Alaska—General

(State-Wide References and References in Which the Location of the Study Area Was Not Identified)

224) Arians, A. (Compiler). 2003. Summary of monitoring studies of the effectiveness of practices under the Alaska Forest Resources and Practices Act: 1990-2002. Grant NA17OZ1113 report written by the Alaska Department of Natural Resources, Division of Forestry, Anchorage, Alaska. Written for the Alaska Coastal Management Program, Office of the Governor. 29pp. (A, B, C, D, E, F, G, H, I, J)

Compiler abstract: This document provides summaries of effectiveness monitoring studies conducted with respect to activities performed under the current Alaska Forest Resources and Practices Act (FRPA). The document is divided into two broad categories—fish habitat and water quality. Within each of those two categories, project summaries are organized by FRPA Regions I, II, and III. A total of 28 projects are described; sixteen projects address fish habitat issues, and 12 projects address water quality issues. Eighteen of the projects were conducted within FRPA Region I (coastal Sitka spruce/hemlock forest), three projects were conducted within FRPA Region II (interior spruce/hardwood forest, south of the Alaska Range), and seven projects were conducted within FRPA Region III (interior spruce hardwood forest, north and west of the Alaska Range). Topics addressed by the summarized projects include all ten of the fish habitat and water quality variables protected by FRPA—channel morphology, clean spawning gravels, food sources, large woody debris, nutrient cycling, stream bank stability, stream flow, sunlight, water quality, and water temperature.

225) Ashton, W.S., and R.F. Carlson. 1984. Determination of seasonal, frequency and durational aspects of streamflow with regard to fish passage through roadway drainage structures. Final Report No. AK-RD-85-06 written by the Institute of Water Resources, University of Alaska, Fairbanks. Written for the Alaska Department of Transportation and Public Facilities, Division of Planning and Programming, Research Section, Fairbanks, Alaska. 51pp. (G)

Author abstract: Optimal design of culverts for fish passage for each stream crossing requires the magnitude, duration, frequency and seasonal relationship of the flow and the timing of fish movement. Although previous studies have measured fish swimming abilities and culvert water velocity profiles, there are limited studies in northern regions of the hydrologic relationship among magnitude, duration, frequency and season of discharge for the design of culverts for fish passage. We analyzed streamflow records from 33 gaging stations in southcentral, western, interior, and arctic Alaska (from watersheds with a drainage area less than 100 mi^2 each) to determine the highest consecutive mean discharge with one-, three-, seven- and fifteen-day durations, and the lowest consecutive mean discharge with three-, seven-, fourteen- and thirty-day durations. Streamflow during three seasons were analyzed: spring, April 1 to June 30; summer, July 1 to August 31; and fall, September 1 to November 30. The lognormal distribution, using the Blom plotting position formula, was used to estimate flows at recurrence intervals of 1.25, 2, 5, 10 and 20 years. Multiple linear regression equations were developed to predict flows from ungaged watersheds. Significant basin and climatic characteristics for high flows were drainage area, mean annual precipitation and percent of the drainage basin with forest cover.

Significant characteristics at low flows were drainage area, mean minimum January temperature, mean annual precipitation and percent of drainage basin covered by forests. This report provides the culvert designer with equations to predict flows, other than the instantaneous peak flows, for use in designing culverts for fish passage. Two example problems are given to show the application of these equations.

226) Balding, G.O. 1976. Water availability, quality, and use in Alaska. USDI Geological Survey Anchorage, Alaska, Open-File Report 76-513. 236pp. (G, I)

Electronic abstract: The Alaska Water Assessment, sponsored by the Water Resources Council, is a specific problem analysis for Alaska of the National Assessment of Water and Related Land Resources. The Alaska region has been divided into six hydrologic subregions and eighteen subareas. For each subarea, estimated mean annual runoff per square mile, suspended-sediment concentrations that can be expected during 'normal' summer runoff, flood magnitudes and frequencies, and ground-water yields are illustrated on maps. Tables show water quality of both ground water and surface water from selected wells and streams. Water use according to the type of use is discussed, and estimates are given for the amounts used. Water-use categories include domestic, irrigation, livestock, seafood processing, oil and gas development, petrochemical processing, pulp mills, hydroelectric, coal processing, steam electric, mineral processing, sand and gravel mining, and fish-hatchery operations.

227) Bauer, S.B., and S.C. Ralph. 1999. Aquatic habitat indicators and their application to water quality objectives within the Clean Water Act. US Environmental Protection Agency, Region 10, Seattle, Washington, EPA-910-R-99-014. (A, B, F, G, J)

Electronic abstract: The objective of this paper is to evaluate the application of aquatic habitat variables to water quality objectives under authority of the Clean Water Act (CWA). The project is limited to freshwater, lotic aquatic habitats in the Pacific Northwest and Alaska with an emphasis on salmonid habitat. Habitat variables were placed into one of the following categories- flow regime, habitat space, channel structure, substrate quality, streambank condition, riparian condition, temperature regime, and habitat access. Candidate habitat variables were evaluated for their relevance to the biotic community, responsiveness to human impacts, applications to target landscapes, and measurement reliability. The most critical obstacles for use of habitat variables at the regional level (state specific water quality criteria for Region 10 EPA) are the quantification of biological effect and the unreliability of the unreliability of the measurement system.

228) Behlke, C.E., D.L. Kane, R.F. McLean, and M.D. Travis. 1991. Fundamentals of culvert design for passage of weak-swimming fish. Final Report No. FHWA-AK-RD-90-10 written by the Water Research Center, Institute of Northern Engineering, University of Alaska; the Alaska Department of Fish and Game, Habitat Division; and the Alaska Department of Transportation and Public Facilities, Statewide Research, Fairbanks, Alaska. Written for the Alaska Department of Transportation and Public Facilities, Statewide Research, Fairbanks, Alaska. 177pp. (K)

Author abstract: Properly designed culverts do not produce water velocities that exceed fish swimming abilities. Fish have two different musculature systems for swimming. A white muscle system that generates power for short, vigorous swimming. A red muscle system that furnished power for long, sustained swimming. The culvert design must account for both swimming modes. Therefore, the engineer must know the hydraulic conditions where the fish swims. These conditions change throughout the culvert. The engineer determines acceptable hydraulic conditions by matching known fish swimming power and energy capabilities.

