do not alter their community structure will also not be detected.

91) Milner, A.M. and G.S. York. 2001. Factors influencing fish productivity in a newly formed watershed in Kenai Fjords National Park, Alaska. Archiv fuer Hydrobiologie. 151: 627-647. (C, E, I)

Electronic abstract: Delusion Creek in McCarty Fjord, southcentral Alaska, was studied over three field seasons from 1992 to 1994 to investigate the factors influencing salmonid colonization and productivity of a new stream system formed by glacial ice recession within the last 40 years. Stream discharge was extremely variable during the summer months. Frequent spate events were a major factor in maintaining an unstable channel and in raising turbidity levels, which limit primary production and the abundance and diversity of invertebrates in the main stream channel available to rearing fish. However, in less than 40 years, Coho (*Oncorhynchus kisutch*), pink (*O. gorbuscha*), and sockeye (*O. nerka*) salmon have colonized Delusion Creek, and over 1,000 sockeye salmon were observed to spawn along the margin of the upper lake in 1993. Ninety-three percent of juvenile sockeye salmon remained in the lakes for two years prior to smolting. Kettle ponds, formed after ice recession, were also found to be important rearing areas for juvenile Coho salmon. In the main stream channel, Dolly Varden (*Salvelinus malma*) char were the most abundant juvenile rearing fish. Water chemistry of the lakes indicated that nitrogen was likely a limiting nutrient to primary production. Experiments with artificial channels showed that enrichment with nitrogen and phosphorus increased chlorophyll-*a* levels and macroinvertebrate drift was significantly reduced from enriched channels. We suggest that primary productivity and invertebrate abundance may be enhanced by the colonization of spawning anadromous salmon which may, thus, act as a positive feedback to productivity of this new stream.

92) Milner, A.M., and R.G. Bailey. 1989. Salmonid colonization of new streams in Glacier Bay National Park, Alaska. Fisheries and Aquaculture Management. 20: 179-192. (G, I, J)

Electronic abstract: Following the rapid recession of a neoglacial ice sheet within the last 250 years, colonization of recently deglaciated streams by salmonid fishes was investigated in Glacier Bay National Park, south-eastern Alaska. The primary factors governing the establishment, species diversity composition and abundance of salmonids in Glacier Bay streams were water temperature, sediment loading and stream discharge. No salmonids were found in the turbid meltwater streams emerging from retreating ice. Coho, *Oncorhynchus kisutch* (Walbaum), and sockeye, *Oncorhynchus nerka* (Walbaum), salmon and Dolly Varden, *Salvelinus malma* (Walbaum), charr were the first salmonids to colonize the youngest clearwater stream.

93) Milner, A.M., D.M. Bishop, and L.A. Smith. 1985. The influence of water temperature and streamflow on sockeye salmon fry emergence and migration in Black Bear Creek, southeastern Alaska. In: Proceedings of the Symposium on Small Hydropower and Fisheries, 1-3 May 1985, Aurora, Colorado. F.W. Olson, R.G. White, and R.H. Hamre, Editors. The American Fisheries Society. Pages 54-58. (G, J)

Author abstract: Accumulated temperature unit and discharge information collected for sockeye salmon embryos from spawning to downstream migration over two successive incubation periods are evaluated with reference to possible impacts of an altered thermal or flow regime from the development of a small hydropower facility.

94) Montgomery, D.R., J.M. Buffington, R.D. Smith, K.M. Schmidt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research. 31: 1097-1106. (A, D)

Electronic abstract: Field surveys of stream channels in forested mountain drainage basins in southeast Alaska and Washington reveal that pool spacing depends on large woody debris (LWD) loading and channel type, slope, and width. Mean pool spacing in pool-riffle, plane-bed, and forced pool-riffle channels systematically decreases from greater than 13 channel widths per pool to less than 1 channel width with increasing LWD loading, whereas pool spacing in generally steeper, step-pool channels is independent of LWD loading. Although plane-bed and pool-riffle channels occur at similar low LWD loading, they exhibit typical pool spacings of greater than 9 and 2-4 channels widths, respectively. Forced pool-riffle channels have high LWD loading, typical pool spacing of <2 channel widths, and slopes that overlap the ranges of free-formed pool-riffle and plane-bed channel types. While a forced pool-riffle morphology may mask either of these low-LWD-loading morphologies, channel slope provides an indicator of probable morphologic response to wood loss in forced pool-riffle reaches. At all study sites, less than 40% of the LWD pieces force the formation of a pool. We also find that channel width strongly influences pool spacing in forest streams with similar debris loading and that reaches flowing through previously clear-cut forests have lower LWD loading and hence fewer pools than reaches in pristine forests.

95) Murphy, M.L. 1985. Die-offs of pre-spawn adult pink salmon and chum salmon in southeastern Alaska. North American Journal of Fisheries Management. 5: 302-308. (K)

Author abstract: About 300 pre-spawn adult pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*Oncorhynchus keta*) died in August 1981 in the intertidal reach of Porcupine Creek, a small stream in an old-growth forest. A combination of low stream flow and neap tides triggered the die-off, and about 1% of the pink salmon and chum salmon spawners died upon returning to Porcupine Creek in 1981. Anoxia, rather than temperature, caused most of the deaths because the maximum stream temperature was 19 C--well below lethal temperatures. Conditions similar to those in 1981 recur in Porcupine Creek about once every 8 years. This type of die-off also appears to be common in other streams in southeastern Alaska and can be predicted from the number of salmon returning, amount of precipitation, and height of the tide.

96) Murphy, M.L., and K.V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources, 21-23 March 1989, Juneau, Alaska. E.B. Alexander, Editor. USDA Forest Service, Alaska Region, R10-MB-77. Page 99. (D)

Author abstract: Natural rates of input and depletion of large woody debris (LWD; fragments >10 cm diameter and >3 m long) in southeast Alaska streams were studied to provide a basis for managing streamside zones to maintain LWD for fish habitat after timber harvest. Large woody debris was inventoried by size and decay classes in 32 reaches of a variety of channel types in undisturbed old-growth forest, and more than 250 pieces were dated from the age of trees growing on them. Longevity of LWD in the streams was directly related to bole diameter. Small pieces (<30 cm diameter) were all less than 100 yr old, whereas large pieces (>90 cm diameter) were up to 226 yr old. Assuming steady-state conditions in old-growth forest, LWD depletion rate was assumed to equal input rate which was calculated from the percentage abundance and average age of LWD in the decay classes. Annual depletion ranged from 1.2% of large pieces in all channel types to 3.0% of small pieces in C2 channels (fourth-order, bedrock-controlled streams). A model of LWD changes after logging, which accounted for LWD depletion, LWD input from second-growth trees, and distance from the stream to LWD sources, indicated that clearcutting without buffer strips along streams reduces LWD >60 cm diameter by 75%, and the minimum level of LWD is reached 90-100 years after logging. Because almost all LWD in streams comes from within 30 m of the stream bank, a 30-m buffer on both sides of the stream should maintain LWD levels in the stream after logging.

97) Murphy, M.L., J.F. Thedinga, K.V. Koski, and G.B. Grette. 1984. A stream ecosystem in an old-growth forest in southeast Alaska. Part V: Seasonal changes in habitat utilization by juvenile salmonids. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 89-98. (A, D)

Author abstract: Seasonal changes in distribution and habitat selection by juvenile salmonid fishes were studied in Porcupine Creek, a small coastal stream in an old-growth forest in southeast Alaska. During summer, coho salmon (*Oncorhynchus kisutch*) were distributed in both stream/estuary ecotone and freshwater reaches, and biomass (g per m^2) was directly related to total pool volume. Trout (*Salmo gairdneri* and *S. clarki*) and Dolly Varden char (*Salvelinus malma*) were not common in the stream/estuary ecotone but were common in freshwater. Total salmonid biomass during summer was directly related to the amount of large organic debris in the stream. Tagged salmonids showed little movement during summer but redistributed themselves within the Porcupine Creek system before winter. Coho moved out of the stream/estuary ecotone to upstream freshwater areas to overwinter. In late autumn, coho used primarily large mainstream pools, backwater pools, and secondary-channel pools, and trout and char used primarily debris or undercut banks on the edges of riffles. Resource managers need to take into account seasonal changes in habitat requirements when assessing effects of logging or other land uses on fish habitat in streams.