Subcritical flow is necessary to pass week-swimming, upstream-migrating fish. Therefore, this requirement precludes the use of inlet control. The engineer may use artificial roughness to create areas of slower water velocities within culverts. Examples of these are depressed inverts, weir baffles, and deep culvert corrugations.

This manual presents design procedures to pass upstream-migrating, weak-swimming fish. The manual also displays criteria for retrofitting existing culverts. This paper does not present cost-effective design criteria for strong-swimming fish.

229) Benson S.L., D.L. Hess, D.F. Meyer, K.A. Peck, and W.C. Swanner. 1997. Water resources data for Alaska, water year 1997. USDI Geological Survey, Water Resources Division, Juneau, Alaska, USGS/WRD/AK-97/1. (G, I)

Electronic abstract: This volume contains records for water discharge at 81 gauging stations; stage or contents only at 8 gauging stations; water quality at 21 gauging stations; and water levels for 60 observation wells. Also included are data for 51 crest-stage partial-record stations and 1 lake. Additional water data were collected at various sites not involved in the systematic data- collection program and is published as miscellaneous measurements and analyses.

230) Bigelow, B.B., R.D. Lamke, P.J. Still, J.L. Van Mannen, and J.E. Vaill. 1985. Water resources data for Alaska, water year 1984. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-84-1 (WRD/HD-85/264). 347pp. (G, I)

Electronic abstract: Water resources data for the 1984 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells. This report contains discharge records for 112 gaging stations; water quality for 43 stations; and water levels for 31 observation wells. Also included are 64 crest-stage, and 59 water quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

231) Bigelow, B.B., R.D. Lamke, P.J Still, J.L. Van Mannen, and J.E. Vaill. 1986. Water resources data for Alaska, water year 1985. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-85-1 (WRD/HD-86/252). 328pp. (G, I)

Electronic abstract: Water resources data for the 1985 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells. This report contains discharge records for 108 gauging stations; water quality for 40 stations; and water levels for 31 observation wells. Also included are 66 crest-stage, 15 low-flow, and 19 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

232) **Bigelow, B.B., R.D. Lamke, P.J. Still, J.L. Van Mannen, and R.L. Burrows. 1989. Water resources data for Alaska, water year 1988. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-88-1 (WRD/HD-89/231). 196pp.** **(G, I)**

Electronic abstract: Water resources data for the 1988 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 85 gaging stations; water quality at 24 gaging stations, and water levels for 26 observation wells. Also included are data for 66 crest-stage partial-record stations and 13 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and is published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

233) **Blevins, V., and R.F. Carlson. 1988. Retrofit design of drainage structures for improved fish passage: Literature review. Report No. AK-RD-89-02 written by the Water Research Center, Institute of Northern Engineering, University of Alaska, Fairbanks. Written for the Alaska Department of Transportation and Public Facilities, Research Section, Fairbanks, Alaska. 38pp.** **(K)**

Author abstract: This report reviews existing literature on issues relevant to retrofitting culverts to mitigate fish passage barriers. The analysis of this information will set the stage for future laboratory experimentation on various retrofitting techniques. The topics in this report include a review of fish swimming capabilities, hydrologic factors involved in choosing a design flow, fish passage problems resulting from conventional culvert design, and potential retrofit solutions to these problems.

234) **Brabets, T.P. 1996. Evaluation of the streamflow-gaging network of Alaska in providing regional streamflow information. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Resources Investigations Report 96-4001. 73pp.** **(G)**

Electronic abstract: In 1906, the U.S. Geological Survey (USGS) began operating a network of streamflow-gaging stations in Alaska. The primary purpose of the streamflow-gaging network has been to provide peak flow, average flow, and low-flow characteristics to a variety of users. In 1993, the USGS began a study to evaluate the current network of 78 stations. The objectives of this study were to determine the adequacy of the existing network in predicting selected regional flow characteristics and to determine if providing additional streamflow-gaging stations could improve the network's ability to predict these characteristics. Alaska was divided into six distinct hydrologic regions: Arctic, Northwest, Southcentral, Southeast, Southwest, and Yukon. For each region, historical and current streamflow data were compiled. In Arctic, Northwest, and Southwest Alaska, insufficient data were available to develop regional regression equations. In these areas, proposed locations of streamflow-gaging stations were selected by using clustering techniques to define similar areas within a region and by spatial visual analysis using the precipitation, physiographic, and hydrologic unit maps of Alaska. Sufficient data existed in Southcentral and Southeast Alaska to use generalized least squares (GLS) procedures to develop regional regression equations to estimate the 50-year peak flow, annual average flow, and a low-flow statistic. GLS procedures were also used for Yukon Alaska but the results should be used with caution because the data do not have an adequate spatial distribution. Network analysis procedures were used for the Southcentral, Southeast, and Yukon regions. Network analysis indicates the reduction in the sampling error of the regional regression equation that can be obtained given different scenarios. For Alaska, a 10-year planning period was used. One scenario showed the results of continuing the current network with no additional gaging stations and another scenario showed the results of adding gaging stations to the network. With the exception of the annual average discharge equation for Southeast Alaska, by adding gaging stations in all three regions, the sampling error was reduced to a greater extent than by not adding gaging stations. The proposed streamflow-gaging network for Alaska consists of 308 gaging stations, of which 32 are designated as index stations. If the proposed network can not be implemented in it's entirely, then a lesser cost alternative would be to establish the index stations and to implement the network for a particular region.