98) Murphy, M.L., J. Heifetz, J.F. Thedinga, S.W. Johnson, and K.V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (*Oncorhynchus*) in the glacial Taku River, southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 46: 1677-1685. (A)

Electronic abstract: Habitat utilization by juvenile Pacific salmon (*Oncorhynchus*) was determined in summer 1986 by sampling 54 sites of nine habitat types: main channels, backwaters, braids, channel edges, and sloughs in the river; and beaver ponds, terrace tributaries, tributary mouths, and upland sloughs on the valley floor. Physical characteristics were measured at all sites, and all habitats except main channels (current too swift for rearing salmon) were seined to determine fish density. Each species of *Oncorhynchus* was absent from about one-quarter of the seining sites of each habitat type. The lower Taku River provides important summer habitat for juvenile salmon, but many suitable areas were unoccupied possibly because of their distance from spawning areas and poor access for colonizing fish.

99) Murphy, M.L., J. Heifetz, S.W. Johnson, K.V. Koski, and J.F. Thedinga. 1986. Effects of clear-cut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Canadian Journal of Fisheries and Aquatic Sciences. 43: 1521-1533. (A, C, D, F, H)

Author abstract: To assess short-term effects of logging on juvenile *Oncorhynchus kisutch*, *Salvelinus malma*, *Salmo gairdneri*, and *Salmo clarki* in southeastern Alaska, we compared fish density and habitat in summer and winter in 18 streams in old-growth forest and in clear-cuts with and without buffer strips. Buffered reaches did not consistently differ from old-growth reaches; clear-cut reaches had more periphyton, lower channel stability, and less canopy, pool volume, large woody debris, and undercut banks than old-growth reaches. In summer, if areas had underlying limestone, clear-cut reaches and buffered reaches with open canopy had more periphyton, benthos, and coho salmon fry (age 0) than old-growth reaches. In winter, abundance of parr (age >0) depended on amount of debris. If debris was left in clear-cut reaches, or added in buffered reaches, coho salmon parr were abundant (10-22/100 m^2). If debris had been removed from clear-cut reaches, parr were scarce (<2/100 m^2). Thus, clear-cutting may increase fry abundance in summer in some streams by increasing primary production, but may reduce abundance of parr in winter if debris is removed. Use of buffer strips maintains or increases debris, protects habitat, allows increased primary production, and can increase abundance of fry and parr.

100) Myren, R.T., and R.J. Ellis. 1984. Evapotranspiration in forest succession and long-term effects upon fishery resources: A consideration for management of old-growth forests. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 183-186. (G)

Author abstract: Evapotranspiration of rapidly growing forests may markedly reduce the minimum streamflows during the summer. In many streams of southeast Alaska, the minimum summer streamflows limit spawning success of pink and chum salmon and may limit the habitat of species such as coho salmon that rear in streams. Extrapolating from the literature leads to the conclusion that converting significant portions of old-growth watersheds to rapidly growing second-growth forests risks permanently reducing summer low flows of the streams and, thus, their ability to produce salmon. It is recommended that this risk be considered in managing the forests and that effects on streamflow of converting old-growth forests to second-growth forests be included in studies of logging in southeast Alaska.

101) Orlikowska, E.H. 2004. The role of red alder in riparian forest structure along headwater streams in southeastern Alaska. Northwest Science. 78: 111-123. (K)

Author abstract: We assessed the influence of red alder on tree species composition, stand density, tree size distribution, tree mortality, and potential for producing large conifers, in 38-42 yr old riparian forests along 13 headwater streams in the Maybe so and Harris watersheds on Prince of Wales Island, Alaska. Red alder ranged from 0 to 53% of the total live basal area of the stands. Tree density, basal area of live and dead trees, and mean diameter of live conifers were not significantly related to the percent of alder as a proportion of total stand live basal area within these riparian forests. The mean diameter of the 100 largest conifers per hectare (the largest trees) was similar among different sites and appeared unrelated to the amount of alder in the stands. The mean diameter of dead conifers increased slightly with increasing proportion of red alder. Most dead trees were small and died standing. Red alder was much more concentrated immediately along stream margins (within 0-1 m distance from the stream bank vs. > 1 m). The presence of red alder did not inhibit the production of large-diameter conifers, and both alder and conifers provided small woody debris for fishless headwater streams in southeastern Alaska. Red alder is an important structural component of young-growth riparian stands.

102) Paustian, S.J. 1987. Monitoring nonpoint source discharge of sediment from timber harvesting activities in two southeast Alaska watersheds. In: Water Quality in the Great Land—Alaska's Challenge. Proceedings: Alaska Section, American Water Resources Association. R.G. Huntsinger, Technical Chairman. Water Research Center, Institute of Northern Engineering, University of Alaska, Fairbanks. Pages: 153-168. (I)

Author abstract: Sediment discharge measurements taken on the mainstem of Indian River near Tenakee Springs in Southeast Alaska showed no significant change in sediment delivery following logging and road building that affected 8% of an 11 mi^2 watershed. More discrete sediment sources from road building were measured below road crossings on three first and second order tributaries to Kadashan River also located in Tenakee Inlet. Short term impacts of road building in Kadashan resulted in increased suspended sediment yield equivalent to 2% of the estimated annual sediment yields. Potential increases in total estimated sediment yield over a two year post-road construction period ranged from 20% to 66% in the three Kadashan study streams. The results of these monitoring studies have important implications for assessment of water quality management goals and objectives in the forested watersheds of coastal Alaska.

103) Pentec Environmental, Inc. 1991. Factors affecting pink salmon pre-spawning mortality in southeast Alaska. Technical Report 91-01 written by Pentec Environmental, Inc., Edmonds, Washington. Written for the Alaska Working Group on Cooperative Forestry/Fisheries Research. 81pp. (G, I, J)

Compiler abstract: In February 1990, the Working Group on Cooperative Forestry/Fisheries Research decided to initiate a two phase study to address three questions:

1. "What environmental factors cause pre-spawner mortality?"
2. "What watershed characteristics or other causative factors or both result in lethal conditions for migrating adult salmon?"

3. “What is the effect of logging on factors that cause pre-spawner mortality?”

This document reports on the first phase of the study, which addressed two objectives:

1. Identification of factors causing low dissolved oxygen (DO) in streams during the pre-spawner migration period, and
2. Verification that low DO causes adult salmon pre-spawner mortality.

Data were collected in seven streams in the central portion of Prince of Wales Island, southeast Alaska. Streams with varying levels of timber harvest, some with a history of fish kills, were selected. DO concentrations were determined by taking diel measurements at the head and tail of typical salmon holding pools, both before and during the time when adult spawning salmon were present. Background DO concentrations were those that were measured without the presence of spawners. The effects of spawner oxygen demand were determined by measuring DO when spawners were present.

Conclusions of the study were:

1. Significant reductions of DO concentrations during summer low flows can result from respiration of adult spawners;
2. Fish respiration can cause reductions in DO concentrations at water temperatures well below lethal levels;
3. The primary factors controlling DO levels during spawner migration were stream discharge and fish abundance, but fish activity level may also be important;
4. The most likely factor causing pre-spawner mortality is low DO concentration resulting from fish respiration in holding pools;
5. Water temperature increases will decrease potential availability of DO while increasing DO uptake by fish—stream discharge will determine how these factors affect DO concentrations.

The greatest potential effect of timber harvest on pre-spawner mortality is most likely related to logging effects on stream discharge. The magnitude of changes in stream discharge and spatial characteristics of these changes relative to salmon holding pools needs to be investigated in second growth basins.

104) Pentec Environmental, Inc. 1993. Fish habitat and channel conditions of nine streams in southeast Alaska and Afognak Island 1992 survey results. Technical Report 93-01 written by Pentec Environmental, Inc., Edmonds, Washington.Written for the Alaska Working Group of Cooperative Forestry/Fisheries Research. 37pp., plus Tables, Figures, and Appendices. (A, B, D, F)

Compiler abstract: A monitoring program was developed by Sealaska and Alaska Forest Association to produce a database of fish habitat and conditions of channels for forested lands that were previously harvested and for those that will be harvested in the future. The purpose was to evaluate the overall effectiveness of new forest practices and best management practices. This was accomplished by developing a multiyear monitoring program to collect data before and after timber harvest in nine streams in Southeast Alaska and Afognak Island for comparative studies between harvested and unharvested basins. Creeks included in the study were: Coon, Coco, Frosty, East Tolstoi,Cabin, Eagle, East Eagle, Little Afognak, and East Fork Little Afognak River. Parameters that were sampled for each creek, that are highly sensitive to and would be affected by BMPs included: LWD size and number, distribution and number of habitat units by type, pool residual depth, bank stability, shade, channel width, and spawning gravel sediment.

Parameters that were sampled for each creek that are indicative of general quality and quantity of fish habitat included: habitat unit area, dominant and subdominant substrate composition, cover type and area, spawning area, cobble embeddedness, riparian type and treatment, and channel gradient. Results are presented separately for each creek.

105) Perkins, S.J. 1999. Landslide inventory and sediment response study for monitored Sealaska streams. Report written by Martin Environmental, Seattle, Washington. Written for Sealaska Corporation, Juneau, Alaska. 27pp plus Appendices and maps. (B, I)

Author abstract (Author Introduction): This report presents the results of a landslide inventory and sediment-response study of twelve streams that are the subject of ongoing studies of forest practices effectiveness by Sealaska and the Alaska Forest Association. The purpose of this was to 1) estimate relative sediment supply levels to the study streams, 2) determine the relative importance of landslides in supplying sediment to each stream, and 3) compile a history of sediment supply changes and historic channel responses to changes in bedload. The results of this study will provide the context for a second study phase: analysis of monitoring data to examine the effects of sediment supply changes on channel substrate and morphology.

The scope of this study consisted of inspection of aerial photographs, topographic maps, and supplemental information from timber harvest managers.

106) Piccolo, J.J., and M.S. Wipfli. 2002. Does red alder (*Alnus rubra*) in upland riparian forests elevate macroinvertebrate and detritus export from headwater streams to downstream habitats in southeastern Alaska? Canadian Journal of Fisheries and Aquatic Sciences. 59: 503-513. (C)

Author abstract: We assessed the influence of riparian forest canopy type on macroinvertebrate and detritus export from headwater streams to downstream habitats in the Tongass National Forest, southeastern Alaska. Twenty-four fishless headwater streams were sampled monthly, from April to August 1998, across four riparian canopy types: old growth, clearcut, young-growth alder, and young-growth conifer. Young-growth alder sites exported significantly greater count (mean = 9.4 individuals$\cdot m^{-3}$ water, standard error (SE) = 3.7) and biomass (mean = 3.1 mg dry mass$\cdot m^{-3}$ water, SE = 1.2) densities of macroinvertebrates than did young-growth conifer sites (mean = 2.7 individuals$\cdot m^{-3}$ water, SE = 0.4, and mean = 1.0 mg dry mass$\cdot m^{-3}$ water, SE = 0.2), enough prey to support up to four times more fish biomass if downstream habitat is suitable. We detected no significant differences in macroinvertebrate export between other canopy types or in detritus export among different canopy types. Roughly 70% of the invertebrates were aquatic; the rest were terrestrial or could not be identified. Although we do not recommend clearcutting as a means of generating red alder, maintaining an alder component in previously harvested stands may offset other potentially negative effects of timber harvest (such as sedimentation and loss of coarse woody debris) on downstream, salmonid-bearing food webs.

107) Rickman, R.L. 1998. Effects of ice formation on hydrology and water quality in the lower Bradley River, Alaska--Implications for salmon incubation habitat. USDI Geological Survey, Anchorage, Alaska, Water-Resources Investigations Report 98-4191. 50pp. (G, I, J)

Electronic abstract: A minimum flow of 40 cubic feet per second is required in the lower Bradley River, near Homer, Alaska, from November 2 to April 30 to ensure adequate salmon egg incubation habitat. The study that determined this minimum flow did not account for the effects of ice formation on habitat. An investigation was made during periods of ice formation. Hydraulic properties and field water-quality data were measured in winter only from March 1993 to April 1995 at six transects in the lower Bradley River. Discharge in the lower Bradley River ranged from 42.6 to 73.0 cubic feet per second (average 57 cubic feet per second) with ice conditions ranging from near ice free to 100 percent ice cover. Stream water velocity and depth were adequate for habitat protection for all ice conditions and discharges. No relation was found between percent ice cover and mean velocity and depth for any given discharge and no trends were found with changes in discharge for a given ice condition. Velocity distribution within each transect varied significantly from one sampling period to the next. Mean depth and velocity at flows of 40 cubic feet per second or less could not be predicted. No consistent relation was found between the amount of wetted perimeter and percent ice cover. Intragravel-water temperature was slightly warmer than surface-water temperature. Surface and intragravel-water dissolved-oxygen levels were adequate for all flows and ice conditions. No apparent relation was found between dissolved-oxygen levels and streamflow or ice conditions. Excellent oxygen exchange was indicated throughout the study reach. Stranding potential of salmon fry was found to be low throughout the study reach. The limiting factors for determining the minimal acceptable flow limit appear to be stream-water velocity and depth, although specific limits could not be estimated because of the high flows that occurred during this study.

108) Roberston, A.L., and A.M. Milner. 2001. Coarse particulate organic matter: A habitat or food resource for the meiofaunal community of a recently formed stream? Archiv fuer Hydrobiologie. 152: 529-541. (C)

Electronic abstract: We examined the role of CPOM as food and/or habitat for lotic meiofauna in Wolf Point Creek, a recently formed stream in Glacier Bay, south-eastern Alaska. Meiofaunal communities in the stream substratum and those colonising mesh bags containing leaf or plastic substrata were compared on 3 occasions during the summer of 1997. MANOVA indicated that the communities of the stony and mesh bag substrata were significantly different but there were no significant differences between the communities occupying the plastic or leaf substrata. Measures of FPOM and biofilm were significantly higher on the leaf than on the plastic substrata. The responses of meiofaunal densities to date and substratum type were taxon specific. CPOM availability in this recently formed stream has had a marked impact on the meiofaunal community; densities increased significantly with CPOM enhancement and its main role appeared to be as habitat. This finding differs from those of similar studies on lotic macroinvertebrate communities. Future increases in allochthonous inputs and stream retention in Wolf Point Creek (following vegetation succession) will lead to an increase in meiofaunal densities. It is likely that the establishment of the riparian zone adjacent to new streams formed

following press disturbances will be a significant influence in the succession of resident meiofaunal communities.