235) Childers, J.M. 1975. Channel erosion surveys along southern segment of the TAPS route, Alaska, 1972 and 1973. USDI Geological Survey, Anchorage, Alaska, Open-File Report. 57pp. (A, F)

Author abstract: This report presents descriptions of preconstruction conditions at selected stream-channel sites along the southern segment of the Trans-Alaska Pipeline System from Flood Creek to Valdez. The information presented can be used in studies of severe channel erosion, streambed scour, bank erosion, or rechannelization. The report also presents a plan for detecting and measuring significant erosion and the important factors causing erosion, such as flood discharge, icing development, and construction activities.

236) Childers, J.M., J.W. Nauman, D.R. Kernodle, and P.F. Doyle. 1977. Water resources along the Taps Route, Alaska, 1970-74. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Open-File Report 78-137. 136pp. (G, I)

Electronic abstract: The U.S. Geological Survey installed 10 streamgaging and water-quality stations along the trans-Alaska pipeline route (TAPS) starting in 1970. These stations, mostly north of Fairbanks, add to the historical network of gaging stations and provide records of hydrologic conditions along the TAPS route. Selected data from 23 gaging stations along the TAPS route for the period 1970-74 (prior to construction of the pipeline) are compiled in graphic form. The data include annual hydrographs of daily mean or instantaneous values of a standard set of parameters which are indicative of physical, chemical and biological conditions of the streams. The hydrographs facilitate comparisons of data, both in time and between stream sites. Thus, they are a tool for evaluating streamflow characteristics along the TAPS route during the preconstruction period.

237) Dingman, S.L. 1973. The water balance in arctic and subarctic regions--annotated bibliography and preliminary assessment. US Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Special Report 187. 131pp. (G)

Electronic abstract: Definitions and boundaries of the arctic and subarctic are reviewed; a map showing these boundaries and annotations of a number of publications dealing with this problem are also presented. A bibliography includes several hundred reports that directly discuss elements of the water balance in arctic and subarctic regions. These annotations are grouped by geographic area: the northern hemisphere, Europe, the U.S.S.R., Alaska, Canada, and Greenland and Iceland. For each area, annotations are presented according to water-balance elements: precipitation, evapotranspiration, runoff, streamflow, groundwater contributions to runoff, and changes in glacial storage. A subsequent section gives annotations of articles on the water balance of the Arctic Ocean. This is followed by a brief assessment of the state of knowledge on the water-balance elements in each geographic region. This bibliography is intended to be complete for the period 1950-1971 (some earlier articles are included), especially for articles published in English. A large number of items from the Russian and European literature are included, but the bibliography is probably less complete for these. A total of 688 annotations are included; many articles are annotated in more than one section, as they include information on more than one water-balance element or more than one geographic area.

238) Dion, C.A. 2002. Growth, foraging behavior and distribution of age-0 Arctic grayling in an Alaskan stream. M.S. Thesis, University of Alaska, Fairbanks. 81pp. (C, J)

Author abstract: I evaluated the ability of three models to relate habitat characteristics to habitat quality for age-0 Arctic grayling *Thymallus arcticus* in an Alaskan stream. A temperature-based growth model made accurate predictions, showing it can reliably assess thermal habitat quality. Deviations between predicted and observed growth were useful because they identified the timing of possible critical periods, when competition for food or space may cause density-dependent mortality and emigration. A foraging model consistently overestimated the mean prey size of fish, showing that such models need further work before they can accurately assess food availability from invertebrate drift. A habitat selection model accurately predicted small fish would occupy the stream margins and the ontogenetic shift into faster, deeper water, but its detailed predictions for larger fish were not very precise. These models were useful tools for assessing habitat quality and gave insight into possible interactions between habitat characteristics and population dynamics.

239) Doyle, P.F., and J.M. Childers. 1975. Channel erosion surveys along TAPS route, Alaska, 1975. USDI Geological Survey, Anchorage, Alaska, Open-File Report. 95pp. (A, F)

Author abstract: Channel surveys at 27 sites along TAPS route during 1975 documented significant channel changes and identified possible causative factors. Some of the important findings of the year's surveillance include: 8 feet (2.4 metres) of flood scour measured at the Salcha River crossing site, 180 feet (55 metres) of lateral bank erosion measured over 3 years on the Middle Fork Koyukuk River near Coldfoot, and rapid shifting of anabranches on braided stream crossings during high water.

Aerial photogrammetric surveys were used for the first time during 1975. Preliminary results show this method is especially suited for surveillance of large braided river channels.

240) Doyle, P.F., and J.M. Childers. 1976. Channel erosion surveys along TAPS route, Alaska, 1976. USDI Geological Survey, Anchorage, Alaska, Open-File Report. 90pp. (A, F)

Author abstract: Channel surveys were made along TAPS route during 1976 at the same 27 sites that were surveyed in 1975. One additional site was put under surveillance in 1976. Except for construction changes wrought by installation of the pipeline, most of the sites surveyed showed very little change since the 1975 surveys. Some of the significant events of 1976 at the monitored crossing sites include: glacier-dammed lake break-out floods on the Tazlina and Tsina Rivers, severe icings on the Gulkana River which resulted in a spring flood 3-4 feet (1 meter) over banktop, and virtual completion of all the buried crossings and all but one overhead crossing before the 1976 channel erosion resurveys were made.

Aerial photogrammetric surveys were used again in 1976 on the same seven sites as in 1975. Comparison of the photogrammetric surveys with each other and with on-the-ground surveys indicate that the method is generally applicable for channel erosion studies. However, it requires engineering judgment and personal knowledge of the site to avoid reaching inaccurate conclusions about channel change in some instances.