109) Robison, E.G., and R.L. Beschta. 1990. Characteristics of coarse woody debris for several coastal streams of southeast Alaska, USA. Canadian Journal of Fisheries and Aquatic Sciences. 47: 1684-1693. (A, D)

Electronic abstract: Coarse woody debris (> 0.2 m in diameter and 1.5 m long) was measured along five undisturbed low-gradient stream reaches; volume, decay class, and horizontal orientation in relation to channel flow of first-, second-, third-, and fourth-order coastal streams were determined. Debris was also classified into four influence zones based on stream hydraulics and fish habitat. Average debris length, diameter, and volume per piece increased with stream size. Eighty percent of debris volume of the first-order and the smaller second-order streams was suspended above or lying outside the bankfull channel, while less than 40% was similarly positioned in the fourth-order stream.

110) Robison, E.G., and R.L. Beschta. 1990. Coarse woody debris and channel morphology interactions for undisturbed streams in southeast Alaska, U.S.A. Earth Surface Processes and Landforms. 15: 149-156. (A, D)

Author abstract: Coarse woody debris and channel morphology were evaluated for five low-gradient streams that ranged from first to fourth order (0-7 to 55 km^2 watershed area). Debris volumes were directly related to variations in bankfull width. Woody debris was associated with 65 to 75 per cent of all pools and the relative proportion of types of pools (i.e. plunge, lateral scour, etc.) varied with stream size. High variability in channel depths and widths was common. The results provide benchmark values of woody debris loadings and channels morphology for undisturbed coastal Alaska stream systems.

111) Savard, C.S., and D.R. Scully. 1984. Surface-water quantity and quality in the lower Kenai Peninsula, Alaska. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water Resources Investigations Report 84-4161. 62 pp. (G, I, J)

Electronic abstract: New information on stream discharge and quality were collected over a 2-year period in the lower Kenai Peninsula. This new information improved understanding of the area's surface-water hydrology. Average annual runoff ranges from 11 inches in the lowland portions of the peninsula to 100 inches in the Seldovia area. For drainage basins in the Kenai Lowland, maximum flood runoff rates range from about 10 to 82 cubic feet per second per square mile. In the Seldovia area maximum peak discharges range from about 65 to 280 cubic feet per second per square mile. Low-flow discharges are higher in the Seldovia area than on the lower peninsula. Calcium and bicarbonate ions dominate the water in streams draining the study area; the water is soft and has a low dissolved-solids content. Measured stream water temperatures range from 0 to 23 degrees Celsius in the Kenai Lowland and from 0 to 11.5 degrees Celsius in the Seldovia area.

112) Schmiege, D.C, A.E. Helmers, and D.M. Bishop. 1974. The forest ecosystem of southeast Alaska. 8. Water. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-28. 26pp. (G, I, J)

Author abstract: One of the most striking characteristics of southeast Alaska is the abundance of water. Large glaciers, icefields, and thousands of streams result from heavy precipitation throughout the year.

Published and unpublished data on water regimen, temperature, sedimentation, and chemistry are combined. These serve as a basis for understanding how this valuable resource may be used and protected so that high quality water may always be abundant and available. A brief section on needed research is included

113) Schult, D.T., and D.J. McGreer. 2001. Effects of forest harvest and roads on water quality and application to watersheds of southeast Alaska. Report written by Western Watershed Analysts, Lewiston, Idaho. Written for Sealaska Corporation, Juneau, Alaska. 12pp. (E, F, I, J)

Compiler abstract: Timber harvest and related road construction can have important effects on water quality in forest streams by affecting sediment, nutrients, dissolved oxygen, and water temperature. This paper presents a review of scientific studies of the potential effects of timber harvest and roads on water quality in cool, wet forests—mostly from the western slopes of the Pacific Northwest—similar to those typically found in southeast Alaska. The authors apply their conclusions to management of Alaska's coastal forests with application of the Alaska Forest Resources and Practices Act.

114) Sedell, J.R. and W.S. Duval. 1985. Influence of forest and rangeland management on anadromous fish habitat in western North America: Water transportation and storage of logs. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-186. 68pp. (C, I)

Electronic abstract: Environmental effects of water transportation of logs in western North America include the historical driving of logs in rivers and streams, and the present dumping, rafting, and storage of logs in rivers and estuaries in British Columbia and southeastern Alaska. The historical perspective focuses on habitat losses and volumes of logs transported by water, both freshwater and marine. The environmental impacts of log handling on the physical habitat, water quality, plant communities, benthic and intertidal invertebrates, and fish are reviewed. Information gaps and research recommendations age given. In general, the environmental impacts of log handling are localized.

115) Seitz, H.R. 1989. The U.S. Geological Survey data base: Streamflow and water quality in southeast Alaska. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources, 21-23 March 1989, Juneau, Alaska. E.B. Alexander, Editor. USDA Forest Service, Alaska Region, R10-MB-77. Page 93. (G, I)

Author abstract: Stream gauges for determination of streamflow have been operated in Southeast Alaska – Yakutat south to the Canadian border – since 1909. Records range in length from 1 to 70 years at 132 gauging sites. The oldest operating stream gauge is Fish Creek near Ketchikan, beginning in 1915. The present gauging network consists of 22 gauge sites. Continuous stream temperature records, less than 5 years in length, have been collected at 43 sites. Chemical analysis of the waters of Southeast Alaska has been sparse and limited to determination of common ions. Streamflow sediment determinations have been limited in areal coverage and range of river stage. Sediment loads carried by streams at peak flows greater than mean annual peaks have not been determined.

116) Sheridan, W.L. 1961. Temperature relationships in a pink salmon stream in Alaska. Ecology. 42: 91-98. (J)

Author abstract (Author Conclusions and Summary): The temperature regimen in 2 pink salmon spawning riffles in Cabin creek, southeast Alaska were studied for a period of 14 months in 1949-50. These studies were undertaken because little was known of the temperature regimens of streams in the area and because survival of both adult and young pink salmon in freshwater depends in part upon suitable water temperatures.

Temperatures of the air, stream water, intragravel water, and bank groundwater were measured. A multiple thermocouple system was installed in each of 2 spawning riffles to measure temperatures in the gravel and in the banks.

Analyses of temperature data showed the following:

1. Although the extent of relationship between temperatures of the various media varied with the season, air temperatures were found to dominate and govern all water temperatures during a large part of the climatic year. During the summer and fall months, the closest relationship existed between temperatures of stream water and intragravel water ($r = 0.99$); the least between air and groundwater temperatures ($r = 0.63$). because of close agreement between air and stream and intragravel water temperatures, abnormal air temperatures can affect pink salmon adult spawners as well as eggs and larvae.
2. Winter stream temperatures depend to a large extent on whether the stream is covered with ice and snow. If the stream is clear of ice, stream temperatures are usually higher than when the stream is covered. If the stream is covered, temperatures in the stream are less influenced by air temperatures. The protective influence of an ice and snow layer was evident in Cabin Creek during one of the coldest winters on record.
3. In the spring, melting snow subdues the effect of high air temperatures on water temperatures. Variable yearly water temperatures in the spring, caused by an interaction of air temperatures and accumulated snow, can influence the number of temperature units available to developing pink salmon larvae, hence may cause fry to migrate to sea at unfavorable times.
4. Temperature gradation was more pronounced in groundwater of the banks than in water within the gravel of the streambed, and was more marked in the intertidal zone than in the stream above tidal influence. In the intertidal zone, temperature gradation was the result of ebb and flow of warmer saltwater over the area. Temperature changes in the intertidal zone depend mainly on tide level, temperatures of stream and saltwater, and permeability of streambed gravels.

Saltwater bathing intertidal zones may give salmon eggs and larva protection against freezing during extremely cold winters and may accelerate developmental rate because of higher temperatures than in the stream above the tides. Pink salmon eggs reared in dilute saltwater also have a higher survival than eggs reared in freshwater controls.