241) Edmundson, J.A. 1997. Growth patterns of juvenile sockeye salmon in different thermal environments of Alaskan lakes. M.S. Thesis, University of Alaska, Fairbanks. 79pp. (J)

Author abstract: Rearing conditions imposed on juvenile salmonids in lakes are important determinants of freshwater growth patterns. In Alaska, sockeye salmon (*Oncorhynchus nerka*) nursery lakes exhibit a wide range in thermal characteristics. Compared to clear lakes, stained lakes are warmer and have longer growing seasons, whereas glacial lakes are colder and have shorter growing seasons. In stained lakes, a shallow thermocline restricts most of the heat to the surface layers. Deep mixing in glacial lakes, concomitant with meltwater intrusion, keep much of the water column near 4 ^{o}C. Mean depth accounts for 77% of the among-lake variation in the seasonal average water temperature (*TS*). Length of growing season is dependent on latitude and altitude; however, water temperature is not. Taken together, the factors *TS,* zooplankton biomass, and sockeye fry density accounted for 70% of the variation in age-1 sockeye smolt size. This limnological information can be included in stock-recruit models of sockeye salmon to improve assessments for management.

242) Elliot, S.T., and D.J. Hubartt. 1984. A study of land use activities and their relationship to the sport fish resources in Alaska. Annual performance report for: Establishment of guidelines for protection of the sport fish resources during land use activities. Federal Aid in Fish Restoration and Anadromous Fish Studies, Volume 25, Study No. D-I, Job No. D-I-A&B. Alaska Department of Fish and Game, Sport Fish Division, Juneau, Alaska. 17pp. (K)

Author abstract: The winter survival of rearing salmonids is considered by managers to be the most important aspect of the influence of timber harvest on salmonid production. The Alaska Working Group on Cooperative Fishery-Forestry Research, of which this project is a member, initiated a study to compare winter survival and movement of rearing fish in clear-cut and forested sections of streams and clear-cut and buffer zone sections of streams. The study also examined the value of ponds and sloughs as "refuge habitat" during the winter months and will attempt to determine the rate of smoltification of juveniles from these areas.

Movement of juveniles occurred mostly between August and November with most of the movement being local, e.g., immediately upstream or downstream. However, juvenile coho (*Oncorhynchus kisutch*) living in the estuarine zone move upstream and disperse throughout the watershed. Rates of survival were highest (73% - 100%) for fish living in old growth forested stream sections and for fish wintering in sloughs and ponds. The survival rate of fish wintering in clear-cuts was the poorest (29% - 70%) and intermediate in buffer zones (40% - 86%).

The issue concerning the fate of coho fry in logged streams (Elliott, 1983) cannot be addressed until smolt work is completed in June 1984. Those results will be included in future reports.

* This report is numbered for the sake of consistency, however, this project received no federal dollars this year.

The results of this study are preliminary, pending further analysis.

243) Emmett, W.W. 1972. The hydraulic geometry of some Alaskan streams south of the Yukon River. USDI Geological Survey, Water Resources Division, Alaska District, Open-File Report. 102pp. (A, G)

Author abstract: Channel geometry surveys were conducted to determine bankfull stage, discharge, and other hydraulic parameters at 22 locations along the proposed route of the trans-Alaska pipeline corridor south of the Yukon river. Combined with the records from gaging stations located at some of the sites, the data are sufficient to describe some of the channel and flow characteristics typical of each of two major hydrologic areas, the Yukon river Region and the South-Central region. Although each region follows general hydrologic trends, least squares relations indicate each exhibits its own particular deviations.

Average values of the hydraulic and geometric properties of rivers were used to illustrate their application to practical engineering problems, namely the computation of depth of channel scour and of bedload discharge. For design purposes, caution is recommended when making computations based on average values. In the absence of other data, however, the average data become useful predictive tools.

244) Everest, F.H., and R.D. Harr. 1982. Silvicultural treatments. In: Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America. W.R. Meehan, Editor. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-134. Pages 1-18. (I, J)

Electronic abstract: Distribution of anadromous salmonids and coniferous forest coincides along much of the Pacific Slope; consequently, the habitat of anadromous fish is subject to a wide variety of silvicultural treatments required to establish and nurture young forests. The silvicultural activities include: cutting prescriptions to improve natural regeneration; preparing sites for planting; removing slash to reduce fire hazard; seeding and planting; reducing competition to enhance growth of young trees. Anadromous salmonids have exacting habitat requirements and most production in forested watersheds occurs in small (first-order to third order) streams. Some silvicultural treatments, such as broadcast burning and machine scarification and piling, can degrade water quality and fish habitat in small streams, but seldom do so because of the low spatial and temporal intensity of the activities. The highest risk of habitat damage from silvicultural activities occurs in areas with erosive soils and high annual precipitation, or high summer solar radiation and low streamflow. Maximum risk from solar heating occurs in western and northeast Oregon, western and central Washington, northwest California, and central Idaho. High-risk areas for decreased water temperatures are located in northern and central Idaho, northeastern Oregon, southeastern Washington, northern British Columbia, and Alaska. Areas of central Idaho; northwest California; western Oregon, Washington, and British Columbia; and southeast Alaska are vulnerable to surface erosion and mass wasting.

245) Everest, F.H., and W.R. Meehan. 1981. Forest management and anadromous fish habitat productivity. In: Transactions of the Forty-Sixth North American Wildlife and Natural Resources Conference. K. Sabol, Editor. Wildlife Management Institute, Washington, D.C. Pages 521-530. (A, D, F, I)

Electronic abstract: The anadromous fishery resources of western North America are produced largely within forested watersheds. Forest and rangeland management activities that can influence the quality of anadromous fish habitat include timber harvest, road construction, and livestock grazing. Organic debris from forested watersheds of the Pacific Northwest and Alaska enters streams through direct litterfall, landslides, debris torrents, timber felling, and streambank erosion, plus blowdown of trees and branches. Large woody debris can create habitat for rearing salmonids, but may cause sedimentation in spawning areas. Large, naturally occurring debris can promote streambank stability and reduce streambed scour. Large accumulations of fine organic debris can adversely affect habitat by reducing dissolved oxygen and producing toxic leachates. Total removal of debris can result in a completely open channel, promoting streambed sour, streambank instability, and loss of fish habitat productivity. Debris torrents, a common mass erosion event in the Pacific Northwest, have a negative impact on habitat and production of anadromous salmonids in small streams immediately downstream from the torrent egress. Studies within a 1-mile reach of Knowles Creek, however, indicate that the total effect of debris torrents in that sediment-poor watershed tends to be positive. Preliminary results of a livestock

grazing study do not show profound effects on fish populations among various grazing systems or between one to three years of season-long grazing and ungrazed controls.