117) Sheridan, W.L. 1962. Relation of stream temperatures to timing of pink salmon escapements in southeast Alaska. In: Symposium of Pink Salmon. H.R. Mac Millan Lectures in Fisheries. Symposium held at the University of British Columbia, 13-15 October 1960, Vancouver, British Columbia. N.J. Wilimovsky, Editor. Pages 87-101. (J)

Author abstract (Author Summary): 1. Fisheries Research Institute stream surveys (conducted from 1949 through 1957) in Southeast Alaska clearly established that (1) pink salmon in this region return and spawn in different streams at different times, and (2) some spawning streams are consistently colder than others, especially during the summer and fall spawning season. 2. Correlation analyses of data on timing of the runs and temperatures of the streams indicate that in most in stances cold streams are entered and spawned in earlier in the season than warmer streams. 3. We suggest that coordination of time of spawning with following temperatures during incubation is necessary for highest survival of the species because a: there is an optimum sequence of temperatures during development of eggs and larvae. Deviations from the normal temperature pattern can cause mortality. b. There is presumably on "best" period of time for the fry to enter saltwater. For fry to migrate to sea during this "best" period eggs must be deposited at a specific time and temperatures during incubation must follow a relatively restricted pattern. c. the normal time of Seward migration (April and May) may be the "best" time because of (1) food availability and (2) saltwater temperatures and salinities or other factors about which very little is known.

118) Sheridan, W.L., M.P. Perensovich, T. Faris, and K. Koski. 1984. Sediment content of streambed gravels in some pink salmon spawning streams in Alaska. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 153-165. (B)

Author abstract: Composition of gravel was measured in selected pink salmon spawning riffles in several streams in southeast Alaska, one stream in Yakutat, and one stream in Prince William Sound, during the period 1963-1971. Over 2,000 streambed samples were analyzed for fine particulate matter. The point measurement, percent < 0.83 mm in diameter, was used throughout. There was good agreement between percent < 0.83 and the "fredle index," and between results of analyzing gravel samples by the volumetric (wet) method and gravimetric (dry) method.

The mean percent particle size < 0.83 mm for 18 streams was 8.9. Separation of streams in logged watersheds from those in unlogged watershed resulted in means of 9.1 percent for streams in logged drainages and 7.1 percent for streams in unlogged watersheds, but tests with a nested Analysis of Variance showed no significant difference in percent fines < 0.83 between six streams in logged watersheds and six streams in unlogged watersheds. Tests for differences between sediment levels sampled during different seasons showed significant differences in some cases, and none in others.

119) Sidle, R.C., and A.J. Campbell. 1983. Suspended sediment regime of Bambi Creek, Chichagof Island, Alaska. Transactions of the American Geophysical Union. 64: 700. (F, G, I)

Electronic abstract: Sedimentation is a major concern to anadromous fish streams because of the potential for reducing oxygen and nutrient transport within stream gravels and forming a barrier to fry emergence. The supply of sediment to forest steams in coastal Alaska is primarily related to the inherent stabilities of landforms and stream channels. Suspended sediment monitoring during the fall storm season at Bambi Creek, a small, second-order stream in the Trap Bay watershed, began in 1980. Over the 3-yr. period from 1980 to 1982, nine storms were sampled including all major storms in 1982. Regression relationships developed for total suspended sediment (TSS) versus discharge for the combined nine storms, indicate that less than 29% of the variation in TSS can be explained by selecting streamflow as the only independent variable. Detailed analysis of sediment data for the five storms sampled in 1982 revealed seasonal and within-storm patterns of transport.

120) Sidle, R.C., and A.J. Campbell. 1985. Patterns of suspended sediment transport in a coastal Alaska stream. Water Resources Bulletin. 21: 909-917. (I)

Electronic abstract: Suspended sediment data from a 154 ha watershed on northeast Chichagof Island, Alaska, were collected over three fall storm seasons from 1980 to 1982. Sediment rating curves for nine pooled storms explained less than 34% of the variation in total suspended solids (TSS). Significantly higher concentrations of suspended sediment occurred during the rising limb of storm hydrographs than for similar flows on the falling limb, accounting for hysteresis loops in TSS versus streamflow plots for individual storms. These hysteresis loops were wider during early season storms, indicating that easily transportable fine sediment may have been flushed from the upper portion of channel banks and from behind large organic debris during early season peak flows. Turbidity correlated well (r=0.94) with TSS for all stormflow data combined. Organic matter constituted an average of 35% of TSS for all water quality samples.

121) Sidle, R.C., and A.M. Milner. 1989. Stream development in Glacier Bay National Park, Alaska, U.S.A. Arctic and Alpine Research. 21: 350-363. (A, F, G)

Electronic abstract: Examines effects of hydraulics, sediment supply, channel condition, and riparian vegetation on stream development over time. Field studies conducted on five streams.

122) Smith, R.D., and J.M. Buffington. 1993. Effects of large woody debris on channel unit distribution in southeast Alaska. In: Proceedings of Watershed '91: A Conference on the Stewardship of Soil, Air, and Water Resources, 16-17 April 1991, Juneau, Alaska. T. Brock, Editor. USDA Forest Service, Alaska Region, R10-MB-217. Pages 43-44. (A, D)

Author abstract: The importance of large woody debris (LWD) in stream channels in forested areas is documented by research conducted over the past several years. As a result, the practice of removing LWD from streams in managed areas has generally been discarded. More information is needed however to refine guidelines, including effective designs for buffer strips for management within riparian zones. Information is also needed to improve guidelines for rehabilitation of streams impacted by outdated management practices. Presumably, the riparian zone must be relied upon to provide the stream channel with a sustained supply of debris necessary for maintenance of channel morphologic characteristics that provide fish habitat. The amounts, sizes, and types of debris required to provide adequate fish habitat are not well known. We are addressing these information needs by conducting studies of the distribution of stream channel units in both undisturbed streams and streams where loading of LWD has been reduced. Channel units are spatial divisions of a stream channel distinguished by local hydraulics and channel morphology and are generally analogous to fish habitat units.

Preliminary results clearly indicate that LWD loading and characteristics are among the most important variables controlling the distribution of channel units, in particular various types of pools.

123) Smith, R.D., R.C. Sidle, and P.E. Porter. 1993. Effects of bedload transport of experimental removal of woody debris from a forest gravel-bed stream. Earth Surface Processes and Landforms. 18: 455-468. (A, D, F, I)

Author abstract: Experimental removal of woody debris from a small, gravel-bed stream in a forested area resulted in a four-fold increase in bedload transport at bankfull discharge. This was caused by increased transportability of sediment previously stored upslope of debris buttresses or in low-energy hydraulic environments related to debris. Bank erosion delivered additional sediment to the channel, and transport energy was increased by an inferred increase in the component of total boundary shear stress affecting grains on the bed. Increased transport following debris removal in May 1987 continued throughout the entire autumn storm season through late November 1987, indicating persistent adjustment of the stream bed and banks despite marked response to earlier flows as large as bankfull. Stream bed adjustments included development of a semi-regular sequence of alternate bars and pools, many of which were spaced independently of former pool locations.

124) Starostka, V.J. 1994. Use of the geographic information system in aquatic habitat management. Northeast Pacific Pink and Chum Salmon Workshop. Pages 171-172. (A)

Electronic abstract: The channel type, an inventory and mapping tool for stream classification based on stream reaches, was incorporated into the geographic information system (GIS) to facilitate manipulation and storage of stream inventory data. The basic component of the channel type is the fluvial process group which describes the interrelationship between runoff, landform relief, geology, and glacial or tidal influences on erosion and depositional processes. Channel type inventories provide key information on fish habitat utilization, habitat capability and enhancement options. Most Tongass National Forest, state, and native corporation streams in Southeast Alaska have been mapped using the channel type method.

125) Stednick, J.D., L.N. Tripp, and R.J. McDonald. 1982. Slash burning effects on soil and water chemistry in southeastern Alaska. Journal of Soil and Water Conservation. 37: 126-128. (I)

Electronic abstract: Timber harvest followed by slash burning in the coastal hemlock-spruce forests of Chicagof Island in southeastern Alaska did not produce significant long-term effects on soil or water resources. A 13 ha site, logged in 1977 and burned in June 1978, was monitored by collecting daily stream water samples from above and below the burn during the snow-free months of 1978 and 1979. Soil samples were also analyzed. Suspended sediment levels were higher in the water below the burn (116.8 mg per liter) than above the burn (35.4 mg per liter). Fourteen of the 16 water quality parameters were not significantly different when above-burn and below-burn sample results were compared. However, total P and K levels were higher in below-burn stream water. In soil samples slash burning produced no significant differences in litter depth, pH, N, P, and Ca levels. However, K and Mg concentrations in the burned soil were about half of the control concentrations.

126) **Still, P.J. 1980. Index of streamflow and water-quality records to September 30, 1978, southeast Alaska. USDI Geological Survey, Anchorage, Alaska, Open-File Report 80-698. 26pp. (G, I)**

Electronic abstract: This report, which is one of a series of reports for Alaska, lists stations in southeast Alaska at which streamflow and water quality data have been collected by the U.S. Geological Survey. Included are a hydrologic subregion map of southeast Alaska and a table listing the types of data collected and periods of record.

127) **Swanson, F.J., M.D. Bryant, G.W. Lienkaemper, and J.R. Sedell. 1984. Organic debris in small streams, Prince of Wales Island, southeast Alaska. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-166. 12pp. (D)**

Author abstract: Quantities of coarse and fine organic debris in streams flowing through areas clearcut before 1975 are 3 and 6 times greater than quantities in streams sampled in old-growth stands in Tongass National Forest, central Prince of Wales Island, southeast Alaska. The concentration of debris in streams of clearcut Sitka spruce-western hemlock forests in southeast Alaska, however, is about half that in streams of clearcut Douglas-fir-western hemlock forests in western Oregon. Management guidelines for maintaining natural debris conditions include minimizing the addition of fresh material to a channel during management activities, leaving natural accumulations of debris, and managing streamside areas for production of a continuous, long-term supply of large debris for channels. Considerations in planning stream cleanup include the length of time the debris has resided in the channel and the stability of debris, which is a function of its size, orientation, and degree of burial and decay.

128) **Swanston, D.N. 1969. Mass wasting in coastal Alaska. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Research Paper PNW-83. 15pp. (K)**

Author abstract: Mass wasting, a dominant form of erosion in coastal Alaska, is common where slopes are oversteepened by glacial erosion, soils are newly developed and shallow, and there is abundant rainfall. Presently, the most practical policy for the forest-land manager is avoidance of susceptible areas during timber harvest. Old debris avalanche and flow scars are visible on aerial photos, but a more accurate identification of these areas can be made from a slope-gradient map, which can be used to (1) delineate potential slide areas, (2) determine percentage of slide-prone ground, and (3) establish cutting patterns causing minimum disturbance.

129) Swanston, D.N. 1974. The forest ecosystem of southeast Alaska. 5. Soil mass movement. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-17. 22pp. (K)

Author abstract: Research in southeast Alaska has identified soil mass movement as the dominant erosion process, with debris avalanches and debris flows the most frequent events on characteristically steep, forested slopes. Periodically high soil water levels and steep slopes are controlling factors. Bedrock structure and the rooting characteristics of trees and other vegetation exert a strong influence on relative stability of individual sites.

Timber harvesting operations have a major impact on initiation and acceleration of these movements. The cutting of timber itself has been directly linked with accelerated mass movements, and the accumulation of debris linked with accelerated mass movements, and the accumulation of debris in gullies and canyons has been identified as a major contributor to the formation of large-scale debris flows or debris torrents. The limited road construction on steeper slopes thus far has had a relatively small impact.

Effective management practices on such terrain consist of identification and avoidance of the most unstable areas and careful control of forest harvesting operations in questionable zones.

130) Swanston, D.N., and R. Erhardt. 1993. Short-term influence of natural landslide-dams on the structure of low-gradient channels: An extended abstract. In: Proceedings of Watershed '91: A Conference on the Stewardship of Soil, Air, and Water Resources, 16-17 April 1991. T. Brock, Editor. USDA Forest Service, Alaska Region, R10-MB-217. Pages 34-38. (A, D, F)

Author abstract: Landslides, one of the principal processes of sediment and large woody debris transport from uplands to anadromous fish streams in southeast Alaska, tend to enter low-gradient channels at nearly right angles. Rapid deceleration from impact of debris with the opposing bank, coupled with a substantial reduction in gradient, causes dewatering and deposition of a debris wedge at and immediately downstream from the point of entry of the landslide. The persistence of the wedge, both as a dam and temporary base-level for the channel, is largely determined by composition of material and the size of flows carried by the channel during storms. Subsequent flows over and around the deposit tend to be sediment poor and energy rich, resulting in more rapid downcutting, increases in downstream channel scour, and the frequent shifting of the channel bed for several hundred meters downstream. In this dynamic environment, the large woody debris piles downstream of the wedge serve as focal points for formation and persistence of habitat elements such as pools, riffles, and side channels. These habitat elements remain viable until occurrence of additional landslides or flood flows with power great enough to remobilize the debris.

131) Swanston, D.N, W.R. Meehan, and J.A. McNutt. 1977. A quantitative geomorphic approach to predicting productivity of pink and chum salmon streams in southeast Alaska. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Research Paper PNW-227. 16pp. (K)

Author abstract: Twenty-one quantitative geomorphic variables, measured from aerial photographs and topographic and geologic maps of 78 watersheds, were tested for significance in differentiating between good and poor producers of pink and chum salmon. A discriminant model was then constructed. Using this model, the decision maker can make a qualititative estimate of potential pink and chum salmon production for any southeast Alaska watershed with minimum field investigation.

132) Swanston, D.N., C.G. Shaw III, W.P. Smith, K.R. Julin, G.A. Cellier, and F.H. Everest. 1996. Scientific information and the Tongass Land Management Plan: Key findings from the scientific literature, species assessments, resource analyses, workshops, and risk assessment panels. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-386. (D, F, I)

Author abstract: This document highlights key items of information obtained from the published literature and from specific assessments, workshops, resource analyses, and various risk assessment panels conducted as part of the Tongass land management planning process. None of this information dictates any particular decision; however, it is important to consider during decision making or when the consequences of any particular decision are evaluated.

133) Thedinga, J.F., M.L. Murphy, J. Heifetz, K.V. Koski, and S.W. Johnson. 1989. Effects of logging on size and age composition of juvenile Coho salmon (*Oncorhynchus kisutch*) and density of presmolts in southeast Alaska streams. Canadian Journal of Fisheries and Aquatic Sciences. 46: 383-391. (C)

Electronic abstract: Short-term effects of logging on age composition and size of juvenile coho salmon (*Oncorhynchus kisutch*) were studied in 18 streams in Southeast Alaska in 1982 and 1983; studies were in old-growth and clear-cut reaches with or without buffer strips. The number of fry (age 0) in summer and winter was proportionately higher in buffered and clear-cut reaches than in old-growth reaches, and all treatments averaged a 20% decrease in fry from summer to winter. Fry length and condition factor were greater for buffered and clear-cut reaches than for old-growth reaches, whereas parr (age 1 and older) size did not differ among treatments. Fry and parr were larger in the southern than in the northern regions and their length and weight were directly related to periphyton biomass and benthos density.