246) Helfield, J.M. 2002. Interactions of salmon, bear and riparian vegetation in Alaska. Dissertation abstracts International Part B: Science and Engineering 62: 5493. (C, D, E, I)

Electronic abstract. Anadromous Pacific salmon (*Oncorhynchus spp*.) spend most of their lives feeding and growing at sea before returning to freshwater to spawn and die in their natal streams. Returning salmon provide a seasonal food source for numerous mammal and bird species, and nutrients from decaying salmon carcasses are incorporated into freshwater biota at various trophic levels. Consequently, annual spawning migrations provide a mechanism for transporting marine-derived nutrients from the fertile northern Pacific Ocean to freshwater and terrestrial ecosystems. Riparian trees and shrubs near spawning streams derive approximately 22-26% of their foliar nitrogen (N) from spawning salmon, and growth rates of Sitka spruce (*Picea sitchensis*) and white spruce (*P. glauca*) are significantly increased as a consequence of this nutrient subsidy. Marine-derived nitrogen (MDN) is less important to riparian ecosystems where symbiotic N-fixation by alder (*Alnus crispa*) is prevalent, although salmon carcasses may be an important source of other marine nutrients affecting productivity in these forests. Since riparian forests affect the quality of instream habitat through shading, sediment and nutrient filtration and production of large woody debris, this fertilization process serves not only to enhance riparian production, but may also act as a positive feedback mechanism by which salmon-borne nutrients improve spawning and rearing habitat for subsequent salmon generations. Brown bear (*Ursus arctos*) are an important vector for transferring marine nutrients to riparian forests, through dissemination of partially- eaten salmon carcasses and salmon-enriched wastes. To the extent that this process affects productivity and species composition in riparian forests, interactions of salmon and bear may be characterized as keystone interactions controlling the long-term structure and dynamics of riparian communities. It should be recognized that marine nutrients may also be transferred to riparian systems via other terrestrial piscivores and abiotic processes, and that the relative importance of these different pathways varies spatially and temporally within and among salmon- bearing watersheds. Accordingly, it may be more meaningful to consider the interactions and processes that structure riparian communities rather than their specific component parts. These findings illustrate the complexity of interactions surrounding riparian ecosystems, the importance of linkages across ecosystem boundaries, and the interdependence of salmon populations, terrestrial wildlife and riparian vegetation.

247) Jordan, M.C., and R.F. Carlson. 1987. Design of depressed invert culverts. Final Report No. FHWA-AK-RD-87-23 written by the Water Research Center, Institute of Northern Engineering, University of Alaska, Fairbanks. Written for the Alaska Department of Transportation and Public Facilities, Research Section, Fairbanks, Alaska. 64pp. (K)

Author abstract: The hydraulic characteristics of a depressed invert culvert were studied. Also, a design procedure for depressed invert culverts is outlined. The hydraulic characteristics were studied by reviewing pertinent literature and by the use of a hydraulic model. The design procedure is similar to that already used by state hydrologists.

Formulas for determining the geometric properties of a depressed invert culvert are presented. The hydraulic model was used to determine the discharge coefficients for a depressed invert culvert flowing under inlet control and set flush to a vertical headwall. A literature review was performed which examined velocity profiles, flow over permeable beds, and flow resistance in culverts and over rough beds.

The design procedure is applicable to depressed invert culverts flowing under nonsubmerged conditions and set flush to a vertical headwall. The design procedure can be used as an outline for the development of a comprehensive design manual for depressed invert culverts.

248) Kemnitz, R.T., K.M. Novcaski, R.L. Rickman, W.C. Swanner, and K.R. Linn. 1993. Water resources data: Alaska water year 1992. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-92-1. 444pp. (G, I)

Author abstract: Water resources data for the 1992 water year for Alaska consists of records of stage, discharge, and water quality of streams; stages of lakes; and water levels and water quality of ground-water wells. This volume contains records for water discharge at 104 gaging stations; water quality at 24 gaging stations; water levels for 73 observation wells; and water quality analyses for 7 wells. Also included are data for 67 crest-stage partial-record stations and 14 lakes. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data system operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

249) Lamke, R.D., J.L. Van Maanen, B.B. Bigelow, P.J. Still, and R.T. Kemnitz. 1990. Water resources data for Alaska, water year 1989. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-89-1. (G, I)

Electronic abstract: Water resources data for the 1989 water year for Alaska consist of records of stage, discharge, and water quality of streams, stage of lakes, and water levels and water quality of ground water wells. This volume contains records for water discharge of 85 gaging stations, water quality at 26 gaging stations, and water levels for 27 observation wells. Also included are data for 73 crest-stage partial record stations and 19 lakes. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

250) Lamke, R.D., P.J. Still, B.B. Bigelow, H.R. Seitz, and J.E. Vaill. 1983. Water resources data for Alaska, water year 1982. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-82-1. 363pp. (G, I)

Electronic abstract: Water resources data for the 1982 water year for Alaska consists of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 108 gaging stations; stage only record for 1 gaging station; water quality for 49 stations; and water levels for 28 observation wells. Also included are 43 low-flow, 67 crest-stage , and 48 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality.

251) Lamke, R.D., R.T. Kemnitz, M.R. Carr, D.S. Thomas, and K.M. Novcaski. 1992. Water resources data for Alaska, water year 1991. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-91-1. (G, I)

Electronic abstract: Water resources data for the 1991 water year for Alaska consists of records of stage, discharge, and water quality of streams; stages, of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 82 gaging stations; water quality at 24 gaging stations; water levels for 75 observation wells; and water quality analyses for 93 wells. Also included are data for 65 crest-stage partial-record stations and 13 lakes. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

252) Lloyd, D.S. 1987. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries. 7: 34-45. (I)

Electronic abstract: Evidence both of trophic level changes induced by reduction in light penetration and of more direct effects of sediment and turbidity on aquatic life indicates that turbidity constitutes a valid and useful water quality standard that can be used to protect aquatic habitats from sediment pollution. A review of studies conducted in Alaska and elsewhere indicated that water quality standards allowing increases of 25 or 5 nephelometric turbidity units above ambient turbidity in clear coldwater habitats provide moderate and relatively high protection, respectively, for salmonid fish resources in Alaska. Even stricter limits may be warranted to protect extremely clear waters, but such stringent limits apparently are not necessary to protect naturally turbid systems.

253) Lloyd, D.S., J.P. Koenings, and J.D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management. 7: 18-33. (C, I)

Electronic abstract: Euphotic volume in lakes correlated strongly with production of juvenile sockeye salmon (*Oncorhynchus nerka*). The authors observed reduced abundance of zooplankton, macroinvertebrates, and Arctic grayling (*Thymallus arcticus*) in naturally and artificially turbid aquatic systems. Turbidity measurements correlated less consistently with measures of suspended sediment concentration (total nonfilterable residue), but provided an adequate estimator for use as a water quality standard to protect aquatic habitats.

254) Loeffler, R.M., and J.M. Childers. 1977. Channel erosion surveys along the TAPS route, Alaska, 1977. USDI Geological Survey, Anchorage, Alaska, Open-File Report 78-611. 90pp. (A, F)

Author abstract: Channel surveys were made along the TAPS route during 1977 at the same 28 sites that were studied in 1976. In addition, a new site at pipeline mile 22 near Deadhorse (alignment No. 134) along the Sagavanirktok River was put under surveillance. Except for changes wrought by the completion of construction, most of the sites showed very little change. Significant events include: virtual completion of all construction activities along the pipeline, the pipeline start-up, and the breakup flood along the Sagavanirktok River which breached many river-training structures. In general, 1977 saw heavy flooding on the streams draining the north and south slopes of the Brooks Range and moderate flooding on streams further south.

Aerial photogrammetric surveys were used again in 1977 on the same seven sites as in 1976. Results document the applicability of the method for channel erosion studies, especially those on large braided rivers. However, it requires engineering judgment and personal knowledge of the particular site to avoid being occasionally led to inaccurate conclusions.

255) MacDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. Sponsored by the Environmental Protection Agency, Seattle, Washington, Region X EPA/910/9-91/001. 180pp. (A, G, I)

Electronic abstract: The publication provides guidance for designing water quality monitoring projects and selecting monitoring parameters. Although the focus is on forest management and streams in the Pacific Northwest and Alaska, a broader perspective is taken and much of the information is more widely applicable. Part I reviews the regulatory mechanisms for nonpoint source pollution and defines seven types of monitoring. A step-by-step process for developing monitoring projects is presented. Because monitoring is a sample procedure, study design and statistical analysis are explicitly addressed. Part II is a technical review of the parameters, and these are grouped into seven categories: physical and chemical constituents, flow, sediment, channel characteristics, riparian, and aquatic organisms.

256) Milner, A.M., and G.E. Petts. 1994. Glacial rivers: Physical habitat and ecology. Freshwater Biology. 32: 295-307. (C, G, I, J)

Electronic abstract: This review examines the physical habitat and ecology of glacial rivers. Typical glacial rivers have summer temperatures below 10 degree C, a single seasonal peak in discharge, which in the Northern Hemisphere typically occurs in July, a diel fluctuation in flow which usually peaks in late afternoon, and turbidity levels in summer that exceed 30 NTU. Where maximum temperatures are less than or equal to 2 degree C benthic invertebrate communities are dominated by Diamesa (Chironomidae). Downstream, temperatures increase, channels become more stable and valley floors become older. Orthocladiinae (Chironomidae), Simuliidae, Baetidae, Nemouridae and Chloroperlidae become characteristic members of the invertebrate community.

257) Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska—requirements for protection and restoration. US Department of Commerce, National Oceanic and Atmospheric Administration, Coastal Ocean Office, Decision Analsysis Series No.7. (K)

Electronic abstract: The document presents a science overview of the major forest management issues involved in the recovery of anadromous salmonids affected by timber harvest in the Pacific Northwest and Alaska. The synthesis reviews salmonid habitat requirements and potential effects of logging, describes the technical foundation of forest practices and restoration, analyzes current federal and non-federal forest practices, and recommends required elements of comprehensive watershed management for recovery of anadromous salmonids. abstract obtained from http://www.cop.noaa.gov/pubs/das/das7.html. Accessed October 27, 2004.

258) Murphy, M.L., and A.M. Milner. 1997. Alaska timber harvest and fish habitat. Freshwaters of Alaska. Ecological Syntheses, Springer, New York. Ecological Studies 119: 229-263. (K)

Electronic abstract: Fishing and timber harvest are major industries in Alaska. If not carefully planned and conducted, timber harvest and associated road construction may adversely affect anadromous fish habitat, which has sometimes brought these industries into conflict. This chapter reviews forestry-fisheries interactions in Alaska, from the early research on the effects of timber harvest to the consensus and compromise of today. The review is organized around two main parts of salmon freshwater life history: spawning and rearing. Spawning is primarily affected by physical habitat variables; rearing is affected by both physical and trophic variables, requiring a broader understanding of the stream ecosystem.