134) Thomas, R.E., J.A. Gharrett, M.G. Carls, S.D. Rice, and A. Moles. 1986. Effects of fluctuating temperature on mortality, stress, and energy reserves of juvenile Coho salmon. Transactions of the American Fisheries Society. 115: 52-59. (J)

Author abstract: The effects of fluctuating diel temperature cycles on survival, growth, plasma cortisol and glucose concentrations, liver weight, and liver glycogen of juvenile coho salmon

(*Oncorhynchus kisutch*) were determined. Temperature cycles (10-13, 9-15, 8-17, and 6.5-20 C) were selected to simulate observed temperatures in clear-cuts of southeastern Alaska. Different levels of feeding, including starvation, were used in each test. LT50s were 28 C for age-0 fish (350 mg) and 26 C for age-II fish (22-g presmolts). Cyclic temperatures for 40 d, averaging 11 C daily, did not influence growth of age-0 fish on any food ration as compared to controls held at a constant 11 C. Plasma cortisol and glucose concentrations were significantly greater in fish maintained for 20 d in the 6.5-20 C cycle, but not different in fish in 10-13 and 9-15 C cycles or a constant 11 C. These elevated concentrations may be indicators of long-term stress. Plasma cortisol concentrations were lower in starved fish than in fed fish at all temperature regimes; however, fluctuating temperature did not enhance starvation effects on cortisol levels. Diel temperature cycles did not affect liver weights or liver glycogen concentrations. It is concluded that temporary high temperatures above lethal limits, even if only for 1-2 h, may be more harmful than long-term fluctuating temperatures.

135) USDA Forest Service, Alaska Region. 2002. A summary of technical considerations to minimize the blockage of fish at culverts on the national forests of Alaska. A supplement to the Alaska Region's June 2, 2002 briefing paper titled Fish Passage on Alaska's National Forests. (K)

Author abstract (Author Introduction): This is a general technical review of the process undertaken by the USDA Forest Service, Region 10 interagency fish passage task force, to address the issue of fish blockage at road crossings. This review will answer the following questions:

1. Why is it important to provide fish passage at road crossings?
2. What is a "blockage" of fish movement at road culverts?
3. How were existing road culverts evaluated to determine if they blocked fish?
4. How are new and reinstalled culverts being designed to ensure fish passage?
5. What additional information is needed to better address fish passage issues?

Providing for fish passage at stream and road intersections is an important consideration when constructing or reconstructing forest roads. Improperly located, installed or maintained stream crossing structures, primarily culverts, can restrict fish movement, thereby adversely affecting fish populations. These structures may present a variety of obstacles to fish migration. The most common obstacles are culvert outlet vertical barriers, debris blockages, and excessive water velocities.

136) Walter, R.A. 1984. A stream ecosystem in an old-growth forest in southeast Alaska. Part II: Structure and dynamics of the periphyton community. In: Fish and Wildlife Relationships in Old-Growth Forests. Proceedings of a symposium, 12-15 April 1982, Juneau, Alaska. W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, Editors. Pages 57-69. (C, E, H)

Author abstract: Average net primary production of periphyton in a small undisturbed stream in southeast Alaska ranged from 1 to 354 mg ash-free dry weight (AFDW).m^{-2}.day^{-1} over a 1 year period. Annual production was 13.2 gAFDW / m^2 for the entire creek. Third-order sections were twice as productive as second-order sections, and the stream / estuary ecotone was more productive than freshwater sections. Primary production was probably limited by light in freshwater and by nutrients or grazing in the stream / estuary ecotone. Weighted mean annual standing crop of chlorophyll *a* for the entire creek was 7.2 mg/m^2. Diatoms dominated volume but not abundance of total algal cells. The filamentous chlorophyte *Ulothrix* dominated production in summer. Many of the dominant species appear to be poorly known or not described. The comparatively high net primary production and unusual species composition of periphyton in Porcupine Creek may be due to the stream's relatively large salmon runs, low gradient, and long intertidal area. If the watershed were logged, nutrients would probably replace light as the factor limiting primary production and standing crop of filamentous chlorophytes could be expected.

137) Wipfli, M.S. 1997. Terrestrial invertebrates as salmonid prey and nitrogen sources in streams: Contrasting old-growth and young-growth riparian forests in southeastern Alaska, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences. 54: 1259-1269. (C)

Author abstract: Terrestrial-derived invertebrate (TI) inputs into streams and predation on them by salmonids (40.180 mm fork length) were measured in six coastal Alaska stream reaches from April through October 1993.1994; riparian habitat of three stream reaches contained conifer-dominated old-growth (no timber harvesting) and three were alder-dominated young-growth (31 years postclearcutting). Data from pan-traps placed on stream surfaces showed that TI biomass and nitrogen inputs averaged up to 66 and 6 mg$\times$m$^{-2}\times$day^{-1}, respectively, with no significant difference between habitats. Stomach contents from coho salmon (*Oncorhynchus kisutch*), cutthroat trout (*O. clarki*), and Dolly Varden (*Salvelinus malma*) revealed that TI and aquatic-derived invertebrates (AI) were equally important prey. Additionally, salmonids from young-growth systems ingested a greater TI proportion than those from old-growth systems. There were trends but no significant differences between habitats of TI and AI biomass ingested; however, statistical power was <0.30. These results showed that TI were important juvenile salmonid prey and that a riparian overstory with more alder and denser shrub understory may increase their abundance. Riparian vegetation management will likely have important consequences on trophic levels supporting predators, including but not limited to fishes.

138) Wipfli, M.S., and D.P. Gregovich. 2002. Export of invertebrates and detritus from fishless headwater streams in southeastern Alaska: Implications for downstream salmonid production. Freshwater Biology. 47: 957-969. (C)

Author abstract: 1. We examined the export of invertebrates (aquatic and terrestrial) and coarse organic detritus from forested headwaters to aquatic habitats downstream in the coastal mountains of southeast Alaska, U.S.A. Fifty-two small streams (mean discharge range: 1.2-3.6 L S-I), representing a geographic range throughout southeast Alaska, were sampled with 250-µm nets either seasonally (April, July, September) or every 2 weeks throughout the year. Samples were used to assess the potential subsidy of energy from fishless headwaters to downstream systems containing fish.

2. Invertebrates of aquatic and terrestrial origin were both captured, with aquatic taxa making up 65-92% of the total. Baetidae, Chironomidae and Ostracoda were most numerous of the aquatic taxa (34, 16 and 8%, respectively), although Coleoptera (mostly Amphizoidae) contributed the

greatest biomass (30%). Mites (Acarina) were the most numerous terrestrial taxon, while terrestrial Coleoptera accounted for most of the terrestrial invertebrate biomass.
3. Invertebrates and detritus were exported from headwaters throughout the year, averaging 163 mg invertebrate dry mass $stream^{-1}$ day^{-1} and 10.4 g detritus $stream^{-1}$ day^{-1}, respectively. The amount of export was highly variable among streams and seasons (5-6000 individuals $stream^{-1}$ day^{-1} and <1-22 individuals m^{-3} water; <1-286 g detritus $stream^{-1}$ day^{-1} and <0.1-1.7 g detritus m^{-3} water). Delivery of invertebrates from headwaters to habitats with fish was estimated at 0.44 g dry mass m^{-2} $year^{-1}$. We estimate that every kilometre of salmonid-bearing stream could receive enough energy (prey and detritus) from fishless headwaters to support 100-2000 young-of-the-year (YOY) salmonids. These results illustrate that headwaters are source areas of aquatic and terrestrial invertebrates and detritus, linking upland ecosystems with habitats lower in the catchment.

139) Wipfli, M.S., and J. Musslewhite. 2004. Density of red alder (*Alnus rubra*) in headwaters influences invertebrate and detritus subsidies to downstream fish habitats in Alaska. Hydrobiologia. 520: 153-163. (C)

Author abstract: We investigated the influence of red alder (*Alnus rubra*) stand density in upland, riparian forest on invertebrate and detritus transport from fishless headwater streams to downstream, salmonid habitats in southeastern Alaska. Red alder commonly regenerates after soil disturbance (such as from natural landsliding or timber harvesting), and is common along streams in varying densities, but its effect on food delivery from headwater channels to downstream salmonid habitats is not clear. Fluvial transport of invertebrates and detritus was measured at 13 sites in spring, summer, and fall during two years (2000-2001). The 13 streams encompassed a riparian red alder density gradient (1-82% canopy cover or 0-53% basal area) growing amongst young-growth conifer (45-yr-old stands that regenerated after forest clearcutting). Sites with more riparian red alder exported significantly more invertebrates than did sites with little alder (mean range across 1-82% alder gradient was about 1-4 invertebrates m^{-3} water and 0.1-1 mg invertebrates m^{-3} water, respectively). Three-quarters of the invertebrates were of aquatic origin: the remainder was of terrestrial origin. Aquatic taxa were positively related to the alder density gradient, while streams with less alder (mean range across 1-82% alders gradient was 0.01-0.06g detritus m^{-3} water). Based on these data, we predict that headwater streams with more riparian alder will provide more invertebrates and support more downstream fish biomass than those basins with little or no riparian alder, provided these downstream food webs utilize this resource subsidy.

140) Wipfli, M.S., J. Hudson, and J. Caouette. 1998. Influence of salmon carcasses on stream productivity: Response of biofilm and benthic macroinvertebrates in southeastern Alaska, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences. 55: 1503-1511. (C, E)

Author abstract: This study was conducted to determine if salmon carcasses (from spawning adults) increased stream biofilm ash-free dry mass (AFDM) and benthic macroinvertebrate abundance in southeastern Alaska, U.S.A. Thirty-six once-through artificial streams were situated along, and received water and drifting invertebrates from, a natural stream. Two treatments (salmon carcass, control) were sampled six times during a 3-month period in a randomized incomplete block design with a 2 x 6 factorial treatment structure. Additionally, two natural stream sites were sampled once for biofilm and macroinvertebrates, one site receiving 75 000 adult salmon migrants during 1996 and the other upstream of spawning salmon. While biofilm AFDM was 15 times higher in carcass-enriched reaches of Margaret Creek, there were no detectable treatment differences in the artificial streams. Total macroinvertebrate densities were up to eight and 25 times higher in carcass-enriched areas of artificial and natural streams, respectively; Chironomidae midges, Baetis and Cinygmula mayflies, and Zapada stoneflies were the most abundant taxa. The increased biofilm in Margaret Creek and macroinvertebrate abundance in both systems suggests that salmon carcasses elevated freshwater productivity. This marine-based positive feedback mechanism may be crucial for sustaining aquatic-riparian ecosystem productivity and long-term salmonid population levels.

141) Wipfli, M.S., J.P. Hudson, D.T. Chaloner, and J.P. Caouette. 1999. Influence of salmon spawner densities on stream productivity in southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 56: 1600-1611. (C, E)

Author abstract: We conducted this study to determine the relationship between salmon spawner abundance and stream biofilm and benthic macroinvertebrate abundance in Southeast Alaska. Experiments took place in outdoor artificial and natural streams. Six pink salmon (*Oncorhynchus gorbuscha*) carcass treatments (0.00, 1.45, 2.90, 4.35, 5.80, and 7.25 kg wet mass) placed in artificial channels were subsampled repeatedly for biofilm ash-free dry mass (AFDM), chlorophyll *a*, and macroinvertebrates. In a small (nonanadromous) forest stream, we sampled benthos throughout a 66-m reach 17 days after distributing 60 carcasses along the lower half of that reach. All response variables significantly increased in response to carcass additions in both artificial and natural streams. Chlorophyll *a* continued to increase across all loading rates, while AFDM and total macroinvertebrate densities showed no further response to loading beyond the first treatment (1.45 kg) in artificial streams. In the natural stream, AFDM and chironomid densities continued increasing across loading levels. These results indicated that increased spawner densities increased lower trophic level abundance until a trophic capacity was reached. Salmon escapement goals should consider food web effects, especially on trophic levels that support juvenile salmonids, that ultimately affect freshwater salmon production.

142) Wipfli, M.S., R.L. Deal, P.E. Hennon, A.C. Johnson, T.L. De Santo, T.A. Hanley, M.E. Schultz, M.D. Bryant, R.T. Edwards, E.H. Orlikowska, and T. Gomi. 2002. Managing young upland forests in southeast Alaska for wood products, wildlife, aquatic resources, and fishes: Problem analysis and study plan. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-558. 64pp. (C, E)

Author abstract: Red alder (*Alnus rubra* Bong.) appears to influence the productivity of young-growth conifer forest and affect the major resources (timber, wildlife, and fisheries) of forested ecosystems in southeast Alaska. We propose an integrated approach to understanding how alder influences trophic links and processes in young-growth ecosystems. The presence of red alder is expected to increase understory biomass, and aquatic, riparian, and terrestrial invertebrate abundance, providing more food for herbivores, fish, and birds. We predict that most red alder trees will die standing, and woody debris will be small and mobile in streams. Nitrogen fixation by red alder in mixed stands may result in larger, more commercially valuable conifers. Inclusion of red alder in the regenerating stand may therefore mitigate some negative impacts of clearcutting, and may increase total wood production form the landscape.

143) Wood-Smith, R.D., and J.M. Buffington. 1996. Multivariate geomorphic analysis of forest streams: Implications for assessment of land use impacts on channel condition. Earth Surface Processes and Landforms. 21: 377-393. (A, D)

Author abstract: Multivariate statistical analyses of geomorphic variables from 23 forest stream reaches in southeast Alaska result in successful discrimination between pristine streams and those disturbed by land management, specifically timber harvesting and associated road building. Results of discriminant function analysis indicate that a three-variable model discriminates 10 disturbed from 13 undisturbed reaches with 90 per cent and 92 per cent correct classification respectively. These variables are the total number of pools per reach, the ratio of mean residual pool depth to mean bankfull depth, and the ratio of critical shear stress of the median surface grain size to bankfull shear stress. The last variable can be dropped without a decrease in rate of correct classification; however, the resulting two-variable model may be less robust. Analysis of the distribution of channel units, including pool types, can also be used to discriminate disturbed from undisturbed reaches and is particularly useful for assessment of aquatic habitat condition. However, channel unit classification and inventory can be subject to considerable error and observer bias. Abundance of pool-related large woody debris is highly correlated with pool frequency and is an important factor determining channel morphology. Results of this study yield a much needed, objective, geomorphic discrimination of pristine and disturbed channel conditions, providing a reference standard for channel assessment and restoration efforts.

144) Ziemer, R.R., and D.N. Swanston. 1977. Root strength changes after logging in southeast Alaska. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Research Note PNW-306. 10pp. (K)

Author abstract: A crucial factor in the stability of steep forested slopes is the role of plant roots in maintaining the shear strength of soil mantles. Roots add strength to the soil by vertically anchoring through the soil mass into failures in the bedrock and by laterally tying the slope together across zones of weakness or instability. Once the covering vegetation is removed, these roots deteriorate and much of the soil strength is lost.

Measurements of change in strength of roots remaining in the soil after logging at Staney Creek on Prince of Wales Island, southeast Alaska, indicate that loss of strength in smaller roots occurs rapidly for all species the first 2 years. Western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) roots are more resistant to loss of strength than are Sitka spruce *(Picea sitchensis* (Bong.) Carr.) roots. By 10 years, even the largest roots have lost appreciable strength.