259) O'Brien, W.J., and J.J. Showalter. 1993. Effects of current velocity and suspended debris on the drift feeding of Arctic grayling. Transactions of the American Fisheries Society. 122: 609-615. (C, G, I)

Electronic abstract: The authors videotaped Arctic grayling *Thymallus arcticus* feeding on large *Daphnia middendorffiana* drifting at different water velocities in an experimental stream with and without stream debris. The angle and distance at which fish first located each prey was determined from the videotapes. Both measures were affected by stream velocity and added debris. Location distance was unchanged at the lower velocities (11.6 and 32.3 cm/s) but declined at higher velocities. However, prey encounter rate increased up to water velocities of 45.8 cm/s, and thus water velocity compensated for reduced search area. Added debris always shortened location distance and decreased location angle. These findings have implications for position choice in streams and search strategies.

260) Oswood, M.W., A.M. Milner, and J.G. Irons III. 1991. Climate change and Alaskan rivers and streams. In: Global Climate Change and Freshwater Ecosystems. P. Firth and S.G. Fischer, Editors. Springer-Verlag, New York. Pages 192-210. (K)

Author abstract (Author Conclusion): Global climate warming in response to increased atmospheric carbon dioxide and other greenhouse gasses is likely to have major impacts on subarctic and arctic streams. Sediment and flow regimes are likely to changes as a result of changing mass balance of glaciers. Thermal regimes of streams also likely to change, resulting in biogeographic changes in freshwater organisms. Release of carbon (as carbon dioxide or as dissolved organic carbon in hydrologic transport) may be a major effect of warming carbon rich soils, potentially exacerbating climate warming. Quality food for stream invertebrates is likely to changes as a result of complex interactions of many climatic and biotic variables. Some of these changes may be synergistic (increasing the impact) or antagonistic (ameliorating the impact); however, given the current state of the climate models, prediction is uncertain at best.

261) Parks, B., and R.J. Madison. 1985. Estimation of the flow and water-quality characteristics of Alaskan streams. USDI Geological Survey, Water-Resources Investigations Report 84-4247. 64pp. (G, I)

Electronic abstract: Although hydrologic data are either sparse or nonexistent for large areas of Alaska, the drainage area, area of lakes, glacier and forest cover, and average precipitation in a hydrologic basin of interest can be measured or estimated from existing maps. Application of multiple linear regression techniques indicates that statistically significant correlations exist between properties of basins determined from maps and measured streamflow characteristics. This suggests that corresponding characteristics of ungaged basins can be estimated. Streamflow frequency characteristics can be estimated from regional equations developed for southeast, south-central and Yukon regions. Statewide or modified regional equations must be used, however, for the southwest, northwest, and Arctic Slope regions where there is a paucity of data. Equations developed from basin characteristics are given to estimate suspended-sediment values for glacial streams and, with less reliability, for nonglacial streams. Equations developed from available specific conductance data are given to estimate concentrations of major dissolved inorganic constituents. Suggestions are made for expanding the existing data base and thus improving the ability to estimate hydrologic characteristics for Alaskan streams.

262) Prowse, T.D. 1994. Environmental significance of ice to streamflow in cold regions. Freshwater Biology. 32: 241-259. (G)

Electronic abstract: The five major hydrologic regimes of cold regions are typically classified as proglacial, wetland, spring-fed, arctic nival and subarctic nival. The hydrologic response of streams in cold regions is influenced significantly by the source and pathways of moisture from the landscape to the stream channel. Snow and ice masses, such as snow cover, permafrost and icings, play principal and unique roles as major moisture sources, and in affecting runoff pathways. Once flow has been routed from the landscape into a channel system, the effects of floating ice begin to control the flow system. Notably, many of the most significant hydrologic events in cold regions, such as floods and low flows, are more the result of in-channel ice effects than of landscape runoff processes.

263) Robison, E.G. 1998. Reach scale sampling metrics and longitudinal pattern adjustment of small streams. P.h.D. Dissertation, Oregon State University, Corvallis. 254pp. (A)

Electronic abstract: Several types of channel morphology measurement parameters used to characterize fish habitat of small streams are refined, developed and evaluated in terms of their accuracy, precision, and sensitivity to disturbance. Data for 74 stream reaches in Oregon and Alaska are used in analysis. Over half the reaches are from a pre-pilot study funded by EPA's Environmental Monitoring and Assessment Program (EMAP). A new methodology for determining residual pools is developed (termed the Longitudinal Streambed Simulation Method). This new method and an older method are compared with a more rigorous time consuming method for determining residual pools. Results indicate a generally close correspondence. For instance, the absolute percent departure of longitudinal residual pool area was typically within 10% and always less than 25% for streams with wetted widths greater than 3.5 meters. Precision is evaluated for three data sets containing replicated stream reach measurements. Directly measured parameters like standard deviation depth are demonstrated as precise and repeatable. in contrast, visual scoring systems and visual determinations of riffles versus pools have low precision. Adequate reach length for determining various channel characteristics is evaluated by using classic sample size statistics, time series, and short versus long reach comparisons.

264) Scannell, P.K.W. 1992. Influence of temperature on freshwater fishes: A literature review with emphasis on species in Alaska. Alaska Department of Fish and Game, Division of Habitat, Juneau, Alaska, Technical Report No. 91-1. 47pp. (J)

Author abstract: Small (1-5^{o}C) changes in water temperature may have consequential effects on fish, depending upon the time of year the changes occur, the magnitude and duration of the changes, and the fish species and life stages of the fish affected. Changes in water temperature affect survival at all life stages, rates of egg development and growth, timing of smolting, and mortality rates during overwintering. Increases or decreases in water temperature may influence reproduction by changing the timing of the spawning run; influencing fish to seek other spawning areas, increasing egg mortality and the occurrence of deformed alevins, changing the time for egg development; or causing fish to avoid certain streams or stream reaches. Changes in temperature have been shown to affect the number of eggs that are successfully fertilized when fish are delayed in migrating to spawning areas.

In Alaska, elevations in temperature may be particularly harmful to fishes that are adapted to coldwater conditions and rarely experience significant summer warming. Many of the studies that relate changes in temperature to effects on fish examine higher ranges than are usually experienced by fish in Alaska. Therefore, acceptable upper and lower temperature ranges from published literature are often not applicable to fish naturally occurring at higher latitudes. This report examines much of the published literature on coldwater species of fish that inhabit freshwater. Summaries are given of the effects of changes on temperature on different life stages. The final section of this report presents recommendations for optimal temperatures for various fish life stages.

265) Slaughter, C.W., and J.W. Aldrich. 1989. Annotated bibliography on soil erosion and erosion control in subarctic and high-latitude regions of North America. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-253. 234pp. (K)

Author abstract: This annotated bibliography emphasizes the physical processes of upland soil erosion, prediction of soil erosion and sediment yield, and erosion control. The bibliography is divided into two sections: (1) references specific to Alaska, the Arctic and subarctic, and similar high-latitude settings; and (2) references relevant to understanding erosion, sediment production, and erosion control. Most of the cited works were published prior to 1981. Annotations generally consist of the author's abstract or summary.

266) Still, P.J., and J.M. Crosby. 1989. Alaska Index: Streamflow, lake levels, and water quality records to September 30, 1988. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Open-File Report 89-269. 189pp. (G, I)

Electronic abstract: Streamflow, lake levels, and water quality data are compiled for stations in the southeast, south-central, southwest, Yukon basin, northwest, and Arctic Slope subregions of Alaska. The report includes a map of each hydrologic subregion and tables listing types of data collected and periods of records.

267) USDI Geological Survey. 1971. Index of surface-water records to September 30, 1970--Part 15. Alaska. USDI Geological Survey Circular 665, Washington, D.C. 21pp. (G)

Electronic abstract: The streamflow stations in Alaska (approximately 600) for which records have been or are to be published in reports of the geological survey for periods through September 30, 1970 are listed. In addition to the continuous-record gaging stations, this index includes crest-stage partial-record stations. A continuous-record station is a gaging station on a stream or reservoir for which the discharge, stage, or contents is published on a daily, weekly, or monthly basis for a continuous period of time. A crest-stage partial-record station is a streamflow station for which only the annual maximum discharge is published over a period of years for use in floodflow analyses.

268) USDI Geological Survey. 1976. Water resources data for Alaska, water year 1975. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-75-1. 410pp. (G, I)

Electronic abstract: Water resources data for the 1975 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 107 gaging stations; stage only records for 2 gaging stations; water quality for 31 stations; and water levels for 19 observation wells. Also included are 85 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

269) USDI Geological Survey. 1977. Water resources data for Alaska, water year 1976. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-76-1. 401pp. (G, I)

Electronic abstract: Water resources data for the 1976 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 102 gaging stations, stage only records for 2 gaging stations, water quality for 71 stations, and water levels for 24 observation wells. Also included are 91 crest-stage partial-record stations and 28 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

270) USDI Geological Survey. 1978. Water resources data for Alaska, water year 1977. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-77-1. 439pp. (G, I)

Electronic abstract: Water resources data for the 1977 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 112 gaging stations, stage only records for 4 gaging stations, water quality for 60 stations, and water levels for 25 observation wells. Also included are 18 low-flow, 91 crest-stage, and 19 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

271) USDI Geological Survey. 1979. Water resources data for Alaska, water year 1978. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-78-1. 425pp. (G, I)

Electronic abstract: Water resources data for the 1978 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 117 gaging stations, stage only records for 2 gaging stations, water quality for 64 stations, and water levels for 28 observation wells. Also included are 79 low-flow, 87 crest-stage, and 24 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

272) USDI Geological Survey. 1980. Water resources data for Alaska, water year 1979. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-79-1. 365pp. (G, I)

Electronic abstract: Water resources data for the 1979 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 111 gaging stations, stage only records for 2 gaging stations, water quality for 58 stations, and water levels for 30 observation wells. Also included are 62 low-flow, 89 crest-stage, and 24 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

273) USDI Geological Survey. 1981. Water resources data for Alaska, water year 1980. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-80-1. 373pp. (G, I)

Electronic abstract: Water resources data for the 1980 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 114 gaging stations, stage only record for 1 gaging station, water quality for 55 stations, and water levels for 33 observation wells. Also included are 56 low-flow, 8 crest-stage, and 2 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

274) USDI Geological Survey. 1982. Water resources data, Alaska water year 1981. USDI Geological Survey, Water Resources Division, Anchorage, Alaska, Water-Data Report AK-81-1. (G, I)

Electronic abstract: Water-resources data for the 1981 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells and springs. This report contains discharge records for 121 gaging stations; stage only record for 1 gaging station; water quality for 63 stations; and water levels for 30 observation wells. Also included are 50 low-flow, 71 crest-stage, and 20 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

275) Vaill, J.E., P.J. Still, R.D. Lamke, B.B. Bigelow, and J.L. Van Maanen. 1988. Water resources data for Alaska, water year 1987. USDI Geological Survey, Water-Data Report AK-87-1 (WRD/HD-89/209). 284pp. (G, I)

Electronic abstract: Water resources data for the 1987 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 83 gaging stations; water quality at 27 gaging stations; and water levels for 29 observation wells. Also included are data for 16 low-flow, 86 crest-stage, and 14 water-quality partial-record stations and 20 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.

276) VanMaanen, J.L., R.D. Lamke, P.J. Still, J.E. Vaill, and B.B. Bigelow. 1988. Water resources data for Alaska, water year 1986. USDI Geological Survey, Water-Data Report AK-86-1 (WRD/HD-88/214). 330pp. (G, I)

Electronic abstract: Water resources data for the 1986 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 103 gaging stations; water quality at 42 gaging stations; and water levels for 30 observation wells. Also included are data for 18 low-flow, 68 crest-stage, and 18 water-quality partial-record stations and 40 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska.