A SUMMARY OF SALMON ENHANCEMENT, REHABILITATION, EVALUATION, AND MONITORING EFFORTS CONDUCTED IN THE KODIAK MANAGEMENT AREA THROUGH 1998

by:

Stephen T. Schrof
Steven G. Honnold
Christian J. Hicks
and
Jeff A. Wadle

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ABSTRACT

Enhancement and rehabilitation of salmon stocks has been ongoing in the Kodiak Island archipelago since the early 1900s, when sockeye salmon *Oncorhynchus nerka* hatcheries were operated at Karluk Lagoon and Afognak Lake. These early programs were not particularly successful. After statehood, the Alaska Territorial Department of Fisheries (ATDF) began new programs to rebuild sockeye salmon stocks. Examples of these programs included hatchery stocking at Kitoi Bay, installation of fishways (fish passes or fish ladders) on the Pauls Lake drainage and the Frazer River, and lake fertilization at Bare Lake. In the 1970s, projects were initiated by the Alaska Department of Fish and Game (ADF&G) to rehabilitate sockeye salmon at Karluk Lake and to enhance pink *O. gorbuscha* and chum *O. keta* salmon at Kitoi Bay. Fish ladders were also installed at various locations on Afognak Island to increase accessible habitat for sockeye, pink, and coho *O. kisutch* salmon.

By the late 1980s and early 1990s, the Kodiak Regional Aquaculture Association (KRAA), in conjunction with the Kodiak Regional Planning Team (KRPT) and the Phase I Comprehensive Plan, planned and implemented various salmon rehabilitation, enhancement, and research programs. These included limnological and fishery research at Karluk and Frazer Lakes, which lead to lake fertilization projects, the construction of Pillar Creek Hatchery to facilitate sockeye salmon outstocking into barren lakes, and fish culture research at Kitoi Bay Hatchery. In 1992, a Phase II Comprehensive Plan was implemented, which focused on increasing lake (fertilization and barren lake stocking) and stream (fish passes) habitat, and natural stock rebuilding (stocking). Phase II projects included sockeye salmon broodstock development at Kitoi Bay Hatchery to facilitate an enhancement project at Spiridon Lake, investigations and subsequent lake fertilization and stocking projects at Afognak, Malina, Laura, Little Waterfall, Portage, Hidden, Crescent, and Ruth Lakes, and improvements and maintenance to fish passes on Afognak Island. In addition, coho salmon enhancement was initiated at Kitoi Bay Hatchery, along with expanded pink and chum salmon production. Lastly, comprehensive monitoring and evaluation programs were started for each of the aforementioned enhancement and rehabilitation projects, which included limnological and fisheries investigations.

This report summarizes enhancement and rehabilitation methods including stocking from Kitoi Bay and Pillar Creek Hatcheries, lake fertilization, the location and operation of barrier bypasses (fish passes), stream clearance activity, and fisheries in special and terminal harvest areas in 1998. The results of enhancement and rehabilitation projects are described in terms of data collected through evaluation and monitoring activities in 1998. Previous year methods and results, as described above, are presented in a series of appendices.

Stocking in 1998 for enhancement included approximately 128 million pink salmon, 7 million chum salmon, 769 thousand coho salmon and 397 thousand sockeye salmon juveniles, which were released directly from Kitoi Bay Hatchery (KBH) into Kitoi Bay. Additional releases for enhancement from KBH in 1998 included 100 thousand late-run sockeye salmon into Little Kitoi Lake and 377 thousand coho salmon into Jennifer, Ruth, Crescent, and Katmai Lakes. Approximately 1.15 million early-run sockeye salmon were stocked from Pillar Creek Hatchery (PCH) into Hidden, Little Waterfall, and Crescent Lakes in 1998 to produce enhanced runs. An

additional 3.4 million late-run sockeye salmon were stocked from the hatchery into Spiridon and Ruth Lakes in 1998 for enhancement projects. The preceding lakes stocked were all barren systems prior to stocking. PCH also stocked two anadromous lakes in 1998. Afognak Lake was stocked with 423 thousand sockeye salmon and Malina Lake with 351 thousand sockeye salmon. The latter stocking was to rebuild a depressed sockeye stock.

Lake enrichment (fertilization) occurred at Afognak, Malina, Laura, and Little Waterfall Lakes in 1998. These projects had been ongoing since the early 1990s. Lakes were treated with nutrient additions composed of an aqueous blended nitrogen and white phosphorus (20-5-0) sprayed from a fixed-wing aircraft. Previously completed fertilization projects occurred at Karluk, Frazer, and Portage Lakes.

There are eight operational barrier bypasses for adult salmon in the Kodiak Island archipelago. Dog Salmon Creek (Frazer River) fish pass is located on Kodiak Island and Little Kitoi Lake, Portage Creek, Laura Creek, Gretchen Creek, Little Waterfall Creek, and Seal Bay Creek fish passes are located on Afognak Island. The Seal Bay Creek fish pass on northern Afognak Island has not always been operational, and annual maintenance was not conducted on a regular basis prior to 1998. A bypass system has been installed and operated at Telrod Creek (Spiridon Lake) to move sockeye salmon smolt downstream around injurious barrier falls, since 1992. Stocked fry utilize the nursery habitat in Spiridon Lake and migrate out as smolt via a pipeline around the falls to the marine environment. In 1998, Jennifer, Ruth and Elk (Little Kitoi) Creeks in the Kitoi Bay area were examined periodically to ensure that no obstructions to smolt passage existed.

Harvest strategies for enhanced salmon returns include special openings in designated terminal harvest areas (THA) and, if broodstock collection is required, in Special Harvest Areas (SHA). There is one SHA (Kitoi Bay SHA) and four THAs (Settler Cove THA, Foul Bay THA, Waterfall Bay THA, and Spiridon Lake THA) in the Kodiak Management Area (KMA).

Evaluation and monitoring of enhancement and rehabilitation projects included both limnological and fishery assessments in 1998. Fourteen lakes on Kodiak and Afognak Island were sampled for limnological data. Light penetration, turbidity, temperature, dissolved oxygen, dissolved constituents (conductivity, pH, alkalinity, calcium, and magnesium), dissolved nutrients (total phosphorus, Kjeldahl nitrogen, inorganic nitrogen, ammonia, inorganic phosphorus, silica), hydrogen sulfide, chlorophyll *a*, and zooplankton data were collected and analyzed. Fishery data collected in 1998 included rearing fish estimates, smolt emigrations estimates, juvenile sockeye age and size data, adult escapement and harvests, adult sockeye age and size data, and broodstock numbers and age data.

Light attenuation and water clarity was lowest in Spiridon Lake and highest in Portage Lake. The remaining lakes had similar measurements within the range of these parameters. Most of the lakes were isothermal in the spring, with the surface waters warming to 13-16^0 C during summer months, then cooling and becoming isothermic in the fall. Shallower lakes were only slightly stratified in the summer. Dissolved oxygen levels were comparable from lake to lake, with the exception of lower levels observed at the bottom of Laura and Little Kitoi Lakes. The latter contained a layer of saline water at the bottom that prevented mixing. In general, major dissolved constituents exhibited little variability between lakes or within lakes. Total phosphorus (TP) concentrations ranged from 3.1 to

11.5 ug L^{-1} and Kjeldahl nitrogen (TKN) concentrations ranged from 101 to 216 ug L^{-1} in the 1-m lake samples. Laura and Little Waterfall Lakes had the highest TP and Little Kitoi had the highest TKN concentration. Hidden and Spiridon Lakes had the lowest TP and TKN concentrations. The remaining dissolved constituents varied little among lakes. Little Kitoi Lake had 13.7 ug L^{-1} concentration of hydrogen sulfide in bottom water samples.

Chlorophyll *a* concentrations ranged from 0.1 in Afognak Lake to a high of 1.8 ug L^{-1} in Little Kitoi and Little Waterfall Lakes. Cladocerans composed the majority of the zooplankton populations in Kodiak Lakes, except at Saltery and Spiridon Lakes, where copepods dominated. Portage Lake had the lowest mean zooplankton density and biomass, and Frazer Lake the highest mean zooplankton density and biomass. The barren lakes varied in zooplankton density and biomass and appeared to fluctuate rapidly to stocking; species compositions also changed in some instances after stocking.

Juvenile sockeye rearing estimates varied among lakes, primarily as result of stocking levels. Smolt emigration estimates ranged from 746 thousand from Spiridon Lake to 57 thousand from Little Kitoi Lake. Estimates from Frazer Lake were inconclusive due to high water washing out the smolt trap. Smolt sampled for age and size were predominately age 1 juveniles at all systems, except at Frazer and Laura Lakes, where age 2 smolt were more abundant. Malina Lake sockeye smolt were fairly evenly distributed between age 1 and age 2 fish. Hidden Lake had the largest smolt and the smallest emigrated from Little Kitoi Lake. All sockeye salmon smolt sampled were in good condition.

A total of 708 thousand sockeye salmon harvested in the Kodiak Management Area (KMA) in 1998 were attributed to enhancement and rehabilitation projects. The largest contributors of sockeye salmon were the Frazer Lake and Spiridon Lake projects. Projects also contributed 6.3 million pink salmon, 38 thousand chum salmon, and 163 thousand coho salmon to the 1998 KMA harvest. Sockeye salmon upper escapement goals were met at Afognak Lake (escapement of ~ 67 thousand) and Frazer Lake (escapement of ~ 245 thousand) in 1998. The lower goals were met at Portage, (escapement of ~ 7 thousand), Malina (escapement of ~ 15 thousand), Thorsheim, (escapement of ~ 6 thousand) and Saltery (escapement of ~ 26 thousand) Lakes. Pauls Bay (Laura Lake) did not meet the minimum escapement goal (escapement of ~ 16 thousand) in 1998. Sockeye salmon were sampled from ten systems, including broodstock samples at Afognak, Laura, Malina, and Saltery Lakes, for age and size data in 1998.

INTRODUCTION

Exploitation, Preservation, and Rebuilding of Kodiak Archipelago Salmon Stocks

Salmon have long been considered an important food source to the indigenous people and other inhabitants of the islands within the Kodiak archipelago. Salmon have been commercially exploited in the Kodiak area for over 150 years, and local people believed it was important to conserve area salmon stocks to provide sustainable harvests (Roppel 1986). Commercial harvests of sockeye salmon *Oncorhynchus nerka* were documented, beginning in 1882. In 1974, a "limited entry system" was adopted by the State of Alaska to restrict participation into the commercial salmon

fisheries (Brennan 1998). In 1998, 608 commercial salmon permits consisting of 384 purse seine, 36 beach seine, and 188 set gillnet were available for use in the Kodiak Management Area (KMA; Prokopowich 2000).

Before Alaska became a state, the federal government was responsible for the management of Alaska's salmon resources. Under federal control, Alaska's resources were heavily exploited as shown by the severe decline in salmon escapements and the huge volume of salmon exported before Statehood in 1959 (1867-1950s) by the powerful canned salmon industry. In 1951, the territorial legislature created the Alaska Territorial Department of Fisheries (ATDF) to preserve and rebuild the salmon runs (Stockley 1996). As a way to rebuild depleted runs and protect healthy stocks, the ATDF focused on the enhancement of the sockeye salmon fisheries (Appendix A). Various strategies including hatchery production, stocking of barren lakes, lake enrichment, and installation of steeppasses (fishways, fish ladders, fish passes) to circumvent impassable falls were employed to increase sockeye salmon production and harvest opportunities in territorial days.

History of Sockeye Salmon Enhancement, Rehabilitation, and Research

Karluk Lake, located on the southwest side of Kodiak Island (Figure 1), was an important commercial salmon producer, during the late 1800s. Sockeye salmon were heavily exploited at Karluk Lagoon during this period. According to Roppel (1982), cannery operators built the first hatchery in Alaska at the mouth of the Karluk River in 1896 (Appendix A). The hatchery was operated until 1917, but failed to produce substantial increases in sockeye salmon runs due to poor release strategies (Schmidt et al. 1997).

Afognak Lake, located on the southwest portion of Afognak Island, was the site of a large federal government sockeye salmon hatchery (White et al. 1990; Figure 1; Appendix A). From 1908-1933, the hatchery released sockeye salmon fry into Afognak Lake and shipped eggs to other facilities in Alaska and other states. Over 79 million eggs were incubated at the hatchery during the peak years of production. The facility closed after many years of marginal returns and amid controversy over hatchery production (Roppel 1982).

Physical barriers previously blocked fish migrations into the upper reaches of the Pauls Lake system which is composed of Pauls, Laura, and Gretchen Lakes, situated in the northeast corner of Perenosa Bay on Afognak Island (Figure 1). Prior to an ATDF salmon enhancement project in the early 1950s, sockeye salmon escapement into the Pauls Lake system was limited to only a few hundred fish and spawning habitat was underutilized in the upper drainage areas due to the barriers (Honnold and Edmundson 1993; Appendix A). The installation of fishways in 1952, enabled returning adults access around the barriers. In addition, sockeye salmon eggs (eyed-egg stage) were planted in Gretchen Creek from 1951-1955 to initiate adult returns to this Laura Lake tributary and to enhance overall sockeye salmon production. By the late 1950s, the sockeye salmon run was well established throughout the Pauls Lake drainage. In 1959, the ADF&G installed a 9 meter steeppass at the original fishway site in Gretchen Creek. In 1964, a 27 meter steeppass was installed by the ADF&G at the highest barrier at Laura Creek (Honnold 1991). Modifications and improvements were continued at both sites in the 1970s and 1980s by adding more steeppasses, resting pools, and water diversion structures (Honnold and Edmundson 1993).

In 1951, the ATDF introduced sockeye salmon into Frazer Lake, which is located on the southwestern end of Kodiak Island (Blackett 1979; Blackett 1987; Kyle et al. 1988; Figure 1; Appendix A). A 10 m waterfall blocked anadromous fish migrations into Frazer Lake. To establish a self-sustaining run of sockeye salmon into Frazer Lake, sockeye salmon eggs were planted in tributary streams, and fry and adults were stocked into the lake. In 1962, an Alaska steeppass (Ziemer 1962) was constructed to allow salmon to navigate around the barrier. The project proved successful in establishing the sockeye salmon run by the late 1970s, and adults from this run have been commercially harvested on an annual basis.

Kitoi Bay Research Station was constructed on the southeastern side of Afognak Island, in 1953 (Hall et al. 1998; Figure 1; Appendix A). The hatchery facility was built to facilitate the research of techniques to successfully introduce sockeye salmon into lakes not utilized by anadromous fish (barren), and to evaluate environmental factors related to species competition, predation, and lake production (Meehan 1966). In 1955, the hatchery became operational and salmon research was initiated at Little Kitoi Lake to estimate the sockeye salmon smolt emigration (Figure 1). In 1956, Ruth Lake (a barren lake in the Kitoi Bay area) was studied to determine how predation by resident fish affects stocked sockeye salmon fry and how lake production responds to different stocking densities. In the early 1960s, steeppasses and concrete raceways were installed at the outlets of Little Kitoi and Ruth Lakes to provide simultaneous migration corridors for adults and smolt. The Ruth Lake steeppass was removed and stocking efforts discontinued after the study was completed.

In 1955, Bare Lake on Kodiak Island (drains into Ayakulik River; Figure 1) was the first lake in Alaska fertilized with a phosphate and sodium nitrate mixture (Roppel 1986; Honnold et al. 1996; Appendix A). The intent of this project was to determine whether increasing nutrient levels in the lake could increase freshwater growth and survival of juvenile sockeye salmon, and subsequently increase adult production. The resultant fertilizer applications increased zooplankton abundance and produced a larger sized smolt (Nelson and Edmondson 1955; Honnold et al. 1996). This project was a precursor to later lake enrichment programs such as Karluk Lake.

Karluk Lake sockeye salmon runs ranged, on average, from one to two million fish from the 1920s through the 1940s, but declined substantially from the 1950s through the 1970s. The Alaska Department of Fish and Game implemented a project from 1978-1987 on the Upper Thumb River (UTR) to rehabilitate a portion of the Karluk Lake early sockeye salmon run (Figure 1; Appendix A; White 1986). UTR sockeye salmon fry were 'back stocked' into the river after eggs and fry were cultured at the Kitoi Bay Hatchery on Afognak Island (1979-1981; Figure 1) and at a remote incubation facility located on the UTR (1982-1983). Eyed eggs were also planted in the gravel on the Upper Thumb River (1980-1987). These fry and egg plants increased the UTR sockeye salmon escapement from less than 4,000 fish in 1980, to nearly 50,000 fish in 1988, which represented an increase in the UTR proportion of the total early run sockeye salmon escapement into the Karluk River from ~ 5% to near 20%.

Other Salmon Enhancement Projects

In the early 1970s, pink salmon enhancement began at Kitoi Bay Hatchery. Fry releases were increased dramatically from thousands to hundreds of millions in the 1980s and 1990s (KRAA

1998b). Kitoi Bay Hatchery also began a chum salmon enhancement project in the early 1980s with mixed results; however, returns to the hatchery have improved in recent years. Pink salmon enhancement on Afognak Island also occurred at Seal Bay and Little Waterfall Creek in the late 1970s (McDaniel 1981; Hornold 1999; Figure 1). Fry plants from Kitoi Bay Hatchery, along with installation of a fish pass did not prove successful at Seal Bay Creek. However, the installation of three fish passes at Little Waterfall Creek allowed for colonization of a majority of previously unused spawning habitat. By the early 1980s, pink salmon production increased at Little Waterfall to allow for an annual harvest in Perenosa Bay. A fish pass was installed at Portage Creek on Afognak Island in the early 1970s to enhance pink salmon (Figure 1). The fish pass also increased sockeye and coho salmon production (White and Edmundson 1993).

Regional Salmon Production Planning

In accordance with Alaska Statutes 16.10.375-470, the Commissioner of the ADF&G has been responsible for the development of a comprehensive plan on salmon production in the KMA (KRPT 1987; 1992). This responsibility was further delegated to the regional planning teams (RPT), consisting of representatives from the ADF&G and the regional aquaculture associations. The RPT's mission has been to plan for the long-term future of the salmon resources within the region by establishing priorities and examining the region's salmon production potential (KRPT 1992). In the KMA, the 1988 total harvest of 18,620,000 and 4,711,000 escapements (actual and indexed) was a combined total of 23,331,000 salmon for all species (KRPT 1992). The total harvest for 1988 was 76% higher than the 19-year average (1970-88) of 8,037,000 salmon (KRPT 1992).

In 1983, the Commissioner of ADF&G (KRPT 1992) officially approved the Kodiak Regional Aquaculture Association (KRAA). The purpose of the KRAA was to provide the public and user-groups assistance in the process of enhancing salmon production in the Kodiak Island area in conjunction with the KRPT planning. In 1983, the results of a questionnaire sent out to commercial, subsistence, and sport fish groups concluded that the preferred salmon species to harvest in descending order were sockeye, pink, coho and chum salmon. Questionnaire results provided a mechanism in establishing production goals for the RPT to follow.

In 1984, the Commissioner of the ADF&G approved Phase I of the Kodiak Regional Comprehensive Salmon Plan, 1982-2002 (KRPT 1992). The Phase I plan was categorized into the production and harvest goals, research and data gathering goals, policy and management goals for the next 20 years of the plan (1982-2002). In 1992, the KRPT scheduled an interim evaluation to assess the plan's progress. The KRPT's project planning was designed to achieve established goals and objectives, and benefit as many of the fishing user groups as possible. This was accomplished by assessing the needs expressed by the groups during the Phase I planning process.

As a result of the planning process, limnological and fishery research was initiated by the ADF&G at Karluk Lake to assess additional rehabilitation (egg planting at Upper Thumb was ongoing at the time) options for sockeye salmon. In 1986 and continuing through 1994, KRAA, ADF&G, and the Kodiak Island Borough began a lake enrichment project at Karluk Lake

(Koenings and Burkett 1987). Similarly, Frazer Lake was investigated from 1985-1987 to determine the appropriate strategy for rebuilding the sockeye salmon run and a lake enrichment program was conducted from 1988-1994 (Kyle et al. 1988). Rebuilding the sockeye salmon run was necessary due to overescapement (escapement goals were established above sustainable production levels) into Frazer Lake.

As part of the Phase I planning (1990), the KRAA and the ADF&G constructed the Pillar Creek Hatchery. This new incubation facility, located on the Kodiak Island road system near the City of Kodiak, was designed for remote sockeye salmon stocking projects (Honnold et al. 1999). At the same time, the Kitoi Bay Hatchery was conducting fish culture research on the late-run Upper Station sockeye salmon stock (Honnold et al. 1998). An age-0 component of this late run stock was incubated and released into Big and Little Kitoi Bays. The intent of the saltwater release was to provide an on-site brood source for sockeye salmon stocking projects (primarily Spiridon Lake) in a relatively short time period (returns were expected in two to three years; Honnold 1997a). Limnological and fishery investigations were also initiated during this period to determine the appropriate enhancement and/or rehabilitation strategy for depressed sockeye salmon stocks or the stocking potential of barriered lakes without anadromous fish (Honnold et al. 1996). In addition to sockeye salmon production projects, pink and chum salmon enhanced production continued, and a coho salmon stocking program was initiated at Kitoi Bay Hatchery.

By 1992, sockeye and pink salmon production was successful as reflected in the achievement of interim goals established in the KRPT plan. The stocking and lake enrichment projects augmented the management strategy to achieve the goals. Wild stock coho and chum salmon production was at all time highs. Due to the early success of Phase I in the plan, the KRPT decided to reevaluate the initial goals and objectives through the Phase II planning process (KRPT 1992). The KRPT, again through the results of a questionnaire, established a new salmon species priority list (sockeye, coho, chum, pink, and chinook) and new salmon production goals and harvest objectives (outlined in Appendix B). Also, the KRPT received suggestions from fishers for potential projects to achieve these harvest objectives. Sockeye salmon enhancement and rehabilitation efforts were directed at increasing lake (fertilization and barren lake stockings) and stream (fish passes) habitat, and natural stock rebuilding (stocking).

Projects Developed to Achieve KRPT Comprehensive Plan Phase II Harvest Objectives

In the early 1990s, broodstock development was expanded at Little Kitoi Bay to include releases of late-run Upper Station sockeye salmon age 1. smolt as well as releases of presmolt into Little Kitoi Lake (Honnold et al. 1998; Honnold et al. 1999; Hall et al. 1999; Figures 2 and 3). In 1997, salt-water releases (age 0. and age 1.) were phased out due to poor adult sockeye salmon returns as well as return timing problems associated with wild pink salmon returns to Spiridon River and the pink salmon fishery at Kitoi Bay Hatchery. Broodstock development for the Spiridon Lake enhancement project was continued in 1998 using the Saltery Lake sockeye salmon stock and presmolt releases into Little Kitoi Lake. The first adult return large enough for broodstock collection is expected in 2001. The long-term goal of this project is to collect sockeye eggs at Little Kitoi and transfer the majority of the eggs to Pillar Creek Hatchery for incubation, rearing, and eventual release at Spiridon and Ruth Lakes (Figures 1 and 2; see below).

In 1988, the ADF&G and KRAA initiated a two-year pre-project assessment to determine options for rehabilitation of the sockeye salmon run at Afognak Lake (White et al. 1990; Figure 1). This assessment resulted in the lake being enriched annually, from 1990-1998 with nutrients (liquid fertilizer) to increase the lake's forage base for rearing juvenile sockeye salmon (Figure 3). In addition, Afognak Lake was stocked with native (Afognak Lake stock) sockeye salmon juveniles as part of the rehabilitation program (1992, 1994, and 1996-1998; Honnold et al. 1999; Figure 4).

In 1990, pre-project limnological and fishery investigations were completed at Malina Lakes (Kyle and Honnold 1991). The sockeye salmon run at Malina Lakes was determined depressed due to limitations in primary and secondary production in the lake. A project similar to the Afognak Lake project was initiated at Malina Lakes to rehabilitate the depressed sockeye salmon run (Figure 1). Lake fertilization (1991-1998) and stocking (1992-1998) were also employed at this system (Figures 3 and 4).

Also, in 1991, after extensive limnological and fishery investigations (Kyle et al. 1990), the Spiridon Lake sockeye salmon enhancement project began (Figure 1). Spiridon Lake was devoid of anadromous fish prior to the stocking of juvenile sockeye salmon (Upper Station Lake, 1990-1994, 1996-1997, and Saltery Lake, 1995, 1998 stocks), because a series of barrier falls in the outlet stream blocked migrations into the lake (Honnold 1997; Figure 4). A pipeline for passing emigrating smolt past the falls (to avoid mortality) was constructed in 1991 and 1992. Since 1992, smolt have been guided into the pipeline by a weir and trapping system. The returning adults from this project are harvested in traditional Westside Kodiak fishing areas and Telrod Cove (also known as the Spiridon Lake Terminal Harvest Area; Figure 5). Stocking occurs each year to continue this 'put and take' enhancement project.

Additional barren lakes such as Hidden Lake (White 1992), Little Waterfall Lake (Edmundson et al. 1994a), and Crescent Lake (Honnold et al. 1999) were evaluated for enhancement potential in the early 1990s (Figure 1). In 1992, sockeye salmon stocking projects using a "put and take" strategy were initiated at these lakes and THAs were developed at Foul Bay (Hidden Lake), Waterfall Bay (Little Waterfall Lake), and Settler Cove (Crescent Lake) to provide for directed fisheries on these runs (Figures 4 and 5). These lakes are stocked annually with Afognak Lake stock juvenile sockeye salmon to continue enhanced adult harvests.

Limnological and fishery investigations at Laura (Pauls Lake system; Honnold and Edmundson 1993) and Portage (White and Edmundson 1993) Lakes resulted in sockeye salmon rehabilitation projects that began in 1993 (Figure 1). Both systems were fertilized from 1993-1998 and Laura Lake was stocked with sockeye salmon fry from 1994-1996 (Figures 3 and 4). In 1993, lake enrichment began at Little Waterfall Lake to improve the survival of fry stocked to enhance the early-run. A "put and take" sockeye salmon enhancement project was started at Jennifer Lake near Kitoi Bay Hatchery in 1993 (Figures 1 and 4; Honnold et al. 1998). This project was designed, through stocking (late-run Upper Station stock), to produce adults for harvest in Duck, Izhut, and Kitoi Bays (Figure 2).

The most recent sockeye salmon enhancement project was started (prior to 1998) at Ruth Lake, located near Kitoi Bay Hatchery (Figures 1-2, 4; Honnold et al. 1998). Saltery Lake juvenile

salmon were stocked into the lake from 1996-1998 to provide for an adult harvest as described for Jennifer Lake (Figure 2).

Fish passes at the Pauls Lake system, Frazer Lake, Portage Lake, Little Kitoi, and Little Waterfall have been improved upon and are maintained annually to sustain sockeye salmon production (Figures 1, 6 and 7). The fish passes at Pauls, Portage, Little Kitoi and Little Waterfall have helped increase and sustain coho production to these systems as well. Coho salmon were also stocked into several of the barren systems at several Kitoi area lakes (1984-1998), at Katmai Lake near the village of Ouzinkie (1987-1998), at Crescent (1988-1998), and at Hidden Lake (1988-1991; Figures 1-2, 4). In addition, coho smolt were released from Kitoi Bay Hatchery (1987-1998). Little Kitoi Lake coho salmon was the broodstock used for these "put and take" enhancement projects.

Chum salmon enhancement at the Kitoi Bay Hatchery was started in 1982, and fry have been released annually (except in 1991, when a virus outbreak occurred; KRAA 1998b). Chum fry are released directly into Big Kitoi Bay after a period of net-pen rearing in the saltwater (Figure 4). Returning adult chum salmon are harvested in Duck, Izhut, and Kitoi Bays (Figure 2).

Pink salmon enhancement at Kitoi Bay Hatchery began in 1973, and fry have been released each year since (KRAA 1998b; Figure 1). Pink fry are released directly into Big Kitoi Bay after a period of net pen rearing in saltwater (Figures 2 and 4). Returning adults are harvested in Duck, Izhut, and Kitoi Bays (Figure 2). The original pink salmon enhancement projects at Little Waterfall and Portage Creeks, as described previously, have continued each year since their inception (Figure 6). Improvements to the fish passes have been made, resulting in increased pink salmon production.

Evaluation and Monitoring

The aforementioned salmon enhancement and rehabilitation projects are evaluated and monitored each year (ADFG 1998; Figure 7). Limnological and fisheries information is collected at each system, including lake primary and secondary production data, juvenile rearing trend data, smolt emigration data, and adult run data. In addition, rearing hatchery fish are assessed for baseline data and, at Kitoi Bay Hatchery, juvenile sockeye salmon are marked to assess the success of different stocking strategies.

The purpose of this report is to summarize salmon stocking, lake enrichment, and other enhancement and rehabilitation activities in 1998, as well as the results of previous year's activities in terms of 1998 evaluation and monitoring data. In addition, previous years' data are presented in a series of appendices.

Description of the Study Area

The study area is located within the Kodiak Management Area (KMA) which comprises waters in the western Gulf of Alaska surrounding the Kodiak Archipelago and the Alaska Peninsula between Cape Douglas and Kilokak Rocks at Imuya Bay (Brennan 1998). The archipelago is composed of Kodiak, Afognak, Shuyak, and many of the smaller area islands.

Salmon enhancement and rehabilitation investigations have encompassed an area from Red Fox Lake (58° 26' N. Lat., 152° 34' W. Long.,) on the northwestern end of Afognak Island to the Olga Lakes (commonly known as Upper Station Lakes) on the southwestern end of Kodiak Island (57° 04' N. Lat., 154° 15' W. Long.; Figure 1). Initially, selected lakes within the study area were assessed for enhancement (stocking) and rehabilitation (fertilization and/or stocking) potential and categorized as such. As more was learned about each system and projects initiated, the lakes were grouped by island location (Kodiak or Afognak) and classified as an enhancement (barren), rehabilitation (anadromous), or monitored system (Table 1). The morphology of each lake has been assessed in terms of surface area (SA), mean depth (MD), maximum depth ($M_{ax}D$), and volume (Appendices C.1-C.5, D.1, E.1, F.1, G.1, H.1, I.1-I.2, J.1-J.3, K.1, L.1, M.1, N.1, O.1, P.1, Q.1-Q.2, and R.1-R.19). Other limnological characteristics such as euphotic zone depth (EZD) and euphotic volume (EV) were also measured for each lake.

Crescent and Spiridon Lakes are enhanced systems where continual stocking of juvenile sockeye salmon is required to maintain supplemental returns (Table 1; Figures 1 and 4). Crescent Lake sockeye salmon (Afognak Lake brood source) return in late May through June. Returning adults are available for 100% harvest in the traditional commercial and subsistence fishing areas (Central Section of the Northwest Kodiak District). The Settler Cove Terminal Harvest Area (SCTHA) was created to harvest adults that escaped the fisheries to the stream terminus (Figure 5). The Spiridon Lake sockeye salmon (Olga and Saltery Lake brood sources) project was originally established as a late run stock. Project goals were changed to a stock with an earlier run timing in order to reduce the incidental harvest of local wild pink and chum salmon stocks. Returning adults are harvested in the traditional areas (purse seine and gillnet) of the Northwest Kodiak District. The Spiridon Lake Terminal Harvest Area (SLTHA) was created to harvest excess fish that eluded outside fisheries (Figure 5).

Other lakes without anadromous salmon runs on Kodiak Island that were investigated for background limnology data include Dry Spruce, Goat, Summit and Silver Salmon Lakes (Table 1; Figure 1). Goat Lake is considered a good candidate for an instream or on-site incubation facility due to its favorable hydrological and limnological characteristics.

Karluk, Frazer, and Bare Lakes are the only lakes on Kodiak Island that have had salmon rehabilitation programs, although many other lakes have been monitored for limnology and fishery data (Table 1; Figure 1). The lakes on the southwestern end of Kodiak Island are the most productive (sockeye salmon escapement and harvest) systems in the Kodiak archipelago. The largest sockeye salmon runs (>500,000 on average) in this area return to Karluk, Red, Frazer, and the Olga Lakes. Sockeye salmon escapement timing into these systems varies from mid May to late September. Minor producing sockeye salmon systems in this area that have an early to mid summer run timing are Little River, Uganik, Mush, (Northwest Kodiak District) and Horse Marine (Alitak Bay District) Lakes. Karluk, Akalura, and the Upper Station Lakes each contain an early and a late sockeye salmon component extending from May to mid-September.

Buskin, Saltery, and Rose Tead Lakes are considered minor sockeye salmon systems and are located on the northeast end of Kodiak Island in proximity to the City of Kodiak (Table 1; Figure 1). The Buskin Lake sockeye escapement returns early, beginning in late May to the end of July. Saltery and Rose Tead Lake sockeye salmon return in late June through early August.

Other anadromous salmon systems on Kodiak Island proper that have been monitored include Barabara, Miam, and Sitkalidak Lakes (Table 1; Figure 1). Of these, Barabara Lake, located on the northern portion of the island has a sockeye salmon run that was considered depressed in the early 1990s, but may be rebounding as a result of a reduction in targeted subsistence fishing. Subsistence fishing by Port Lions residents has been focused more on enhanced Crescent Lake sockeye salmon in recent years (L. Malloy, KRAA, personal communication, Kodiak)

Hidden, Jennifer, Little Kitoi, Little Waterfall, and Ruth Lakes are enhanced systems located on Afognak Island where continual stocking of juvenile sockeye salmon is required to maintain returns (Table 1; Figures 1 and 4). Hidden and Little Waterfall Lakes sockeye salmon (Afognak Lake brood source) return in late May through June. Adult sockeye salmon that return to Foul Bay (Hidden) and Waterfall Bay (Waterfall) THAs are available for 100% harvest (Figure 5). The Little Kitoi Lake sockeye salmon project was originally established as a late-run (Upper Station stock) broodstock development program; however, project goals were changed to an earlier run timing. The earlier run timing of the Saltery Lake stock would reduce the incidental harvest during the directed pink salmon fishery at Kitoi Bay Hatchery (Honnold et al. 1998). In addition, early run sockeye salmon (Afognak Lake stock) that were stocked into Little Kitoi Lake were discontinued when the late-run Upper Station stock was changed to the Saltery Lake stock. The stocking strategy was to only stock Saltery Lake sockeye salmon. Jennifer Lake was also stocked with a late-run Upper Station stock and stocking was discontinued when the late-run broodstock was changed. Ruth Lake has been stocked with Saltery Lake sockeye each year since 1996. Returning adults (both broodstocks) from the Kitoi Lakes (Little Kitoi, Jennifer, and Ruth) are harvested from late June through mid-September in the Izhut Bay, Duck Bay and Kitoi Bay statistical fishing areas (Figure 2). Once the returns are from only the new broodstock (Saltery Lake), the run will end by mid to late August. The Kitoi Bay Special Harvest Area (KBSHA) is a designated area for hatchery personnel to collect broodstock and/or open a cost recovery fishery, when either option was necessary (Figures 2 and 5).

Other lakes without anadromous salmon runs on Afognak Island that have been monitored for limnology data include Sorg, Big Waterfall, Big Kitoi, and Pillar Lakes (Table 1; Figure 1). Sorg Lake was stocked with sockeye salmon in 1997; however, stocking was discontinued because an artificial outlet was not constructed as planned to provide for smolt emigration. Big Waterfall Lake was also stocked one year (1992).

Afognak Island anadromous sockeye salmon stocks (Afognak, Pauls/Laura, Portage, Thorsheim, Malina, Red Fox, and Little Afognak) enter their respective systems starting in late May with peak escapements occurring in June (Figure 1). Afognak Lake and the Pauls Lake system are the largest sockeye salmon producers on Afognak Island. Escapements into Afognak Lake have exceeded the upper escapement goal (60,000) every year for the past ten years. The sockeye salmon escapement goals (20,000-40,000) for the Pauls Lake system were not being met from the mid-1980s to the early 1990s. Sockeye salmon escapements to the Pauls Lake system ranged from a high of 50,933 (1980) to a low of 3,237 (1991), and an average escapement of 19,432. Sockeye salmon escapements into Portage Lake from weir count estimates have averaged 3,200 from 1985-1993 and 8,850 from index escapement counts (1994-1998). Sockeye salmon escapements into the Malina Lakes system have averaged 9,733 from 1992-1998. Thorsheim and Red Fox Lakes are considered minor sockeye salmon systems in this area with limited escapement information.

Coho, chum, and pink salmon enhancement projects occur at Kitoi Bay Hatchery and Kitoi area lakes. Coho enhancement projects have been ongoing at Katmai Lake, near the Village of Ouzinkie, and Crescent Lake, near the Village of Port Lions (Figures 1-2, 4). Pink salmon enhancement projects at Little Waterfall and Portage Creeks increased spawning habitat availability when the steeppasses became operational (Figures 1 and 6). Returning sockeye and chum salmon adults from projects in the Kitoi Bay area return in June and July, pink salmon return in July and August, and coho salmon return in August and September. Katmai and Crescent Lake coho are primarily harvested in subsistence and sport fisheries near the villages in August and September. Pink salmon returning to Little Waterfall and Portage are harvested in the Perenosa Bay section during late July and August.

OBJECTIVES

The 1998 objectives for salmon enhancement and rehabilitation projects are described in the Pillar Creek Hatchery (Honnold et al. 1998) and Kitoi Bay Hatchery (Hall et al. 1998) Annual Management Plans (AMPs). Similarly, the evaluation and monitoring objectives for 1998 are outlined in individual operational plans by project (ADF&G 1998). Previous year objectives were similar to 1998 and can be reviewed in Pillar Creek Hatchery and Kitoi Bay Hatchery Basic Management Plans (KRAA 1998a,b), previous year AMPs (ADF&G 1989; ADF&G 1990; ADF&G 1991a,b-1994a,b; Honnold and Clevenger 1995; Honnold and Joyce 1995; Clevenger et al. 1996, 1997; Hall et al. 1996, 1997), and ADF&G operational plans (unpublished 1990-1997).

METHODS

Hatchery Production

Kitoi Bay Hatchery

Two general methods of hatchery production were used in 1998 to enhance and/or rehabilitate salmon stocks in the KMA. KBH was utilized as a (1) *site specific* production facility to incubate and rear four species of juvenile salmon (Hall et al. 1998, 1999; Figures 1 and 2). The hatchery program focused on an on-site egg take (Big Kitoi Creek-BKC and Little Kitoi Creek-LKC), incubation, and rearing (all life stages) strategy. Pink and chum salmon were reared in saltwater net pens and released in Big Kitoi Bay (BKB), timing releases with area plankton blooms. Most coho were reared in raceways (depending on release strategies) and short-term reared in net pens before release in BKB. Sockeye salmon smolt were also reared in raceways and short term reared in net pens before release into Little Kitoi Bay. A smaller portion of coho and sockeye salmon were reared in raceways at the hatchery and released into designated lakes in the Kitoi Bay area that do not have anadromous salmon runs (barren lakes).

Saltwater releases in 1998 included 127,685,500 pink salmon (BKC broodstock), 6,859,982 chum salmon (BKC broodstock), 769,000 coho salmon (BKC broodstock), and 397,000 late-run

(Upper Station broodstock) sockeye salmon (Table 2; Figures 2 and 3). In addition, Little Kitoi Lake was stocked with 99,085 late-run (LKL) sockeye salmon. In 1998, 165,000 coho salmon (BKC broodstock) were stocked into Jennifer Lakes and 35,000 coho (BKC broodstock) were stocked into Ruth Lake. A portion of the saltwater and freshwater sockeye salmon releases were marked (fin-clipped) to assess survival and assist with run reconstruction.

Another hatchery production method employed in 1998 was (2) *remote lake outstocking*. This entails incubation and rearing at the hatchery and then releasing juvenile salmon into lakes located in areas distant from the facility. This included barren lake (enhancement projects) or anadromous system (rehabilitation projects) stockings. Remote lakes stocked via KBH in 1998 were Crescent (163 thousand BKC coho salmon) and Katmai (14,000 BKC coho salmon) Lakes (Table 2; Figures 2 and 4). Historical KBH salmon releases are described, by species, in Appendices C.6-C.12.

Pillar Creek Hatchery

The Kodiak Island area remote lake outstocking program has been primarily associated with Pillar Creek Hatchery (PCH; Honnold et al. 1998, 1999; Figure 1). PCH was constructed for the primary purpose of stocking barren lakes and to rehabilitate depressed anadromous systems. PCH raises sockeye salmon juveniles for stocking several barren lakes in the Kodiak Island area (Honnold et al. 1998, 1999). In addition, a small number of coho salmon are reared at PCH to enhance sport fish opportunities along the Kodiak Island road system. Sockeye salmon egg takes for barren lake stocking occurred at Afognak and Saltery Lakes (Figure 1). Egg takes have also occurred at Upper Station Lakes (Olga Lakes). Juvenile sockeye salmon are incubated and reared at PCH to the fry, fingerling, and presmolt life stages, prior to release into the selected lakes.

In 1998, early-run sockeye salmon (Afognak Lake broodstock) releases from PCH included 340,400 into Hidden Lake, 237,300 into Little Waterfall Lake, and 571,000 into Crescent Lake (Table 2; Figure 4). Early-run sockeye salmon releases into Little Kitoi and Sorg Lakes were discontinued after 1997. In 1998, Spiridon Lake was stocked with 3,340,000 sockeye salmon and 100,000 were stocked into Ruth Lake (Saltery Lake stock) from PCH (Table 2; Figure 4). Historical releases of sockeye salmon from PCH into the aforementioned barren lakes are described in Appendices D.2, E.2, F.2, and G.2. Also, in 1998, approximately 135,000 coho salmon juveniles were stocked into Kodiak Island lakes located on the road system (Honnold et al. 1999).

Remote outstocking of juvenile sockeye salmon incubated and reared at PCH occurred at two anadromous systems in 1998. Afognak Lake was stocked with 422,700 juveniles and Upper Malina Lake with 350,500 sockeye salmon juveniles (Table 2; Figure 4). Both systems were stocked with juveniles originating from their respective native stocks. In 1997, the Pauls Lake sockeye salmon escapement goal was achieved, resulting in the projected spawners into the system sufficient for natural recruitment of juvenile sockeye salmon. Therefore, the planned egg take was cancelled, and Laura Lake was not stocked with sockeye salmon juveniles in 1998. Historical releases of sockeye salmon from PCH into the aforementioned anadromous lakes are described in Appendices H.2, I.3, and J.4.

The fish culture methods used to incubate, rear, and release the salmon that were stocked from KBH and PCH are described in the respective hatchery annual management plans (Hall et al. 1998

and Honnold et al. 1998). In addition, the 1998 egg takes are described in Hall et al. (1999) and Honnold et al. (1999).

Planning Annual Stocking Levels

The primary considerations in developing stocking recommendations, are most importantly, the forage base status of each lake, and secondarily, the rearing limitations (i.e., lack of water, rearing units) at Pillar Creek Hatchery and Kitoi Bay Hatchery. The initial stocking capacity for each lake was determined by analyses of the bathymetry and two years of light penetration data. These data were applied to a euphotic volume (EV) model as described by Koenings and Burkett (1987). Individual analyses resulted in a recommended range of fry released into a lake, which could produce either threshold (60 millimeter or 2 gram) or optimal (85 millimeter or 5 gram) size sockeye salmon smolt. The lower or optimum level was used as a guide for beginning stocking projects at each barren lake. Stocking levels for anadromous lakes that were considered rehabilitation candidates were adjusted based on fry recruitment from the parent year escapement.

In addition, previous stocking projects provided new insight to modify the EV model calculations used to adjust stocking capacities for some lakes. Consequently, for the last several years, stocking levels have been dynamic, and adjusted in accordance with the zooplankton abundance and biomass trends at each lake. The anadromous systems (Afognak, Malina, and Laura Lakes) are evaluated for stocking levels in a similar manner to the barren lakes; however, escapement and lake enrichment are significant factors considered in planning. Lake enrichment has successfully increased the zooplankton abundance and biomass in these lakes and allows more flexibility in stocking. In 1994, a response to declines in the forage base at barren lakes resulted in the implementation of a pre-smolt rearing strategy at the hatcheries. This rearing strategy, in which sockeye salmon are reared until October, was employed to reduce rearing time in the stocked lakes to take advantage of the lower basal metabolism of juveniles in order to lessen the impact on the zooplankton population. Preliminary data indicate that this strategy has worked. Most barren lakes (Hidden, Waterfall, and Little Kitoi) are now stocked with pre-smolt. Hidden Lake was stocked for several years with both fry and presmolt; however, reductions in zooplankton indicate that pre-smolt may be the only option to continue production until the forage base rebounds. Anadromous lakes, however, appear more resilient, and rebound quicker when overgrazing of the zooplankton population occurs. Fertilization buffers anadromous lakes, allowing fry to be stocked at higher levels under the rehabilitation program.

The goal of the planning process is to incorporate what has been learned to maintain healthy lake rearing environments while continuing smolt and adult production at cost effective levels. The former ADF&G Limnology Section advised ADF&G Kodiak staff and KRAA staff on the appropriate stocking levels for each lake on an annual basis from 1993-1996. Typically, the zooplankton data analysis for a given year was complete by early winter and initial stocking recommendations were provided prior to drafting the AMPs. Recommendations from the Limnology staff were utilized to adjust the next egg take/rearing cycle a year in advance. For example, 1995 zooplankton data would be used to recommend stocking for 1997. These

recommendations were adjusted slightly to accommodate the rearing capacity and schedule of the hatcheries.

Since 1996, in-season analysis of zooplankton data collected at each lake stocked assisted with planning current year stocking adjustments (if needed) and also the following year's goals. The Limnology staff provided stocking recommendations the initial year of in-season analysis. Beginning in 1997, limnology support was discontinued, and Kodiak ADF&G staff developed the stocking recommendations (Honnold et al. 1999).

Lake Enrichment

From 1990-1998, lake enrichment programs are still ongoing at Afognak (started in 1990), Malina (upper lake was started in 1991 and the lower lake was started in 1996), Laura (1993), and Little Waterfall Lakes (started in 1994; Figure 3). Lake enrichment projects were completed at Karluk (1986-1990), Frazer (1988-1992), and Portage (1993-1997) Lakes (Figure 1). The intent of the lake enrichment projects are to increase zooplankton biomass, increase fry growth and survival, and increase adult returns.

Lakes were treated with nutrient additions composed of an aqueous nitrogen (N), white phosphorus (P), and potassium (K; 20 N-5 P-0 K ratio) solution sprayed from a fixed wing aircraft (Kyle 1994; Koenings and Kyle 1997). The fertilizer type was dependent upon the phosphorus and nitrogen levels. Phosphorus was added in the form of inorganic phosphate and nitrogen as a mixture of ammonium, nitrate, and urea. The fertilizer N-to-P ratio of 20:1 was the optimal ratio used for non blue-green algal production. Calculations were based on supplemental phosphorus levels on an annual mean loading rate of 90% according to equations by Vollenweider (1976). The fertilizer was applied to the lake surface on a weekly basis from June through August and was distributed to minimize rapid flushing of nutrients. The amount of liquid fertilizer applied in 1998 ranged from 3,084 (lower Malina) to 26,848 (Afognak) kilograms (Table 3). Historical nutrient applications by lake are described in Appendices F.3, H.3, I.4, J.5, K.2, L.2, and M.2.

Barrier Bypasses – Increasing Available Habitat

Another method used to increase salmon production in the Kodiak Island archipelago has been the installation and operation of barrier bypasses (also referred to as fishways, steeppasses, fish passes, or fish ladders) to provide for access and use of previously unavailable spawning and rearing habitat. Currently, there are eight operational bypasses in the Kodiak Island archipelago: Dog Salmon Creek (Frazer River) fish pass is located on Kodiak Island and Little Kitoi Lake, Portage Creek, Laura Creek, Gretchen Creek, Little Waterfall Creek, and Seal Bay Creek fish passes are located on Afognak Island (Table 4; Figure 6). The Seal Bay Creek fish pass on northern Afognak Island has not always been operational, and annual maintenance was not conducted on a regular basis prior to 1998.

Frazer Lake Bypass System

Dog Salmon Creek (Frazer River) has a 10 meter (m) high barrier falls, which originally blocked fish migrations into Frazer Lake (Blackett 1979; 1987; Table 4). Sockeye salmon were introduced into Frazer Lake beginning in 1951 (chinook salmon were introduced in 1966) and an Alaska steeppass, approximately 60 m long was constructed in 1962 to overcome the impassable falls (Appendix L.3 photo). A second fish pass was constructed alongside the first and became operational in 1979 (Blackett 1987). Sockeye and king salmon utilize habitat above the falls as a result of the fish pass.

Gretchen and Laura (Pauls) Creek Bypasses

A 9.1 m Alaska steeppass was installed on Gretchen Creek in 1959 to bypass a 2.4 m barrier falls (Honnold and Edmundson 1993; Table 4; Appendix J.6 photo). Gretchen Creek is the main tributary to Laura Lake, which in turn drains via Laura (Pauls) Creek into Pauls Lake (Figure 6). The primary sockeye salmon spawning habitat in this system is located in Gretchen Creek and much of the habitat is upstream of the fish pass.

The original fishway installed at Laura (Pauls) Creek in the 1950s was replaced in 1964 with a 27.4 m run of steeppass to bypass the highest barrier (5.5 m) between Pauls and Laura Lakes (Table 4; Appendix J.6 photo). Sockeye salmon were introduced into Gretchen Creek from 1951-1955 and began using the fishways in the mid-1950s and continue to rely on these structures annually to remain self-sustaining. Coho salmon also use these bypasses and have substantially expanded their use of habitat upstream of Pauls Lake as a result.

Little Kitoi Lake Bypass

The Little Kitoi steeppass (and concrete raceways) was originally designed in the 1950s to provide adult salmon access into the lake while enumerating and sampling outmigrating salmon smolt, simultaneously. A 1.8 m barrier falls at the outlet of Little Kitoi Lake is bypassed with a 12.2 m steeppass to provide access to the lake by coho and sockeye salmon, and a small number of pink salmon (Table 4). The fish pass drains directly into Little Kitoi estuary (Appendix C.13 photo). The base of the bypass is flooded on 1.6 m or greater tides; however, in most cases, the ladder is easily accessible to returning salmon twelve to sixteen hours per day.

Little Waterfall Creek Bypasses

Little Waterfall Creek has several barriers (1.8 m, 2.4 m, 7.3 m, and >10m) that prevented salmon from migrating upstream to spawn (Table 4). Bypasses were constructed and installed on the first three barriers, to enable pink and coho salmon access to previously unavailable spawning habitat (Edmundson et al. 1994a; Honnold 1997b; Honnold 1999). Two of the bypasses (9.1 m and 12.2 m) were constructed and installed in Little Waterfall Creek in the mid-1970s (Appendices F.4 photos). The construction and installation of a third bypass (the largest at 31.9 m and most upstream) was completed in the fall of 1980 and renovated to improve fish passage, in 1995 (Appendix F.4 photo).

Portage Creek Bypass

A steeppass was installed in 1969 on Portage Creek to primarily provide pink salmon access into previously unused habitat above a small 1.8 m barrier (Table 4; Appendix K.3 photo). Sockeye and coho salmon also use the steeppass, even though previous spawners were not impeded by the falls except during high water periods.

Adult Bypass Summary

The steeppasses are maintained and operated by the ADF&G annually from late May through early September to provide salmon access to the spawning grounds (ADF&G 1998). In 1998, as in past years, diversion weirs were used at Frazer River and Little Waterfall Creek to guide salmon to the entrance of the steeppasses and prevent 'wash over' upon their exit from the upper end of the steeppasses (Appendix L.3 and F.4 photos). The remaining steeppasses do not require diversion weirs; however, water diversion structures are often used at low flow periods upstream of the bypasses to keep them operational (Appendix F.4, J.6, K.3, and L.3). Specific sampling and escapement estimation methods associated with all the steeppasses are described in system-specific operational plans (ADF&G 1998).

Spiridon Lake Smolt Bypass

A bypass system has been installed and operated at Telrod Creek (draining Spiridon Lake) to move sockeye salmon smolt downstream around injurious barrier falls, since 1992. Stocked fry utilize the nursery habitat in Spiridon Lake and migrate out as smolt via a pipeline around the falls to the marine environment. The current bypass consists of a smolt weir, two Canadian-type fan traps, two tanks for dewatering, one tank for enumeration and sampling (Appendix D.3 photo), and a 756 m long 15 cm inside diameter pipeline. The initial design was improved in 1993 with the addition of structural aluminum tanks that replaced wood construction. Smolt are enumerated and sampled for age and size as they pass through the bypass system. For a more detailed description of the design and materials used and other methods, refer to Hornold (1997a) and ADF&G (1998).

Stream Clearance

The last method to provide for improved access to spawning and rearing habitat is stream clearance. In 1998, Jennifer, Ruth and Elk (Little Kitoi) Creeks in the Kitoi Bay area (Figure 6) were examined periodically to ensure that no obstructions to smolt passage existed. Beaver dams on the Ruth Lake outlet were removed upon discovery. Low to no water flow between Upper and Lower Jennifer Lakes required personnel to occasionally dig out the channel to increase water flow. The outlet creek at Lower Jennifer Lake was also checked for beaver dams blocking smolt passage and removed, if necessary. Beaver dams blocking salmon migrations were also removed upon discovery on the outlet creek from Gretchen Lake (Figure 6).

Harvest Opportunities for Enhanced Salmon

Salmon enhancement projects require methods for harvesting adult salmon returns in an orderly fashion and without adversely affecting wild stocks (Honnold et al. 1998; Hall et al. 1998). Harvest strategies for enhanced salmon returns include special openings in designated terminal harvest area (THA) and, if broodstock collection is required, in Special Harvest Areas (SHA). These harvest strategies are part of management plans for the KMA previously approved by the Alaska Board of Fisheries (BOF; Prokopowich 2000). There is one SHA (Kitoi Bay SHA) and four THAs (Settler Cove THA, Foul Bay THA, Waterfall Bay THA, and Spiridon Lake THA) in the KMA.

Kitoi Bay SHA

The Kitoi Bay harvest strategy is described in the Eastside Afognak Management Plan (5AAC 18.365) for the Duck, Izhut, and Kitoi Bay Sections (ADF&G 1996; Hall et al. 1998; Figure 2). The Kitoi Bay Hatchery provides enhanced salmon fishing opportunities for the Kodiak common property fisheries by increasing returns of sockeye, coho, pink and chum salmon to Kitoi Bay (Hall et. al 1999). The Kitoi Bay SHA was created to harvest all excess salmon after broodstock needs are met (Table 5). Kitoi Bay SHA boundaries are all waters northwest of a line from the regulatory markers located at the entrance to Kitoi Bay commonly known as "the jaws" (Hall et al. 1999; Figure 5; Appendix C.14).

Settler Cove THA

Juvenile sockeye salmon have been stocked into Crescent Lake annually, since 1992 (Honnold et al. 1998; Figure 3; Appendix G.2). Crescent Lake, a barren lake, empties into Settler Cove, part of Kizhuyak Bay. These areas are managed within the Central Section of the Northwest Kodiak District. Coho salmon have also been stocked into the lake each year since 1988 (Appendix G.2). A management plan was adopted (5AAC 18.364) by the Alaska BOF in 1990 governing the harvest of Crescent Lake coho salmon (Brennan 1998). This plan did not cover a harvest strategy for returning sockeye salmon. However, a terminal harvest area was established into regulation, 5AAC 18.377, to provide for the harvest of returns to Settler Cove (Figure 5). The Settler Cove Terminal Harvest Area boundaries are all waters of Settler Cove west of 152° 50.80' W long. (Table 5; Appendix G.3).

Foul Bay THA

Juvenile sockeye salmon have been stocked into Hidden Lake annually since 1992, under a cooperative agreement between the United States Fish and Wildlife Service (USFWS), ADF&G, and the KRAA (White 1992; Honnold et al. 1998; Figure 3; Appendix E.2). The intent of this project is to enhance the common property fishery in the KMA using an early-run (June to early July) sockeye salmon stock (Afognak Lake) returning to Foul Bay. The Foul Bay Terminal Harvest Area (in regulation 5ACC 18.375) boundaries encompass all waters of Foul Bay east of 152° 47.20' W long. to the terminus of Hidden Creek (stream #251-406; Table 5; Figure 5; Appendix E.3). All returning adult sockeye salmon are available for harvest in the commercial fishery by the installation of a barrier weir across Hidden Creek (Appendix E.4).

Waterfall Bay THA

The Waterfall Lake early-run sockeye salmon enhancement project was started in 1992 to increase the fish available for commercial harvest by the permit holders in the KMA (Honnold et al. 1998; Figure 4; Appendix F.2). Little Waterfall Lake has been used as a rearing area for juvenile sockeye salmon that eventually migrate to the ocean and return to Waterfall Bay as adults. All returning adult sockeye salmon are made available for commercial harvest by the use of a barrier net blocking salmon migrations into Little Waterfall Creek (Appendix F.5). The Waterfall Bay THA was put into regulation (5AAC 18.376) to provide for the orderly harvest of the commercial fishery. The THA boundaries include all waters within one nautical mile of Little Waterfall Creek (stream # 251-822; Table 5; Figure 5; Appendix F.6).

Spiridon Lake THA

The Spiridon Lake sockeye salmon enhancement project was initiated in the late 1980s (Honnold 1997a; Honnold et al. 1998; Figure 4; Appendix D.2), under a cooperative agreement between the United States Fish and Wildlife Service (USFWS). The purpose of the project was to provide supplemental sockeye salmon for the commercial harvest in traditional fishing areas (Kodiak's westside) of the KMA. In 1993, the BOF adopted the Spiridon Lake Sockeye Salmon Management Plan (5AAC 18.366) establishing the terminal harvest area at Telrod Cove as a designated area to harvest surplus sockeye salmon (Figure 5). The Spiridon Lake Terminal Harvest Area (SLTHA) boundaries include all waters of Telrod Cove north of a line extending from Stream Point 57° 39.00' N lat., 153° 38.50' W long. to 57° 38.80' N lat., 153° 37.60' W long (Table 5; Appendix D.4). The SLTHA boundary had originally encompassed a larger area in Spiridon Bay but was reduced to Telrod Cove in 1995 to limit interception of chum and pink salmon destined for the Spiridon River at the head of Spiridon Bay.

Evaluation and Monitoring: Limnological Assessment

All lakes were assessed for baseline limnology data for a minimum of two years prior to the initiation of salmon enhancement (stocking) and / or rehabilitation (stocking and/or fertilization) projects. Once stocking and/or fertilization projects were initiated, monitoring annual limnological trends at each lake was continued throughout the program. Lakes in which sockeye salmon broodstocks were collected or were in the post-project phase (lakes are monitored for a minimum of two post-project years) were monitored. In 1998, lakes assessed included Afognak, Little Waterfall, and Malina (lower and upper) Lakes (Table 6; Figure 7). Laura Lake was assessed for fertilization only; Crescent, Hidden, Jennifer (upper), Little Kitoi, Ruth, and Spiridon Lakes were assessed for stocking effects. Saltery Lake was also monitored because of the use of sockeye salmon for broodstock. Spiridon and Hidden lakes were monitored more frequently for more limnological parameters to comply with the USFWS Environmental Assessment (EA) criteria. Lastly, Frazer and Portage Lakes were monitored in 1998 as part of a post-fertilization assessment.

Lake Sampling Protocol

Limnological surveys were conducted on 13 Kodiak and Afognak Island lakes in 1998 (Table 6). Surveys were conducted at ~4-6 week intervals during the ice free season (May-September) for a total of four to five surveys per lake (except for Frazer Lake where only three zooplankton samples were collected). Float-equipped aircraft provided transportation to and from sampling sites. Surveys were conducted after mooring to an anchored buoy (station) at the deepest point in the lake. Because of its relatively large area and EA sampling requirements, two sampling stations were established at Spiridon Lake. At each station, measurements of temperature, dissolved oxygen, light penetration (except at Frazer Lake) were taken, and zooplankton samples collected. In addition, water samples were also collected from Afognak, Hidden, Laura, Little Kitoi, Little Waterfall, Malina, Portage, and Spiridon Lakes. Sampling and laboratory analysis methods are described in detail below or cited from previous reports.

Lake Morphometry

An Eagle[1] model Mach 1 graph recorder (fathometer) was used to chart the bathymetry (bottom profiles) of each lake. Depth profiles were determined for each lake following procedures by Honnold et al. (1996). The surface area (SA) of each contour was determined using a calibrated polar planimeter and a map of the lake. For each lake, the basin volume (V) was derived by summing the volume in each depth stratum or contour (Hutchinson 1957; Wetzel and Likens 1991). The maximum depth (Z_x) was the greatest recorded depth, and the mean or average depth (Z) was derived by dividing the lake volume by the surface area (V/SA).

Light and Water Clarity

Underwater light intensity (foot-candles) or downward light penetration was measured using a Protomatic submersible photometer sensitive to the visible spectral range (400-700 nanometers). Measurements were taken at 0.5-m increments from the surface to a depth of 5 m, and at subsequent 1-m increments to the lake bottom or to a depth equivalent to 1% of the subsurface reading. The vertical extinction coefficient for downward light (K_d, m^{-1}) was obtained from the relation:

$$I_z = I_o e^{-Kd} \text{ or } \ln I_z = \ln I_o - K_d z \qquad (1)$$

where I_z and I_o are the values of light penetration at z meters (m) and just below the surface, respectively (Wetzel and Likens 1991). The linear regression coefficient of $\ln I_z$ against depth (z) gives the value of K_d. Assuming K_d is constant with depth, the euphotic zone depth (EZD) or the depth at which 1% of the subsurface light remains, is given by $4.6/K_d$ (Kirk 1994). Water transparency was measured using a standard 20-cm diameter black and white Secchi disk as the depth at which the disk just disappears and reappears from the observer's view. The two readings were averaged.

[1] Mention of commercial products and trade names does not constitute endorsement by ADF&G.

Temperature, Dissolved Oxygen, and Salinity

Temperature profiles (°C) and dissolved oxygen levels (DO; milligrams/liter) were measured from the lake surface to the bottom or to a maximum depth of 50 meters at 1-m increments using a YSI model 50-B analyzer. Temperature probe accuracy was calibrated against a mercury thermometer in each lake. The meter self-calibrates for DO levels, and personnel responsible for sampling would double-check the DO levels against the temperature and altitude conversion table on the back of the meter to ensure the meter was working properly.

General Water Chemistry and Nutrients

Water samples for general water chemistry and nutrient analysis were collected from the 1-m stratum and a sample just off the lake bottom or at the 50-m depth using a 6-L opaque Van Dorn sampler. The contents were then emptied into a pre-cleaned polyethylene carboy. Carboys were kept cool and dark in the float of the plane until processed at the lab in Kodiak. Samples for color and dissolved inorganic nutrients were filtered through a rinsed 47 mm-diameter Whatman GF/F cellulose fiber filter and stored frozen in phosphate free soap-washed poly bottles until analysis. Samples for the analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and general water chemistry were stored as frozen filtered and unfiltered samples, and refrigerated samples (4° C) in clean poly bottles (Koenings et al. 1987; Honnold 1997).

Conductivity was measured with a YSI model-32 conductance meter and the readings were standardized to 25° C. The pH of water was measured with an Orion 499A meter. Alkalinity (mg L^{-1} as $CaCO_3$) was determined from 100-ml sample titrated with 0.02 N H_2SO_4 to a pH of 4.5 and measured with a pH meter (AHPA 1985). Calcium and magnesium levels were determined on the same sample from separate ethylene diamine tetra acetic acid (EDTA) titrations as detailed by Golterman (1969).

Total iron was determined colorimetrically after HCL digestion and reduction with hydroxylamine (Golterman 1969; Strickland and Parsons 1972). Turbidity, expressed as nephelometric turbidity units (NTU), was measured with a calibrated HF model DRT100 turbidimeter. Water color was determined from the spectrophometric absorption of filtered water samples at 400 nanometers (nm) converted to equivalent platinum cobalt (Pt) units after Koenings et al. (1987).

Filterable reactive phosphorus (FRP) was analyzed by the molybdate blue-ascorbic acid method (Murphy and Riley 1962) as modified by Eisenreich et al. (1975). Total phosphorus (TP) was analyzed after potassium persulfate digestion using the FRP procedure (Eisenreich et al. 1975). Samples for nitrate + nitrite (NO_3^- + NO_2^-) and ammonia (NH_4^+) were analyzed on a Technicon autoanalyzer using the cadmium reduction and phenylhypochlorite methods, respectively as outlined in Stainton et al. (1977). Analysis of total Kjeldahl nitrogen (TKN) utilized the acid block digestion and phenate methodology devised by Crowther et al. (1980).

Soluble reactive silicon (SR-Si) concentrations were determined using the automated ascorbic acid reduction procedure (Stainton et al. 1977). Samples for particulate organic carbon (POC) analysis were filtered (sample volume usually 0.5 or 1.0 L) under low vacuum (15 psi) onto

rinsed Whatman GFF filters. Filters were stored frozen in separate plexiglass slides until analyzed. For POC analysis, the wet oxidation technique with dichromate described by Newel (1982) was used.

Hydrogen Sulfide

An anoxic hydrogen sulfide layer was discovered on the bottom of Little Kitoi Lake in 1990 (ADF&G 1998). In 1995, a high quality, high density polyethylene pipe (10-cm diameter) was submerged in the lake in the basin with the majority of hydrogen sulfide. The pipe extended from the basin to the Little Kitoi fish pass compound and was configured to provide for gravity flow over the compound spillway. Once all salmonids had moved into the lake in the fall of 1995, the hydrogen sulfide was gravity fed from the lake into the Little Kitoi estuary. Siphoning continued through the winter and early spring to remove the anoxic hydrogen sulfide.

In 1997 and 1998, water samples were collected using a Van Dorn sampler from 1 m, 22 m, and 25 m in Little Kitoi Lake and tested for the presence of hydrogen sulfide. Samples were collected and prepared for analysis as outlined by Strickland and Parsons (1972) and Cline (1969) and modified by Koenings et al. (1987). Sulfide converted to a violet-colored compound by its reaction with p-phenylenediamine and ferric chloride.

Chlorophyll *a*

Discrete depth samples for the analysis of the algal pigment chlorophyll *a* (chl *a*) were collected as described previously for the water samples. For chl *a* analysis, 1.0 L of sample water was filtered through a Whatman GF/F filter under 15 psi vacuum pressure. Approximately 2 ml of magnesium chloride ($MgCO_3$) were added to the final 50 ml of sample near the end of the filtration process. Filters were stored frozen and in individual plexiglass slides until analyzed. Filters were ground in 90% buffered acetone using a mechanical tissue grinder and the slurry was refrigerated in separate 15-ml glass centrifuge tubes for 4 hours to ensure maximum pigment extraction. Pigment extracts were centrifuged, decanted, and diluted to 15 ml with 90% acetone (Koenings et al. 1987). The extracts were analyzed fluorometrically with a Turner 112 fluorometer equipped with a F4T5B lamp and calibrated with purified chl *a* (Sigma Chemical). After the initial fluorescence reading, the extract was acidifed with 0.05 ml 0.2 N HCL and reread to correct for phaeophytin (Riemann 1978).

Zooplankton

Vertical zooplankton hauls from each site were collected using a 0.2 m diameter, 153 μm mesh, conical net. The net was pulled manually at a constant speed (~0.5 m sec^{-1}) from 2-m off the lake bottom or from a maximum depth of 50 m to the surface. Net contents from each tow were emptied into separate 125-ml polybottles and preserved in 10% neutralized formalin. Cladocerans and copepods were identified according to taxonomic keys in Pennak (1989) and Thorp and Covich (1991). Zooplankton were enumerated and measured in triplicate 1-ml sub-samples taken with a Hansen-Stempel pipette and placed in a Sedgewick-Rafter counting chamber. Lengths of 15 animals of each species were measured to the nearest 0.01 mm and the

mean body length for each taxon was calculated. Biomass was estimated from species-specific linear regression equations between length and dry weight derived by Koenings et al. (1987).

Marine Temperature, Salinity, and Plankton Sampling

Temperature (°C) and salinity in parts per thousand (0/00) profiles were determined at four sites in Kitoi Bay using a YSI model 33 S-C-T meter. Readings were taken at the surface down to 20 meters or just off the bottom at 1-m increments.

Plankton tows were conducted to measure phytoplankton and zooplankton levels at three sites in Kitoi Bay. At each site, two vertical tows were retrieved manually at a constant rate using a 23 cm. diameter, 153 µm mesh plankton net. Both plankton samples were poured into a graduated settling cylinder for 24 hours before measuring. Phytoplankton and zooplankton volumes were measured separately to the nearest milliliter (ml.).

Evaluation and Monitoring: Juvenile Assessment

Indices of Juvenile Rearing Abundance

Hydroacoustic surveys were conducted on Hidden, Little Kitoi, Little Waterfall, Saltery and Spiridon Lakes in 1998 to provide indices of juvenile rearing sockeye salmon populations. Surveys consisted of collecting data along transects perpendicular to the longitudinal axis of each lake. Data were recorded along each transect at night when juvenile sockeye salmon are more likely to be distributed in the upper to middle part of the water column (Unger and Brandt 1989; Hansson 1993; Appenzeller and Leggett 1995). Specific field methods and instruments used for data acquisition are described by the ADF&G (1998).

Analysis of the hydroacoustic data by "Echo Counting" techniques for each lake was conducted by staff using procedures as described by the ADF&G (1998). The lakes' surface area, strata depths, target counts, and percents per stratum were entered into a computer program. Targets (fish) attributable to the estimate were enumerated by zooming to a depth range, working across each depth range in each transect, and counting the number of echoes per fish. The echoes per fish were entered into the computer program. Estimates for each stratum were computer-generated and total population estimates made by summing the strata. The variances and 95% confidence intervals (CI) for the total fish estimates were calculated using formulae after Thorne (1982) described by Kyle (1990).

Species Composition, Age, and Size of Rearing Sockeye Salmon

Townetting was conducted in conjunction with hydroacoustic surveys at Little Kitoi and Saltery Lakes as described by Honnold (1993), Edmundson et al. (1994b), and Swanton et al. (1996). A 2-m x 2-m net (Gjernes 1979) was towed along the axis of each lake at depths where the highest numbers of acoustic targets were observed. The duration of the tow was dependent on the size and depth of the lake. All juvenile sockeye salmon and sticklebacks caught were enumerated and sockeye salmon were preserved in a 10% neutralized formalin solution. Preserved samples were

allowed to stabilize for four to six weeks and then measured to fork length (to the nearest mm), weighed (0.1 g), and condition coefficient calculated (Bagenal 1978). A scale smear was taken from the preferred area (INPFC 1963) of each fish, placed on a glass slide, and ages were assigned after Mosher (1968) using a microfiche projector.

Townet catches were used to estimate the juvenile sockeye salmon population for each survey by multiplying the composition of sockeye in the combined townet catches by the total fish population estimate. Transect and strata variances as well as the 95% CI for juvenile sockeye population estimates were calculated using formulae from Thorne (1983), described by Kyle (1990). Species composition estimates were not made for Hidden, Little Waterfall, and Spiridon Lakes because water clarity complicated the successful capture of sockeye salmon. Few other species reside in these lakes so hydroacoustic estimates were used as indices of rearing sockeye salmon abundance. Estimates of abundance generated by townet data as applied to hydroacoustic data were typically from anadromous lakes (e.g., Saltery Lake) where large populations of sticklebacks occur. These estimates were also considered relative indices of abundance.

Historically, hydroacoustic and townet surveys have been conducted at most project lakes and other lakes previously monitored for fishery trends. Previous surveys occurred at Afognak, Akalura, Crescent, Frazer, Karluk, Laura, Malina, Portage, Red, and Upper Station Lakes (Figure 1).

Sockeye Salmon Smolt Estimates

Frazer and Malina Lakes. Mark-recapture (M/R) dye test programs were reinstituted at Frazer Lake in 1990 and initiated at Malina Lakes in 1992 to estimate the emigrating sockeye smolt populations. The M/R program was conducted each year through 1998 at Frazer Lake. At Malina Lake, the smolt project was discontinued and then reinstated in 1997 and continued in 1998. The methods used at Frazer Lake were similar to those employed at Malina Lake and are described in detail in the 1998 operational plan (ADF&G 1998) and Sagalkin (1999).

Little Kitoi Lake. Each year since 1995, a fyke net trap (4 mm mesh) was set up in the fish pass compound at the outlet of Little Kitoi Lake, in conjunction with an electronic counter, to estimate the sockeye smolt emigrations. The trap and counter system was operated from the 6 May to 7 July in 1998. An average sockeye composition percentage of 93.4% (May 6 - 9) was applied to smolt counts from April 22 - May 5 during which no trapping took place. The goal of the trapping effort was to capture a representative sample of the daily smolt emigration to establish salmon species composition that was applied to the total daily counter number (ADF&G 1998). The proportion of captured sockeye salmon smolt was multiplied by the total counter number to produce a daily emigration estimate, As in 1997, a live box was attached to the fyke net allowing the trap to remain fishing 24 hours a day. The catch was checked twice daily and was tallied and identified to species. Sockeye salmon smolt caught in the live box were examined for fin clips and sub-sampled for age, weight, and length.

Spiridon Lake. As previously described, a bypass system has been used since 1992 to pass smolt emigrating from Spiridon Lake around the outlet falls (Honnold 1997a). In 1998, time counts of smolt passing through the bypass system were used to estimate the daily sockeye smolt outmigration from 23 April to 12 July. Smolt were hand-tallied if there were an insufficient number

of smolt migrating to conduct a time count. Counts were conducted every 30 minutes from 2300 hours through 0500 hours at the "counting box" (most downstream tank), with a target count of 1,000 smolt/period. The counting period (every 1/2 hour) ranged from 1.5 minutes (minimum) to 8.0 minutes (maximum). The duration of the period was determined by the rate of smolt movement, with the minimum time used during large migrations and the maximum time used during slower smolt movements. Counts were facilitated by moving one of the entrance pipes over a catch basket submerged in the tank and using a stop watch to start and end a time period (each entrance pipe drained a separate dewatering tank). The counts were alternated between the two pipes each 30-minute period. The migration estimate (total smolt) per ½ hour was determined by (number of smolt counted per time period) x (time period/30 minutes). Actual counts of smolt were made when migrations were slow, primarily early and late in the season. Smolt in the de-watering and counting tanks holding for more than 24 hours were estimated and then removed manually in buckets and placed in front of the entrance to the pipeline. This technique prevented excessive injury or mortality. In addition, a 6.0 m long, 1.2 m deep seine with 0.6 cm mesh was used to crowd smolt through the system when large numbers were observed holding for long periods upstream of the traps.

Prior to 1998, sockeye salmon smolt emigrations were estimated from other Kodiak Island lakes including Afognak, Akalura (Coggins and Sagalkin 1999), Karluk, Red (Coggins 1997), and Upper Stations Lakes (Barrett et al. 1993).

Sockeye and Coho Salmon Smolt Age and Size

Sockeye and coho salmon smolt were captured to sample for age and size during outmigrations, as described above, from Afognak, Hidden, Laura, Little Waterfall, Portage, and Ruth Lakes. Smolt were collected using a Canadian fan trap, fyke net, incline trap, dip net or beach seine in the outlet stream or drainage of the respective lake. In addition, raceway-rearing smolt or pre-smolt were sampled from Pillar Creek Hatchery and Kitoi Bay Hatchery prior to release. Smolt were anesthetized in a tricaine methanesulfonate (MS-222) and water solution and sampled for AWL as previously described for rearing fish.

Assessment and Monitoring: Adult Production

Enhanced Salmon Runs: Early Run

Crescent Lake. Crescent Lake sockeye and coho salmon runs were monitored by tracking catches in the Settler Cove THA (259-35) through the ADF&G database. Prior to July 16, the THA is not open to commercial fishing unless a large number of adults escape the normal fishing periods in the traditional fishing areas in the KMA. A barrier net was not used to block these two species from entering freshwater, due to natural barriers preventing salmon access to the lake, and the villagers of Port Lions utilize all inriver escapement for subsistence purposes. Subsistence catches were tracked through the ADF&G fish ticket database. Field data are not collected from the Crescent Lake sockeye and coho salmon runs.

Hidden Lake. In 1992, a monitoring camp was established in the southeast corner of Foul Bay ~500 meters from the creek mouth in 1992 to monitor the Hidden Lake sockeye salmon run (ADF&G 1998; Honnold et al. 1998). Returns of sockeye salmon to Foul Bay did not occur until 1994. At that time, age 1.1 fish (jacks) were the only returns to Foul Bay. Beginning in 1995, the Foul Bay Terminal Harvest Area (statistical area 251-41) was designated for the commercial harvest of early run sockeye salmon returning to Hidden Creek. To prevent adult sockeye salmon from escaping into the creek, a barrier weir (Appendix E.4) was installed and maintained from ~1-30 June, annually. The weir was located ~100 m upstream from the stream terminus. Assembling the barrier weir and materials needed are summarized by the ADF&G (1998).

Daily surveys were conducted in Foul Bay to assess sockeye salmon run strength with information relayed to the commercial fishery managers at 0800 and 2000 hour radio schedules. During the fishery, the date, fishing and tender vessel names, fishing location, and estimated catch by species were recorded. All sockeye salmon harvested in the FBTHA (statistical area 251-41) were attributed to the Hidden Lake enhancement project. Field site estimates of salmon catches were compared to the catches reported and summarized on the ADF&G fish ticket database.

Little Kitoi Lake. Early-run sockeye salmon releases were discontinued at Little Kitoi Lake in 1998. However, returns from previous releases continued to be monitored as in past years. Harvests of all salmon species were estimated by field personnel in the Kitoi Bay section (statistical area 252-32) by interviewing fishers and tenders operators. The ADF&G fish ticket database was used to estimate catches in the Kitoi, Duck and Izhut Bay sections (statistical areas 252-30 and 252-31).

The sockeye salmon broodstock development program at Little Kitoi Lake was evaluated and a determination made to change the broodstock from Upper Station Lake to Saltery Lake for the Spiridon Lake enhancement project. In 1998, the sockeye salmon (Upper Station stock) escapement was prevented from entering Little Kitoi Lake due to changes in the broodstock (Honnold 1997; Honnold et al 1998; Hall et al. 1998). The weir was checked daily to ensure that the compound remained "fish tight". Periodically, the fish pass was opened to prevent straying of sockeye salmon holding in the estuary and check for fin clipped fish during fishery closures. Sockeye salmon collected in the compound were examined for marks, sampled, and returned to salt water, where they became available for commercial harvest. Sockeye salmon returned to salt water were hole punched in the caudal fin for an external mark to identify previously sampled fish that re-enter the compound through the fish pass. The fish pass was opened 25 August to permit the passage of coho salmon into the lake.

Little Waterfall Lake. A monitoring camp was established at Little Waterfall Creek in the early 1980s to maintain fish passes and monitor pink salmon production (Honnold 1999). Beginning in 1994, the camp has been utilized to monitor the sockeye salmon return to Little Waterfall Creek. Monitoring activities in the Waterfall Bay THA (statistical area 251-84) parallel those at the Foul Bay THA. The only exception was the use of a barrier net (Appendix F.6) rather than barrier weir. Beginning in 1995, a barrier net 7 meter (24 feet) deep by 183 meter (600 feet) in length with a one inch mesh size was anchored and secured in Little Waterfall Bay, approximately 0.5 km from the creek terminus to prevent sockeye salmon escapement into Little Waterfall Creek.

The net was kept clean of kelp and other debris daily and inspected to insure that it was "fish tight". A buoyed line was installed ~8 meters in front of the net to indicate the area closed to commercial fishing. In 1998, the barrier seine was redesigned and improved upon to better maintain a fish tight barrier. The improved design included the addition of an 18" skirt sewn on either side of the lead line to enlarge surface area for weighing down the net and to create a more even distribution of that weight to either side of the lead line. In addition, the net was installed and suspended from a taught line and stretched between two solid anchors on either bank, high above the top of the net. The net was positioned where the bottom contour was smooth and gently sloped.

Enhanced Salmon Runs: Late Run

Jennifer, Little Kitoi, and Ruth Lakes. Sockeye salmon that returned to Jennifer, Little Kitoi, and Ruth Lakes that were caught in the commercial fishery were sampled for age-length-sex by ADF&G personnel. System specific run evaluations did not occur for Jennifer and Ruth Lakes. Returning adults were harvested in the same statistical areas as Little Kitoi fish.

Spiridon Lake. Spiridon Lake late-run sockeye salmon that escaped the traditional fisheries in the Northwest Kodiak District were targeted for harvest in the Spiridon Lake THA located at Telrod Cove. ADF&G personnel monitored the commercial salmon fishery at Telrod Cove and Spiridon Bay from mid-July to mid-September, 1994-1996 (Honnold 1997a) and 1997-1998. A tent camp was established on Anguk Island in 1994; however, to improve monitoring, the camp was relocated to Telrod Cove in 1995. A seine web (~2.6 cm squares) barrier net ~100 m long and ~7 m deep was installed ~0.3 km seaward of the terminus of Telrod Creek each year from 1995 - 1997. The net was deployed at low tide and set shore to shore attached by cable to cliff out croppings with come-a-longs used to keep it secure and taut. Sandbags and chain were attached to the lead line for additional weight to keep the net in place. Additional large buoys were attached to the floats for buoyancy and to provide increased visibility of the barrier net to vessels fishing in the area. Visual checks were made several times daily to assure that the net was "fish tight," and at low tides, the net was cleaned of debris and repositioned, if necessary. Wildlife activity around the net was monitored daily.

Pink salmon abundance seaward of the net was monitored. When sufficient numbers were present, a local permit holder, using a seine vessel, captured the fish and released the catch into a plastic tote filled with seawater. The fish were transported by raft shoreward over the net at high tide and released. The intent was to release a minimum of 100 pink salmon over the net to provide escapement to lower Telrod Creek. Due to straying concerns expressed by the ADF&G Genetics staff, the net was not installed in 1998 so that any fish escaping the fishery were free to ascend Telrod Creek. The return of both Saltery and Upper Station sockeye salmon stocks to Telrod Cove in 1998 required monitoring of the fishery from late June through mid-September.

Natural Salmon Runs

Adult production from the rehabilitation projects at these systems was primarily assessed through monitoring of escapement and harvests trends. Escapements were enumerated through weirs at Afognak (1978-1998), Pauls (1984-1998), and Malina (1992-1998) Lakes. Portage Creek escapements were enumerated through a weir for some years (1989-1993), but are primarily

indexed through tributary foot surveys and aerial surveys. In addition, a weir was operated to enumerate sockeye salmon escapement in 1998 at Thorsheim Creek as part of an evaluation of straying associated with the barrier weir at Hidden Lake Creek (ADF&G 1998; Honnold at al. 1998). Harvests were primarily tracked through the ADF&G fish ticket database.

Lastly, the Saltery Lake sockeye salmon were monitored for escapement trends as related to broodstock collection. In-season escapement estimates are used to determine if egg takes could occur and how many brood fish could be used (Honnold et al. 1998; Hall et al. 1998). Frazer Lake sockeye salmon escapements were also enumerated via the fish pass.

Field camps, weir configurations and operations are described in detail by Brodie (1999) and the ADF&G (1998).

Commercial Catch, Escapement and Broodstock Sampling

Sockeye salmon catches were sampled for age, length, and sex (ALS) data at the Foul Bay THA (Hidden Lake run), Waterfall Bay THA (Little Waterfall Lake run), Kitoi Bay (Little Kitoi, Jennifer, Ruth Lakes and Little Kitoi Bay runs), and Spiridon Lake THA (Telrod Cove). Other catches in the Northwest Kodiak District and the Afognak District were sampled to identify Spiridon Lake sockeye salmon as part of run reconstruction efforts (Honnold 1997a; Nelson 1999).

Afognak, Pauls, Malina and Portage sockeye salmon escapements were sampled for ALS data. Little Kitoi sockeye salmon escapements were also sampled prior to the change in the late-run broodstock.

Frazer, Saltery, and Upper Station Lakes sockeye salmon escapements were also sampled for ALS data. Commercial harvests were sampled for ALS data as part of the Frazer Lake and Upper Station run reconstructions. Sockeye salmon used for broodstock from Afognak, Malina, Laura (Pauls), Little Kitoi, Upper Station, and Saltery Lakes were sampled for freshwater age (collection of otoliths and scales), genetic baseline data (tissue samples), and disease incidence (ovarian fluid). Chum salmon broodstock at Kitoi Bay Hatchery were also sampled for ALS data.

Sampling procedures for the above collections were followed as described by the ADF&G (1998).

PROJECT EVALUATION AND MONITORING RESULTS

Limnological Assessment

Lake Sampling

Sampling was conducted at 14 lakes on Kodiak and Afognak Islands in 1998 (Table 6; Figure 7). Lakes were sampled based upon project category (fertilization, stocking, broodstock, post fertilization, and environmental assessment). Little Kitoi and Spiridon Lakes had two sampling stations and all other lakes had one station. Four samples were collected from each lake (except

for five samples collected at Spiridon and Hidden) from 16 May to 6 October. A total of 47 water samples were obtained from nine lakes and 66 zooplankton tows were pulled from 14 lakes. In the past, more samples were collected annually from Kodiak and Afognak Lakes. However, budget constraints have reduced sampling efforts in recent years (Appendix C.15, D.5, E.5, F.7, G.4, H.4, I.5, J.7, K.4, L.4, M.3, N.2, O.2, P.2, Q.3, and R.20).

Lake Morphometry

The morphometric characteristics of each lake are summarized in Table 1 and bathymetric maps of each lake, including those surveyed in prior years are presented in Appendices C.1-C.5, D.1, E.1, F.1, G.1, H.1, I.1-I.2, J.1-J.3, K.1, L.1, M.1, N.1, O.1, P.1, Q.1-Q.2, and R.1-R.19. Karluk Lake has the largest surface area (39.4 km^2) and total volume (1,920 x 10^6 m^3) of the lakes surveyed. Frazer Lake is the second largest in volume (551 x 10^6 m^3), but has only about a third of the volume and less than half the maximum depth of Karluk Lake. Spiridon (318 x 10^6 m^3), Red (208 x 10^6 m^3), and the Upper Olga (208 x 10^6 m^3) Lakes are the third through fifth in total volume (Table 1). Smaller lakes at the other end of the spectrum in terms of volume (x 10^6 m^3) are Ruth (1.1), Gretchen (1.4), Summit (1.6), and Big Waterfall (1.6). Lakes that have a smaller basin size (volume) typically have morphometric characteristics (surface area, mean depth) of similar size. These lakes, except for Summit Lake, are located on Afognak Island.

Karluk was the deepest lake surveyed at 126 m with a mean depth of 48.6 m. Lower Olga Lake was the shallowest lake at 2 m on Kodiak Island. Hidden and Thorsheim Lakes are fairly close to each other in location on Afognak Island; however, they differ greatly in basin parameters. Hidden Lake has a maximum depth of 42 m and a mean depth of 10.8 m, whereas Thorsheim Lake has a maximum depth 12.4 m and a mean depth of 5.1 m.

Light Penetration and Turbidity

The mean vertical extinction coefficient (K_d m^{-1}) or rate of light attenuation was lowest in Spiridon Lake (0.24) and highest in Portage Lake (1.57) in 1998 (Table 7). Spiridon Lake had the greatest euphotic zone depth (EZD; 20.7 m); Portage Lake had the lowest EZD (4.3 m). Average Secchi disk (SD) transparency readings ranged from a depth of 9.3 m in Spiridon Lake to a depth of 2.5 m in Saltery Lake. Thus, Spiridon Lake was the most transparent or clear and Portage Lake was the least transparent.

Other low light attenuated or optically deep lakes included Hidden, Upper Jennifer, Lower and Upper Malina Lakes. In these lakes, K_d ranged from 0.38 to 0.49 m^{-1}, EZD from 11.8 to 9.2 m, and SD transparency from 6.1 to 3.4 m. In contrast, Saltery Lake exhibited a slightly greater attenuation (K_d >0.7 m^{-1}), reduced SD transparency of 2.5 m; however, the EZD of 7.7 m was within the range of other lakes measured. With the exception of Spiridon and Portage Lakes, the remaining 11 lakes were grouped fairly close together as indicated by the water clarity and transparency measurements.

Temperature and Dissolved Oxygen

For most lakes, spring temperatures from the surface to the bottom varied slightly indicating isothermal (no difference in temperatures) conditions during the first sampling period in 1998 (Table 8). Upper Jennifer, Little Kitoi and Ruth Lakes (Kitoi area lakes) had more temperature variation or stratification from top to bottom than the other lakes sampled. Earlier lake surface ice melting and/or later lake sampling dates (May 20-28) could explain the disparity of the top and bottom temperature readings. Spiridon Lake exhibited strong isothermal conditions possibly due to the slower warming of a larger volume of water. Maximum lake surface temperatures ranged from 13-16° C during the summer sampling period except at Saltery Lake, where maximum temperatures reached only 9° C. Shallower lakes (Afognak and Lower Malina) showed little or no temperature variation from top to bottom in the summer. The water column of shallow lakes often times stay well mixed in this region due to strong winds throughout the year. Fall temperatures profiles varied from lake to lake. Temperatures in the water column of deeper lakes (Spiridon, Hidden) remain stratified longer than in shallower lakes (Lower Malina, Portage, Afognak).

Dissolved oxygen (DO) concentrations in the spring (May-June) ranged between 9 and 12.5 mg L^{-1} throughout the entire water column for the lakes sampled (Table 9) except for Laura Lake and Little Kitoi Lake. Lower DO levels of 7.7 mg L^{-1} at Laura Lake and 2.8 mg L^{-1} at Little Kitoi Lake were measured at the bottom of each lake. Little Kitoi Lake contained a layer of saline water on the lake bottom that inhibited the water column from completely mixing. During the summer (July-August), DO levels decreased ~1-3 mg L^{-1} near the surface and varied considerably near the bottom throughout the lakes sampled. In some cases (Spiridon, Hidden), near bottom layers below the thermocline contained higher DO levels than surface layers. Low DO levels at the bottom of Ruth Lake in the summer and fall indicate lack of mixing in the water column. Spring samples at Ruth Lake showed oxygenation throughout the water column.

Major Dissolved Constituents

Electrolyte content as measured by conductivity ranged from 43-106 umhos cm^{-1} for the sample lakes. This range of readings indicates low to moderate conductivity levels (Table 10). The conductivity in four sample lakes did not change in the hypolimnion layer. Other parameters such as pH and alkalinity exhibited little seasonal variation between lakes and sampling within each lake as indicated by the low standard deviations. Calcium and magnesium levels also varied little between and within each lake sampled in 1998. Little Kitoi Lake showed slightly elevated calcium levels (9.6 mg L^{-1}) as compared to the other lakes sampled (3.0-6.9 mg L^{-1}). Iron levels were more elevated at the bottom of Afognak Lake (48 ug L^{-1}) and the 1-m sample at Little Waterfall Lake (59 ug L^{-1}). Seasonal variation in the iron levels of these two lakes was higher compared to the rest of the lakes sampled. Historical summaries of all Kodiak area lakes sampled for water chemistry parameters are provided in Appendices C.16-18, D.6, E.6, F.8, G.5, H.5, I.6, J.8, K.5, L.5, M.4, N.3, O.3, P.3, Q.4, and R.21.

Dissolved Nutrients

Mean seasonal total phosphorus (TP) concentrations ranged from 3.1 to 11.5 ug L^{-1} and Kjeldahl (organic nitrogen + ammonia) nitrogen (TKN) concentrations ranged from 101 to 216 ug L^{-1} in the 1-m stratum lake samples (Table 11). Laura and Little Waterall Lakes had the highest TP, and Little Kitoi Lake had the highest TKN concentration. Hidden and Spiridon Lakes had the lowest levels for TP and TKN of the lakes sampled. Of the lakes sampled, Afognak, Laura, Malina, and Little Waterfall Lakes were fertilized with a nitrogen-phosphorus mixture. Little Kitoi Lake was not fertilized but TP concentrations were within the levels of the fertilized lakes and TKN levels at Little Kitoi were the highest of the lakes sampled.

Inorganic dissolved nitrogen (ammonia and nitrate + nitrite) levels were grouped with little variation between lakes (Table 11). Nitrate + nitrite levels were noticeably (>120 ug L^{-1}) higher at Spiridon Lake, especially in the hypolimnetic region. Mean seasonal ammonia concentrations in the 1-m stratum ranged from 4 to 27 ug L^{-1}. There was some seasonal or temporal variation for ammonia concentrations in Afognak and Little Kitoi Lakes.

Inorganic phosphorus concentrations varied little among the lakes. Mean seasonal total filterable phosphorus (TFP) at the 1m stratum within and between lakes ranged from 1.5 to 5.5 ug L^{-1}; and filterable reactive phosphorus (FRP) ranged from <1 to 3.7 ug L^{-1} (Table 11). Little Kitoi Lake had the highest TFP and FRP concentrations among the lakes. Approximately half of the lakes were sampled in the hypolimnetic region providing limited information for comparison. For lakes where deepwater samples were collected, the deepwater TFP and FRP levels were within the range at the 1m stratum.

Mean silica concentration ranged from 1,127 to 2,500 ug L^{-1} (Table 11). The Malina Lakes had the highest silica concentration and Laura Lake had the lowest. There was seasonal variation in silica levels at Malina and Laura Lakes, but it was not substantial.

Hydrogen Sulfide

In 1998, the hypolimnetic zone in Little Kitoi Lake was tested for the presence of H_2S and 23 ug L^{-1} of H_2S was detected. The 23 ug L^{-1} H_2S level was multiplied by 0.60 based on the pH of the sample water to determine toxic levels of the bottom layer (Koenings et al. 1987). Toxicity of the H_2S layer was 13.7 ug L^{-1} with 3 ug L^{-1} considered lethal to fish. Testing to quantify the volume of H_2S on the lake bottom was started in 1993 (Appendix C.19). A project to remove the H_2S was completed in 1996-1997 and Appendices C.20 and C.21 show the volume of H_2S before and after siphoning of water.

Chlorophyll *a*

The mean near-surface (1-m) chlorophyll *a* concentration ranged from 0.1 in Afognak Lake to a high of 1.8 ug L^{-1} in Little Kitoi Lake and Little Waterfall Lake (Table 11). Seasonal values fluctuated throughout the growing season as indicated by the standard deviations. In addition to seasonal variation, chlorophyll levels decreased with depth in most of the lakes. Phaeophytin *a* concentrations ranged from 0.03 to 3.06 ug L^{-1} with little seasonal variation (except Laura Lake).

Laura Lake had the highest mean concentration (3 ug L^{-1}) and Afognak Lake the lowest at 0.03 ug L^{-1}.

Historical nutrient, and algal pigment concentrations for each lake sampled are summarized in Appendices C.22-C.24, D.7, E.7, F.9, G.6, H.6, I.7, J.9, K.6, L.6, M.5, N.4, O.4, P.4, Q.5, and R.22.

Zooplankton Abundance and Species Composition

In Alaska lakes, the zooplankton community is primarily composed of the cladocerans *Bosmina*, *Daphnia*, and *Holopedium* and the copepods *Epischura*, *Diaptomus*, and *Cyclops*. The majority of zooplankton samples from Kodiak lakes were primarily composed of cladocerans (Table 12). Hidden, Upper Jennifer, Portage, Saltery, and Spiridon were the only lakes where cladocerans did not make up over 90% of the zooplankton community. However, in Hidden (53%), Upper Jennifer (52%), and Portage (77%) Lakes cladocerans still made up the majority of plankton density levels measured. The zooplankton communities in Saltery (78%) and Spiridon (82%) Lakes were dominated by copepods.

Mean zooplankton density, biomass, and body size (length) by taxa for all lakes in 1998 are presented in Table 13. Mean total zooplankton (TMZ) density (animals per m^2) ranged from a low of 23,500 to a high of 722,556, and TMZ biomass (milligram per m^2) ranged from 28 to 1,488. Portage Lake had the lowest mean density and smallest biomass, and Frazer Lake had the highest mean density (722,556 m^{-2}) and TMZ (1,488 mg m^{-2}). Frazer Lake was sampled three times (June to August) to determine a weighted mean. Zooplankton levels typically decrease in the fall, which would bring the mean level down. The high level of abundance may not be a true indicator at Frazer Lake.

Spiridon Lake had a high zooplankton density of 440,615 m^{-2} and Upper Jennifer Lake had one of the highest mean biomasses (812 mg m^{-2}). At Frazer Lake, the *Cyclops* (58%) and *Bosmina* (41%) were the most abundant genera identified. The most abundant zooplankton genera in Spiridon Lake was *Cyclops*, comprising ~81% TMZ density, while the cladocerans *Daphnia* and the smaller sized *Bosmina* together were ~14% of the TMZ density in Spiridon Lake. *Cyclops* (44%) and *Bosmina* (39%) TMZ compositions were more evenly distributed in Upper Jennifer Lake.

The other sample lakes were mostly composed of *Cyclops*, *Bosmina*, and *Daphnia* genera. *Epischura*, *Diaptomus*, and *Holopedium* composed the remaining zooplankton identified in the lakes sampled. However, the latter three genera contribute to each lake's TMZ density and biomass were minor with the exception of *Epischura* to Afognak Lake, *Diaptomus* to Upper Jennifer and Spiridon Lakes, and *Holopedium* to Spiridon Lake.

In 1998 (and most prior years), the barren lakes have varied in TMZ densities and biomass. For example, Spiridon, Crescent, and Upper Jennifer Lakes had the highest TMZ densities and biomass, while Hidden Lake has a low TMZ density (99,357) and a higher TMZ biomass (270). All of these lakes have ongoing stocking programs and, zooplankton levels have responded quicker to stocking compared to anadromous systems. These responses have also exhibited

substantial changes in the genera. Mean sizes for the six genera of zooplankton were varied and did not elicit a pattern between the lakes.

Annual trends in zooplankton density, biomass, and size for Kodiak area lakes are summarized in attached appendices (Appendices C.25-32, D.8-9, E.8-9, F.10-11, G.7, H.7-8, I.10-13, J.10-11, K.7-8, L.7-8, M.6-7, N.5-6, O.5-6, P.5-6, Q.6-9, and R.23).

Marine Temperature, Salinity, and Plankton Abundance: Kitoi Bay

Water temperatures in Kitoi Bay ranged from 6 to 7°C at the four sites in May and gradually surface temperatures increased to 10°C in June (Table 14). Temperatures below the surface (below 3 m) gradually decreased with depth in early June and warmer temperatures were measured at the hypolimnion layer in June. Historical water temperature profiles are summarized in Appendix C.33.

Salinity readings were taken concurrently to temperature measurements (Table 15). Salinity levels ranged from 5 to 26 parts per thousand (ppt). However, surface readings had considerably lower salinities (June 2 sampling) at the Big Kitoi and inside Little Kitoi Bay stations. Both of these inner bays have high levels of freshwater influence from local area systems. Historical salinity levels are summarized in Appendix C.34.

Total plankton levels were the highest (222-275 ml) measured on 2 June (Table 16). Zooplankton levels increased after each successive sampling period. Phytoplankton levels decreased on the second set of samples; peak levels were measured on the 2 June and decreased again on 10 June. Historical plankton levels for Kitoi Bay are summarized in Appendix C.35.

Fishery Assessment

Juvenile Rearing Abundance

Sockeye salmon population estimates in 1998 for five Kodiak area lakes are summarized in Table 17. The highest estimated fish population was 1,980,704 +/- 376,722 (95% confidence interval) at Spiridon Lake and the lowest, 81,261 +/- 12,652, estimated at Little Kitoi Lake. Juvenile sockeye salmon population estimates at Little Kitoi Lake of 6,176 and for Saltery Lake of 680,419 were derived from townet catches to determine species composition (Table 17). Towing effort and catch compositions are summarized in Table 18.

Historical juvenile population estimates by hydroacoustic methods for each lake are summarized in Appendices C.36, D.10, E.10, F.12, G.9, H.9, I.14, J.12, K.9, L.9, M.8, N.7, O.7, P.7, and Q.10. Historical townet effort and catch composition are summarized in Appendices C.37, F.13, G.10, H.10, I.15, J.13, K.10, L.10, M.9, N.8, O.8, P.8, and Q.11.

Age and Size of Rearing Juveniles

Of the 20 sockeye salmon captured by townetting in Little Kitoi Lake in 1998, 14 were included in the AWL database. Nine (64.3%) were age-0 fish, four (28.6%) were age-1 fish, and one (7.1%)

age-2 fish (Table 19). Age-0 fry had a mean size of 58 mm in length, weighed 2.1 g, and had an average condition factor (K) of 1.07. Age-2 fry averaged 73 mm (length), 4.3 g (weight), and had a K of 1.02. The age-2 fish was 64 mm long, weighed 3 g, which equated to a K of 1.14.

Saltery Lake sockeye salmon captured by townet in 1998 were 4.8% age-0 fish (n=10), 94.3% age-1 fish (n=198), and 0.9% age-2 fish (n=2; Table 19). The age-0 fish averaged 50 mm in length and 1.4 g in weight, while the age-1 fish were 57 mm, and weigh 2 g. Age-2 fish were approximately the same size (56 mm and 1.9 g) as age-1 fry. All fish sampled for size exhibited good weight to length proportions (1.07-1.09 K).

Sockeye salmon AWL data for prior years townet catches are summarize in Appendices C.38, F.14, G.11, H.11, I.16, J.14, K.11, L.11, M.10, N.9, O.9, P.9, and Q.12.

Sockeye Salmon Smolt Estimates

Frazer and Malina Lakes. The smolt trap at Frazer Lake was inoperable after 2 June in 1998 due to high water, making total emigration estimates impossible (Sagalkin 1999). Large numbers of smolt were observed to emigrate from the lake and AWL samples (n=1841) indicated that smolt ages during the migration may have been similar to past years (predominantly age-2 smolt).

Smolt trapping was conducted at the outlet of lower Malina Lake from 3 May – 11 June in 1998 (Table 20). A total of 211,309 sockeye salmon smolt were trapped and mark/recapture trials resulted in a total emigration estimate of 488,777 (95% CI = 441,041 - 535,318) sockeye salmon smolt. The emigration were 52% age-1 (255,142) and 47% age-2 (228,259) smolt with a small number (5,377) of age-3 fish also represented.

Little Kitoi Lake. Hatchery personnel installed the smolt counter at the Little Kitoi Lake compound on April 22 and daily counts were recorded until July 7. Fyke netting resulted in a total catch of 10,070 sockeye salmon smolt which were applied as daily catches to total fish enumerated through the electronic counter. This resulted in a total emigration estimate of 57,372 (95% CI = 26,297 - 88,447) sockeye salmon, of which 83% (47,676) were age-1, 15% (8,778) age-2, and 2% (918) age-3 fish.

Several lots of juvenile sockeye salmon stocked previously into Little Kitoi Lake were marked (fin clipped) to assess survival to the smolt and adult stage. The mark recovery data collected from smolt and adults for 1998 has not been summarized or analyzed for inclusion into this document.

Spiridon Lake. Sockeye salmon smolt emigrated through the Spiridon Lake bypass system and pipeline from 26 April through 11 July in 1998 (Table 20). Time and actual count estimates indicated that 746,950 smolt emigrated (95% CI = 716,192 - 777,708) in 1998. Of these, 77% (578,139) were age-1, and 23% (168,064) were age-2. Approximately 2.9% (21,000) of the sockeye salmon smolt emigrating perished as a result of negotiating the weir, trap, and counting apparatus. An estimated 725,629 live smolt exited the pipeline, of which 71% (514,606) were age-1 and 29% (210,731) were age-2 smolt.

Other Systems. Sockeye salmon smolt captured at other systems for AWL sampling in 1998 included 163 from Afognak Lake, 471 from Hidden Lake, 251 from Laura Lake, 200 from Little Waterfall Lake, and 181 from Portage Lake (Table 20).

Sockeye salmon smolt trapping and abundance data from Kodiak area lakes for prior years are summarized in Appendices C.39, D.11, H.12-13, I.17, L.12, M.11, O.10, P.10, and Q.13.

Emigration Timing

Sockeye salmon smolt emigrated from Little Kitoi (22 April-7 July) and Spiridon (23 April-12 July) Lakes from late April through early July (Figure 8). Emigrations from Malina Lake were from early May through mid-July (5 May-15 July). Sockeye salmon smolt emigrated from Frazer Lake beginning in late April and were observed (trapping was discontinued on 2 June) through late June (Sagalkin 1999). Peak emigrations occurred in late May at Little Kitoi Lake, late May-early June at Malina Lake, and early May at Spiridon Lake. The largest count of smolt at Frazer Lake was in late May, just prior to the removal of the trap, and corresponded to previous years' peak counts (Sagalkin 1999). Timing of sockeye salmon smolt emigrations from Kodiak area systems (prior to 1998) are summarized in Appendices C.40, D.11, H.12-13, I.18, L.13, O.11, and Q.13.

Smolt Age and Size

In 1998, sockeye salmon smolt sampled for AWL information were predominantly age-1 juveniles from Afognak (71%), Hidden (99%), Little Kitoi (83%), Little Waterfall (98%), Portage (74%), and Spiridon (78%) Lakes (Table 21). Age-2 smolt were the more predominate age class sampled from Frazer (66%) and Laura (96%) Lakes. Smolt sampled from the Malina Lakes emigrations were fairly proportional between age-1 (52%) and age-2 (47%) juveniles.

The largest sockeye salmon smolt were captured migrating from Hidden Lake (age-1; 112 mm, 13 g) and the smallest smolt were captured in Afognak River (age-1; 66 mm, 2.6 g; Table 21). Sockeye salmon smolt migrating from Little Kitoi Lake were the smallest smolt sampled of the age-2 class. All sockeye salmon sampled were in good condition as reflected by K factors > 0.70. As expected, age-1 sockeye salmon smolt released from Kitoi Bay Hatchery were large (108 mm, 12 g) and robust (K=0.91).

Small numbers of coho salmon smolt were sampled as they emigrated from Jennifer Lake (n=40), Laura Lake (n=4), Little Waterfall Creek (n=25), Malina Lake (n=171), and Portage Lake (n=29) in 1998 (Table 22). Coho smolt (n=200) were sampled for AWL prior to release from Kitoi Bay Hatchery. The 'wild' coho smolt were predominantly age-2 or age-3 juveniles. Malina Lake (largest sample) emigrations appeared to be primarily age-3 (55%), but also with a good representation of age-2 (43%) smolt. Smolt sizes were fairly similar between systems for each age class, with the exception of age-2 fish, which were more variable. The coho smolt sampled were all in excellent condition (most K > 0.85), including the smolt released from Kitoi Bay Hatchery which were extremely robust (K = 1.10).

Sockeye salmon AWL data for prior year smolt catches are summarized in Appendices C.41, D.12, E.11, F.15, H.14, I.19, J.15, K.12, L.14, M.12, N.10, O.12, P.11, and Q.14.

Preseason Forecasts, Catches, and Total Enhanced Run Estimates

Crescent Lake (Settler Cove THA). The preseason forecast for the 1998 sockeye salmon run as a result of the stocking of Crescent Lake was 14,000 early-run adults (Table 23). Commercial fishing opened 9 June 1998 for a 33-hour opening in the SCTHA (statistical area 259-35) and again on 14 June (Prokopowich 2000). The latter fishery opening continued until 8 July, and the final fishing period in the THA was from 13 July through 16 July. Throughout this period, four vessels made nine landings, harvesting 3,085 sockeye salmon, which averaged 4.3 pounds (lbs.) and resulted in an ex-vessel value of $15,415 (Table 23; Appendix S). The majority of the sockeye salmon catch, of 2,600, occurred from 10-18 June in the SCTHA. Subsistence fishers harvested an additional 888 sockeye salmon in 1998 for a total run to the SCTHA of 3,973 sockeye salmon. Commercial harvest of Crescent Lake sockeye salmon occurred in the Central Section of the Northwest Kodiak District outside of SCTHA. A run reconstruction program was not implemented for these areas in 1998 to enable assignment of catches to specific stocks.

A coho salmon run of 7,000 adults was projected in 1998 as a result of Crescent Lake stocking (Table 23). However, the actual harvest was only 593 coho salmon, of which 293 were caught in the subsistence fishery and 200 in the sport fishery. The only other commercially harvested salmon in the SCTHA were 20 chum salmon (Appendix S).

Anecdotal data suggest that both sockeye and coho salmon runs may have been less than projected due to obstructions (beaver dams) to smolt emigration from the Crescent Lake system.

Hidden Lake (Foul Bay THA). Approximately 13,000 sockeye were projected to return to the Hidden Lake system in 1998 (Table 23). The FBTHA (statistical area 251-41) was open to commercial fishing continuously from 9 June through 8 July in 1998 (Prokopowich 2000; Table 24). Fourteen vessels made 31 landings, harvesting 8,270 sockeye salmon in the FBTHA (Table 23; Appendix S). The average weight of each sockeye salmon harvested was 4.1 lbs. for ex-vessel value of $39,400. In addition, 55 pink salmon and 57 chum salmon were harvested incidentally to sockeye salmon in the FBTHA in 1998. The majority of the sockeye were harvested from early to mid-June, similar to the timing of the broodstock used (Afognak Lake) for stocking Hidden Lake (Figure 9; Table 24; Appendix S).

Kitoi Bay Area: (Kitoi, Duck, Izhut Bays). The preseason forecast for early-run sockeye salmon returning to Little Kitoi Lake was 18,000 adults (Table 23). The Kitoi Bay (252-32), Duck Bay (252-31), and Izhut Bay (252-30) statistical fishing areas were open in anticipation of the early-run returns from 9 June through 19 June (Prokopowich 2000; Table 24). There were also openings in these three sections on 8 and 9 July, and the Duck Bay and Izhut Bay sections from 13-16 July. Catches of sockeye salmon during these openings were 11,449 in Kitoi Bay, 698 in Duck Bay, and 1,796 in Izhut Bay for a total catch of 13,943 Little Kitoi fish (Tables 23 and 24; Appendix S). These sockeye salmon averaged 4.4 lbs. for an ex-vessel value of $71,288. The majority of sockeye salmon were harvested in early July (Table 24; Figure 10; Appendix S). Approximately 90 additional early run sockeye salmon were harvested by sport fishers in the

Kitoi Bay area, which increases the Little Kitoi Lake early run to 14,033 adults in 1998 (Table 23).

In 1998, the late-run sockeye salmon return of 38,000 was forecasted as a result of the stocking projects at Jennifer, Little Kitoi, and Ruth Lakes, as well as salt water releases in Little Kitoi Bay (Table 23). The same sections as described above were opened from 20 July through 13 September with the exception of Kitoi Bay, which was closed from 11-26 August, and from 24-26 August (Prokopowich 2000; Table 24). The late-run sockeye salmon harvest was 22,422 from Kitoi Bay, 24,710 from Duck Bay, and 14,431 from Izhut Bay for a total harvest of 61,563 adults (Tables 23 and 24; Appendix S). The late-run sockeye salmon commercial harvest (4.4 lb. fish) was worth $314,759. The majority of this harvest occurred from mid-July through mid-August (Table 24; Figure 10; Appendix S). Another 90 late-run sockeye salmon were harvested by sport fishers in the Kitoi Bay area which increased the late run to 61,653 adults in 1998 (Table 23). In 1998, the overall run (early and late) to the Kitoi area was 75,686 sockeye salmon.

Pink, chum, and coho salmon also returned in 1998 to the Kitoi area from releases into Big Kitoi Bay and some minor releases of coho in Jennifer, Little Kitoi, and Ruth Lakes. Returns of approximately 1.1 million (850,000 for harvest) pink salmon, 43,500 (13,500 for harvest) chum salmon, and 134,000 (131,000) coho salmon were forecasted for 1998 (Table 23). Actual commercial harvests were 6,272,029 pink salmon (late July to late August timing), 38,118 chum salmon (late June to late July timing), and 148,333 coho salmon (late July to early September timing; Table 23; Appendix S). The ex-vessel values of these harvests were $3,364,316 for pink salmon, $46,839 for chum salmon, and $463,511 for coho salmon. Overall in 1998, 1,438 landings were made in harvesting pink salmon, chum salmon, coho salmon, and sockeye salmon returns to Kitoi Bay Hatchery. The total run of pink salmon was 6,696,362, which included 424,306 broodstock and escapement and a small subsistence catch of 27. A total of 18,650 chum salmon were used for broodstock or escapement, resulting in a total run of 56,768 fish in 1998. Approximately 6,000 coho were used for broodstock and escapement and subsistence fishers harvested another 115; therefore, the total coho run was 154,448 in 1998.

Little Waterfall Lake (Waterfall Bay THA). Approximately 28,000 sockeye salmon were projected to return to Little Waterfall Lake (WBTHA) in 1998 (Table 23). The Waterfall Bay THA (251-84) was open continuously from 9 June through 8 July (Prokopowich 2000), where 13 permit holders made 30 landings and harvested 11,057 sockeye salmon (Tables 23 and 24; Appendix S). The fish weighed an average of 3.9 lbs. for an ex-vessel value of $50,108. The timing of harvests in the WBTHA paralleled those in the FBTHA (Figure 9). Subsistence fishers harvested 200 sockeye salmon and 600 adults were observed in Little Waterfall Creek for a total run of 11,857 sockeye salmon in 1998. The only incidental harvest during the sockeye fishery was 127 chum salmon (Appendix S).

The pink salmon run to Little Waterfall Creek was 155,029 in 1998. Only 3,364 pink salmon were harvested at Little Waterfall due to strong returns of pink salmon in the KMA that reduced fishing effort to the Waterfall pink salmon stock. The ex-vessel value of the pink salmon harvest was $1,709 (Table 23).

Spiridon Lake (Spiridon Lake THA). The 1998 Spiridon Lake run was forecast at 255,000 sockeye salmon (Geiger and Hart 1999; Table 23). The SLTHA (254-50) was open to continuous fishing from 2 July through 4 September (Prokopowich 2000; Table 24). The harvest in the THA was 88,449 sockeye salmon and an additional incidental catch of 101,717 pink salmon, 2,814 chum salmon, and 213 coho salmon (Table 24; Appendix S). A formal sockeye salmon stock separation analysis was not conducted in 1998 as in past years to delineate Spiridon Lake fish in other Northwest Kodiak District fishing areas or in the SW Afognak Section harvests (P.A. Nelson, ADF&G, Kodiak, personal communication). This was due to the run timing differences between the overlapping returns of Upper Station and Saltery Lake sockeye and the difficulties in identifying Spiridon Lake fish from non-local stocks (Figure 11). Therefore, the average proportion of sockeye harvested in the SLTHA from 1994-1997 (41%) was applied to the 1998 SLTHA harvest to estimate the harvest in the SW Afognak Section and NW Kodiak Districts combined. The total 1998 Spiridon Lake harvest was estimated to be 215,729 sockeye salmon, which averaged 4.6 lbs. each and had an ex-vessel value of $1,145,176 (Tables 23 and 24). An additional 5,000 sockeye (Telrod Creek escapement) were not harvested; thus, the total run was estimated to be 220,729 adults in 1998. The run timing paralleled the broodstock's escapement timing; Saltery Lake fish returned primarily in July and Upper Station fish returned primarily in August (Figure 11).

Katmai Lake (near the Village of Ouzinkie). In 1998, the forecast for coho returns to Katmai Lake was 1,500 (Table 23). Harvest monitoring of this run was limited to sport and subsistence catch data from Ouzinkie village residents. Anecdotal information from the village indicated that the run returned as forecasted and the majority of coho salmon were harvested near the village.

Historical preseason forecasts, catches, and total enhanced run estimates for the aforementioned systems are described in Appendices C.42, D.13, E.13, F.16, and G.12.

Preseason Forecasts, Catches, Escapements, and Total Natural Run Estimates

Afognak Lake. Afognak Lake sockeye salmon runs have not been formally forecasted; however, supplemental production is projected each year. Based on stocking numbers, approximately 9,000 supplemental sockeye salmon were projected to return in 1998 (Table 23). The total harvest from statistical area 252-34 (Afognak Bay) was 26,060 sockeye salmon (Appendix S), of which the number of supplemental fish was not delineated by stock separation analysis. Lake enrichment along with stocking contributes some unknown level of production. The projected supplemental harvest was estimated at 9,000 sockeye salmon, which were worth $42,878 (4.1 lb. fish; Table 23). The subsistence and sport fishery harvests were estimated to be 4,690 and 300 sockeye salmon, respectively, plus an additional 66,869 fish (slightly more than the 60,000 upper escapement goal; Prokopowich 2000) were counted through the weir (Brodie 1999). Thus, the total Afognak Lake sockeye salmon run in 1998 was 97,919 adults. The run timing of this early-run stock was similar to the average timing of previous years (Table 9a).

Laura (Pauls) and Portage Lakes (Perenosa Bay Section). Laura and Portage Lakes sockeye, pink, and coho salmon runs have not been formally forecasted. Supplemental sockeye salmon production is projected each year for Laura Lake. Based on stocking numbers, approximately 7,000 supplemental sockeye salmon were projected to return in 1998 (Table 23). The total

harvest from statistical area 251-82, 251-83 (Perenosa Bay) was 78 sockeye salmon (Appendix S). Lake enrichment along with stocking at Laura Lake contributes an unknown level of production. In 1998, the sockeye salmon returns contributed toward the escapement into the lake. Seventy-eight sockeye salmon were harvested for an ex-vessel value of $317 (3.5 lb. fish; Table 23). The subsistence fishery harvest was estimated at 126 sockeye salmon, plus an additional 15,343 fish were counted through the weir (Brodie 1999). The total Laura Lake sockeye salmon run in 1998 was 15,547 adults, which was below the minimum escapement goal of 20,000 (Prokopowich 2000). The peak aerial count at the Portage Lake system was 3,600 sockeye salmon in 1998 (Prokopowich 2000), which was similar to tributary surveys (3,400); however, this level of escapement may not represent the total escapement due to survey bias (Cousins et al. 1982). Thus, by expanding the peak count by 2.0 (Barrett et al.1990), a total escapement estimate was approximately 7,000 sockeye salmon. The minimum indexed sockeye salmon escapement goal for Portage Lake of 5,000 was met in 1998 (Prokopowich 2000). The run timing of these early-run stocks was similar to the average timing of previous years (Figure 12; Honnold et al. 1998).

The coho salmon harvest from the Perenosa Bay section was 12,528 adults in 1998 (Table 23; Appendix S). These fish averaged 9.2 lbs. each for an ex-vessel value of $42,876. Subsistence and sport fishers harvested another 1,299 coho and the escapement through the Pauls Bay weir was 15,514 fish (Brodie 1999), for a total run of 29,341 in 1998. Coho salmon typically return to Pauls Bay in August and early September (Figure 12). Also, 12,053 pink salmon were enumerated through the weir at Pauls Bay in July and August, 1998.

Malina Lakes. Malina Lakes sockeye salmon runs were not formally forecasted but supplemental production was projected. Based on stocking numbers, approximately 15,000 supplemental sockeye salmon were projected to return in 1998 (Table 23). The number of supplemental fish harvested in 1998 was not delineated by stock separation analysis. Although lake enrichment along with stocking contributes some unknown level of production, we assume that since the escapement (14,917) did not meet the upper goal (20,000; Prokopowich 2000), supplemental harvest was negligible. Thus, the total Malina Lake sockeye salmon run in 1998 was equal to the escapement of 14,917 adults (Brodie 1999). The run timing of this early-run stock was similar to the average timing of previous years (Figure 12; Honnold et al. 1999).

Frazer Lake. The sockeye salmon run to Frazer Lake was forecasted to be 539,000 adults with a projected harvest of 399,000 (Table 23; Geiger and Hart 1999). The actual catch was 360,949 sockeye salmon valued at $2,165,983. The escapement was 245,409 sockeye, for a total run of 606,358 in 1998 (Brodie 1999; Sagalkin 1999).

Thorsheim Lake. Thorsheim Lake sockeye salmon production was not forecasted due to lack of stock separation analysis to determine harvests and escapement levels to monitor production trends. The 1998 escapement (June timing) was estimated to be 6,248 sockeye salmon (Brodie 1999).

Saltery Lake. Saltery Lake sockeye salmon production was not forecasted due to lack of stock separation analysis to determine harvests; therefore, escapement levels are monitored to judge production trends. In 1998, 26,263 sockeye salmon were enumerated through the Saltery Lake

weir (Brodie 1999). Escapement timing (July) was similar in 1998 to the previous ten-year average (Figure 11).

Salmon production estimates (primarily escapement counts) for the aforementioned systems are described in Appendices F.17, H.15, I.20, J.16, K.13, L.15, M.13, N.11, O.13, P.12, Q.15, and R.24-R.26.

Age Compositions of Escapements, Harvests, and Broodstock

Sockeye salmon were sampled from ten systems (including Frazer Lake) associated with enhancement, rehabilitation, and monitoring projects in 1998 (Table 25). Sample sizes ranged from a high of 2,045 sockeye from Spiridon Lake THA (and adjacent set net sites) to a low of 337 sockeye from the Saltery Lake escapement. The most predominant age classes for each system sampled were: Afognak Lake escapement – age 1.3 fish (48%); Foul Bay THA harvest – age 1.2 (50%); Frazer Lake escapement and harvest – age 2.2 fish (48%; Sagalkin 1999); Little Kitoi Lake/Bay escapement/harvest – age 1.2 fish (67%); Malina Lake escapement – age 1.1 (39%) and age 2.2 (21%) fish; Pauls Lake escapement – age 2.2 fish (44%); Saltery Lake escapement – age 1.2 (34%) and age 2.2 (21%) fish; Spiridon Lake THA harvest – age 1.2 fish (82%); Waterfall Bay THA harvest – age 1.2 fish (55%); and Thorsheim Lake escapement – age 2.2 fish (44%).

Sockeye salmon broodstock was collected from Afognak (1,060 adults), Laura (530 adults), Malina (530 adults), and Saltery (4,640 adults) Lakes in 1998 (Table 26). The proportions of the total escapements used for egg takes were less than 5%, with the exception of broodstock collected from Saltery Lake, which was 18% of the sockeye escapement. Otolith samples collected indicated that the majority of the broodstock were age-2 fish except the Afognak Lake sockeye salmon, which were age-1 fish.

Age compositions of escapements, catches, and broodstocks for prior years are described in Appendices C.43-44, D.14, E.13, F.18, H.16-17, I.21-22, J.17-18, K.14, and N.12-13.

SUMMARY

Lake habitat is critical for rearing juvenile sockeye salmon. To assess sockeye salmon rearing habitat in the systems with rehabilitation and enhancement projects, a limnological sampling program was implemented in the Kodiak Management Area to closely monitor the physical, chemical, and biological parameters. The study lakes possess oligotrophic characteristics, which include deep depths, steep-sided banks, fairly transparent water, and abundant oxygen levels (Cole 1983). As a whole, the lakes evaluated exhibited seasonal and annual variations that were within the normal range of parameters typically measured on these types of lakes.

To further evaluate and monitor production, juvenile sockeye salmon populations were estimated utilizing hydroacoustic surveys in the lakes or mark-recapture and other techniques in outlet streams as fish were emigrating from their respective lakes. Smolt estimates have provided

managers with additional information to forecast adult returns, along with AWL information to look at the overall health (condition coefficient) of the migrating smolt. The latter data provide insight into the health of the zooplankton and status of other lake parameters by comparing pre-project smolt AWL data to current smolt data. The smolt length to weight relationships are evaluated to adjust stocking levels and fertilizer applications.

Adult salmon production was determined by weir escapement counts and foot surveys at systems under evaluation. Enhanced production of sockeye salmon was estimated at terminal harvest areas from on-site ADF&G field personnel and fish ticket harvest data. Age composition of salmon stocks and contributions to the commercial fisheries were made using SPA.

Salmon rehabilitation, enhancement, and research programs have been conducted in the KMA since the early 1900s. Data collected from more recent salmon projects in the late 1980s through the 1990s have been presented in this report.

In these investigations, the lakes were either classified as anadromous (self-sustaining) or non-anadromous (barren) systems. Anadromous systems such as Karluk, Afognak, Malina, and Portage Lakes were considered depressed sockeye salmon systems. Sockeye salmon escapement goals were not being achieved and these systems were referred to as rehabilitation systems. Non-anadromous systems such as Frazer, Laura, Spiridon, Hidden, Little Waterfall, Crescent and Ruth Lakes were considered enhancement projects with the intent to provide supplemental sockeye salmon to commercial fisheries. Fish passes were constructed on some lakes' (Frazer, Laura and Little Kitoi Lakes) outlet streams to create access routes around impassable barriers to enhance previously unused lake habitat; fish passes were also constructed on several streams (Little Waterfall, Portage, and Seal Bay) to bypass barriers to unused upper stream habitat (pink and coho salmon).

Rehabilitation and enhancement projects have involved sockeye salmon outstockings to accelerate the rebuilding of depressed runs and as continual stockings into barren lakes. The study lakes' production potential was monitored to determine levels in the lakes' forage base that sockeye salmon feed on. Depressed production levels have lead to lake enrichment projects at Karluk, Frazer, Afognak, Malina, Laura, Portage, and Little Waterfall Lakes. Lake fertilization and stocking have been applied together to improve the lakes' rearing potential, except for Frazer and Portage Lakes. Juvenile sockeye salmon were not stocked into Frazer and Portage Lakes.

Two facilities, Kitoi Bay Hatchery and Pillar Creek Hatchery produce juvenile salmon to increase supplemental harvest production in the KMA common property fishery. Kitoi Bay Hatchery produces pink, chum, and coho salmon for commercial fishers. Sockeye salmon production at Kitoi Bay Hatchery also provides for broodstock development and supplemental harvest in the commercial fishery through outstocking projects at Kitoi Bay area lakes. Pillar Creek Hatchery was built as an outstocking facility to enhance sockeye salmon production through barren lake stockings and to rehabilitate depressed sockeye salmon systems.

This report summarized data collected from the various rehabilitation, enhancement, and evaluation projects in KMA from the mid-1980s to the present. Future reports will be produced with more in-depth analyses of these data and critical evaluations of specific projects.

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Table 1. Geographic location and morphometric parameters for Kodiak and Afognak Island area lakes.

Lake[a]	Latitude (N)	Longitude (W)	Surface Area (km^2)	Mean Depth (m)	Maximum Depth (m)	Volume ($x10^6$ m^3)
Kodiak Island						
Akalura	57° 11'	154° 12'	4.9	9.9	22.0	48.0
Barabara	57° 49'	152° 57'	1.4	3.1	11.6	4.4
Buskin	57° 46'	152° 32'	1.1	10.4	16.8	11.6
Crescent	**57° 85'**	**152° 88'**	**0.6**	**10.3**	**35.4**	**6.2**
Dry Spruce	57° 53'	152° 59'	0.6	8.0	26.0	4.9
Frazer	**57° 15'**	**154° 08'**	**16.6**	**33.2**	**58.9**	**551**
Goat	57° 27'	153° 01'	0.7	13.2	25.2	8.9
Horse Marine	57° 07'	153° 55'	0.9	12.2	28.7	11.0
Karluk	**57° 21'**	**154° 02'**	**39.4**	**48.6**	**126.0**	**1,920**
Little River	57° 75'	153° 65'	1.4	12.7	18.2	17.4
Miam	57° 30'	152° 35'	0.6	3.8	7.0	2.5
Mush	57° 41'	153° 27'	0.3	10.3	13.4	3.1
Red	57° 15'	154° 17'	8.4	24.7	45.0	208
Rose Tead	57° 29'	152° 28'	0.9	2.0	5.2	1.8
Saltery	**57° 32'**	**152° 45'**	**1.1**	**21.0**	**36.0**	**22.0**
Sitkalidak	57° 11'	153° 19'	na[b]	na[b]	na[b]	na[b]
Spiridon	**57° 43'**	**153° 41'**	**9.2**	**34.7**	**82.0**	**318**
Summit	57° 32'	152° 32'	0.3	6.0	13.4	1.6
Uganik	57° 39'	152° 20'	0.8	17.2	79.0	13.0
Upper Station - Upper	57° 04'	154° 15'	7.9	26.2	70.0	208
- Lower	57° 04'	154° 15'	na[b]	na[b]	2.0	na[b]
Uyak (Salmon)	57° 58'	153° 98'	0.4	6.6	11.0	2.8
Afognak Island						
Afognak	**58° 06'**	**152° 55'**	**5.3**	**8.6**	**23.0**	**46.0**
Big Waterfall	58° 24'	152° 35'	0.3	5.8	15.0	1.6
Big Kitoi	58° 11'	152° 23'	na[b]	na[b]	38.1	na[b]
Gretchen	58° 23'	152° 18'	0.3	4.5	15.2	1.4
Hidden	**58° 23'**	**152° 42'**	**1.9**	**10.8**	**42.0**	**20.6**
Jennifer - Upper	**58° 11'**	**152° 17'**	**0.4**	**10.6**	**26.0**	**4.1**
- Lower	**58° 11'**	**152° 18'**	**0.2**	**9.8**	**26.0**	**1.7**
Little Kitoi	**58° 12'**	**152° 22'**	**0.4**	**11.1**	**24.4**	**4.8**
Little Afognak	58° 08'	152° 24'	1.4	5.8	28.0	8.1
Little Waterfall	**58° 22'**	**152° 33'**	**1.0**	**6.8**	**18.3**	**6.7**

-Continued-

Table 1. (page 2 of 2)

Lake	Latitude (N)	Longitude (W)	Surface Area (km^2)	Mean Depth (m)	Maximum Depth (m)	Volume ($x10^6 m^3$)
Laura	**58° 21'**	**152° 18'**	**4.2**	**12.0**	**39.0**	**50.5**
Malina - Upper	**58° 09'**	**153° 05'**	**1.2**	**15.3**	**33.5**	**18.4**
- Lower	**58° 09'**	**153° 08'**	**0.7**	**6.9**	**15.0**	**4.6**
Pillar	58° 11'	152° 09'	0.4	4.8	27.0	2.1
Paul's	**58° 22'**	**152° 19'**	**0.6**	**11.4**	**21.3**	**6.9**
Portage	**58° 16'**	**152° 25'**	**1.7**	**7.6**	**22.8**	**13.0**
Red Fox	58° 26'	152° 34'	0.3	5.8	21.3	1.7
Ruth	**58° 12'**	**152° 18'**	**0.2**	**7.1**	**17.1**	**1.1**
Sorg	58° 08'	152° 20'	0.5	7.3	19.0	3.6
Thorsheim	58° 15'	152° 49'	0.5	5.1	12.4	2.5

[a] Area lakes in **bold** were enhanced, rehabilitated, or monitored in 1998.

[b] na indicates data are not available.

Table 2. Kodiak Management Area salmon stocking numbers by stocking location, species, life stage, date, and size at stocking, 1998.

Stocking Location [a]	Species [b]		SMOLT [c] (BY96)	FRY [c] (BY97)	FINGERLING [c] (BY97)	PRESMOLT [c] (BY97)	Lake Totals
Afognak Lake	Sockeye	Number			334,200	88,500	422,700
		Date / Size			17-Jun / 1.2 g; 20-Aug /5 g	28-Aug /6 g	
Big Kitoi Bay	Chum	Number		6,859,982			6,859,982
		Date / Size		late March - 30-May / 1.5 g			
Big Kitoi Bay	Coho	Number	769,000				769,000
		Date / Size	1-5 -June / 23.9 g				
Big Kitoi Bay	Pink	Number		127,685,500			127,685,500
		Date / Size		late March - 30 May / 0.5 g			
Crescent Lake	Coho	Number		163,000			163,000
		Date / Size		6-June / 0.6 g			
Crescent Lake	Sockeye	Number		463,000	108,000		571,000
		Date / Size		18-May / 0.6 g	11-Aug / 4 g		
Hidden Lake	Sockeye	Number				340,400	340,400
		Date / Size				4-Sep / 7 g	
Jennifer Lake	Coho	Number		165,000			165,000
		Date / Size		30 May / 0.5 g			
Katmai Lake	Coho	Number		14,000			14,000
		Date / Size		1-Nov./ 7.2 g			

-Continued-

Table 2. (page 2 of 4)

Stocking Location [a]	Species [b]		SMOLT [c] (BY96)	FRY [c] (BY97)	FINGERLING [c] (BY97)	PRESMOLT [c] (BY97)	Lake Totals
Laura Lake	Sockeye	Number					0
		Date / Size					
Little Kitoi Bay	Sockeye	Number	397,000				397,000
		Date / Size	20-30 May / 15.1 g				
Little Kitoi Lake	Sockeye	Number	99,085				99,085
		Date / Size	1-May / 11.7 g				
Little Waterfall Lake	Sockeye	Number				237,300	237,300
		Date / Size				3-Sep / 7 g	
Malina Lake	Sockeye	Number			93,300	257,200	350,500
		Date / Size			16-Aug / 3.6 g	5-Sep / 6 g	
Ruth Lake	Sockeye	Number			100,000		100,000
		Date / Size			13-July/ 0.7 g		
Ruth Lake	Coho	Number		35,000			35,000
		Date / Size		30 May/ 0.5 g			
Spiridon Lake	Sockeye	Number		784,000	2,556,000		3,340,000
		Date / Size		18-Jun/ 0.4 g	1-13-Jul / 0.5 - 0.9 g		
Pillar Creek sockeye		Totals	0	1,247,000	3,191,500	923,400	5,361,900
Kitoi Bay sockeye		Totals	496,085	0	0	0	496,085
KMA sockeye		Totals	496,085	1,247,000	3,191,500	923,400	5,857,985

-Continued-

Table 2. (page 3 of 4)

Stocking Location [b]	Species [a]		SMOLT [c] (BY95)	FRY [c] (BY96)	FINGERLING [c] (BY96)	PRESMOLT [c] (BY96)	Lake Totals
Kitoi Bay coho	coho	Totals	769,000	363,000	0	0	1,146,000
KMA coho	coho	Totals	769,000	363,000	0	0	1,146,000
Kitoi Bay chum	chum	Totals	0	6,859,982	0	0	6,859,982
Kitoi Bay pink	pink	Totals	0	127,685,500	0	0	127,685,500
Pillar Creek		Totals	0	1,247,000	3,191,500	923,400	5,460,985
Kitoi Bay		Totals	1,265,085	134,908,482	0	0	137,057,482
KMA		Totals	1,265,085	136,155,482	3,191,500	923,400	142,518,467

[a] Incubation and rearing facility: PC Pillar Creek Hatchery; KB Kitoi Bay Hatchery.

[b] Brood stocks (Timing): Afognak Lake sockeye (June) - Afognak, Crescent, Hidden, Little Kitoi, Little Waterfall, Sorg Lakes - PC
Big Kitoi Creek chum (June) - Big Kitoi Bay - KB
Big Kitio Creek coho (August) - Big Kitoi Bay, Crescent Lake, Jennifer, Katmai, Ruth Lakes - KB
Big Kitoi Creek pink (July/August) - Big Kitoi Bay - KB
Buskin Lake coho (August/September - Kodiak Road System Lakes - PC
Laura Lake sockeye (June) - Laura Lake - PC
Malina Lake sockeye (June) - Malina Lake - PC
Little Kitoi Lake sockeye (August) - Little Kitoi Lake - KB
Saltery Lake sockeye (July) - Ruth Lake - PC
Upper Station sockeye (August) - Little Kitoi Bay - KB; Jennifer, Spiridon Lakes - PC

-Continued-

Table 2. (page 4 of 4)

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[c] Smolt: Juvenile salmon at the time of physiological adaptation to life in the marine environment most commonly one year old. Hatchery smolt released in May or June to coincide with wild smolt emigration. Fry: Salmon life stage from emergence until reaching 100% of emergent size. Normal size of sockeye fry is from .15 to 0.5 grams depending on the stock.
Fingerling: Salmon life stage at a size of >100% and <2000% of emergent size. Normal size of sockeye fingerling is from 0.3 to 5.25 grams depending on the stock.
Pre-Smolt: Juvenile salmon >2000% of emergent weight but not yet at the physiological changes of smolting. Commonly presmolt are from 5 to 13 grams and released from September through November.

Table 3. Amount of P-enriched fertilizer (20-5-0) applied and nutrient status of the five enriched lakes in 1998. Values for total phosphorus (TP), end of year TP (TP_{eoy}), total nitrogen (TN), nitrogen to phosphorus ratio (N:P), and chlorophyll (CHL) levels are means derived from the 1-m stratum, May-October, 1998.

Lake	20-5-0 (kg)	TP (mg L^{-1})	TP_{eoy} (mg L^{-1})	TN (mg L^{-1})	N:P (molar ratio)	CHL (mg L^{-1})
Afognak	30,000	9.0	7.4	193	47	0.1
Laura	11,000	11.5	6.6	186	36	1.38
Malina, Lower	3,200	9.5	11.1	237	55	0.51
Malina, Upper	9,500	9.7	6.2	211	48	1.68
Waterfall	6,000	10.2	6.2	209	45	1.79

Table 4. Barrier height, bypass length, bypass slope, bypass grade, and affected salmon species for Kodiak Island operational barrier bypasses.

System	Geographic Location	Barrier Height (m)	Barrier Bypass			Affected Salmon Species
			Length (m)	Slope [a]	Grade (%)	
Dog Salmon Creek (Frazer River)	57°13' N, 154°04' W	10.0	60.0	6:1	22	Sockeye, Chinook
Gretchen Creek	58°23' N, 152°18' W	2.4	9.1	4:1	25	Coho and Sockeye
Laura Creek	58°21' N, 152°18' W	5.5	27.4 [b]	5:1	20	Coho and Sockeye
Little Kitoi Lake	58°12' N, 152°22' W	1.8	12.2	7:1	14	Pink, Coho, Sockeye
Little Waterfall Creek	58°22' N, 152°33' W	1.8	9.1	5:1	20	Pink and Coho
		2.4	12.2	5:1	20	Pink and Coho
		7.3	31.9 [b]	4.4:1	[c]	Pink and Coho
Portage Creek	58°16' N, 152°25' W	1.8	15.2	8:1	13	Pink, Coho, Sockeye

[a] Length to height ratio

[b] Total length composed of two or three bypasses

[c] Lower section originally 26%, upper section 28%; modified in 1995 so both sections are 17% and additional lower section added at 20% grade.

Table 5. Description and location of the terminal harvest and special harvest areas in the Kodiak Management Area, 1998.

Project Lake	Harvest Area		Boundaries
	Location	Designation	
Big Kitoi Creek and Little Kitoi Lake	Kitoi Bay	Kitoi Bay Special Harvest Area	All waters northwest of a line from the regulatory markers located at the entrance to Kitoi Bay commonly known as " The Jaws" to the terminus of Big and Little Kitoi Creeks (streams #252-323 and #252-324).
Crescent	Settler Cove	Settler Cove Terminal Harvest Area	All waters of Settler Cove west of 152° 50.80' W. Long.
Hidden	Foul Bay	Foul Bay Terminal Harvest Area	All waters of Foul Bay east of 152° 47.20' W. Long. to the terminus of Hidden Creek (stream #251-406).
Little Waterfall	Waterfall Bay	Waterfall Bay Terminal Harvest Area	All waters within one nautical mile arch of Little Waterfall Creek (stream #251-822).
Spiridon	Telrod Cove	Spiridon Lake Terminal Harvest Area	All waters of Telrod Cove north of a line extending from Stream Point 57° 39.00' N. Lat., 153° 38.50' W. Long. to 57° 38.80' N. Lat., 153° 37.60' W.Long.

Table 6. Kodiak area lakes assessed or monitored for limnology data, by category, 1998.

Lake	Project Category [a]	Sampling		
		Stations	Water	Zooplankton
Afognak	F, S, BS	1	4	4
Crescent	S	1	4	4
Frazer	PF	1	0	3
Hidden	S, EA	1	5	5
Jennifer - upper	S	1	0	4
Laura	F, BS	1	4	4
Little Kitoi	S, BS	2	8	8
Little Waterfall	F, S	1	4	4
Malina - lower	F	1	4	4
- upper	F, S, BS	1	4	4
Portage	PF	1	4	4
Ruth	S	1	0	4
Saltery	BS	1	0	4
Spiridon	S, EA	2	10	10
Total			51	66

[a] F = Fertilization - sampling scheduled every six weeks
S = Stocking - sampling scheduled every six weeks
BS = Broodstock - sampling scheduled every six weeks
PF = Post fertilization - sampling scheduled every six weeks
EA = Environmental assessment - sampling scheduled every four weeks

Table 7. Average light extinction coefficient (K_d), euphotic zone depth (EZD), secchi disk (SD) transparency for Kodiak and Afognak Island area lakes, 1998.

Lake	Kd (m^{-1})	std. dev.	EZD (m)	std. dev.	SD (m)	std. dev.
Afognak	0.568	0.055	7.57	0.87	3.75	1.21
Crescent	0.525	0.145	8.59	1.54	4.42	1.04
Hidden	0.485	0.480	9.17	0.90	6.05	1.14
Upper Jennifer	0.398	0.035	10.90	0.98	6.13	1.70
Laura	0.586	0.084	7.65	0.90	3.50	0.61
Little Kitoi	0.602	0.204	7.90	2.27	3.75	1.02
Little Waterfall	0.678	0.147	6.61	1.56	3.67	1.01
Lower Malina	0.384	0.091	11.48	3.23	5.63	0.92
Upper Malina	0.413	0.127	11.76	3.45	3.44	0.47
Portage	1.566	1.354	4.29	2.19	3.44	0.47
Ruth	0.565	0.162	7.84	2.34	4.75	1.08
Saltery	0.713	0.364	7.66	3.91	2.50	1.98
Spiridon	0.235	0.089	20.73	5.68	9.30	1.57

Table 8. Temperatures (°C) measured at the 1-meter and near bottom strata in the spring (May-June), summer (July-August), and fall (September-October) for the Kodiak area lakes, 1998. If more than one measurement was obtained for a time period, the concentrations were averaged.

	Spring		Summer		Fall	
Lake	Surface	Bottom	Surface	Bottom	Surface	Bottom
Afognak	7.9	7.7	14.3	13.0	11.8	11.6
Crescent	7.9	7.3	14.0	8.3	9.1	8.8
Frazer	na	na	na	na	na	na
Hidden	6.4	5.7	13.5	6.8	10.3	7.0
U. Jennifer	10.1	5.2	16.1	5.2	10.9	5.9
Laura	7.2	6.2	14.8	6.4	9.9	6.8
L. Kitoi	8.0	4.7	16.4	5.0	10.6	8.5
L. Waterfall	7.7	6.6	15.6	8.5	8.5	7.7
L. Malina	6.6	6.5	13.0	12.9	10.2	10.1
U. Malina	6.1	5.9	12.7	9.1	10.5	10.4
Portage	8.7	7.1	15.8	9.4	9.5	9.3
Ruth	8.8	4.8	16.2	5.1	10.4	5.1
Saltery	6.5	4.7	9.0	6.2	7.7	7.6
Spiridon	3.6	3.5	12.6	5.2	10.0	5.7

na - Temperature was not measured.

Table 9. Dissolved oxygen concentrations (mg L^{-1}) measured at the 1-meter and near bottom strata in the spring (May-June), summer (July-August), and fall (September-October) for the Kodiak area lakes, 1998. If more than one measurement was obtained for a time period, the concentrations were averaged.

	Spring		Summer		Fall	
Lake	Surface	Bottom	Surface	Bottom	Surface	Bottom
Afognak	11.8	11.7	10.2	6.1	10.2	10.0
Crescent	11.2	11.1	12.0	11.0	11.4	11.3
Frazer	na	na	na	na	na	na
Hidden	11.5	12.3	9.7	11.0	11.0	10.5
U. Jennifer	11.2	11.4	9.7	7.0	11.0	10.0
Laura	11.5	7.7	9.2	8.8	11.4	9.4
L. Kitoi	11.8	2.8	9.6	7.8	11.1	9.1
L. Waterfall	11.8	12.5	9.1	6.4	11.4	11.7
L. Malina	12.2	12.2	10.3	9.9	11.3	10.1
U. Malina	12.3	12.2	10.5	8.0	11.0	11.0
Portage	12.1	9.2	9.8	8.1	11.4	11.6
Ruth	11.5	9.0	9.8	3.8	11.5	2.4
Saltery	12.0	12.0	10.1	9.3	12.4	10.9
Spiridon	12.4	12.0	10.4	12.1	11.6	12.3

na - Dissolved oxygen levels were not measured.

Table 10. Summary of seasonal mean water chemistry parameters by station and depth for lakes in the Kodiak Management Area, 1998.

Lake	Station	Depth (m)	Sp. Cond. (umhos cm^{-1})	SD	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
Afognak	1	1	48.7	0.6	7.0	0.1	12.6	1.3	1.7	1.2	17.7	10.7	3.2	0.5	0.8	0.2	25.7	15.0
	1	18	48.0	na	7.0	na	11.8	na	2.0	na	11.0	na	3.3	na	1.0	na	48.0	na
Hidden	1	1	43.3	1.0	6.9	0.0	9.8	1.7	0.9	0.5	13.3	1.0	3.0	0.5	0.7	0.2	24.5	6.6
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	42	44.8	1.5	6.8	0.1	9.3	0.5	0.9	0.4	13.8	0.4	3.0	0.5	0.7	0.2	26.1	3.5
Laura	1	1	63.7	0.6	7.1	0.2	12.7	2.0	1.0	0.6	15.3	2.5	3.5	0.2	1.2	0.2	20.3	4.0
L. Kitoi	1	1	106.3	0.6	7.4	0.1	30.3	2.7	0.8	0.7	22.7	2.9	9.6	0.6	2.1	0.3	18.0	5.3
L. Malina	1	1	71.7	1.5	7.3	0.1	25.4	4.0	1.2	0.7	9.3	4.0	6.6	0.1	1.6	0.2	17.3	7.5
	1	11	71.0	na	7.3	na	22.5	na	1.1	na	5.0	na	6.9	na	1.6	na	24.0	na
L.Waterfall	1	1	57.3	2.5	7.2	0.1	17.2	3.3	0.9	0.3	19.3	0.6	4.6	0.6	1.0	0.1	58.7	10.1
U. Malina	2	1	69.0	1.0	7.3	0.1	23.8	2.8	1.3	1.0	10.3	1.2	6.6	0.5	1.3	0.2	23.0	3.6
	2	26	69.0	na	7.2	na	21.4	na	2.0	na	6.0	na	6.8	na	1.3	na	28.0	na
Portage	1	1	69.0	0.0	7.3	0.1	22.6	1.7	1.7	0.5	8.2	3.1	6.7	0.1	1.3	0.0	25.5	3.5
Spiridon	1	1	72.3	0.5	7.4	0.1	24.5	2.0	1.0	0.4	7.5	3.4	5.8	0.2	2.4	0.1	11.5	5.7
	1	50	73.8	0.5	7.3	0.1	22.9	0.7	0.7	0.4	5.5	0.6	5.7	0.1	2.5	0.0	9.3	4.6
	2	1	74.0	0.8	7.4	0.1	24.6	1.9	1.0	0.7	5.8	2.9	5.7	0.1	2.5	0.1	10.8	5.9
	2	50	72.0	3.4	7.3	0.0	23.7	1.5	0.6	0.4	5.0	0.8	5.7	0.1	2.5	0.1	9.3	5.3

SD - standard deviation; na - not available

Table 11. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for lakes in the Kodiak Management Area, 1998.

Lake	Station	Depth (m)	Total-P (ug L^{-1})	SD	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+ nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll a (ug L^{-1})	SD	Phaeophytin a (ug L^{-1})	SD
Afognak	1	1	9.0	1.7	3.3	0.8	1.9	0.0	192.9	7.7	21.2	13.9	38.1	15.9	2387.0	73.0	151.7	118.8	0.10	0.0	0.04	0.0
	1	18	7.5	na	3.7	na	1.9	na	182.2	na	24.5	na	62.6	na	2311.0	na	36.0	na	0.09	na	0.03	na
Hidden	1	1	3.1	1.0	2.4	0.8	1.7	0.9	100.5	11.5	5.5	4.5	13.3	4.8	1651.0	227.2	80.0	27.4	0.45	0.2	0.15	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.18	0.2	0.08	0.1
	1	42	3.2	0.5	2.5	0.8	1.8	0.8	98.2	16.6	6.4	3.8	17.2	5.8	1627.5	214.0	113.8	51.8	0.38	0.2	0.16	0.0
Laura	1	1	11.5	4.2	3.7	2.3	0.9	0.5	174.6	17.9	4.1	2.5	11.0	5.1	1127.7	296.1	188.7	91.5	1.38	0.4	3.06	3.0
L. Kitoi	1	1	8.4	3.7	5.5	0.8	3.7	1.2	216.3	42.8	22.9	20.0	17.5	10.9	2002.0	319.7	121.7	52.5	1.80	2.2	0.96	0.8
L. Malina	1	1	9.5	1.5	5.0	2.7	3.5	1.7	168.3	15.1	27.0	8.6	69.0	7.6	2479.3	493.5	91.3	40.4	0.51	0.0	0.57	0.1
	1	11	9.6	na	2.6	na	1.4	na	175.0	na	37.6	na	64.6	na	1955.0	na	80.0	na	0.73	na	0.89	na
L.Waterfall	1	1	10.2	3.5	3.3	1.0	2.4	0.4	183.6	29.0	9.2	8.4	24.9	21.5	1520.0	110.4	183.7	92.8	1.79	1.3	0.62	0.6
U. Malina	2	1	9.7	4.0	3.1	0.1	2.6	0.6	171.8	19.7	12.6	7.9	39.2	24.3	2396.0	279.8	232.3	42.3	1.68	1.1	1.16	0.5
	2	26	7	na	2.7	na	2.1	na	145	na	26.4	na	39.1	na	2416.0	na	144	na	0.92	na	0.80	na
Portage	1	1	8.3	1.9	2.9	0.2	2.4	0.4	158.4	18.9	19.5	9.8	39.2	0.1	2406.0	14.1	188.2	62.5	1.30	0.5	0.98	0.3
Spiridon	1	1	4.8	1.57	2.7	1.8	1.7	1.0	138.3	20.5	8.4	6.08	121.5	24.7	2239.25	174.3	100.25	55.7	0.43	0.3	0.12	0.1
	1	50	4	0.42	1.6	0.8	1.3	0.5	118.4	10.1	10.2	5.36	174.43	19.6	2355.25	42.43	32.5	18.7	0.14	0.0	0.11	0.0
	2	1	3.9	1.21	1.5	1.1	1.4	0.6	124.6	10.1	4.9	1.36	148.25	12.2	2262.25	105.2	38.5	38.0	0.38	0.3	0.10	0.1
	2	50	4	1.68	1.5	0.9	1.5	0.7	122.9	12.0	9.6	4.48	171.93	26.4	2296.5	93.34	31.75	24.1	0.21	0.1	0.11	0.0

SD - standard deviation; na - not available

Table 12. Weighted mean zooplankton density, biomass, and size by genera for Kodiak area project lakes, 1998.

		Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
Lake	Station	of Samples	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)
Afognak	1,2	4	15,672	51.0	0.90	1,088	4.0	0.96	2,070	3.4	0.64	169,971	151.0	0.29	10,881	15.0	0.54	5,441	9.0	0.39	205,123	233
Crescent	1	4	53	0.0	0.62	-	-	-	11,996	29.0	0.84	88,562	137.0	0.41	220,992	308.0	0.58	9,608	31.0	0.59	331,158	505
Frazer [a]	1	3	-	-	-	-	-	-	419,406	983.0	0.81	294,267	474.0	0.45	8,883	31.0	0.80	-	-	-	722,556	1,488
Hidden	1	5	1,316	11.0	1.25	-	-	-	45,527	123.0	0.85	29,667	68.0	0.49	18,605	44.0	0.73	4,242	24.1	0.67	99,357	270
U. Jennifer	1	4	-	-	-	10,722	83.0	1.23	141,986	325.0	0.79	125,903	263.0	0.47	32,644	94.0	0.75	8387	47.0	0.75	319,642	812
Laura	1	4	-	-	-	-	-	-	5,531	14.0	0.83	38,687	36.0	0.31	43,904	53.0	0.49	5387	5.0	0.43	93,509	108
L. Kitoi	1	4	-	-	-	8	0.0	0.64	9,045	7.0	0.50	62,943	49.0	0.29	21,924	21.0	0.45	1,244	1.4	0.40	95,164	78
L. Waterfall	1	4	3,026	5.0	0.72	85	0.1	0.52	3,681	7.0	0.73	75,457	74.0	0.31	12,997	15.0	0.58	610	1.0	0.42	95,856	102
Malina (lower)	1	4	263	1.0	0.93	231	0.5	0.76	311	0.4	0.58	31,099	28.0	0.31	1,107	1.2	0.62	56	0.1	0.42	33,066	32
U. Malina (upper)	2	4	6,714	58.0	1.26	4,432	19.0	1.00	3,503	4.0	0.57	144,666	139.0	0.32	8,626	12.2	0.55	637	1.2	0.48	168,578	233
Portage	1	4	4,331	9.0	0.77	-	-	-	1,051	1.0	0.64	10,065	9.0	0.30	7,509	8.0	0.52	558	0.5	0.35	23,514	28
Ruth	1	4	1,088	4.0	0.93	239	1.0	0.93	10,497	20.0	0.71	44,879	39.0	0.30	79,446	116.0	0.76	9,236	23.0	0.52	145,385	203
Saltery	1	4	-	-	-	-	-	-	165,898	326.0	0.73	1,911	2.0	0.35	44,586	102.0	0.69	-	-	-	212,395	430
Spiridon	1, 2	5	-	-	-	8,153	63.0	1.23	354,953	448.0	0.80	23,652	58.5	0.55	37,601	120.0	1.06	16,256	77.5	0.85	440,615	767

[a] The high density and biomass levels at Frazer Lake could be high due to only three samples being averaged for the season. A late season (fall) sample was not collected when zooplankton levels typically decrease.

Table 13. Summary of the cladoceran and copepod compositions in Kodiak area project lakes, 1998.

Lake	Cladoceran density (number/ meter^2)	Cladoceran composition	Copepod density (number/ meter^2)	Copepod composition	Cladoceran:Copepod
Afognak	186,293	90.8%	18,830	9.2%	9.89
Crescent	319,162	96.4%	12,049	3.6%	26.49
Frazer	303,150	42.0%	419,406	58.0%	0.72
Hidden	52,514	52.9%	46,843	47.1%	1.12
U. Jennifer	166,934	52.2%	152,708	47.8%	1.09
Laura	87,978	94.1%	5,531	5.9%	15.91
L. Kitoi	86,111	90.5%	9,053	9.5%	9.51
L. Waterfall	89,064	92.9%	6,792	7.1%	13.11
Malina - lower	32,262	97.6%	805	2.4%	40.08
Malina - upper	153,929	91.3%	14,649	8.7%	10.51
Portage	18,132	77.1%	5,382	22.9%	3.37
Ruth	133,561	91.9%	11,824	8.1%	11.30
Saltery	46,497	21.9%	165,898	78.1%	0.28
Spiridon	77,509	17.6%	363,106	82.4%	0.21

Table 14. Temperature data (°C) at four stations in the Kitoi Bay Section (252-32), May 12-June 10, 1998.

Depth	Mid-Bay Kitoi (station 1)				Big Kitoi Bay (station 2)				Little Kitoi Bay (station 3)				Inside Little Kitoi Bay (station 4)			
(m)	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun
0	7.0	7.0	10.0	10.1	7.2	7.5	9.8	10.1	7.0	7.0	10.0	10.1	7.0	8.0	10.0	10.1
0.5	7.0	7.0	9.8	10.1	7.2	7.5	9.5	10.1	7.0	7.1	9.5	10.1	7.0	7.0	9.5	10.2
1.0	7.0	7.0	9.2	10.5	7.2	7.5	9.2	11.0	7.0	7.1	9.2	11.0	7.0	7.0	9.0	11.0
1.5	7.0	7.0	8.9	11.1	7.2	7.5	9.0	11.5	7.0	7.1	8.8	11.1	7.0	7.0	8.5	11.7
2.0	6.9	6.9	8.5	11.7	7.0	7.5	8.8	11.6	6.9	7.0	8.2	11.5	7.0	7.0	8.0	11.8
2.5	6.8	6.9	8.0	11.7	7.0	7.2	8.2	11.8	6.9	7.0	8.0	12.0	7.0	7.0	8.0	12.0
3.0	6.8	6.8	8.0	11.9	7.0	7.0	8.0	11.9	6.8	7.0	8.0	12.0	7.0	7.0	7.8	12.0
3.5	6.8	6.8	8.0	12.0	7.0	7.0	8.0	12.0	6.8	7.0	8.0	12.0				
4.0	6.8	6.8	7.8	12.0	7.0	7.0	7.9	12.0	6.8	6.9	8.0	12.0				
4.5	6.8	6.8	7.8	12.1	6.9	7.0	7.8	12.0	6.8	6.9	7.8	12.1				
5.0	6.8	6.8	7.5	12.1	6.8	6.8	7.5	12.1	6.8	6.9	7.5	12.1				
6.0	6.8	6.8	7.2	12.1	6.8	6.8	7.5	12.1	6.8	6.8	7.5	12.1				
7.0	6.8	6.8	7.2	12.1	6.8	6.8	7.2	12.1	6.8	6.5	7.2	12.1				
8.0	6.5	6.5	7.2	12.1	6.8	6.5	7.2	12.2	6.8	6.5	7.0	12.1				
9.0	6.5	6.5	7.0	12.1	6.5	6.5	7.0	12.5	6.5	6.5	7.0	12.1				
10.0	6.5	6.5	7.0	12.2	6.5	6.5	7.0	12.5	6.5	6.5	7.0	12.5				
11.0	6.0	6.5	7.0	12.2	6.5	6.5	7.0	12.5	6.5	6.5	7.0	12.5				
12.0	6.0	6.5	7.0	12.2	6.1	6.5	7.0	12.5	6.5	6.5	7.0	12.5				
13.0	6.0	6.5	7.0	12.2	6.0	6.5	7.0	12.5	6.0	6.5	6.8	12.5				
14.0	6.0	6.5	6.8	12.2	6.0	6.5	7.0	12.5	6.0	6.5	6.8	12.5				
15.0	6.0	6.5	6.8	12.2	6.0	6.5	6.8	12.5	6.0	6.2	6.8	12.6				
16.0	6.0	6.5	6.8	12.2	6.0	6.5	6.8	12.5	6.0	6.2	6.8	12.6				
17.0	6.0	6.5	6.8	12.2	6.0	6.5	6.8	12.5	6.0	6.2	6.8	12.6				
18.0	6.0	6.5	6.5	12.2	6.0	6.5	6.8	12.5	6.0	6.2	6.5	12.6				
19.0	6.0	6.5	6.5	12.2	6.0	6.5	6.8	12.5	5.9	6.2	6.5	12.6				
20.0	5.9	6.5	6.5	12.5	6.0	6.5	6.8	12.7	5.9	6.2	6.5	12.6				

Table 15. Salinity data (parts/thousand) at four stations in the Kitoi Bay Section (252-32), May 12-June 10, 1998.

Depth	Mid-Bay Kitoi (station 1)				Big Kitoi Bay (station 2)				Little Kitoi Bay (station 3)				Inside Little Kitoi Bay (station 4)			
(m)	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun	12-May	19-May	2-Jun	10-Jun
0	24.0	20.2	12.5	20.6	16.1	16.8	5.0	10.9	19.0	18.0	11.5	10.0	12.0	5.0	8.0	5.0
0.5	24.5	20.5	21.2	20.6	22.5	16.8	19.5	21.2	24.1	19.0	21.2	14.0	20.0	17.5	20.0	12.0
1.0	24.5	20.5	23.7	24.2	24.2	18.8	24.8	23.2	23.7	19.0	22.5	23.0	23.0	20.2	22.0	23.5
1.5	24.5	20.5	25.0	24.5	25.0	19.5	25.0	23.8	24.5	20.0	24.9	24.5	24.2	20.0	24.2	24.8
2.0	24.5	20.5	25.0	24.5	25.0	20.0	25.2	23.8	24.5	20.0	25.2	24.8	25.0	20.5	25.0	24.8
2.5	24.5	20.5	25.5	24.5	25.0	20.5	25.5	23.8	25.0	20.8	25.5	24.8	25.0	20.5	25.0	24.8
3.0	24.5	20.5	25.5	23.5	25.0	20.5	25.5	23.8	25.0	21.0	25.5	24.8	25.0	20.5	25.0	24.8
3.5	24.5	20.5	25.5	23.5	25.0	20.5	25.5	23.8	25.0	21.0	25.2	24.8				
4.0	24.5	20.5	25.5	23.5	25.0	20.5	25.5	23.8	25.0	21.0	25.2	24.8				
4.5	24.5	20.5	25.5	23.5	25.0	20.5	25.5	23.8	25.0	21.0	25.5	24.8				
5.0	24.5	20.5	26.0	23.5	25.0	20.5	25.5	23.8	25.0	21.0	25.5	24.8				
6.0	24.5	20.5	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.0	25.5	24.8				
7.0	24.5	20.5	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	25.8	24.8				
8.0	24.5	20.8	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
9.0	24.5	20.8	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
10.0	24.5	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
11.0	24.5	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
12.0	24.5	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
13.0	25.0	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
14.0	25.0	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
15.0	25.0	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
16.0	25.0	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.2	26.0	24.8				
17.0	25.0	21.0	26.0	23.5	25.0	20.5	25.6	23.8	25.0	21.5	26.0	24.8				
18.0	25.0	21.0	26.2	23.5	25.0	20.5	26.2	23.8	24.8	21.5	26.0	24.8				
19.0	25.0	21.0	26.2	23.5	25.0	20.5	26.2	23.8	24.8	21.5	26.0	24.8				
20.0	25.0	21.0	26.2	23.5	25.0	20.5	26.2	23.8	24.8	21.5	26.0	24.8				

Table 16. Results of plankton surveys (in milliliters) at three stations in the Kitoi Bay Section (252-32), May 12-June 10, 1998.

Date	Station	zooplankton (ml)	phytoplankton (ml)	total plankton (ml)
May 12	1	2.0	190.0	192.0
May 12	2	1.5	150.5	152.0
May 12	3	1.5	148.5	150.0
May 19	1	2.5	82.5	85.0
May 19	2	3.0	92.0	95.0
May 19	3	4.0	94.0	98.0
June 2	1	4.0	256.0	260.0
June 2	2	5.0	270.0	275.0
June 2	3	3.5	218.5	222.0
June 10	1	5.0	112.0	117.0
June 10	2	12.0	97.0	109.0
June 10	3	28.0	150.0	178.0

Station #1: Mid-Bay
Station #2: Big Kitoi Bay
Station #3: Little Kitoi Bay

Table 17. Juvenile sockeye salmon estimates based on townet catches and hydroacoustic fish population estimates for Kodiak area lakes, 1998.

		Total Fish Estimates			Sockeye Estimates			Sockeye
			95% C. I.			95% C. I.		Composition
Lake	Date	Number	Low	High	Number	Low	High	(%)
Hidden[a]	24-Apr	115,768	94,283	137,253	115,768	94,283	137,253	
L. Kitoi	18-Aug	81,261	68,609	93,913	6,176	5,214	7,138	7.6
L. Waterfall[a]	23-Apr	114,107	92,427	134,787	114,107	92,427	134,787	
Saltery	16-Sep	686,598	611,227	761,969	680,419	609,690	751,148	99.1
Spiridon[a]	25-Apr	1,341,645	1,226,528	1,456,762	1,341,645	1,226,528	1,456,762	
	15-Sep	1,980,704	1,603,982	2,357,426	1,980,704	1,603,982	2,357,426	

[a] Tow net catch sampling was not conducted at Hidden, Little Waterfall, and Spiridon Lakes.

Table 18. Townet catches from Little Kitoi and Saltery Lakes, 1998.

Lake	Number of Tows	Total Minutes	Catch by Species					
			Sockeye			Stickleback		
			No.	%	CPUE[a]	No.	%	CPUE[a]
L. Kitoi	6	31	14	7.6	0.5	170	92.4	5.5
Saltery	2	27	229	99.1	8.5	2	0.9	0.1

[a] CPUE - Catch Per Unit Effort

Table 19. Mean age, length, weight, and conditon coefficient for juvenile sockeye salmon caught by tow net at Little Kitoi and Saltery Lakes, 1998.

		Age-0					Age-1					Age-2				
System	Sampling Week	N	%	Length (mm)	Weight (g)	Condition (K)	N	%	Length (mm)	Weight (g)	Condition (K)	N	%	Length (mm)	Weight (g)	Condition (K)
Little Kitoi	34 (8/16-8/22)	9	64.3	57.8	2.1	1.07	4	28.6	72.5	4.3	1.02	1	7.1	64	3	1.14
Saltery	38 (9/13-9/19)	10	4.8	49.7	1.4	1.09	198	94.3	56.8	2	1.08	2	0.9	56	1.9	1.07

Table 20. Sockeye salmon smolt captured for age and size data, and total population estimates[a] by age class from selected Kodiak area systems, 1998.

System	Trapping Dates	Total Captured	Smolt Estimates by Age Class 1	2	3	Total Emigration Number	95% Confidence Interval Variance	Lower	Higher
Frazer Lake	3-May thru 27-Jun	nd	0 33.6	0 65.4	0 1.0	nd			
Little Kitoi	6-May thru 7-Jul	10,070	47,676 83.1	8,778 15.3	918 1.6	57,372	2.5E+08	26,297	88,447
Malina Lake	3-May thru 11-Jul	211,309	255,142 52.2	228,259 46.7	5,377 1.1	488,777	5.8E+08	441,041	535,318
Spiridon[b]	26-Apr thru 11-Jul	746,950	578,139 77.4	168,064 22.5	301 0.1	746,950	2.5E+08	716,192	777,708
Afognak Lake	24-May thru 30-May	163	AGE, LENGTH AND WEIGHT SAMPLING ONLY						
Hidden Lake	24-May thru 27-Jun	471	AGE, LENGTH AND WEIGHT SAMPLING ONLY						
Laura Lake	3-Jun 13-Jun 14-Jun	251	AGE, LENGTH AND WEIGHT SAMPLING ONLY						
L. Waterfall Lake	11-Jun	200	AGE, LENGTH AND WEIGHT SAMPLING ONLY						
Portage	31-May 5-Jun 17-Jun	181	AGE, LENGTH AND WEIGHT SAMPLING ONLY						

nd - emigration estimate not determined due to high water event.

[a] Little Kitoi Lake, Malina Lake, and Spiridon Lake.

[b] Both live and dead sockeye smolt are trapped; live sockeye smolt, only, are included in total emigration estimates (by actual counts and time estimates).

Table 21. Mean age, length, weight, and condition coefficient by age for sockeye salmon smolt sampled at Kodiak area lakes, 1998.

		Age-1					Age-2					Age-3				
System	Sampling Weeks	N	%	Length (mm)	Weight (g)	Condition (K)	N	%	Length (mm)	Weight (g)	Condition (K)	N	%	Length (mm)	Weight (g)	Condition (K)
Afognak Lake	22 (5/24-5/30)	116	71.2	66.4	2.6	0.82	46	28.2	88.0	6.6	0.90	1	0.6	103.0	10.0	0.92
Frazer Lake	19-26 (5/3-6/27)	618	33.6	97.5	8.1	0.86	1205	65.5	109.6	10.4	0.79	18	0.8	114.4	11.8	0.78
Hidden Lake	22-26 (5/24-6/27)	455	98.5	111.5	12.7	0.91	7	1.5	141.3	24.6	0.87	0	0.0	0.0	0.0	0.00
Laura Lake	23-25 (5/31-6/20)	10	4.0	85.6	5.6	0.84	239	96.0	79.4	4.3	0.86	0	0.0	0.0	0.0	0.00
Little Kitoi Bay [a]	19-20 (5/3-5/16)	200	100.0	107.9	12.1	0.91	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
Little Kitoi Lake	20-28 (5/10-7/11)	1125	83.1	91.1	5.8	0.72	207	15.3	69.4	2.4	0.72	22	1.6	72.7	2.9	0.74
L.Waterfall Lake	22-24 (5/24-6/13)	194	97.5	99.7	8.3	0.84	5	2.5	111.8	13.1	0.85	0	0.0	0.0	0.0	0.00
Malina Lake	19-28 (5/3-7/11)	818	52.2	92.8	6.3	0.75	773	46.7	77.5	3.7	0.78	17	1.1	89.4	6.0	0.81
Portage Lake	23-25 (5/31-6/20)	134	74.0	75.4	3.9	0.89	47	26.0	80.3	4.9	0.90	0	0.0	0.0	0.0	0.00
Spiridon Lake	18-27 (4/26-7/4)	1496	78.3	93.3	6.3	0.76	414	21.7	126.7	15.4	0.75	0	0.0	0.0	0.0	0.00

[a] Smolt reared at Kitoi Bay Hatchery; sampled prior to release into Little Kitoi Bay.

Table 22. Mean age, length, weight, and condition coefficient by age for coho salmon smolt sampled at Kodiak area lakes, 1998.

System	Sampling Weeks	Age-1 N	Age-1 %	Age-1 Length (mm)	Age-1 Weight (g)	Age-1 Condition (K)	Age-2 N	Age-2 %	Age-2 Length (mm)	Age-2 Weight (g)	Age-2 Condition (K)	Age-3 N	Age-3 %	Age-3 Length (mm)	Age-3 Weight (g)	Age-3 Condition (K)
Jennifer Lake	22 (5/24-5/30)	2	5.0	113.0	13.5	0.93	31	77.5	119.6	15.9	0.91	7	17.5	149.9	31.9	0.91
Laura	23 (5/31-6/6)	0	0.0	0.0	0.0	0.00	2	50.0	119.0	13.3	0.79	2	50.0	138.5	24.5	0.90
Little Kitoi Bay [a]	19-20 (5/3-5/16)	200	100.0	115.4	17.5	1.10	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
L. Waterfall Lake	22 (6/24-5/30)	2	8.0	120.0	15.6	0.86	22	88.0	108.3	11.7	0.90	1	4.0	142.0	30.9	1.08
Malina Lake	23-24 (5/31-6/13)	4	2.3	117.0	14.1	0.87	73	42.7	132.7	21.8	0.90	94	55.0	145.3	27.9	0.89
Portage Lake	23 (5/31-6/6)	0	0.0	0.0	0.0	0.00	15	45.9	131.7	24.4	0.96	14	54.1	140.5	31.3	0.97

[a] Smolt reared at Kitoi Bay Hatchery; sampled prior to release into Little Kitoi Bay.

Table 23. Kodiak Management Area escapement and common property salmon harvest for systems with salmon enhancement and rehabilitation projects, 1998.

Project	Species	Escape/ Brood	Pre-season Forecast of Harvest	Common Property Harvest						Total Run
				Commercial [a]	Average Wt (lbs)	Value [b]	Subsistence [c]	Sport [d]	Total	
Kitoi Area [a,f]	pink	424,306	850,000	6,272,029	3.6	$3,364,316	27	0	6,272,056	6,696,362
(hatchery stocking)	chum	18,650	13,500	38,118	6.4	$46,839	0	0	38,118	56,768
	coho	6,000	131,000	148,333	8.4	$463,511	115	0	148,448	154,448
	sockeye - E.Run		18,000	13,943	4.4	$71,288	0	90	14,033	14,033
	sockeye - L.Run		38,000	61,563	4.4	$314,759	0	90	61,653	61,653
	sockeye - Total Run		56,000	75,506	4.4	$386,047	0	180	75,686	75,686
Frazer Lake [g]	sockeye	245,409	399,000	360,949	5.2	$2,165,983	0	0	360,949	606,358
(fishpass; fertilization)										
Laura/Portage Lakes [b]	coho	15,514	No Forecast	12,528	9.2	$42,876	8	1,291	13,827	29,341
(fishpasses;stocking;fertilization)	sockeye	15,343	0	78	3.5	$317	126	0	204	15,547
	pink	12,053	No Forecast	na	na	na	0	0	0	12,053
Little Waterfall Creek	pink	151,655	No Forecast	3,374	3.4	$1,709	0	0	3,374	155,029
and Lake [e]	sockeye	600	28,000	11,057	3.9	$50,108	200	0	11,257	11,857
fishpasses; stocking; fertilization)										
Afognak Lake [b]	sockeye	66,869	9,000	26,060	4.1	$124,155	4,690	300	31,050	97,919
(fertilization; stocking)										
Malina Lakes [b]	sockeye	14,917	15,000	na	na	na	0	0	0	14,917
(fertilization; stocking)										
Hidden Lake [c]	sockeye	0	13,000	8,270	4.1	$43,773	0	0	8,270	8,270
(stocking)										
Spiridon Lake [c]	sockeye	5,000	255,000	215,729	4.6	$1,145,176	0	0	215,729	220,729
(stocking)										
Crescent Lake [c]	sockeye	0	14,000	3,085	4.3	$15,415	888	0	3,973	3,973
(stocking)	coho	0	7,000	0	na	$0	293	300	593	593
Totals:	pink			6,275,403		$3,366,025	27	0	6,275,430	
	chum			38,118		$46,839	0	0	38,118	
	sockeye			700,656		$3,930,657	5,904	480	707,040	
	coho			160,861		$506,387	416	1,591	162,868	
	all species			7,175,038		$7,849,908	6,347	2,071	7,183,456	

-Continued-

Table 23. (page 2 of 2)

na - not available - assumed that some level of harvest has occurred in other Statistical Areas.

[a] From ADF&G fish ticket summaries for regulatory management units; Afognak-252-34; Kitoi-252-30-32; Laura/Portage/Waterfall-251-82-84; Hidden-251-41; Crescent-259-35;

[b] Commercial harvest exvessel value = average weight (lb) x price per pound x catch - sockeye - $1.16/lb; coho - $.37/lb; chum - $.19/lb; pink - $.15/lb.

[c] Estimated based on field staff observations and ADF&G Individual subsistence permittee harvest reports.

[d] Sport harvest data are estimates from field project staff.

[e] Non-anadromous system; total harvest reflects supplemental production.

[f] Kitoi Area early and late sockeye run estimates refer to broodstock run timing and are derived from mark observation data; therefore, they may not agree with management data delineated by the July 15 separation date. Kitoi Area sockeye escapement includes returns to Kitoi Bay Hatchery.

[g] System originally non-anadromous; enhanced by fishpass which is operated annually; currently is anadromous and production includes rehabilitation efforts (lake enrichment) from 1988-1992.

[h] Anadromous system; production soley attributed to fertilization is not available (na); fishpass operation considered essential to any production..

Table 24. Sockeye salmon commercial fishing effort and harvest at Foul Bay (251-41), Waterfall Bay (251-84), and Telrod Cove (254-50) terminal harvest areas; and Kitoi (252-32), Duck (252-31), and Izhut (252-30) Bays combined, June 9 - September 13, 1998.

	Foul Bay THA (251-41)			Waterfall Bay THA (251-84)			Telrod Cove THA			Kitoi, Duck, Izhut Bays		
Date	Landings	Daily	Cumulative	Landings	Daily	Cumulative	Landings	Daily	Cumulative	Landings	Daily	Cumulative
9-Jun	2	567	567	7	3,186	3,186	closed			4	1,108	1,108
10-Jun	5	1,770	2,337	3	676	3,862	closed			9	1,662	2,770
11-Jun	6	1,431	3,768	1	28	3,890	closed			4	977	3,747
12-Jun	6	958	4,726	2	320	4,210	closed			3	419	4,166
13-Jun	2	425	5,151	3	869	5,079	closed			1	488	4,654
14-Jun	0	0	5,151	0	0	5,079	closed			0	0	4,654
15-Jun	1	661	5,812	0	0	5,079	closed			0	0	4,654
16-Jun	0	0	5,812	0	0	5,079	closed			0	0	4,654
17-Jun	1	362	6,174	3	1,991	7,070	closed			0	0	4,654
18-Jun	3	682	6,856	0	0	7,070	closed			0	0	4,654
19-Jun	1	235	7,091	1	907	7,977	closed			closed @ 9 PM		4,654
20-Jun	0	0	7,091	0	0	7,977	closed			closed		4,654
21-Jun	1	712	7,803	1	712	8,689	closed			closed		4,654
22-Jun	0	0	7,803	1	900	9,589	closed			closed		4,654
23-Jun	0	0	7,803	0	0	9,589	closed			closed		4,654
24-Jun	0	0	7,803	2	418	10,007	closed			closed		4,654
25-Jun	0	0	7,803	3	240	10,247	closed			closed		4,654
26-Jun	0	0	7,803	0	0	10,247	closed			closed		4,654
27-Jun	1	421	8,224	1	610	10,857	closed			closed		4,654
28-Jun	0	0	8,224	0	0	10,857	closed			closed		4,654
29-Jun	0	0	8,224	0	0	10,857	closed			closed		4,654
30-Jun	2	46	8,270	2	200	11,057	closed			closed		4,654
1-Jul	0	0	8,270	0	0	11,057	closed			closed		4,654
2-Jul	0	0	8,270	0	0	11,057	13	4,752	4,752	closed		4,654
3-Jul	0	0	8,270	0	0	11,057	6	1,790	6,542	closed		4,654
4-Jul	0	0	8,270	0	0	11,057	2	723	7,265	closed		4,654
5-Jul	0	0	8,270	0	0	11,057	0	0	7,265	closed		4,654
6-Jul	0	0	8,270	0	0	11,057	0	0	7,265	closed		4,654
7-Jul	0	0	8,270	0	0	11,057	7	2,354	9,619	closed		4,654
8-Jul	0	0	8,270	0	0	11,057	3	511	10,130	10	9,639	14,293
9-Jul	closed		8,270	closed		11,057	6	2,073	12,203	0	0	14,293
10-Jul	closed		8,270	closed		11,057	8	1,718	13,921	0	0	14,293
11-Jul	closed		8,270	closed		11,057	9	2,002	15,923	0	0	14,293

-Continued-

Table 24. (page 2 of 3)

	Foul Bay THA (251-41)			Waterfall Bay THA (251-84)			Telrod Cove THA			Kitoi, Duck, Izhut Bays		
Date	Landings	Daily	Cumulative	# of Boats	Daily	Cumulative	Landings	Daily	Cumulative	Landings	Daily	Cumulative
12-Jul	closed		8,270	closed		11,057	14	4,854	20,777	0	0	14,293
13-Jul	closed		8,270	closed		11,057	7	2,367	23,144	0	0	14,293
14-Jul	closed		8,270	closed		11,057	8	1,878	25,022	0	0	14,293
15-Jul	closed		8,270	closed		11,057	6	1,090	26,112	0	0	14,293
16-Jul	closed		8,270	closed		11,057	6	2,127	28,239	0	0	14,293
17-Jul	closed		8,270	closed		11,057	8	1,851	30,090	0	0	14,293
18-Jul	closed		8,270	closed		11,057	7	5,716	35,806	0	0	14,293
19-Jul	closed		8,270	closed		11,057	8	5,056	40,862	0	0	14,293
20-Jul	closed		8,270	closed		11,057	9	6,716	47,578	10	12,195	26,488
21-Jul	closed		8,270	closed		11,057	4	1,109	48,687	3	2,731	29,219
22-Jul	closed		8,270	closed		11,057	2	351	49,038	4	2,139	31,358
23-Jul	closed		8,270	closed		11,057	4	880	49,918	8	3,598	34,956
24-Jul	closed		8,270	closed		11,057	3	3,123	53,041	17	4,628	39,584
25-Jul	closed		8,270	closed		11,057	9	2,487	55,528	9	1,435	41,019
26-Jul	closed		8,270	closed		11,057	10	1,948	57,476	16	2,618	43,637
27-Jul	closed		8,270	closed		11,057	3	1,529	59,005	18	2,269	45,906
28-Jul	closed		8,270	closed		11,057	6	4,559	63,564	21	1,800	47,706
29-Jul	closed		8,270	closed		11,057	7	2,776	66,340	24	2,000	49,706
30-Jul	closed		8,270	closed		11,057	7	510	66,850	33	3,143	52,849
31-Jul	closed		8,270	closed		11,057	3	462	67,312	20	1,186	54,035
1-Aug	closed		8,270	closed		11,057	1	136	67,448	38	1,932	55,967
2-Aug	closed		8,270	closed		11,057	3	436	67,884	59	2,190	58,157
3-Aug	closed		8,270	closed		11,057	1	411	68,295	52	1,766	59,923
4-Aug	closed		8,270	closed		11,057	0	0	68,295	64	1,592	61,515
5-Aug	closed		8,270	closed		11,057	1	265	68,560	61	1,783	63,298
6-Aug	closed		8,270	closed		11,057	1	549	69,109	52	1,264	64,562
7-Aug	closed		8,270	closed		11,057	0	0	69,109	48	791	65,353
8-Aug	closed		8,270	closed		11,057	1	195	69,304	46	998	66,351
9-Aug	closed		8,270	closed		11,057	0	0	69,304	31	669	67,020
10-Aug	closed		8,270	closed		11,057	1	505	69,809	39	523	67,543
11-Aug	closed		8,270	closed		11,057	1	915	70,724	47	379	67,922
12-Aug	closed		8,270	closed		11,057	3	2,668	73,392	39	264	68,186
13-Aug	closed		8,270	closed		11,057	2	1,209	74,601	44	375	68,561
14-Aug	closed		8,270	closed		11,057	3	2,042	76,643	55	389	68,950
15-Aug	closed		8,270	closed		11,057	2	1,300	77,943	36	624	69,574
16-Aug	closed		8,270	closed		11,057	4	2,311	80,254	53	513	70,087

-Continued-

Table 24. (page 3 of 3)

	Foul Bay THA (251-41)			Waterfall Bay THA (251-84)			Telrod Cove THA			Kitoi, Duck, Izhut Bays		
Date	Landings	Daily	Cumulative	# of Boats	Daily	Cumulative	Landings	Daily	Cumulative	Landings	Daily	Cumulative
17-Aug	closed		8,270	closed		11,057	4	1,253	81,507	49	535	70,622
18-Aug	closed		8,270	closed		11,057	2	150	81,657	57	881	71,503
19-Aug	closed		8,270	closed		11,057	1	745	82,402	56	551	72,054
20-Aug	closed		8,270	closed		11,057	0	0	82,402	45	417	72,471
21-Aug	closed		8,270	closed		11,057	0	0	82,402	42	494	72,965
22-Aug	closed		8,270	closed		11,057	0	0	82,402	27	210	73,175
23-Aug	closed		8,270	closed		11,057	2	630	83,032	31	217	73,392
24-Aug	closed		8,270	closed		11,057	2	513	83,545	20	124	73,516
25-Aug	closed		8,270	closed		11,057	0	0	83,545	18	121	73,637
26-Aug	closed		8,270	closed		11,057	2	738	84,283	19	180	73,817
27-Aug	closed		8,270	closed		11,057	4	518	84,801	22	360	74,177
28-Aug	closed		8,270	closed		11,057	5	1,368	86,169	10	138	74,315
29-Aug	closed		8,270	closed		11,057	2	608	86,777	15	370	74,685
30-Aug	closed		8,270	closed		11,057	3	1,244	88,021	5	157	74,842
31-Aug	closed		8,270	closed		11,057	2	320	88,341	0	0	74,842
1-Sep	closed		8,270	closed		11,057	1	108	88,449	0	0	74,842
2-Sep	closed		8,270	closed		11,057	closed			1	36	74,878
3-Sep	closed		8,270	closed		11,057	closed			4	152	75,030
4-Sep	closed		8,270	closed		11,057	closed			8	216	75,246
5-Sep	closed		8,270	closed		11,057	closed			9	68	75,314
6-Sep	closed		8,270	closed		11,057	closed			3	39	75,353
7-Sep	closed		8,270	closed		11,057	closed			6	82	75,435
8-Sep	closed		8,270	closed		11,057	closed			4	16	75,451
9-Sep	closed		8,270	closed		11,057	closed			0	0	75,451
10-Sep	closed		8,270	closed		11,057	closed			2	27	75,478
11-Sep	closed		8,270	closed		11,057	closed			3	22	75,500
12-Sep	closed		8,270	closed		11,057	closed			2	6	75,506
13-Sep	closed		8,270	closed		11,057	closed			2	0	75,506

Table 25. Estimated age composition of sockeye salmon escapements and harvests from Kodiak Management Area enhancment or rehabilitation systems, 1998.

Location	Sample Weeks	Sample Size		Ages												Total
				0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	3.3	
Afognak Lake	23-29	1,240	Numbers	0	9,810	0	4,105	3,847	23,943	5,470	106	193	2,893	0	0	50,367
(escapement) [a]	(5/31-7/18)		Percent	0.0	19.5	0.0	8.2	7.6	47.5	10.9	0.2	0.4	5.7	0.0	0.0	100
Foul Bay THA	24-27	646	Numbers	0	2180	0	4360	349	1308	436	0	0	87	0	0	8,720
(harvest)	(6/9-6/29)		Percent	0.0	25.0	0.0	50.0	4.0	15.0	5.0	0.0	0.0	1.0	0.0	0.0	100
Little Kitoi Lake/Bay [b]	23-37	940	Numbers	151	3,851	0	50,287	529	18,877	680	0	0	1,133	0	0	75,506
(escapement +harvest)	(5/31-9/12)		Percent	0.2	5.1	0.0	66.6	0.7	25	0.9	0.0	0.0	1.5	0.0	0.0	100
Malina Lake	22-32	596	Numbers	0	5,818	0	2,536	298	298	3,133	149	0	2,387	149	149	14,917
(escapement)	(5/24-8/8)		Percent	0.0	39.0	0.0	17.0	2.0	2.0	21.0	1.0	0.0	16.0	1.0	1.0	100
Pauls Lake	23-35	535	Numbers	0	2,301	0	307	3,682	614	6,751	0	0	1,688	0	0	15,343
(escapement)	(5/31-8/29)		Percent	0.0	15	0.0	2	24	4	44	0.0	0.0	11	0.0	0.0	100
Saltery Lake	30-31	337	Numbers	64	161	32	3,673	483	1,998	2,223	193	0	1,965	0	64	10,856
(escapement) [c]	(7/19-8/1)		Percent	0.6	1.5	0.3	33.8	4.5	18.4	20.5	1.8	0.0	18.1	0.0	0.6	100
Spiridon Lake THA [d]	31-38	1,943	Numbers	0	3,715	0	72,351	1,769	531	9,464	0	0	442	88	0	88,449
(harvest)	(7/26-9/19)		Percent	0.0	4.2	0.0	81.8	2.0	0.6	10.7	0.0	0.0	0.5	0.1	0.0	100
Spiridon Bay (HP) [d]	28-33	76	Numbers	0	0	0	56	0	2	17	0	0	0	1	0	76
(harvest)	(7/7-8/15)		Percent	0.0	0.0	0.0	73.7	0.0	2.6	22.4	0.0	0.0	0.0	1.3	0.0	100
Spiridon Bay (TR) [d]	28-33	26	Numbers	0	0	1	5	0	0	17	0	0	0	3	0	26
(harvest)	(7/5-8/15)		Percent	0.0	0.0	3.8	19.2	0.0	0.0	65.4	0.0	0.0	0.0	11.5	0.0	100
Waterfall Bay THA [d]	24-36	491	Numbers	0	774	221	6,081	111	3,428	111	0	0	332	0	0	11,057
(harvest)	(6/9-8/31)		Percent	0.0	7	2	55	1	31	1	0.0	0.0	3	0.0	0.0	100
Thorsheim Lake	24-27	519	Numbers	0	194	0	231	0	2,287	2,718	0	0	818	0	0	6,248
(escapement)	(6/9-6/25)		Percent	0.0	3.1	0.0	3.7	0.0	36.6	43.5	0.0	0.0	13.1	0.0	0.0	100

[a] Actual escapement was 66,869; reduced apportionment due to no late season sampling.

[b] Based on age samples and marks observed at Little Kitoi fish pass and Big Kitoi raceways; applied to escapement and harvest from statistical areas 252-30 (Izhut Bay), 31 (Duck Bay), and 32 (L.Kitoi Bay).

[c] Actual escapement was 26,263; reduced apportionment due to no late season sampling.

[d] THA = Terminal harvest area; HP = Hook Point; TR = Thistle Rocks

Table 26. Sockeye salmon total and excess escapement counts, broodstock numbers, and estimated freshwater age compositions for Afognak, Laura, Malina, and Saltery Lakes, 1998.

Lake	Escapement Counts		Broodstock		Percent of Escapement		Estimated Fresh Water Age Composition				Totals	Number of samples
	Total [a]	Excess [b]	Number (thousand)	Eggs (million)			0	1	2	3		
Afognak	66,869	26,869	1.06	1.7	1.6	Percent	0.0	90.0	10.0	0.0	100	100
						Number	0	90	10	0	100	
Laura	15,343	- [c]	0.53	0.8	3.5	Percent	0.0	27.7	66.3	6.0	100	83
						Number	0	23	55	5	83	
Malina	14,917	- [c]	0.53	0.8	3.6	Percent	0.0	39.1	58.7	2.2	100	46
						Number	0	18	27	1	46	
Saltery	26,263	6,263	4.64	8.4	17.7	Percent	0	39	54	7	100	363
						Number	0	141	197	25	363	

[a] Total sockeye salmon escapement counted into the system.

[b] Number in excess of the minimum escapement goal of 40,000 sockeye salmon at Afognak Lake and the minimum escapement goal of 20,000 sockeye salmon into Saltery Lake.

[c] Systems are being rehabilitated and do not contain excess escapements.

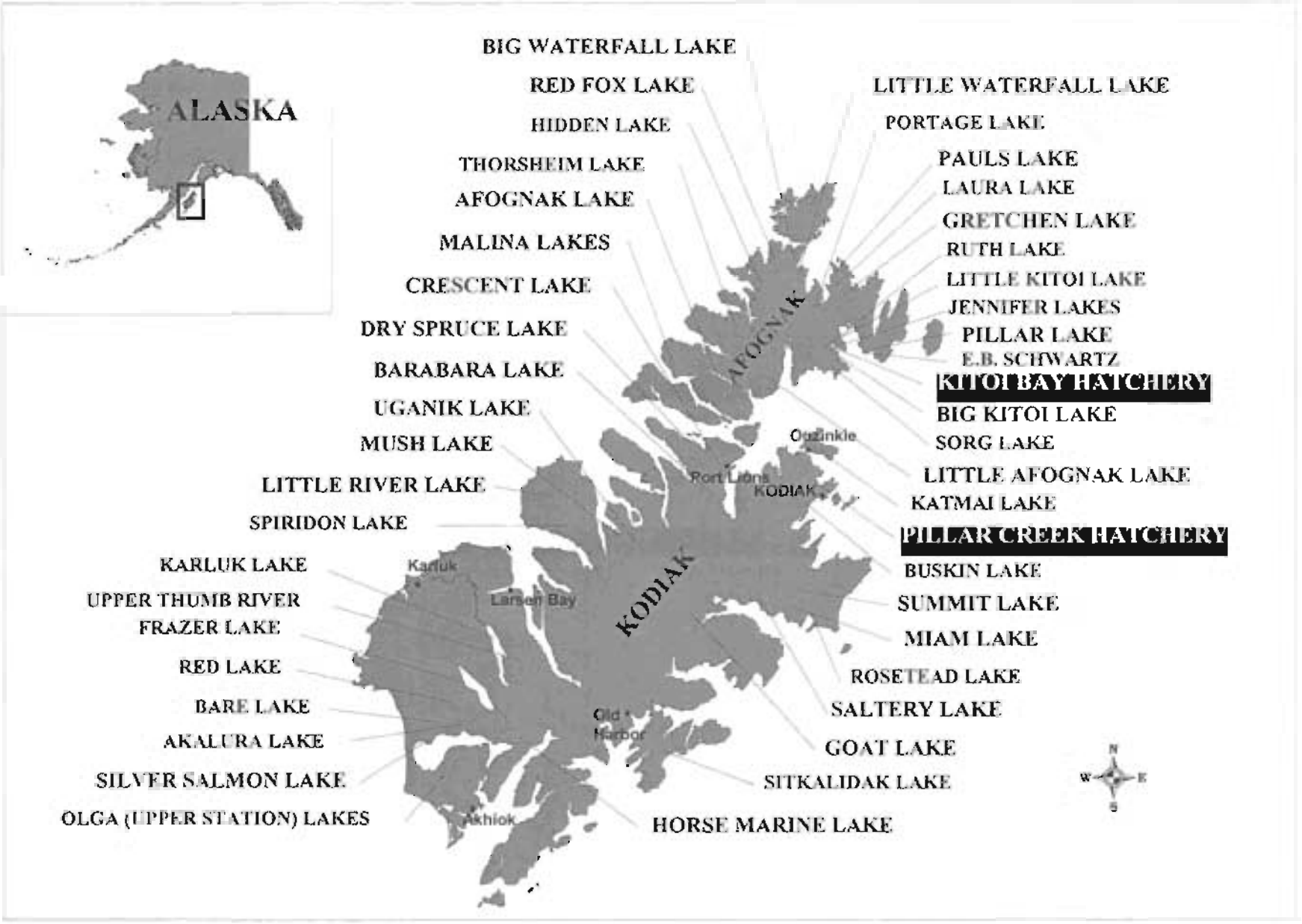


Figure 1. Locations of salmon investigations on Kodiak and Afognak Islands, 1951 - 1998.

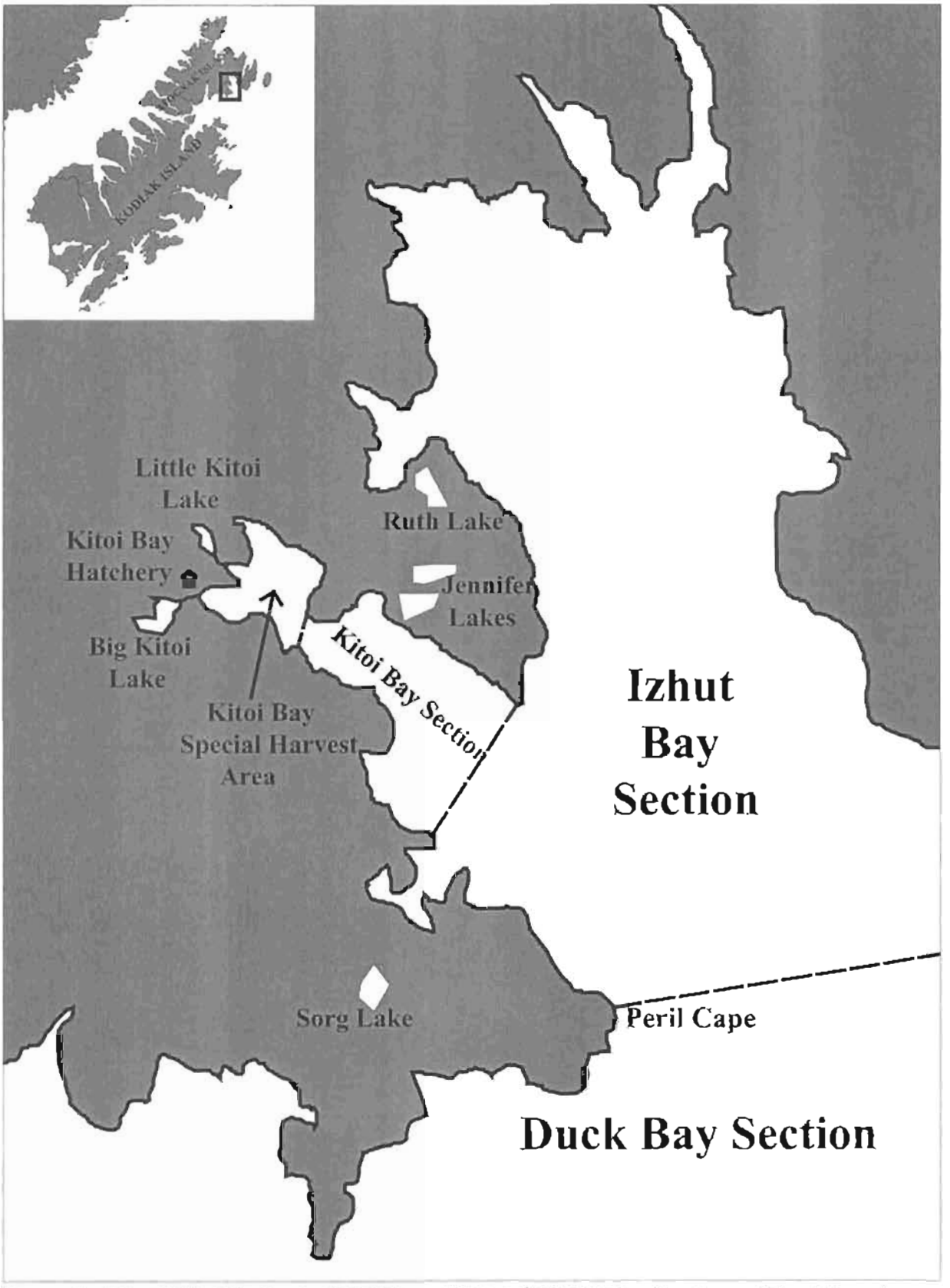


Figure 2. Izhut (252-30), Duck (252-31), and Kitoi (252-32) Bay Sections of the Afognak Commercial Fishing District.

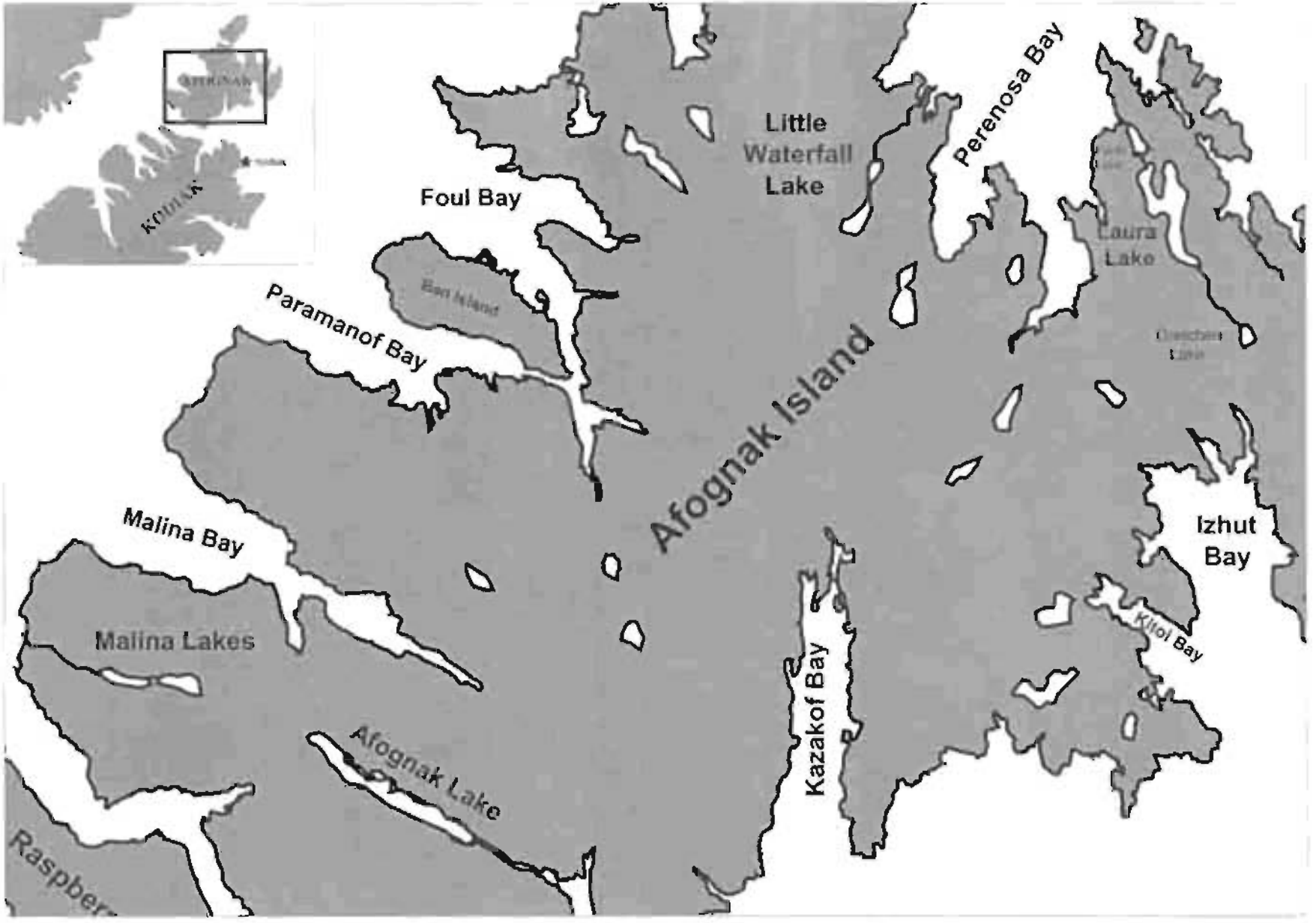


Figure 3. Location of lake enrichment systems on Afognak Island, 1998.

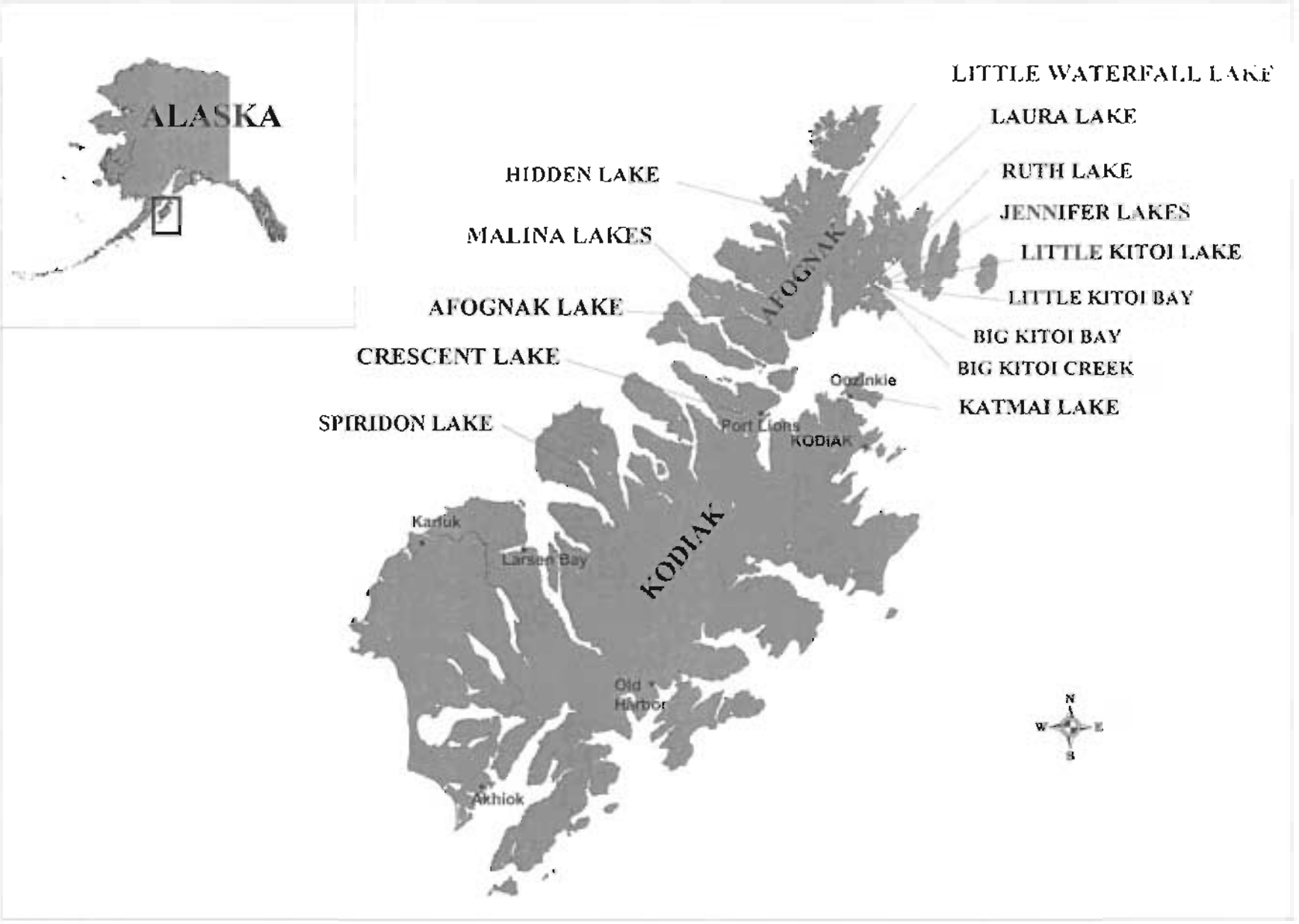


Figure 4. Salmon stocking locations on Kodiak and Afognak Islands, 1998.

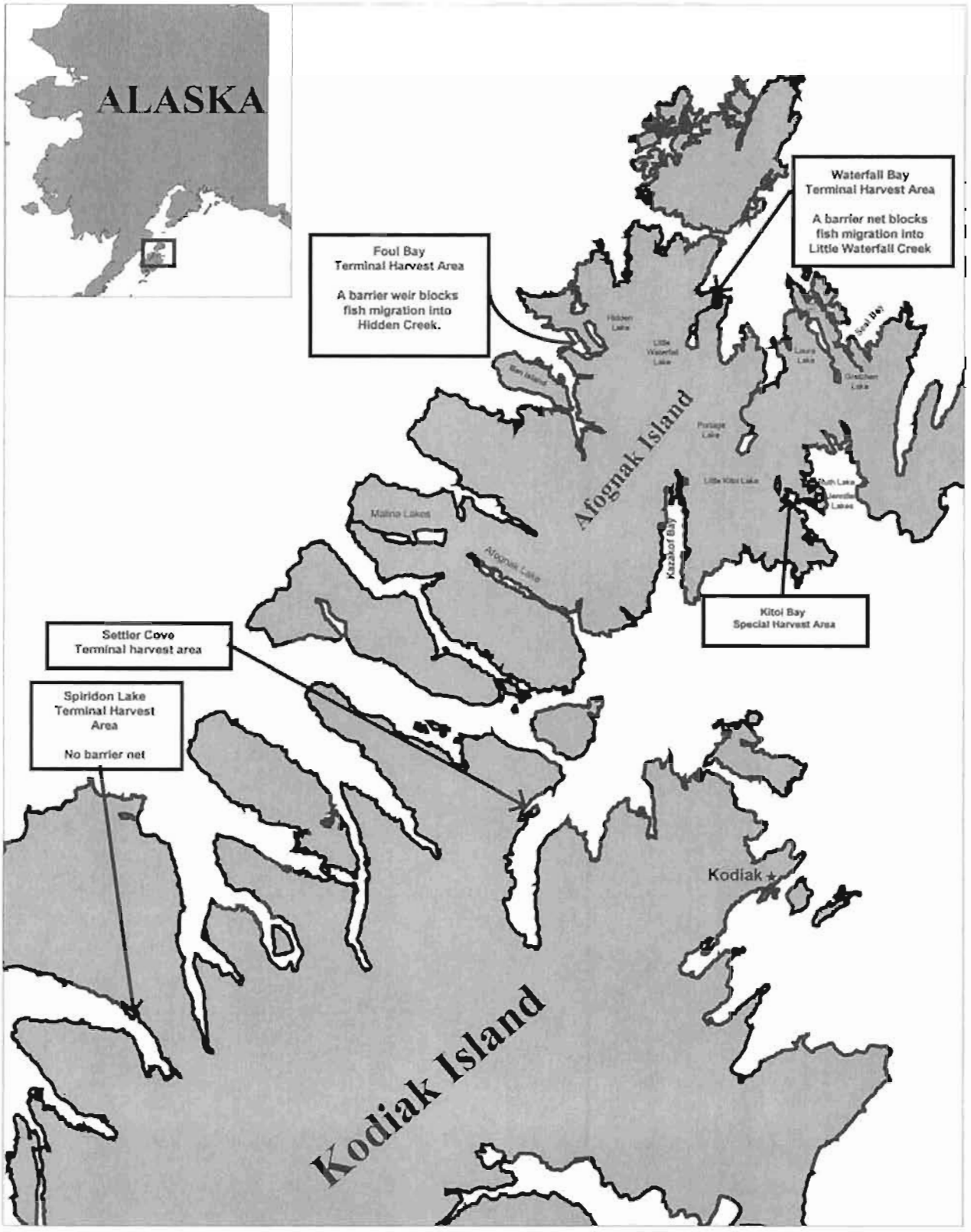


Figure 5. Locations of terminal and special harvest areas with associated barrier weirs/nets that block salmon migration into these systems, 1998.

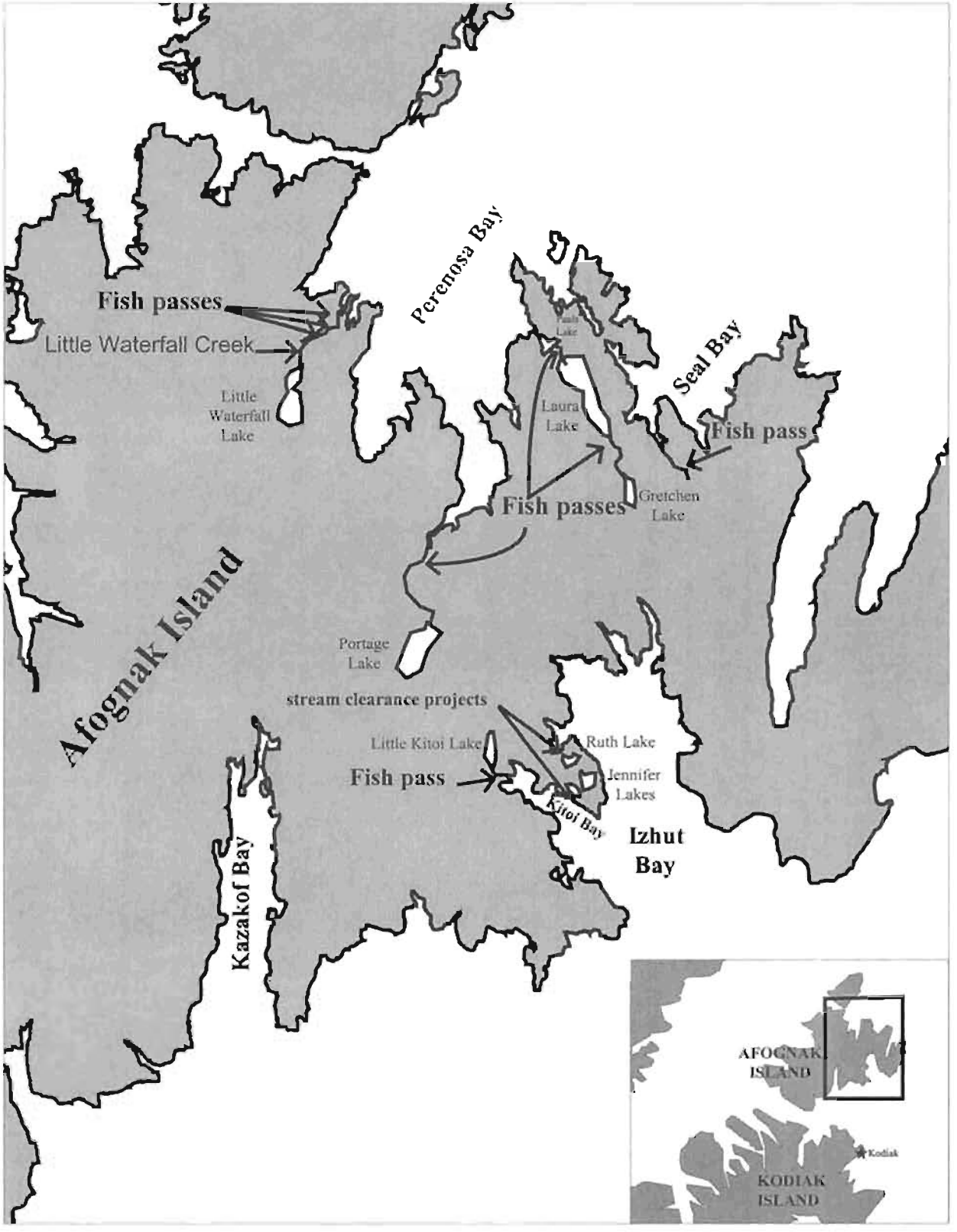


Figure 6. Location of fish passes and stream clearance operations at salmon systems on Afognak Island, 1998.

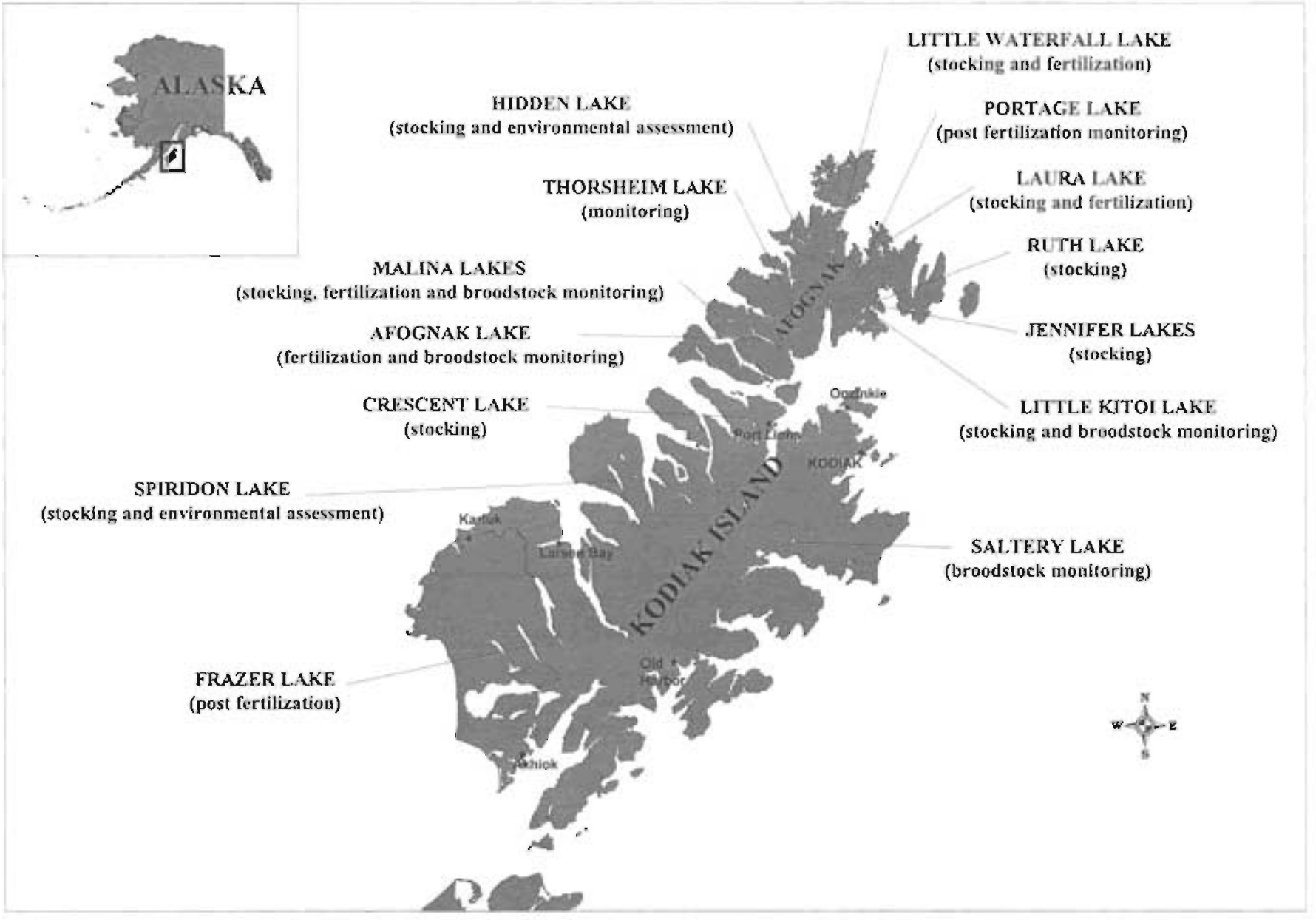


Figure 7. Locations of sockeye salmon evaluation and monitoring programs on Kodiak and Afognak Islands, 1998.

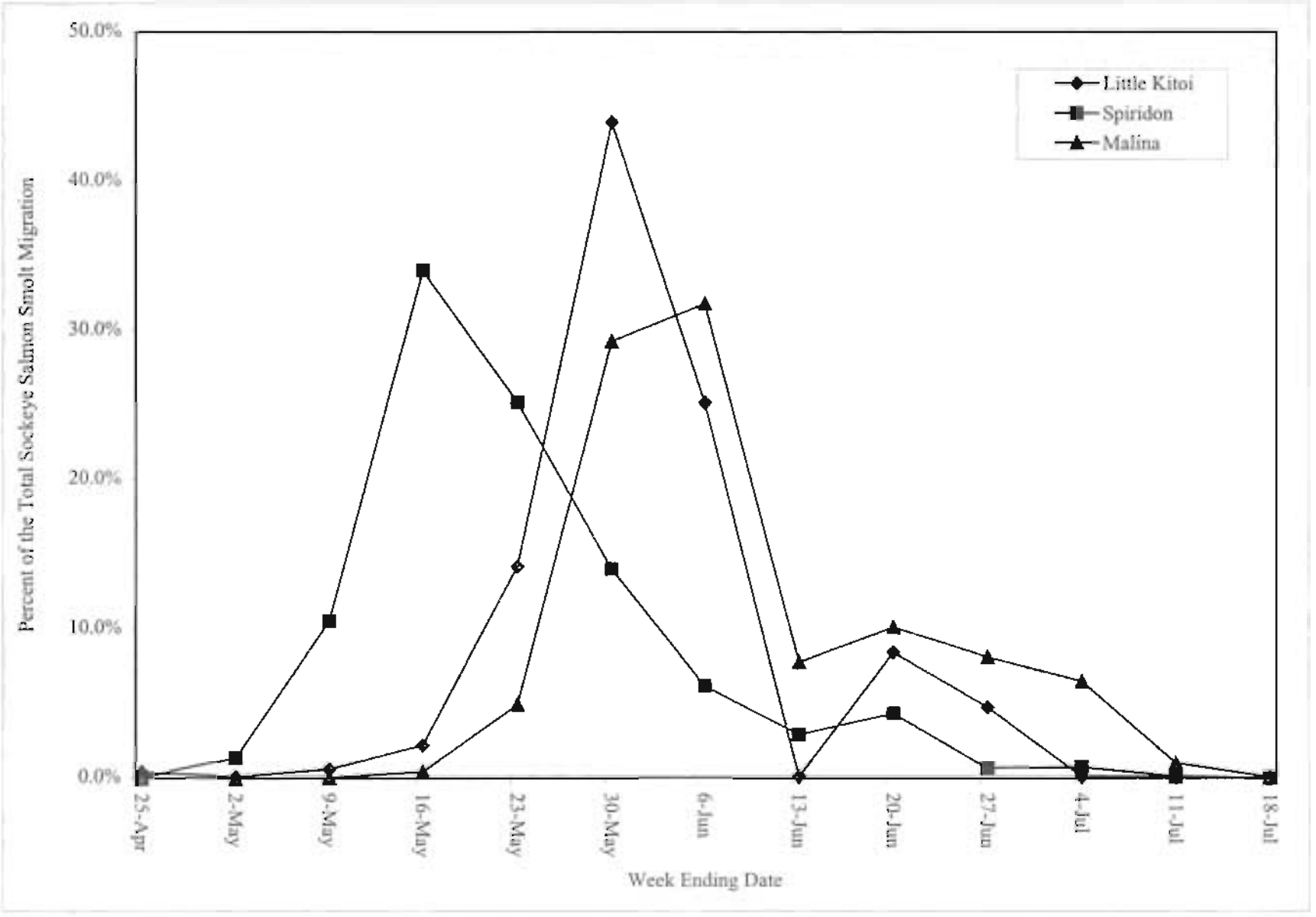


Figure 8. Sockeye salmon smolt emigration timing from Little Kitoi, Spiridon, and Malina Lakes, 1998.

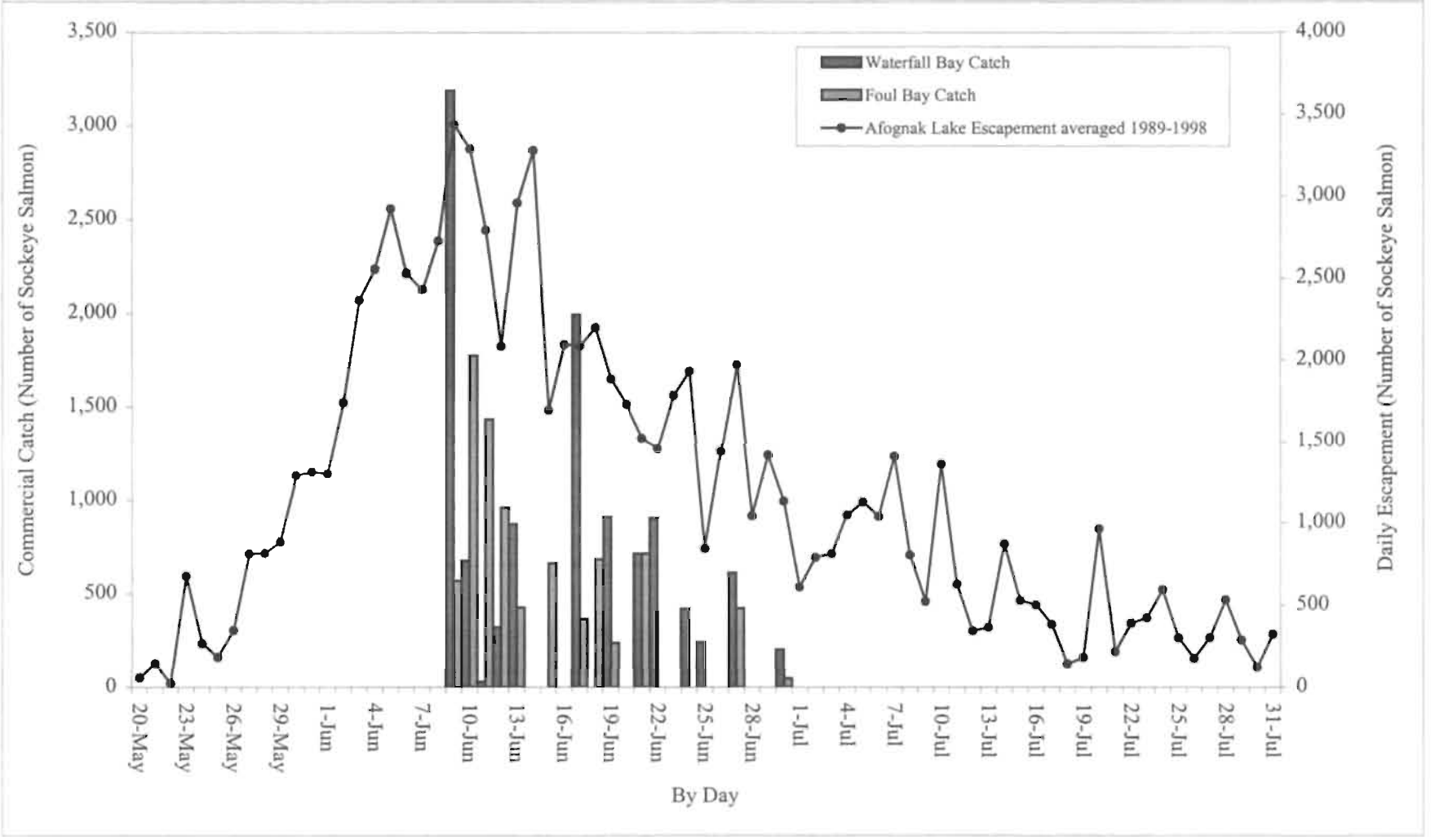


Figure 9. Commercial harvest of sockeye salmon in the Waterfall Bay and Foul Bay terminal harvest areas in 1998 compared to the escapement timing of the Afognak Lake brood source from 1989-1998.

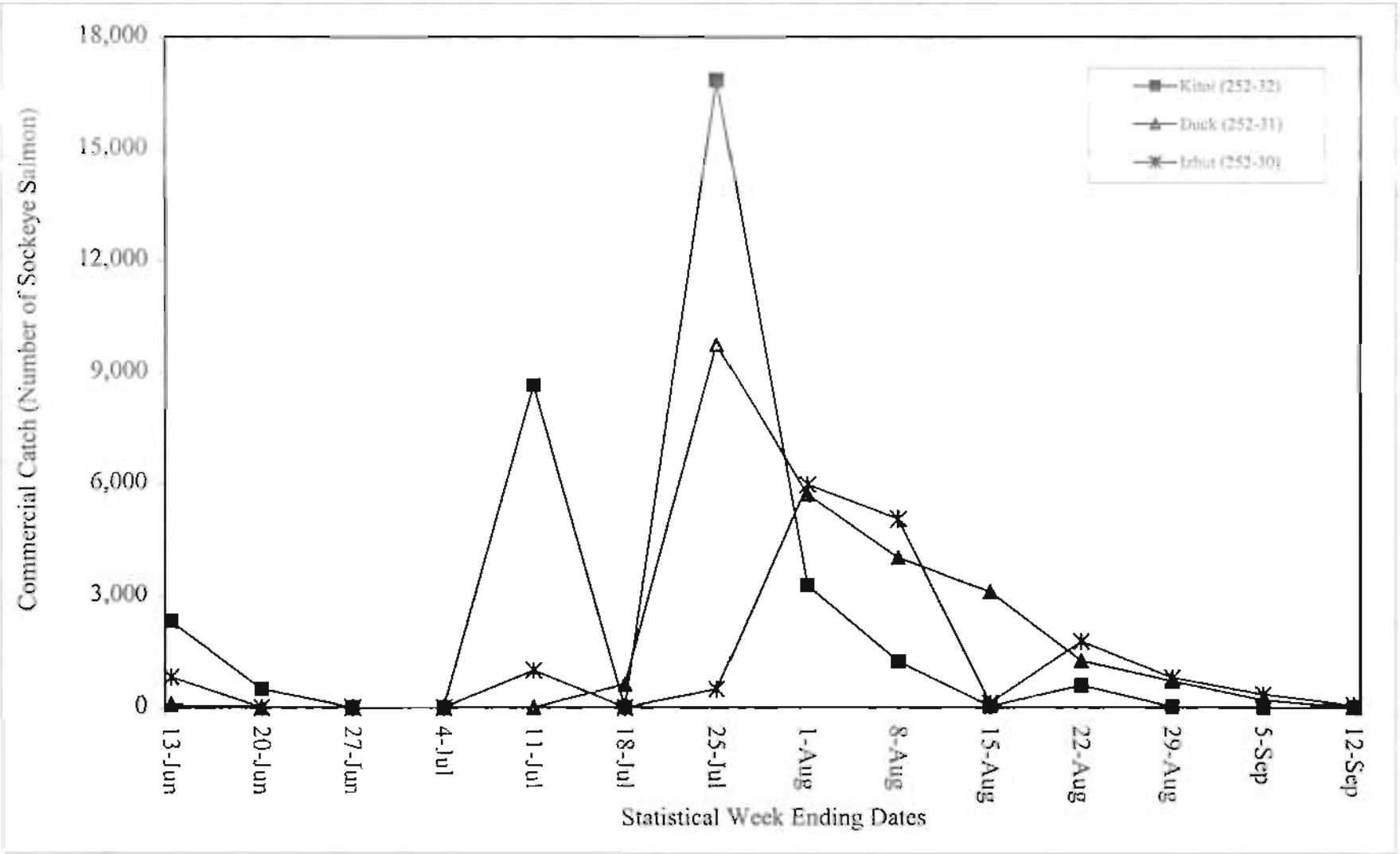


Figure 10. Sockeye salmon commercial catches in the Kitoi (252-32), Duck (252-31), and Izhut (252-30) Bay Sections, 1998.

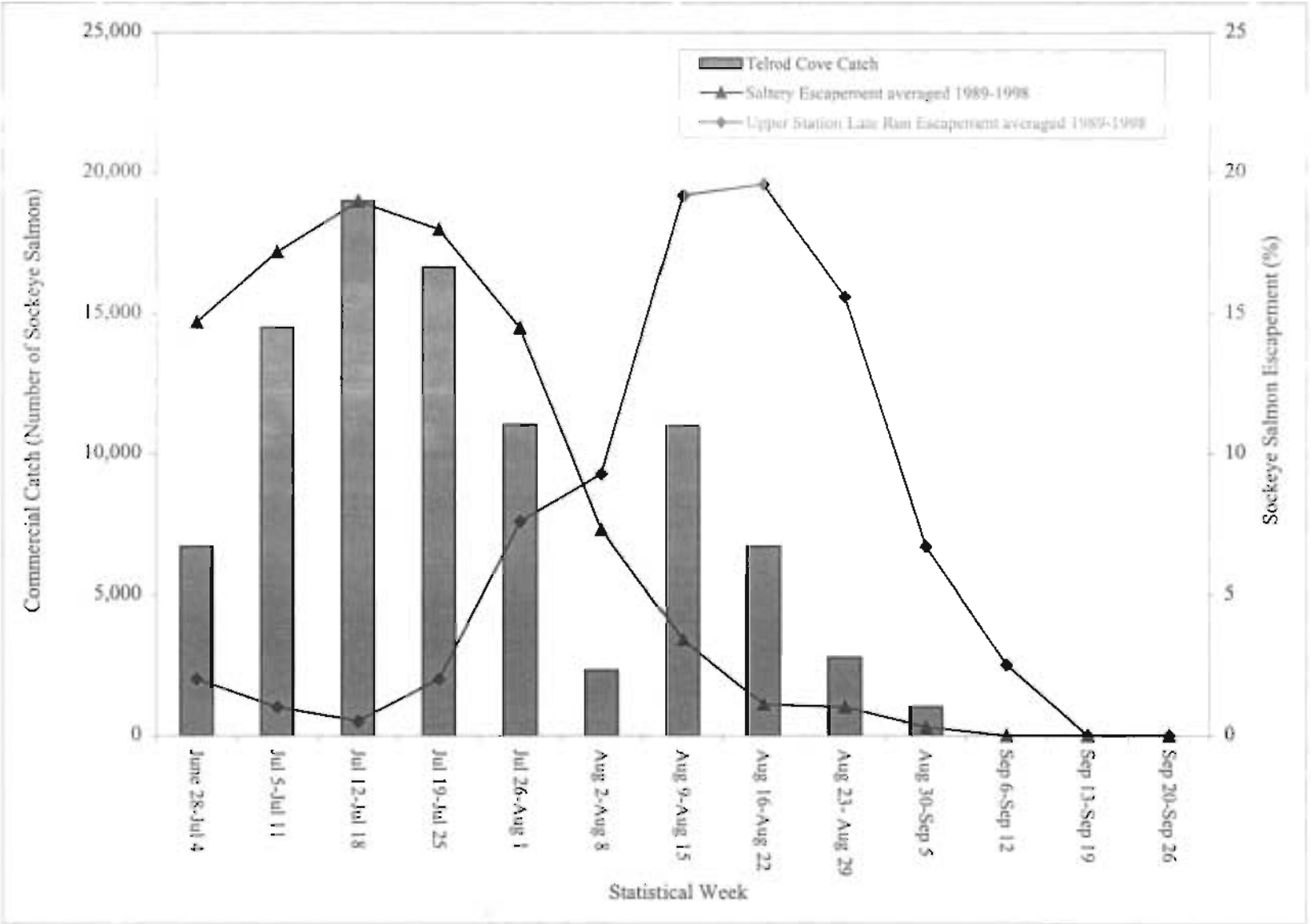


Figure 11. Commercial harvest of sockeye salmon in the Spiridon Lake Terminal Harvest Area in 1998 compared to the escapement timing of the Upper Station Lake and Saltery Lake brood sources (1989-1998).

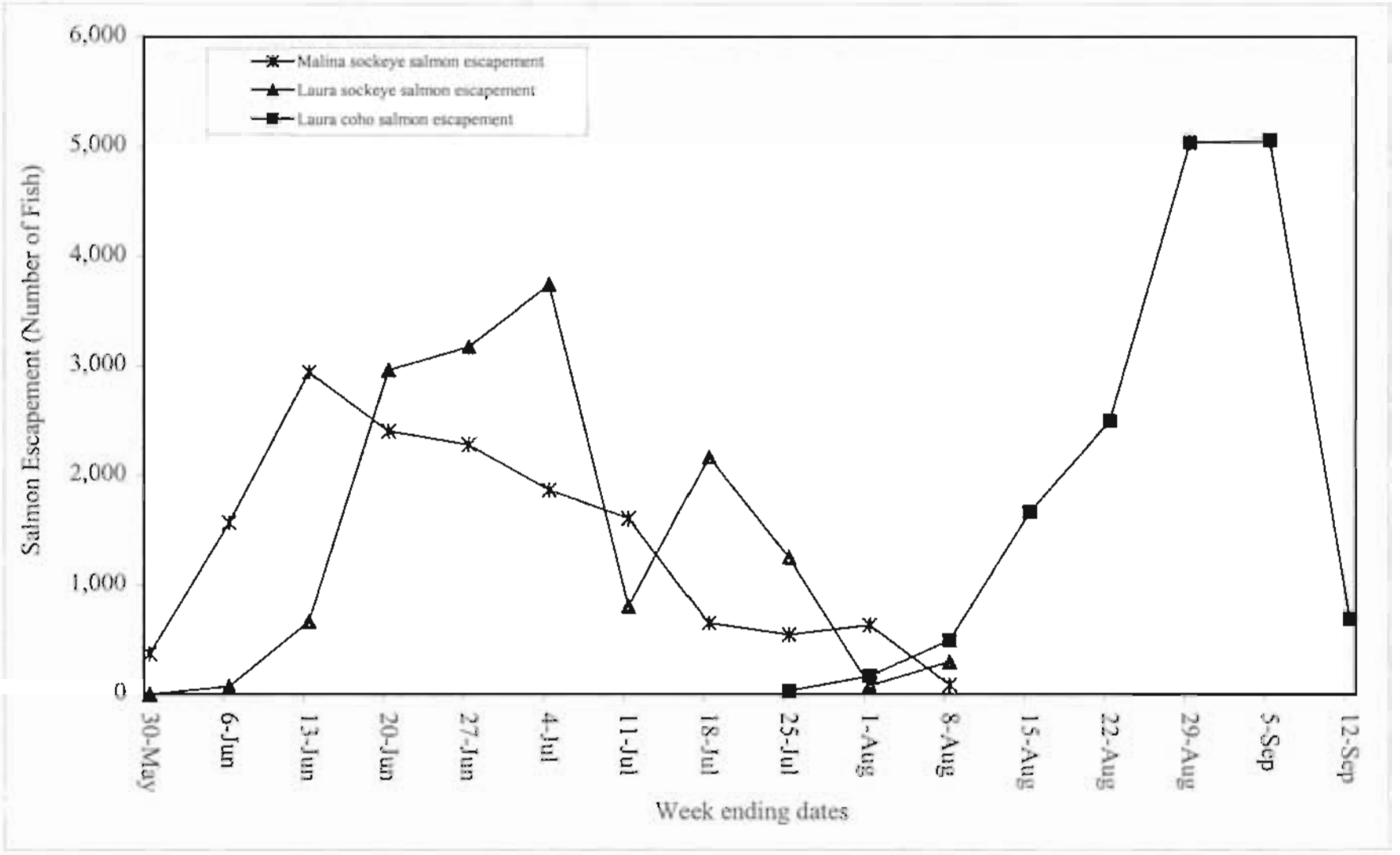


Figure 12. Escapement timing of sockeye salmon and coho salmon into the Pauls/Laura Lake system and sockeye salmon escapement into Malina Lakes, 1998.

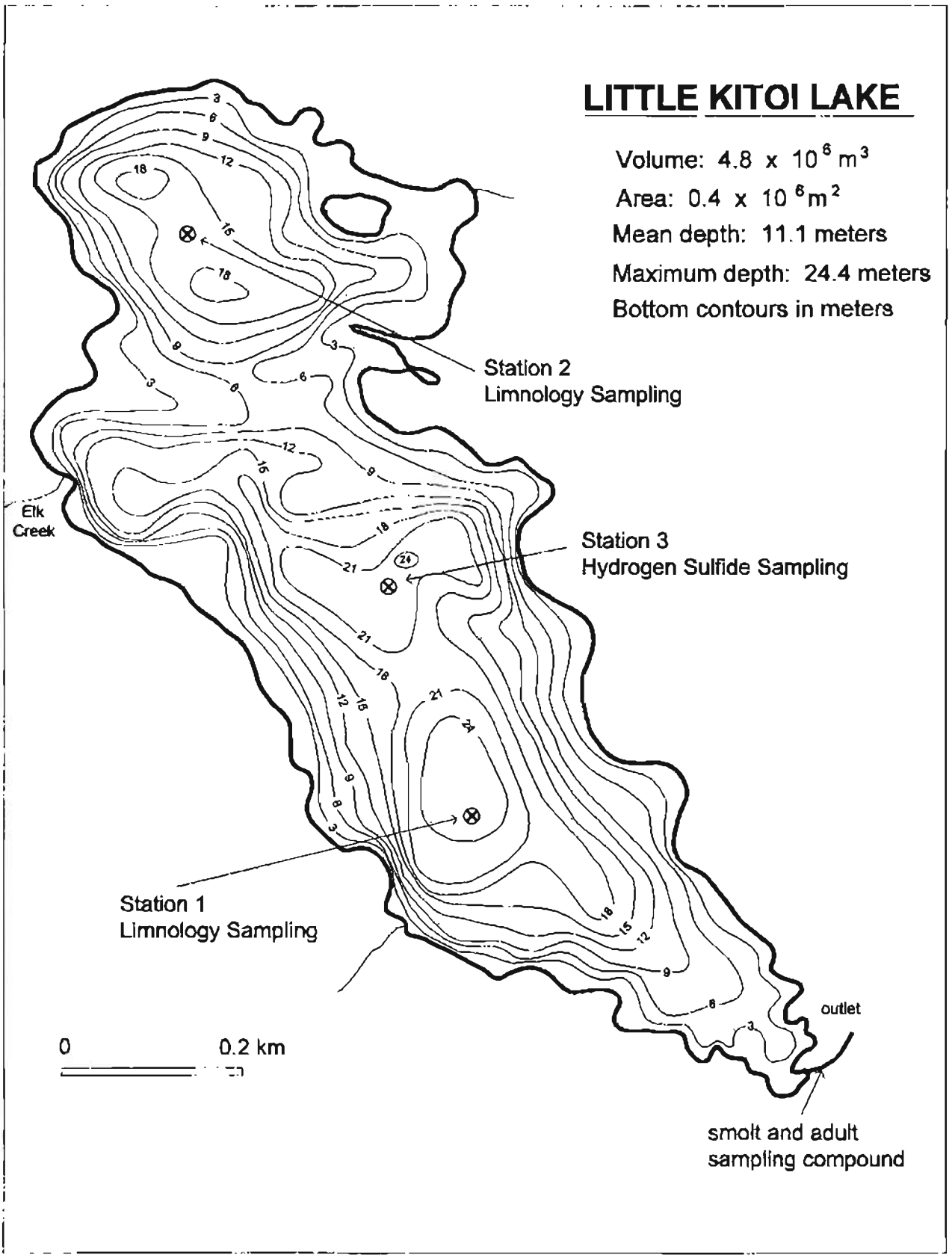
APPENDIX

Appendix A. History of Kodiak Island sockeye salmon enhancement and restoration projects, 1890-1998.

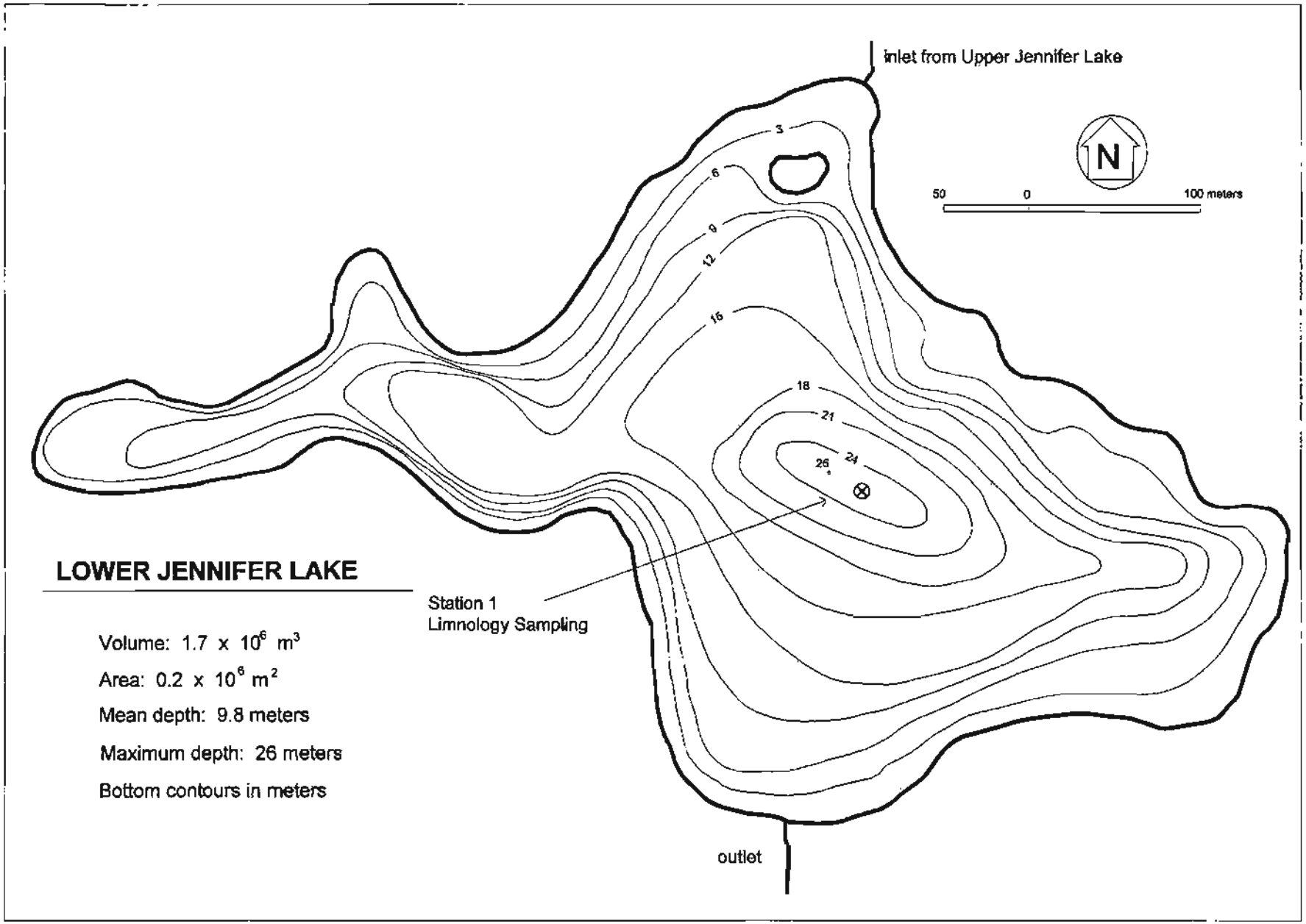
Project	Years	Funding Source
Karluk Voluntary Hatchery	1891, 1896-1917	Cannery Operators
Afognak Lake Federal Hatchery	1908-1932	Bureau of Fisheries
Paul's Lake System Egg Plants and Fishway Development	1951-1955	Territorial Department of Fisheries (TDF)
Frazer Lake Egg Plants, Fry Stocking, Adult Transplants, and Fish Ladder	1951-1971	TDF; Alaska Department of Fish and Game (ADF&G)
Kitoi Bay Research Station/Hatchery	1953-1972	TDF; ADF&G
Bare Lake Enrichment	1955	USF&WS
Karluk Lake Streamside Incubation/ Egg Plants	1979-1986	ADF&G
Kodiak Regional Aquaculture Association (KRAA)	1983-present	Fishery Enhancement Tax
Karluk Lake Enrichment	1986-1990	KRAA; Kodiak Island Borough (KIB)
Frazer Lake Enrichment	1988-1992	KRAA; KIB
Kodiak and Afognak Island Lakes Feasibility Investigations	1990-1992	KRAA
Portage Lake Enrichment	1993-1997	KRAA
Jennifer Lakes Stocking	1993-1997	KRAA

Appendix B. Kodiak Comprehensive Salmon Plan 1982-2002, Phase II harvest objectives (natural, supplemental, and total), by species.

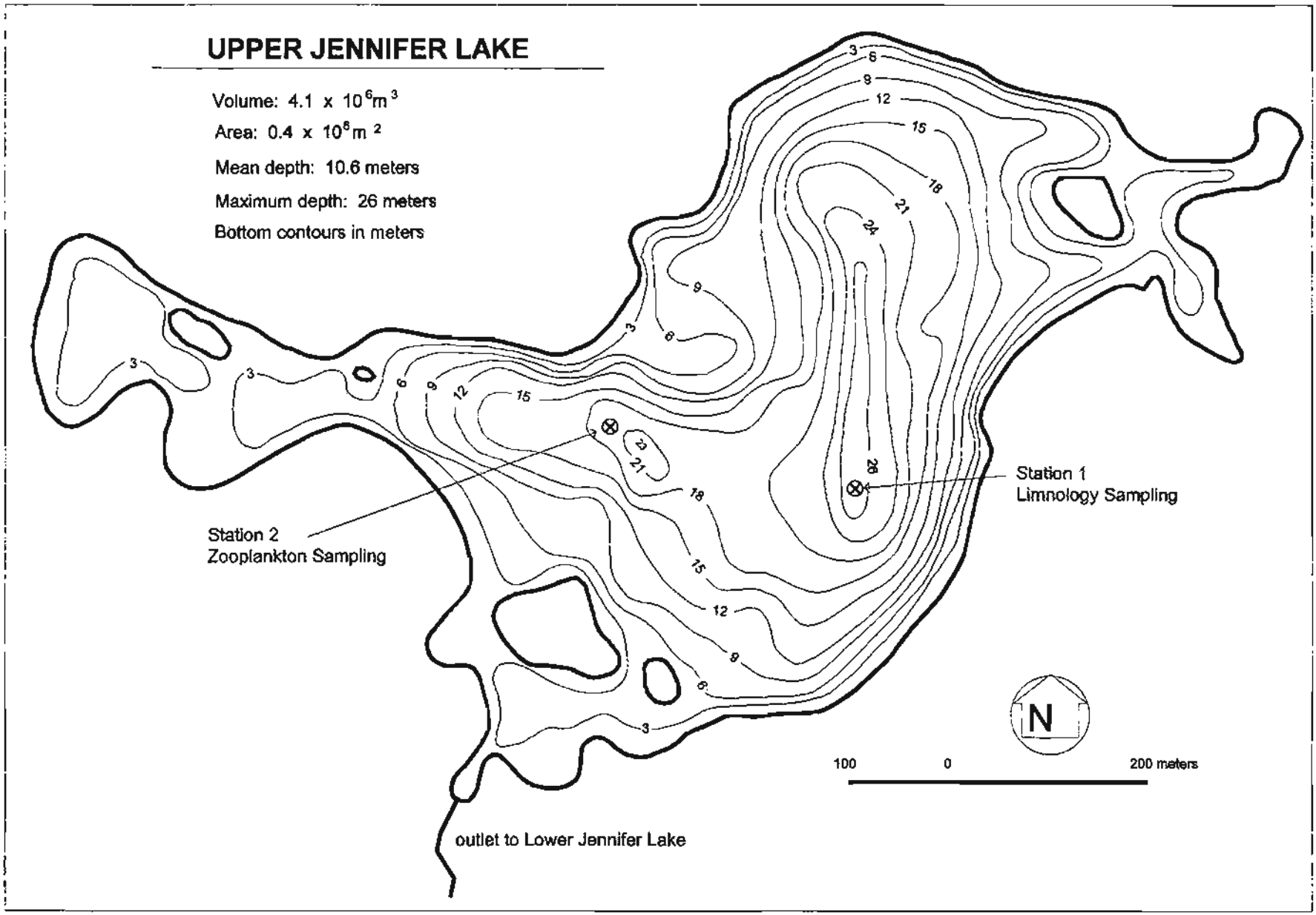
Species	Harvest Objective			Harvest Gap
	Natural (wild runs)	Supplemental (enhanced runs)	Total	
Pink				
odd year	7,500,000	11,500,000	19,000,000	-
even year	12,000,000	11,500,000	23,500,000	500,000
Sockeye	2,700,000	1,700,000	4,400,000	1,700,000
Chum	900,000	1,100,000	2,000,000	1,100,000
Coho	161,000	382,000	543,000	382,000
Chinook	12,000	3,000	15,000	3,000
Total Harvest:				
odd year	11,273,000	14,685,000	25,958,000	3,185,000
even year	15,773,000	14,685,000	30,458,000	3,685,000



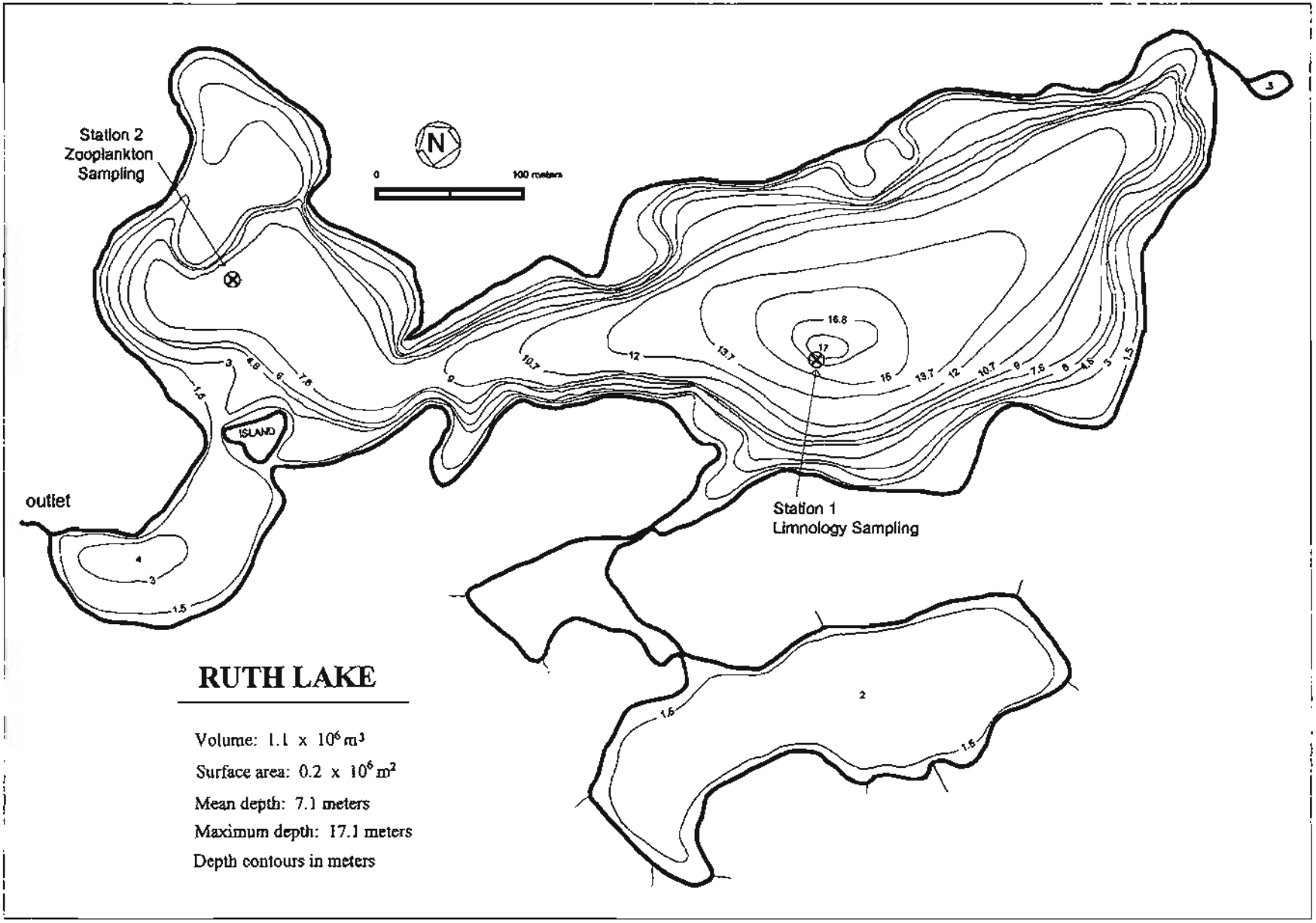
Appendix C.1. Morphometric map showing the limnology and hydrogen sulfide stations, and the smolt and adult sampling compound on Little Kitoi Lake.



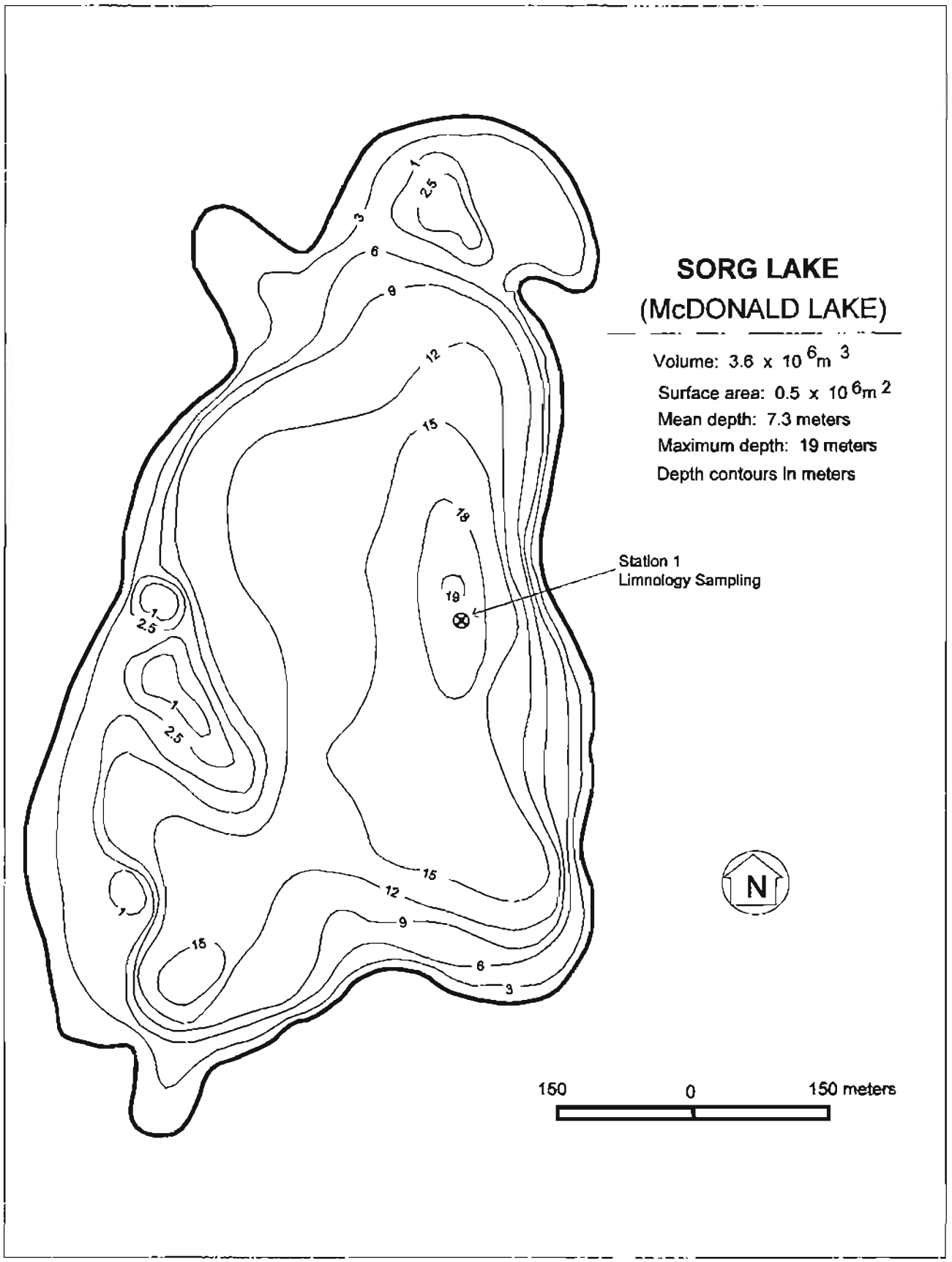
Appendix C.2. Morphometric map showing the limnology station for Lower Jennifer Lake.



Appendix C.3. Morphometric map showing the limnology and zooplankton stations on Upper Jennifer Lake.



Appendix C.4. Morphometric map showing the limnology and zooplankton stations on Ruth Lake.



Appendix C.5. Morphometric map showing the limnology station on Sorg Lake.

Appendix C.6. Historical pink salmon releases from Kitoi Bay Hatchery for brood years, 1972-1998.

Brood Year	Broodstock	Number of Fry Released	Release Location	Avg. Weight (g)	Release Year
1972	Big Kitoi	493,130	Big Kitoi Bay	[a]	1973
1973	Big Kitoi	447,642	Big Kitoi Bay	[a]	1974
1974	Big Kitoi	1,226,314	Big Kitoi Bay	[a]	1975
1975	Big Kitoi	2,486,410	Big Kitoi Bay	[a]	1976
1976	Big Kitoi	4,722,152	Big Kitoi Bay	0.50	1977
1977	Big Kitoi	17,255,424	Big Kitoi Bay	0.44	1978
1978	Big Kitoi	17,319,537	Big Kitoi Bay	[a]	1979
1979	Big Kitoi	22,458,947	Big Kitoi Bay	0.63	1980
1980	Big Kitoi	26,351,664	Big Kitoi Bay	0.93	1981
1981	Big Kitoi	47,828,701	Big Kitoi Bay	[a]	1982
1982	Big Kitoi	72,054,096	Big Kitoi Bay	0.79	1983
1983	Big Kitoi	87,065,569	Big Kitoi Bay	0.58	1984
1984	Big Kitoi	75,109,442	Big Kitoi Bay	0.29	1985
1985	Big Kitoi	97,773,052	Big Kitoi Bay	0.78	1986
1986	Big Kitoi	90,017,823	Big Kitoi Bay	0.27	1987
1987	Big Kitoi	94,172,516	Big Kitoi Bay	0.73	1988
1988	Big Kitoi	80,502,220	Big Kitoi Bay	0.62	1989
1989	Big Kitoi	84,907,550	Big Kitoi Bay	0.61	1990
1990	Big Kitoi	124,148,019	Big Kitoi Bay	0.60	1991
1991	Big Kitoi	147,145,130	Big Kitoi Bay	0.80	1992
1992	Big Kitoi	169,552,112	Big Kitoi Bay	0.51	1993
1993	Big Kitoi	163,192,575	Big Kitoi Bay	0.45	1994
1994	Big Kitoi	134,104,406	Big Kitoi Bay	0.53	1995
1995	Big Kitoi	144,045,245	Big Kitoi Bay	0.48	1996
1996	Big Kitoi	102,583,724	Big Kitoi Bay	0.50	1997
1997	Big Kitoi	128,101,460	Big Kitoi Bay	0.50	1998
1998	Big Kitoi	127,685,500	Big Kitoi Bay	0.54	1999

[a] Average release weights were not determined.

Appendix C.7. Historical chum salmon fry releases from Kitoi Bay Hatchery for brood years, 1981-1998.

Brood Year	Broodstock	Number of Fry Released	Release Location	Avg. Weight (g)	Release Year
1981	Sturgeon R.	36,846	Big Kitoi Creek	0.56	1982
1982	Sturgeon R.	105,058	Big Kitoi Creek	1.05	1983
1983	Sturgeon R.	630,422	Big Kitoi Creek	1.16	1984
1984	Sturgeon R.	784,078	Big Kitoi Creek	0.67	1985
1985	Sturgeon R.	414,233	Big Kitoi Creek	[b]	1986
1986	Big Kitoi	693,166	Big Kitoi Creek	2.00	1987
1987	Big Kitoi	4,737,587	Big Kitoi Creek	2.10	1988
1988	Big Kitoi	3,289,878	Big Kitoi Creek	1.85	1989
1989	Big Kitoi	1,502,501	Big Kitoi Creek	2.44	1990
1990	Big Kitoi	[a]	Big Kitoi Creek	[b]	1991
1991	Big Kitoi	22,214,472	Big Kitoi Creek	1.80	1992
1992	Big Kitoi	10,101,986	Big Kitoi Creek	2.02	1993
1993	Big Kitoi	6,507,497	Big Kitoi Creek	1.52	1994
1994	Big Kitoi	9,738,472	Big Kitoi Creek	1.51	1995
1995	Big Kitoi	20,139,843	Big Kitoi Creek	1.27	1996
1996	Big Kitoi	23,500,000	Big Kitoi Creek	1.50	1997
1997	Big Kitoi	12,310,015	Big Kitoi Creek	1.50	1998
1998	Big Kitoi	6,859,982	Big Kitoi Creek	1.03	1999

[a] A disease outbreak occurred, all chum fry were destroyed.

[b] Average release weights were not determined.

Appendix C.8. Historical coho salmon releases at Big Kitoi and Little Kitoi systems for brood years, 1983-1997.

Brood Year	Broodstock	Number Released	Release Location	Avg. Weight (g)	Release Year
1983	L.Kitoi	127,700	Little Kitoi Lake	1.00	1984
1984	L.Kitoi	33,472	Little Kitoi Lake	1.50	1985
1985	L.Kitoi	53,360	Little Kitoi Lake	6.10	1986
1986	L.Kitoi	171,103	Little Kitoi Lake	1.79	1987
1986	L.Kitoi	9,600	Big Kitoi Creek	5.00	1987
1987	L.Kitoi	43,807	Little Kitoi Lake	1.52	1988
1988	L.Kitoi	137,493	Big Kitoi Bay	23.30	1990
1990	L.Kitoi	60,755	Big Kitoi Bay	32.00	1992
1991	L.Kitoi	70,605	Little Kitoi Lake	1.40	1992
1991	L.Kitoi	613,681	Big Kitoi Bay	18.90	1993
1992	L Kitoi	139,147	Little Kitoi Lake	1.30	1993
1992	L Kitoi	5,163	Big Kitoi Creek	14.60	1993
1992	L Kitoi	97,973	Big Kitoi Bay	28.40	1994
1993	Big Kitoi	258,926	Big Kitoi Bay	25.90	1995
1994	Big Kitoi	894,486	Big Kitoi Bay	23.54	1996
1995	Big Kitoi	819,046	Big Kitoi Bay	19.57	1997
1996	Big Kitoi	769,000	Big Kitoi Bay	23.90	1998
1997	Big Kitoi	1,098,338	Big Kitoi Bay	19.30	1999

Appendix C.9. Historical sockeye salmon releases at Big Kitoi and Little Kitoi systems for brood years, 1988-1997.

Brood Year	Broodstock	Number Released	Release Location	Avg. Weight (g)	Year Released
1988	Upper Station	143,725	Little Kitoi Bay	2.5	1989
1989	Upper Station	578,932	Little Kitoi Lake	0.3	1990
1989	Upper Station	1,312,728	Little Kitoi Bay	3.0	1990
1990	Upper Station	1,250,000	Little Kitoi Bay	2.5	1991
1991	Upper Station	1,463,000	Little Kitoi Bay	1.6	1992
1991	Afognak	182,000	Little Kitoi Bay	1.5	1992
1992	Upper Station	52,418	Little Kitoi Lake	3.1	1993
1992	Upper Station	326,500	Little Kitoi Bay	15.0	1994
1993	Afognak	293,000	Little Kitoi Bay	1.9	1994
1993	Upper Station	1,672,710	Little Kitoi Bay	0.82 - 15.0	1994
1993	Afognak	183,000	Little Kitoi Lake	12.0	1994
1993	Little Kitoi	10,108	Little Kitoi Lake	4.6	1994
1993	Afognak	3,500	Little Kitoi Lake	23.0	1995
1993	Little Kitoi	916,677	Little Kitoi Bay	10.1	1995
1994	Upper Station	266,952	Little Kitoi Lake	1.8	1995
1994	Afognak	112,900	Little Kitoi Lake	10.0	1995
1994	Little Kitoi	84,861	Little Kitoi Lake	5.0	1995
1994	Little Kitoi	573,242	Little Kitoi Bay	12.7	1996
1995	Afognak	50,650	Little Kitoi Lake	10.0	1996
1995	Little Kitoi	155,687	Little Kitoi Lake	3.2	1996
1995	Upper Station	587,435	Little Kitoi Bay	12.1	1997
1996	Afognak	125,800	Little Kitoi Lake	9.5	1997
1996	Little Kitoi	77,039	Little Kitoi Lake	3.3	1997
1996	Little Kitoi	99,085	Little Kitoi Lake	11.7	1998
1996	Little Kitoi	397,000	Little Kitoi Bay	15.1	1998
1997	Saltery	106,658	Little Kitoi Lake	17.7	1999

Appendix C.10. Historical sockeye and coho salmon releases into Upper Jennifer Lake for brood years, 1991-1994 and 1996-1997.

Species	Brood Year	Broodstock	Number Released	Release Location	Avg. Weight (g)	Year Released
sockeye	1992	U. Station	180,000	U. Jennifer Lake	0.5	1993
sockeye	1993	U. Station	370,000	U. Jennifer Lake	0.2	1994
sockeye	1994	U. Station	200,000	U. Jennifer Lake	0.2	1995
sockeye	1996	U. Station	458,000	U. Jennifer Lake	0.5	1997
coho	1991	Little Kitoi	162,387	U. Jennifer Lake	4.5	1992
coho	1992	Little Kitoi	135,486	U. Jennifer Lake	1.9	1993
coho	1994	Big Kitoi	165,000	U. Jennifer Lake	1.5	1995
coho	1996	Big Kitoi	163,000	U. Jennifer Lake	0.4	1997
coho	1997	Big Kitoi	165,000	U. Jennifer Lake	0.5	1998

Appendix C.11. Historical sockeye and coho salmon releases into Ruth and Sorg Lakes for brood years, 1994-1998.

Species	Brood Year	Broodstock	Number Released	Release Location	Avg. Weight (g)	Year Released
sockeye	1995	Saltery	150,000	Ruth Lake	0.2	1996
sockeye	1996	Saltery	147,000	Ruth Lake	0.2	1997
coho	1994	Big Kitoi	59,500	Ruth Lake	1.7	1995
coho	1996	Big Kitoi	35,000	Ruth Lake	0.4	1997
coho	1997	Big Kitoi	35,000	Ruth Lake	0.5	1998
coho	1998	Big Kitoi	35,000	Ruth Lake	0.6	1999
sockeye	1995	Afognak	146,000	Sorg Lake	6.3	1996

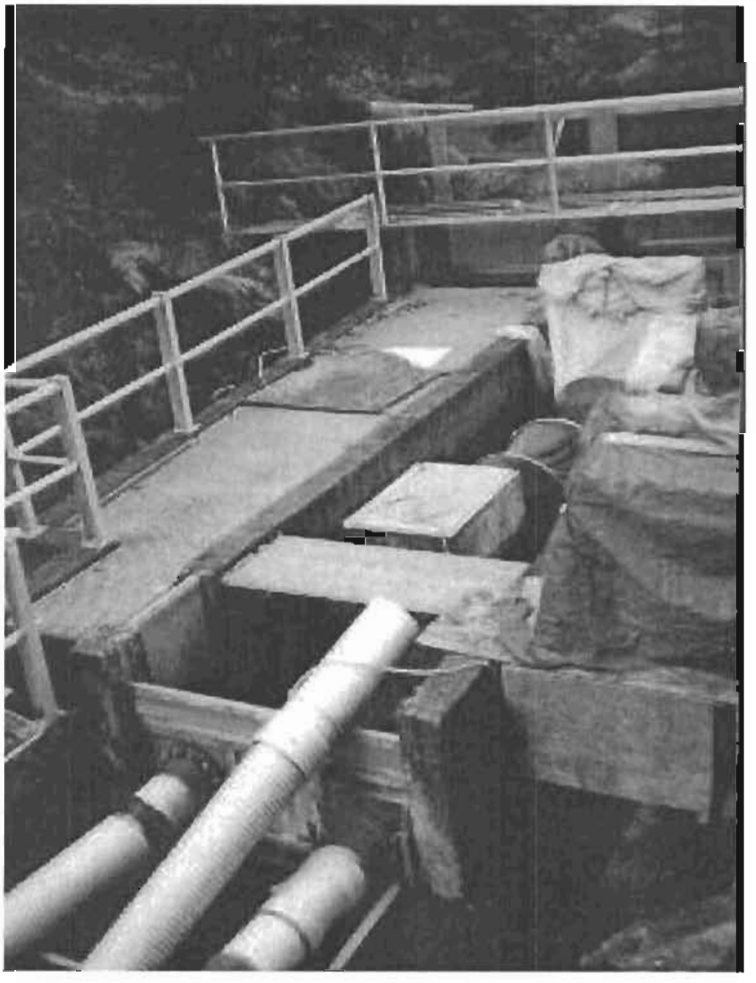
Appendix C.12. Historical coho salmon releases at Katmai Creek for brood years, 1986-1998.

Brood Year[a]	Broodstock	Number Released	Release Location	Avg. Weigh (g)	Year Released
1986	Little Kitoi	22,349	Katmai Creek	0.5	1987
1987	Little Kitoi	20,000	Katmai Creek	0.7	1988
1991	Little Kitoi	14,973	Katmai Creek	4.5	1992
1992	Little Kitoi	15,052	Katmai Creek	1.9	1993
1993	Little Kitoi	13,178	Katmai Creek	23.3	1994
1994	Little Kitoi	16,489	Katmai Creek	5.9	1995
1995	Little Kitoi	15,246	Katmai Creek	5.0	1996
1996	Little Kitoi	15,735	Katmai Creek	7.3	1997
1997	Little Kitoi	14,000	Katmai Creek	7.2	1998
1998	Little Kitoi	15,000	Katmai Creek	6.0	1999

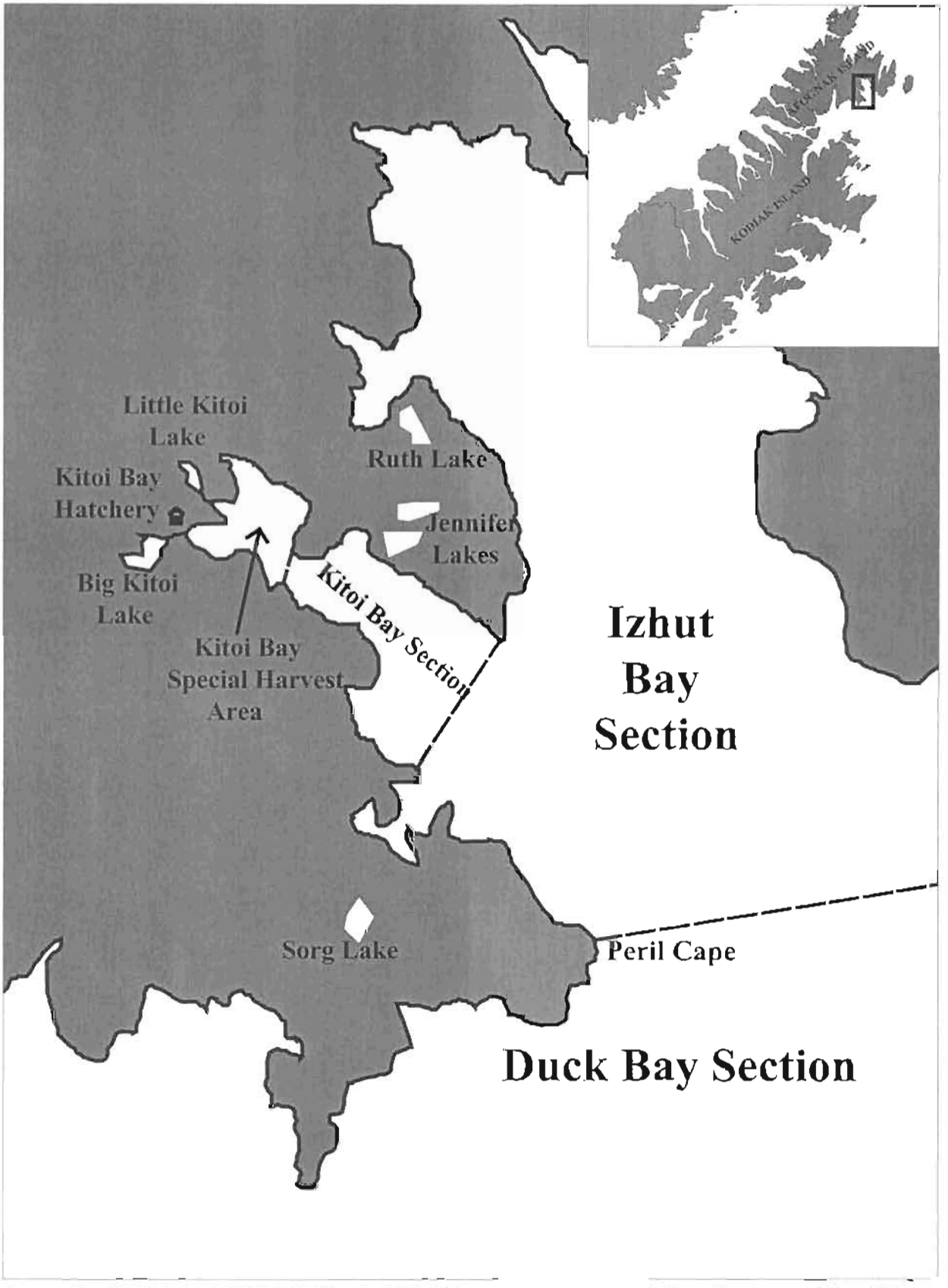
[a] For brood years 1988-1990, coho salmon were not released into Katmai Creek.

a.

b.



Appendix C.13. Little Kitoi fish pass (a) and smolt/adult sampling compound (b).



Appendix C.14. Izhut (252-30), Duck (252-31), and Kitoi (252-32) Bay Sections of the Afognak Commercial Fishing District.

Appendix C.15. Limnological sampling stations and sampling frequencies for Kitoi area lakes, 1990-1998.

Lake	Year	Sampling Stations		Sampling Frequency
Big Kitoi	1991	1		5
	1992	1		5
	1993	1		5
	1994	1		4
Jennifer	1990	1	2	3
	1993	1	2	4
	1994	1	2	4
	1995	1	2	5
	1996	1	2	5
	1997	1	2	4
	1998	1		4
Little Kitoi	1990	1		4
	1991	1		6
	1992	1		5
	1993	1		5
	1994	1	2	4
	1995	1	2	5
	1996	1	2	4
	1997	1	2	4
	1998	1		4
Ruth	1994	1	2	4
	1995	1	2	4
	1996	1	2	4
	1997	1		4
	1998	1		4
Sorg	1995	1		4
	1996	1		4
	1997	1		4

Appendix C.16. Summary of seasonal mean water chemistry parameters by stations and depth for Little Kitoi Lake, 1990-1998.

Year	Stations	Depth (m)	Specific Conductance (umhos/cm)	S.D.	pH (Units)	S.D.	Alkalinity (mg/L)	S.D.	Turbidity (NTU)	S.D.	Color (Pt units)	S.D.	Calcium (mg/L)	S.D.	Magnesium (mg/L)	S.D.	Iron (ug/L)	S.D.
1990	1	1	114.8	6.5	7.5	0.2	27.8	2.5	1.5	1.9	10.5	1.3	10.8	1.6	1.7	1.0	32.0	11.4
	1	24	16,215.0	1,146.0	7.4	0.2	337.0	125.9	68.1	50.7	76.5	29.6	142.4	84.2	234.9	202.3	279.3	233.9
1991	1	1	111.5	30.8	7.4	0.1	27.4	2.0	0.9	0.3	13.5	3.4	9.9	0.6	2.2	0.7	27.7	18.3
	1	25	13,493.7	6,380.1	7.5	0.1	387.2	88.5	39.2	54.7	87.8	28.7	218.4	94.1	371.2	115.2	141.8	21.4
1992	1	1	119.0	5.4	7.2	0.4	25.0	4.1	1.4	1.3	13.2	2.6	9.4	0.3	2.6	0.6	51.0	54.0
	1	21	11,348.0	852.3	7.4	0.1	222.6	20.4	18.8	25.4	73.8	11.9	123.1	20.2	283.0	41.4	221.8	130.9
1993	1	1	116.4	18.3	7.2	0.3	27.6	3.2	0.4	0.2	10.8	2.8	10.6	0.6	2.3	1.1	26.0	13.9
	1	22	9,490.0	2,645.3	7.6	0.3	237.0	65.9	14.2	27.9	62.6	16.0	152.5	116.4	242.2	147.0	167.0	56.7
1994	1	1	112.0	14.9	6.9	0.3	26.5	2.1	0.7	0.3	19.3	0.5	10.3	1.2	2.1	0.4	33.3	19.7
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	18	1,671.8	2,880.9	7.0	0.5	61.3	65.9	0.8	0.1	37.8	39.6	30.0	38.7	38.5	67.7	81.5	81.4
	2	1	138.5	58.6	7.0	0.5	30.0	4.1	0.8	0.4	20.5	4.7	10.8	2.0	1.7	0.8	40.0	20.3
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	15	136.5	15.6	6.7	0.2	31.5	1.9	2.0	2.5	19.0	1.4	11.7	0.7	2.2	0.1	42.3	35.1
1995	1	1	112.4	4.2	7.1	0.3	25.3	1.2	1.1	0.8	40.8	33.9	9.1	0.6	2.2	0.4	34.8	23.8
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	22	12,500.0	2,984.9	7.4	0.1	308.7	64.0	54.7	98.9	69.6	28.8	140.8	32.6	319.2	64.7	238.3	46.6
	2	1	124.6	21.2	7.3	0.2	26.7	1.9	0.7	0.4	31.6	9.7	8.7	0.4	1.9	0.3	37.6	19.8
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	18	148.8	4.8	6.7	0.1	31.3	5.5	1.8	0.7	19.6	7.8	11.8	1.1	2.2	0.4	81.8	37.3
1996 [a]	1	1	124.3	2.6	7.3	0.2	28.1	1.6	1.1	1.1	13.8	3.8	9.4	0.1	2.2	0.4	30.0	14.3
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	24	260.0	128.3	6.8	0.1	28.3	2.2	1.2	1.0	16.3	2.1	10.3	0.8	4.4	2.0	47.5	7.1
	2	1	125.3	3.3	7.3	0.2	28.2	1.6	0.9	0.7	13.8	2.9	9.3	0.1	1.9	0.1	38.5	15.7
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	16	139.3	5.0	6.7	0.1	28.4	1.0	1.2	0.7	15.5	2.4	10.1	0.4	2.2	0.3	57.0	20.3
1997	1	1	115.3	4.0	7.5	0.1	29.8	1.4	0.6	0.1	16.5	1.7	9.1	0.2	1.7	0.5	27.5	9.5
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	24	215.7	116.6	6.9	0.2	30.4	5.0	1.7	1.5	16.0	5.4	9.5	0.5	3.9	1.8	29.3	5.3
	2	1	116.0	4.5	7.5	0.0	32.5	3.0	0.5	0.1	14.8	3.6	9.1	0.2	1.9	0.1	22.3	8.7
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	15	147.3	3.5	7.1	0.1	36.7	3.2	0.8	0.1	13.3	0.5	11.2	0.7	2.5	0.1	31.5	12.9
1998	1	1	106.3	0.6	7.4	0.1	30.3	2.7	0.8	0.7	22.7	2.9	9.6	0.6	2.1	0.3	18.0	5.3

[a] A hydrogen sulfide layer was siphoned from the lake bottom during the winter, 1995-1996.

SD - standard deviation; na - data not collected.

Appendix C.17. Summary of seasonal mean water chemistry parameters by station and depth for Lower and Upper Jennifer Lakes, 1990-1994.

Lake	Year[a]	Stations	Depth (m)	Specific Conductance (umhos/cm)	S.D.	pH (Units)	S.D.	Alkalinity (mg/L)	S.D.	Turbidity (NTU)	S.D.	Color (Pt units)	S.D.	Calcium (mg/L)	S.D.	Magnesium (mg/L)	S.D.	Iron (ug/L)	S.D.
Lower	1990	1	1	117.7	15.0	7.0	0.5	15.0	1.8	1.1	0.5	8.7	0.6	5.7	0.4	3.0	0.7	26.0	15.1
		1	21	137.3	2.5	6.8	0.1	17.2	0.8	0.7	0.5	10.3	2.1	6.9	1.8	1.8	1.5	34.7	6.4
Lower	1993	1	1	132.0	1.4	7.1	0.3	20.9	4.8	0.6	0.3	4.8	2.2	6.6	0.4	2.9	0.7	24.3	12.0
		1	22	133.3	2.5	6.7	0.2	18.0	0.8	0.6	0.3	4.3	0.5	6.9	0.2	2.9	0.3	36.0	11.2
Lower	1994	1	1	130.3	2.1	6.7	0.2	18.0	0.8	0.6	0.2	19.5	7.6	6.1	0.6	2.4	0.8	33.8	9.7
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
		1	20	133.3	4.3	6.5	0.2	17.8	1.0	0.6	0.3	17.8	3.0	6.1	0.4	2.6	0.8	41.3	13.7
Upper	1993	1	1	132.8	5.3	7.3	0.5	17.8	1.7	0.6	0.5	3.5	0.6	6.8	0.7	3.1	0.7	15.5	8.7
		1	25	135.0	1.6	6.8	0.3	17.5	1.9	0.4	0.1	3.3	0.5	6.6	0.9	2.9	0.7	15.0	6.8
Upper	1994	1	1	129.3	2.6	6.7	0.3	16.6	0.5	0.4	0.2	9.8	2.2	5.6	0.6	3.0	1.1	7.3	4.4
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
		1	21	132.8	0.5	6.5	0.2	17.8	0.9	0.8	0.8	9.8	1.7	6.1	1.0	2.9	0.7	23.5	32.5

[a] Water samples were not collected in 1991-1992, and 1995-1998.

na - data not available.

Appendix C.18. Summary of seasonal mean water chemistry parameters by stations and depth for Ruth and Sorg Lakes, 1993-1994.

Lake	Year	Stations	Depth (m)	Specific Conductance (umhos/cm)	S.D.	pH (Units)	S.D.	Alkalinity (mg/L)	S.D.	Turbidity (NTU)	S.D.	Color (Pt units)	S.D.	Calcium (mg/L)	S.D.	Magnesium (mg/L)	S.D.	Iron (ug/L)	S.D.
Ruth	1994	1	1	126.8	3.2	6.8	0.3	22.0	2.1	0.8	0.2	8.0	6.0	7.6	0.5	2.4	0.4	94.0	65.9
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
		1	12	130.0	5.9	6.5	0.1	22.8	0.9	0.8	0.2	9.3	5.4	7.1	0.9	2.4	0.4	102.0	61.5
Sorg	1993	1	1	106.0	nc	7.1	nc	15.0	nc	0.3	nc	4.0	nc	3.9	nc	3.8	nc	28	nc
		1	17	91.0	nc	6.6	nc	14.0	nc	0.6	nc	9.0	nc	3.9	nc	2.5	nc	100	nc
Sorg	1994	1	1	88.8	8.7	6.8	0.1	13.8	1.5	0.8	0.3	12.5	1.0	4.0	0.1	2.1	0.4	68.3	32.0
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
		1	14	90.0	9.0	6.5	0.2	13.5	1.7	0.7	0.2	11.0	0.8	4.0	0.1	2.4	0.3	85.0	29.6

S.D. - standard deviation.

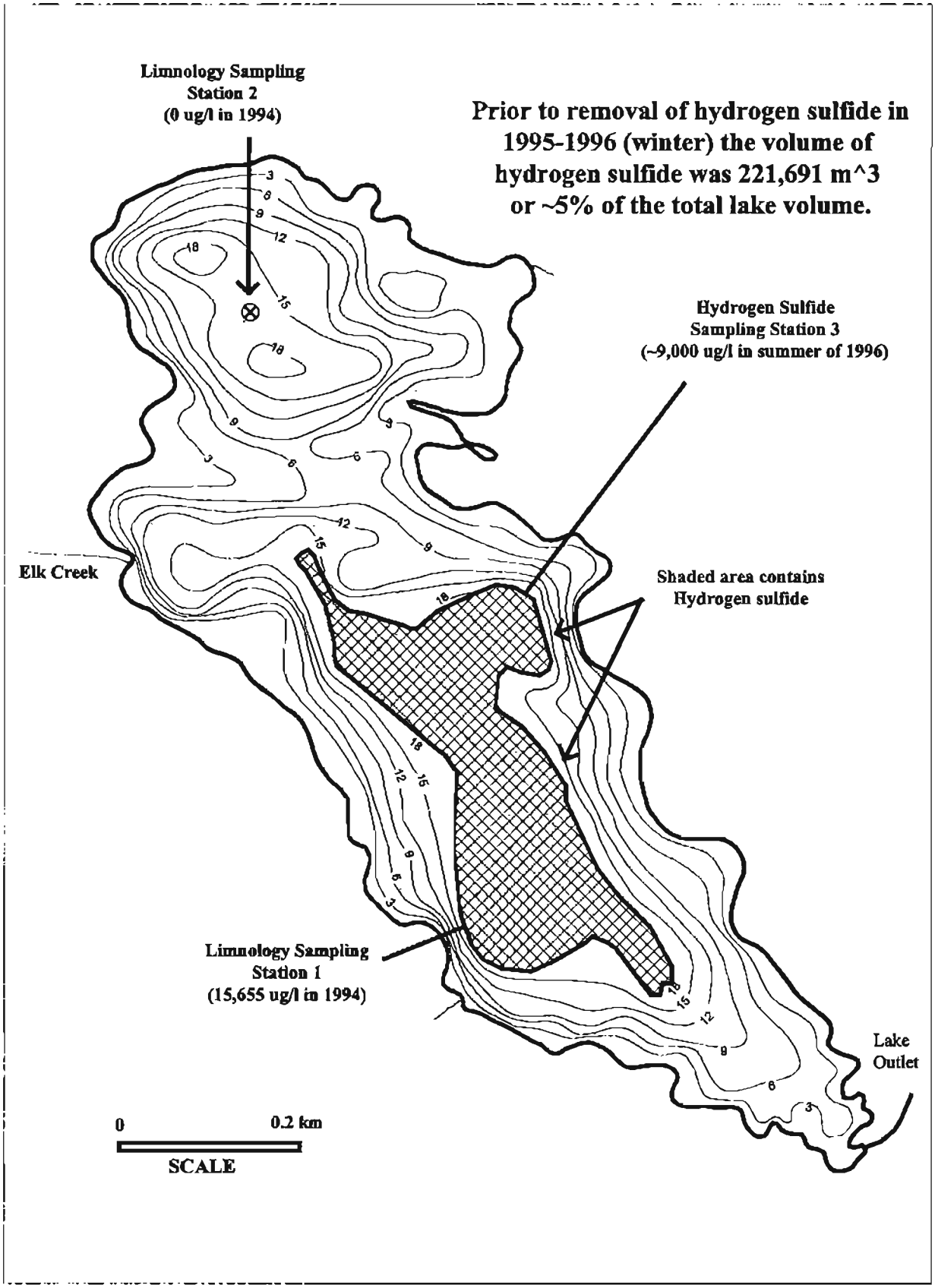
na - data not available.

nc - not calculated, only one sample was collected through out the field season.

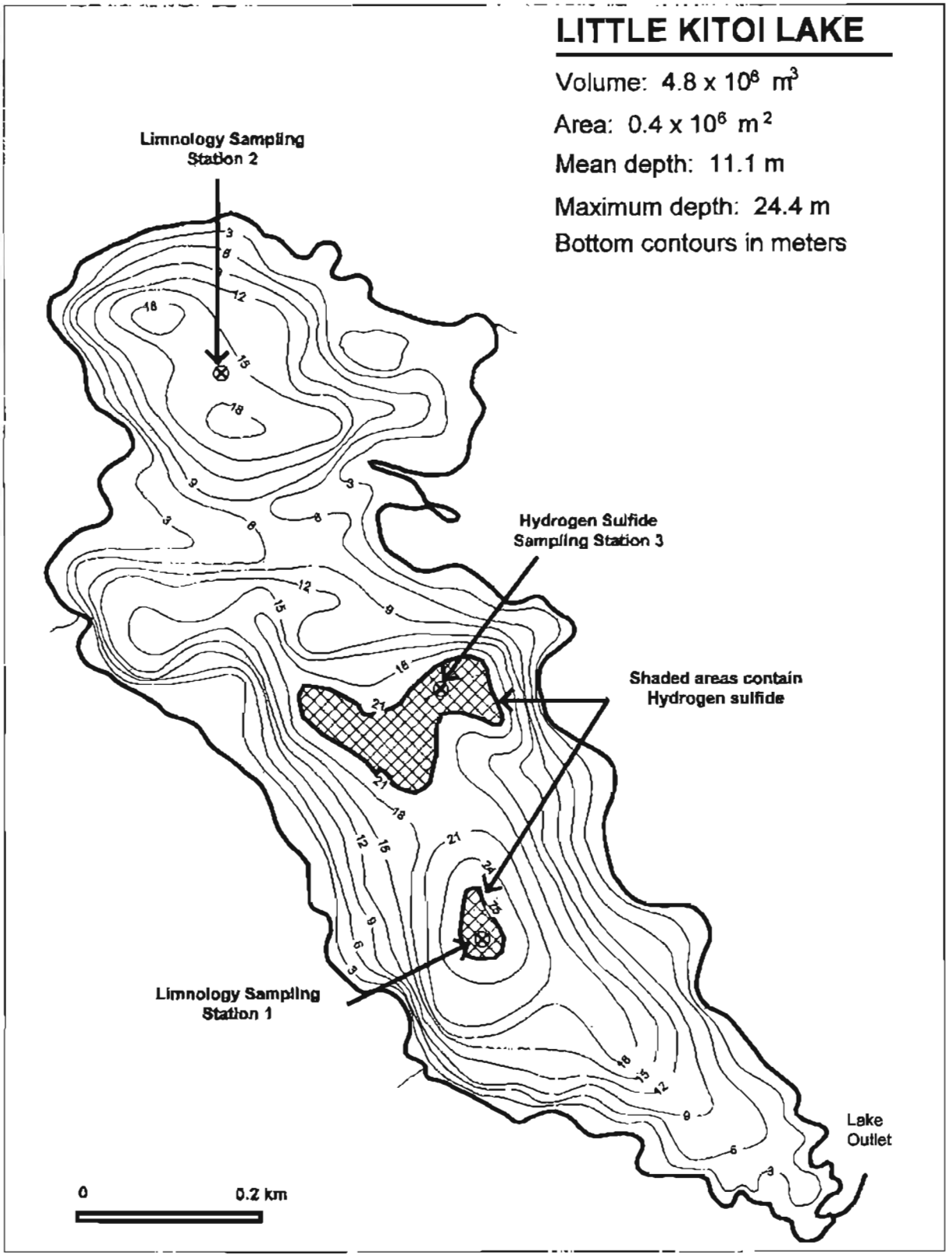
Appendix C.19. Historical hydrogen sulfide (H_2S) levels measured at Little Kitoi Lake, 1993-1994 and 1996-1998.

Year	Month	Depth (m)	Total H_2S (ug/l)	Toxic H_2S Present[a] (ug/l)	Comments
Station 1: Main Basin					
1993	April	21.0	3,023	2,209	
	July	22.5	6,310	909	
1994	August	21.0	52,183	15,655	
1996	August	24.0	88	48	
1997	June	24.0	1	<dl	
	August	24.0	1	<dl	
1998	August	25.0	23	13.7	These are average figures, replicates varied greatly.
Station 2: North Basin					
1993	July	21.0	2	1	
1994	August	18.0	0	0	
1997	June	18.0	0	<dl	
1998	No Sampling in 1998				
Station 3: Middle Basin					
1996	August	23.0	29,982	8,995	
1997	June	23.0	5,318	1,861	
	August	23.0	4,455	2,005	
1998	No Sampling in 1998				

[a] Some readings were less than the detectable level (<dl).



Appendix C.20. Morphometric map of Little Kitoi Lake showing the volume of hydrogen sulfide prior to removal in the winter of 1995-1996.



Appendix C.21. Morphometric map of Little Kitoi Lake showing the residual hydrogen sulfide that remained in the two basins after siphoning efforts in the winter of 1995-1996.

Appendix C.22. Summary of seasonal mean nutrient and algal concentrations by stations and depth for Little Kitoi Lake, 1990-1998.

Year	Stations	Depth (m)	Total-P (ug/L P)	S.D.	Total Filterable-P (ug/L P)	S.D.	Filterable Reactive-P (ug/L P)	S.D.	Total Kjeldahl Nitrogen (ug/L N)	S.D.	Ammonia (ug/L N)	S.D.	Nitrate+nitrite (ug/L N)	S.D.	Reactive Silicon (ug/L Si)	S.D.	Organic carbon (ug/L)	S.D.	Chlorophyll *a* (ug/L)	S.D.	Phaeophytin *a* (ug/L)	S.D.
1990	1	1	3.7	0.6	2.8	1.7	2.9	1.8	122.7	29.1	9.5	7.7	19.8	29.3	1,649.5	759.8	167.8	39.6	0.60	0.3	0.42	0.2
	1	24	752.8	658.8	707.1	738.6	440.6	661.2	10,587.0	4,363.4	7,780.0	3,022.9	2.3	1.8	7,901.3	4,097.4	545.8	22.5	0.49	0.4	0.25	0.0
1991	1	1	5.8	1.5	4.2	1.9	2.7	1.6	116.5	22.6	17.3	3.8	36.7	39.9	2,044.7	348.7	191.0	42.0	1.10	0.4	0.41	0.2
	1	25	974.4	407.9	878.0	380.1	925.6	409.4	10,358.6	3,087.7	7,331.5	2,656.6	1.9	1.5	12,112.7	4,900.0	554.2	37.7	0.13	0.1	0.21	0.0
1992	1	1	4.5	1.1	3.0	1.5	2.3	0.9	131.0	20.9	6.0	3.5	48.1	41.7	2,382.4	442.7	169.0	32.3	0.78	0.2	0.38	0.1
	1	21	189.2	34.9	172.6	37.0	175.4	36.4	6,756.3	903.5	5,605.4	1,018.8	3.8	0.4	10,090.4	958.6	913.8	86.3	0.31	0.2	0.29	0.1
1993	1	1	4.2	0.5	2.4	0.7	2.2	0.6	143.3	19.8	12.9	7.4	103.9	64.7	2,142.4	348.8	166.4	64.7	1.19	0.5	0.29	0.1
	1	22	274.9	176.4	271.6	189.6	282.2	181.8	5,392.9	4,063.9	5,934.6	2,383.0	31.2	36.6	9,468.0	1,953.6	1,088.4	233.8	0.39	0.3	0.44	0.2
1994	1	1	4.7	0.7	3.1	0.6	1.7	0.4	159.5	26.5	9.8	7.6	160.7	63.2	2,424.5	354.7	139.0	63.5	0.89	0.2	0.43	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.90	0.2	0.41	0.1
	1	18	18.9	29.6	18.6	30.7	16.8	29.6	936.4	1,564.1	578.4	1,096.8	222.4	80.6	4,010.8	1,951.3	208.3	275.7	0.29	0.1	0.26	0.1
	2	1	5.6	1.4	3.6	0.8	2.0	0.4	171.8	27.6	11.4	7.3	161.8	62.4	2,452.8	363.8	155.8	55.4	1.03	0.3	0.36	0.1
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.96	0.3	0.41	0.1
	2	15	4.8	1.3	3.4	0.6	2.0	0.9	143.8	47.9	11.1	7.7	244.5	15.8	3,078.3	148.5	59.5	24.2	0.46	0.1	0.30	0.0
1995	1	1	6.8	1.7	4.1	3.0	3.3	2.5	159.8	26.5	13.7	7.1	128.3	49.9	2,483.6	384.9	165.8	43.5	1.33	0.5	0.47	0.2
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.46	0.6	0.42	0.2
	1	22	404.3	281.1	308.0	145.8	299.9	136.4	8,611.2	2,459.1	7,067.8	1,517.5	7.7	8.4	13,879.0	3,199.7	872.6	41.3	0.14	0.0	0.30	0.1
	2	1	5.7	0.9	4.5	2.5	2.8	1.5	162.9	21.4	15.2	6.9	32.5	64.0	2,454.4	388.1	162.6	34.3	1.40	0.7	0.45	0.3
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.35	0.8	0.47	0.2
	2	18	11.3	8.0	5.3	2.1	2.5	1.2	129.9	4.7	18.9	10.8	55.3	114.9	3,219.0	344.0	105.6	29.5	0.54	0.2	0.37	0.1
1996[a]	1	1	4.6	0.7	2.0	0.5	1.9	0.5	185.1	14.5	3.3	3.2	78.7	36.7	2,241.3	138.7	191.3	57.6	0.50	0.3	0.28	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.57	0.2	0.29	0.0
	1	24	4.8	0.7	2.6	0.9	2.0	0.5	170.9	13.6	27.3	20.5	203.8	48.3	3,062.5	443.6	131.3	21.5	0.22	0.1	0.22	0.1
	2	1	5.5	1.1	2.1	0.7	1.9	0.5	174.5	24.4	4.9	3.3	75.9	36.4	2,154.8	138.3	176.0	22.6	0.49	0.1	0.19	0.1
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.54	0.1	0.26	0.1
	2	16	5.8	1.3	2.1	0.2	2.0	0.4	150.4	23.3	8.1	11.8	192.4	18.3	3,033.8	327.9	133.5	17.7	0.28	0.1	0.26	0.0
1997	1	1	5.8	1.5	3.7	1.2	3.4	1.5	193.4	51.8	5.7	2.6	46.0	30.1	1,940.3	299.9	183.5	45.6	0.90	0.2	0.62	0.2
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.88	0.2	0.56	0.1
	1	24	5.4	1.1	4.3	2.3	3.4	2.1	150.5	34.3	12.3	6.7	183.3	36.9	2,883.3	492.5	114.5	28.1	0.36	0.1	0.50	0.1
	2	1	5.8	0.7	3.3	0.9	2.6	0.9	165.3	18.3	5.5	3.5	45.6	32.7	1,932.8	305.3	148.0	29.9	0.71	0.1	0.56	0.1
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.74	0.2	0.60	0.1
	2	15	6.2	1.7	2.9	1.2	2.6	0.9	155.5	13.6	9.7	6.3	148.2	24.3	2,804.0	405.3	150.8	53.2	1.11	0.9	0.74	0.4
1998	1	1	8.4	3.7	5.5	0.8	3.7	1.2	216.3	42.8	22.9	20.0	17.5	10.9	2,002.0	319.7	121.7	52.5	1.80	2.2	0.96	0.8

[a] A hydrogen sulfide layer was siphoned from the lake bottom during the winter, 1995-1996.

SD - standard deviation; na - data not available or not collected.

Appendix C.23. Summary of seasonal mean nutrient and algal concentrations by station and depth for Lower and Upper Jennifer Lakes, 1990-1994.

Lake	Year[a]	Stations	Depth (m)	Total-P (ug/L P)	S.D.	Total Filterable-P (ug/L P)	S.D.	Filterable Reactive-P (ug/L P)	S.D.	Total Kjeldahl Nitrogen (ug/L N)	S.D.	Ammonia (ug/L N)	S.D.	Nitrate+nitrite (ug/L N)	S.D.	Reactive Silicon (ug/L Si)	S.D.	Organic carbon (ug/L)	S.D.	Chlorophyll *a* (ug/L)	S.D.	Phaeophytin *a* (ug/L)	S.D.
Lower	1990	1	1	2.3	0.4	2.8	0.6	2.1	1.0	150.6	26.2	2.6	1.6	1.9	1.9	1074.7	35.2	164.0	54.6	0.17	0.1	0.13	0.1
		1	21	13.1	18.3	2.3	0.3	1.8	0.2	211.7	103.1	14.8	6.5	53.4	20.9	1599.0	164.4	134.3	72.9	0.21	0.1	0.20	0.0
Lower	1993	1	1	4.8	0.6	2.8	1.0	1.9	0.5	146.3	4.0	3.7	1.1	15.7	28.3	1878.8	92.5	98.0	16.8	0.40	0.2	0.29	0.0
		1	22	4.6	1.1	2.8	1.3	2.2	1.1	123.5	12.8	10.7	5.7	50.6	25.8	2376.0	166.7	82.5	56.8	0.15	0.1	0.34	0.1
Lower	1994	1	1	4.9	0.7	4.8	4.1	3.4	3.8	178.9	11.6	16.4	8.9	184.8	83.8	1885.8	260.2	152.0	73.0	0.38	0.3	0.20	0.1
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.31	0.2	0.16	0.1
		1	20	14.8	20.5	3.3	0.6	2.2	0.8	194.3	35.0	26.3	6.9	269.0	22.2	2437.5	209.1	74.5	55.0	0.15	0.0	0.20	0.0
Upper	1993	1	1	3.9	0.5	2.3	0.5	1.8	0.5	148.8	8.2	2.5	1.3	4.2	5.5	1283.3	102.8	127.8	47.3	0.37	0.2	0.27	0.1
		1	25	4.3	1.4	2.2	0.4	1.4	0.2	131.2	7.0	8.4	7.0	29.7	8.9	1638.5	171.9	63.8	5.1	0.32	0.1	0.32	0.0
Upper	1994	1	1	5.1	1.2	2.6	1.0	1.6	1.1	159.7	14.2	9.3	2.7	23.2	17.5	1193.8	177.5	117.0	56.8	0.39	0.3	0.13	0.0
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.26	0.1	0.18	0.0
		1	21	3.6	1.0	2.4	0.7	1.2	0.3	144.4	12.3	22.4	7.0	84.3	13.6	1588.8	67.0	67.3	23.1	0.13	0.1	0.17	0.1

[a] Water samples were not collected in 1991-1992, and 1995-1998.

na - data not available.

Appendix C.24. Summary of seasonal mean nutrient and algal pigment concentrations by stations and depth for Ruth and Sorg Lakes, 1993-1994.

Lake	Year	Stations	Depth (m)	Total-P (ug/L P)	S.D.	Total Filterable-P (ug/L P)	S.D.	Filterable Reactive-P (ug/L P)	S.D.	Total Kjeldahl Nitrogen (ug/L N)	S.D.	Ammonia (ug/L N)	S.D.	Nitrate+nitrite (ug/L N)	S.D.	Reactive Silicon (ug/L Si)	S.D.	Organic carbon (ug/L)	S.D.	Chlorophyll *a* (ug/L)	S.D.	Phaeophytin *a* (ug/L)	S.D.
Ruth	1994	1	1	4.6	2.2	3.3	0.6	1.5	0.5	176.4	10.8	10.4	2.8	42.1	na	1516.8	277.8	127.0	15.1	0.60	0.2	0.19	0.0
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.52	0.1	0.20	0.0
		1	12	5.3	2.1	4.7	1.8	2.4	0.6	169.8	17.7	21.9	12.6	77.3	33.0	2173.8	195.4	87.0	28.8	0.33	0.2	0.28	0.1
Sorg	1993	1	1	3.0	nc	1.7	nc	0.6	nc	124.4	nc	<1.7	nc	<4.0	nc	2125.0	nc	123.0	nc	0.46	nc	0.31	nc
		1	17	5.6	nc	2.8	nc	1.1	nc	116.6	nc	<1.7	nc	12.5	nc	2864.0	nc	83.0	nc	0.35	nc	0.42	nc
Sorg	1994	1	1	4.8	0.7	4.5	3.4	2.8	1.7	165.4	26.5	5.7	6.0	21.6	27.8	2542.3	327.8	164.5	54.7	0.78	0.1	0.29	0.1
		1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.74	0.1	0.26	0.0
		1	14	7.8	6.9	2.5	1.0	1.8	0.5	144.3	13.2	12.0	9.7	57.2	18.2	2529.0	745.4	117.3	47.3	0.35	0.3	0.24	0.0

S.D. - standard deviation.

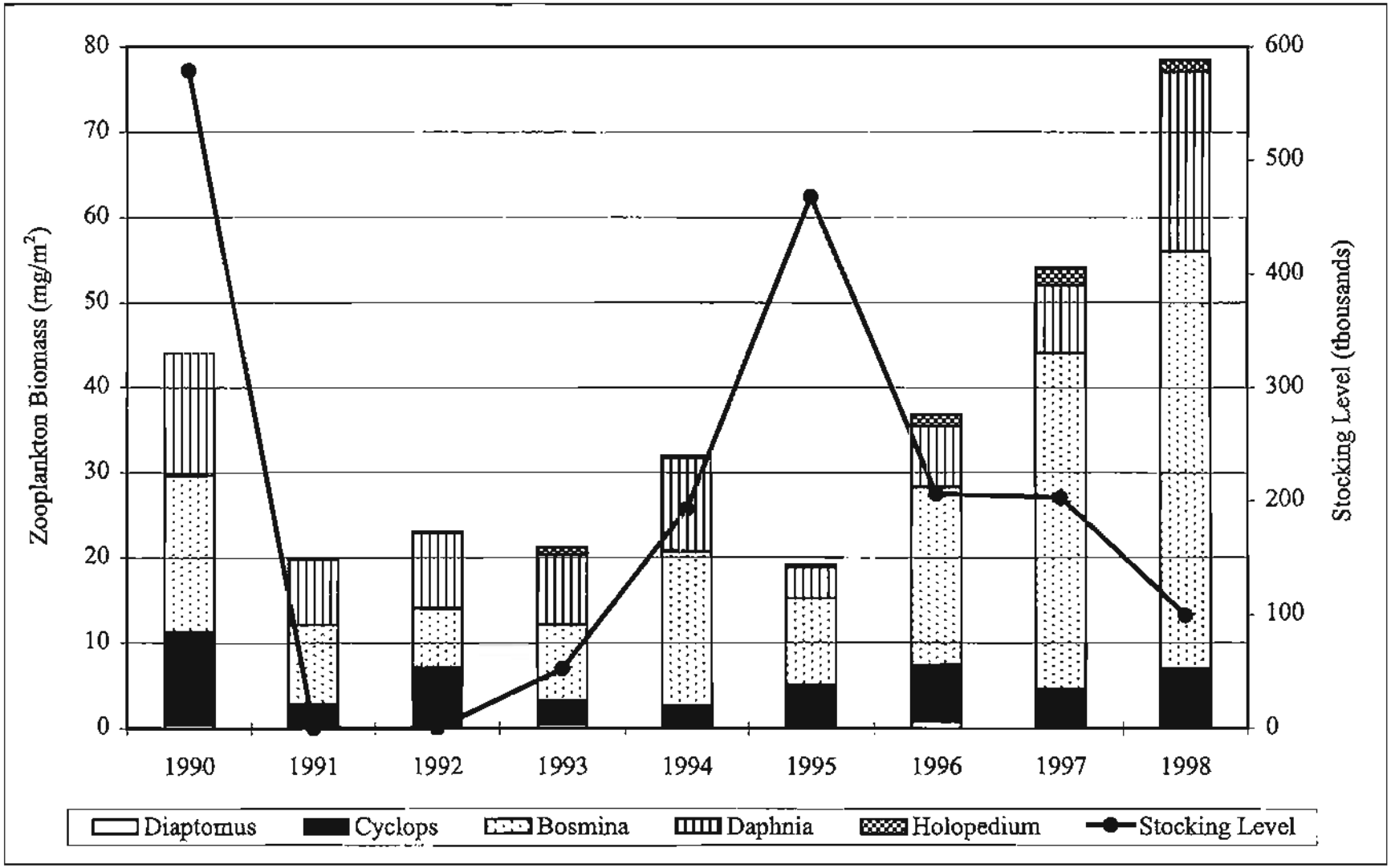
na - data not available.

nc - not calculated, only one sample was collected through out the field season.

Appendix C.25. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Little Kitoi Lake, 1990-1998.

Station	Number	*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1 & 2	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1990	4	66	0.45	1.18	8,188	10.8	0.63	24,337	18.4	0.29	12,553	14.4	0.53	199	<1	-	45,343	44.1
1991	6	34	0.05	0.70	8	2.8	0.55	0	9.2	0.30	0	7.6	0.49	0	0.2	0.42	42	19.7
1992	5	0.0	0.0	0.00	6,136	7.1	0.59	9,023	6.9	0.29	7,580	8.9	0.53	42	0.1	0.45	22,781	23.0
1993	5	85	0.47	1.10	2,840	2.7	0.54	11,348	8.9	0.30	7,749	8.3	0.51	340	0.8	0.53	22,362	21.2
1994	4	27	0.05	0.72	3,089	2.6	0.51	23,686	18.1	0.30	12,268	11.0	0.47	135	0.2	0.44	39,191	31.9
1995	5	6	0.04	1.18	5,314	5.0	0.54	13,663	10.1	0.29	3,356	3.6	0.51	196	0.3	0.43	22,532	19.1
1996	4	198	0.72	1.04	7,411	6.6	0.52	28,074	20.9	0.29	6,588	7.2	0.51	963	1.4	0.42	43,207	36.8
1997	4	16	0.02	0.68	5,223	4.5	0.51	48,834	39.6	0.30	8,750	7.9	0.47	1,675	2.1	0.41	54,123	54.1
1998	4	8	0.01	0.64	9,045	7.0	0.50	62,943	49.0	0.29	21,924	21.0	0.45	1,244	1.4	0.40	95,164	78.4
Avg =	5	49	0.23	0.90	5,251	5.5	0.54	24,656	20.1	0.29	8,974	10.0	0.50	533	0.8	0.44	38,305	36.5

[8] Stocking includes only juvenile sockeye salmon planted in Little Kitoi Lake, and does not include juvenile coho salmon planted in Little Kitoi, Elk, and Finger Lakes.



Appendix C.26. Weighted mean zooplankton biomass by genera (stations 1&2 averaged) and juvenile sockeye salmon stocking levels for Little Kitoi Lake, 1990-1998.

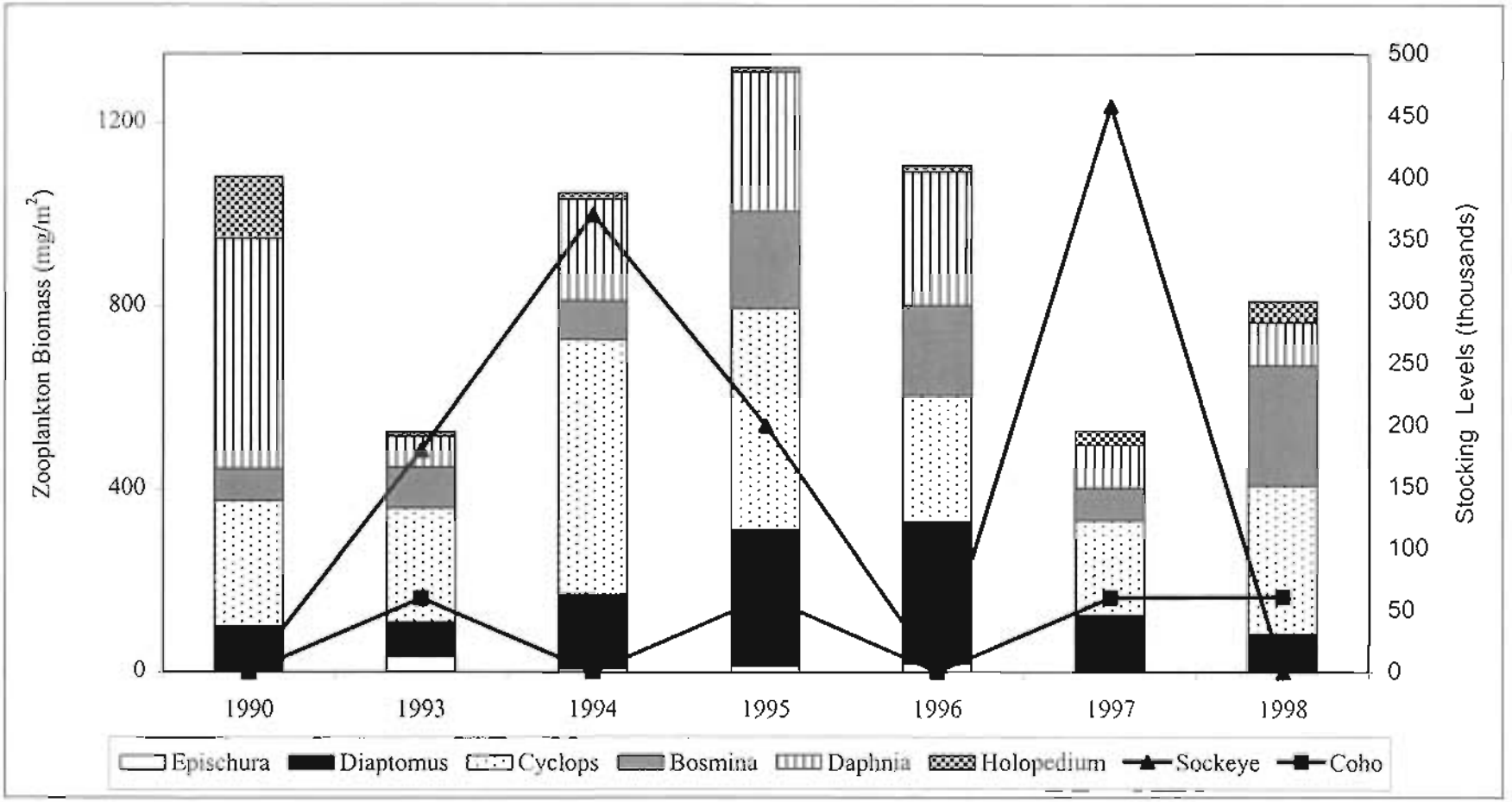
Appendix C.27. Weighted mean zooplankton density, biomass, and size by genera for Lower and Upper Jennifer Lakes, 1990 and 1993-1998.

LOWER JENNIFER LAKE

Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1993	4	2,309	22	1.30	29,485	182	1.14	59,475	161	0.87	26,672	42	0.41	20,886	48	0.73	3,901	28	0.83	142,728	483
1994	4	Data Not Available.																			
1995	5	552	11	1.71	29,703	201	1.18	86,730	277	0.94	22,484	41	0.44	63,778	200	0.84	807	5	0.78	204,054	736
1996	5	212	3	1.46	26,306	124	1.03	106,773	308	0.90	21,932	34	0.41	67,516	181	0.78	4,756	26	0.74	227,495	674
1997	4	0	0	0	43,471	159	0.94	113,588	293	0.85	15,154	24	0.41	29,579	67	0.72	4,644	26	0.75	206,436	569
1998		No samples collected.																			
Avg	4	768	9	1.12	32,241	166	1.07	91,642	260	0.89	21,561	35	0.42	45,440	124	0.77	3,527	21	0.78	195,178	616

UPPER JENNIFER LAKE

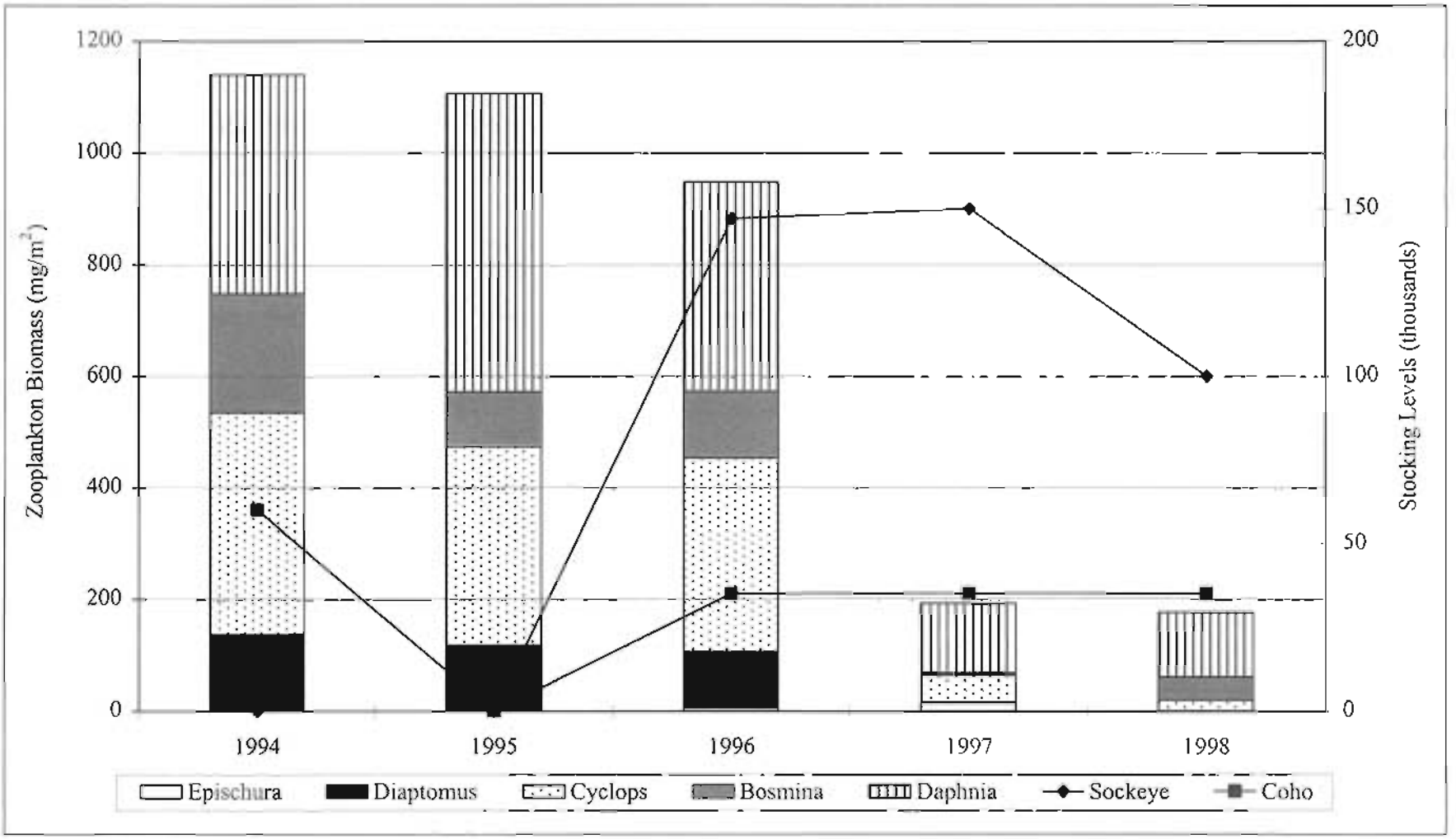
Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1990	3	88	2	1.85	11,854	98	1.26	116,861	275	0.82	28,751	70	0.51	111,465	502	0.99	8,758	135	1.13	277,777	1,082
1993	4	4,379	34	1.21	10,032	75	1.22	98,754	250	0.85	51,142	89	0.43	28,131	68	0.74	1,593	10	0.70	194,031	526
1994	4	398	7	1.65	31,874	163	1.06	208,942	558	0.87	36,386	84	0.49	55,520	221	0.93	1,991	14	0.81	335,111	1,047
1995	5	552	13	1.80	35,223	298	1.27	154,819	485	0.94	82,017	209	0.52	72,399	305	0.96	1,147	9	0.87	346,157	1,320
1996	5	764	18	1.78	50,573	310	1.13	107,983	278	0.85	84,120	197	0.50	72,824	291	0.94	1,996	14	0.82	318,260	1,107
1997	4	0	0	0	21,099	124	1.12	86,279	206	0.82	31,768	71	0.49	32,272	95	0.81	6,688	33	0.71	178,105	529
1998	4	0	0	0	10722	83	1.23	141986	325	0.79	125903	263	0.47	32644	94	0.75	8387	47	0.75	319,642	812
Avg	4	1,030	12	1.38	26,776	178	1.18	128,940	342	0.86	52,364	120	0.49	62,102	247	0.89	3,695	36	0.84	281,298	918



Appendix C.28. Weighted mean zooplankton biomass by genera and stocking levels for Upper Jennifer Lake, 1990 and 1993-1998.

Appendix C.29. Weighted mean zooplankton density, biomass, and size by genera for Ruth Lake, 1994-1998.

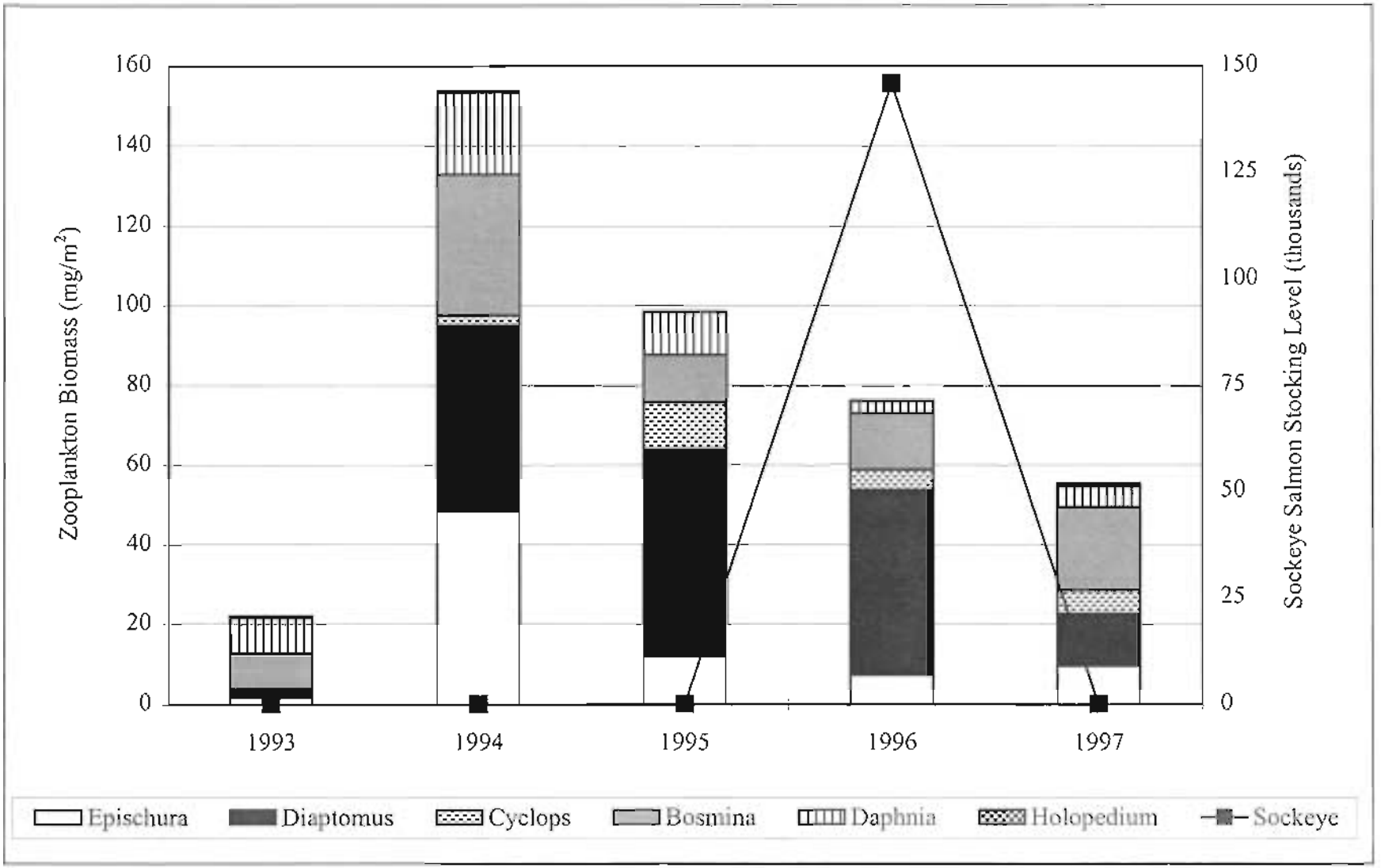
Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1994	4	133	2.4	1.64	24,045	134	1.09	165,767	399	0.83	87,500	212	0.51	102,601	392	0.92	2,866	20	0.82	382,911	1,160
1995	4	106	0	0.68	21,656	117	1.08	119,268	358	0.92	39,013	98	0.51	120,595	535	1.00	1,009	8	0.88	301,646	1,115
1996	4	1,964	6	0.85	12,872	100	1.23	160,059	348	0.79	51,035	120	0.50	88,535	375	0.98	239	1.0	0.66	314,703	949
1997	4	4,644	15	0.89	372	1	0.82	16,508	48	0.90	3,569	4	0.35	69,228	124	0.65	4,087	14	0.61	98,407	206
1998	4	1,088	4	0.93	239	1	0.93	10,497	20	0.71	44,879	39	0.30	79,446	116	0.8	9,236	23	0.52	145,385	203
Avg	4	1,712	5.9	1.02	14,736	88	1.05	115,400	288	0.86	45,279	108	0.47	95,240	357	0.88	2,050	11	0.74	274,417	858



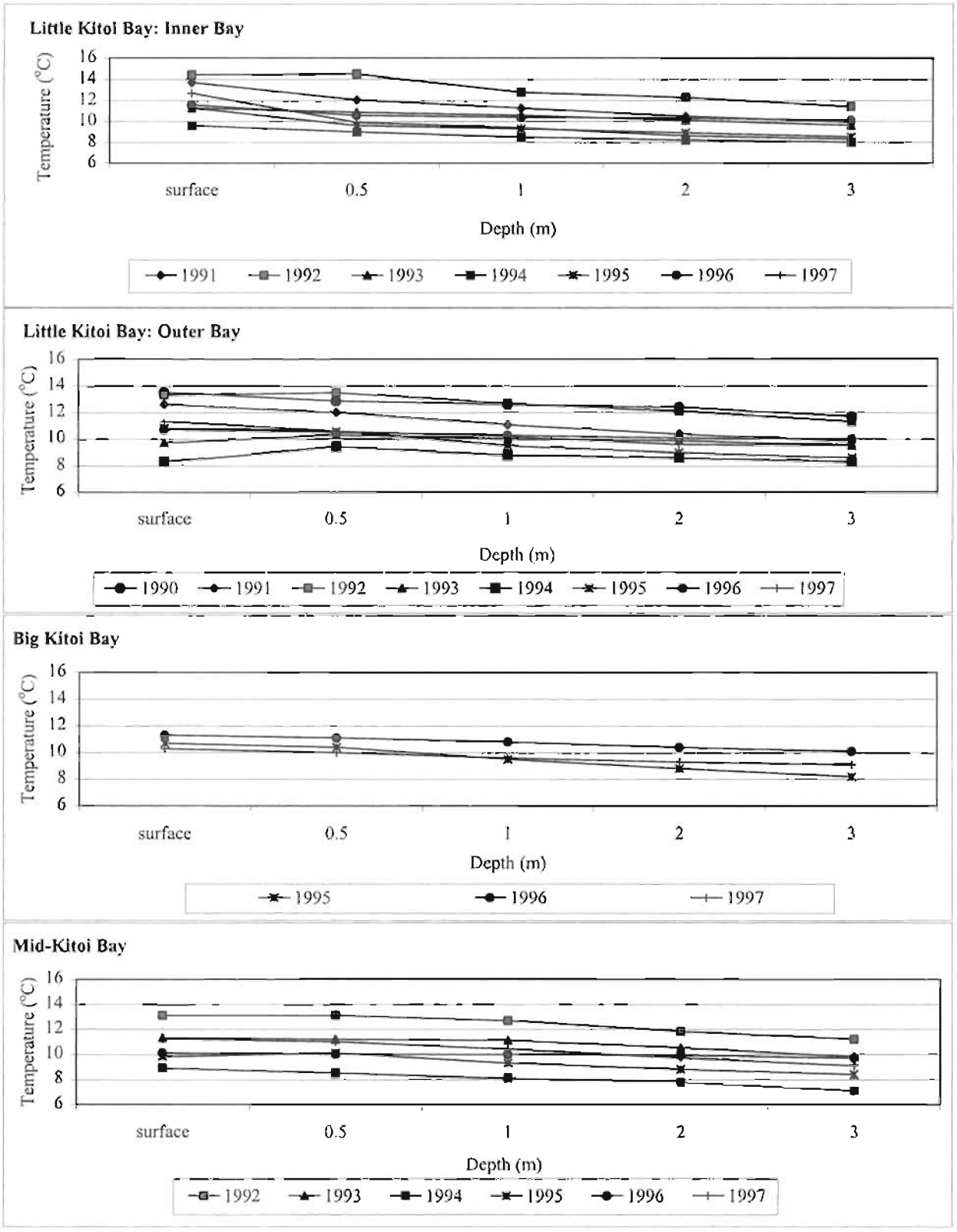
Appendix C.30. Weighted mean zooplankton biomass by genera and juvenile sockeye and coho salmon stocking levels for Ruth Lake, 1994-1998.

Appendix C.31. Weighted mean zooplankton density, biomass, and size by genera for Sorg Lake, 1993-1997.

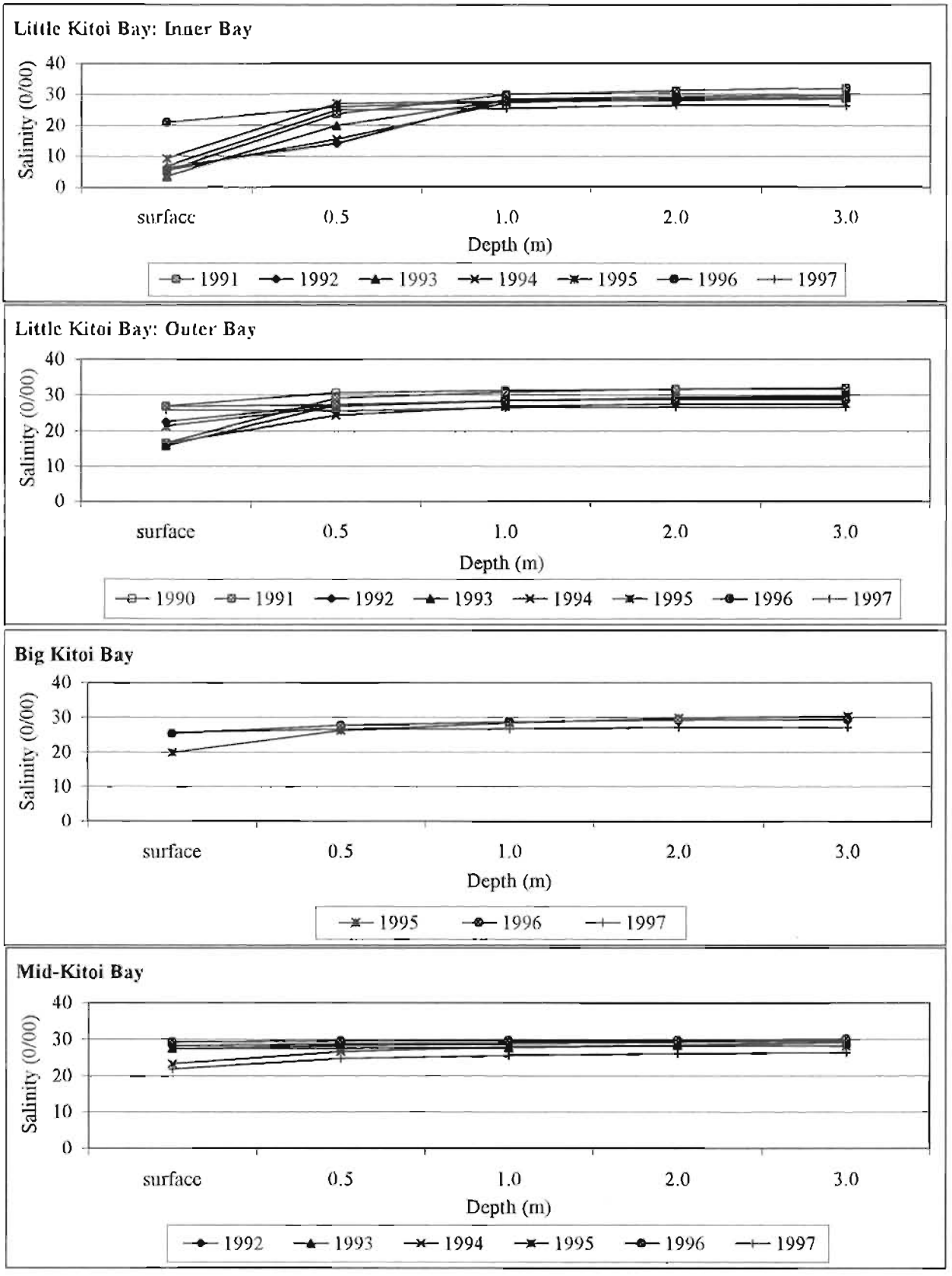
Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1993	1	1,062	1.7	0.70	318	1.5	1.04	1,433	0.6	0.37	13,748	8.9	0.27	7,060	8.9	0.55	212	0.4	0.47	23,833	22.0
1994	4	11,346	48.3	0.98	12,261	46.6	0.96	2,773	2.6	0.53	43,591	35.1	0.30	14,239	20.7	0.59	159	0.4	0.56	84,369	153.8
1995	4	4,671	12.0	0.82	10,510	51.8	1.05	10,576	11.9	0.58	15,035	11.9	0.30	8,705	10.7	0.54	53	0.11	0.50	49,549	98.5
1996	4	3,002	7.4	0.81	10,467	46.2	1.01	5,083	5.2	0.55	15,802	14.2	0.32	2,919	3.1	0.50	101	0.2	0.47	37,373	76.2
1997	4	3,766	9.7	0.82	3,302	13.0	0.97	8,116	5.9	0.47	27,076	20.8	0.29	4,537	5.1	0.52	486	0.7	0.44	47,281	55.3
Avg =	3	4,769	15.8	0.83	7,371	31.8	1.01	5,596	5.2	0.50	23,050	18.2	0.30	7,492	9.7	0.54	202	0.4	0.49	48,481	81.2



Appendix C.32. Weighted mean zooplankton biomass by genera and juvenile sockeye stocking levels for Sorg Lake, 1993-1997.



Appendix C.33. Historical water temperature profiles measured in Kitoi Bay from mid-May to mid-August, 1990-1997.



Appendix C.34. Historical salinity levels measured in Kitoi Bay from mid-May to mid-August, 1990-1997.

Appendix C.35. Historical zooplankton densities measured in milliliters at three sites in Kitoi Bay, 1991-1998.

station	Week ending	statistical week	Sampling Years 1991	1992	1993	1994	1995	1996	1997	1998	average 1991-98
mid-Kitoi 1	16-May	20				12.00			3.60	1.20	5.60
	23-May	21			0.12				12.00	1.50	4.54
	30-May	22			0.60		0.11	1.80			0.84
	6-Jun	23			0.12		0.11	1.80	4.80	2.40	1.85
	13-Jun	24			1.20		0.11	6.60	16.80	3.00	5.54
	20-Jun	25			1.20		0.11	19.30			6.87
	27-Jun	26		10.83							10.83
	4-Jul	27		6.02							6.02
	11-Jul	28		48.14							48.14
	18-Jul	29	16.85								16.85
	25-Jul	30	96.28	101.09							98.69
	1-Aug	31									
	8-Aug	32		45.73							45.73
	15-Aug	33									
	22-Aug	34									
	29-Aug	35									
	5-Sep	36									
	12-Sep	37		4.81							4.81
		average	56.57	36.10	0.65	12.00	0.11	7.38	9.30	2.03	15.52
Big Kitoi 2	16-May	20							2.40	0.90	1.65
	23-May	21							12.00	1.80	6.90
	30-May	22					1.06	1.80			1.43
	6-Jun	23					0.11	11.40	5.40	3.00	4.98
	13-Jun	24					4.77	10.20	12.00	7.20	8.54
	20-Jun	25					1.60	20.50			11.05
	27-Jun	26									
		average					1.88	10.98	7.95	3.23	6.94
Little Kitoi 3	16-May	20				14.40			1.20	0.90	5.50
	23-May	21			0.12				12.00	2.40	4.84
	30-May	22			0.60		0.11	2.40			1.04
	6-Jun	23			0.12		0.11	9.00	3.60	2.10	2.99
	13-Jun	24			3.61		0.11	5.40	19.30	16.80	9.04
	20-Jun	25			1.20		0.59	14.40			5.40
	27-Jun	26		7.22							7.22
	4-Jul	27		14.44							14.44
	11-Jul	28		60.17							60.17
	18-Jul	29	7.22								7.22
	25-Jul	30	91.46	63.78							77.62
	1-Aug	31									
	8-Aug	32		26.48							26.48
	15-Aug	33									
	22-Aug	34									
	29-Aug	35									
	5-Sep	36									
	12-Sep	37		6.02							6.02
		average	49.34	29.69	1.13	14.40	0.23	7.80	9.03	5.55	14.64

[a] Weeks with multiple samples were averaged.

Appendix C.36. Juvenile sockeye salmon estimates based on townet catches and hydroacoustic fish population estimates for Little Kitoi Lake, 1994-1995 and 1998.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	Number	Low	High	Number	Low	High	(%)
10/31/94	407,708	239,508	575,908	46,886	27,543	66,229	11.5
05/14/95	50,258	32,406	68,110	46,086	29,716	62,456	91.7
7/15/95[a]	55,205	42,418	67,992	nc	nc	nc	nc
08/18/98	81,261	68,609	93,913	6,176	5,214	7,138	7.6

[a] nc - sockeye salmon estimates were not calculated.

Appendix C.37. Townet catches from Little Kitoi Lake, 1994-1995 and 1998.

			Catch by Species					
	Tow		Sockeye			Stickleback		
Date	No.	Minutes	No.	%	CPUE	No.	%	CPUE
10/31/94	5	38	39	11.5	1.0	300	88.5	7.9
05/14/95	4	26	11	91.7	0.4	1	8.3	0.0
07/15/95	0 [a]							
08/18/98	6	31	14	7.6	0.5	170	92.4	5.5

[a] no tows were conducted.

Appendix C.38. Mean length, weight, and condition coefficient of juvenile sockeye salmon captured by townet at Little Kitoi Lake, 1995 and 1998[a].

	Age-0					Age-1					Age-2				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
1995	8	80.0	48.3	1.3	1.15	2	20.0	103.5	13.4	0.95	0	0	0.0	0.0	0.00
1998	9	64.3	57.8	2.1	1.07	4	28.6	72.5	4.3	1.68	1	7.1	64.0	3.0	1.14

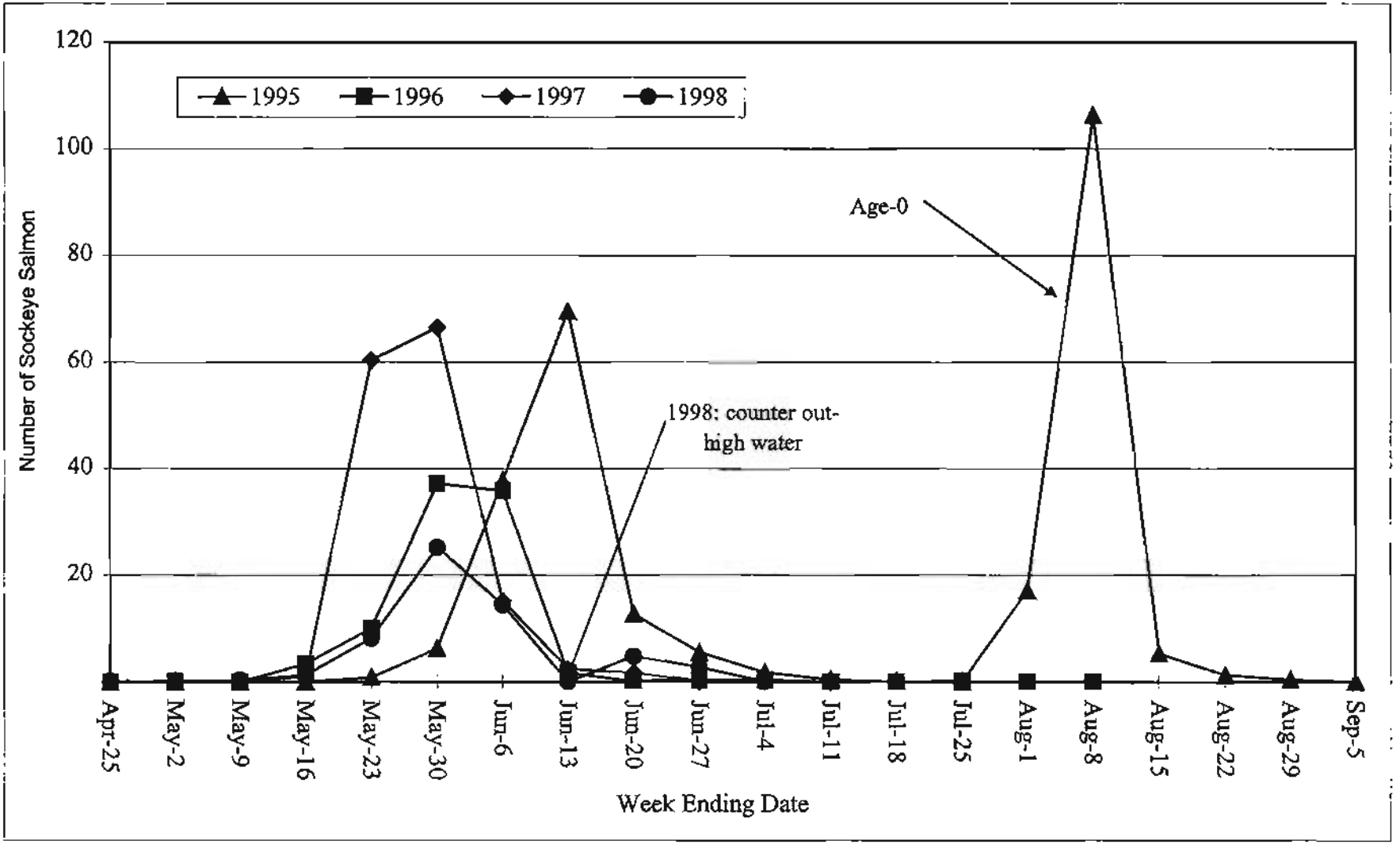
[a]Tow net samples collected in 1994 were lost before size information was obtained .

Appendix C.39. Estimated sockeye salmon smolt outmigration from Little Kitoi Lake by week, 1995-1998.

Stat Week	Week Ending Date	Weekly Totals[a] 1995	1996	1997	1998
17	Apr 25	-	-	-	221
18	May 2	0	0	10	60
19	May 9	91	0	96	352
20	May 16	97	3,396	1,049	1,272
21	May 23	851	10,007	60,358	8,120
22	May 30	6,240	37,177	66,557	25,192
23	Jun 6	37,629	35,816	15,118	14,417
24	Jun 13	69,478	1,722	2,488	65
25	Jun 20	12,655	174	1,690	4,825
26	Jun 27	5,540	257	136	2,722
27	Jul 4	1,771	367	7	68
28	Jul 11	407	13	0	56
29	Jul 18	93	1	0	0
30	Jul 25	69	2	0	0
31	Aug 1	17,043	1	0	0
32	Aug 8	106,199	0	0	0
33	Aug 15	5,231	0	0	0
34	Aug 22	1,220	0	0	0
35	Aug 29	450	0	0	0
36	Sep 5	41	0	0	0
Total[b]		134,922	88,933	147,509	57,370

[a] Trap pulled August 31, 1995; July 31, 1996; June 30, 1997; and July 7, 1998.

[b] Excludes zero checks planted in July 1995, which outmigrated the same year (130,184 zero checks).



Appendix C.40. Sockeye salmon smolt outmigration timing from Little Kitoi Lake, 1995-1998.

Appendix C.41. Mean length, weight, and condition coefficient of Little Kitoi, Jennifer, and Ruth Lake sockeye salmon smolt samples by age, 1993-1998.

		Age-1					Age-2					Age-3				
Lake	Sampling Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
Little Kitoi	1993	38	10.5	63.6	2.0	0.77	306	85.1	70.8	2.8	0.86	16	4.4	82.4	4.7	0.79
	1994	115	33.9	65.9	2.2	0.78	224	66.1	69.7	2.7	0.79	0	0	0.0	0.0	0.00
	1995	917	94.3	110.6	11.1	0.77	55	5.7	76.1	3.9	0.75	0	0	0.0	0.0	0.00
	1996	1011	90.8	92.7	5.8	0.70	102	9.1	66.9	2.1	0.70	1	0.1	92.0	4.9	0.63
	1997	1032	81.6	91.2	6.0	0.73	226	17.9	71.6	2.9	0.74	6	0.5	72.7	2.9	0.74
	1998	1125	83.1	91.1	5.8	0.72	207	15.3	69.4	2.4	0.72	22	1.6	72.7	2.9	0.74
Jennifer	1996	181	87.4	116.7	15.2	0.92	26	12.6	146.8	33.1	0.93	0	0	0.0	0.0	0.00
	1997	0	0	0.0	0.0	0.00	2	66.7	178.0	46.3	0.82	1	33.3	209.0	77.2	0.85
Ruth	1997	128	100.0	123.5	15.9	0.84	0	0	0.0	0.0	0.00	0	0	0.0	0.0	0.00

Appendix C.42. Kitoi Bay Hatchery adult salmon production numbers, by species, 1974-1998.

Year	Common Property Harvest [a,b]			
	pinks	chums	sockeye	coho
1974	8,794	NA	NA	NA
1975	13,012	NA	NA	NA
1976	53,783	NA	NA	NA
1977	49,682	NA	NA	NA
1978	234,409	NA	NA	NA
1979	417,505	NA	NA	NA
1980	886,837	NA	NA	NA
1981	880,276	NA	NA	NA
1982	321,989	NA	NA	NA
1983	192,281	NA	NA	NA
1984	401,178	3,301	NA	NA
1985	3,582,973	5,840	NA	NA
1986	317,753	1,670	NA	3,477
1987	1,050,911	5,749	NA	9,889
1988	693,750	4,001	NA	16,075
1989	0	0	NA	0
1990	619,518	6,322	NA	7,227
1991	1,390,681	31,719	NA	9,359
1992	845,395	9,868	25,407	7,681
1993	12,076,738	11,886	31,221	32,517
1994	2,051,375	10,799	14,134	45,884
1995	4,519,885	215,351	31,326	42,235
1996	979,143	14,188	21,909	56,854
1997	1,211,128	11,021	50,392	108,940
1998	6,272,029	38,118	75,506	148,333

NA = not applicable.

[a] Cost recovery harvest occurred for pinks in 1987-1989 (165,773 - 1987; 298,439 - 1988; 6,641,889 - 1989).

[b] Total harvest from ADF&G Kodiak statistical areas 252-30 (Izhut Bay), 252-31 (Duck Bay), and 252-32 (Kitoi Bay) are considered an index of total harvest.

Appendix C.43. Estimated age composition of Little Kitoi Lake sockeye salmon escapement, 1992 - 1998.

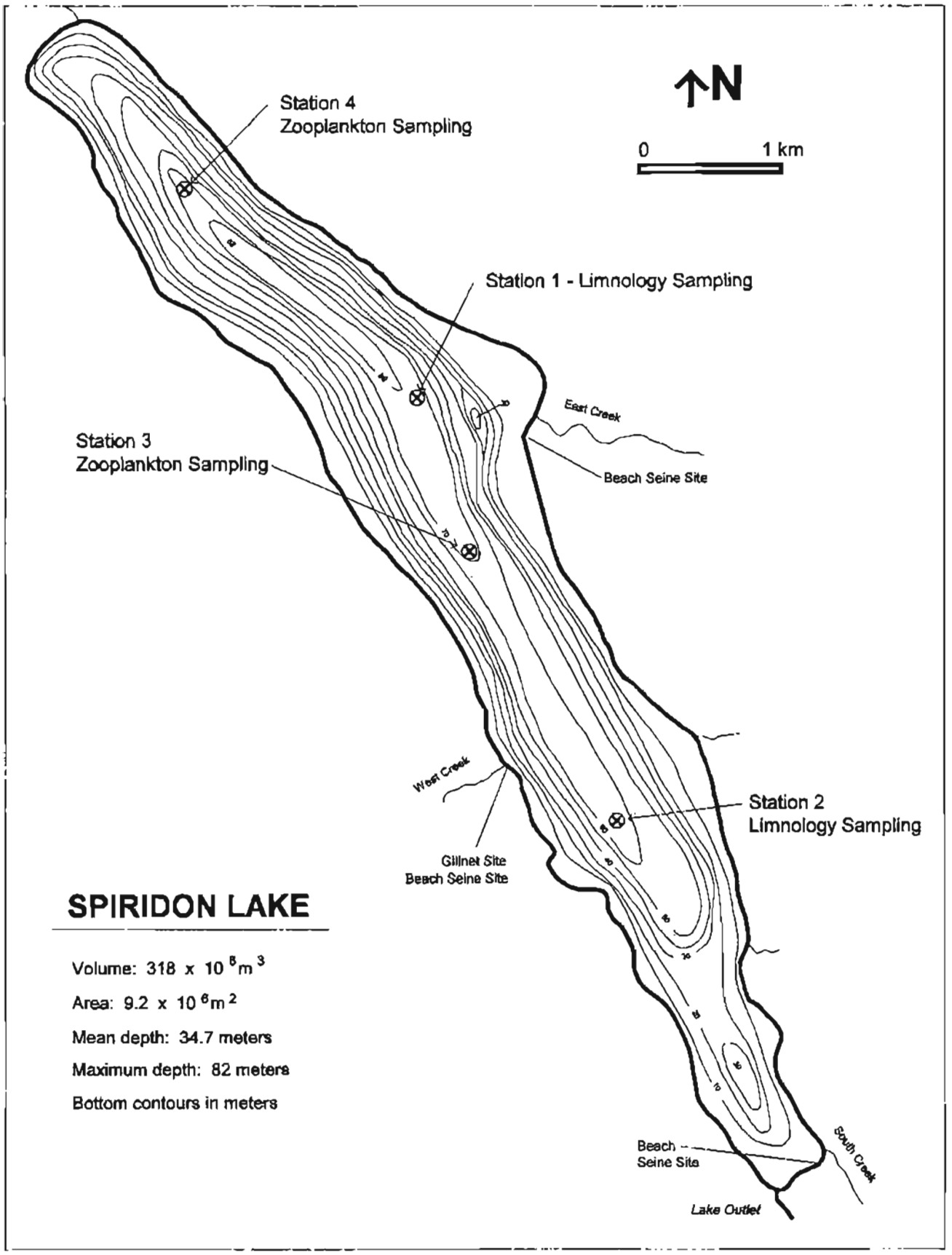
		Ages														
Year		0.1	0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	Total
1992	Number	0	3	2	17	283	101	1	18	199	62	0	0	20	0	706
	Percent	0.0%	0.4%	0.3%	2.4%	40.1%	14.3%	0.1%	2.5%	28.2%	8.8%	0.0%	0.0%	2.8%	0.0%	100.0%
1993	Number	0	0	0	8	328	448	0	60	882	816	4	8	24	118	2,696
	Percent	0.0%	0.0%	0.0%	0.3%	12.2%	16.6%	0.0%	2.2%	32.7%	30.3%	0.1%	0.3%	0.9%	4.4%	100.0%
1994	Number	0	1	0	1	41	45	0	2	82	31	0	0	4	0	207
	Percent	0.0%	0.5%	0.0%	0.5%	19.8%	21.7%	0.0%	1.0%	39.6%	15.0%	0.0%	0.0%	1.9%	0.0%	100.0%
1995	Number	1	0	1	12	21	112	1	8	52	93	0	0	1	0	302
	Percent	0.3%	0.0%	0.3%	4.0%	7.0%	37.1%	0.3%	2.6%	17.2%	30.8%	0.0%	0.0%	0.3%	0.0%	100.0%
1996	Number	0	1	0	658	263	44	0	8	181	26	0	0	0	0	1,181
	Percent	0.0%	0.1%	0.0%	55.7%	22.3%	3.7%	0.0%	0.7%	15.3%	2.2%	0.0%	0.0%	0.0%	0.0%	100.0%
1997[a]	Number	3	0	0	27	78	22	0	1	2	4	0	0	0	0	137
	Percent	2.2%	0.0%	0.0%	19.7%	56.9%	16.1%	0.0%	0.7%	1.5%	2.9%	0.0%	0.0%	0.0%	0.0%	100.0%
1998[a]	Number	0	2	0	40	207	142	0	5	3	7	0	0	0	0	406
	Percent	0.0%	0.5%	0.0%	9.9%	51.0%	35.0%	0.0%	1.2%	0.7%	1.7%	0.0%	0.0%	0.0%	0.0%	100.0%

[a] Limited escapement allowed, not representative of run composition.

Appendix C.44. Little Kitoi Lake sockeye salmon egg takes, 1992-1997.

Brood Year	Number Adults	Eggs (millions)	Incubation Facility	Stocking Number	Stocking Year	Stocking Location
1992	1,011	0.59	Kitoi Bay	52,418	1993	Little Kitoi Bay
1993	1,050	1.10	Kitoi Bay	916,677	1995	Little Kitoi Bay
1994	600	1.50	Kitoi Bay	84,861	1995	Little Kitoi Lake
				587,435	1996	Little Kitoi Bay
				200,000	1995	Jennifer Lake
1995	155	0.19	Kitoi Bay	155,687	1996	Little Kitoi Lake
1996	1,210	1.20	Kitoi Bay	77,039	1997	Little Kitoi Lake
1997 [a]	0	0.00	Pillar Creek	106,658	1998	Little Kitoi Lake

[a] Little Kitoi lake was a back up egg take location in 1997; the late run brood source was changed to Saltery Lake stock in 1997. Brood stock collection was not anticipated at Little Kitoi Lake until 2001 or 2002.



Appendix D.1. Morphometric map showing limnology and zooplankton stations (1 - 4) and beach seine and gillnet sites on Spiridon Lake.

Appendix D.2. Juvenile sockeye salmon stocked into Spiridon Lake, 1990-1998.

	Release Year								
Life stage [a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
fry	249,346 [d]	3,300,000 [b]	2,200,000 [b]	4,246,000 [b]	5,676,000 [b]	2,813,000 [c]	1,100,000 [b]	5,500,000 [b]	784,000 [c]
fingerling						1,786,000 [c]	3,744,000 [b]	1,200,000 [b]	2,556,000 [c]
TOTAL	249,346	3,300,000	2,200,000	4,246,000	5,676,000	4,599,000	4,844,000	6,700,000	3,340,000

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock).

[b] Upper Station broodstock reared at Pillar Creek Hatchery.

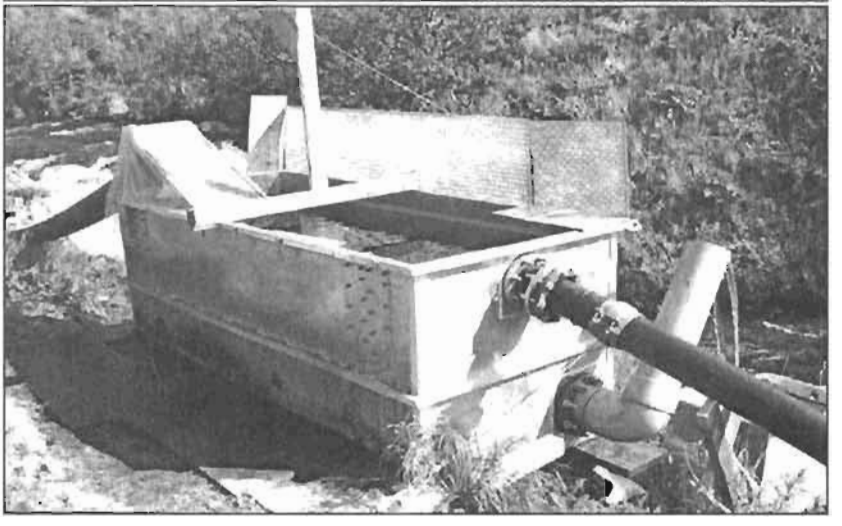
[c] Saltery Lake broodstock reared at Pillar Creek Hatchery.

[d] Upper Station broodstock reared at Kitoi Bay Hatchery; short term fresh and salt water rearing and release as age 0. juveniles.

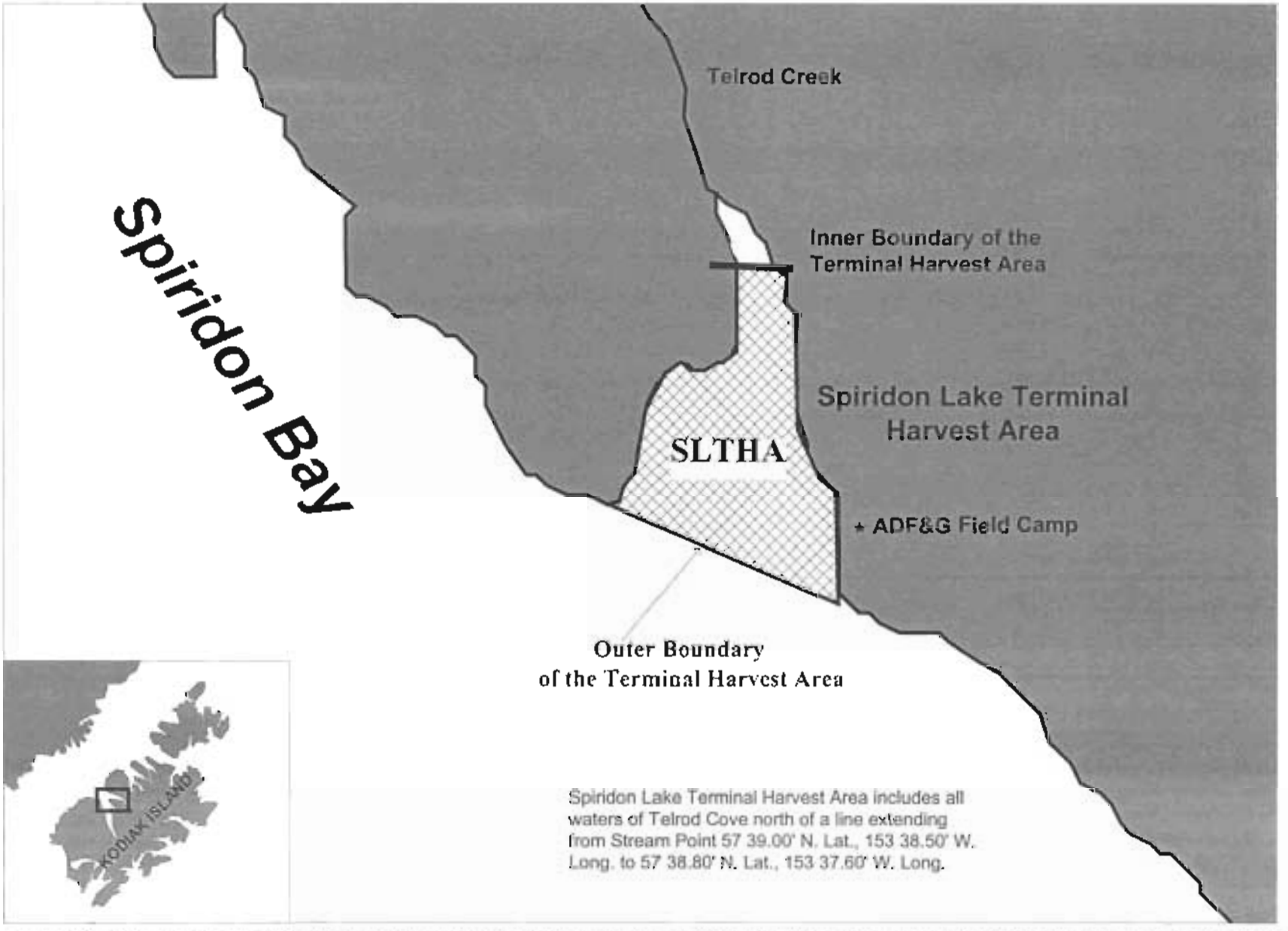
a.

b.

c.



Appendix D.3. Spiridon Lake smolt bypass system which includes the trap and de-watering tanks (a); pipeline from de-watering tanks to counting tank (b); and smolt counting tank (c).



Appendix D.4. Spiridon Lake (Telrod Cove) Terminal Harvest Area boundaries (SLTHA), and ADF&G camp location in Telrod Cove.

Appendix D.5. Limnological sampling stations and sampling frequencies for Spiridon Lake, 1988-1998.

Year	Sampling	
	Stations	Frequency
1988	1, 2	4
1989	1, 2	5
1990	1, 2	5
1991	1, 2	7
1992	1, 2	6
1993	1, 2	6
1994	1-4	6
1995	1-4	6
1996	1-4	6
1997	1-4	6
1998	1, 2	5

Appendix D.6. Summary of seasonal mean water chemistry parameters by station and depth for Spiridon Lake, 1988-1998[a].

	Sta	Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	tion	(m)	(μmhos/cm)	S.D.	(Units)	S.D.	(μg L^{-1})	S.D.	(NTU)	S.D.	(Pt units)	S.D.	(μg L^{-1})	S.D.	(μg L^{-1})	S.D.	(μg L^{-1})	S.D.
1988	1	1	71.5	1.0	7.1	0.2	20.8	1.7	0.6	0.3	7.0	2.3	6.1	1.0	2.3	0.5	16.50	3.0
1988	1	50	71.5	0.6	7.0	0.1	20.5	1.3	0.6	0.4	5.8	0.5	6.1	0.8	2.2	0.7	12.00	3.3
1988	2	1	71.7	0.6	7.1	0.2	20.0	1.0	0.4	0.1	8.0	0.0	7.7	2.8	1.3	1.6	16.33	5.9
1988	2	50	71.6	0.5	7.0	0.1	19.4	0.9	0.7	0.5	7.4	2.8	5.4	0.2	3.2	1.0	15.00	6.7
1989	1	1	75.0	6.2	7.3	0.2	22.2	2.8	0.3	0.1	13.8	6.4	5.7	1.0	2.0	0.3	8.60	3.6
1989	1	50	76.8	8.6	7.3	0.2	22.8	3.5	0.3	0.1	12.4	3.8	6.3	0.6	2.3	0.7	12.00	9.0
1989	2	1	73.6	1.5	7.3	0.2	21.4	0.9	0.7	0.6	12.0	3.9	5.9	0.4	2.4	0.4	25.20	35.4
1989	2	50	72.6	1.7	7.3	0.1	20.2	4.1	0.8	0.9	14.4	6.2	5.8	0.6	2.4	0.7	84.40	144.4
1990	1	1	76.2	7.2	7.4	0.2	23.7	2.6	0.5	0.4	5.0	1.9	5.7	0.9	2.2	0.6	14.00	8.8
1990	1	50	73.2	1.9	7.3	0.2	23.4	1.5	0.5	0.4	4.8	0.8	6.1	0.6	2.3	0.6	16.40	8.3
1990	2	1	73.0	1.2	7.4	0.1	23.2	1.3	0.5	0.3	6.0	2.8	6.3	0.5	2.0	0.5	19.40	7.3
1990	2	50	73.2	0.8	7.3	0.2	23.0	1.6	0.5	0.4	5.8	2.9	5.7	0.8	2.5	0.6	15.80	12.0
1991	1	1	83.7	23.5	7.3	0.1	21.1	3.6	0.7	0.4	6.6	2.2	6.1	0.4	2.4	0.8	23.00	23.9
1991	1	50	75.4	4.0	7.3	0.1	22.1	2.0	1.5	2.1	7.4	3.9	6.2	0.7	2.4	0.5	113.86	232.1
1991	2	1	74.3	4.4	7.4	0.1	23.0	0.6	0.7	0.5	8.4	5.9	6.4	0.4	2.3	0.3	22.43	13.8
1991	2	50	75.0	1.7	7.3	0.2	25.9	8.0	0.8	0.4	6.1	4.1	6.1	0.6	2.2	0.4	29.43	25.3
1992	1	1	72.8	1.3	7.1	0.1	20.4	0.8	0.7	0.3	4.2	0.4	5.9	0.7	2.5	0.8	20.50	9.2
1992	1	50	74.3	0.5	7.1	0.1	20.8	0.4	0.5	0.1	8.0	4.8	6.2	0.5	2.3	0.5	19.67	9.3
1992	2	1	74.2	0.8	7.2	0.1	21.0	0.0	0.6	0.3	8.2	4.3	6.2	0.7	2.5	1.0	18.20	7.6
1992	2	50	73.8	0.4	7.0	0.1	20.7	0.4	0.7	0.5	4.2	2.5	6.0	0.9	2.2	0.4	14.60	4.4
1993	1	1	80.3	5.2	7.3	0.6	23.1	2.5	1.1	1.3	3.5	0.8	6.7	1.6	2.2	0.6	15.83	9.7
1993	1	50	89.2	28.0	7.0	0.4	22.3	2.3	1.0	0.6	3.5	0.8	6.2	0.7	2.8	1.0	23.00	15.1
1993	2	1	79.8	5.6	7.3	0.6	23.6	2.8	0.8	0.6	4.8	2.4	6.5	1.2	2.5	0.4	15.00	7.6
1993	2	50	78.3	2.4	7.0	0.1	21.8	0.8	0.4	0.1	4.5	2.1	6.1	0.6	2.5	0.4	13.67	7.3
1994	1	1	77.3	0.8	6.9	0.4	21.8	1.3	0.4	0.1	8.5	1.5	6.3	0.5	2.2	0.3	7.67	9.1
1994	1	50	78.7	2.3	6.9	0.3	21.9	0.9	0.3	0.1	8.0	1.5	6.3	0.5	2.4	0.7	5.33	4.4
1994	2	1	77.3	1.0	7.0	0.3	22.1	0.8	0.4	0.1	9.2	2.3	6.1	0.4	2.5	0.7	18.17	25.2
1994	2	50	77.7	0.8	6.9	0.3	22.3	0.9	0.7	0.9	7.8	3.3	6.1	0.4	2.3	0.3	31.17	48.1

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Year	Station	Depth (m)	Sp. Cond. (μ mhos/cm)	S.D.	pH (Units)	S.D.	Alkalinity (μg L^{-1})	S.D.	Turbidity (NTU)	S.D.	Color (Pt units)	S.D.	Calcium (μg L^{-1})	S.D.	Magnesium (μg L^{-1})	S.D.	Iron (μg L^{-1})	S.D.
1995	1	1	76.0	3.1	6.8	0.1	21.7	0.5	1.0	0.7	4.2	1.5	5.6	0.2	2.4	0.3	10.80	4.6
1995	1	50	75.4	1.5	6.9	0.1	22.5	2.0	0.7	0.5	5.5	2.3	5.8	0.5	2.8	0.8	9.00	6.0
1995	2	1	76.3	2.8	7.0	0.1	22.3	0.7	0.7	0.6	3.7	1.2	5.8	0.3	2.3	0.5	11.33	6.3
1995	2	50	76.0	2.0	6.9	0.2	22.8	1.2	0.7	0.6	6.3	4.6	5.8	0.3	2.3	0.5	11.33	5.4
1996	1	1	77.0	2.8	7.0	0.2	22.4	0.6	0.6	0.2	4.2	0.8	5.5	0.1	2.6	0.2	10.67	4.5
1996	1	50	77.3	3.0	7.0	0.1	22.6	1.1	0.6	0.3	4.8	1.8	5.5	0.1	2.6	0.2	8.83	4.0
1996	2	1	76.8	1.5	7.2	0.1	22.0	0.4	0.6	0.4	4.0	0.6	5.5	0.1	2.6	0.2	13.50	9.6
1996	2	50	77.7	2.4	7.0	0.1	22.0	0.5	0.6	0.2	5.8	3.5	5.5	0.1	2.6	0.2	7.67	1.4
1997	1	1	75.7	3.3	7.6	0.3	24.8	2.6	0.5	0.1	7.8	5.6	5.8	0.9	2.5	0.4	13.8	3.9
1997	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	50	75.2	0.4	7.4	0.1	23.6	0.6	0.5	0.1	5.7	1.4	5.4	0.2	2.4	0.5	11.5	5.3
1997	2	1	75.3	0.5	7.5	0.0	24.1	1.0	0.5	0.1	5.3	2.2	5.5	0.2	2.5	0.4	12.5	5.5
1997	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	2	50	75.0	0.6	7.4	0.1	23.7	0.6	0.4	0.1	7.5	2.1	5.4	0.3	2.7	0.4	10.8	5.0
1998	1	1	72.3	0.5	7.4	0.1	24.5	2.0	1.0	0.4	7.5	3.4	5.8	0.2	2.4	0.1	11.5	5.7
1998	1	50	73.8	0.5	7.3	0.1	22.9	0.7	0.7	0.4	5.5	0.6	5.7	0.1	2.5	0.0	9.3	4.6
1998	2	1	74.0	0.8	7.4	0.1	24.6	1.9	1.0	0.7	5.8	2.9	5.7	0.1	2.5	0.1	10.8	5.9
1998	2	50	72.0	3.4	7.3	0.0	23.7	1.5	0.6	0.4	5.0	0.8	5.7	0.1	2.5	0.1	9.3	5.3

[a] Table revised from S.G. Honnold. 1997. The results of sockeye salmon stocking into Spiridon Lake on the Kodiak National Wildlife Refuge: juvenile and adult production, commercial harvest, and ecosystem effects, 1987-1996.

SD - standard deviation; na - not available.

Appendix D.7. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Spiridon Lake, 1988-1998.[a]

Year	Station	Depth (m)	Total - P (μg L^{-1})	S.D.	Total filterable - P (μg L^{-1})	S.D.	Filterable reactive - P (μg L^{-1})	S.D.	Total Kjeldahl - N (μg L^{-1})	S.D.	Ammonia (μg L^{-1})	S.D.	Nitrate + nitrite (μg L^{-1})	S.D.	Reactive silicon (μg L^{-1})	S.D.	Chlorophyll *a* (μg L^{-1})	S.D.
1988	1	1	3.8	1.4	3.0	1.1	2.5	1.2	102.8	11.4	9.9	2.7	220.5	26.0	2,171	160	0.45	0.09
1988	1	50	3.8	0.6	2.2	0.6	1.7	0.5	94.9	9.0	11.2	5.5	256.9	9.6	2,279	172	0.16	0.06
1988	2	1	3.5	0.1	2.0	0.6	1.8	0.3	100.5	11.3	7.8	6.6	221.3	11.1	2,283	170	0.40	0.10
1988	2	50	4.0	0.6	1.9	0.6	1.8	0.5	91.4	9.9	8.6	4.4	236.2	27.5	2,237	157	0.29	0.12
1989	1	1	3.6	0.7	3.7	1.9	3.0	2.2	103.4	7.6	8.5	2.5	207.1	35.4	2,162	214	0.19	0.11
1989	1	50	4.2	1.0	3.2	1.2	2.4	0.4	97.9	18.6	11.5	7.3	242.8	54.9	2,277	353	0.32	0.18
1989	2	1	6.1	3.7	2.7	1.0	2.5	0.4	114.8	45.7	9.5	5.2	197.9	61.9	2,129	119	0.18	0.13
1989	2	50	7.3	7.8	2.7	0.7	2.7	0.7	104.0	40.1	12.5	11.0	209.8	50.4	2,173	109	0.37	0.28
1990	1	1	3.5	1.8	2.4	0.6	2.0	0.8	92.5	16.5	4.9	2.0	203.4	36.8	2,114	93	0.23	0.11
1990	1	50	3.0	0.7	2.8	0.5	2.0	0.6	85.3	10.9	6.3	2.5	228.5	24.8	2,171	96	0.34	0.21
1990	2	1	2.4	0.6	4.1	3.2	3.3	2.4	83.2	6.4	4.7	1.7	185.0	79.4	2,127	80	0.24	0.09
1990	2	50	2.5	0.8	2.8	1.1	2.9	1.9	87.7	12.3	6.6	2.8	187.3	80.1	2,205	109	0.24	0.12
1991	1	1	4.9	5.9	2.8	0.8	2.6	0.9	93.7	7.3	7.6	4.4	234.0	38.1	2,082	57	0.38	0.14
1991	1	50	5.2	3.7	3.3	2.0	2.8	1.4	87.5	12.9	9.4	4.8	265.1	20.9	2,131	54	0.20	0.09
1991	2	1	3.6	0.8	4.8	3.3	4.6	3.3	91.8	8.6	8.2	4.5	237.0	29.6	2,081	66	0.35	0.12
1991	2	50	3.8	1.5	3.6	3.3	3.4	3.2	88.6	7.4	11.3	5.8	267.7	7.7	2,137	46	0.25	0.14
1992	1	1	3.7	0.6	2.1	0.7	1.5	0.5	89.6	10.1	1.5	0.8	239.5	12.3	2,082	131	0.27	0.15
1992	1	50	4.9	1.4	4.2	3.1	3.7	3.0	87.0	8.0	4.6	3.3	258.7	16.9	2,111	102	0.22	0.07
1992	2	1	3.6	0.3	2.6	1.4	2.4	1.4	98.4	18.2	1.7	0.6	235.2	25.9	2,025	90	0.27	0.21
1992	2	50	4.5	0.8	3.1	2.8	2.0	1.1	83.2	24.8	5.3	3.7	273.4	7.7	2,112	46	0.23	0.11
1993	1	1	2.7	0.9	2.2	1.1	1.6	0.8	93.6	11.2	2.4	1.5	231.6	37.6	2,023	164	0.75	0.24
1993	1	50	3.0	0.9	3.0	4.0	1.8	1.8	90.7	10.8	5.2	3.4	240.2	22.8	2,122	94	0.42	0.20
1993	2	1	2.9	1.0	3.2	3.5	2.6	3.3	97.0	12.0	1.8	0.5	230.3	41.5	2,026	163	0.77	0.29
1993	2	50	2.5	0.1	3.2	2.5	2.8	2.5	85.4	3.8	5.4	3.7	247.7	30.6	2,128	96	0.40	0.22
1994	1	1	3.2	1.3	1.9	1.5	1.5	1.1	101.8	3.9	3.2	4.7	204.3	22.1	2,092	131	0.26	0.21
1994	1	50	3.9	2.0	1.2	0.2	1.1	0.4	97.5	16.1	6.7	3.6	218.1	18.3	2,184	95	0.21	0.13
1994	2	1	2.8	0.7	2.2	1.5	1.4	0.9	105.7	12.8	1.6	1.3	202.1	17.2	2,144	77	0.31	0.15
1994	2	50	3.3	1.2	2.2	1.3	1.9	1.1	105.6	13.2	5.8	2.5	225.7	20.6	2,190	85	0.20	0.07

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Year	Station	Depth (m)	Total - P ($\mu g\ L^{-1}$)	S.D.	Total filterable - P ($\mu g\ L^{-1}$)	S.D.	Filterable reactive - P ($\mu g\ L^{-1}$)	S.D.	Total Kjeldahl - N ($\mu g\ L^{-1}$)	S.D.	Ammonia ($\mu g\ L^{-1}$)	S.D.	Nitrate + nitrite ($\mu g\ L^{-1}$)	S.D.	Reactive silicon ($\mu g\ L^{-1}$)	S.D.	Chlorophyll *a* ($\mu g\ L^{-1}$)	S.D.
1995	1	1	3.4	2.2	0.9	0.1	0.9	0.2	108.8	12.3	2.2	1.6	203.1	26.8	2,300	95	0.95	0.49
1995	1	50	3.4	1.3	1.5	0.3	1.4	0.4	105.6	20.4	3.5	2.4	241.6	6.6	2,340	105	0.58	0.44
1995	2	1	3.9	2.0	1.2	0.4	1.1	0.2	125.2	24.1	2.2	1.0	213.4	19.8	2,297	75	1.02	0.41
1995	2	50	3.2	0.9	0.9	0.2	0.9	0.1	108.2	18.6	4.5	3.0	243.1	9.1	2,329	102	0.58	0.45
1996	1	1	2.7	0.6	1.5	0.9	1.0	0.5	113.4	34.1	5.1	2.8	183.6	18.5	2,042	93	0.49	0.16
1996	1	50	3.0	1.1	1.3	0.7	1.0	0.4	90.5	18.5	9.3	5.0	210.8	9.0	2,148	51	0.51	0.23
1996	2	1	2.7	0.7	1.4	0.7	1.1	0.3	105.5	20.7	5.6	1.6	180.2	14.4	2,083	82	0.47	0.14
1996	2	50	4.4	1.7	1.5	0.7	1.5	1.3	101.1	16.9	10.2	4.1	217.9	2.4	2,179	82	0.57	0.33
1997	1	1	3.0	0.6	3.4	3.5	3.5	4.1	103.6	12.0	11.2	5.8	147.4	31.1	2154.8	63.8	0.57	0.3
1997	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.58	0.4
1997	1	50	2.8	0.7	1.8	0.4	1.8	0.5	90.5	5.2	11.1	6.3	191.0	19.7	2222.7	98.3	0.38	0.2
1997	2	1	3.1	0.9	3.2	3.3	3.1	3.2	106.1	11.3	11.2	6.4	168.2	25.2	2138.7	102.6	0.59	0.3
1997	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.57	0.3
1997	2	50	3.8	1.5	3.1	1.0	3.2	1.0	107.4	30.3	10.7	6.2	188.3	17.5	2205.2	82.6	0.44	0.2
1998	1	1	4.8	1.6	2.7	1.8	1.7	1.0	138.3	20.5	8.4	6.1	121.5	24.7	2239.3	174.3	0.43	0.3
1998	1	50	4.0	0.4	1.6	0.8	1.3	0.5	118.4	10.1	10.2	5.4	174.4	19.6	2355.3	42.4	0.14	0.0
1998	2	1	3.9	1.2	1.5	1.1	1.4	0.6	124.6	10.1	4.9	1.4	148.3	12.2	2262.3	105.2	0.38	0.3
1998	2	50	4.0	1.7	1.5	0.9	1.5	0.7	122.9	12.0	9.6	4.5	171.9	26.4	2296.5	93.3	0.21	0.1

[a] Table revised from S.G. Honnold. 1997. The results of sockeye salmon stocking into Spiridon Lake on the Kodiak National Wildlife Refuge: juvenile and adult production, commercial harvest, and ecosystem effects, 1987-1996.

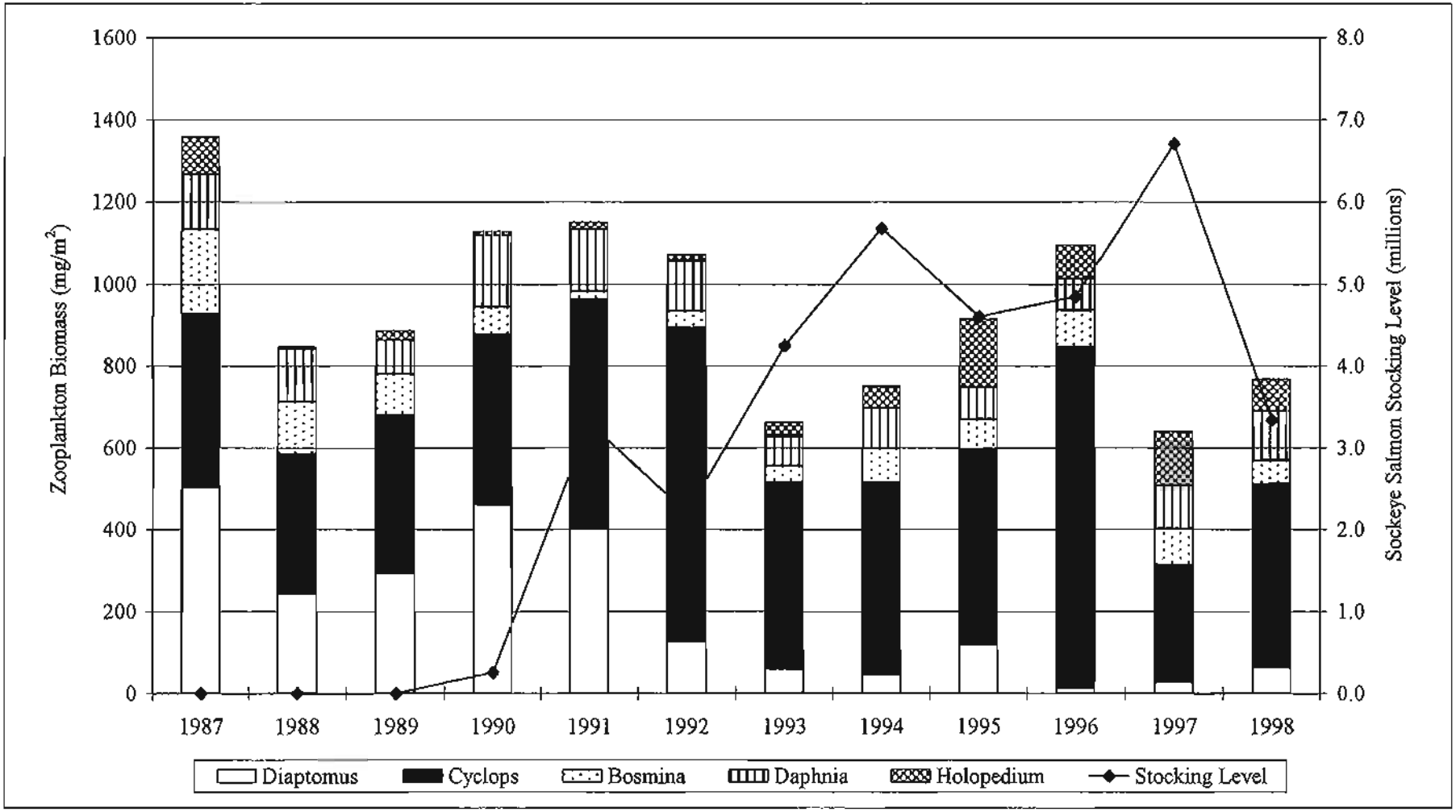
SD - standard deviation; na - not available.

Appendix D.8. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Spiridon Lake, 1987-1998.

Station 1 - 2	No. of Sample	*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*[a]			*Holopedium*			TOTALS	
Year[b]	Dates	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2
1987	1	131,369	503	0.96	225,318	426	0.74	65,287	203	0.57	54,140	133	0.75	5,573	93	1.17	481,687	1,359
1988	4	53,344	243	1.02	146,961	341	0.81	38,694	129	0.61	19,043	130	1.20	763	4	0.73	258,806	847
1989	5	95,435	293	0.89	317,795	386	0.60	33,559	101	0.56	18,949	83	0.96	3,344	23	0.82	469,081	886
1990	5	111,385	460	0.99	206,688	415	0.76	21,178	69	0.59	30,069	175	1.10	1,486	8	0.69	370,806	1,127
1991	7	113,778	401	0.94	329,343	562	0.70	6,786	20	0.55	32,956	151	0.99	824	18	0.76	483,688	1,151
1992	5	20,328	125	1.13	261,093	768	0.91	11,825	41	0.60	24,893	121	1.01	1,780	16	0.91	319,919	1,072
1993	6	11,047	59	1.06	269,740	455	0.70	16,211	40	0.51	23,932	72	0.80	3,738	35	0.83	324,668	662
1994	6	8,090	45	1.09	240,942	471	0.75	27,941	82	0.55	39,411	98	0.75	7,754	55	0.85	324,139	751
1995	6	12,816	117	1.30	213,531	479	0.81	29,839	74	0.51	28,966	77	0.78	19,836	167	0.83	304,987	915
1996	6	3,096	14	0.99	384,605	832	0.78	28,268	91	0.58	20,846	77	0.92	8,873	83	0.91	445,689	1,096
1997	6	3,176	26	1.26	119,126	287	0.82	31,962	89	0.54	25,177	105	1.00	17,551	132	0.84	196,993	640
1998	5	8,153	63	1.23	354,953	448	0.80	23,652	59	0.55	37,601	120	1.06	16,256	78	0.85	440,615	767
Avg =	5	51,260	208	1.06	246,831	493	0.76	28,323	85	0.56	28,944	111	0.93	6,502	58	0.85	361,860	955

[a] Daphnia data are a combination of both species, *Daphnia l*. and *Daphnia r*.

[b] Zooplanktion data for years 1987-1996 taken from Honnold, S.G. 1997. RIR #4K97-47. Some values corrected to include sub-categories excluded at time of publication.



Appendix D.9. Weighted mean zooplankton biomass by genera (stations 1&2 averaged) and juvenile sockeye stocking levels for Spiridon Lake, 1987-1998.

Appendix D.10. Juvenile sockeye salmon estimates based on hydroacoustic fish population surveys in Spiridon Lake, 1992 and 1994-1998.

		Total Fish Estimates [a]		
			95% Confidence Interval	
Year	Date	Number	Low	High
1992	13-Sep	470,587	263,248	677,926
1994	25-Apr	701,521	586,692	816,350
	24-Jun	132,793	85,712	179,874
	26-Sep	562,029	406,414	717,644
1995	2-May	770,610	624,763	916,457
	27-Jun	166,412	136,694	196,130
	29-Sep	1,463,235	970,958	1,955,512
1996	4-May	775,092	480,683	1,069,501
	1-Jul	119,466	98,065	140,867
	19-Sep	658,871	40,670	1,277,072
1997	28-Apr	719,530	520,732	918,328
	7-Jul	592,241	360,022	824,460
	11-Sep	1,577,625	1,203,260	1,951,990
1998	25-Apr	1,341,645	1,226,528	1,456,762
	15-Sep	1,980,704	1,603,982	2,357,426

[a] Total fish population estimates include all species residing in the lake. Townet sampling to determine species composition in the lake was attempted in 1992 and 1994, however, no rearing juvenile sockeye were captured. Juvenile sockeye grow quickly in size to avoid capture by townet.

Appendix D.11. Daily sockeye salmon smolt emigration estimates from Spiridon Lake, 1992-1998.

	Total Smolt Emigration						
Date	1992	1993	1994	1995	1996	1997	1998
23 Apr	0	0	0	0	0	0	16
24 Apr	0	0	0	0	0	0	106
25 Apr	0	0	0	0	1	1	302
26 Apr	0	0	0	1	0	1	201
27 Apr	0	0	0	0	1	0	140
28 Apr	0	0	1	0	0	0	693
29 Apr	0	0	1	9	0	1	3,265
30 Apr	0	0	7	20	0	79	3,815
1 May	0	0	9	52	0	44	1,560
2 May	0	0	16	68	0	457	502
3 May	0	0	37	337	10	1,202	2,141
4 May	0	0	11	973	35	2,819	3,799
5 May	0	0	97	300	181	20,378	7,302
6 May	353	15,659	49	1,182	2,184	10,123	27,033
7 May	5,000	4,561	889	1,485	188	5,578	20,765
8 May	466	13,746	542	3,673	169	16,018	5,057
9 May	47	6,253	8,740	2,056	228	108,639	12,243
10 May	6,513	3,953	3,026	4,300	5,196	29,773	78,222
11 May	8,442	709	426	19,021	3,801	6,011	14,998
12 May	73,695	31,664	20,666	3,403	7,800	2,638	60,438
13 May	149,523	50,853	25,627	25,733	3,837	9,926	47,142
14 May	7,768	91,670	27,718	11,061	14,801	163,534	5,291
15 May	184,299	89,746	21,212	30,641	3,422	24,775	4,478
16 May	101,401	7,280	10,633	51,470	100,606	9,516	43,312
17 May	37,735	1,136	19,456	27,961	259,686	56,220	4,046
18 May	58,892	1,474	67,357	11,441	116,622	41,144	1,713
19 May	141,103	2,089	33,371	12,812	25,951	45,624	50,534
20 May	96,785	664	13,375	13,322	72,497	58,592	5,968
21 May	62,408	401	58,559	21,205	21,480	67,029	42,070
22 May	87,527	6,675	32,340	27,913	4,585	35,836	60,768
23 May	20,501	10,568	31,763	71,338	21,288	78,103	22,817
24 May	201,062	950	58,745	39,606	63,983	15,154	9,059
25 May	159,082	3,124	142,295	35,022	7,083	11,291	24,201
26 May	2,257	1,876	40,920	26,843	26,474	19,253	14,968
27 May	6,164	98	67,604	7,657	75,210	6,545	6,384
28 May	24,587	71	22,861	26,127	22,810	22,831	32,078
29 May	12,150	60	18,634	25,385	7,464	6,206	15,118
30 May	12,350	49	19,779	12,888	21,601	2,323	2,669
31 May	16,862	71	15,585	9,552	19,121	1,695	8,621
1 Jun	1,380	35	11,830	4,828	18,324	2,891	14,473
2 Jun	444	123	12,038	4,918	14,474	3,206	6,472

-Continued-

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3 Jun	535	0	4,358	8,476	28,804	1,303	7,579
4 Jun	885	0	4,193	15,749	15,744	1,750	2,853
5 Jun	494	0	2,582	7,148	17,808	980	3,751
6 Jun	793	0	4,223	8,674	8,903	1,430	2,361
7 Jun	890	0	875	4,562	7,135	458	3,359
8 Jun	476	0	3,825	9,336	8,221	517	489
9 Jun	371	0	1,707	2,885	5,584	379	6,065
10 Jun	103	0	2,601	1,862	2,985	361	2,265
11 Jun	183	0	5,681	1,191	2,449	263	2,366
12 Jun	73	0	1,765	2,561	2,307	336	2,514
13 Jun	169	0	2,697	1,368	1,895	500	4,766
14 Jun	185	0	2,603	1,527	1,580	191	14,213
15 Jun	868	0	2,269	1,483	553	795	8,065
16 Jun	0	0	1,793	2,508	181	0	5,332
17 Jun	0	0	2,431	1,825	748	0	2,935
18 Jun	0	0	1,671	2,066	586	0	195
19 Jun	0	0	988	981	695	0	1,491
20 Jun	0	0	1,580	853	532	0	181
21 Jun	0	0	1,011	1,077	253	0	414
22 Jun	0	0	2,013	1,319	878	0	2,272
23 Jun	0	0	1,076	989	1,689	0	216
24 Jun	0	0	1,338	374	592	0	172
25 Jun	0	0	1,764	748	334	0	73
26 Jun	0	0	2,010	478	771	0	1,239
27 Jun	0	0	1,218	350	1,379	0	370
28 Jun	0	0	979	0	746	0	2,048
29 Jun	0	0	1,757	0	430	0	1,344
30 Jun	0	0	764	0	291	0	806
1 Jul	0	0	435	0	0	0	483
2 Jul	0	0	782	0	0	0	385
3 Jul	0	0	442	0	0	0	287
4 Jul	0	0	698	0	0	0	160
5 Jul	0	0	0	0	0	0	125
6 Jul	0	0	0	0	0	0	174
7 Jul	0	0	0	0	0	0	211
8 Jul	0	0	0	0	0	0	103
9 Jul	0	0	0	0	0	0	109
10 Jul	0	0	0	0	0	0	77
11 Jul	0	0	0	0	0	0	141
12 Jul	0	0	0	0	0	0	181
Totals	1,484,821	345,558	850,348	614,993	1,055,186	894,719	746,950
%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Appendix D.12. Mean age, length, weight, and condition coefficient for sockeye salmon smolt captured by trapping at Spiridon Lake, 1991-1998.

	Age-1					Age-2					Age-3				
Year	n [a]	%	Length (mm)	Weight (g)	Condition (K)	n [a]	%	Length (mm)	Weight (g)	Condition (K)	n [a]	%	Length (mm)	Weight (g)	Condition (K)
1991	596	100.0	127.0	19.3	1.08	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
1992	1393/1389	98.8	115.0	12.7	0.81	16/14	1.1	183.0	58.9	0.80	0	0.0	0.0	0.0	0.0
1993	817/493	66.8	116.0	13.4	0.83	404/240	33.0	155.0	33.8	0.88	2/2	0.2	178.0	50.7	0.90
1994	1477/929	73.5	106.0	9.3	0.78	526/344	26.2	152.0	28.5	0.79	6/4	0.3	254.0	145.8	0.88
1995	1697/999	60.9	104.0	9.2	0.81	1081/667	38.8	138.0	25.1	0.95	6/5	0.2	244.0	102.8	0.84
1996	2224/1573	76.1	109.0	10.3	0.79	694/513	23.7	141.0	20.7	0.73	6/5	0.2	221.0	85.6	0.77
1997	1428/876	66.2	102.0	8.6	0.80	720/441	33.4	137.0	20.6	0.80	11/6	0.5	169.0	41.9	0.81
1998	2205/1496	77.4	93.3	6.3	0.76	727/414	22.5	127.0	15.4	0.75	3/0	0.1			

[a] n for age/n for length, weight, and condition.

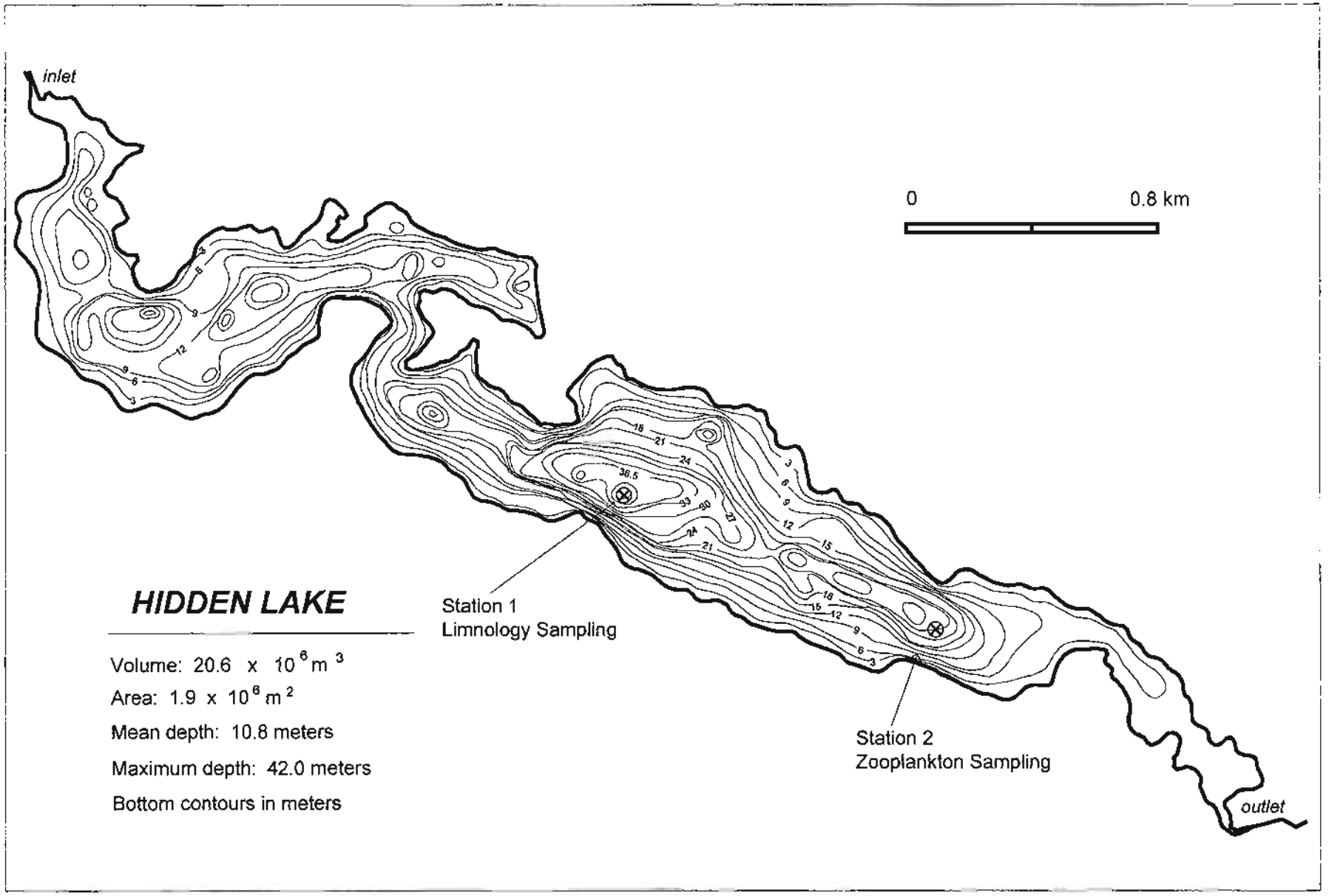
Appendix D.13. Commercial harvest of sockeye salmon in the Spiridon Lake Terminal Harvest Area (254-50) by statistical week, 1994-1998.

Period	Statistical Week	Year				
		1994[a]	1995[b]	1996[c]	1997[d]	1998[e]
27	June 28-Jul 4					6,700
28	Jul 5-Jul 11					14,500
29	Jul 12-Jul 18					19,000
30	Jul 19-Jul 25		1,757			16,653
31	Jul 26-Aug 1		3,178	27,066	2,247	11,040
32	Aug 2-Aug 8	312	2,663	34,309	879	2,300
33	Aug 9-Aug 15	77,789	10,600	42,586	4,404	11,000
34	Aug 16-Aug 22	13,890	6,914	45,242	13,067	6,716
35	Aug 23- Aug 29	9,997	3,970	9,923	10,939	2,750
36	Aug 30-Sep 5	13,200	2,461	2,648	15,882	1,000
37	Sep 6-Sep 12		149	344	13,792	
38	Sep 13-Sep 19				3,174	
39	Sep 20-Sep 26					
Total:		115,188	31,692	162,118	64,384	91,659

[a] The commercial fishery at Telrod Cove was closed on September 18.
[b] The commercial fishery at Telrod Cove was closed on September 12.
[c] The commercial fishery at Telrod Cove was closed September 8.
[d] The commercial fishery at Telrod Cove was closed September 15.
[e] The commercial fishery at Telrod Cove was closed on September 4.

Appendix D.14. Estimated age composition of adult sockeye salmon harvest from Spiridon Lake Terminal Harvest Area, 1994-1998.

Year	Sample Size		Ages 0.2	1.1	0.3	1.2	2.1	1.3	2.2	2.3	3.1	3.2	Total
1994	1,329	Numbers	0	149	0	114,624	356	30	21	9	0	0	115,189
		Percent	0	0.1	0	99.5	0.4	0	0	0	0	0	100
1995	1,313	Numbers	19	6,312	37	19,089	595	1,563	3,667	409	0	0	31,691
		Percent	0.1	19.9	0.1	60.2	1.9	4.9	11.6	1.3	0	0	100
1996	1,875	Numbers	0	2,846	0	128,123	7,448	303	23,192	0	111	97	162,120
		Percent	0	1.8	0	79	4.6	0.2	14.3	0	0.1	0	100
1997	1,703	Numbers	0	1,795	0	40,297	1,822	1,557	18,874	25	7	7	64,384
		Percent	0	2.8	0	62.6	2.8	2.4	29.3	0.1	0	0	100
1998	1,943	Numbers	0	3,726	0	72,354	1,785	543	9,448	485	0	111	88,452
		Percent	0	4.2	0	81.8	2	0.6	10.7	0.5	0	0.1	100
Mean	1,633	Percent	0.0	5.8	0.0	76.6	2.3	1.6	13.2	0.4	0.0	0.0	100
		Numbers	4	2,966	7	74,897	2,401	799	11,040	186	24	43	92,367



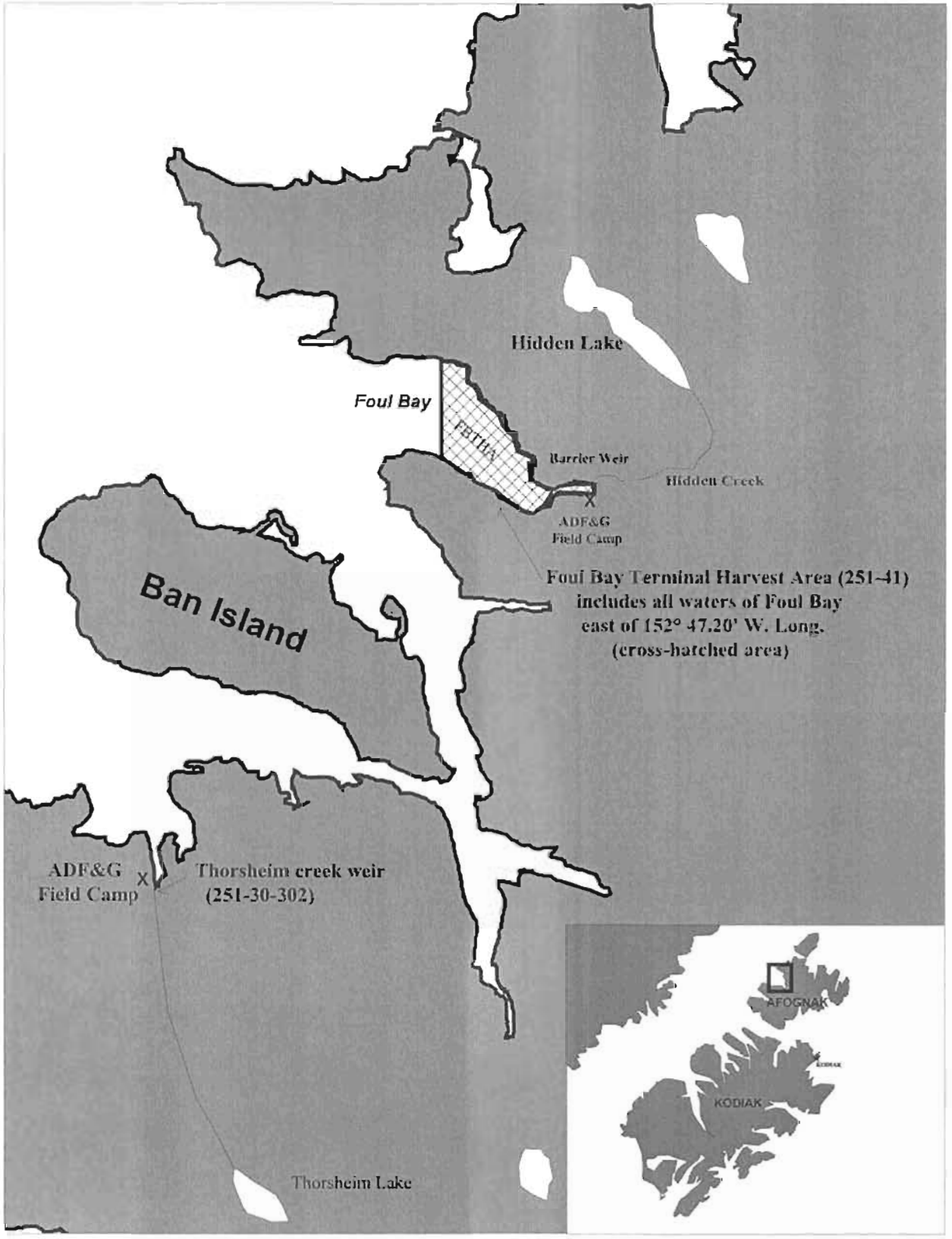
Appendix E.1. Morphometric map showing the limnology and zooplankton stations on Hidden Lake.

Appendix E.2. Hidden Lake sockeye and coho salmon stocking history, 1988-1998.

	Coho Releases			Sockeye Releases							
Life stage[a]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
fry						554,600	250,000		252,000	287,700	
fingerling	137,585	239,817	250,889								
pre-smolt					260,000			98,650	138,800[b]	167,500[b]	340,400[b]
TOTAL	137,585	239,817	250,889		260,000	554,600	250,000	98,650	252,000	287,700	340,400

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g).

[b] Pre smolt releases were air droppped from a fixed wing aircraft.



Appendix E.3. Location of the Foul Bay Terminal Harvest Area, ADF&G field camps, and fish weirs at Hidden Creek and Thorsheim Creek.

Appendix E.4. Hidden Creek barrier weir.

Appendix E.5. Limnological sampling stations and sampling frequencies at Hidden Lake, 1987-1998.

Year	Sampling	
	Stations	Frequency
1987	1	3
1989	1	1
1990	1	4
1991	1	5
1992	1	6
1993	1	6
1994	1, 2	7
1995	1, 2	7
1996	1, 2	6
1997	1, 2	6
1998	1	5

Appendix E.6. Summary of seasonal mean water chemistry parameters by station and depth for Hidden Lake, 1987 and 1990-1998.

	Sta	Depth	Specific Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	tion	(m)	(umhos/cm)	SD	(Units)	SD	(mg/L)	SD	(NTU)	SD	(Pt units)	SD	(mg/L)	SD	(mg/L)	SD	(ug/L)	SD
1987	1	1	41.3	1.2	6.7	0.2	7.5	1.5	0.5	0.4	9.7	2.1	2.7	0.1	0.4	0.2	83.3	98.5
	1	25	42.0	1.7	6.7	0.2	6.7	1.5	0.6	0.4	11.7	2.5	2.8	0.2	0.6	0.2	94.3	86.6
1990	1	1	62.8	2.0	6.9	0.2	8.2	1.3	0.7	0.3	17.0	7.6	3.7	0.6	1.1	0.6	52.0	16.0
	1	29	66.3	3.1	6.7	0.2	8.5	0.9	0.5	0.1	13.0	2.0	3.9	0.5	1.1	0.3	39.8	9.3
1991	1	1	45.0	8.2	6.8	0.1	9.0	1.0	0.7	0.4	17.4	6.3	3.3	0.6	0.8	0.1	33.8	14.6
	1	30	46.2	8.3	6.8	0.2	10.3	1.9	0.5	0.2	15.6	3.0	3.3	0.5	0.9	0.3	37.8	10.7
1992	1	1	47.0	1.4	6.6	0.1	8.5	1.5	0.7	0.5	10.7	0.8	4.0	0.4	0.8	0.5	33.2	10.4
	1	27	47.3	1.0	6.5	0.2	10.6	5.3	0.8	0.7	12.0	1.1	3.5	0.8	1.0	0.6	68.7	88.7
1993	1	1	50.5	3.9	6.6	0.2	9.1	1.4	0.8	0.4	10.2	1.6	3.8	0.4	0.9	0.3	34.8	9.3
	1	42	50.3	3.1	6.5	0.2	8.8	1.0	0.6	0.5	10.7	2.3	4.0	0.2	0.9	0.3	54.0	27.2
1994	1	1	47.9	2.9	6.5	0.2	7.2	0.6	0.7	0.3	11.6	1.5	3.2	0.5	1.0	0.3	56.2	22.7
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	40	46.6	1.3	6.3	0.3	7.1	0.7	0.5	0.3	12.6	1.0	3.0	0.1	0.9	0.3	46.8	17.5
1995	1	1	50.0	4.2	6.4	0.1	8.7	1.5	0.9	0.9	15.3	5.7	3.0	0.5	1.0	0.6	78.6	104.4
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	43	50.3	1.4	6.2	0.1	7.3	0.2	0.4	0.2	12.3	1.8	2.8	0.3	0.8	0.5	38.9	7.4
1996	1	1	50.3	1.6	6.6	0.2	8.2	0.7	0.8	0.7	14.8	1.9	2.9	0.3	0.9	0.4	36.8	9.5
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	42	51.5	1.6	6.3	0.1	7.4	0.3	0.5	0.3	16.5	2.1	2.7	0.1	0.9	0.4	22.8	7.5
1997	1	1	49.2	1.2	6.9	0.1	9.9	1.5	0.4	0.1	12.0	1.7	2.9	0.2	0.8	0.3	29.3	9.3
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	43	50.5	0.8	6.7	0.1	9.6	0.7	0.4	0.1	14.3	1.9	2.8	0.1	0.8	0.3	28.3	8.4
1998	1	1	43.3	1.0	6.9	0.0	9.8	1.7	0.9	0.5	13.3	1.0	3.0	0.5	0.7	0.2	24.5	6.6
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	42	44.8	1.5	6.8	0.1	9.3	0.5	0.9	0.4	13.8	0.4	3.0	0.5	0.7	0.2	26.1	3.5

SD - standard deviation; na - not analyzed

Appendix E.7. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Hidden Lake, 1987 and 1990-1998.

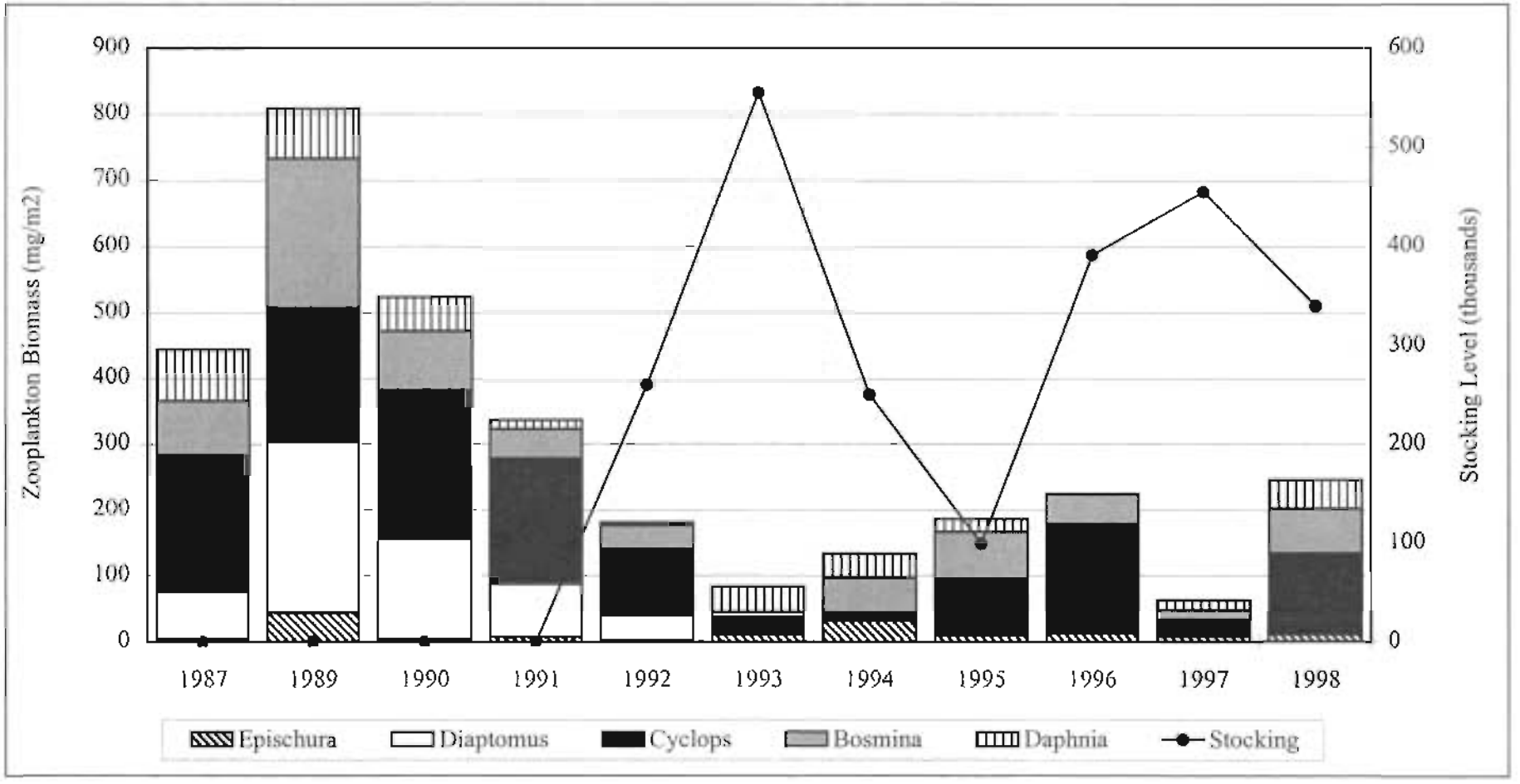
Year	Station	Depth (m)	Total-P (ug/L P)	SD	Total filterable-P (ug/L P)	SD	Filterable reactive-P (ug/L P)	SD	Total Kjeldahl nitrogen (ug/L N)	SD	Ammonia (ug/L N)	SD	Nitrate+nitrite (ug/L N)	SD	Reactive silicon (ug/L Si)	SD	Organic carbon (ug/L)	SD	Chlorophyll *a* (ug/L)	SD	Phaeophytin *a* (ug/L)	SD
1987	1	1	4.2	0.4	2.2	0.7	0.9	0.1	90.1	2.4	4.3	3.1	82.0	11.7	1840.0	436.6	49.3	14.5	0.15	0.0	0.15	0.0
	1	25	4.0	1.6	2.9	0.9	1.1	0.2	80.7	11.4	4.6	3.2	90.9	5.7	1875.0	454.7	78.3	38.0	0.06	0.1	0.14	0.0
1990	1	1	3.9	2.2	3.6	3.8	2.1	1.1	101.3	48.7	3.8	4.3	65.9	11.3	1906.8	318.5	151.5	71.3	0.29	0.0	0.18	0.0
	1	29	2.1	1.2	1.4	0.3	1.2	0.2	79.2	34.0	6.1	2.3	88.7	16.4	1956.5	172.9	120.5	67.2	0.11	0.0	0.15	0.1
1991	1	1	4.1	1.9	4.0	3.1	3.4	2.6	75.2	44.5	12.0	4.1	53.4	25.1	1727.4	83.1	na	na	0.18	0.1	0.20	0.0
	1	30	3.1	0.7	2.5	0.7	1.9	0.8	82.9	19.1	13.6	3.4	70.4	13.7	1733.8	205.8	na	na	0.07	0.1	0.18	0.1
1992	1	1	4.0	0.4	2.0	0.4	1.8	0.2	93.7	41.0	4.1	2.9	64.9	15.8	1746.5	74.0	87.0	29.8	0.22	0.1	0.18	0.1
	1	27	5.1	3.8	2.5	0.9	2.4	1.1	98.8	34.3	3.7	2.5	74.3	16.0	1806.0	99.2	130.2	155.1	0.11	0.1	0.29	0.2
1993	1	1	3.7	2.6	5.1	6.3	3.0	3.3	102.0	30.9	12.6	11.4	45.7	22.1	1721.7	133.1	na	na	0.79	0.4	0.28	0.1
	1	42	3.1	1.6	2.4	1.1	1.9	1.1	84.2	23.4	16.2	9.0	90.4	16.1	1896.0	82.5	na	na	0.20	0.2	0.32	0.1
1994	1	1	4.6	1.7	1.7	0.5	1.2	0.5	120.3	33.3	4.3	2.5	19.7	19.9	1651.6	101.5	178.3	91.0	1.11	0.3	0.13	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.87	0.9	0.17	0.1
	1	40	4.3	2.3	1.5	0.5	1.2	0.4	88.2	17.7	7.4	3.8	54.9	3.4	1813.9	82.5	66.0	47.2	0.08	0.1	0.14	0.0
1995	1	1	3.8	2.2	2.2	1.6	1.7	1.2	108.6	24.6	9.7	3.0	39.4	15.8	1893.9	248.5	na	na	0.77	0.3	0.31	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.70	0.3	0.30	0.1
	1	43	3.6	2.2	2.0	0.8	1.3	0.7	91.7	12.9	10.2	1.9	64.2	3.6	1934.7	112.9	na	na	0.22	0.2	0.27	0.1
1996	1	1	3.4	0.9	3.6	0.4	1.9	0.2	92.6	8.0	3.8	4.6	38.9	13.8	1650.3	85.1	na	na	0.51	0.1	na	na
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.46	0.1	na	na
	1	42	3.7	1.5	3.6	0.8	1.9	0.4	80.4	7.1	7.2	3.7	72.5	5.1	1754.7	30.3	na	na	0.14	0.1	na	na
1997	1	1	3.1	1.4	1.9	0.4	1.6	0.3	93.0	8.8	7.8	8.3	20.1	13.2	1792.5	136.3	84.3	16.4	0.39	0.1	0.32	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.41	0.1	0.39	0.1
	1	43	3.3	1.2	2.7	1.1	2.2	1.1	87.7	14.2	15.1	9.5	47.7	3.0	1908.8	136.2	56.3	9.7	0.12	0.1	0.16	0.0
1998	1	1	3.1	1.0	2.4	0.8	1.7	0.9	100.5	11.5	5.5	4.5	13.3	4.8	1651.0	227.2	80.0	27.4	0.45	0.2	0.15	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.18	0.2	0.08	0.1
	1	42	3.2	0.5	2.5	0.8	1.8	0.8	98.2	16.6	6.4	3.8	17.2	5.8	1627.5	214.0	113.8	51.8	0.38	0.2	0.16	0.0

na - not analyzed

SD - standard deviation

Appendix E.8. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Hidden Lake, 1987 and 1989-1998.

Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS		Stocking
1 & 2	of	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Level
Year	Samples	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	(thousands)
1987	3	204	4	1.74	12,058	72	0.88	90,499	208	0.81	31,766	82	0.52	23,629	78	0.86	6,281	66	0.97	176,459	510	0
1989	1	2,654	44	1.58	59,505	259	0.98	107,219	203	0.74	91,826	226	0.51	16,985	76	0.99	4,246	38	0.91	314,756	982	0
1990	4	133	4	1.92	33,174	152	1.02	92,622	226	0.83	30,852	90	0.55	15,061	51	0.87	1,526	16	0.96	173,368	539	0
1991	5	411	7	1.60	23,447	81	0.93	82,307	190	0.81	15,864	44	0.54	5,320	14	0.77	3,372	53	1.14	130,721	389	0
1992	6	288	3	1.37	17,693	37	0.77	51,177	101	0.76	13,498	35	0.52	1,894	5	0.81	3,813	43	1.00	88,363	224	260
1993	6	1,561	11	1.17	0	0	0	12,062	26	0.79	3,463	8	0.50	20,510	39	0.66	8,364	60	0.83	45,960	144	555
1994	7	4,589	32	1.22	0	0	0	4,384	13	0.89	25,239	52	0.47	13,835	37	0.77	19,193	159	0.89	67,240	292	250
1995	7	1,892	9	1.02	76	0.6	1.23	34,141	85	0.85	30,965	71	0.49	8,245	20	0.74	9,851	81	0.87	85,131	267	99
1996	6	3,185	12	0.95	35	0.2	1.10	70,897	166	0.82	21,447	45	0.46	650	1	0.62	6,420	42	0.80	102,617	266	391
1997	6	1,018	8	1.16	47	0.1	0.70	12,515	26	0.76	9,205	14	0.40	7,774	16	0.67	8,887	67	0.84	39,446	131	455
1998	5	1,316	11	1.25	0	0	0	45,527	123	0.85	29,667	68	0.49	18,605	44	0.73	4,242	24	0.67	99,357	270	340
Avg =	6	1,568	13	1.36	18,254	75	0.95	54,850	124	0.81	27,617	67	0.50	12,046	35	0.77	6,927	59	0.90	120,311	365	221



Appendix E.9. Weighted mean zooplankton biomass by genera (stations 1&2 averaged) and juvenile sockeye salmon stocking levels for Hidden Lake, 1987 and 1989-1998.

Appendix E.10. Juvenile sockeye salmon estimates based on hydroacoustic fish population surveys of Hidden Lake, 1994-1998.

Sample		Sockeye Salmon Estimates[a]		
			95% Confidence Interval	
Year	Month	Number	Low	High
1994	October	91,181	63,700	118,662
1995	November	75,149	35,690	114,608
1996	May	34,347	8,084	60,610
	July	21,241	12,264	30,218
	October	175,154	111,678	238,630
1997	May	103,310	51,157	155,463
	June	25,659	4,603	46,715
1998	April	115,768	94,283	137,253

[a] Townet surveys were discontinued due to sockeye avoidance of the trawl net.

Appendix E.11. Mean age, length, weight, and condition coefficient of sockeye salmon smolt collected from Hidden Creek, 1993-1998.

			Age-1				Age-2			
Year	Statistical Week	Date	Sample Size	Mean Length (mm)	Mean Weight (g)	Condition Factor (K)	Sample Size	Mean Length (mm)	Mean Weight (g)	Condition Factor (K)
1993	21	May 17-23	324	100.5	8.5	0.83	0	0.0	0.0	0.00
1994	24-27	June 7-July 4	214	122.9	16.2	0.87	4	145.0	29.1	0.92
1995	23-26	May 31-June 27	148	124.5	20.5	1.00	5	164.3	45.8	1.02
1996	23-25	May 31-June 20	426	125.3	18.4	0.94	14	159.5	41.6	0.95
1997	23-26	May 31-June 27	439	109.2	11.4	0.87	3	120.0	14.7	0.78
1998	22-26	May 24-June 27	455	111.1	12.3	0.89	7	140.0	24.1	0.87

Appendix E.12. Foul Bay Terminal Harvest Area (251-41) daily commercial salmon catches[a] by species, 1995-1998.

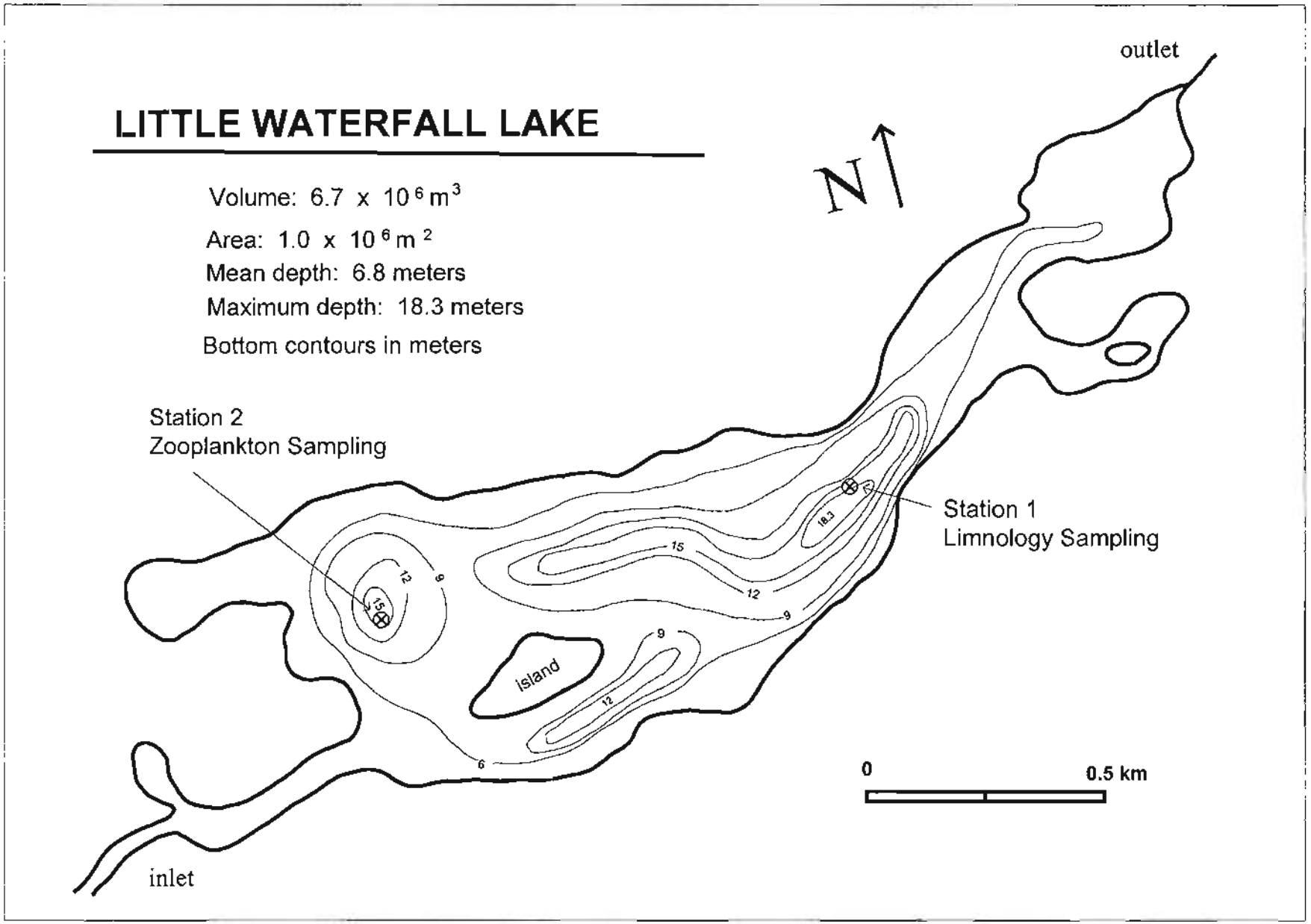
	1995[b]			1996			1997			1998		
Date	Sockeye	Pink	Chum	Sockeye	Pink	Chum	Sockeye	Pink	Chum	Sockeye	Pink	Chum
9-Jun	0	0	0	14,890	0	0	5,000	0	0	567	0	0
10-Jun	5,357	0	0	2,962	0	20	0	0	0	1,770	0	0
11-Jun	4,460	0	0	4,816	0	0	0	0	0	1,431	0	43
12-Jun	2,208	0	0	2,173	0	0	0	0	0	958	0	0
13-Jun	0	0	0	759	0	0	0	0	0	425	0	0
14-Jun	5,832	0	0	0	0	0	0	0	0	0	0	0
15-Jun	1,691	0	3	0	0	0	0	0	0	661	0	0
16-Jun	0	0	0	0	0	0	0	0	0	0	0	0
17-Jun	3,378	0	0	70	0	0	0	0	0	362	0	0
18-Jun	0	0	0	668	0	9	0	0	0	682	0	0
19-Jun	3,093	20	5	0	0	0	0	0	0	235	0	0
20-Jun	654	0	0	0	0	0	0	0	0	0	0	0
21-Jun	153	0	0	0	0	0	1,484	0	0	712	0	0
22-Jun	1,625	0	0	1,397	7	34	2,388	0	0	0	0	0
23-Jun	733	0	0	0	0	0	5,256	0	0	0	0	0
24-Jun	0	0	0	250	0	0	3,030	5	2	0	0	0
25-Jun	0	0	0	568	0	0	867	0	0	0	0	0
26-Jun	0	0	0	122	0	0	580	0	0	0	0	0
27-Jun	1,360	0	0	122	0	0	0	0	0	421	47	12
28-Jun	0	0	0	0	0	0	0	0	0	0	0	0
29-Jun	646	0	0	392	0	0	146	0	0	0	0	0
30-Jun	0	0	0	0	0	0	0	0	0	46	8	2
Totals:	31,190	20	8	29,189	7	63	18,751	5	2	8,270	55	57

[a] Catch information obtained from the ADF&G Fish Ticket Database.

[b] In 1995, an additional 11,742 sockeye salmon were caught in the Foul Bay Terminal Harvest Area (251-41), and reported as caught in the outer Foul Bay area (251-40).

Appendix E.13. Estimated age composition of Foul Bay Terminal Harvest Area commercial sockeye salmon catch, 1994-1998.

Year	Sample Size		Ages											Total
			1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	
1994	50	Numbers	49	0	1	0	0	0	0	0	0	0	0	50
		Percent	98.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
1995	485	Numbers	749	31	29,443	0	530	31	0	0	405	0	0	31,190
		Percent	2.4	0.1	94.4	0.0	1.7	0.1	0.0	0.0	1.3	0.0	0.0	100
1996	537	Numbers	289	0	9,160	108	18,050	1,454	0	0	127	0	0	29,189
		Percent	1.0	0.0	31.4	0.4	61.8	5.0	0.0	0.0	0.4	0.0	0.0	100
1997	562	Numbers	788	0	8,288	19	8,344	656	19	38	469	56	38	18,751
		Percent	4.2	0.0	44.2	0.1	44.5	3.5	0.1	0.2	2.5	0.3	0.2	100
1998	646	Numbers	1,580	0	4,379	227	1,579	473	0	0	33	0	0	8,270
		Percent	29.6	0.0	47.8	4.4	12.7	4.8	0.0	0.0	0.7	0.0	0.0	100



Appendix F.1. Morphometric map showing the limnology and zooplankton stations on Little Waterfall Lake.

Appendix F.2. Juvenile sockeye salmon stocked into Little Waterfall Lake, 1992-1998.

	Release Year						
Life stage[a]	1992	1993	1994	1995	1996	1997	1998
fry	493,000						
fingerling	96,000	205,000					
pre-smolt			150,000	100,000	82,300 [b]	246,800 [b]	237,300
smolt				97,800			
TOTAL	589,000	205,000	150,000	197,800	82,300	246,800	237,300

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g). Smolt are released in May or June two years following brood year at the time of physiological adaptation to life in the marine environment at a size of 10 to

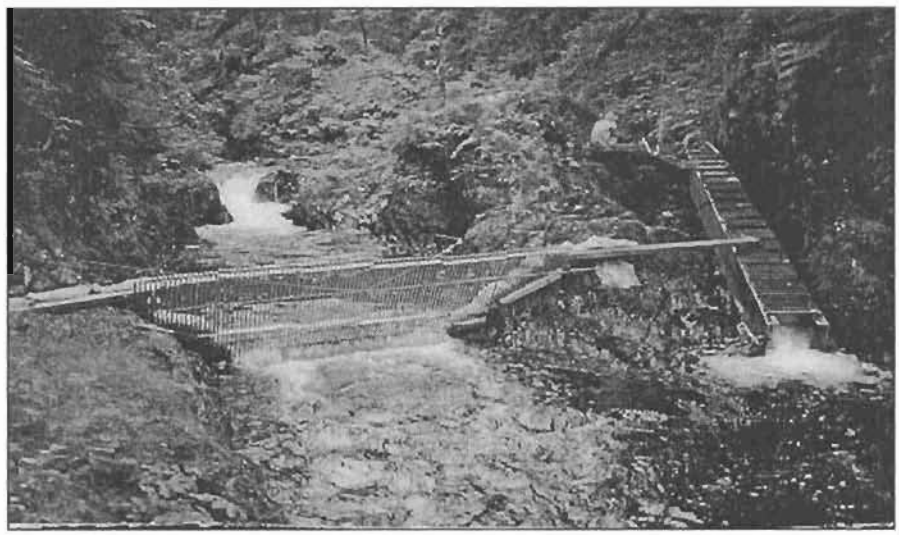
[b] Pre smolt releases were air dropped from a fixed wing aircraft.

Appendix F.3. Nutrient addition amounts and type for enrichment at Little Waterfall Lake, 1993-1998.

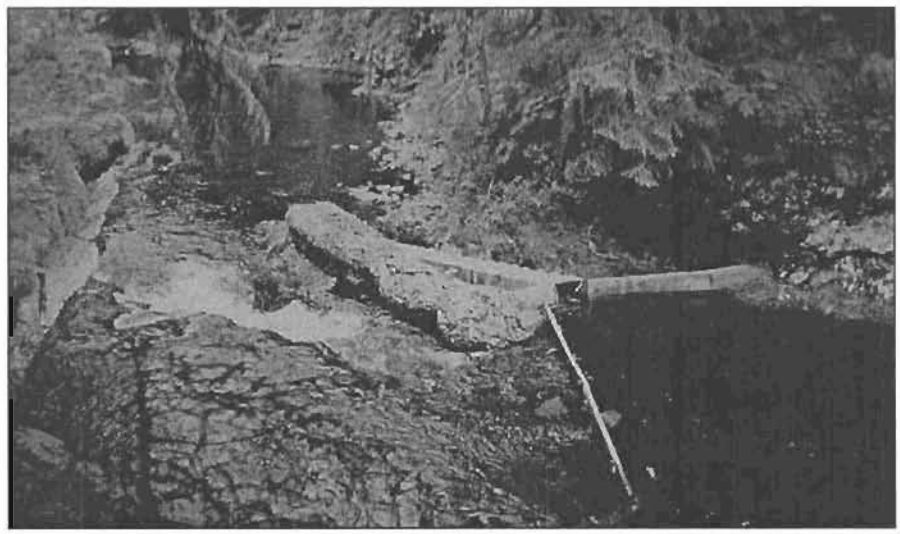
Year	Fertilizer ratio [a]	Amount (kg)
1993	20-5-0	2,836
1994	20-5-0	3,628
1995	20-5-0	4,536
1996	20-5-0	5,080
1997	20-5-0	5,080
1998	20-5-0	5,080

[a] Nitrogen-Phosphorus-Potassium

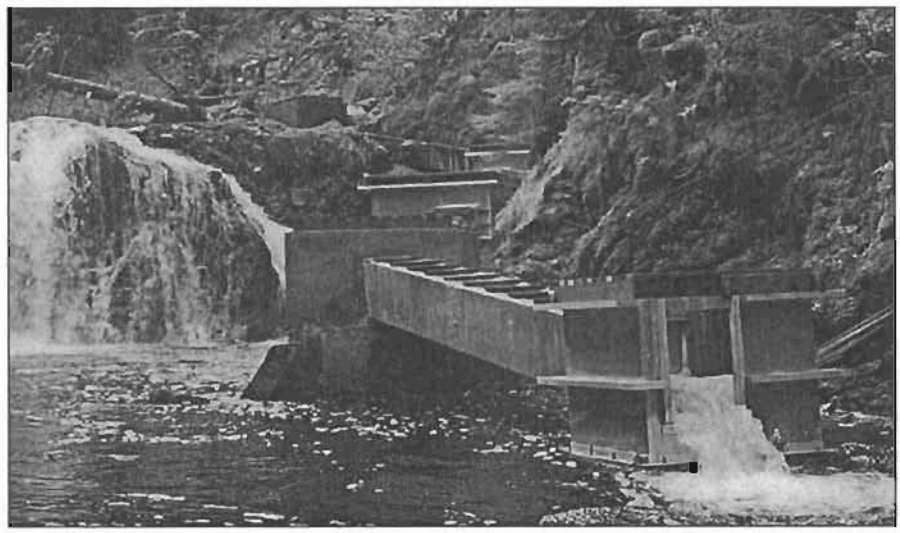
a.



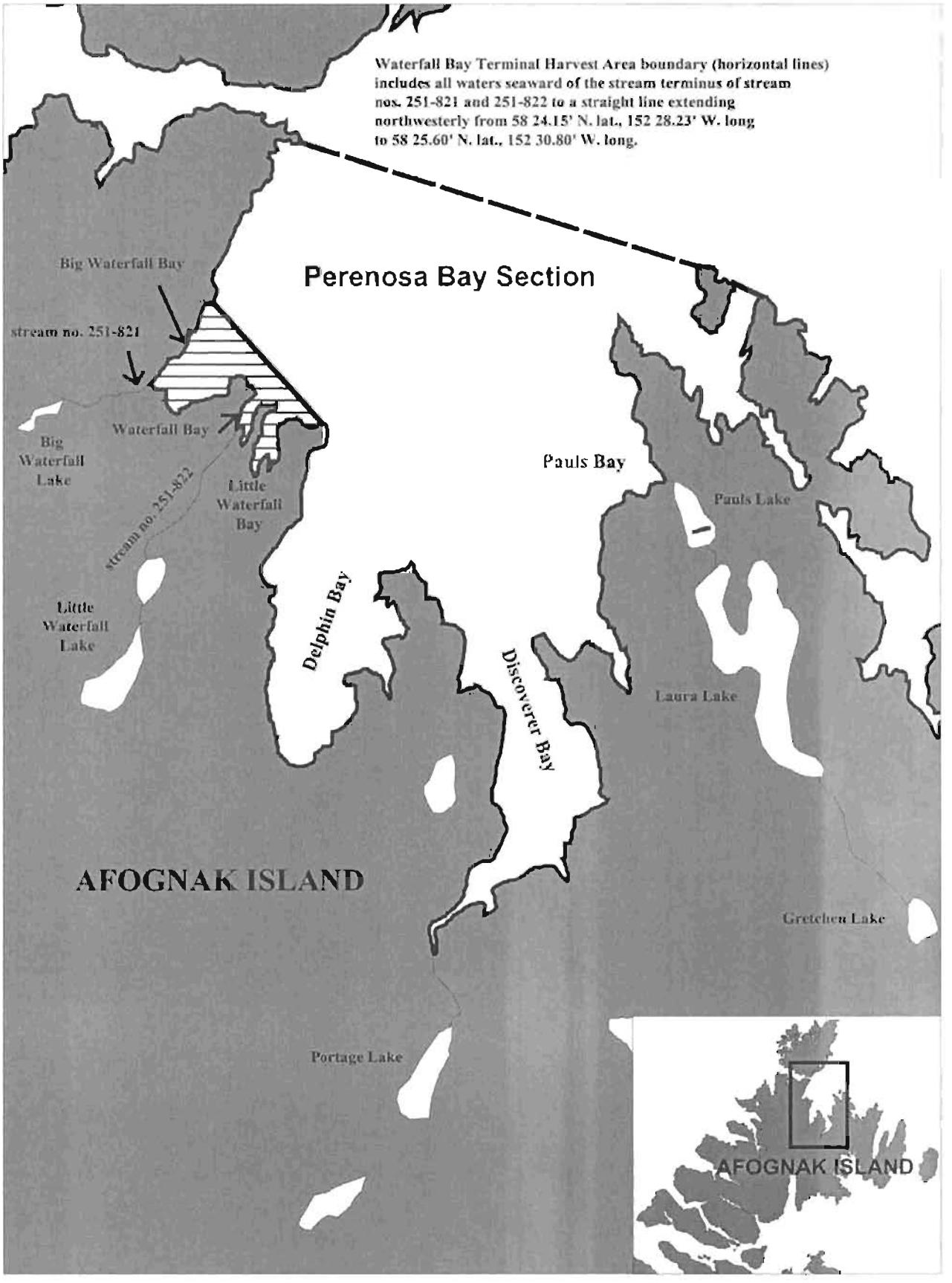
b.



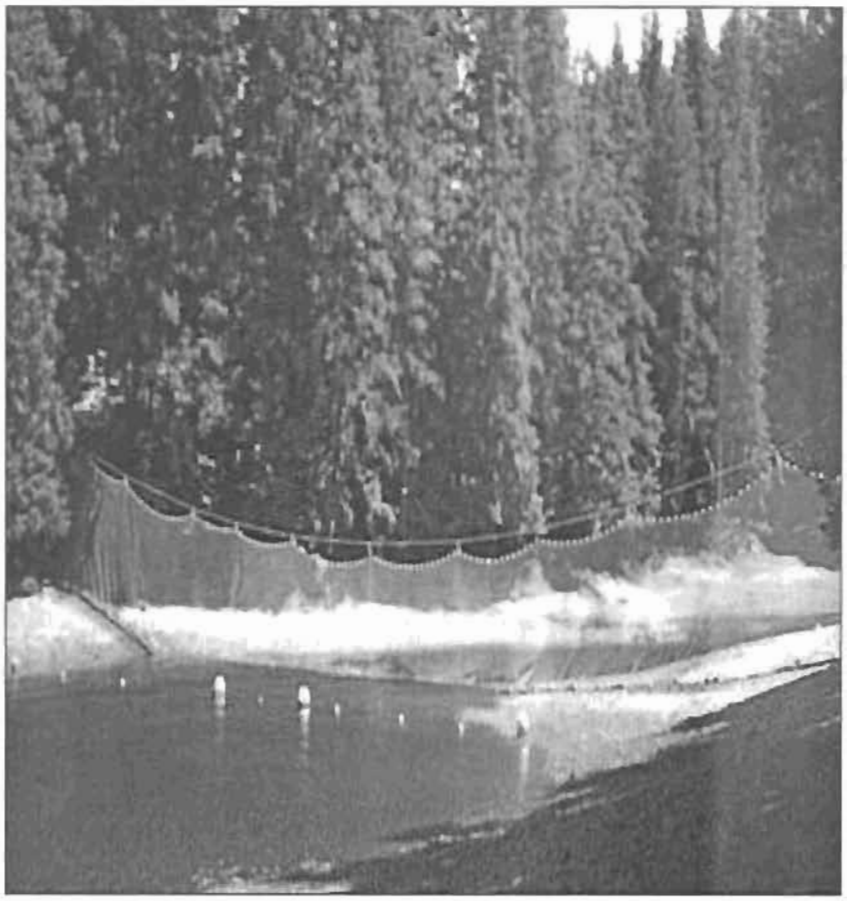
c.



Appendix F.4. The lower (a), middle (b), and upper (c) fish passes at Little Waterfall Creek.



Appendix F.5. Waterfall Bay (Little and Big Waterfall Lakes) Terminal Harvest Area and rehabilitation project sites in Perenosa Bay.



Appendix F.6. Little Waterfall Creek barrier net.

Appendix F.7. Limnological sampling stations and sampling frequencies per year at Little Waterfall Lake, 1990-1998.

Year	Sampling	
	Stations	Frequency
1990	1	4
1991[a]	nc	nc
1992	1	5
1993	1	5
1994	1, 2	7
1995	1, 2	7
1996	1, 2	6
1997	1, 2	6
1998	1	4

[a] nc - samples were not collected.

Appendix F.8. Summary of seasonal mean water chemistry parameters by station and depth from Little Waterfall Lake, 1990 - 1998.

	Sta	Depth	Sp. Conductivity		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	tion	(m)	(umhos cm^{-1})	SD	(Units)	SD	(mg L^{-1})	SD	(NTU)	SD	(Pt units)	SD	(mg L^{-1})	SD	(mg L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	57.3	1.9	7.2	0.1	12.8	2.2	0.5	0.2	13.5	5.3	4.8	1.0	1.5	0.1	120.3	15.6
1990	1	12	54.5	2.4	7.1	0.2	13.3	0.5	1.7	1.9	15.8	6.2	4.8	0.9	1.1	0.3	125.7	43.5
1992	1	1	55.0	5.8	6.9	0.1	14.8	2.4	0.7	0.3	13.2	2.4	4.9	1.0	1.2	0.3	163.4	36.0
1992	1	15	49.5	8.6	6.8	0.3	13.4	3.3	1.3	1.4	13.2	1.4	5.3	1.0	0.9	0.4	141.5	78.1
1993	1	1	58.8	7.3	6.9	0.2	15.4	3.2	1.4	1.8	13.4	3.2	6.1	1.0	1.6	0.6	104.8	20.7
1993	1	12	55.4	4.8	6.6	0.2	13.5	2.4	0.7	0.1	15.4	2.6	5.4	1.2	1.1	0.6	110.6	49.7
1994	1	1	56.4	5.3	6.8	0.2	13.4	2.9	1.0	0.6	15.6	5.0	5.1	1.0	1.1	0.3	117.1	29.0
1994[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	15	51.9	3.7	6.5	0.2	10.6	1.2	1.1	0.7	15.6	4.1	4.3	0.5	0.9	0.3	87.1	41.6
1995	1	1	52.3	5.0	6.6	0.2	11.7	2.6	1.2	0.6	13.1	2.7	4.2	0.8	1.2	0.6	130.1	43.6
1995[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	15	50.0	4.5	6.3	0.1	10.4	1.9	1.4	0.6	12.0	4.6	3.7	0.6	1.1	0.7	148.9	82.7
1996	1	1	60.5	2.4	6.8	0.1	13.9	1.8	1.1	0.6	16.0	4.0	4.9	1.0	1.1	0.2	109.8	28.3
1996[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	14	66.7	16.5	6.5	0.3	12.4	1.9	1.0	0.5	15.0	4.4	4.3	0.5	1.2	0.5	89.8	47.5
1997	1	1	59.5	5.5	7.2	0.2	16.1	3.8	0.8	0.1	13.0	4.8	5.1	1.0	0.7	0.4	59.8	28.9
1997[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	14	57.8	6.0	6.8	0.2	12.5	1.9	0.8	0.3	14.7	3.9	3.9	0.4	0.9	0.3	59.3	25.8
1998	1	1	57.3	2.5	7.2	0.1	17.2	3.3	0.9	0.3	19.3	0.6	4.6	0.6	1.0	0.1	58.7	10.1

[a] na - parameters were not analyzed at the 2 meter depth.

SD - standard deviation

Appendix F.9. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth from Little Waterfall Lake, 1990 - 1998.

	Sta	Depth	Total-P		Total filter-able-P		Filterable reactive-P		Total Kjel-dahl nitrogen		Ammonia		Nitrate+ nitrite		Reactive silicon		Organic carbon		Chloro-phyll a		Phaeo-phytin a	
Year	tion	(m)	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	3.1	0.7	2.5	0.7	1.7	0.4	160.5	27.7	4.7	2.7	35.6	21.8	1765.3	329.1	na	na	0.52	0.2	0.29	0.1
1990	1	12	4.6	2.4	3.5	2.4	1.8	0.6	152.3	19.2	5.8	3.8	49.0	9.1	1835.8	208.7	na	na	0.24	0.1	0.33	0.1
1992	1	1	5.4	2.1	3.6	0.9	2.7	0.6	132.1	37.4	2.2	0.9	52.9	54.7	1734.8	266.5	247.0	47.4	0.60	0.6	0.38	0.1
1992	1	15	5.1	0.9	5.4	1.1	4.1	0.4	96.3	41.6	4.3	3.8	88.7	36.6	1683.5	137.5	232.0	140.9	0.29	0.5	0.26	0.2
1993	1	1	6.7	3.0	3.5	0.9	1.9	0.6	148.7	58.4	5.1	3.4	35.1	31.3	1450.8	350.5	233.8	88.5	1.27	1.1	0.61	0.4
1993	1	12	6.1	1.2	3.9	1.3	2.6	1.1	133.2	39.6	7.0	6.5	54.2	21.7	1714.8	79.0	176.8	36.0	0.72	0.0	0.52	0.1
1994	1	1	5.9	2.1	2.7	1.3	1.9	1.4	133.8	35.3	2.7	2.8	11.9	15.1	1492.4	233.5	166.1	83.6	1.46	1.2	0.44	0.3
1994[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.75	1.2	0.35	0.2
1994	1	15	4.0	1.0	2.5	1.7	1.9	1.6	103.4	23.7	7.4	7.1	37.3	11.2	1740.1	139.0	152.4	132.9	0.53	0.8	0.24	0.2
1995	1	1	7.1	4.3	2.7	1.0	2.4	0.7	145.4	44.2	11.5	14.3	35.7	15.7	1636.3	300.2	na	na	2.48	3.5	0.77	0.7
1995[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.44	3.4	0.75	0.5
1995	1	15	5.0	1.7	2.2	0.8	1.7	1.0	120.5	39.3	19.3	17.4	40.7	10.5	1877.0	256.7	na	na	0.44	0.3	0.37	0.2
1996	1	1	7.0	2.1	2.9	0.8	2.1	0.7	124.9	31.3	8.9	7.2	17.8	16.8	1553.5	328.1	132.8	78.2	1.47	1.2	0.44	0.3
1996[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.34	1.0	0.34	0.2
1996	1	14	5.9	1.3	3.6	2.3	2.8	1.4	114.6	29.8	19.7	17.3	49.7	15.3	1896.0	122.3	50.0	23.0	0.32	0.1	0.26	0.1
1997	1	1	8.3	3.2	2.3	1.0	1.5	0.3	153.3	46.3	3.2	1.9	13.2	13.4	1478.0	451.3	172.8	66.3	1.28	1.0	0.72	0.4
1997[a]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.24	0.9	0.80	0.5
1997	1	14	6.4	2.9	2.8	0.9	2.3	1.1	99.1	25.5	7.1	6.0	39.6	7.8	1827.7	252.4	103.3	32.8	0.38	0.2	0.45	0.2
1998	1	1	10.2	3.5	3.3	1.0	2.4	0.4	183.6	29.0	9.2	8.4	24.9	21.5	1520.0	110.4	183.7	92.8	1.79	1.3	0.62	0.6

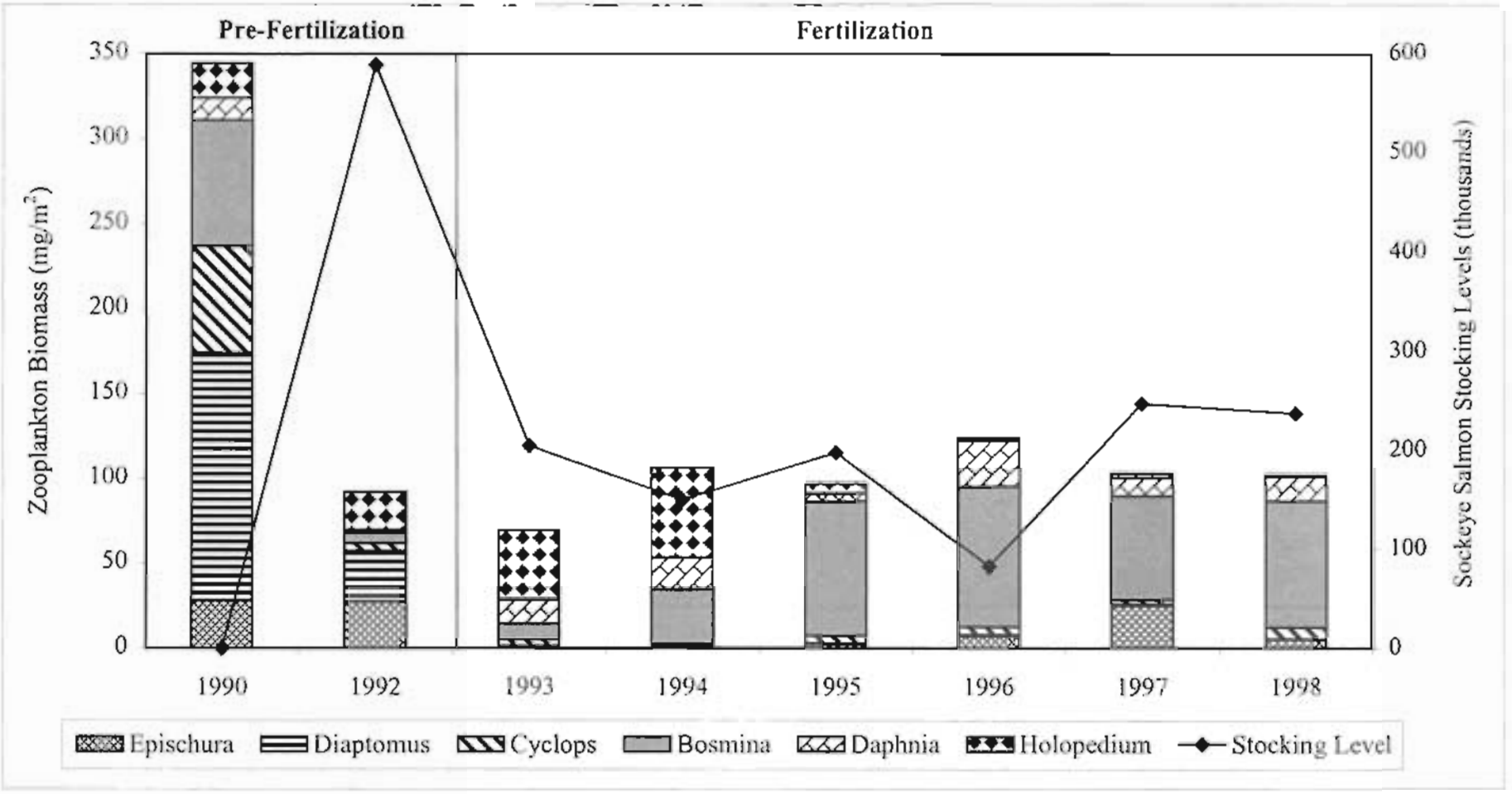
[a] na - parameters were not analyzed at the 2 meter depth.

SD - standard deviation

Appendix F.10. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) from Little Waterfall Lake, 1990, 1992 -1998.

Station Number		*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1 & 2 Year [a]	Sample Dates	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2
1990	4	1,194	28	1.79	26,341	146	1.09	27,468	63	0.81	35,762	74	0.47	8,227	13	0.62	7,099	20	0.57	106,091	344
1992	5	6,582	27	0.97	18,471	30	0.71	2,442	5	0.74	2,873	6	0.46	1,435	2	0.54	3,322	23	0.80	35,124	92
1993	5	61	0	0.71	326	1	0.90	1,844	4	0.79	9,646	9	0.33	11,194	14	0.55	8,017	41	0.72	31,088	69
1994	7	82	0	0.85	109	0	0.96	805	2	0.79	38,086	32	0.31	18,079	19	0.50	8,257	53	0.73	65,418	106
1995	7	447	2	1.10	144	0	0.81	1,959	4	0.82	99,655	79	0.30	2,410	5	0.65	5,064	6	0.39	109,680	97
1996	5	1,140	7	1.10	165	1	0.92	2,502	5	0.74	102,053	82	0.30	18,272	28	0.59	1,129	1	0.40	125,262	124
1997	5	7,023	25	0.92	132	1	1.13	1,123	3	0.84	89,931	61	0.27	6,708	11	0.63	1,480	3	0.46	106,396	103
1998	4	3,026	5	0.72	85	0	0.52	3,681	7	0.73	75,457	74	0.31	12,997	15	0.58	610	1	0.42	95,856	102
Avg =	5	2,361	13	1.06	6,527	26	0.93	5,449	12	0.79	54,001	49	0.35	9,475	13	0.58	4,910	21	0.58	84,364	130

[a] Samples were not collected in 1991.Data collection began at station 2 in 1994. Average of stations 1 & 2 was used for years 1994 to 1997.



Appendix F.11. Weighted mean zooplankton biomass by genera (stations 1&2 averaged), lake enrichment time period, and juvenile sockeye salmon stocking levels for Little Waterfall Lake, 1990, 1992-1998.

Appendix F.12. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Little Waterfall Lake, 1992 and 1994-1998.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	No.	Low	High	No.	Low	High	(%)
9/29/92	89,869	58,052	121,686	89,869	58,052	121,686	100.0
10/26/94	353,462	278,963	427,961	26,407	8,974	43,840	23.4
5/11/95[a]	120,000	80,430	159,570	120,000	80,430	159,570	
7/13/95[a]	42,445	28,652	56,238	42,445	28,652	56,238	
11/1/95	89,408	64,622	114,194	626	452	800	0.8
5/9/96[a]	50,197	17,412	82,982	50,197	17,412	82,982	
7/11/96[a]	30,474	4,951	55,997	30,474	4,951	55,997	
10/24/96	311,773	195,585	427,961	10,912	6,845	14,979	3.5
5/5/97[a]	125,905	71,886	179,924	125,905	71,886	179,924	
6/23/97[a]	83,492	40,075	126,909	83,492	40,075	126,909	
4/23/98[a]	114,107	93,427	134,787	114,107	93,427	134,787	

[a] Townet surveys were not conducted to determine species composition.

Appendix F.13. Townet catches from Little Waterfall Lake, 1992-1996.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Date	Number	Minutes	Number	%	CPUE[a]	Number	%	CPUE[a]
9/29/92	5	36	17	100.0	0.47	0	0.0	0.0
9/20/93	5	50	100	90.9	2.0	10	9.1	0.2
10/26/94	3	29	43	23.4	1.5	141	76.6	4.9
11/1/95	4	31	1	0.8	0.0	150	99.2	4.8
10/24/96	6	37	2	3.5	0.1	55	96.5	1.5

[a] CPUE - Catch per Unit Effort

Appendix F.14. Mean length, weight, and condition coefficient by age of juvenile sockeye salmon captured by townet from Little Waterfall Lake, 1992-1996.

	Age-0					Age-1				
Sampling Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
9/29/92	17	100.0	69.0	4.0	1.20	0	0.0	0.0	0.0	0.00
9/20/93	57	74.0	65.8	3.5	1.23	20	26.0	89.7	8.0	1.11
10/1/94	29	90.6	95.4	10.7	1.22	3	9.4	95.3	10.8	1.25
11/1/95	1	100.0	na[a]	na[a]	na[a]	0	0.0	0.0	0.0	0.00
10/24/96	0	0.0	0.0	0.0	0.00	2	100.0	91.5	10.1	1.31

[a] na - information is not available.

Appendix F.15. Mean length, weight, and condition coefficient by age of sockeye smolt migrating from Little Waterfall Lake, 1993-1998.

Sampling Date	Age-1					Age-2				
	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
5/24-25/93	197	100.0	77.6	3.5	0.73	0	0.0	0.0	0.0	0.00
5/17-23/94 6/21-27/94	5	33.3	86.6	5.4	0.83	10	66.7	98.4	7.5	0.79
6/1-15/95	176	99.4	110.0	12.4	0.89	0	0.0	0.0	0.0	0.00
6/4-12/96	232	98.7	105.2	9.7	0.83	3	1.3	104.3	10.1	0.88
6/2-20/97	201	98.0	97.7	8.0	0.85	4	2.0	111.5	13.1	0.88
5/30-6/11/98	194	97.5	99.7	8.3	0.83	5	2.5	111.8	13.1	0.85

Appendix F.16. Commercial catch[a] by species in the Perenosa Bay Section (251-82 and 251-83) and Waterfall Bay Terminal Harvest Area (251-84), 1988-1998.

	Perenosa Bay Section 251-82			Perenosa Bay Section 251-83			Waterfall Terminal Harvest Area[b] 251-84		
Year	sockeye	pink	coho	sockeye	pink	coho	sockeye	pink	coho
1988	648	198,256	14,338	740	145,130	6,527			
1989	*Exxon Valdez* oil spill, no commercial fishing.								
1990	145	43,214	2,494	290	18,605	1,788			
1991	1	6,505	237	34	3,532	14			
1992				4	2,349	336			
1993	27	89,297	95	55	48,203	371			
1994	37	11,214	1,925	102	12,154	591			
1995	3,930	277,560	4,659	783	73,387	1,356	13,684	141,043	284
1996	64	32	125	4,921	287	1,483	41,481	319	1,608
1997	17	10,729	8,940	15	2,165	12,823	27,873	915	1,308
1998	72	3,168	10,132	6	62	2,396	11,057	144	0

[a] Commercial catch data obtained from the ADF&G fish ticket database.

[b] The Waterfall Bay Terminal Harvest Area was created in 1994 to harvest the enhanced sockeye salmon stocked into Little Waterfall Lake.

Appendix F.17. Pink and coho salmon peak survey counts, bypass counts, and escapement estimates for Little Waterfall Creek, 1981-1998.

	Pink Total System			Coho Total System		
Year [a]	Peak Count	Bypass Count [b]	Escapement Estimate	Peak Count	Bypass Count [b]	Escapement Estimate
1981	nd	55,447	61,247	10	3	24
1982	40,000	47,829	47,829	nd	16	16
1983	11,000	21,560	21,560	40	5	96
1984	40,000	36,016	40,016	65	15	156
1985	80,000	119,211	119,211	2	0	5
1986	25,000	50,884	50,884	200	2	480
1987	26,000	29,093	29,093	1	1	2
1988	14,500	nd	27,550	nd	nd	nd
1989	96,301	nd	147,016	16	nd	38
1990	14,165	42,060	47,000	18	18	43
1991	63,483	99,136	115,000	31	31	74
1992	26,109	35,763	43,000	34	3	82
1993	109,023	nd	166,391	0	nd	0
1994	22,724	nd	50,937	142	nd	341
1995	36,690	nd	100,223	0	nd	0
1996	5,509	nd	13,624	91	nd	218
1997	14,920	nd	24,339	0	nd	0
1998	94,668	nd	151,655	106	nd	254
Mean 81-98:	42,358	53,700	69,810	47	9	108
Mean 81-98 (OY):	54,677	64,889	87,120	43	9	97
Mean 81-98 (EY):	31,408	42,510	52,499			

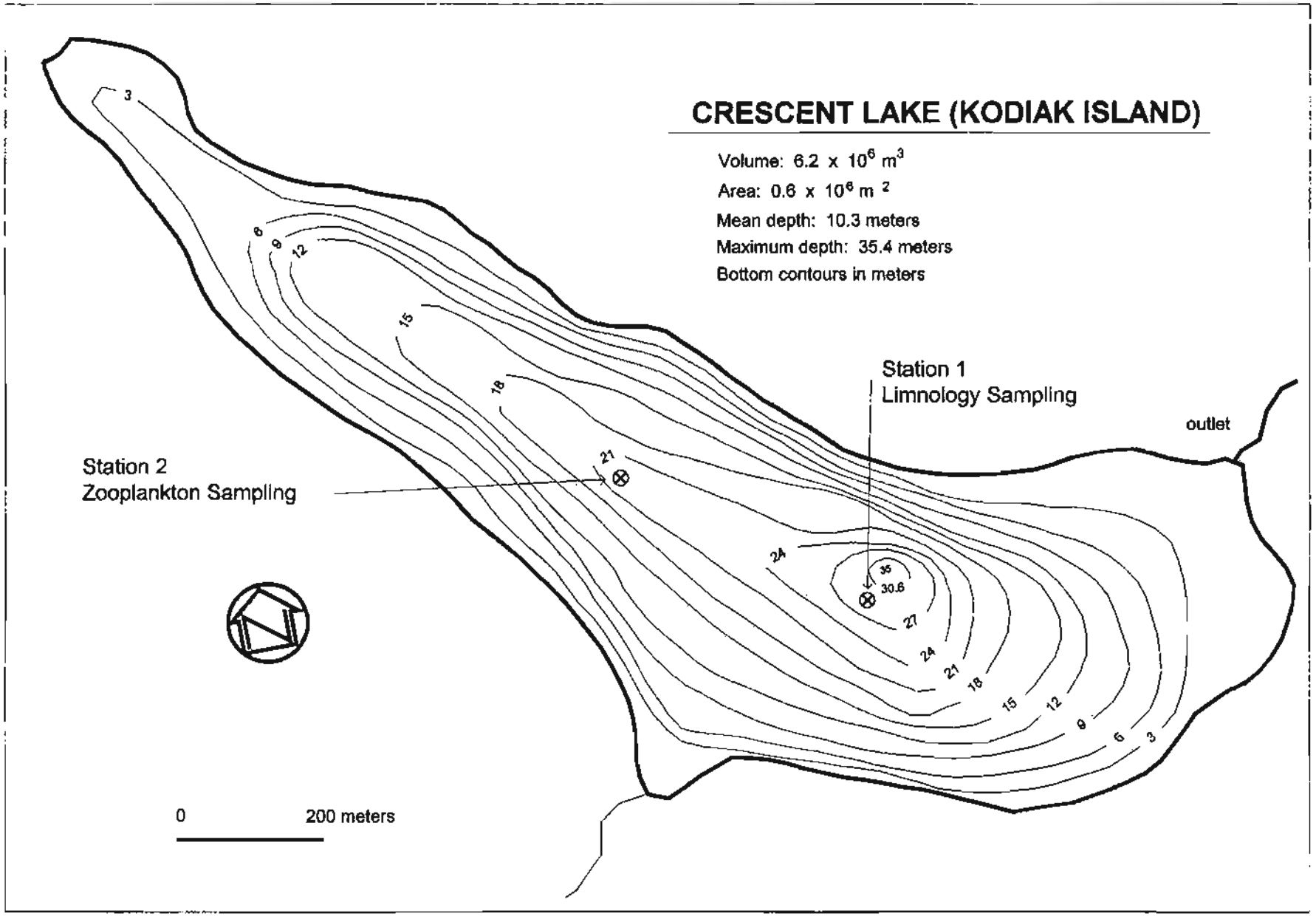
OY - Odd Year; EY - Even Year; nd - no data.

[a] First two barriers bypassed with fish passes in 1979; third bypassed in 1980 ; 1981-1998 escapements were enhanced as a result.

[b] Salmon counted as they exit most downstream bypass.

Appendix F.18. Estimated age composition of the sockeye salmon commercial catch in the Little Waterfall Bay Terminal Harvest Area, 1994-1998.

Year		Ages									Total
		0.2	0.3	1.1	1.2	1.3	2.1	2.2	2.3	3.2	
1994	Number	1	0	49	0	0	0	0	0	0	50
	Percent	2.0	0.0	98.0	0.0	0.0	0.0	0.0	0.0	0.0	100
1995	Number	29	57	891	11,585	230	259	632	0	0	13,684
	Percent	0.2	0.4	6.5	84.7	1.7	1.9	4.6	0.0	0.0	100
1996	Number	0	0	836	8,949	22,497	669	6,272	2,007	251	41,481
	Percent	0.0	0.0	2.0	21.6	54.2	1.6	15.1	4.8	0.6	100
1997	Number	124	0	993	11,422	10,739	0	2,669	1,924	0	27,873
	Percent	0.4	0.0	3.6	41.0	38.5	0.0	9.6	6.9	0.0	100
1998	Number	23	203	653	6,125	3,468	113	158	293	23	11,057
	Percent	0.2	1.8	5.9	55.4	31.4	1.0	1.4	2.6	0.2	100

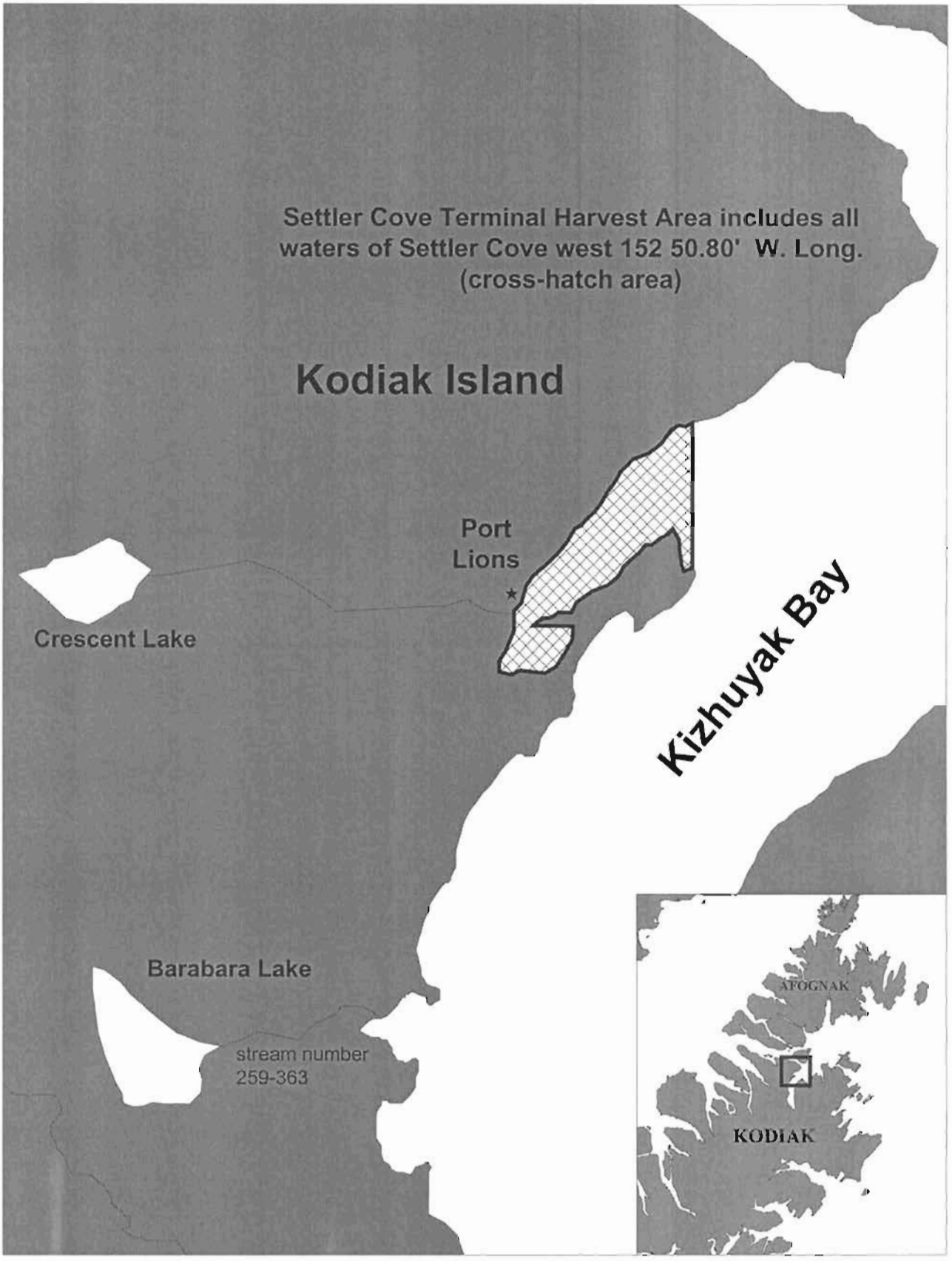


Appendix G.1. Morphometric map showing the limnology and zooplankton stations on Crescent Lake.

Appendix G.2. Juvenile coho and sockeye salmon stocked into Crescent Lake, 1988-1998.

		Release Year										
Species	Life stage[a]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Coho	fry									163,200	165,000	163,000
	fingerling	241,373	202,955		191,416			163,680	167,778			
	pre-smolt					69,100	66,420					
	Totals:	241,373	202,955		191,416	69,100	66,420	163,680	167,778	163,200	165,000	163,000
Sockeye	fry							314,000		427,000	432,000	463,000
	fingerling					399,000	202,000					108,000
	pre-smolt								90,200			
	Totals:					399,000	202,000	314,000	90,200	427,000	432,000	571,000

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g). Smolt are released in May or June two years following brood year at the time of physiological adaptation to life in the marine environment at a size of 10 to 23 g.



Appendix G.3. Settler Cove (Crescent Lake) Terminal Harvest Area boundaries in Kizhuyak Bay.

Appendix G.4. Limnological sampling locations and sampling frequencies for Crescent Lake, 1987 and 1990-1998.

Year	Sampling	
	Stations	Frequency
1987	1	3
1990	1	4
1991	1	3
1992	1	5
1993	1	5
1994	1,2	6
1995	1,2	6
1996	1,2	5
1997	1,2	5
1998	1	4

Appendix G.5. Summary of seasonal mean water chemistry parameters by station and depth from Crescent Lake, 1990-1994.

Year	Station	Depth (m)	Sp. Cond. (umhos cm^{-1})	SD	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1990	1	1	40.5	1.7	6.8	0.1	6.3	0.5	0.8	0.4	13.5	3.4	2.9	1.4	0.4	0.3	120.8	24.3
	1	16	41.3	1.0	6.7	0.2	6.1	0.6	0.7	0.4	11.0	2.2	3.2	1.8	0.4	0.3	128.3	38.7
1991	1	1	38.0	0.8	6.7	0.1	10.4	7.8	0.9	0.3	13.0	0.8	2.1	0.3	0.8	0.5	210.0	31.1
	1	14	38.3	1.0	6.6	0.2	6.9	0.3	0.9	0.2	15.8	3.9	1.9	0.1	0.8	0.5	190.3	45.0
1992	1	1	34.5	1.2	6.6	0.2	5.8	1.0	0.9	0.5	11.5	3.4	2.5	0.9	0.6	0.3	156.5	9.3
	1	24	34.5	0.5	6.3	0.1	4.9	1.0	0.8	0.6	10.7	1.5	2.5	1.2	0.6	0.3	162.3	56.9
1993	1	1	36.5	1.0	6.6	0.1	7.5	2.7	0.5	0.1	6.6	7.5	2.2	0.4	1.3	1.1	103.6	34.9
	1	25	39.0	4.0	6.4	0.4	7.8	2.1	0.5	0.2	10.0	10.7	2.6	0.9	0.8	0.1	134.2	52.0
1994	1	1	39.0	6.5	6.6	0.2	6.2	2.0	1.1	0.8	5.0	3.2	2.2	0.9	0.6	0.2	140.7	44.0
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	26	36.0	0.9	6.3	0.3	6.5	2.5	0.7	0.3	5.5	4.7	2.2	0.5	0.6	0.2	197.2	87.7

na - not analyzed; SD - standard deviation

Appendix G.6. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth from Crescent Lake, 1990-1994.

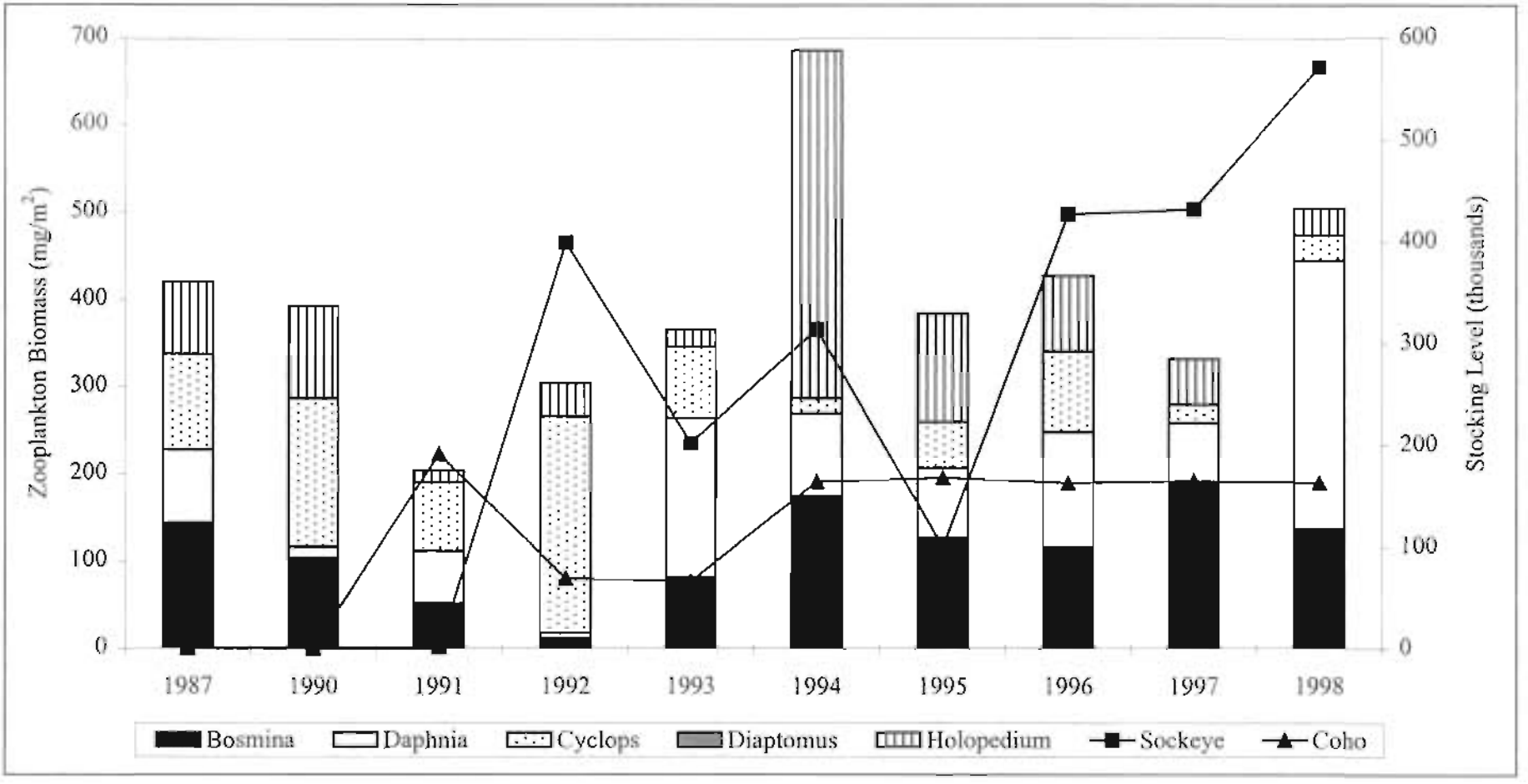
Year	Station	Depth (m)	Total-P (ug L^{-1})	SD	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+ nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll a (ug L^{-1})	SD	Phaeophytin a (ug L^{-1})	SD
1990	1	1	4.5	1.5	2.9	4.2	3.7	1.7	128.0	16.5	8.0	3.0	40.3	29.1	3249.8	247.5	144.5	13.0	0.34	0.2	0.17	0.0
	1	16	5.1	2.3	1.3	1.3	2.8	1.1	117.7	22.7	9.7	4.2	65.0	29.1	3389.8	154.5	144.0	30.6	0.21	0.0	0.28	0.1
1991	1	1	5.0	2.8	3.2	0.6	2.3	0.4	150.6	22.6	11.5	1.8	56.8	21.3	2865.0	108.6	na	na	0.31	0.2	0.27	0.1
	1	14	4.6	1.5	6.0	3.5	4.5	3.2	138.3	12.3	13.6	5.0	69.7	23.2	2966.0	156.3	na	na	0.22	0.1	0.22	0.1
1992	1	1	3.8	0.5	4.1	2.5	3.1	2.4	135.0	13.9	3.3	1.7	61.7	26.1	3162.8	158.9	198.8	64.1	0.44	0.3	0.28	0.1
	1	24	3.9	1.7	4.0	3.2	2.6	1.7	127.4	12.8	9.6	4.1	92.8	23.1	3181.7	198.0	162.6	52.9	0.31	0.2	0.28	0.1
1993	1	1	4.5	0.8	3.7	1.3	2.8	0.5	148.0	18.5	5.0	2.2	49.1	30.4	3132.2	220.6	146.8	53.3	1.01	0.3	0.36	0.0
	1	25	4.9	1.3	8.5	11.7	6.8	9.9	136.2	17.3	19.4	10.1	98.4	31.7	3379.6	244.0	120.6	47.5	0.52	0.2	0.45	0.1
1994	1	1	5.7	0.7	4.5	3.3	3.6	2.3	159.8	23.8	3.2	1.7	39.8	21.4	2843.3	122.4	114.3	33.0	0.56	0.3	0.28	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.56	0.3	0.34	0.1
	1	26	5.3	1.1	4.8	3.9	4.2	3.2	160.4	17.7	15.2	9.7	74.3	23.8	3176.7	285.5	128.2	52.1	0.36	0.2	0.27	0.1

na - not analyzed; SD - standard deviation

Appendix G.7. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) from Crescent Lake, 1987 and 1990-1998.

Station	Number	*Bosmina*			*Daphnia*			*Cyclops*			*Diaptomus*			*Holopedium*			TOTAL	
1 & 2	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year [a]	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1987	3	65,154	144	0.48	32,599	84	0.77	41,401	110	0.87	4,423	21	1.04	9,466	83	0.90	153,043	442
1990	4	46,178	104	0.49	7,166	13	0.65	88,110	170	0.75	54,472	213	0.97	10,881	107	0.94	206,807	606
1991	3	21,139	51	0.51	20,807	60	0.81	28,052	79	0.89	10,218	44	1.00	889	14	1.13	81,104	248
1992	5	6,454	12	0.45	4,055	6	0.57	128,482	249	0.75	531	1	0.82	4,384	38	0.89	143,907	305
1993	5	50,095	82	0.42	90,774	183	0.68	31,083	81	0.86	191	1	1.23	4,140	20	0.71	176,284	368
1994	6	113,490	175	0.41	47,217	95	0.68	12,173	17	0.65	473	2	0.95	32,900	398	1.02	206,253	687
1995	6	76,574	127	0.42	32,015	80	0.75	19,471	53	0.87	1,415	7	1.02	24,372	124	0.71	153,847	391
1996	5	108,189	117	0.34	84,113	132	0.61	33,524	92	0.88	764	0.7	0.58	17,654	87	0.71	244,245	429
1997	5	177,861	191	0.34	56,214	68	0.54	6,511	21	0.95	102	0.1	0.60	19,807	53	0.54	260,495	333
1998	4	88,562	137	0.41	220,992	308	0.58	11,996	29	0.84	0	0.0	0.00	9,608	31	0.59	331,158	505
AVERAGES =		75,370	114	0.43	59,595	103	0.66	40,080	90	0.83	7,259	29	0.82	13,410	96	0.81	195,714	431

[a] Stations 1 and 2 were averaged from 1994-1997.



Appendix G.8. Weighted mean zooplankton biomass by genera (stations 1&2 averaged) and juvenile stocking levels for Crescent Lake, 1987 and 1990-1998.

Appendix G.9. Juvenile sockeye salmon estimates based on townet catches and hydroacoustic fish population estimates from Crescent Lake, 1992 and 1994.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	Number	Low	High	Number	Low	High	(%)
9/28/92	84,705	68,049	101,361	75,557	60,700	90,414	89.2
10/14/94	149,254	85,187	213,321	0[a]	0	0	0

[a] Sockeye salmon estimates are based on townet catches to determine species composition in the lake environment. Four tows were conducted, capturing 0 sockeye and 21 sticklebacks. Juvenile sockeye salmon have been stocked into the lake, annually, since 1992.

Appendix G.10. Townet catches from Crescent Lake, 1992 and 1994.

			Catch by Species					
	Tow		Sockeye			Stickleback		
Year	No.	Minutes	No.	%	CPUE	No.	%	CPUE
9/28/92	3	39	83	91.1	2.1	10	8.9	0.3
10/14/94	4	52	0	0.0	0.0	21	100.0	0.4

Appendix G.11. Mean length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Crescent Lake, 1992 and 1994.

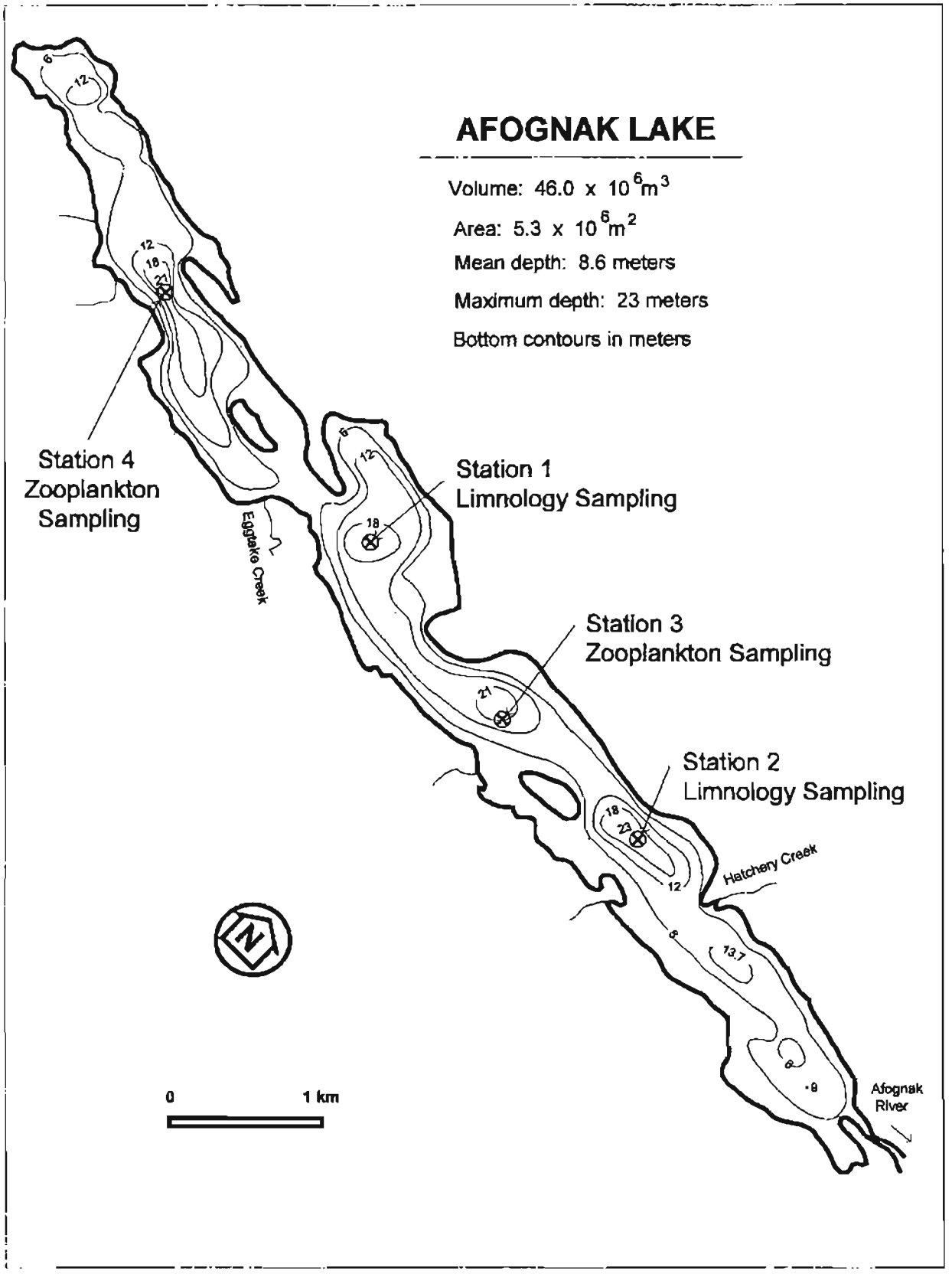
	Age-0					Age-1				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
9/28/92	83	100.0	67.2	3.5	1.13	0	0.0	0.0	0.0	0.0
10/14/94	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0

Appendix G.12. Common property salmon harvest in Settler Cove Terminal Harvest Area from the Crescent Lake enhancement project, 1990-1998.

	Sockeye		Coho	
Year	Commercial	Subsistence	Commercial	Subsistence
1990	0	0	0	1,158
1991	0	0	0	1,505
1992	0	0	0	1,391
1993	0	15	0	1,271
1994[a]	0	450	1,100	897
1995	253	1,263	79	1,184
1996	13,000	1,205	0	263
1997	6,356	1,620	0	372
1998	3,085	888	0	293

[a] Sockeye salmon returns to the terminal harvest area did not occur until 1994.

Data was obtained from the ADF&G fish ticket and subsistence harvest data base, 1990-1998.



Appendix H.1. Morphometric map showing the limnology and zooplankton stations on Afognak Lake.

Appendix H.2. Juvenile sockeye salmon stocked into Afognak Lake, 1992-1998.

Brood		Release Year						
Source	Life Stage[a]	1992	1993	1994	1995	1996	1997	1998
Afognak	fingerling	160,000		311,000		528,000	197,300	334,200
Lake	pre-smolt	304,000					131,000	88,500
	Total:	464,000		311,000		528,000[b]	328,300	422,700

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g).

[b] A portion of the fingerling outstocked were air dropped from a fixed-wing aircraft.

Appendix H.3. The amount of nutrient enrichment additions and ratios into Afognak Lake, 1990-1998.

Year	Fertilizer ratio[a]	Amount (kg)
1990	20-5-0	11,818
1990	32-0-0	18,181
1991	20-5-0	13,636
1991	32-0-0	19,364
1992	20-5-0	13,636
1992	32-0-0	19,363
1993	20-5-0	21,818
1994	20-5-0	27,216
1995	20-5-0	27,216
1996	20-5-0	25,400
1997	20-5-0	25,400
1998	20-5-0	25,400

[a] Nitrogen-Phosphorus-Potassium

Appendix H.4. Limnological sampling stations and sampling frequencies for Afognak Lake, 1987-1998.

Year	Sampling	
	Stations	Frequency
1987	1, 2	4
1988	1, 2	4
1989	1, 2	5
1990	1, 2	7
1991	1, 2	6
1992	1, 2	7
1993	1, 2	7
1994	1 - 4	8
1995	1 - 4	7
1996	1 - 4	5
1997	1 - 4	6
1998	1	4

Appendix H.5. Summary of seasonal mean water chemistry parameters by station and depth for Afognak Lake, 1990 - 1998.

Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD[a]	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1990	1	1	40.5	1.7	6.8	0.1	6.3	0.5	0.8	0.4	13.5	3.4	2.9	1.4	0.4	0.3	120.8	24.3
1990	1	16	41.3	1.0	6.7	0.2	6.1	0.6	0.7	0.4	11.0	2.2	3.2	1.8	0.4	0.3	128.3	38.7
1991	1	1	38.0	0.8	6.7	0.1	10.4	7.8	0.9	0.3	13.0	0.8	2.1	0.3	0.8	0.5	210.0	31.1
1991	1	14	38.3	1.0	6.6	0.2	6.9	0.3	0.9	0.2	15.8	3.9	1.9	0.1	0.8	0.5	190.3	45.0
1992	1	1	34.5	1.2	6.6	0.2	5.8	1.0	0.9	0.5	11.5	3.4	2.5	0.9	0.6	0.3	156.5	9.3
1992	1	24	34.5	0.5	6.3	0.1	4.9	1.0	0.8	0.6	10.7	1.5	2.5	1.2	0.6	0.3	162.3	56.9
1993	1	1	36.5	1.0	6.6	0.1	7.5	2.7	0.5	0.1	6.6	7.5	2.2	0.4	1.3	1.1	103.6	34.9
1993	1	25	39.0	4.0	6.4	0.4	7.8	2.1	0.5	0.2	10.0	10.7	2.6	0.9	0.8	0.1	134.2	52.0
1994	1	1	39.0	6.5	6.6	0.2	6.2	2.0	1.1	0.8	5.0	3.2	2.2	0.9	0.6	0.2	140.7	44.0
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	26	36.0	0.9	6.3	0.3	6.5	2.5	0.7	0.3	5.5	4.7	2.2	0.5	0.6	0.2	197.2	87.7
1995	1	1	59.7	5.6	6.6	0.2	9.8	1.0	2.0	0.8	10.9	2.6	3.7	1.4	1.3	0.4	85.0	45.6
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	17	59.6	5.4	6.5	0.2	10.0	1.3	2.3	1.2	9.1	2.0	3.4	0.5	1.6	0.5	101.4	33.0
1995	2	1	57.9	4.9	6.6	0.2	9.7	1.1	1.9	0.9	10.9	4.3	3.2	0.3	1.1	0.3	87.4	55.9
1995[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	2	11	58.4	4.3	6.5	0.2	9.6	1.1	2.0	0.8	10.0	5.5	3.5	0.4	1.3	0.3	100.9	53.9
1996	1	1	56.4	1.5	6.7	0.2	10.5	0.7	1.4	1.0	9.8	2.5	3.2	0.5	1.3	0.2	54.0	25.9
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	18	56.8	2.7	6.6	0.1	11.2	1.9	1.5	0.7	9.4	0.5	3.1	0.5	1.1	0.3	72.2	33.2
1996	2	1	56.0	1.4	6.7	0.1	10.7	1.0	1.2	0.6	9.2	1.3	3.1	0.5	1.1	0.3	53.6	25.7
1996[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	2	11	56.6	1.1	6.7	0.1	10.7	1.0	1.5	0.6	10.8	2.6	2.9	0.5	1.5	0.3	89.4	43.4
1997	1	1	53.0	0.6	7.1	0.2	12.1	1.6	1.1	0.1	9.2	1.9	3.1	0.4	1.1	0.3	27.7	16.6
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	18	57.7	6.7	6.8	0.2	13.9	3.5	1.7	0.4	10.3	0.8	2.9	0.5	1.7	1.1	68.2	37.7
1997	2	1	53.2	0.8	7.1	0.1	11.7	0.5	1.0	0.2	10.8	3.8	3.0	0.3	1.0	0.3	33.8	17.3
1997[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	2	13	53.4	0.5	7.0	0.1	11.9	0.3	1.3	0.5	9.6	3.0	2.9	0.3	1.0	0.3	44.4	25.8
1998	1	1	48.7	0.6	7.0	0.1	12.6	1.3	1.7	1.2	17.7	10.7	3.2	0.5	0.8	0.2	25.7	15.0
1998	1	18	48.0	na	7.0	na	11.8	na	2.0	na	11.0	na	3.3	na	1.0	na	48.0	na

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

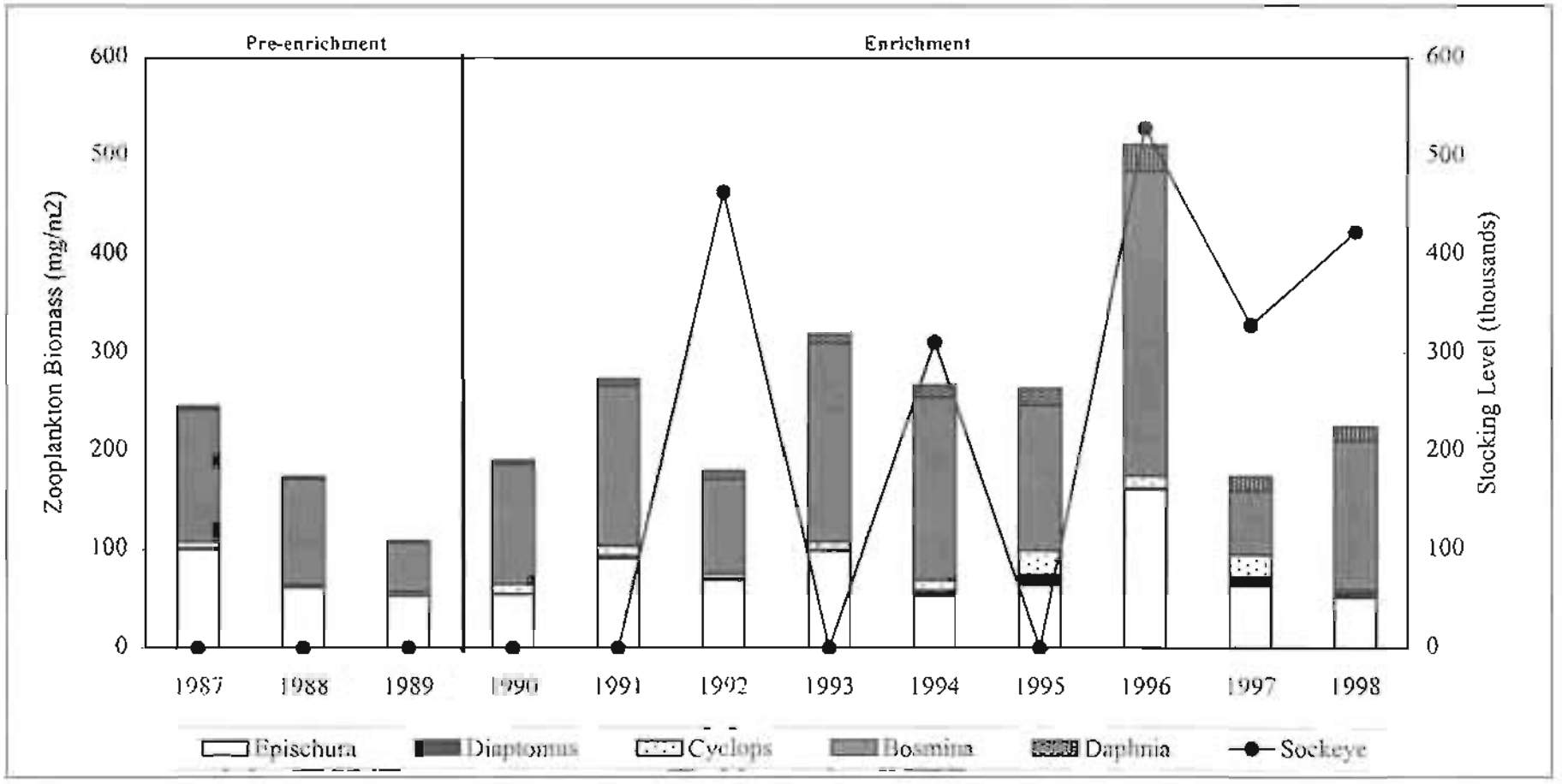
Appendix H.6. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Afognak Lake, 1990 - 1998.

Year	Station	Depth (m)	Total Phosphorus (ug L^{-1})	SD[a]	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon[b] (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1990	1	1	4.5	1.5	2.9	4.2	3.7	1.7	128.0	16.5	8.0	3.0	40.3	29.1	3249.8	247.5	144.5	13.0	0.34	0.2	0.17	0.0
1990	1	16	5.1	2.3	1.3	1.3	2.8	1.1	117.7	22.7	9.7	4.2	65.0	29.1	3389.8	154.5	144.0	30.6	0.21	0.0	0.28	0.1
1991	1	1	5.0	2.8	3.2	0.6	2.3	0.4	150.6	22.6	11.5	1.8	56.8	21.3	2865.0	108.6	NA	NA	0.31	0.2	0.27	0.1
1991	1	14	4.6	1.5	6.0	3.5	4.5	3.2	138.3	12.3	13.6	5.0	69.7	23.2	2966.0	156.3	NA	NA	0.22	0.1	0.22	0.1
1992	1	1	3.8	0.5	4.1	2.5	3.1	2.4	135.0	13.9	3.3	1.7	61.7	26.1	3162.8	158.9	198.8	64.1	0.44	0.3	0.28	0.1
1992	1	24	3.9	1.7	4.0	3.2	2.6	1.7	127.4	12.8	9.6	4.1	92.8	23.1	3181.7	198.0	162.6	52.9	0.31	0.2	0.28	0.1
1993	1	1	4.5	0.8	3.7	1.3	2.8	0.5	148.0	18.5	5.0	2.2	49.1	30.4	3132.2	220.6	146.8	53.3	1.01	0.3	0.36	0.0
1993	1	25	4.9	1.3	8.5	11.7	6.8	9.9	136.2	17.3	19.4	10.1	98.4	31.7	3379.6	244.0	120.6	47.5	0.52	0.2	0.45	0.1
1994	1	1	5.7	0.7	4.5	3.3	3.6	2.3	159.8	23.8	3.2	1.7	39.8	21.4	2843.3	122.4	114.3	33.0	0.56	0.3	0.28	0.1
1994[c]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.56	0.3	0.34	0.1
1994	1	26	5.3	1.1	4.8	3.9	4.2	3.2	160.4	17.7	15.2	9.7	74.3	23.8	3176.7	285.5	128.2	52.1	0.36	0.2	0.27	0.1
1995	1	1	8.7	2.7	3.0	1.5	2.0	1.1	168.3	21.6	9.5	14.1	65.9	22.1	1873.1	735.0	na	na	3.92	2.4	1.13	0.6
1995[c]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	4.42	3.0	1.15	0.7
1995	1	17	8.1	2.0	1.9	1.1	1.1	0.4	186.8	47.1	34.7	44.3	45.1	35.0	2045.9	618.4	na	na	3.13	1.7	1.10	0.5
1995	2	1	7.4	2.1	2.1	1.2	1.7	1.0	168.7	31.0	9.4	14.0	54.4	33.2	1941.9	753.9	na	na	4.20	2.9	1.05	0.7
1995[c]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	3.71	2.2	1.06	0.6
1995	2	11	7.2	1.7	2.2	2.0	1.6	1.1	157.0	26.0	16.4	17.4	51.9	34.1	2142.6	805.6	na	na	3.27	2.2	1.05	0.6
1996	1	1	9.2	2.6	3.4	0.7	2.8	0.3	161.4	34.0	17.5	13.9	39.6	29.2	2465.0	297.2	224.8	80.3	2.39	1.2	0.82	0.4
1996[c]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.16	1.0	1.08	0.5
1996	1	18	8.2	2.7	2.4	0.7	2.2	0.3	161.4	56.5	36.3	37.6	50.9	27.8	2662.6	176.1	190.4	73.1	1.40	0.6	0.81	0.4
1996	2	1	8.8	2.6	2.7	0.8	2.2	0.4	160.3	37.3	8.2	14.6	40.7	25.9	2466.0	275.0	225.6	52.5	1.77	0.5	0.85	0.4
1996[c]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.72	0.3	0.83	0.4
1996	2	11	8.4	2.8	3.4	1.6	2.9	1.3	147.2	41.3	28.7	24.5	49.7	25.9	2629.8	220.7	168.6	55.7	1.07	0.3	0.77	0.3
1997	1	1	7.3	1.9	2.7	1.0	2.6	0.9	155.2	33.9	14.0	14.2	21.9	23.9	2346.7	354.4	273.3	63.8	2.56	1.4	1.51	0.7
1997[c]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.59	1.5	1.58	0.8
1997	1	18	7.2	1.5	2.6	0.5	2.3	0.4	193.7	68.6	63.6	53.3	55.3	14.5	2994.5	503.5	196.8	28.8	1.12	0.5	1.08	0.4
1997	2	1	6.9	1.7	3.6	1.8	3.1	1.5	155.8	37.8	13.3	15.8	16.9	21.8	2435.2	351.3	252.2	62.8	1.68	1.3	1.19	0.8
1997[c]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.78	1.3	1.23	0.8
1997	2	13	6.5	1.4	2.8	1.9	2.3	0.8	148.1	38.7	20.9	12.4	29.6	20.1	2584.0	433.5	155.8	50.6	1.33	1.2	1.06	0.8
1998	1	1	9.0	1.7	3.3	0.8	1.9	0.0	192.9	7.7	21.2	13.9	38.1	15.9	2387.0	73.0	151.7	118.8	0.10	0.0	0.04	0.0
1998	1	18	7.5	na	3.7	na	1.9	na	182.2	na	24.5	na	62.6	na	2311.0	na	36.0	na	0.09	na	0.03	na

[a] SD - standard deviation
[b] Organic carbon levels were not determined from 1995 samples.
[c] na - parameters were not analyzed at the 2 meter depth.

Appendix H.7. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) from Afognak Lake, 1987-1998.

Station	Number	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1 & 2	of	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Samples	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)
1987	4	28,835	100	0.91	173	1	0.91	4,127	6	0.65	138,370	134	0.33	3,218	4	0.54	2,574	6	0.52	177,297	251
1988	4	16,508	61	0.95	20	0	1.44	1,997	3	0.70	107,650	107	0.33	1,184	3	0.68	1,085	3	0.54	128,444	177
1989	5	13,314	53	0.95	0	0	0.00	2,462	4	0.66	58,937	50	0.31	1,099	2	0.64	950	2	0.47	76,762	110
1990	7	13,994	54	0.95	4	0	0.90	6,724	11	0.67	141,664	121	0.31	2,871	5	0.63	4,485	8	0.47	169,741	198
1991	6	20,282	91	1.00	770	3	0.84	5,442	10	0.74	181,458	163	0.32	3,718	8	0.69	4,554	9	0.50	216,222	283
1992	7	16,208	69	0.97	315	1	0.94	3,122	5	0.68	94,856	96	0.33	4,017	9	0.72	2,443	5	0.45	120,959	185
1993	7	26,463	99	0.94	425	1	0.76	4,921	8	0.67	207,962	202	0.33	5,130	10	0.67	3,852	8	0.49	248,751	326
1994	8	17,360	53	0.89	1,314	5	0.95	6,484	11	0.67	191,551	186	0.33	6,971	13	0.65	4,870	9	0.47	228,548	276
1995	7	14,476	64	0.98	3,382	10	0.91	16,993	25	0.64	162,147	148	0.32	11,321	17	0.60	1,281	2	0.47	209,599	265
1996	5	31,502	161	1.04	223	1	0.99	7,272	13	0.73	285,276	309	0.35	10,202	27	0.77	2,240	4	0.45	336,715	515
1997	6	14,022	63	1.00	4,494	9	0.75	14,194	23	0.66	83,825	65	0.29	10,686	15	0.57	919	1	0.42	128,140	175
1998	4	15,672	51	0.90	1,088	4	0.96	2,070	3	0.64	169,971	151	0.29	10,881	15	0.54	5,441	9	0.39	205,123	233
AVG =	6	19,053	77	0.69	1,017	3	0.31	6,317	10	0.33	151,972	144	0.23	5,941	10	0.34	2,891	5	0.41	187,192	249



Appendix H.8. Weighted mean zooplankton biomass by genera (stations 1&2 averaged), lake enrichment time period, and juvenile sockeye salmon stocking levels for Afognak Lake, 1987-1998.

Appendix H.9. Juvenile sockeye salmon estimates based on townet catches and hydroacoustic fish population estimates for Afognak Lake, 1990 and 1992-1995.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% Confidence Interval			95% Confidence Interval		Composition
Year	Number	Low	High	Number	Low	High	(%)
9/4/90	3,605,299	1,842,657	5,367,941	30,051	19,848	40,254	0.6
9/10/92	2,582,981	2,120,870	3,045,092	135,462	111,748	159,176	5.5
10/9/93	3,002,179	2,675,902	3,328,456	172,461	127,629	217,293	4.5
10/12/94	3,439,596	2,441,089	4,438,103	1,996,715	1,477,661	2,515,769	52.1
9/12/95	2,097,152	1,479,667	2,714,637	23,069	16,277	29,861	1.1

Appendix H.10. Townet catches from Afognak Lake, 1990 and 1992-1995.

			Catch by Species					
	Number	Total	Sockeye			Stickleback		
Year	of Tows	Minutes	Number	%	CPUE[a]	Number	%	CPUE[a]
9/5/90	2	60	6	0.7	0.1	927	99.3	15.5
9/11/92	3	52	132	13.8	2.5	2,253	86.2	43.3
10/10/93	3	60	32	6.7	0.5	673	93.4	11.2
10/12/94	1	19	114	52.1	6.0	105	47.9	5.5
9/12/95	5	na[b]	37	1.1	na[b]	3,396	98.9	na[b]

[a] CPUE - Catch per unit of effort

[b] na - data were not available.

Appendix H.11. Mean length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet from Afognak Lake, 1990 and 1992-1995.

	Age-0					Age-1				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
9/5/90	5	83.3	56.0	2.3	1.31	1	16.7	71.0	4.5	1.26
9/10/92	62	93.9	63.5	3.4	1.31	4	6.1	68.8	4.1	1.24
10/10/93	25	83.3	59.0	2.7	1.28	5	16.7	77.6	5.5	1.17
10/13/94	50	98.0	59.6	2.6	1.20	1	2.0	76.0	5.6	1.28
9/13/95	1	3.6	53.2	1.9	1.25	27	96.4	67.4	3.7	1.21

Appendix H.12. Population estimate of the sockeye smolt emigration from Afognak Lake, 1990.

	Trap Catch					Dye Test			
	Sockeye	Sockeye	Estimated	95% Confidence Interval		Dyed	Dyed	Cum.	Trap
Date	Daily	Cumulative	Migration	lower	upper	Released	Recovered	Recovered	Efficiency
23-May	52	52	723	432	1,013				7.4% [1]
24-May	216	268	3,003	1,997	4,008				7.4% [1]
25-May	228	496	3,169	2,112	4,227	474	35	35	7.4%
26-May	84	580	1,168	736	1,599		0	35	7.4%
27-May	115	695	1,599	1,032	2,166		0	35	7.4%
28-May	45	740	626	366	885		0	35	7.4%
29-May	72	812	1,001	622	1,380		0	35	7.4%
30-May	72	884	1,440	752	2,128	342	18	18	5.3%
31-May	38	922	760	366	1,154		0	18	5.3%
1-Jun	90	1,012	1,800	958	2,642		0	18	5.3%
2-Jun	71	1,083	1,420	741	2,099		0	18	5.3%
3-Jun	100	1,183	2,000	1,072	2,928		0	18	5.3%
4-Jun	215	1,398	4,300	2,388	6,212		0	18	5.3%
5-Jun	260	1,658	5,200	2,903	7,497		0	18	5.3%
6-Jun	226	1,884	4,520	2,514	6,526		0	18	5.3%
7-Jun	202	2,086	2,359	1,626	3,092	480	42	42	8.8%
8-Jun	275	2,361	3,211	2,236	4,186		0	42	8.8%
9-Jun	226	2,587	2,639	1,828	3,452		0	42	8.8%
10-Jun	169	2,756	1,973	1,350	2,597		0	42	8.8%
11-Jun	107	2,863	1,249	833	1,666		0	42	8.8%
12-Jun	198	3,061	2,312	1,592	3,032		0	42	8.8%
13-Jun	49	3,110	572	352	793		0	42	8.8%
14-Jun	40	3,150	467	278	656		0	42	8.8%
15-Jun	64	3,214	747	475	1,019		0	42	8.8%
16-Jun	24	3,238	280	149	412		0	42	8.8%
17-Jun	5	3,243	58	8	109		0	42	8.8%
18-Jun	29	3,272	339	189	488		0	42	8.8%
19-Jun	22	3,294	257	133	381		0	42	8.8%
20-Jun	13	3,307	152	64	240		0	42	8.8%
21-Jun	21	3,328	245	125	365		0	42	8.8%
22-Jun	4	3,332	47	2	91		0	42	8.8%
23-Jun	10	3,342	117	41	192		0	42	8.8%
24-Jun	4	3,346	47	2	91		0	42	8.8%
Total:	3,346	3,346	49,800	30,274	69,326	1,296		95	7.1%

[a] The first mark/recapture test strata calculation on May 25 was expanded to the daily catches from May 23-24.

Appendix H.13. Population estimate of the sockeye salmon smolt emigration from Afognak Lake, 1991.

	Trap Catch					Dye Test			
	Sockeye	Sockeye	Estimated	95% Confidence Interval		Dyed	Dyed	Cum.	Trap
Date	Daily	Cumulative	Migration	lower	upper	Released	Recovered	Recovered	Efficiency
13-May	1	1	12	0	34				8.6%[a]
14-May	7	8	84	21	147				8.6%[a]
15-May	8	16	95	27	164				8.6%[a]
16-May	5	21	60	8	112				8.6%[a]
17-May	5	26	60	8	112				8.6%[a]
18-May	31	57	370	205	535				8.6%[a]
19-May	15	72	179	79	279				8.6%[a]
20-May	44	116	525	311	739				8.6%[a]
21-May	125	241	1,492	981	2,003				8.6%[a]
22-May	54	295	645	393	896				8.6%[a]
23-May	77	372	919	583	1,255				8.6%[a]
24-May	1,184	1,556	14,133	9,818	18,448				8.6%[a]
25-May	571	2,127	6,816	4,701	8,930	431	34	34	7.9%
26-May	169	2,296	2,017	1,348	2,687		3	37	8.6%
27-May	289	2,585	3,450	2,348	4,551		0	37	8.6%
28-May	565	3,150	18,875	10,173	27,576		0	37	8.6%
29-May	154	3,304	5,145	2,687	7,602		0	37	8.6%
30-May	132	3,436	4,410	2,287	6,532		0	37	8.6%
31-May	616	4,052	20,578	11,102	30,055		0	37	8.6%
1-Jun	540	4,592	18,039	9,717	26,362	504	14	14	2.8%
2-Jun	187	4,779	6,247	3,288	9,206		1	15	3.0%
3-Jun	474	5,253	15,835	8,515	23,154		1	16	3.2%
4-Jun	173	5,426	3,187	1,991	4,383		0	16	3.2%
5-Jun	63	5,489	1,161	675	1,646		0	16	3.2%
6-Jun	490	5,979	9,027	5,796	12,258		0	16	3.2%
7-Jun	375	6,354	6,908	4,415	9,401		0	16	3.2%
8-Jun	91	6,445	1,676	1,009	2,344	499	25	25	5.0%
9-Jun	403	6,848	7,424	4,751	10,097		2	27	5.4%
10-Jun	257	7,105	4,735	2,999	6,470		1	28	5.6%
11-Jun	307	7,412	3,918	2,708	5,128		0	28	5.6%
12-Jun	177	7,589	2,259	1,532	2,986		0	28	5.6%
13-Jun	275	7,864	3,510	2,418	4,601		0	28	5.6%
14-Jun	210	8,074	2,680	1,830	3,530		0	28	5.6%

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	Trap Catch					Dye Test			
	Sockeye	Sockeye	Estimated	95% Confidence Interval		Dyed	Dyed	Cum.	Trap
Date	Daily	Cumulative	Migration	lower	upper	Released	Recovered	Recovered	Efficiency
15-Jun	305	8,379	3,892	2,690	5,095	499	6	6	1.2%
16-Jun	246	8,625	3,139	2,156	4,123		32	38	7.6%
17-Jun	236	8,861	3,012	2,065	3,958		2	40	8.0%
18-Jun	425	9,286	5,776	3,934	7,618		0	40	8.0%
19-Jun	256	9,542	3,479	2,341	4,617		0	40	8.0%
20-Jun	132	9,674	1,794	1,174	2,414		0	40	8.0%
21-Jun	194	9,868	2,637	1,757	3,516		0	40	8.0%
22-Jun	146	10,014	1,984	1,306	2,663		0	40	8.0%
23-Jun	99	10,113	1,345	864	1,827	477	34	34	7.1%
24-Jun	80	10,193	1,087	686	1,488		2	36	7.5%
25-Jun	87	10,280	1,182	752	1,613		0	36	7.5%
26-Jun	53	10,333	720	434	1,006		0	36	7.5%
Total:	10,333	228,108	196,516	118,873	274,159	2,410		157	6.6%

[a] The first mark/recapture test strata calculation on May 25 was expanded to the daily catches from May 13-24.

Appendix H.14. Mean length, weight, and condition coefficient by age for sockeye salmon smolt samples at Afognak Lake, 1987-1998.

	Age-1					Age-2					Age-3				
			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition
Date	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)
8-Jun	36	16.2	74.9	3.6	0.85	186	83.8	79.3	3.6	0.86	0	0.0	0.0	0.0	0.00
15-Jun	202	100.0	77.9	4.1	0.90	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
15-Jun	208	99.1	76.8	4.1	0.91	2	0.9	78.0	5.2	1.10	0	0.0	0.0	0.0	0.00
May23-June 24	544	96.3	68.8	2.5	0.76	21	3.7	77.3	3.4	0.73	0	0.0	0.0	0.0	0.00
May 13-June 26	1,895	91.5	72.9	3.1	0.78	176	8.5	78.3	3.9	0.81	0	0.0	0.0	0.0	0.00
June 7-20	268	87.9	77.0	3.8	0.82	37	12.1	76.9	3.8	0.83	0	0.0	0.0	0.0	0.00
May 24-30	274	92.9	72.7	3.0	0.78	21	7.1	74.8	3.3	0.79	0	0.0	0.0	0.0	0.00
May 17-23	138	49.3	72.0	3.0	0.81	142	50.7	84.3	4.7	0.79	0	0.0	0.0	0.0	0.00
May 31-June 13	394	98.7	69.4	2.8	0.84	5	1.3	78.8	3.6	0.74	0	0.0	0.0	0.0	0.00
June 5-11	54	13.7	80.9	4.6	0.87	339	86.3	81.6	4.8	0.88	0	0.0	0.0	0.0	0.00
May 24-30	76	38.2	81.7	4.3	0.78	122	61.3	82.1	4.4	0.79	1	0.5	90.0	5.6	0.77
May 24-30	116	71.2	66.4	2.6	0.82	46	28.2	88.0	6.6	0.90	1	0.6	103.0	10.0	0.92

Appendix H.15. Afognak Lake sockeye salmon escapement counts, 1989-1998.

					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/20										60
5/21									4	280
5/22									5	43
5/23					3			1,688	151	864
5/24			1	162	213			719	165	325
5/25			27	172	38			81	5	775
5/26			7	60	41			1,313	630	23
5/27		38	285	174	101			636	2,180	2,287
5/28		88	668	94	329	21		1,833	3,112	394
5/29		317	207	7	52	1	1	1,161	5,993	227
5/30		460	4	102	969	9	1,884	1,685	5,011	1,500
5/31		520	117	521	350	10	23	4,062	2,938	3,282
6/1	45	363	2,456	46	147	78	1,148	6,144	481	2,113
6/2	1,010	909	2,358	294	47	82	3,805	6,693	1,565	620
6/3	493	1,230	2,461	3,105	3,300	1,078	5,153	3,453	1,983	1,408
6/4	1,482	2,492	3,144	895	53	750	5,525	4,015	6,233	994
6/5	3,273	2,387	2,871	919	3,000	1,235	2,797	3,505	4,558	4,703
6/6	2,740	1,033	3,743	1,628	1,841	616	561	2,629	7,872	2,633
6/7	1,458	4,383	3,576	1,502	2,615	5	3,929	4,434	761	1,651
6/8	310	983	7,003	2,341	1,034	5,149	360	3,484	5,819	797
6/9	3,731	2,568	3,237	1,352	503	1,934	8,320	6,683	3,970	2,041
6/10	7,447	3,345	4,500	2,182	2,521	1,535	4,208	1,859	4,693	607
6/11	2,892	3,682	2,320	755	950	1,106	4,642	159	8,072	3,364
6/12	3,635	1,257	523	4,399	2,097	1,458	466	250	6,126	613
6/13	2,461	10,303	3,733	942	2,238	317	9	720	8,478	397
6/14	847	6,162	5,670	1,152	1,096	6,481	2,659	1,011	6,956	775
6/15	300	3,342	2,562	240	2,404	680	855	285	5,075	1,168
6/16	2,136	613	2,205	2,229	1,677	5,631	4,587	220	1,190	436
6/17	800	492	685	208	3,710	5,300	3,614	1,402	3,585	1,040
6/18	5,386	1,948	1,833	4,572	2,329	1,017	948	175	3,172	585
6/19	776	3,344	1,161	941	1,373	1,621	3,513	3,736	1,070	1,270
6/20	536	5,235	655	1,963	791	3,368	2,274	1,031	870	539
6/21	3,360	3,185	546	866	1,454	1,986	1,114	902	1,081	704
6/22	3,285	1,017	501	1,602	2,924	804	2,570	281	1,344	218
6/23	1,416	343	683	1,706	1,037	317	4,217	2,539	989	4,546
6/24	4,384	843	107	2,466	1,857	1,681	872	2,734	4,082	263
6/25	878	936	1,802	970	815	427	1,610	128	809	87
6/26	1,555	1,453	1,650	2,083	1,084	2,108	2,519	174	1,276	495

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					------YEAR------					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
6/27	2,012	295	1,977	1,060	1,678	7,163	2,850	1,075	103	1,472
6/28	1,850	641	1,486	1,408	845	995	1,058	1,505	374	263
6/29	828	242	2,652	1,160	2,112	1,799	1,207	876	962	2,313
6/30	1,576	224	1,992	510	1,988	1,493	1,988	8	1,335	192
7/1	949	535	498	760	31	957	867	105	732	670
7/2	152	1,729	222	1,313	917	1,374	241	279	192	1,498
7/3	168	391	38	1,325	324	627	1,252	2,584	99	1,328
7/4	149	671	750	2,071	539	1,507	2,227	2,421	34	115
7/5	966	74	910	926	3,113	1,234	2,220	1,452	218	167
7/6	245	1,185	202	1,080	236	1,629	276	5,489	39	0
7/7	175	805	185	1,091	5,872	689	2,129	2,730	305	80
7/8	221	529	348	5,077	325	426	457	251	22	408
7/9	284	2,374	331	1,020	60	306	73	286	192	300
7/10	450	685	118	967	429	5,009	603	909	3,820	618
7/11	108	513	12	1,053	582	2,281	48	449	579	640
7/12	405	343	0	327	313	682	281	822	120	115
7/13	7	179	179	518	281	807	506	562	20	573
7/14	4,127	2,010	130	440	148	451	87	425	362	558
7/15	1,701	72	44	566	100	56	1,349	100	385	894
7/16	917	717	120	1,275	98	0	1,048	300	110	416
7/17	687	0	142	448	0	624	774	210	568	362
7/18	81	116	135	239	120	84	95	317	188	36
7/19	65	360	164	15	110	102	250	443	179	110
7/20	167	320	132	940	397	50	459	440	327	6,389
7/21	183	145	25	334	118	90	379	160	169	539
7/22	57	2,058	97	1,193	91	51	52	6	23	253
7/23	1,855	63	263	984	255	25	54	507	136	71
7/24	1,541	142	758	392	431	295	20	2,269	46	57
7/25	871	145	541	161	363	187	104	399	170	45
7/26	502	213	37	556	143	163	7	86	0	21
7/27	355	2,086	132	58	108	182	23	61	0	13
7/28	756	1,842	195	1,638	180	111	375	5	159	60
7/29	1,014	568	70	81	147	301	582	57	0	44
7/30	505	154	59	136	149	37	56	1	52	56
7/31	35	295	2,238	105	140	90	56	8	153	101
8/1	99	806	6	546	82	72	211	40	1,821	54
8/2	425	216	22	48	51	151	166	6	136	227
8/3	376	189	251	938	6	245	209	70	166	338
8/4	281	168	43	177	13	471	93	68	193	52
8/5	62	96	103	102	10	338	25	228	143	261

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					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/6	274	41	166	69	16	99	44	56	140	54
8/7	131	90	5	71	30	112	50	69	262	116
8/8	431	102	34	26	91	38	41	64	2,302	118
8/9	43	55	6	60	45	27	51	98	344	34
8/10	141	39	113	28	96	24	22	71	38	26
8/11	40	168	45	71	118	9	16	60	174	38
8/12	130	41	27	120	33	2	263	83	9	19
8/13	86	6	2,875	58	22	5	38	87	150	74
8/14	102	54	73	90	1,257	2	10	42	441	77
8/15	97	66	3,295	142	93	0	26	34	90	86
8/16	469	71	2	36	18	1	41	47	30	62
8/17	1,207	31	57	10	35	3	27	19	78	48
8/18	934	28	20	16	153	15	7	14	26	42
8/19	107	32	367	50	803	2	7	50	26	29
8/20	54	32	33	25	95	0	5	44	38	20
8/21	19	31	7	18	28	31	9	115	89	13
8/22	57	12	23	3	121	26	15	10	66	10
8/23	31	18	16	71	9	14	11	30	57	13
8/24	24	20	9	18	3	3	31	272	14	28
8/25	121	17	70	2	422	16	11	32	8	10
8/26	39	9	69	5	26	5	44	49	8	2
8/27	34	23	22	4	11	4	35	14	8	5
8/28	35	5	6	13	4	2	43	8	17	6
8/29	13	2	45	21	3	8	33	5	23	1
8/30	8	0	15	15	1	2	38	2	8	3
8/31	29	1	3	4	3	1	30	3	23	50
9/1	38	8	9	3	5	1	12	0	11	18
9/2	10	5	1	5	4	2	8	6	4	11
9/3	5	20	210	6	1	1	5	0	4	3
9/4	8	6	11	0	4	2	4	0	4	1
9/5	6	3	6	2	4	2	84	0	27	6
9/6	4	2	6	0	2	3	8	344	19	4
9/7	7	4	3	0	2	0	13	119	478	4
9/8	3	6	0	4	1	1	2	17	86	2
9/9	0	3	0	0	3	0	2	13	12	0
9/10	1	2	0	0	0	80	3	8	0	0
9/11	5	2	0	0	0	5	2	0	0	0
9/12	7	5	0	3	0	0	100	0	0	0
9/13	4	0	0	2	0	3	0	0	0	0
9/14	1	113	0	1	0	8	0	0	0	0

-Continued-

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					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
9/15	16	0	0	500	0	5	0	0	0	0
9/16	8	26	0	0	0	19	0	0	0	0
9/17	138	0	0	0	0	28	0	0	0	0
9/18	23	0	0	0	0	0	0	0	0	0
9/19	27	0	0	0	0	0	0	0	0	0
9/20	15	0	0	0	0	0	0	0	0	0
Total:	88,825	90,666	88,557	77,260	71,460	80,570	100,131	101,718	132,050	66,869

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix H.16. Estimated age composition of the Afognak Lake sockeye salmon escapement, 1987-1998.

Year	Sample Size		Ages 0.1	0.2	0.3	1.1	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	Total
1987	281	Percent	0.4	0.0	0.0	6.4	37.0	1.1	36.3	4.3	0.0	0.0	14.6	0.0	0.0	0.0	100
		Numbers	96	0	0	1,695	9,797	284	9,609	1,131	0	0	3,863	0	0	0	26,474
1988	933	Numbers	0	51	55	263	23,059	824	9,773	4,488	0	0	429	0	0	0	39,012
		Percent	0.0	0.1	0.1	0.7	59.1	2.1	25.1	11.5	0.0	0.0	1.1	0.0	0.0	0.0	100
1989	1,088	Numbers	0	0	0	13,288	13,404	3,135	35,165	16,314	0	0	7,519	0	0	0	88,825
		Percent	0.0	0.0	0.0	15.0	15.1	3.5	39.6	18.4	0.0	0.0	8.5	0.0	0.0	0.0	100
1990	1,053	Numbers	0	0	26	597	42,314	553	20,518	7,754	0	261	18,613	0	26	0	90,662
		Percent	0.0	0.0	0.0	0.7	46.7	0.6	22.6	8.6	0.0	0.3	20.5	0.0	0.0	0.0	100
1991	1,062	Numbers	0	0	0	295	13,054	196	67,805	3,101	0	0	4,106	0	0	0	88,557
		Percent	0.0	0.0	0.0	0.3	14.7	0.2	76.6	3.5	0.0	0.0	4.6	0.0	0.0	0.0	100
1992	1,025	Numbers	0	0	0	16,362	17,115	7,681	23,096	2,938	90	394	9,526	61	0	0	77,263
		Percent	0.0	0.0	0.0	21.2	22.2	9.9	29.9	3.8	0.1	0.5	12.3	0.0	0.0	0.0	100
1993	852	Numbers	0	0	0	11,837	7,634	12,318	21,667	8,818	53	0	8,965	163	0	0	71,455
		Percent	0.0	0.0	0.0	16.6	10.7	17.2	30.3	12.3	0.1	0.0	12.5	0.2	0.0	0.0	100
1994	840	Numbers	0	222	0	7,703	24,648	3,337	28,385	8,316	125	61	7,708	64	0	0	80,569
		Percent	0.0	0.3	0.0	9.6	30.6	4.1	35.2	10.3	0.2	0.1	9.6	0.1	0.0	0.0	100
1995	848	Numbers	0	0	161	2,281	21,788	837	56,367	10,773	0	149	7,776	0	0	0	100,132
		Percent	0.0	0.0	0.2	2.3	21.8	0.8	56.3	10.8	0.0	0.1	7.8	0.0	0.0	0.0	100
1996	1,119	Numbers	0	0	80	16,340	9,398	2,184	44,744	2,095	0	185	26,427	80	185	0	101,718
		Percent	0.0	0.0	0.1	16.0	9.2	2.1	44.0	2.1	0.0	0.2	26.0	0.1	0.2	0.0	100
1997	1,168	Numbers	0	0	0	5,234	29,004	7,330	47,888	2,351	0	41	14,840	0	0	170	106,858
		Percent	0.0	0.0	0.0	4.9	27.1	6.9	44.8	2.2	0.0	0.0	13.9	0.0	0.0	0.2	100
1998	1,240	Numbers	0	0	0	13,039	5,483	5,082	31,763	7,289	134	267	3,812	0	0	0	66,869
		Percent	0.0	0.0	0.0	19.5	8.2	7.6	47.5	10.9	0.2	0.4	5.7	0.0	0.0	0.0	100

Source:

1987-1989 age compositions from White et al. Limnological and Fisheries Assessment of Sockeye Salmon Production in Afognak Lake. 1990.

1990-1993,1996-1997 age composition from ADF&G Database, unpublished.

1998 age compositions from Nelson, P.A. 1999. Kodiak Management Area Salmon Escapement and Catch Sampling Results, 1998.

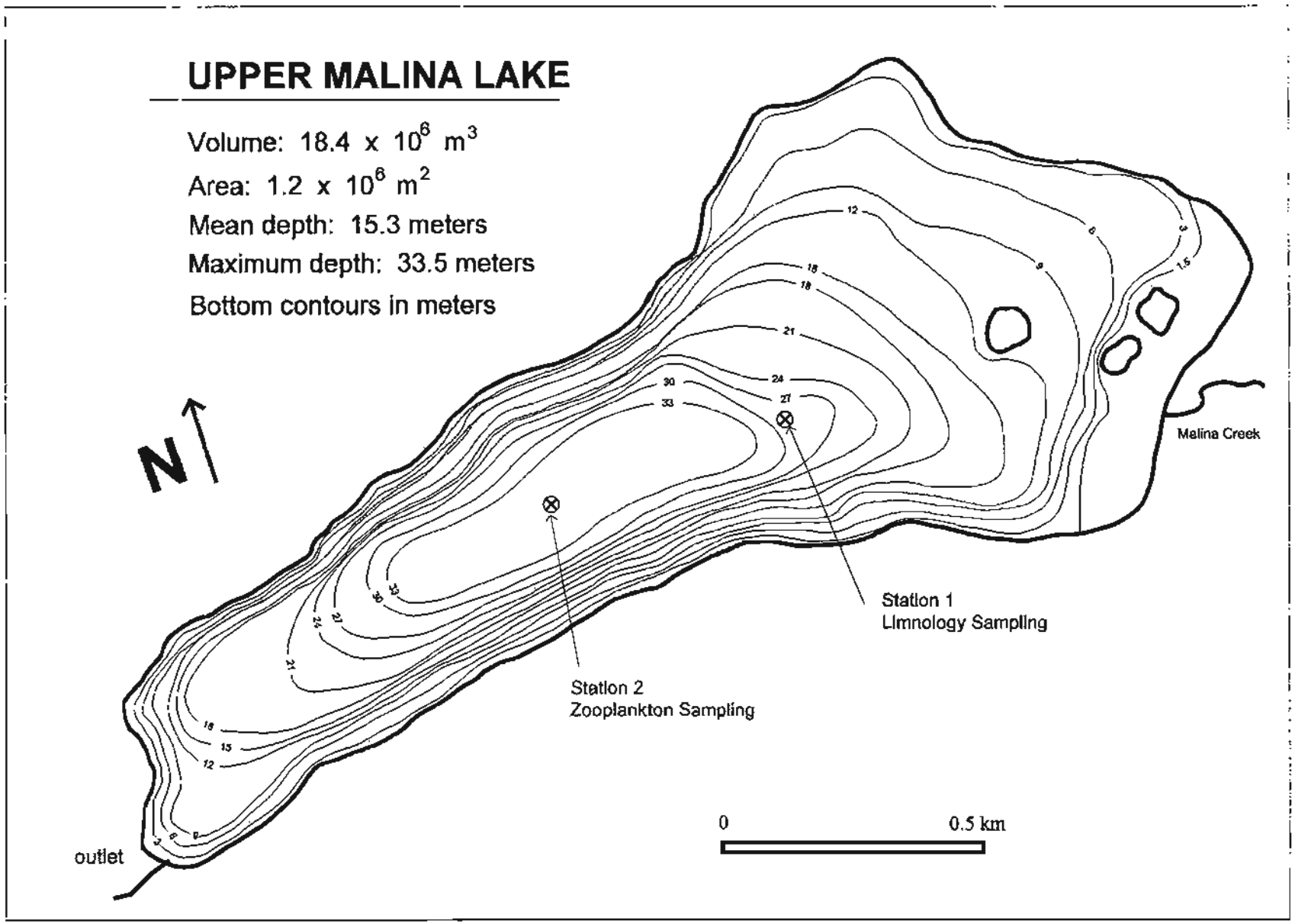
Appendix H.17. Afognak Lake sockeye salmon escapement counts, broodstock number and estimated freshwater age composition, 1991-1998.

Year	Escapement Count	Broodstock Number[a]	% of Fish Used[b]		Estimated Freshwater Age Composition 0	1	2	3	Totals	Number of samples
1991	88,557	2,076	2.3	Number	-	-	-	-	-	
				Percent						
1992	77,260	1,890	2.4	Number	-	-	-	-	-	
				Percent						
1993	71,460	2,169	3.0	Number	-	-	-	-	-	
				Percent						
1994	80,570	1,190	1.5	Number	-	-	-	-	-	
				Percent						
1995	100,131	1,440	1.4	Number	-	-	-	-	-	
				Percent						
1996	101,718	1,700	1.7	Number	-	-	-	-	-	
				Percent						
1997	132,050	1,600	1.2	Number	-	-	-	-	-	
				Percent						
1998[c]	66,869	1,060	1.6	Number	0	90	10	0	100	100
				Percent	0	90	10	0	100	

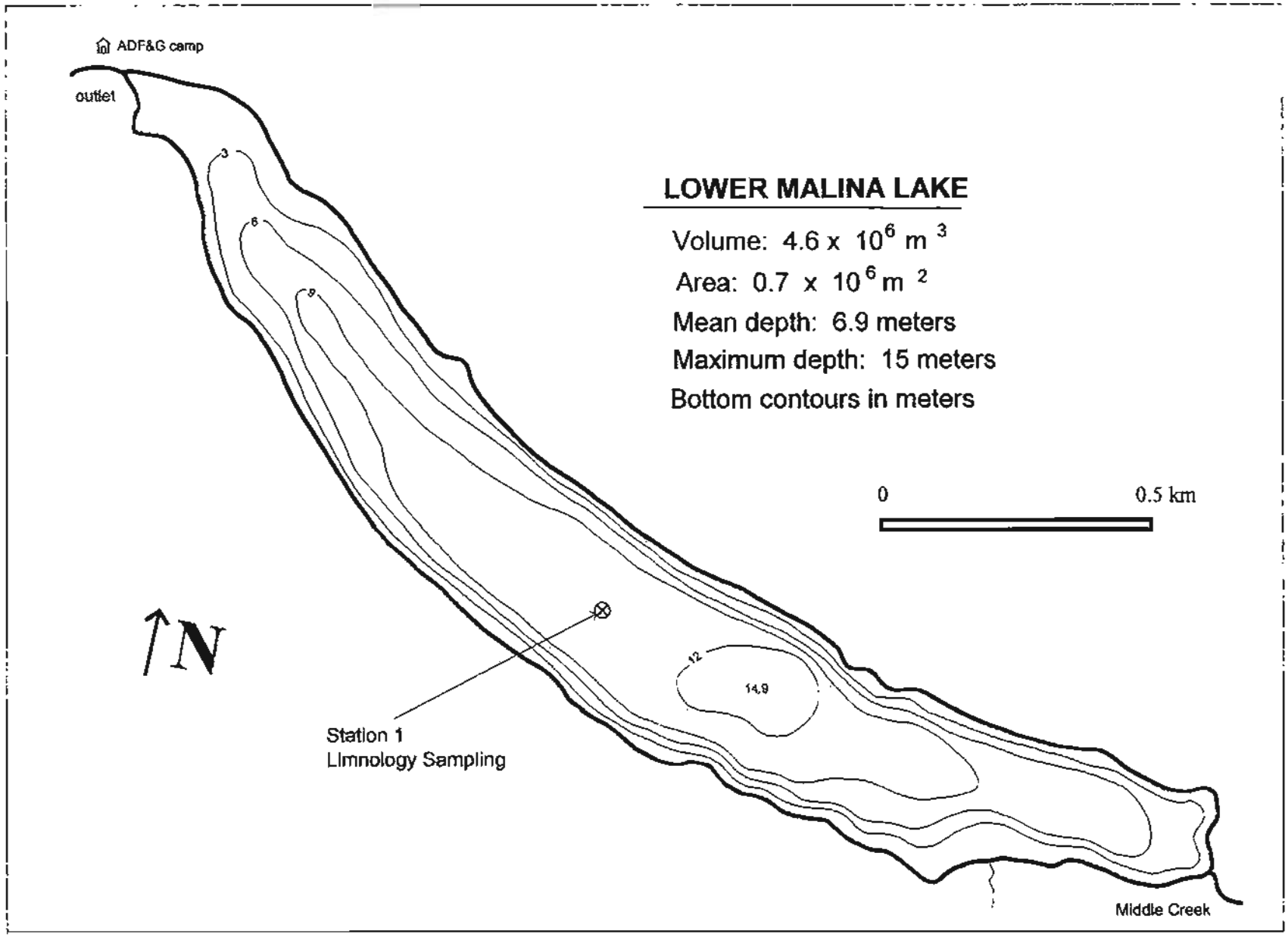
[a] The number of sockeye salmon utilized at the egg takes.

[b] The percentage of sockeye salmon used at the egg take from the total escapement.

[c] Freshwater ages were not determined prior to 1998.



Appendix I.1. Morphometric map showing the limnology and zooplankton stations on Upper Malina Lake.



Appendix I.2. Morphometric map showing the limnology station on Lower Malina Lake.

Appendix I.3. Juvenile sockeye salmon stocked into Upper Malina Lake, 1992-1998.

	Release Year						
Life Stage[a]	1992	1993	1994	1995	1996	1997	1998
fry		201,000	547,000				
fingerling	85,000	117,000			182,000	166,000	93,300
pre-smolt				53,500	229,300	224,400	257,200
Totals:	85,000	318,000	547,000	53,500	411,300	390,400	350,500

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g). Smolt are released in May or June two years following brood year at the time of physiological adaptation to life in the marine environment at a size of 10 to 23 g.

Appendix I.4. The amount of nutrient enrichment additions and ratios into Upper and Lower Malina Lakes, 1991-1998.

Lake	Year	Fertilizer ratio[a]	Amount (kg)
Upper Malina	1991	20-5-0	3,636
	1991	32-0-0	1,636
	1992	20-5-0	3,636
	1992	32-0-0	1,636
	1993	20-5-0	5,454
	1994	20-5-0	5,454
	1995	20-5-0	5,454
	1996	20-5-0	6,096
	1997	20-5-0	5,080
	1998	20-5-0	8,618
Lower Malina	1996	20-5-0	2,032
	1997	20-5-0	2,540
	1998	20-5-0	2,901

[a] Nitrogen-Phosphorus-Potassium

Appendix I.5. Limnological sampling stations and sampling frequencies for Upper and Lower Malina Lakes, 1989-1998.

Year	Sampling	
	Stations	Frequency
1989	1, 2	3
1990	1, 2	5
1991	1, 2	6
1992	1, 2	7
1993	1, 2	7
1994	1-3	8
1995	1-3	7
1996	1-3	5
1997	1-3	6
1998	1, 2	4

Appendix I.6. Summary of seasonal mean water chemistry parameters for Lower Malina Lake, 1989-1998.

Year	Station	Depth (m)	Sp. Conductivity umhos/cm	S.D.	pH (Units	S.D.	Alkalinity (mg/L	S.D.	Turbidity (NTU	S.D.	Color (Pt units	S.D.	Calcium (mg/L	S.D.	Magnesium (mg/L	S.D.	Iron (ug/L)	S.D.
1989	1	1	82.0	0.0	7.5	0.1	21.0	1.0	0.4	0.1	8.7	2.0	7.6	0.5	1.6	0.1	38.3	11.2
1989	1	11	81.0	1.0	7.4	0.2	21.7	1.2	0.5	0.1	8.3	0.7	7.4	0.5	1.6	0.1	41.7	11.5
1990	1	1	80.8	1.1	7.3	0.1	22.8	1.9	0.7	0.2	5.0	0.7	7.1	0.9	1.5	0.2	27.4	17.1
1990	1	10	81.0	1.2	7.3	0.1	22.1	1.5	0.6	0.2	5.0	0.0	7.3	1.2	1.7	0.5	22.6	17.4
1991	1	1	77.1	2.3	7.3	0.2	21.6	1.8	1.0	0.8	7.7	4.0	6.9	0.3	1.7	0.5	69.9	88.3
1991	1	10	77.0	2.3	7.3	0.2	21.3	3.7	0.8	0.2	13.6	10.2	7.2	0.9	1.5	0.3	58.4	53.0
1992	1	1	76.1	2.4	7.2	0.3	21.6	1.4	0.7	0.2	8.9	4.8	7.7	1.0	1.7	0.4	22.3	10.7
1992	1	9	75.3	2.0	7.2	0.2	21.7	1.6	0.7	0.4	5.9	1.2	7.5	0.9	1.6	0.8	23.7	27.6
1993	1	1	77.0	2.5	7.1	0.3	20.6	1.5	0.7	0.3	7.0	3.4	7.2	0.5	1.5	0.4	34.7	11.0
1993	1	10	77.6	2.4	7.0	0.4	20.1	2.4	0.9	0.5	6.4	2.0	7.4	0.6	1.8	0.5	59.4	45.9
1994	1	1	75.3	2.6	6.9	0.1	21.1	0.9	0.7	0.2	15.8	14.1	8.0	1.9	1.7	0.4	40.1	18.9
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	9	76.8	5.3	6.9	0.2	20.9	1.1	0.8	0.3	9.4	6.2	7.9	1.9	1.5	0.3	40.9	16.2
1995	1	1	80.4	3.5	6.9	0.1	20.5	1.1	1.0	0.3	5.3	1.8	7.0	0.3	2.0	0.2	42.9	18.3
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	9	81.6	2.8	7.0	0.2	20.3	0.1	1.2	0.5	4.4	2.7	6.9	0.3	1.9	0.2	64.4	33.3
1996	1	1	80.6	2.2	7.2	0.1	21.7	0.8	0.8	0.4	11.8	1.9	7.3	0.2	1.9	0.4	21.8	10.1
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	9	82.3	1.3	7.3	0.2	22.3	0.7	0.5	0.0	12.5	6.9	6.9	0.5	1.6	0.6	34.8	8.4
1997	1	1	78.7	1.2	7.5	0.2	23.3	0.8	0.7	0.3	7.5	1.8	6.7	0.6	1.7	0.6	23.7	16.2
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	9	79.8	1.3	7.5	0.1	23.3	1.3	0.7	0.4	12.5	8.9	6.9	0.5	1.6	0.5	20.3	8.8
1998	1	1	71.7	1.5	7.3	0.1	25.4	4.0	1.2	0.7	9.3	4.0	6.6	0.1	1.6	0.2	17.3	7.5
1998[c]	1	11	71.0	na	7.3	na	22.5	na	1.1	na	5.0	na	6.9	na	1.6	na	24.0	na

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

[c] One deep sample was collected, standard deviations were not calculated.

Appendix I.7. Summary of seasonal mean water chemistry parameters for Upper Malina Lake, 1989-1998.

Year	Station	Depth (m)	Sp. Conductivity umhos/cm	S.D.	pH (Units)	S.D.	Alkalinity (mg/L	S.D.	Turbidity (NTU)	S.D.	Color (Pt units)	S.D.	Calcium (mg/L	S.D.	Magnesium (mg/L	S.D.	Iron (ug/L)	S.D.
1989	2	1	80.0	1.0	7.5	0.1	19.7	1.5	0.8	0.2	8.1	0.8	7.0	0.4	1.5	1.3	48.7	11.6
1989	2	19	87.3	13.6	7.8	0.6	23.7	8.1	0.6	0.1	7.9	0.7	6.9	0.4	2.8	2.4	45.7	28.7
1990	2	1	78.2	1.6	6.7	1.4	21.0	1.4	0.9	0.2	6.4	1.5	7.1	0.9	1.5	0.2	38.6	19.9
1990	2	25	79.0	1.4	7.2	0.3	21.1	1.2	0.7	0.3	8.4	3.3	6.9	0.9	1.4	0.4	43.0	26.3
1991	2	1	74.0	4.2	7.2	0.2	19.5	4.2	1.0	0.5	10.4	3.8	7.4	1.0	1.5	1.0	60.6	30.6
1991	2	27	74.1	4.4	7.1	0.3	20.1	3.2	0.7	0.2	10.7	4.0	7.2	0.5	1.5	0.7	58.6	37.9
1992	2	1	72.9	1.5	7.2	0.2	20.4	1.2	0.8	0.3	5.7	2.4	7.1	1.1	1.6	0.7	29.0	13.5
1992	2	26	73.6	1.6	7.0	0.2	19.9	0.8	0.7	0.3	5.6	1.6	7.3	1.1	1.6	0.7	38.6	15.3
1993	2	1	75.6	1.5	7.0	0.4	21.5	2.7	0.9	0.6	7.3	2.1	7.3	0.6	1.7	0.4	46.6	8.0
1993	2	27	76.0	2.3	6.9	0.3	20.5	2.4	0.9	0.5	7.3	2.8	7.0	0.3	1.8	0.4	51.7	15.6
1994	2	1	71.1	2.0	6.9	0.2	19.1	1.0	1.0	0.2	6.9	1.6	6.8	0.3	1.4	0.2	52.6	27.8
1994[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	2	27	72.1	2.0	6.7	0.1	18.9	0.8	1.0	0.4	8.9	4.5	6.9	0.2	1.5	0.3	60.5	22.1
1995	2	1	79.0	3.2	7.0	0.2	18.6	1.2	1.0	0.2	6.9	3.3	6.3	0.3	2.0	0.5	57.0	28.9
1995[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	2	27	80.4	4.6	6.8	0.3	18.6	1.5	1.0	0.4	5.8	3.2	6.7	0.5	1.7	0.4	68.3	26.3
1996	2	1	87.8	0.8	7.2	0.2	19.8	0.7	1.0	0.5	12.2	3.5	6.4	0.1	1.7	0.4	30.6	9.2
1996[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	2	27	79.2	2.2	6.9	0.2	19.4	1.0	0.9	0.5	13.2	4.9	6.6	0.4	1.7	0.4	46.6	13.3
1997	2	1	76.7	0.8	7.4	0.1	21.7	1.2	0.8	0.3	9.7	2.9	6.3	0.2	1.6	0.4	24.0	13.5
1997[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	2	27	77.5	1.2	7.1	0.3	20.2	0.7	1.2	0.4	8.0	2.3	6.3	0.3	1.6	0.4	31.8	15.8
1998	2	1	69.0	1.0	7.3	0.1	23.8	2.8	1.3	1.0	10.3	1.2	6.6	0.5	1.3	0.2	23.0	3.6
1998[c]	2	26	69.0	na	7.2	na	21.4	na	2.0	na	6.0	na	6.8	na	1.3	na	28.0	na

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

[c] One deep sample was collected, standard deviations were not calculated.

Appendix I.8. Summary of seasonal mean nutrient and algal pigment concentrations for Lower Malina Lakes, 1989-1998.

	Sta	Depth	Total-P		Total Filterable P		Filterable Reactive P		Total Kjeldahl N		Ammonia		Nitrate+Nitrite		Reactive Silicon		Organic Carbon		Chlorophyll *a*		Phaeophytin *a*	
Year	tion	(m)	(ug/L P)	SD[a]	(ug/L P)	SD	(ug/L P)	SD	(ug/L N)	SD	(ug/L N)	SD	(ug/L N)	SD	(ug/L Si)	SD	(ug/L)	SD	(ug/L)	SD	(ug/L)	SD
1989	1	1	5.7	0.3	3.7	0.7	4.3	0.6	139.2	1.7	7.5	5.8	85.1	21.3	2499.3	125.7	na	na	0.61	0.2	0.37	0.1
1989	1	11	5.7	0.8	3.2	0.4	3.8	0.4	131.6	8.5	12.2	8.2	84.3	18.8	2559.3	84.6	na	na	0.47	0.3	0.38	0.1
1990	1	1	5.0	0.5	3.2	0.6	2.4	0.4	84.9	26.8	9.2	5.5	75.2	31.3	2964.4	536.6	190.4	106.3	1.15	0.5	0.52	0.2
1990	1	10	5.6	1.2	3.5	0.9	2.5	0.3	87.5	26.6	10.4	7.0	74.5	30.9	2883.0	619.9	187.4	76.4	1.03	0.5	0.52	0.1
1991	1	1	4.9	1.2	3.2	2.2	3.1	2.1	121.1	26.5	10.0	7.2	90.6	50.7	2559.9	207.1	na	na	1.40	0.7	0.59	0.1
1991	1	10	5.6	1.9	6.9	10.0	6.1	9.0	121.1	30.2	13.9	6.5	101.1	33.2	2552.7	207.8	na	na	1.10	0.8	0.57	0.2
1992	1	1	5.8	1.5	4.9	4.0	3.6	2.9	137.5	8.3	8.3	4.9	119.3	45.1	2766.6	247.1	168.1	48.2	0.83	0.2	0.46	0.1
1992	1	9	5.0	0.7	2.3	0.7	1.8	0.3	125.6	21.4	9.9	5.1	131.0	51.5	2707.9	176.0	149.3	55.9	0.81	0.2	0.45	0.1
1993	1	1	5.6	1.4	3.0	0.7	2.5	0.5	141.8	14.8	6.1	4.7	97.8	51.1	2644.6	142.1	148.5	56.8	1.57	0.9	0.47	0.2
1993	1	10	5.3	1.7	2.7	1.5	2.5	1.2	134.4	15.4	8.7	5.7	100.3	52.1	2758.6	212.1	188.8	55.9	1.27	0.8	0.48	0.2
1994	1	1	6.0	1.2	10.2	12.9	8.9	11.3	153.7	10.3	7.7	4.6	111.4	48.0	2541.4	135.9	176.3	73.1	1.22	0.4	0.31	0.1
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.18	0.4	0.31	0.1
1994	1	9	5.3	1.0	4.5	2.0	4.0	1.7	139.5	10.4	10.6	5.8	112.3	47.2	2558.5	153.7	156.1	54.9	0.88	0.4	0.30	0.0
1995	1	1	7.3	6.4	4.5	5.3	2.1	1.2	151.8	17.2	11.2	8.4	82.8	41.3	2880.4	169.8	241.9	75.8	3.10	1.5	0.60	0.3
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.89	1.1	0.64	0.2
1995	1	9	6.6	2.1	2.3	0.5	1.7	0.3	149.9	14.2	13.2	9.9	84.8	36.7	2894.9	208.6	281.6	124.1	2.84	1.6	0.71	0.2
1996	1	1	6.0	1.3	5.5	1.2	3.1	2.6	110.7	23.1	9.0	6.9	75.6	39.4	2655.6	210.6	145.8	35.7	1.67	0.4	0.48	0.2
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.48	0.3	0.46	0.3
1996	1	9	7.4	3.8	5.9	2.1	2.9	1.0	95.4	24.2	12.2	15.1	84.4	41.0	2669.0	231.3	128.8	26.9	1.45	0.5	0.51	0.2
1997	1	1	6.8	2.5	2.6	1.1	2.0	1.0	126.9	28.1	6.2	4.0	43.5	37.9	2599.3	281.4	147.2	41.0	1.15	0.3	0.83	0.4
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.13	0.3	0.78	0.3
1997	1	9	5.2	1.2	5.2	6.3	4.3	5.3	115.8	20.0	13.6	10.9	48.6	40.3	2568.2	271.9	125.8	34.7	0.96	0.3	0.72	0.2
1998	1	1	9.5	1.5	5.0	2.7	3.5	1.7	168.3	15.1	27.0	8.6	69.0	7.6	2479.3	493.5	91.3	40.4	0.50	0.0	0.60	0.1
1998[c]	1	11	9.6	na	2.6	na	1.4	na	175.0	na	37.6	na	64.6	na	1955.0	na	80.0	na	0.73	na	0.89	na

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

[c] One deep sample was collected, standard deviations were not calculated.

Appendix I.9. Summary of seasonal mean nutrient and algal pigment concentrations for Upper Malina Lake, 1989-1998.

Year	Station	Depth (m)	Total-P (ug/L P)	SD[a]	Total Filterable P (ug/L P)	SD	Filterable Reactive P (ug/L P)	SD	Total Kjeldahl N (ug/L N)	SD	Ammonia (ug/L N)	SD	Nitrate+Nitrite (ug/L N)	SD	Reactive Silicon (ug/L Si)	SD	Organic Carbon (ug/L)	SD	Chlorophyll *a* (ug/L)	SD	Phaeophytin *a* (ug/L)	SD
1989	2	1	6.0	0.3	4.1	0.5	5.1	0.8	136.4	21.3	6.5	3.3	128.5	44.8	2740.7	149.4	0.0	0.0	0.80	0.3	1.27	0.1
1989	2	19	6.1	1.0	3.2	0.5	4.3	0.2	133.5	16.9	10.6	10.3	136.5	35.4	2789.3	152.9	0.0	0.0	0.31	0.1	0.52	0.0
1990	2	1	5.4	1.2	4.0	1.1	2.9	0.9	84.9	40.7	6.3	0.7	79.5	36.5	3165.2	481.9	229.0	38.1	1.37	0.7	0.63	0.2
1990	2	25	4.8	1.2	4.5	2.7	3.8	2.2	71.4	39.5	17.2	14.8	103.5	13.3	3244.4	425.8	133.0	55.7	0.50	0.3	0.40	0.1
1991	2	1	9.7	6.3	4.2	2.9	3.7	2.9	167.2	67.0	14.0	8.8	82.0	62.2	2641.9	218.9	0.0	0.0	2.72	2.8	0.64	0.2
1991	2	27	7.0	2.5	3.8	2.7	3.4	2.2	137.4	22.9	23.4	14.3	131.7	49.4	2875.9	127.5	0.0	0.0	0.97	0.6	0.40	0.1
1992	2	1	6.7	2.5	3.0	2.6	2.1	2.2	139.8	40.3	8.1	4.1	119.8	48.1	2866.6	160.6	321.3	99.2	2.61	1.6	1.04	0.6
1992	2	26	5.0	1.6	2.5	1.3	1.4	0.9	99.5	20.6	15.6	11.7	162.0	49.7	3078.4	170.8	168.1	108.7	0.74	0.6	0.55	0.4
1993	2	1	8.1	3.0	3.3	1.2	3.1	1.1	175.4	42.9	6.5	6.3	92.7	78.2	2688.1	212.7	322.5	98.8	3.36	1.9	0.72	0.6
1993	2	27	5.0	1.0	3.1	1.3	2.9	0.9	122.1	24.1	19.9	20.0	189.8	54.0	3036.9	229.1	121.5	36.5	0.84	0.4	0.44	0.2
1994	2	1	6.9	2.7	2.8	0.7	3.0	0.7	161.7	24.0	6.5	2.9	125.8	67.7	2632.4	201.6	251.8	84.4	2.36	0.8	0.52	0.4
1994[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.38	0.8	0.45	0.3
1994	2	27	6.4	1.2	3.9	1.4	3.8	1.9	140.5	9.3	19.0	13.6	135.1	62.0	2925.5	243.7	152.4	49.6	0.98	0.7	0.29	0.1
1995	2	1	7.7	2.4	3.2	1.5	2.3	0.9	162.3	36.7	6.9	5.2	105.7	53.1	2940.0	174.8	325.5	117.5	4.68	2.5	1.01	0.7
1995[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	4.28	2.6	0.86	0.6
1995	2	27	5.9	1.0	2.1	0.8	1.7	0.6	128.6	21.6	24.8	15.0	147.4	22.7	3111.6	204.0	155.6	25.5	1.23	0.6	0.56	0.2
1996	2	1	7.7	1.9	5.1	0.8	2.4	0.6	134.0	39.1	3.0	2.0	70.9	55.8	2704.2	246.0	281.0	172.7	3.40	1.9	0.82	0.5
1996[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	3.06	1.5	0.66	0.4
1996	2	27	6.3	1.6	4.6	1.1	3.2	1.4	99.0	32.2	10.6	14.2	136.2	53.8	3052.8	304.0	136.2	49.3	1.23	0.7	0.53	0.2
1997	2	1	6.6	1.9	3.3	1.6	2.8	1.5	131.6	24.8	11.1	1.4	58.3	42.0	2725.5	242.3	222.8	75.9	1.92	0.8	1.07	0.5
1997[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.01	0.8	1.14	0.5
1997	2	27	7.0	1.8	2.3	0.7	1.9	0.6	120.3	35.7	14.7	7.5	121.5	40.7	3074.2	467.2	116.0	33.7	0.89	0.2	0.70	0.2
1998	2	1	7.5	1.8	3.1	0.1	2.6	0.6	171.8	19.7	12.6	7.9	39.2	24.3	2396.0	279.8	232.3	42.3	1.70	1.1	1.20	0.5
1998[c]	2	26	7.0	na	2.7	na	2.1	na	145.0	na	26.4	na	39.1	na	2416.0	na	144.0	na	0.92	na	0.80	na

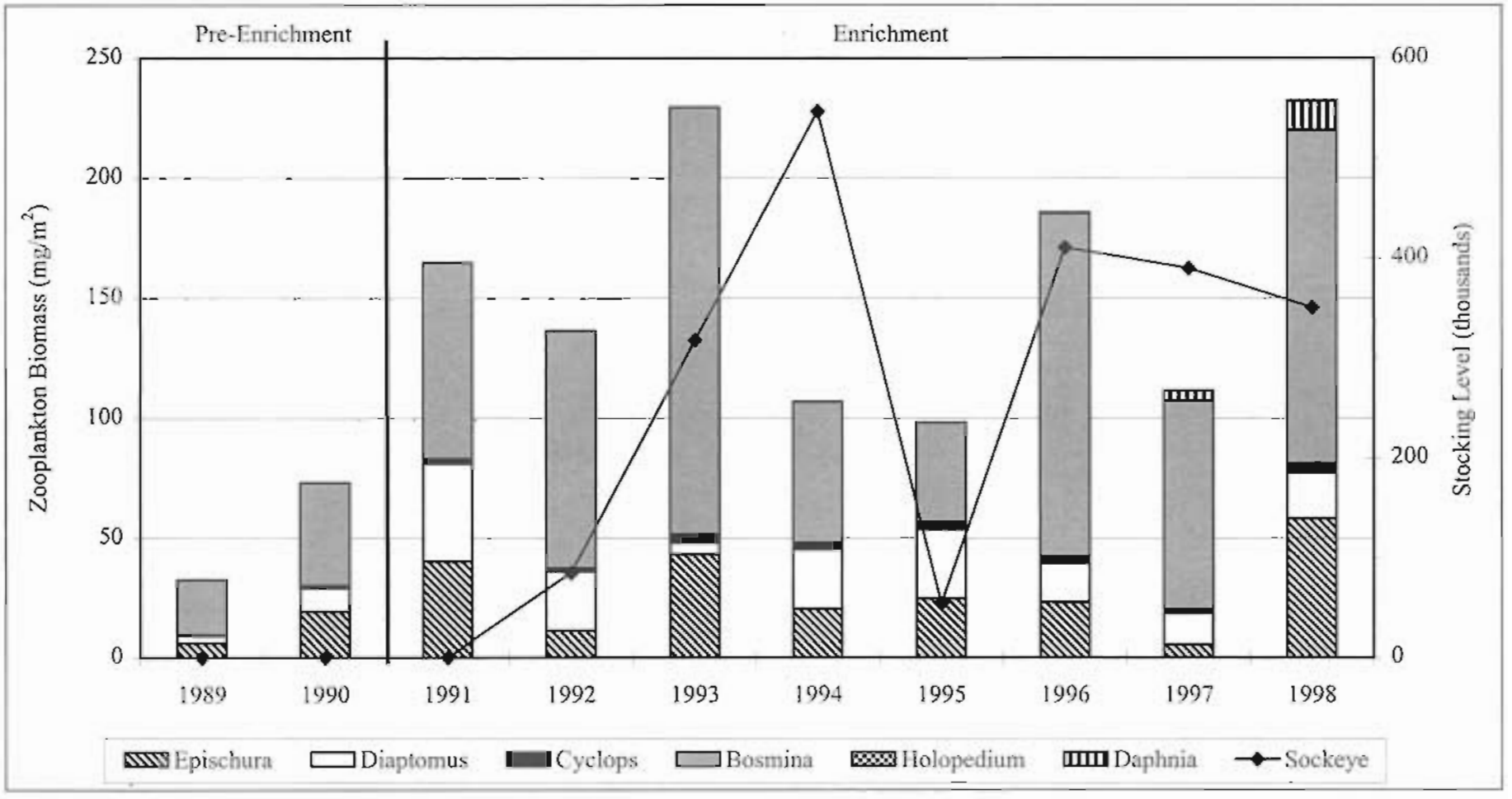
[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

[c] One deep sample was collected, standard deviations were not calculated.

Appendix I.10. Weighted mean zooplankton density, biomass, and size by genera (stations 2 & 3 averaged) from Upper Malina Lake, 1989-1998.

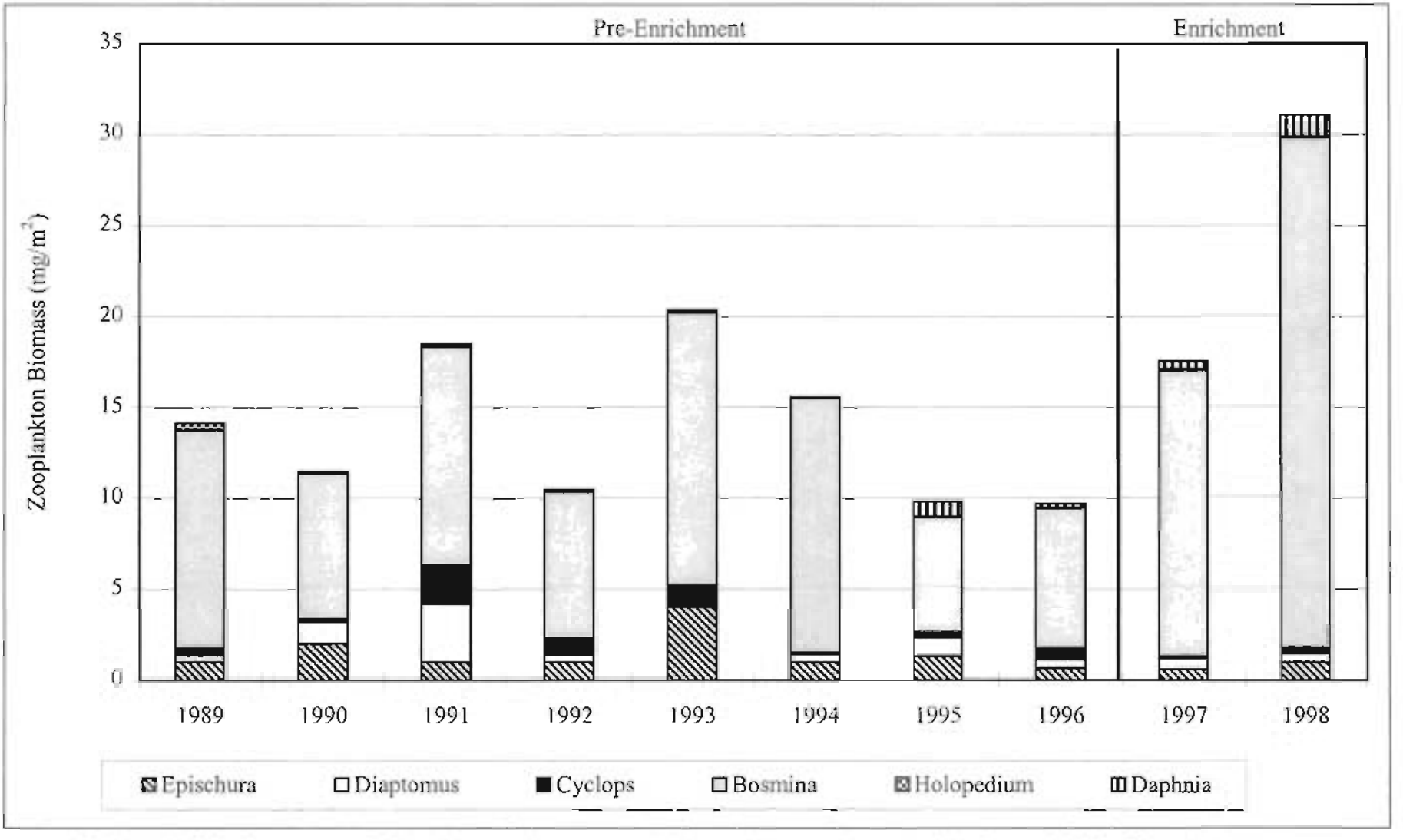
Station	No. of	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
2 and 3	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1989	3	2,566	6	0.80	1,194	3	0.80	442	0.4	0.54	32,245	23	0.28	0	0	0	44	<1	0.62	36,491	32
1990	5	2,229	19	1.25	4,910	10	0.77	929	0.9	0.54	42,251	43	0.34	0	0	0	212	0.55	0.54	50,531	73
1991	6	7,042	40	1.09	8,935	41	1.02	1,292	1.8	0.64	92,286	82	0.31	0	0	0	168	0.41	0.53	109,723	165
1992	7	2,828	11	0.96	13,467	25	0.74	1,130	1.3	0.58	112,307	99	0.31	243	0	0	0	0.00	0.00	129,975	136
1993	7	8,492	43	1.04	1,251	5	0.97	2,844	3.6	0.61	219,025	178	0.30	0	0	0	76	<1	0.42	231,688	230
1994	8	4,034	20	1.03	8,386	25	0.88	2,435	2.8	0.58	85,383	59	0.32	50	0.10	0.66	113	0.29	0.54	100,401	107
1995	7	3,434	25	1.09	10,167	29	0.85	2,361	3.1	0.62	68,341	42	0.32	5	0.01	0.38	35	0.09	0.46	84,342	98
1996	5	4,136	23	1.06	4,577	16	0.93	2,718	2.9	0.57	165,730	143	0.31	244	0.44	0.63	138	0.25	0.24	177,543	186
1997	6	1,381	5	0.91	5,749	13	0.72	1,194	1.4	0.60	107,894	88	0.29	3,741	4.26	0.52	53	0.07	0.44	120,012	112
1998	4	6,714	58	1.26	4,432	19	1.00	3,503	4.0	0.57	144,666	139	0.32	8,626	12.21	0.55	637	1.21	0.48	168,578	233
Avg =	6	4,286	25	1.05	6,307	19	0.87	1,885	2.2	0.58	107,013	90	0.31	1,291	1.89	0.30	148	0.36	0.43	120,928	137



Appendix I.11. Weighted mean zooplankton biomass by genera (stations 2&3 averaged), lake enrichment time period, and juvenile sockeye salmon stocking levels for Upper Malina Lake, 1989-1998.

Appendix I.12. Weighted mean zooplankton density, biomass, and size by genera for Lower Malina Lake, 1989-1998.

Station	No. of	*Epischura*			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^3	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1989	3	486	1.0	0.77	133	0.3	0.84	177	0.4	0.81	16,808	12	0.28	0	0.00	0.00	221	0.39	0.46	17,825	14
1990	5	338	2.0	1.09	879	1.2	0.66	166	0.2	0.58	9,207	8	0.31	3	0.00	0.37	38	0.09	0.53	10,631	11
1991	6	318	1.0	0.93	513	3.2	1.14	1,420	2.1	0.67	15,283	12	0.29	88	0.16	0.65	0	0.00	0.00	17,622	18
1992	7	547	1.0	0.61	243	0.4	0.70	369	0.9	0.85	10,344	8	0.30	76	0.13	0.64	5	0.01	0.41	11,584	10
1993	7	1,797	4.0	0.81	15	0.1	1.11	432	1.1	0.86	19,305	15	0.29	76	0.10	0.55	30	0.05	0.44	21,655	20
1994	8	238	1.0	0.86	292	0.4	0.67	109	0.1	0.56	20,328	14	0.28	27	0.05	0.68	0	0.00	0.51	20,994	16
1995	7	531	1.3	0.81	819	1.0	0.64	223	0.3	0.63	12,396	6	0.28	332	0.85	0.76	18	0.02	0.39	14,319	10
1996	5	175	0.7	0.94	350	0.5	0.66	454	0.6	0.63	11,290	8	0.28	96	0.24	0.76	8	0.01	0.42	12,372	10
1997	6	186	0.6	0.90	276	0.6	0.77	75	0.1	0.71	24,676	16	0.27	425	0.43	0.49	64	0.08	0.41	25,701	18
1998	4	263	1.0	0.93	231	0.5	0.76	311	0.4	0.58	31,099	28	0.31	1,107	1.19	0.49	56	0.06	0.42	33,067	31
Avg =	6	488	1.4	0.86	375	0.8	0.80	374	0.6	0.69	17,074	13	0.29	223	0.31	0.54	44	0.07	0.40	18,577	16



Appendix I.13. Weighted mean zooplankton biomass by genera and lake enrichment time period for Lower Malina Lake, 1989-1998.

Appendix I.14. Juvenile sockeye salmon estimates based on townet catch species composition and hydroacoustic fish population estimates for Upper and Lower Malina Lakes, 1990 and 1992-1995.

	Total Fish Estimates			Sockeye Estimates			Sockeye
	Number	95% C. I.		Number	95% C. I.		Composition
Year		Low	High		Low	High	(%)
1-Oct-90	481,725	377,207	586,243	78,039	61,107	94,971	16.2
11-Sep-92	1,607,325	1,125,782	2,088,868	170,620	112,213	229,027	11.4
4-Oct-93	1,308,928	1,188,320	1,429,536	123,095	110,681	135,509	9.7
9-Oct-94 [a]	2,110,452	1,583,000	2,637,904	39,709	32,326	47,092	1.7
11-Oct-94 [b]	335,565	197,413	473,717	27,351	17,469	37,233	6.0
14-Sep-95	1,657,937	1,290,806	2,025,068	243,903	186,938	300,868	14.9

[a] hydroacoustic survey conducted on the upper lake.

[b] hydroacoustic survey conducted on the lower lake.

Appendix I.15. Townet catches from Upper and Lower Malina Lakes, 1990 and 1992-1995.

			Catch by Species					
	Tow		Sockeye			Stickleback		
Year	No.	Minutes	No.	%	CPUE	No.	%	CPUE
2-Oct-90	3	60	97	17.9	1.6	503	82.1	8.4
12-Sep-92	3	51	49	11.4	1.0	379	88.6	7.4
5-Oct-93	3	48	50	9.7	1.0	466	90.3	9.7
10-Oct-94 [a]	4	67	35	1.7	0.5	1,987	98.3	29.7
11-Oct-94 [b]	4	69	35	6.0	0.5	547	94.0	7.9
15-Sep-95	4	na[c]	30	14.9	na	172	85.1	na

[a] townet surveys conducted on the upper lake.

[b] townet surveys conducted on the lower lake.

[c] The times for each tow were not available.

Appendix I.16. Mean length, weight, and condition coefficient by age of juvenile sockeye salmon captured by townet from Upper and Lower Malina Lakes, 1990 and 1992-1995.

	Age-0					Age-1					Age-2				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
2-Oct-90	43	86.9	46.1	0.8	0.83	11	13.1	62.4	2.3	0.91	0	0.0	0.0	0.0	0.00
12-Sep-92	22	66.7	44.0	1.1	1.25	11	33.3	65.6	3.4	1.18	0	0.0	0.0	0.0	0.00
5-Oct-93	47	81.0	50.4	1.5	1.18	11	19.0	70.6	4.2	1.17	0	0.0	0.0	0.0	0.00
10-Oct-94 [a]	12	57.1	48.7	1.4	1.09	9	42.9	65.6	3.1	1.10	0	0.0	0.0	0.0	0.00
11-Oct-94 [b]	31	96.9	49.8	1.3	0.99	1	3.1	57.0	1.8	0.97	0	0.0	0.0	0.0	0.00
15-Sep-95	7	30.4	43.0	1.0	1.28	15	65.2	64.2	3.2	1.11	1	4.3	74	4.3	1.07

[a] samples collected from the upper lake.

[b] samples collected from the lower lake.

Appendix I.17. Upper and Lower Malina Lakes sockeye salmon smolt emigration estimates, by age, 1992 and 1997-1998.

Date		Age 1	Age 2	Age 3	Estimate	95% Confidence Interval Low	95% Confidence Interval High
May 10-June 27, 1992	Percent	4.9	94.6	0.5			
	Number	49,842	962,262	5,086	1,017,190	660,252	1,374,129
May 10-July 4, 1997	Percent	50.5	48.6	0.9			
	Number	254,912	245,322	4,543	504,777	468,988	540,566
May 3-July 18, 1998	Percent	52.2	46.7	1.1			
	Number	254,830	227,980	5,370	488,180	441,041	535,318

Appendix I.18. Upper and Lower Malina Lakes sockeye salmon emigration timing and estimates a by age class, 1992 and 1997-1998.

	Statistical		Age Class					Population
Year	Period	Week	0	1	2	3	4	Estimate
1992	18	4/26-5/02						
	19	5/03-5/09						
	20	5/10-5/16	0	37	2,603	0	0	2,640
	21	5/17-5/23	0	2,157	70,724	1,487	0	74,368
	22	5/24-5/30	0	42,084	537,159	5,261	0	584,504
	23	5/31-6/06	0	8,610	187,062	0	0	195,672
	24	6/07-6/13	0	5,657	98,900	314	0	104,767
	25	6/14-6/20	0	2,769	45,806	0	0	48,575
	26	6/21-6/27	0	0	6,482	0	0	6,482
	27	6/28-7/04						
	28	7/05-7/11						
	29	7/12-7/18						
			0	61,314	948,737	7,062	0	1,017,113
1997	18	4/26-5/02						
	19	5/03-5/09						
	20	5/10-5/16	0	13,199	14,323	140	0	27,662
	21	5/17-5/23	0	11,540	13,189	254	0	24,982
	22	5/24-5/30	0	41,378	135,168	2,759	0	179,306
	23	5/31-6/06	0	56,350	117,244	1,818	0	175,412
	24	6/07-6/13	0	21,182	13,130	525	0	34,837
	25	6/14-6/20	0	27,329	13,391	273	0	40,993
	26	6/21-6/27	0	16,236	4,059	0	0	20,295
	27	6/28-7/04	0	883	406	0	0	1,290
	28	7/05-7/11						
	29	7/12-7/18						
			0	188,097	310,910	5,769	0	504,776
1998	18	4/26-5/02						
	19	5/03-5/09	0	40	84	0	0	124
	20	5/10-5/16	0	238	756	12	0	1,006
	21	5/17-5/23	0	5,206	5,942	525	0	11,673
	22	5/24-5/30	0	90,791	59,771	757	0	151,319
	23	5/31-6/06	0	152,897	36,558	952	0	190,407
	24	6/07-6/13	0	39,208	5,685	226	0	45,119
	25	6/14-6/20	0	16,272	10,802	553	0	27,627
	26	6/21-6/27	0	9,357	21,472	155	0	30,984
	27	6/28-7/04	0	6,792	18,130	328	0	25,250
	28	7/05-7/11	0	1,939	2,323	0	0	4,262
	29	7/12-7/18	0	187	223	0	0	410
			0	322,929	161,745	3,507	0	488,181

[a] Estimates based on seasonal mean age compositions.

Appendix I.19. Upper and Lower Malina Lakes sockeye salmon smolt age and size composition, by year, 1991-1998.

		Age-1					Age-2					Age-3				
Year	Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
1991	May 24-June 6	74	44.8	74.5	2.9	0.70	90	54.5	77.4	3.2	0.69	1	0.6	72.0	2.7	0.72
1992	May 10-June 27	84	4.9	71.5	2.3	0.64	1,614	94.6	73.0	2.6	0.66	8	0.5	77.8	3.6	0.75
1993	May 24-June 6	24	2.5	76.1	3.4	0.76	876	89.5	78.5	3.7	0.76	79	8.1	82.0	4.2	0.76
1994	May 17-June 6 [a]	33	8.4	75.8	3.0	0.69	350	89.3	78.0	3.3	0.69	8	2.0	84.5	4.5	0.71
1995	May 31-June 27	639	93.2	70.5	2.5	0.70	45	6.6	89.8	6.5	0.78	0	0.0	0.0	0.0	0.00
1996	May 3-June 20	249	20.4	99.0	7.3	0.73	965	79.2	79.9	4.0	0.75	4	0.3	83.3	4.2	0.72
1997	May 10-July 4	687	50.6	81.1	3.8	0.70	660	48.6	85.5	4.6	0.71	12	0.9	85.3	4.7	0.73
1998	May 3-July 18	818	52.2	92.8	6.3	0.75	733	46.7	77.5	3.7	0.78	17	1.1	89.4	6.0	0.81

[a] In 1994, one age-0 smolt captured was 79.0 mm, 3.4 g, and a condition of 0.7.

Appendix I.20. Upper and Lower Malina Lakes sockeye salmon escapement counts, 1992-1998.

	--YEAR--						
Day	1992	1993	1994	1995	1996	1997	1998
5/24					4		36
5/25					8		0
5/26					18	29	8
5/27					50	125	62
5/28					109	38	27
5/29			6		73	145	0
5/30			13		197	56	237
5/31		34	94		138	111	135
6/1		41	23		557	71	283
6/2		124	62	123	397	126	208
6/3	13	104	72	268	336	51	181
6/4	54	116	50	276	285	3	291
6/5	309	151	71	217	117	43	315
6/6	350	359	115	221	295	85	151
6/7	85	65	177	216	353	11	220
6/8	324	185	113	281	282	57	198
6/9	51	319	50	290	218	131	27
6/10	45	103	72	167	301	736	325
6/11	47	279	135	206	150	480	731
6/12	53	184	168	304	262	17	366
6/13	26	281	212	391	67	100	1072
6/14	0	186	186	158	120	44	336
6/15	59	251	205	512	102	70	143
6/16	101	261	327	343	258	1893	774
6/17	24	138	215	211	52	146	262
6/18	62	230	117	245	161	241	150
6/19	67	46	84	139	7	615	113
6/20	35	121	46	225	84	61	619
6/21	62	187	52	266	107	327	77
6/22	134	120	105	87	66	160	500
6/23	29	111	59	245	231	227	237
6/24	255	106	27	91	66	844	363
6/25	221	79	50	112	109	15	617
6/26	167	109	5	240	110	64	390
6/27	216	78	29	219	44	37	93

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Day	1992	1993	-Year- 1994	1995	1996	1997	1998
6/28	128	41	38	116	307	38	99
6/29	155	33	60	79	86	27	596
6/30	108	100	88	223	70	25	313
7/1	69	99	94	527	56	176	141
7/2	183	487	243	341	24	69	148
7/3	245	263	205	200	14	211	427
7/4	163	224	66	530	67	43	137
7/5	258	268	59	178	47	53	602
7/6	102	305	93	211	37	110	60
7/7	135	62	39	217	7	14	113
7/8	39	56	32	119	15	19	232
7/9	34	42	33	73	19	35	191
7/10	154	123	150	102	48	11	357
7/11	161	27	65	128	25	71	47
7/12	108	126	311	183	36	9	183
7/13	130	167	189	157	72	52	151
7/14	162	79	186	190	143	110	40
7/15	71	44	45	72	83	8	2
7/16	27	38	305	79	285	10	62
7/17	52	26	192	65	278	0	38
7/18	67	33	277	85	35	56	173
7/19	69	212	353	23	38	27	26
7/20	127	24	102	135	40	222	42
7/21	97	17	533	170	22	107	169
7/22	46	11	53	117	8	39	106
7/23	56	47	229	52	88	27	120
7/24	54	52	218	105	13	17	54
7/25	15	106	63	40	22	45	25
7/26	27	93	266	17	12	7	5
7/27	108	75	190	31	33	5	63
7/28	159	139	265	22	12	30	262
7/29	97	136	193	44	122	124	101
7/30	104	122	91	19	27	9	33
7/31	93	28	107	19	0	20	96
8/1	88	82	77	19	26	5	72

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Day	1992	1993	-Year- 1994	1995	1996	1997	1998
8/2	55	4	134	21	11	8	25
8/3	61	22	79	28	27	26	20
8/4	127	21	100	13	8	39	5
8/5	72	15	65		0	0	12
8/6	65	11	53		0	342	18
8/7	51	3	43		33	50	4
8/8	28	5	24				
8/9	85	3	58				
8/10	122	6	16				
8/11	101	28	6				
8/12	63		14				
8/13	300						
Total	7,610	8,273	9,042	10,803	8,030	9,455	14,917

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54, Kodiak.

Appendix I.21. Estimated age composition of Upper and Lower Malina Lakes sockeye salmon escapement, 1990 and 1992-1998.

		Ages										
Year		1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	Total
1990	Number	0	109	0	12	381	1	1	0	4	0	508
	Percent	0	21.5	0.0	2.4	75.0	0.2	0.2	0.0	0.8	0.0	100
1992	Number	67	247	517	547	3,812	1,468	7	232	644	67	7,610
	Percent	0.9	3.2	6.8	7.2	50.1	19.3	0.1	3.1	8.5	0.9	749
1993	Number	206	321	183	2,022	2,450	2,503	0	84	374	130	8,273
	Percent	2.5	3.9	2.2	24.4	29.6	30.3	0.0	1.0	4.5	1.6	100
1994	Number	388	765	607	1,893	4,005	1,299	0	24	49	12	9,042
	Percent	4.3	8.5	6.7	20.9	44.3	14.4	0.0	0.3	0.5	0.1	100
1995	Number	48	167	502	1,028	4,756	4,206	0	24	72	0	10,803
	Percent	0.4	1.5	4.6	9.5	44.0	38.9	0.0	0.2	0.7	0.0	100
1996	Number	44	192	209	113	3,127	4,163	0	26	122	35	8,030
	Percent	0.5	2.4	2.6	1.4	38.9	51.8	0.0	0.3	1.5	0.4	100
1997	Number	2,837	832	879	558	946	3,262	0	47	85	9	9,455
	Percent	30.0	8.8	9.3	5.9	10.0	34.5	0.0	0.5	0.9	0.1	100
1998	Number	5,757	2,553	275	350	3,204	2,428	25	100	150	75	14,917
	Percent	38.6	17.1	1.8	2.3	21.5	16.3	0.2	0.7	1.0	0.5	100

Appendix I.22. Upper and Lower Malina Lakes sockeye salmon escapement counts, broodstock number and estimated freshwater age composition, 1991-1998.

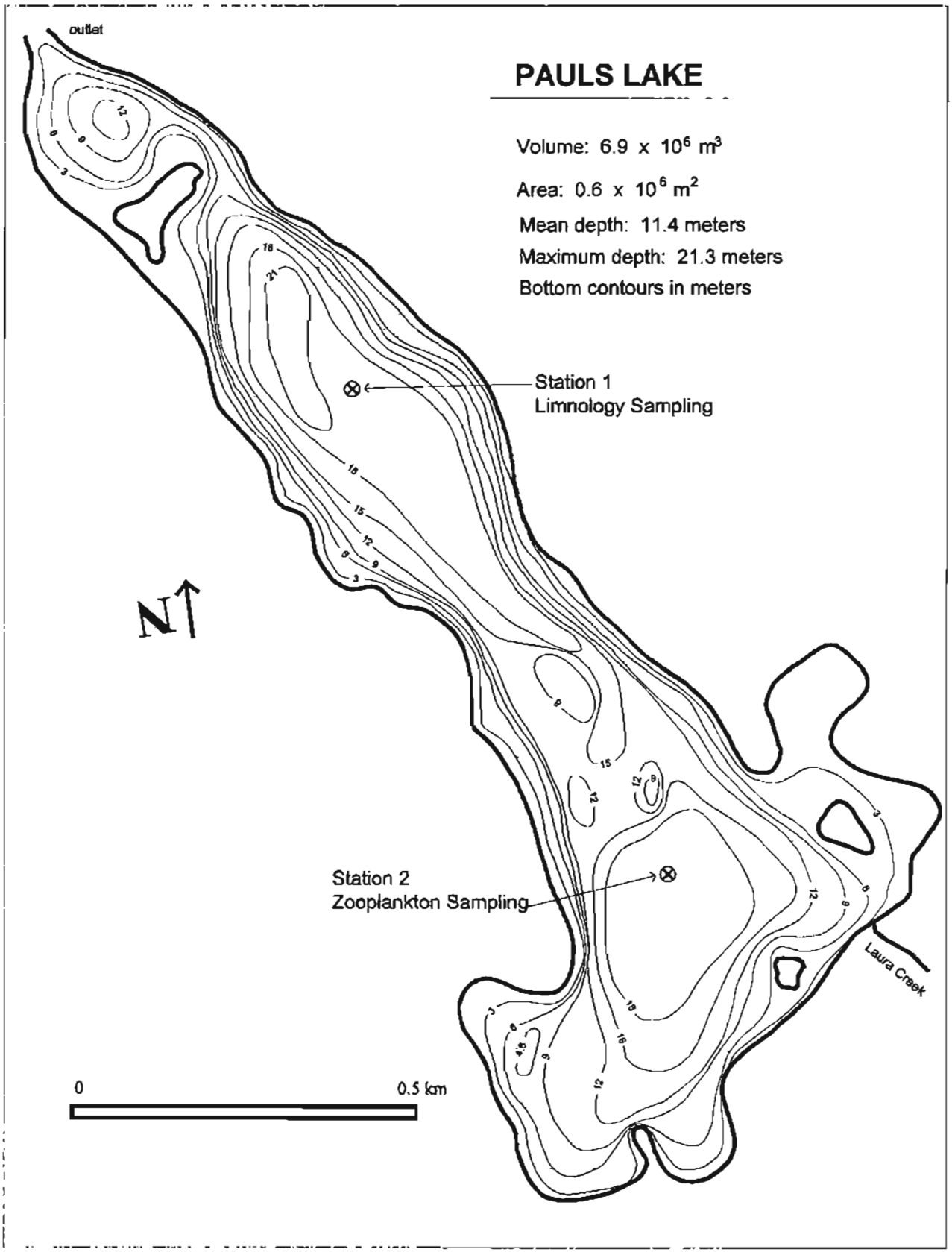
Year	Escapement Count	Broodstock Number [a]	% of Fish Used [b]		Estimated Freshwater Age Composition				Totals
					0	1	2	3	
1991	3,850 [c]	120		%	-	-	-	-	-
				#					
1992	7,610	1,005	13.2	%	-	-	-	-	-
				#					
1993	8,273	644	7.8	%	-	-	-	-	-
				#					
1994	9,042	350	3.9	%	-	-	-	-	-
				#					
1995	10,903	400	3.7	%	-	-	-	-	-
				#					
1996	8,030	454	5.7	%	-	-	-	-	-
				#					
1997	9,455	470	5.0	%	-	-	-	-	-
				#					
1998[d]	14,917	550	3.7	%	0	39.1	58.7	2.2	100
				#	0	18	27	1	46

[a] The number of sockeye salmon utilized at the egg takes.

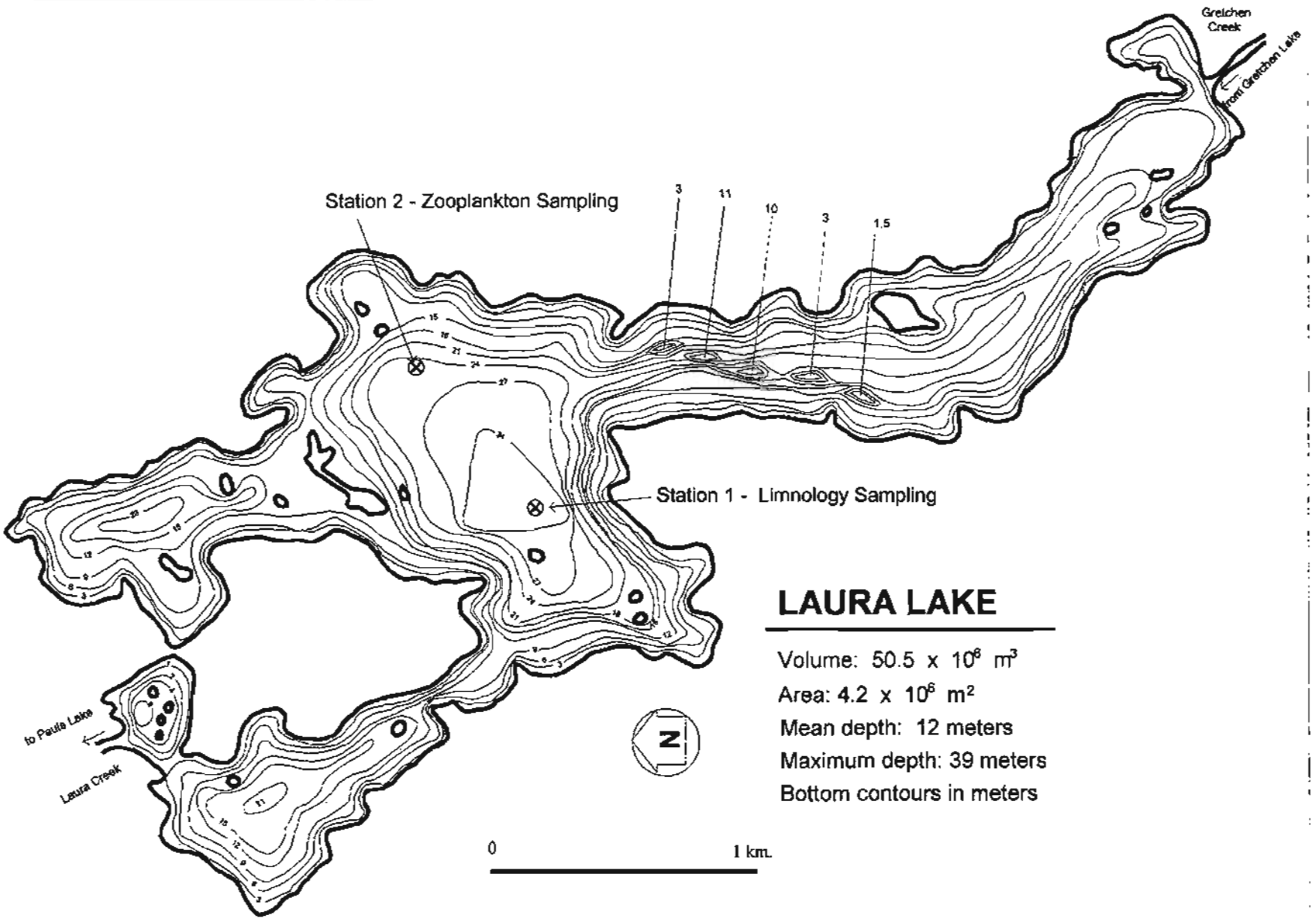
[b] The percentage of sockeye salmon used at the egg take from the total escapement.

[c] A weir was not installed until 1992, the escapement count was from an aerial survey.

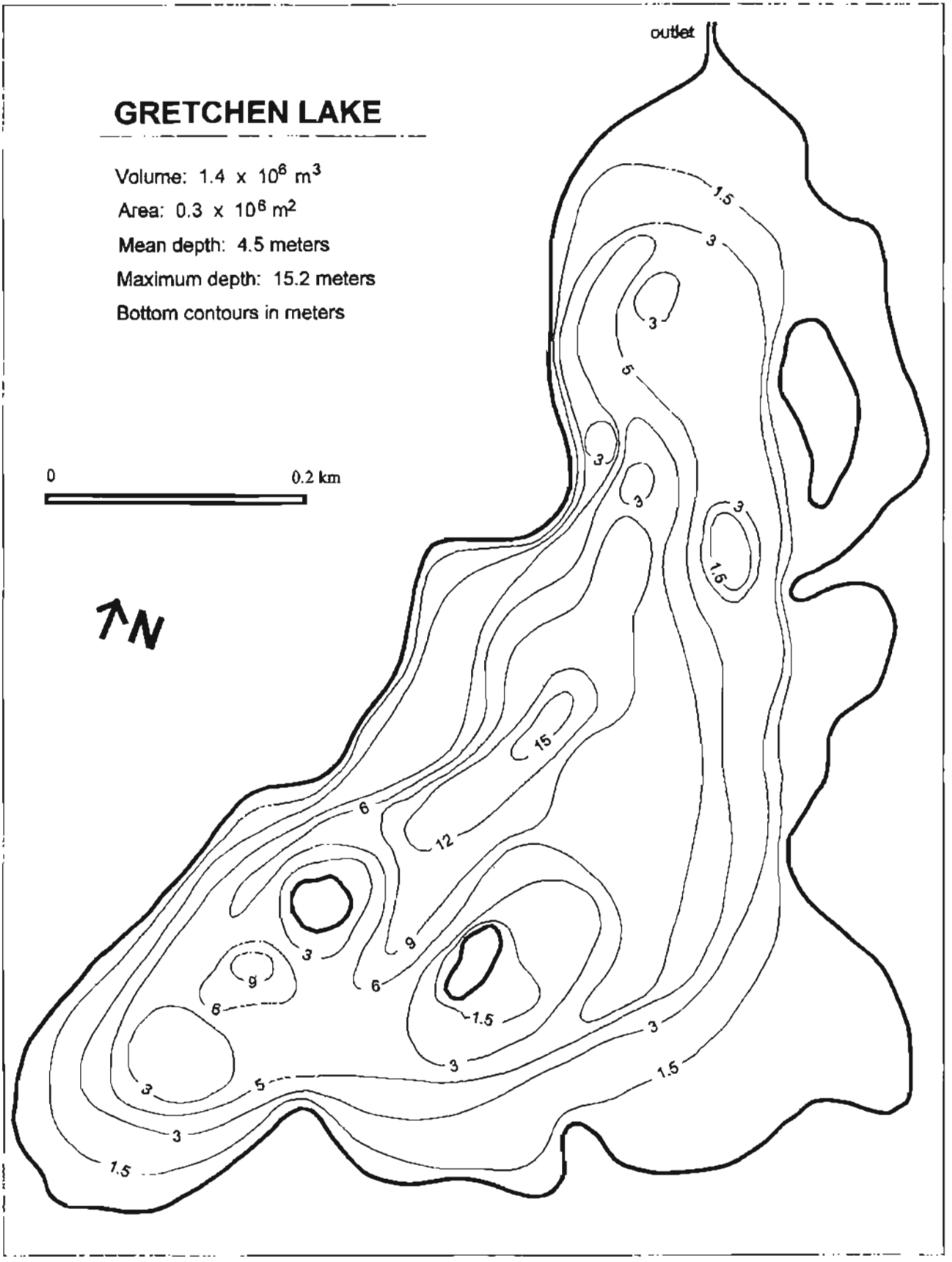
[d] Freshwater ages were not determined prior to 1998.



Appendix J.1. Morphometric map showing the limnology and zooplankton stations on Pauls Lake.



Appendix J.2. Morphometric map showing the limnology and zooplankton stations on Laura Lake.



Appendix J.3. Morphometric map of Gretchen Lake.

Appendix J.4. Juvenile sockeye salmon stocked into Laura Lake, 1992-1998.

	Release Year						
Life Stage[a]	1992	1993	1994	1995	1996	1997	1998
fry			117,000	16,000			
fingerling					52,000		
pre-smolt					130,000		
TOTAL	0	0	117,000	16,000	182,000	0	0

[a] Fry are released from April to July at up to 200% of emergent size (normally 0.15 to 0.5 g depending on the stock). Fingerling are released from June to September at a size of >200% to <2100% of emergent size (normally 0.3 to 5.25 g depending on the stock). Pre-smolt are released from August to November at a size of >2100% of emergent size but not yet at the physiological stage of smolting (normally 5 to 13 g).

Appendix J.5. The amount of nutrient enrichment additions and ratios into Laura Lake, 1993-1998.

Year	Fertilizer Ratio[a]	Amount (kg)
1993	20-5-0	20,000
1994	20-5-0	18,144
1994	32-0-0	3,629
1995	20-5-0	18,144
1995	32-0-0	3,629
1996	20-5-0	17,272
1996	32-0-0	3,048
1997	20-5-0	8,128
1998	20-5-0	8,000

[a] Nitrogen-Phosphorus-Potassium

a.

b.

Appendix J.6. Laura Creek (a) and Gretchen Creek (b) fish passes.

Appendix J.7. Limnological sampling locations and sampling frequencies for Laura and Pauls Lakes, 1990-1998.

Lake	Year	Sampling	
		Stations	Frequency
Laura	1990	1	3
	1991	1	5
	1992	1	4
	1993	1	7
	1994	1,2	7
	1995	1,2	7
	1996	1,2	6
	1997	1,2	6
	1998	1	4
Pauls	1994	1,2	4

Appendix J.8. Summary of seasonal mean water chemistry parameters by station and depth for Laura and Pauls Lakes, 1990 - 1998.

Lake	Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD[a]	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
Laura	1990	1	1	72.0	1.7	7.0	0.2	11.0	1.0	0.7	0.3	14.3	2.3	4.4	2.4	1.0	0.8	56.7	22.3
	1990	1	29	74.7	1.2	6.8	0.2	11.5	0.9	0.4	0.2	15.3	2.5	4.8	1.4	1.3	1.1	62.7	24.1
	1991	1	1	68.8	1.6	7.0	0.0	11.5	2.2	0.9	0.4	17.6	3.5	3.8	0.1	1.1	0.6	77.4	37.7
	1991	1	32	70.4	1.1	6.8	0.1	11.0	1.7	0.6	0.2	20.8	7.6	4.1	0.4	1.4	0.3	69.0	24.8
	1992	1	1	60.8	1.0	6.8	0.2	8.8	2.1	0.5	0.2	15.0	2.9	4.1	0.5	1.3	0.5	56.3	16.0
	1992	1	35	63.8	1.0	6.4	0.2	10.1	0.6	0.7	0.3	13.8	1.3	3.8	0.6	1.4	0.5	58.3	25.6
	1993	1	1	65.9	1.5	6.8	0.1	11.1	1.5	1.2	1.6	13.1	1.8	4.2	0.5	1.7	0.4	53.1	36.2
	1993	1	34	67.9	5.4	6.8	0.7	12.9	3.6	0.6	0.3	15.1	2.3	4.6	1.4	1.7	0.4	85.4	68.8
	1994	1	1	66.0	1.7	6.5	0.2	10.3	2.1	0.9	0.5	13.6	3.5	4.1	0.4	1.1	0.3	57.6	23.9
	1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1994	1	36	70.0	5.4	6.4	0.3	10.5	1.7	0.9	0.2	14.1	1.6	4.2	0.8	1.9	0.5	75.3	24.9
	1995	1	1	67.3	3.8	6.4	0.2	9.1	0.5	1.5	0.5	20.6	9.4	3.6	0.4	1.3	0.0	73.0	31.6
	1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1995	1	36	71.0	1.3	6.2	0.1	8.9	0.6	0.8	0.2	16.0	2.8	3.7	0.2	1.3	0.0	70.4	31.1
	1996	1	1	69.5	1.0	6.6	0.2	10.5	0.5	0.8	0.4	17.2	3.7	3.6	0.1	1.2	0.1	60.2	36.0
	1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1996	1	33	70.8	1.9	6.3	0.1	9.9	0.5	0.8	0.5	18.2	1.2	3.6	0.1	1.2	0.1	81.8	34.1
	1997	1	1	70.5	1.5	7.0	0.1	12.2	1.4	0.8	0.3	14.0	3.1	3.5	0.1	1.3	0.2	37.5	4.7
	1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1997	1	34	71.0	1.0	6.6	0.1	11.8	0.4	0.7	0.1	16.0	1.7	3.7	0.1	1.2	0.2	54.0	16.1
	1998	1	1	63.7	0.6	7.1	0.2	12.7	2.0	1.0	0.6	15.3	2.5	3.5	0.2	1.2	0.2	20.3	4.0
Pauls	1994	1	1	1,453.5	1,892.3	7.1	0.3	16.3	5.2	0.7	0.2	10.5	3.1	15.6	15.8	29.1	40.6	31.8	14.5
	1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1994	1	12	31,575.0	2,642.4	7.5	0.6	215.3	91.9	2.1	1.0	35.3	22.4	322.0	50.2	767.0	27.4	103.5	63.8

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix J.9. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Laura and Pauls Lakes, 1990 - 1998.

Lake	Year	Station	Depth (m)	Total-P (ug L^{-1})	SD[a]	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
Laura	1990	1	1	3.9	0.9	2.4	0.2	1.6	0.3	125.1	10.2	4.6	0.8	6.0	7.4	1836.0	112.3	251.3	45.0	0.80	0.4	0.37	0.1
	1990	1	29	2.3	0.4	2.9	1.9	2.1	0.9	101.4	6.8	11.5	4.0	30.2	5.4	1983.3	132.1	137.0	44.2	0.27	0.0	0.20	0.0
	1991	1	1	4.1	0.6	2.8	1.3	1.9	0.8	82.6	23.8	10.0	3.3	10.2	12.4	1696.2	136.7	na	na	0.79	0.2	0.32	0.1
	1991	1	32	4.0	0.6	3.5	2.0	2.6	2.3	82.9	24.9	15.6	6.8	27.6	6.1	1824.6	57.3	na	na	0.35	0.4	0.17	0.1
	1992	1	1	6.0	3.2	3.7	1.6	3.4	1.2	100.3	11.0	5.4	2.5	10.0	3.3	1707.0	198.4	186.5	45.8	0.58	0.4	0.36	0.1
	1992	1	35	6.1	2.6	2.2	0.4	1.9	0.3	91.9	19.0	9.0	2.7	30.8	8.1	1954.8	9.6	99.3	33.4	0.48	0.3	0.34	0.1
	1993	1	1	12.1	3.9	3.9	1.0	1.8	0.4	189.0	37.2	6.6	3.6	8.2	0.0	984.8	512.1	242.1	64.0	2.65	0.8	0.83	0.4
	1993	1	34	8.3	4.1	4.8	4.2	3.1	2.8	139.2	23.4	14.9	8.6	26.2	11.5	1861.0	221.1	125.3	86.2	0.72	0.9	0.37	0.2
	1994	1	1	10.0	4.2	2.8	0.9	1.5	0.2	184.0	47.6	9.4	8.9	31.7	40.5	953.6	550.1	166.3	81.1	2.59	1.6	0.54	0.3
	1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.67	1.6	0.60	0.3
	1994	1	36	4.5	0.8	2.3	0.6	1.5	0.4	151.9	37.2	42.2	34.9	29.1	28.5	1784.3	87.8	90.7	25.6	0.39	0.1	0.25	0.0
	1995	1	1	8.9	4.1	4.3	3.9	3.3	3.9	176.0	46.6	10.1	4.5	25.1	18.6	1417.9	367.7	na	na	3.90	3.0	1.00	0.7
	1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	4.11	3.5	1.18	0.8
	1995	1	36	6.1	2.0	2.4	1.1	1.5	0.7	138.2	41.5	26.0	17.6	55.5	15.4	1870.4	107.5	na	na	0.54	0.5	0.33	0.0
	1996	1	1	11.9	4.1	5.2	3.1	3.2	1.8	192.5	71.9	9.9	7.1	17.0	12.0	1435.2	270.5	261.8	101.2	5.31	3.9	0.98	0.4
	1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	4.88	4.4	0.88	0.6
	1996	1	33	6.7	2.3	3.9	2.1	2.7	1.7	125.6	23.7	18.6	15.5	57.7	16.2	1836.6	27.2	73.8	24.1	1.77	1.7	0.55	0.3
	1997	1	1	7.8	0.5	3.5	1.9	2.1	1.9	169.1	47.9	6.7	2.5	9.7	0.5	1059.0	327.8	229.7	39.7	1.76	1.1	1.00	0.2
	1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.72	0.6	1.17	0.7
	1997	1	34	6.1	1.5	3.1	0.8	1.9	0.6	124.1	9.9	13.8	6.7	53.7	11.1	1911.2	212.1	89.8	30.6	0.36	0.2	0.43	0.1
	1998	1	1	11.5	4.2	3.7	2.3	0.9	0.5	174.6	17.9	4.1	2.5	11.0	5.1	1127.7	296.1	188.7	91.5	1.38	0.4	3.06	3.0
Pauls	1994	1	1	355.2	691	2.675	1.4	1.775	0.5	1757.9	3015	15.05	17.3	19.4	na	1232	499	264.8	112	1.828	1.1	0.483	0.5
	1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.26	0.7	0.453	0.2
	1994	1	12	677	707	876.3	581	991.5	660	3017.5	3189	4292	2864	2.4	2.5	8347	4197	964.8	192	4.81	na	25.71	17

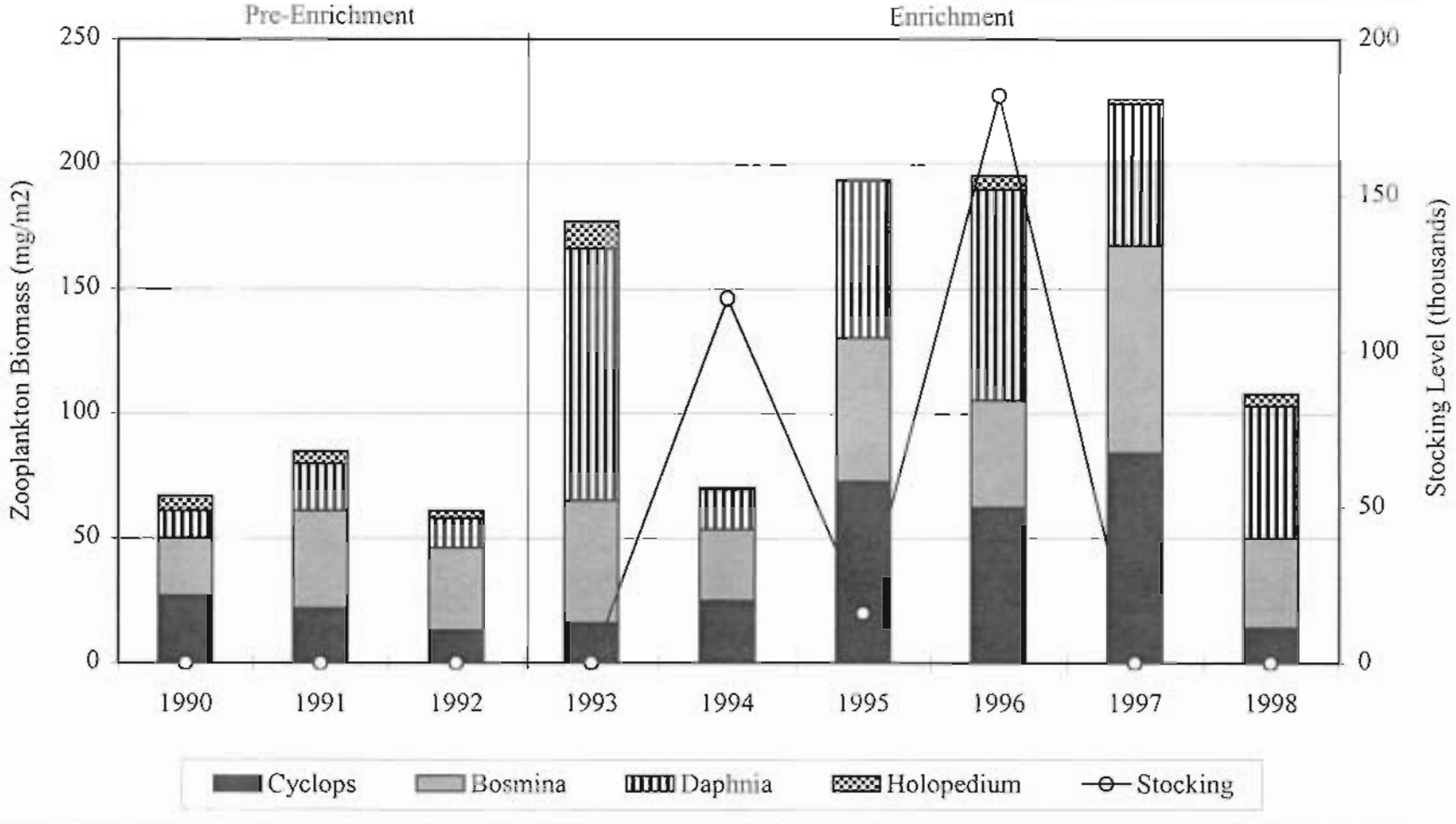
[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix J.10. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) from Laura Lake, 1990-1998.

Station	No. of	*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1 and 2	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year [a]	Days	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1990	3	12,900	27	0.78	27,816	23	0.30	10,218	11	0.50	2,553	6	0.51	53,487	67
1991	5	47,054	22	0.89	47,054	39	0.31	14,293	19	0.56	2,532	5	0.50	110,933	85
1992	4	4,624	13	0.91	33,852	33	0.33	8,920	12	0.56	1,778	3	0.47	49,174	61
1993	7	7,037	16	0.80	49,924	49	0.33	70,951	101	0.58	4,838	11	0.52	132,750	177
1994	7	7,804	25	0.93	31,628	29	0.31	12,323	16	0.56	309	0.7	0.43	52,064	70
1995	7	23,358	73	0.93	65,347	58	0.31	50,174	63	0.55	133	0.4	0.49	139,012	194
1996	6	24,058	62	0.80	53,494	43	0.30	79,937	85	0.51	2,813	5.6	0.49	160,302	196
1997	6	25,035	84	0.95	95,101	83	0.31	41,712	57	0.57	1,083	1.9	0.47	162,931	226
1998	4	5,531	14	0.83	38,687	36	0.31	43,904	53	0.49	5,387	5	0.43	93,509	108
Avg =	5	7,804	25	0.88	65,347	58	0.32	12,323	16	0.56	309	1	0.50	106,018	132

[a] Data from 1994 - 1997 was averaged from two stations, and the remaining years, only samples from station 1 were obtained.



Appendix J.11. Weighted mean zooplankton biomass by genera (stations 1&2 averaged), lake enrichment time period, and juvenile sockeye salmon stocking levels for Laura Lake, 1990-1998.

Appendix J.12. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Laura Lake, 1991-1997.

	Total Fish Estimates			Sockeye Estimates			Sockeye Composition
		95% C. I.			95% C. I.		
Date	Number	Low	High	Number	Low	High	(%)
27-Aug-91	1,111,608	734,342	1,488,874	170,076	112,354	227,798	15.3
2-Oct-92	1,837,604	1,310,334	2,364,874	183,760	131,033	236,487	10.0
16-Sep-93	897,732	862,637	932,827	104,137	100,066	108,208	11.6
3-Oct-94	1,089,645	870,045	1,309,245	64,289	51,333	77,245	5.9
30-Aug-95	2,729,625	1,969,959	3,489,291	414,903	299,434	530,372	15.2
16-Sep-96	1,932,933	1,604,064	2,261,802	71,519	59,351	83,687	3.7
17-Sep-97	4,218,356	3,783,430	4,653,282	21,092	18,917	23,267	0.5

Appendix J.13. Townet catches from Laura Lake, 1991-1997.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Year	Number	Minutes	Number	%	CPUE [a]	Number	%	CPUE [a]
28-Aug-91	5	58	83	15.3	1.4	459	84.7	7.9
03-Oct-92	6	69	78	10.0	1.1	702	90.0	10.2
17-Sep-93	5	68	106	11.6	1.6	811	88.4	11.9
04-Oct-94	7	86	29	5.9	0.3	461	94.1	5.4
31-Aug-95	6	46	78	15.2	1.7	435	84.8	9.5
17-Sep-96	6	60	47	3.7	0.8	1,236	96.3	20.6
17-Sep-97	6	43	1	0.5	0.0	208	99.5	4.8

[a] CPUE - Catch per unit of effort

Appendix J.14. Mean length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Laura Lake, 1991-1997.

	Age-0					Age-1					Age-2				
Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
28-Aug-91	39	68.4	52.8	1.6	1.07	18	31.6	63.7	2.8	1.05	0	0.0	0.0	0.0	0.00
3-Oct-92	56	81.2	53.3	1.8	1.14	12	17.4	66.6	3.2	1.07	1	1.4	71.1	3.9	1.09
17-Sep-93	69	95.9	53.2	1.9	1.24	2	4.1	65.5	3.5	1.26	0	0.0	0.0	0.0	0.00
4-Oct-94	19	90.4	51.2	1.7	1.20	1	4.8	63.0	3.1	1.24	1	4.8	74.0	5.1	1.26
31-Aug-95	63	78.8	55.9	1.9	1.04	17	21.2	67.7	3.4	1.08	0	0.0	0.0	0.0	0.00
17-Sep-96	6	12.8	50.7	1.5	1.16	40	85.1	59.9	2.6	1.21	1	2.1	76.0	4.2	0.96
17-Sep-97	0	0.0	0.0	0.0	0.00	1	100.0	46.0	0.9	0.92	0	0.0	0.0	0.0	0.00

Appendix J.15. Mean length, weight, and condition coefficient by age for sockeye salmon smolt outmigrating from Laura Lake, 1953-1957 a and 1992-1998.

	Age-1					Age-2					Age-3				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
1953	1238	100	132.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1954	8702	82.5	nd	nd	nd	1842	17.5	nd	nd	nd	nd	nd	nd	nd	nd
1955	936	31.5	nd	nd	nd	1853	62.3	nd	nd	nd	184	6.2	nd	nd	nd
1956	nd	86.1	nd	nd	nd	nd	3	nd	nd	nd	nd	10.9	nd	nd	nd
1957	226	69.8	nd	nd	nd	66	20.4	nd	nd	nd	32	9.9	nd	nd	nd
June 10-12, 1992	189	74.7	69.9	2.6	0.75	64	25.3	76.3	3.3	0.75	0	0.0	0.0	0.0	0.00
June 14-15, 1993	124	88.6	72.5	3.1	0.80	16	11.4	78.0	3.8	0.79	0	0.0	0.0	0.0	0.00
Jun 7-13, 1994	221	92.1	70.8	2.8	0.80	19	7.9	80.8	4.0	0.75	0	0.0	0.0	0.0	0.00
May 31-June 13, 1995	114	85.1	67.4	2.4	0.79	20	14.9	74.7	3.0	0.72	0	0.0	0.0	0.0	0.00
Jun 13-18, 1996	132	67.3	76.9	3.6	0.79	63	32.1	83.1	5.0	0.84	1	0.5	85.0	5	0.82
May 31-June 13, 1997	54	27.3	82.5	4	0.69	144	72.7	77.0	3.3	0.72	0	0.0	0.0	0.0	0.00
May 31-June 20, 1998	10	4.0	85.6	5.6	0.84	239	96.0	79.4	4.3	0.86	0	0.0	0.0	0.0	0.00

[a] for years 1953-1957, date of capture and length-weight-condition information are unknown; data presented are total smolt trapped (Stockley, unpublished field notes, 1953).

nd - no data available

Appendix J.16. Pauls Bay sockeye salmon escapement counts, 1989-1998.

					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/31										1
6/1										1
6/2										0
6/3									16	0
6/4									0	67
6/5		40							75	1
6/6	76	66	201						42	0
6/7	144	37	42	100				3	29	0
6/8	42	695	2	29		5	3	0	0	11
6/9	169	359	5	21		1	0	0	20	0
6/10	1,713	3	0	151	223	0	156	768	307	0
6/11	347	7	0	17	586	1	61	0	444	210
6/12	152	7	4	5	132	143	7	51	25	84
6/13	11	29	30	22	1,654	187	0	453	104	358
6/14	89	21	31	0	1,409	725	1,092	307	160	323
6/15	86	1	25	84	230	1,175	58	2,857	708	2,000
6/16	130	67	7	239	53	0	2,029	3,206	110	49
6/17	3,463	36	0	6	249	863	384	4,309	467	215
6/18	609	29	2	152	89	794	0	1,413	147	86
6/19	12	38	36	316	238	2,230	6	7,144	2,202	276
6/20	21	792	1	46	1,778	283	14	616	595	9
6/21	291	68	26	43	1,197	0	0	487	3,727	127
6/22	164	546	377	53	857	2	5	1,115	2,922	30
6/23	206	378	268	150	119	8	15	3,827	1,483	35
6/24	1,624	4,449	57	18	179	165	75	99	57	2,546
6/25	1	633	36	303	6	0	310	312	37	216
6/26	52	530	0	465	59	0	39	352	469	138
6/27	265	25	0	136	56	0	5	3,333	374	79
6/28	210	101	23	486	254	0	1,007	861	79	484
6/29	10	317	110	1,186	475	116	40	3,017	911	450
6/30	32	0	114	2,005	153	133	73	3,046	26	28
7/1	428	2	373	2,000	89	225	1,853	1,183	32	80
7/2	21	0	391	0	375	406	664	428	38	1,877
7/3	3	12	0	0	41	5	508	309	33	442
7/4	19	391	26	0	194	7	545	120	74	377
7/5	573	705	0	0	41	202	237	2	114	278
7/6	0	266	118	0	214	1,031	10	176	99	88
7/7	0	0	0	0	83	1	0	140	9	1

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					------YEAR------					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
7/8	0	153	67	0	3	16	29	72	75	0
7/9	0	205	73	0	279	0	1	123	0	2
7/10	20	754	266	0	121	2	81	2	0	12
7/11	2	82	0	0	178	45	309	27	264	421
7/12	0	17	20	0	19	0	162	8	247	251
7/13	37	83	0	0	2	0	695	72	6,200	93
7/14	192	847	0	0	109	951	56	30	829	163
7/15	321	147	6	0	17	489	0	37	286	245
7/16	8	128	0	0	500	0	147	5	0	1,307
7/17	33	340	0	0	0	0	337	0	3	54
7/18	3	189	500	0	0	7	161	61	21	49
7/19	1,000	4	0	0	0	93	66	1	1,809	25
7/20	0	469	0	0	0	1,850	154	50	3,610	127
7/21	0	137	0	0	0	77	479	1	574	605
7/22	0	44	0	0	0	254	33	0	201	141
7/23	0	4	0	0	0	204	49	0	78	133
7/24	0	0	0	0	0	648	15	74	104	200
7/25	0	5	0	0	0	477	0	5	61	16
7/26	0	0	0	0	0	284	9	3	28	5
7/27	0	20	0	0	0	147	3	6	84	11
7/28	0	12	0	0	0	53	5	9	65	3
7/29	0	0	0	0	0	0	24	183	0	36
7/30	0	15	0	0	0	5	61	12	3	9
7/31	0	27	0	0	0	0	1	37	0	13
8/1	0	49	0	0	0	0	4	68	8	0
8/2	0	37	0	0	0	36	41	11	5	76
8/3	0	56	0	0	0	30	162	32	14	18
8/4	0	6	0	0	0	24	68	26	22	14
8/5	0	3	0	0	0	0	32	59	3	30
8/6	0	0	0	0	0	46	126	8	24	11
8/7	0	4	0	0	42	8	14	0	27	116
8/8	0	8	0	0	4	152	108	0	32	30
8/9	0	5	0	0	4	54	5	1	17	23
8/10	0	2	0	0	0	39	251	60	5	17
8/11	6	1	0	0	0	61	82	42	0	19
8/12	0	1	0	0	1	2	244	12	116	2

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	YEAR									
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/13	2	0	0	0	5	39	74	0	164	12
8/14	4	0	0	0	36	94	22	1	41	12
8/15	5	1	0	0	3	28	15	1	38	14
8/16	0	0	0	0	3	107	0	2	102	0
8/17	2	2	0	0	2	49	9	1	19	2
8/18	1	0	0	0	0	3	3	5	16	3
8/19	1	0	0	0	5	15	9	0	25	4
8/20	2	0	0	0	4	31	14	10	115	9
8/21	0	0	0	0	11	369	7	4	12	3
8/22	0	0	0	0	10	183	24	4	24	0
8/23	0	2	0	0	5	80	3	0	52	2
8/24	0	0	0	0	0	57	7	2	29	6
8/25	0	0	0	0	2	9	13	4	13	3
8/26	0	0	0	0	15	9	10	0	37	1
8/27	0	0	0	0	6	43	1	5	18	0
8/28	0	0	0	0	7	41	24	0	1	2
8/29	1	0	0	0	1	9	8	0	0	7
8/30	0	0	0	0	5	19	2	0	0	8
8/31	0	0	0	0	7	23	3	2	0	0
9/1	0	0	0	0	3	16	2	1	0	3
9/2	0	0	0	0	0	26	1	13	0	2
9/3	0	1	0	0	0	22	0	0	0	2
9/4	0	0	0	0	0	31	0	0	0	2
9/5	1	0	0	0	0	4	0	1	0	0
9/6	0	0	0	0	0	31	0	1	0	0
9/7	0	0	0	0	0	0	9	0	0	2
9/8	0	0	0	0	0	0	10	2	0	0
9/9	1	0	0	0	0	0	0	0	0	0
9/10	0	0	0	0	0	0	0	5	0	0
9/11	0	0	0	0	0	0	0	10	0	0
Total:	12,605	14,510	3,237	8,033	12,442	16,100	13,480	41,145	31,456	15,343

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix J.17. Estimated age composition of Pauls Bay sockeye escapement samples, 1955-1957, 1990-1991 and 1993-1998.

		Age										
Year		1.1	1.2	2.1	1.3	2.2	1.4	2.3	2.4	3.2	3.3	Totals
1955	Number	7	42	8	0	0	0	1	0	0	0	58
	Percent	12.1	72.4	13.8	0.0	0.0	0.0	1.7	0.0	0.0	0.0	100
1956	Number	2	68	1	4	12	0	0	0	0	0	87
	Percent	2.3	78.2	1.1	4.6	13.8	0.0	0.0	0.0	0.0	0.0	100
1957	Number	64	71	5	64	19	0	7	0	0	0	230
	Percent	27.8	30.9	2.2	27.8	8.3	0.0	3.0	0.0	0.0	0.0	100
1990	Number	69	3,431	34	4,700	1,543	137	4,494	69	0	34	14,510
	Percent	0.5	23.6	0.2	32.4	10.6	0.9	31.0	0.5	0.0	0.2	100
1991	Number	262	234	85	1,062	460	14	1,105	14	0	0	3,237
	Percent	8.1	7.2	2.6	32.8	14.2	0.4	34.1	0.4	0.0	0.0	100
1993	Number	31	3,065	306	3,892	3,739	61	1,195	0	0	31	12,442
	Percent	0.2	24.6	2.5	31.3	30.0	0.5	9.6	0.0	0.0	0.2	100
1994	Number	324	2,708	59	8,889	1,825	59	2,178	29	29	0	16,100
	Percent	2	17	0	55	11	0	14	0	0	0	100
1995	Number	3,073	907	673	1,639	1,522	0	5,648	0	0	0	13,461
	Percent	23	7	5	12	11	0	42	0	0	0	100
1996	Number	351	22,625	351	1,315	11,663	0	4,823	0	0	0	41,128
	Percent	1	55	1	3	28	0	12	0	0	0	100
1997	Number	151	5,569	6,622	8,880	4,139	0	6,096	0	0	0	31,456
	Percent	0	18	21	28	13	0	19	0	0	0	100
1998	Number	2,323	287	3,642	574	6,825	0	1,663	0	29	0	15,343
	Percent	15	2	24	4	44	0	11	0	0	0	100

Appendix J.18. Pauls/Laura sockeye salmon weir counts, broodstock number and estimated freshwater age composition, 1993-1998.

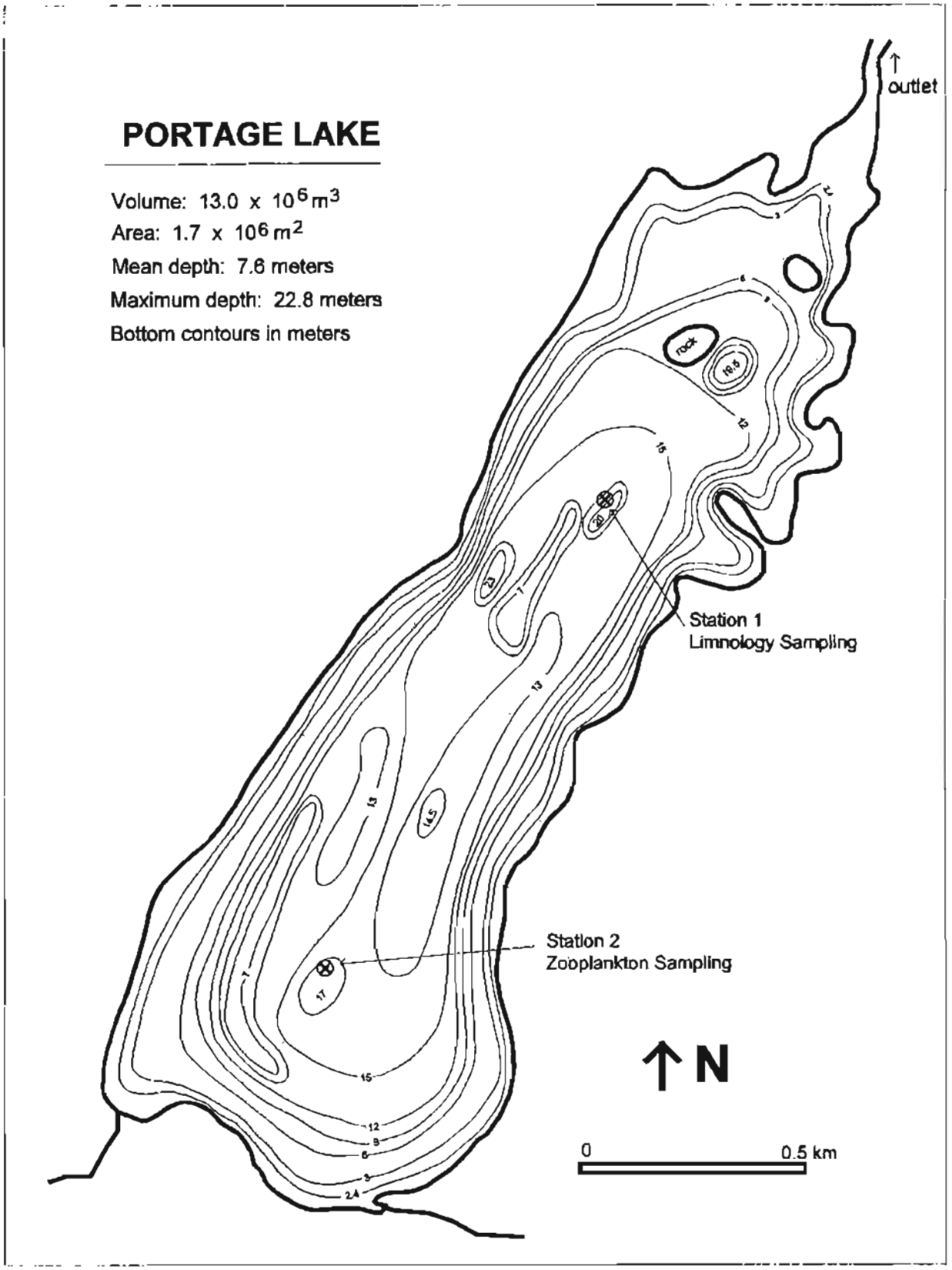
Year	Escapement Count	Broodstock Number [a]	% of Fish Used [b]		Estimated Freshwater Age Composition 0	1	2	3	Totals	Number of samples
1993	12,442	218	1.8	Number	-	-	-	-	-	
				Percent						
1994	16,100	53	0.3	Number	-	-	-	-	-	
				Percent						
1995	13,480	170	1.3	Number	-	-	-	-	-	
				Percent						
1996 [c]	41,145	0	0.0	Number	-	-	-	-	-	
				Percent						
1997 [c]	31,456	0	0.0	Number	-	-	-	-	-	
				Percent						
1998 [d]	15,343	250	1.6	Number	0	90	10	0	100	100
				Percent	0.0	90.0	10.0	0.0	100.0	

[a] The number of sockeye salmon utilized at the egg takes.

[b] The percentage of sockeye salmon used at the egg take from the total escapement.

[c] The escapement goal was achieved, no egg takes were necessary.

[d] Freshwater ages were not determined prior to 1998.



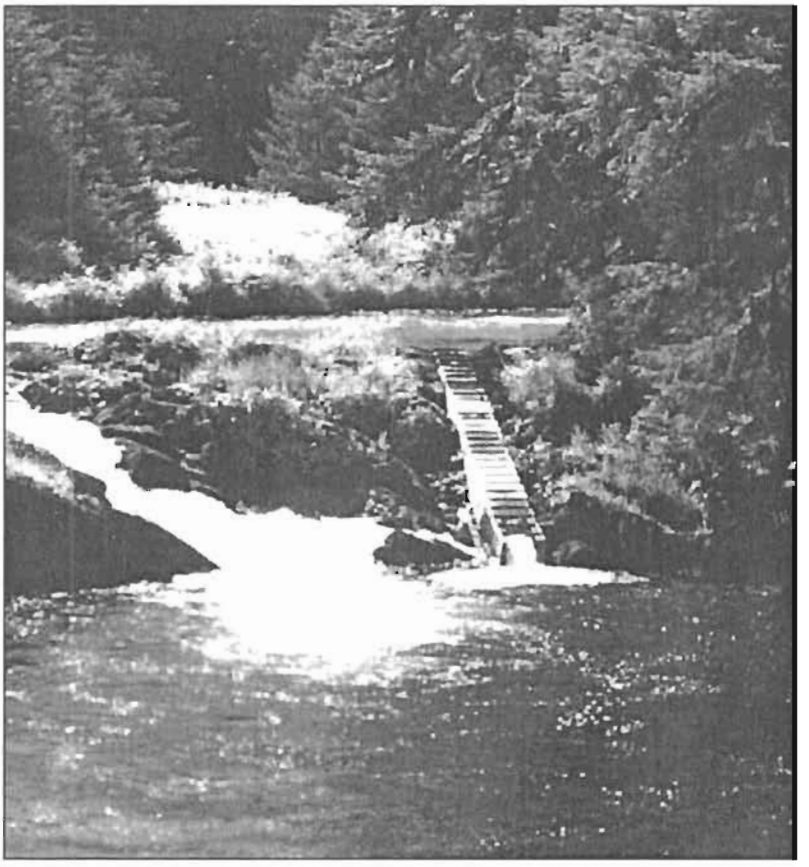
Appendix K.1. Morphometric map showing the limnology and zooplankton stations for Portage Lake.

Appendix K.2. The amount of nutrient enrichment additions and ratios into Portage Lake, 1993-1997.

Year	Fertilizer ratio[a]	Amount (kg)
1993	20-5-0	18,181
1994	20-5-0	15,422
1995	20-5-0	13,608
1996	20-5-0	15,240
1996	32-0-0	2,032
1997	20-5-0	12,192

[a] Nitrogen-Phosphorus-Potassium

a.



b.

Appendix K.3. Portage Creek fish pass, looking upstream (a) and downstream (b).

Appendix K.4. Limnological sampling locations and sampling frequencies for Portage Lake, 1990-1998.

Year	Sampling	
	Stations	Frequency
1990	1	4
1991	1	4
1992	1	4
1993	1	7
1994	1,2	7
1995	1,2	7
1996	1,2	6
1997	1,2	6
1998	1	4

Appendix K.5. Summary of seasonal mean water chemistry parameters by station and depth for Portage Lake, 1990 - 1998.

Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD[a]	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1990	1	1	52.0	2.9	7.0	0.2	11.5	1.0	0.8	0.3	20.8	5.6	3.9	0.5	0.9	0.2	219.0	77.1
1990	1	16	53.5	2.4	6.9	0.1	11.5	1.0	0.7	0.5	20.3	5.9	4.3	0.5	0.9	0.2	189.3	57.6
1991	1	1	47.8	2.1	6.9	0.1	11.0	2.2	0.9	0.3	19.5	3.7	4.3	1.2	1.1	0.4	148.0	45.3
1991	1	14	47.3	1.5	6.7	0.3	10.3	2.5	1.0	0.4	22.5	3.0	3.9	0.8	1.0	0.3	160.8	52.3
1992	1	1	49.5	1.3	6.7	0.2	12.8	2.3	1.0	0.5	18.0	2.9	4.8	0.8	1.8	1.6	206.5	87.5
1992	1	15	48.5	1.7	6.6	0.3	11.5	1.6	0.7	0.3	26.3	10.9	4.3	0.5	1.2	1.1	171.0	40.0
1993	1	1	52.9	1.2	6.8	0.2	11.4	1.0	1.7	1.2	23.4	9.4	4.6	0.4	1.0	0.3	147.4	51.5
1993	1	16	51.7	1.5	6.5	0.2	10.4	0.8	1.0	0.4	21.7	8.3	4.4	0.5	0.9	0.3	142.3	49.4
1994	1	1	47.3	1.9	6.6	0.2	9.9	0.9	1.5	0.6	22.4	3.0	3.9	0.1	1.0	0.3	172.7	68.3
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	16	49.5	3.1	6.3	0.3	9.6	0.9	1.6	1.0	22.1	2.8	4.0	0.1	0.9	0.3	189.9	83.2
1995	1	1	50.9	3.2	6.5	0.1	10.3	1.2	1.4	0.4	20.3	7.3	3.6	0.3	0.9	0.4	198.7	85.6
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	15	50.7	3.6	6.3	0.2	9.1	1.1	1.4	1.0	19.6	8.9	3.5	0.5	0.9	0.4	181.0	108.0
1996	1	1	56.0	2.5	6.7	0.1	11.9	1.4	1.2	0.6	16.2	4.7	3.8	0.7	1.0	0.4	122.7	65.2
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	18	54.3	2.6	6.4	0.4	10.9	1.9	1.3	0.6	19.8	6.2	3.6	0.1	1.0	0.4	138.7	73.8
1997	1	1	53.7	1.0	7.0	0.2	12.4	1.3	1.0	0.4	17.0	8.7	4.0	0.6	0.8	0.3	80.5	37.1
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	15	53.0	1.9	6.7	0.2	11.7	1.2	1.1	0.5	17.8	4.4	3.8	0.4	0.9	0.3	89.8	36.3
1998	1	1	53.3	0.5	6.8	0.2	12.1	0.4	1.1	0.1	17.4	0.6	3.9	0.1	0.8	0.1	85.2	6.6

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix K.6. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Portage Lake, 1990 - 1998.

Year	Station	Depth (m)	Total-P (ug L^{-1})	SD[a]	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1990	1	1	6.1	2.7	3.0	1.0	1.8	0.4	112.4	44.7	3.8	5.4	20.9	23.7	2160.5	343.3	202.0	81.1	0.50	0.1	0.50	0.4
1990	1	16	6.1	2.4	2.3	0.3	2.0	0.2	113.6	45.2	7.1	5.6	45.2	21.0	2262.8	353.0	166.3	86.0	0.16	0.1	0.25	0.1
1991	1	1	7.1	2.0	3.3	0.6	2.8	0.5	na	na	5.5	2.5	35.2	19.4	1888.0	142.7	na	na	0.55	0.2	0.33	0.2
1991	1	14	7.0	1.4	3.6	0.4	2.8	0.5	na	na	7.3	2.9	43.8	15.3	1924.8	96.2	na	na	0.29	0.3	0.26	0.1
1992	1	1	5.2	1.1	5.5	3.2	4.1	2.6	143.6	15.0	2.2	1.1	35.4	39.8	2015.5	213.5	255.8	63.2	0.58	0.5	0.35	0.2
1992	1	15	6.0	0.9	6.7	4.0	6.2	5.4	100.0	66.8	3.9	4.5	75.0	13.0	2163.3	158.6	186.8	25.9	0.32	0.3	0.31	0.1
1993	1	1	17.6	11.2	10.1	14.7	6.1	9.3	250.3	76.7	5.8	5.8	19.7	12.5	1852.1	337.1	343.4	144.1	6.35	6.2	0.72	0.4
1993	1	16	7.1	2.4	6.6	5.9	4.2	3.4	159.3	51.1	9.9	5.8	46.0	13.2	2198.6	92.4	123.3	105.9	0.62	0.5	0.49	0.2
1994	1	1	10.5	5.0	3.4	1.0	2.1	0.5	176.8	68.7	6.9	3.6	18.0	8.7	1695.3	519.9	276.1	208.0	1.90	1.3	0.59	0.3
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.41	1.0	0.55	0.3
1994	1	16	5.9	1.3	2.7	0.4	2.2	0.5	164.8	39.2	20.7	22.6	30.6	8.0	2143.6	154.1	116.9	50.7	0.24	0.2	0.34	0.2
1995	1	1	7.7	1.9	3.6	0.7	1.7	0.7	184.3	43.0	12.3	4.6	23.3	10.4	2022.4	501.6	na	na	2.05	1.5	0.85	0.5
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.06	1.6	0.82	0.5
1995	1	15	6.3	1.6	3.0	1.0	1.8	0.9	169.9	33.5	24.4	20.2	37.3	10.6	2295.6	360.2	na	na	0.52	0.3	0.38	0.1
1996	1	1	6.8	1.6	4.6	2.4	3.6	1.9	150.9	56.5	8.0	8.0	64.6	90.3	1810.8	303.7	145.3	71.0	1.81	1.3	0.67	0.4
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.68	1.1	0.68	0.4
1996	1	18	6.1	2.5	5.1	5.5	5.0	5.4	110.9	29.2	17.5	9.8	52.5	8.6	2190.0	110.4	51.3	29.1	0.39	0.2	0.30	0.1
1997	1	1	9.3	4.9	4.1	2.0	2.9	2.2	185.0	54.7	15.7	13.1	14.1	10.2	2007.3	619.8	276.3	213.3	1.94	1.8	1.27	0.9
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.92	1.7	1.37	1.0
1997	1	15	5.2	2.0	2.9	0.6	1.9	0.4	148.5	53.4	29.8	19.6	30.9	6.4	2121.7	274.9	98.2	35.3	0.44	0.1	0.61	0.2
1998	1	1	7.3	2.9	3.5	0.9	2.4	0.7	166.7	25.8	22.7	10.0	22.5	11.9	2064.5	80.8	187.3	126.0	1.43	0.9	1.08	0.4

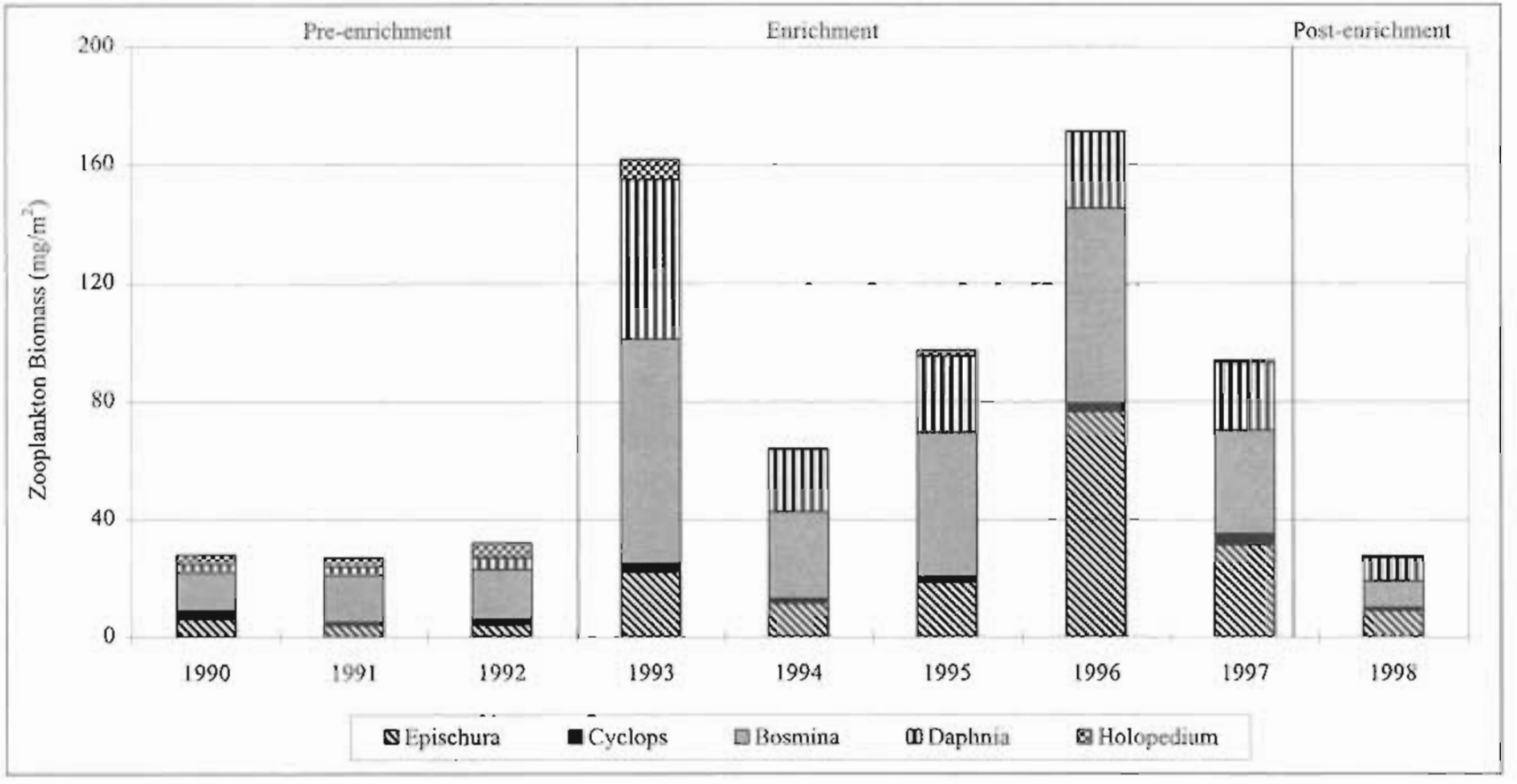
[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix K.7. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Portage (Perenosa) Lake, 1990-1998.

Station	No. of	*Epischura*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
1 & 2	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1990	4	3,463	6	0.76	1,573	3.0	0.70	15,347	13	0.31	2,456	3	0.56	1,473	3.0	0.48	24,312	28
1991	4	2,305	4	0.73	1,007	1.0	0.65	19,308	16	0.31	2,308	3	0.53	1,372	3.0	0.53	26,300	27
1992	4	1,513	4	0.81	1,770	2.0	0.60	20,993	17	0.30	3,702	4	0.53	2,672	5.0	0.46	30,650	32
1993	7	5,909	22	0.93	2,397	3.0	0.64	93,807	76	0.30	42,815	54	0.55	3,146	7.0	0.52	148,074	162
1994	7	4,597	12	0.83	1,336	1.6	0.60	43,916	30	0.28	19,801	21	0.50	241	0.4	0.46	69,891	64
1995	7	5,335	19	0.92	1,249	1.9	0.67	61,231	49	0.30	18,778	26	0.60	1,154	2.0	0.46	87,745	97
1996	6	16,885	77	0.99	1,725	2.9	0.69	86,303	66	0.29	20,176	26	0.55	11	0.01	0.38	125,100	171
1997	6	8,894	31	0.91	1,622	3.7	0.82	47,403	35	0.29	21,645	23	0.51	521	0.8	0.43	80,085	94
1998	4	4,331	9	0.77	1,051	1	0.64	10,065	9	0.30	7,509	8	0.52	558	0.5	0.35	23,514	28
Avg =	5	5,915	20	0.85	1,525	2.2	0.67	44,264	34	0.30	15,466	19	0.54	1,239	2	0.45	68,408	78

Data collection began at station 2 in 1994. Average of stations 1 and 2 was used for years 1994 to 1997.



Appendix K.8. Weighted mean zooplankton biomass by genera (stations 1&2 averaged) and lake enrichment time period for Portage (Perenosa) Lake, 1990-1998.

Appendix K.9. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Portage Lake, 1994-1997.

	Total Fish Estimates			Sockeye Estimates			Sockeye Composition
		95% C. I.			95% C. I.		
Year	Number	Low	High	Number	Low	High	(%)
5-Oct-94	1,951,212	1,629,680	2,272,744	54,634	45,631	63,637	2.8
17-Oct-95	755,236	662,504	847,968	68,726	60,287	77,165	9.1
18-Sep-96	311,773	195,585	427,961	6,859	0	9,415	2.2
18-Sep-97	767,747	677,359	858,135	36,084	31,836	40,332	4.7

[a] the hydroacoustic survey was not conducted, however, a townet survey was completed.

Appendix K.10. Townet catches from Portage Lake, 1993-1997.

			Catch by Species					
	Number	Total	Sockeye			Stickleback		
Year	of Tows	Minutes	No.	%	CPUE	No.	%	CPUE
21-Sep-93	5	42	53	10.7	1.3	444	89.3	10.6
5-Oct-94	4	69	140	2.8	2.0	4,910	97.2	71.2
17-Oct-95	2	18	14	9.5	0.8	140	90.5	7.8
18-Sep-96	6	60	10	2.2	0.2	453	97.8	7.6
18-Sep-97	7	52	29	4.7	0.6	591	95.3	11.4

Appendix K.11. Mean length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Portage Lake, 1993-1997.

	Age-0					Age-1					Age-2				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
21-Sep-93	8	36.4	58.6	2.6	1.27	13	59.1	74.2	5.3	1.25	1	4.5	81.0	7.2	1.35
5-Oct-94	133	97.8	47.6	1.3	1.12	3	2.2	66.0	3.4	1.16	0	0.0	0.0	0.0	0.00
17-Oct-95	6	60.0	61.5	2.3	0.98	4	40.0	66.5	3.8	1.33	0	0.0	0.0	0.0	0.00
18-Sep-96	0	0.0	0.0	0.0	0.00	10	100.0	67.5	3.7	1.20	0	0.0	0.0	0.0	0.00
18-Sep-97	0	0.0	0.0	0.0	0.00	21	91.3	53.9	1.8	1.12	2	8.7	57.0	2.1	1.09

Appendix K.12. Mean length, weight, and condition coefficient, by age of sockeye smolt collected from Portage Creek, 1994-1996 and 1998.

	Age-1					Age-2				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
June 7-13, 1994	176	91.2	74.6	3.3	0.80	17	8.8	79.7	4.2	0.81
June 7-13, 1995	45	100.0	61.5	2.0	0.80	0	0.0	0.0	0.0	0.00
June 7-13, 1996	6	54.5	76.5	4.0	0.88	5	45.5	74.2	3.3	0.82
May 31-June 17, 1998	134	74.0	75.4	3.9	0.89	47	26.0	80.3	4.9	0.90

Appendix K.13. Portage Lake (Perenosa) sockeye salmon daily escapement counts, 1989-1993.

	----YEAR----				
DAY	1989	1990	1991	1992	1993
6/9				800	
6/10				0	
6/11				0	
6/12				0	
6/13				0	
6/14				105	
6/15				0	
6/16				0	
6/17				340	
6/18				0	
6/19			900	0	
6/20			112	0	
6/21			0	167	
6/22			0	0	
6/23			0	0	41
6/24			0	176	73
6/25			23	0	2
6/26			0	0	2
6/27			85	765	0
6/28			0	238	4
6/29			0	454	0
6/30			0	0	0
7/1			121	3,000	0
7/2			20	0	0
7/3			0	0	43
7/4			404	0	0
7/5			0	0	0
7/6			0	0	133
7/7			0	0	0
7/8			0	0	0
7/9			23	0	0
7/10			1,757	0	0
7/11			0	0	0
7/12			0	0	0

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			---YEAR---		
DAY	1989	1990	1991	1992	1993
7/13			16	0	0
7/14			0	0	0
7/15			0	0	15
7/16			5	0	5,050
7/17			2,000	0	0
7/18			0	0	0
7/19			0	0	0
7/20		119	0	0	0
7/21		16	0	0	0
7/22		0	0	0	0
7/23		0	0	0	0
7/24		0	0	0	0
7/25		0	0	0	0
7/26		0	0	0	0
7/27		0	0	0	0
7/28		88	0	0	0
7/29		2	0	0	0
7/30		0	0	0	0
7/31		2	0	0	0
8/1		37	0	0	0
8/2		310	0	0	0
8/3		309	0	0	0
8/4		309	0	0	0
8/5		309	0	0	0
8/6		309	0	0	0
8/7		309	0	0	0
8/8		309	0	0	0
8/9		309	0	0	0
8/10		309	0	0	0
8/11		309	0	0	0
8/12		309	0	0	0
8/13		0	0	0	0
8/14		0	0	0	0
8/15		0	0	0	0

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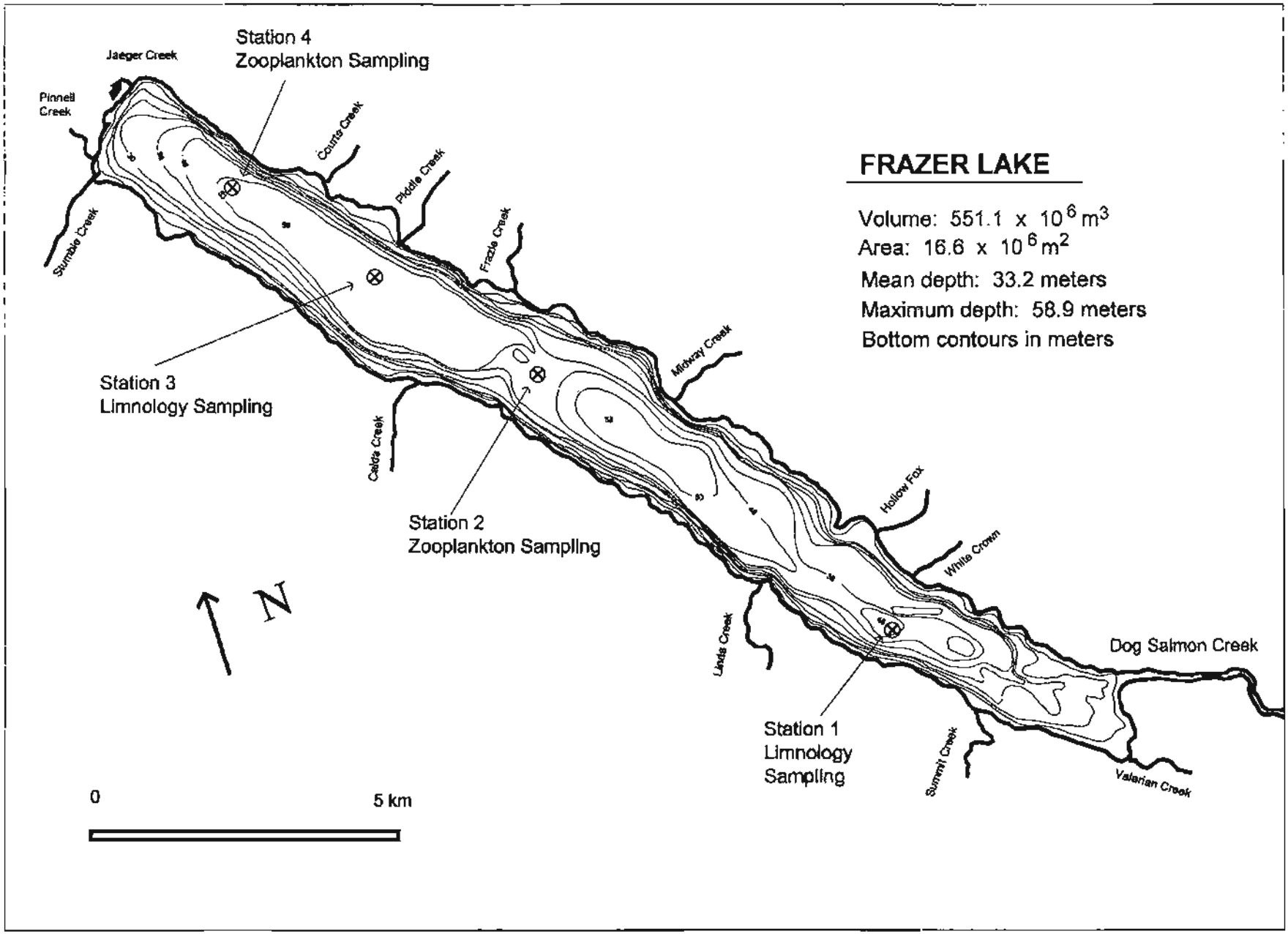
			----YEAR----		
DAY	1989	1990	1991	1992	1993
8/16	2	0	0	0	0
8/17	2	0	0	0	0
8/18	1	0	0	0	0
8/19	0	0	0	0	0
8/20	0	0	0	0	0
8/21	0	0	0	0	0
8/22	1	2	0	0	0
8/23	2	0	0	0	0
8/24	0	0	0	0	0
8/25	0	0	0	0	0
8/26	1	0	0	0	0
8/27	0	0	0	0	0
8/28	0	0	0	0	0
8/29	0	0	0	0	0
8/30	0	0	0	0	0
8/31	0	0	0	0	0
9/1	0	0	0	0	0
9/2	0	0	0	0	0
9/3	0	0	0	0	0
9/4	0	2	0	0	0
9/5	0	2	0	0	0
	9	3,670	5,466	6,045	5,363

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix K.14. Estimated age composition of Portage Lake (Perenosa) sockeye salmon escapement samples, 1993 and 1998.

Year		Ages										Total
		0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.2	
1993	Number	0	0	134	670	536	134	402	2,413	1,073	0	5,363
	Percent	0.0	0.0	2.5	12.5	10.0	2.5	7.5	45.0	20.0	0.0	100
1998 [a]	Number	0	0	37	19	45	1	92	83	5	1	283
	Percent	0.0	0.0	13.1	6.7	15.9	0.4	32.5	29.3	1.8	0.4	100

[a] The total was the amount sampled not an escapement count. A weir was not operated in 1998.

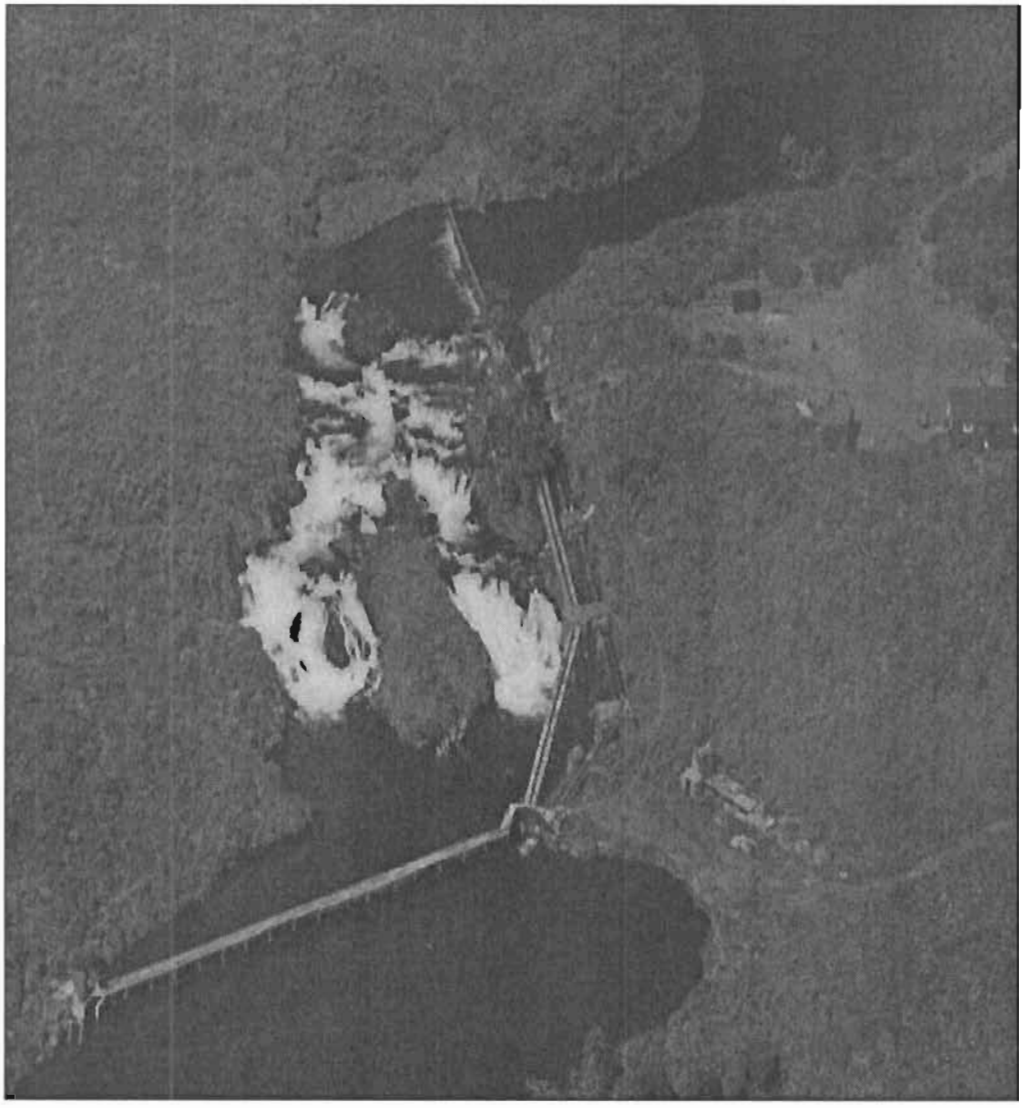


Appendix L.1. Morphometric map showing the limnology and zooplankton stations on Frazer Lake.

Appendix L.2. The amount of nutrient enrichment additions and ratios into Frazer Lake, 1988-1992.

Year	Fertilizer type	Amount (kg)
1988	27-7-0	60,960
1989	20-5-0	66,040
1990	20-5-0	76,200
1991	20-5-0	76,200
1992	20-5-0	76,200

[a] Nitrogen-Phosphorus-Potassium



Appendix L.3. Frazer Lake fish passes, diversion weir, and ADF&G complex.

Appendix L.4. Limnological sampling stations and sampling frequencies for Frazer Lake, 1986-1998.

Year	Sampling	
	Stations	Frequency
1986	1, 2	6
1987	1, 2	6
1988	1, 2	9
1989	1, 2	9
1990	1, 2	9
1991	1, 2	7
1992	1, 2	6
1993	1, 2	5
1994	1-4	4
1995	1-4	4
1996	1-4	4
1997	1, 2	4
1998	1	3

Appendix L.5. Summary of seasonal mean water chemistry parameters by station and depth for Frazer Lake, 1990-1996.

		Depth	Sp. Conductivity		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(umhos cm^{-1})	SD[a]	(Units)	SD	(mg L^{-1})	SD	(NTU)	SD	(Pt units)	SD	(mg L^{-1})	SD	(mg L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	50.6	0.9	7.1	0.2	13.9	1.2	0.8	0.3	6.0	2.4	4.4	1.2	0.9	0.3	31	23.7
1990	1	23	50.3	0.7	7.1	0.1	13.9	0.7	0.9	0.4	5.3	1.3	4.6	1.0	0.9	0.5	29	14.1
1990	3	1	50.7	0.9	7.1	0.1	14.3	0.8	0.8	0.3	4.7	0.9	4.4	0.7	0.8	0.4	48	76.4
1990	3	50	50.6	0.7	7.1	0.2	14.6	0.7	0.8	0.3	5.0	2.4	4.5	0.9	0.8	0.4	37	35.5
1991	1	1	52.6	0.8	7.2	0.2	13.1	2.0	0.8	0.5	6.0	2.6	4.7	0.3	0.9	0.6	21	20.3
1991	1	23	52.9	0.9	7.1	0.1	13.2	2.3	1.0	0.5	6.9	2.6	4.6	0.3	1.1	0.4	32	21.0
1991	3	1	52.6	1.1	7.0	0.2	13.1	2.3	1.0	0.5	7.9	3.3	4.5	0.6	0.9	0.6	28	23.6
1991	3	45	52.6	1.0	7.0	0.1	13.4	2.6	1.2	0.4	5.0	1.2	4.6	0.3	0.9	0.4	47	22.8
1992	1	1	52.9	6.0	7.0	0.1	12.9	1.0	0.6	0.2	6.1	2.5	5.1	0.4	1.2	0.6	17	5.3
1992	1	20	51.7	2.7	7.0	0.2	13.1	1.1	0.7	0.4	6.0	1.8	5.0	0.8	1.4	0.5	52	46.7
1992	3	1	51.7	0.8	7.1	0.2	13.3	0.4	0.8	0.3	6.5	1.8	5.0	0.7	1.4	0.9	20	5.0
1992	3	50	51.2	0.8	7.0	0.3	13.3	0.9	0.6	0.3	6.0	1.7	4.7	0.5	1.5	0.4	17	3.2
1993	1	1	53.4	2.6	6.8	0.1	13.1	0.7	0.8	0.4	6.4	4.7	4.7	0.4	1.5	0.6	20	10.6
1993	1	25	54.8	4.8	6.8	0.3	13.9	1.6	0.7	0.5	3.8	1.3	5.3	1.0	1.5	0.6	17	4.6
1993	3	1	53.8	2.6	6.8	0.2	12.8	0.8	0.7	0.4	3.6	0.9	4.9	0.2	1.5	0.6	21	9.9
1993	3	50	70.0	28.8	7.0	0.7	14.8	2.5	1.2	1.2	3.8	1.6	5.6	1.3	1.4	0.7	23	1.0
1994	1	1	55.5	1.3	7.0	0.4	14.0	1.2	0.6	0.5	5.3	1.0	4.9	0.1	1.3	0.1	23	13.4
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	23	54.8	1.9	6.9	0.3	13.5	1.0	0.4	0.1	5.0	2.2	4.9	0.1	1.3	0.1	22	11.3
1994	3	1	55.0	0.8	6.8	0.2	13.1	0.6	0.6	0.3	5.5	1.9	4.9	0.1	1.3	0.1	26	12.5
1994[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	3	48	54.3	0.5	6.7	0.2	12.6	0.5	0.4	0.0	3.8	0.5	4.9	0.1	1.3	0.1	24	17.0
1995	1	1	50.0	2.6	6.8	0.2	12.9	0.9	1.3	0.8	7.8	2.1	4.5	0.2	1.0	0.4	28	21.8
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	44	50.7	4.2	6.6	0.1	13.1	1.6	1.1	0.9	6.3	2.9	4.4	0.1	0.8	0.3	21	14.2
1995	3	1	50.8	3.2	6.6	0.3	13.8	1.1	1.1	0.5	6.8	2.2	4.5	0.2	1.0	0.4	22	11.3
1995[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	3	52	50.8	3.2	6.6	0.2	12.4	1.3	1.0	0.6	7.0	2.9	4.7	0.4	1.1	0.3	22	8.5
1996	1	1	53.3	1.5	6.8	0.2	13.9	0.4	0.5	0.1	7.0	2.4	4.6	0.1	0.7	0.3	13	10.4
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	44	54.8	2.2	6.9	0.2	14.1	0.9	0.8	0.3	7.3	3.0	4.6	0.1	0.9	0.4	17	11.8
1996	3	1	53.7	1.2	6.9	0.2	14.0	0.3	0.5	0.1	6.3	1.3	4.6	0.1	0.7	0.3	18	9.6
1996[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	3	50	54.0	1.4	6.7	0.0	14.0	0.3	1.1	0.6	6.3	1.3	4.6	0.1	0.9	0.4	15	10.4

[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix L.6. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Frazer Lake, 1990-1996.

Year	Station	Depth (m)	Total-P (ug L^{-1})	SD	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate + nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1990	1	1	5.5	1.2	2.9	0.5	1.2	0.5	63.8	20.4	6.4	4.3	46.8	24.9	1673	492.7	224	123.9	1.80	1.1	0.71	0.5
1990	1	23	5.7	1.8	2.7	0.4	1.3	0.5	68.9	17.5	6.5	3.6	47.4	20.3	1719	481.7	255	151.4	1.74	1.2	0.88	0.7
1990	3	1	6.3	1.9	3.1	0.6	1.2	0.4	69.0	26.7	6.1	5.1	40.7	21.1	1656	542.4	172	118.8	1.60	1.7	0.67	0.5
1990	3	50	5.5	1.5	2.7	0.1	1.3	0.5	70.4	24.7	12.7	12.6	48.8	14.9	1803	480.4	217	156.0	1.74	1.3	0.84	0.5
1991	1	1	5.2	0.8	3.4	0.6	2.1	0.8	93.6	29.1	6.5	10.6	43.9	24.6	970	55.6	0	0.0	1.35	0.4	0.70	0.5
1991	1	23	5.4	0.9	5.3	3.8	3.0	1.9	100.4	23.9	10.1	10.2	55.1	14.6	1008	53.2	0	0.0	1.77	0.9	0.59	0.5
1991	3	1	5.6	1.1	3.7	0.9	2.3	0.9	104.6	26.1	7.2	11.4	46.2	23.4	1014	67.3	0	0.0	1.65	0.8	0.68	0.4
1991	3	45	6.4	0.6	4.0	0.4	2.2	0.5	96.6	22.2	13.6	15.9	61.7	7.5	1005	100.5	0	0.0	2.14	1.4	0.67	0.2
1992	1	1	5.1	2.2	2.6	1.3	1.4	0.6	107.6	40.7	5.4	3.0	64.1	24.7	1409	89.6	166	54.8	1.41	1.0	0.79	0.4
1992	1	20	5.7	3.2	2.8	1.2	1.3	0.6	105.2	25.1	9.4	8.0	75.6	19.0	1239	484.3	154	126.7	1.14	0.7	0.71	0.4
1992	3	1	5.2	2.2	2.6	1.0	1.2	0.4	119.1	48.0	5.8	2.6	56.7	17.8	1436	73.1	174	57.7	1.47	0.5	0.95	0.3
1992	3	50	4.7	4.2	2.7	1.4	1.4	0.7	86.3	25.1	13.3	7.3	85.3	12.4	1493	130.1	90	37.1	0.75	0.5	0.52	0.2
1993	1	1	5.1	1.0	3.7	1.0	2.1	0.7	97.2	12.4	5.6	1.6	55.5	32.4	1780	119.8	151	69.4	1.70	0.6	0.45	0.2
1993	1	25	5.4	0.8	3.1	0.7	1.9	0.5	99.5	17.2	10.7	8.7	79.6	12.1	1819	100.2	162	60.5	1.82	0.9	0.54	0.2
1993	3	1	5.3	0.7	3.1	1.3	2.1	0.5	104.3	19.9	7.0	0.0	58.1	28.5	1803	134.8	150	49.2	1.69	0.5	0.48	0.2
1993	3	50	5.4	1.1	3.2	1.1	1.7	0.3	97.4	15.5	10.5	6.8	80.3	21.8	1870	114.9	102	20.1	1.19	0.5	0.51	0.2
1994	1	1	6.3	2.7	1.8	0.2	1.4	0.3	94.9	7.7	6.2	3.5	61.1	16.0	1900	41.2	136	27.4	0.65	0.1	0.14	0.0
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.66	0.1	0.16	0.0
1994	1	23	3.8	0.6	2.0	0.4	1.4	0.3	91.9	7.0	10.9	10.4	71.4	12.2	1961	62.6	142	20.4	0.63	0.2	0.13	0.1
1994	3	1	6.4	3.2	2.4	0.9	1.6	0.6	108.7	22.2	4.4	1.1	57.1	22.0	1957	76.8	137	37.5	0.70	0.1	0.17	0.0
1994[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.69	0.1	0.17	0.0
1994	3	48	6.3	4.9	1.8	0.5	1.4	0.4	97.8	8.1	16.1	12.8	79.3	8.6	2013	93.1	76	32.9	0.46	0.2	0.16	0.1
1995	1	1	5.2	0.6	2.1	0.3	1.5	0.2	94.4	14.7	3.4	2.3	70.4	20.9	2192	68.6	162	31.9	1.98	0.7	0.59	0.2
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	2.01	0.9	0.61	0.1
1995	1	44	4.0	0.4	1.9	0.5	1.5	0.3	80.5	8.6	10.4	6.2	95.1	8.2	2320	104.1	89	21.5	1.55	0.4	0.49	0.1
1995	3	1	5.2	0.8	2.0	0.5	1.4	0.3	96.2	11.7	3.2	2.2	71.4	20.1	2239	66.5	164	80.1	1.86	1.1	0.51	0.2
1995[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.95	0.8	0.58	0.3
1995	3	52	4.7	0.8	2.0	0.1	1.5	0.3	79.7	13.3	11.1	6.3	104.8	6.6	2331	96.6	56	20.2	1.01	0.4	0.43	0.1
1996	1	1	4.8	1.7	2.5	1.0	1.9	1.2	114.7	24.8	4.5	3.6	30.4	26.9	2104	127.0	141	19.5	0.55	0.1	0.24	0.0
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.39	0.4	0.20	0.2
1996	1	44	5.4	2.2	1.8	0.5	1.4	0.4	103.8	9.0	9.1	7.1	58.9	3.5	2165	160.0	129	66.2	0.57	0.1	0.27	0.0
1996	3	1	5.3	0.7	2.1	1.0	1.3	0.6	117.9	24.3	3.0	1.7	28.2	22.2	2204	174.5	128	14.4	0.55	0.2	0.24	0.0
1996[b]	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.53	0.5	0.26	0.3
1996	3	50	4.4	0.9	1.9	1.0	1.7	1.1	98.1	4.9	9.6	8.3	70.1	13.8	2176	166.5	91	56.8	0.40	0.1	0.23	0.1

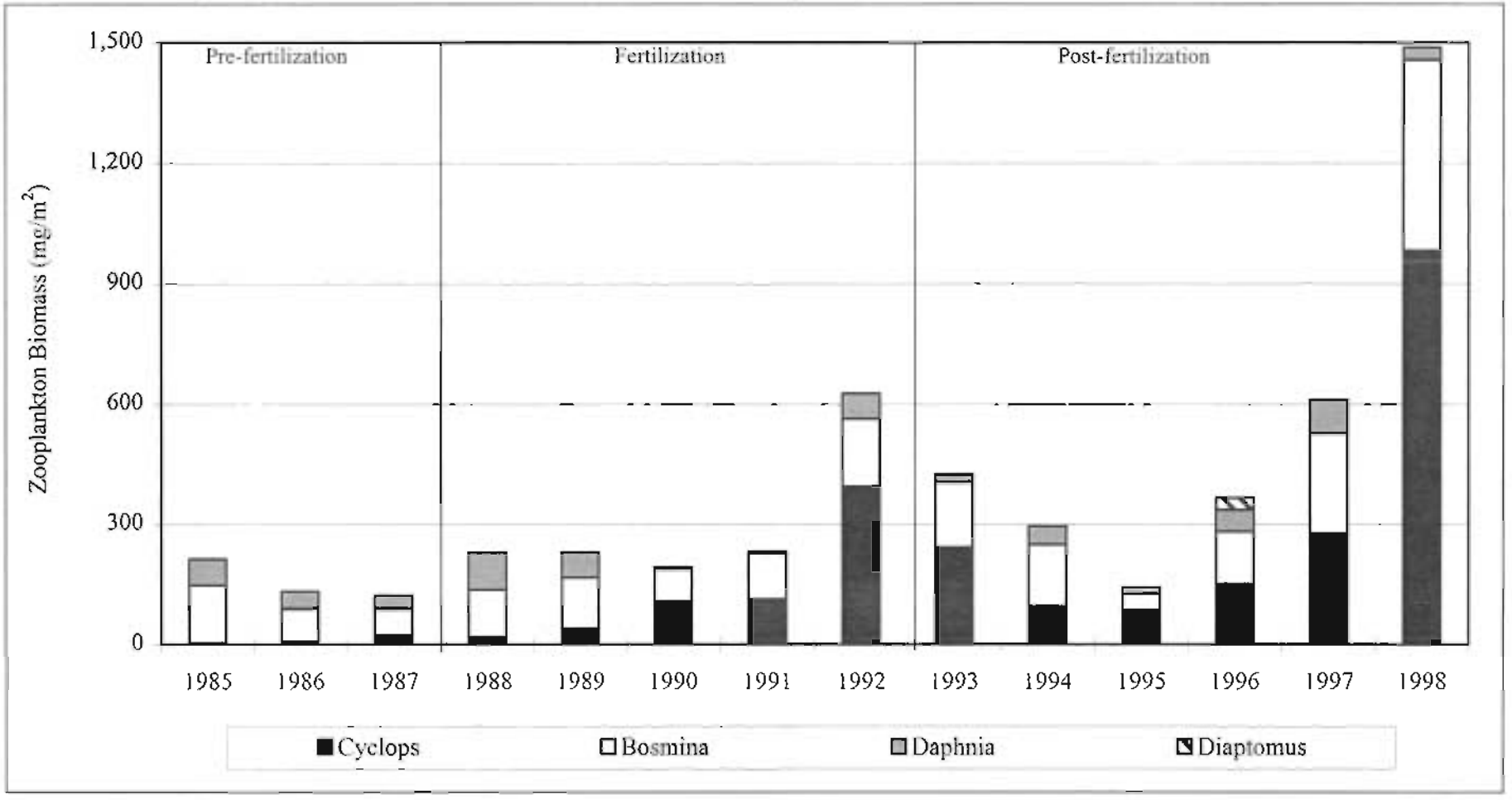
[a] SD - standard deviation

[b] na - parameters were not analyzed at the 2 meter depth.

Appendix L.7. Weighted mean zooplankton density, biomass, and size by genera (stations 1& 3 averaged) for Frazer Lake, 1985-1998.

Station	No. of	Diaptomus				Cyclops				Bosmina				Daphnia				TOTALS		
1 & 3	Sample	Density	Density	Biomass	Size	Density	Density	Biomass	Size	Density	Density	Biomass	Size	Density	Density	Biomass	Size	Density	Density	Biomass
Year	Dates	(no/m^2)	(no/m^3)	(mg/m^2)	(mm)	(no/m^2)	(no/m^3)	(mg/m^2)	(mm)	(no/m^2)	(no/m^3)	(mg/m^2)	(mm)	(no/m^2)	(no/m^3)	(mg/m^2)	(mm)	(no/m^2)	(no/m^3)	(mg/m^2)
1985	5	40	1	0	0.70	1,512	37	3	0.78	121,746	3,682	145	0.36	42,255	1,092	65	0.60	165,552	4,812	213
1986	7	38	1	0	0.00	3,431	90	7	0.73	66,766	2,063	83	0.37	27,516	777	42	0.60	97,750	2,931	132
1987	8	95	2	1	0.96	13,175	378	23	0.70	47,676	1,453	67	0.39	18,028	489	31	0.64	78,973	2,323	121
1988	7	0	0	0	0.00	5,725	153	19	0.94	92,281	3,410	118	0.37	59,256	1,912	92	0.61	157,261	5,475	229
1989	6	0	0	0	0.45	15,731	448	40	0.84	94,708	3,286	128	0.38	42,142	1,258	62	0.59	152,581	4,991	229
1990	9	74	3	0	0.82	50,756	1,498	106	0.77	58,587	1,461	82	0.39	2,136	51	4	0.65	111,552	3,013	192
1991	7	228	10	0	0.64	55,012	1,341	112	0.76	111,598	3,720	114	0.34	2,969	109	5	0.62	169,806	5,181	231
1992	7	8	0	0	1.24	133,548	3,416	395	0.91	117,044	3,756	169	0.39	28,677	717	63	0.71	279,277	7,889	627
1993	5	213	4	1	0.95	120,295	3,035	242	0.76	161,651	5,079	164	0.33	12,654	345	18	0.59	294,812	8,463	425
1994	4	93	4	1	1.04	49,801	1,183	94	0.73	114,400	2,954	156	0.38	28,145	779	45	0.61	192,439	4,919	295
1995	4	0	0	0	0.00	59,089	1,270	85	0.65	39,823	866	41	0.34	10,403	218	16	0.60	109,315	2,354	141
1996	4	10,483	210	30	0.87	103,485	2,144	150	0.64	118,218	2,521	133	0.35	33,685	728	53	0.61	265,870	5,603	366
1997	4	0	0	0	0.00	88,137	1,916	276	0.93	181,369	3,981	250	0.39	59,554	1,297	84	0.58	329,060	7,193	611
1998	3[a]	0	0	0	0.00	419,406	8,388	983	0.81	294,267	5,885	474	0.45	8,883	178	31	0.80	722,556	14,451	1,488
Avg=	6	805	17	3	0.55	79,936	1,807	181	0.78	115,724	3,151	151	0.37	26,879	711	44	0.63	223,343	5,686	378

[a] The high density and biomass levels could be skewed high due to only three samples collected.



Appendix L.8. Weighted mean zooplankton biomass by genera (stations 1&3 averaged) and lake enrichment time period for Frazer Lake, 1985-1998.

Appendix L.9. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Frazer Lake, 1990-1997.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	Number	Low	High	Number	Low	High	(%)
6-Sep-90	7,434,331	5,892,227	8,976,435	5,709,566	4,524,308	6,894,825	76.8
19-Sep-91	8,320,947	7,038,830	9,603,064	6,265,673	5,297,874	7,233,472	75.3
16-Sep-92	8,340,877	5,709,471	10,972,283	1,501,358	1,028,027	1,974,689	18
1-Oct-93	12,519,826	11,699,503	13,340,149	788,749	736,361	841,137	6.3
10-Sep-94	9,069,751	8,150,824	9,988,678	36,279	32,602	39,956	0.4
2-Oct-95	3,927,893	3,244,987	4,610,799	15,712	12,996	18,427	0.4
5-Sep-96	1,948,829	1,850,215	2,047,443	327,403	310,939	343,867	16.8
4-Sep-97	2,411,638	1,865,126	2,958,150	1,285,403	1,283,181	1,287,625	53.3

Appendix L.10. Townet catches from Frazer Lake, 1990-1996.

Date	Number of Tows	Total Tow Minutes	Catch by Species					
			Sockeye			Stickleback		
			No.	%	CPUE	No.	%	CPUE
7-Sep-90	3	60	106	76.8	1.8	32	23.2	0.5
20-Sep-91	3	60	174	75.3	2.9	57	24.7	1.0
17-Sep-92	3	90	328	18.0	3.6	1,496	82.0	16.6
2-Oct-93	3	60	16	6.3	0.3	238	93.7	4.0
11-Sep-94	3	60	2	0.4	0.0	513	99.6	8.6
3-Oct-95	8	121	3	0.4	0.1	828	99.6	6.8
6-Sep-96	5	75	113	16.8	1.5	558	83.2	7.4

Appendix L.11. Mean age, length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Frazer Lake, 1990-1996.

	Age-0					Age-1					Age-2				
Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
7-Sep-90	64	61.5	50	1.5	1.19	40	38.5	77	5.2	1.15	0	0.0	0.0	0.0	0.00
20-Sep-91	54	53.5	50	1.2	0.92	47	46.5	70	3.4	0.95	0	0.0	0.0	0.0	0.00
17-Sep-92	51	24.8	64	2.9	1.05	132	64.1	87	6.5	1.00	23	11.1	91	7.5	0.99
2-Oct-93	22	91.7	66	1.6	0.58	2	8.3	97	5.0	0.55	0	0.0	0.0	0.0	0.00
11-Sep-94	2	100.0	68	1.7	0.54	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
3-Oct-95	2	100.0	53	1.6	1.07	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
6-Sep-96	6	5.8	44	1.0	1.17	95	91.3	58	2.2	1.08	3	2.9	80	5.4	1.05

Appendix L.12. Estimated number of sockeye salmon smolt emigrating from Frazer Lake by year and age class, 1991-1998.

Smolt Outmigration Year	Number and Relative Percent of Smolt by Age Class				Total Population Estimate	SE	95% CI	
	1.	2.	3.	4.			Lower	Upper
1991	1,940,906	2,870,690	6,905	0	4,818,501	1,077,978	2,705,664	6,931,337
	40.3%	59.6%	0.1%	0.0%				
1992	82,415	4,978,109	305,253	0	5,365,777	624,657	4,141,448	6,590,106
	1.5%	92.8%	5.7%	0.0%				
1993	22,221	4,046,434	3,364,676	966	7,434,298	1,397,839	4,694,534	10,174,062
	0.3%	54.4%	45.3%	0.0%				
1994	673,765	4,450,246	537,478	0	5,661,489	344,992	4,985,306	6,337,672
	11.9%	78.6%	9.5%	0.0%				
1995	53,410	8,684,874	85,492	0	8,823,777	551,775	7,742,298	9,905,256
	0.6%	98.4%	1.0%	0.0%				
1996	57,487	3,480,272	282,845	0	3,820,604	268,297	3,294,742	4,346,466
	1.5%	91.1%	7.4%	0.0%				
1997	244,298	2,196,609	628,446	0	3,069,352	295,134	2,490,891	3,647,814
	8.0%	71.6%	20.5%	0.0%				
1998	Due to high water, smolt emigration estimates are not available							
	33.6%	65.5%	1.0%	0.0%				

Appendix L.13. Frazer Lake sockeye salmon smolt emigration by age class, 1991-1995.

Year	Statistical Week	Dates	Age Class 1	2	3	4	Population Estimate
1991	19	5/03-5/09	0	0	0	0	0
	20	5/10-5/16	2,172	2,498	0	0	4,670
	21	5/17-5/23	873,195	1,004,644	0	0	1,877,839
	22	5/24-5/30	93,892	118,123	0	0	212,015
	23	5/31-6/06	1,058,220	1,791,367	0	0	2,849,587
	24	6/07-6/13	399,064	492,833	2,181	0	894,078
	25	6/14-6/20	61,525	131,956	0	0	193,481
	26	6/21-6/27	53,327	185,212	1,147	0	239,686
	27	6/28-7/04	10,577	46,961	423	0	57,961
	28	7/05-7/11	863	3,832	35	0	4,730
	29	7/12-7/18	0	0	0	0	0
	30	7/19-7/25	0	0	0	0	0
	31	7/26-8/01	0	0	0	0	0
	32	8/02-8/08	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0
	Total		2,552,835	3,777,426	3,786	0	6,334,047
1992	19	5/03-5/09	470	3,287	2,348	0	6,105
	20	5/10-5/16	11,406	840,207	315,553	0	1,167,165
	21	5/17-5/23	17,968	752,402	137,004	0	907,374
	22	5/24-5/30	7,724	613,311	23,173	0	644,208
	23	5/31-6/06	13,356	1,073,806	13,356	0	1,100,518
	24	6/07-6/13	46,927	1,578,459	59,725	0	1,685,112
	25	6/14-6/20	2,938	369,217	5,876	0	378,031
	26	6/21-6/27	3,841	216,723	549	0	221,112
	27	6/28-7/04	3,859	267,035	0	0	270,894
	28	7/05-7/11	0	24,703	0	0	24,703
	29	7/12-7/18	0	0	0	0	0
	30	7/19-7/25	0	0	0	0	0
	31	7/26-8/01	0	0	0	0	0
	32	8/02-8/08	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0
	Total		108,489	5,739,150	557,584	0	6,405,222

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Appendix L.13 (page 2 of 3)

Year	Statistical Week	Dates	Age Class 1	2	3	4	Population Estimate
1993	19	5/03-5/09	0	16	756	0	772
	20	5/10-5/16	0	4,081	45,508	612	50,202
	21	5/17-5/23	0	356,218	944,914	0	1,301,132
	22	5/24-5/30	0	1,129,985	1,761,446	0	2,891,431
	23	5/31-6/06	0	2,024,932	1,471,534	0	3,496,466
	24	6/07-6/13	0	1,204,317	433,554	0	1,637,871
	25	6/14-6/20	23,496	358,317	29,370	0	411,183
	26	6/21-6/27	0	0	0	0	0
	27	6/28-7/04	0	0	0	0	0
	28	7/05-7/11	0	0	0	0	0
	29	7/12-7/18	0	0	0	0	0
	30	7/19-7/25	0	0	0	0	0
	31	7/26-8/01	0	0	0	0	0
	32	8/02-8/08	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0
	Total		23,496	5,077,866	4,687,082	612	9,789,057
1994	19	5/03-5/09	0	0	0	0	0
	20	5/10-5/16	875	85,197	59,813	0	145,886
	21	5/17-5/23	11,726	439,417	166,016	0	617,158
	22	5/24-5/30	6,345	1,895,113	213,623	0	2,115,082
	23	5/31-6/06	110,768	1,398,245	96,320	0	1,605,333
	24	6/07-6/13	181,603	680,122	28,487	0	890,212
	25	6/14-6/20	271,445	80,336	2,123	0	353,905
	26	6/21-6/27	121,944	25,067	442	0	147,454
	27	6/28-7/04	23,073	4,759	0	0	27,833
	28	7/05-7/11	0	0	0	0	0
	29	7/12-7/18	0	0	0	0	0
	30	7/19-7/25	0	0	0	0	0
	31	7/26-8/01	0	0	0	0	0
	32	8/02-8/08	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0
	Total		727,779	4,608,256	566,824	0	5,902,863

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Appendix L.13 (page 3 of 3)

Year	Statistical Week	Dates	Age Class 1	2	3	4	Population Estimate
1995	19	5/03-5/09	0	0	0	0	0
	20	5/10-5/16	0	1,747,768	30,573	0	1,778,341
	21	5/17-5/23	3,789	1,314,676	3,789	0	1,322,253
	22	5/24-5/30	13,581	2,349,522	6,791	0	2,369,893
	23	5/31-6/06	22,857	1,908,587	28,572	0	1,960,016
	24	6/07-6/13	13,261	751,479	4,420	0	769,161
	25	6/14-6/20	3,483	154,989	2,322	0	160,794
	26	6/21-6/27	2,589	22,911	129	0	25,629
	27	6/28-7/04	0	0	0	0	0
	28	7/05-7/11	0	0	0	0	0
	29	7/12-7/18	0	0	0	0	0
	30	7/19-7/25	0	0	0	0	0
	31	7/26-8/01	0	0	0	0	0
	32	8/02-8/08	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0
	Total		59,560	8,249,932	76,596	0	8,386,087

Appendix L.14. Summary of mean length, weight, and condition coefficient by age class of Frazer Lake sockeye salmon smolt, 1989-1998.

	Age-1					Age-2					Age-3					Age-4				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
1989	22	3.4	87.0	5.5	0.84	620	96.6	100.5	8.0	0.78	0	0	0	0	0	0	0	0	0	0
1990	573	49.0	84.3	4.5	0.74	553	47.3	104.3	9.0	0.79	43	3.7	112.0	11.7	0.82	0	0	0	0	0
1991	746	35.6	89.7	5.4	0.74	1,344	64.2	89.5	5.6	0.77	4	0.2	120.8	15.7	0.85	0	0	0	0	0
1992	49	1.5	86.4	6.1	0.94	2,951	92.5	83.9	5.5	0.92	191	6.0	91.1	7.2	0.93	0	0	0	0	0
1993	8	1.1	89.9	6.1	0.83	682	98.0	100.3	8.3	0.82	913	0.4	104.2	17.7	0.85	3	0.4	121.3	17.7	0.85
1994	713	28.9	86.3	5.2	0.81	1,456	58.9	102.6	8.1	0.75	302	12.2	112.8	10.7	0.74	0	0	0	0	0
1995	39	1.8	86.7	5.3	0.74	2,154	97.3	91.2	5.6	0.73	20	0.9	115.2	13.6	0.79	0	0	0	0	0
1996	42	2.2	91.3	6.2	0.78	1,718	91.6	87.2	5.2	0.78	116	6.2	103.6	9.7	0.81	0	0	0	0	0
1997	544	21.1	88.8	5.5	0.78	1,385	53.8	93.5	6.4	0.77	638	24.8	106.1	9.5	0.79	9	0.3	112.6	11.9	0.81
1998	618	33.6	97.5	8.1	0.86	1,205	65.5	109.6	10.4	0.79	18	1.0	114.4	11.8	0.78	0	0	0	0	0

Appendix L.15. Frazer Lake sockeye salmon escapement, catch, run, and exploitation rate, 1970-1998.

	Escapement					Exploitation
Year	DS Weir [a]	Fish Ladder	River [b]	Catch [c]	Run	Rate (%)
1970		24,039		3,904	27,943	14
1971		55,366		10,549	65,915	16
1972		66,419		2,761	69,180	4
1973		56,255		1,210	57,465	2
1974		82,609		2,765	85,374	3
1975		64,199		3,300	67,499	5
1976		119,321		8,770	128,091	7
1977		139,548		1,366	140,914	1
1978		141,981		30,336	172,317	18
1979		126,742		26,805	153,547	17
1980		405,535		55,173	460,708	12
1981		377,716		110,210	487,926	23
1982		430,423		76,232	506,655	15
1983	166,655	158,340	8,315	29,668	196,323	15
1984 [d]	48,844	53,524	-4,680	13,853	62,697	22
1985	506,336	485,835	20,501	131,535	637,871	21
1986	136,553	126,529	10,024	41,652	178,205	23
1987	48,956	40,544	8,412	8,626	57,582	15
1988	248,055 [e]	246,704	1,351	210,406	458,461	46
1989	362,007	360,373	1,634	708,864	1,070,871	66
1990	254,540	226,707	27,833	725,293	979,833	74
1991	288,013	190,358	97,655	980,132	1,268,145	77
1992	206,406	185,825	20,581	212,367	418,773	51
1993	198,412	178,391	20,021	552,993	751,405	74
1994	240,913	206,071	34,842	409,132	650,045	63
1995	222,170	196,323	25,847	730,207	952,377	77
1996	208,638	198,695	9,943	492,275	700,913	70
1997	268,328	205,264	63,064	148,091	416,419	36
1998	245,409	233,755	11,654	360,949	606,358	60
Average	228,140	185,634	22,312	209,980	407,925	51
10 yr Average	249,484	218,176	31,307	532,030	781,514	68

[a] Prior to 1983 the Dog Salmon weir was not in operation.

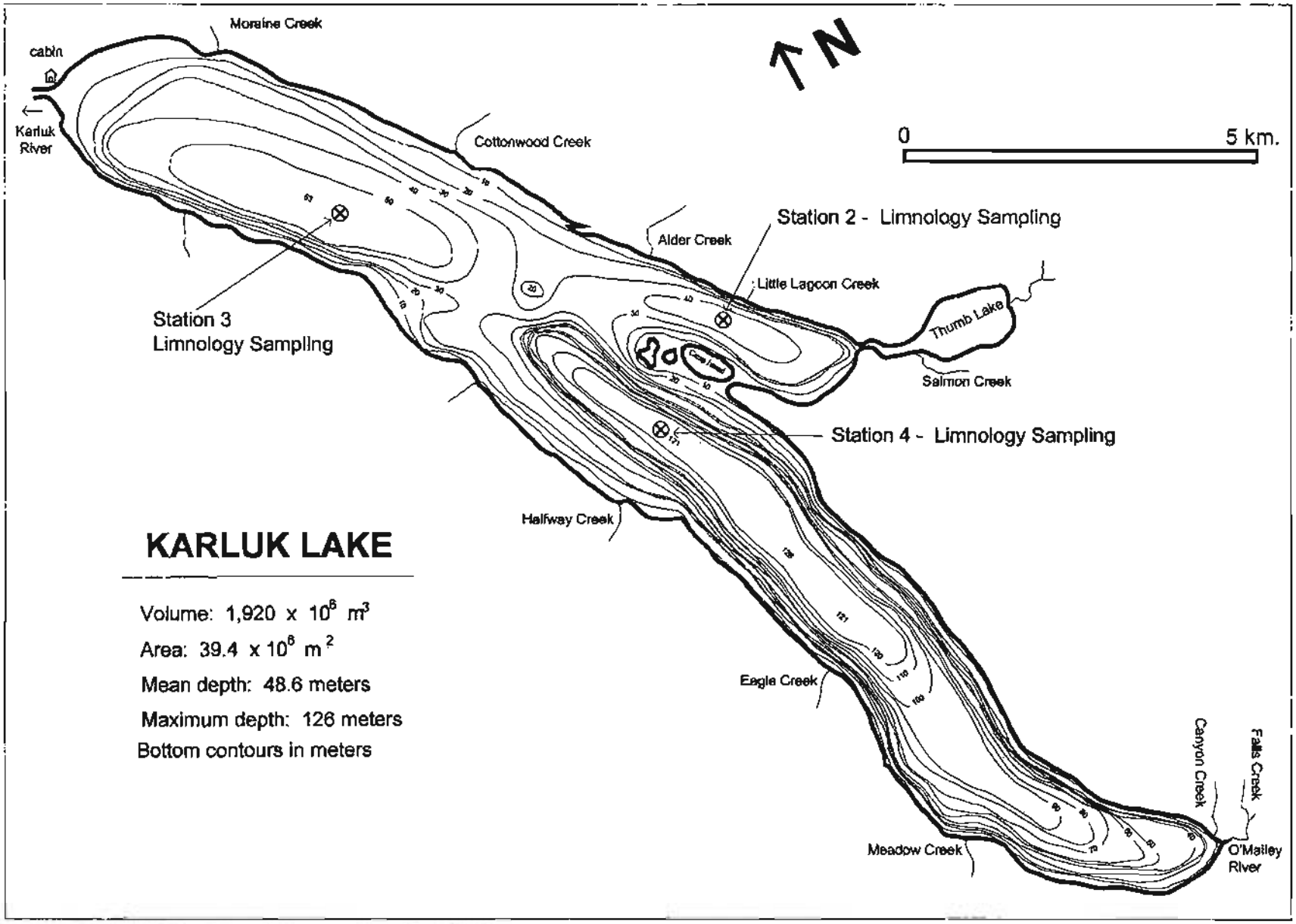
[b] Dog Salmon weir count minus Frazer fish ladder count.

[c] Although Frazer Lake sockeye catch occurred prior to 1983, numbers are unreliable.

[d] In 1984, the Dog Salmon weir count is inaccurate due to high water; Alitak catch based upon Frazer count.

[e] Estimated value, weir was inoperable for part of season actual count was 241,970 sockeye.

Sagalkin, N. 1999. Frazer Lake Fish Pass Sockeye Salmon Smolt and Adult Research, 1997 and 1998. Alaska Dept. of Fish and Game, Division of Commercial Fish. RIR No. 4K99-59. Kodiak.



Appendix M.1. Morphometric map showing the limnology stations (2 - 4) on Karluk Lake.

Appendix M.2. The amount of nutrient enrichment additions and ratios into Karluk Lake, 1986-1990.

Year	Fertilizer Ratio[a]	Amount (kg)
1986	27-7-0	87,272
1987	27-7-0	87,272
1988	27-7-0	87,272
1989	20-5-0	77,272
1990	20-5-0	27,272
1990	32-0-0	59,091

[a] Nitrogen-Phosporus-Potassium

Appendix M.3. Limnological sampling stations and sampling frequencies for Karluk Lake, 1990-1997.

Year	Sampling Stations	Sampling Frequency
1990	3	9
1991	3	6
1992	3	5
1993	1	5
1994	1	4
1995	2	4
1996	1	4
1997	2	4

Appendix M.4. Summary of seasonal mean water chemistry parameters by station and depth for Karluk Lake, 1985-1994.

Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1985 [a]	2	1	63.0	na	7.3	na	22.0	na	1.0	na	4.0	na	8.3	na	1.6	na	10.0	na
	2	35	63.0	na	7.2	na	23.0	na	2.0	na	NA	na	8.6	na	1.5	na	10.0	na
	3	1	64.0	na	7.0	na	22.0	na	0.7	na	4.3	na	8.3	na	1.3	na	7.0	na
	3	50	65.0	na	7.1	na	22.0	na	0.6	na	NA	na	8.0	na	1.6	na	10.0	na
	4	1	62.0	na	7.3	na	21.0	na	0.8	na	5.0	na	7.5	na	1.8	na	10.0	na
	4	50	60.0	na	7.1	na	21.0	na	2.1	na	NA	na	8.2	na	1.2	na	13.0	na
1986 [a]	2	1	64.0	na	7.2	na	24.0	na	0.5	na	3.2	na	na	na	na	na	14.0	na
	2	35	62.0	na	7.1	na	24.0	na	1.0	na	3.7	na	na	na	na	na	8.0	na
	3	1	64.0	na	7.2	na	24.0	na	0.8	na	4.3	na	na	na	na	na	26.0	na
	3	50	63.0	na	7.1	na	23.0	na	0.5	na	4.0	na	na	na	na	na	8.0	na
	4	1	64.0	na	7.2	na	23.0	na	0.5	na	4.8	na	na	na	na	na	8.0	na
	4	50	64.0	na	7.1	na	24.0	na	0.7	na	4.2	na	na	na	na	na	17.0	na
1987 [a]	2	1	63.0	na	7.0	na	22.0	na	0.5	na	2.9	na	6.5	na	1.4	na	22.0	na
	2	35	64.0	na	7.0	na	22.0	na	0.5	na	2.7	na	6.5	na	1.3	na	16.0	na
	3	1	64.0	na	7.0	na	22.0	na	0.5	na	3.6	na	6.5	na	1.6	na	15.0	na
	3	50	64.0	na	7.0	na	22.0	na	0.5	na	4.0	na	6.5	na	1.3	na	27.0	na
	4	1	64.0	na	7.0	na	22.0	na	0.4	na	2.9	na	6.5	na	1.5	na	26.0	na
	4	50	62.0	na	7.0	na	21.0	na	0.4	na	3.3	na	6.5	na	1.6	na	33.0	na
1988	2	1	63.4	3.0	7.4	0.5	20.3	1.3	0.6	0.4	8.5	3.4	na	na	na	na	17.8	11.3
	2	30	63.8	1.0	7.0	0.2	20.6	1.4	0.6	0.3	7.4	1.5	na	na	na	na	14.4	9.4
	3	1	63.3	0.7	7.2	0.4	20.1	1.0	0.6	0.4	8.8	3.5	na	na	na	na	17.4	11.9
	3	40	64.4	1.7	7.1	0.3	19.8	1.2	0.5	0.1	11.9	10.8	na	na	na	na	16.0	10.7
	4	1	63.0	1.1	7.2	0.2	20.3	1.0	0.6	0.2	9.1	4.2	na	na	na	na	13.6	10.4
	4	80	63.9	0.4	7.1	0.2	20.0	0.8	0.5	0.2	7.4	2.1	na	na	na	na	19.3	13.4
1989	2	1	64.0	1.0	7.2	0.2	21.4	1.7	0.4	0.1	5.3	1.1	7.5	0.3	1.0	0.7	7.9	4.9
	2	30	64.7	1.3	7.1	0.2	21.4	2.0	0.4	0.2	5.0	1.7	7.2	0.3	1.2	0.5	11.0	6.1
	3	1	64.1	0.6	7.1	0.2	20.8	1.8	0.4	0.2	5.2	2.0	7.4	0.5	1.4	0.2	5.8	4.9
	3	40	64.8	0.9	7.1	0.2	21.3	1.9	0.4	0.1	5.0	2.0	7.4	0.5	1.4	0.2	12.1	4.3
	4	1	63.9	0.4	7.2	0.2	21.0	2.2	0.3	0.1	5.9	2.9	7.1	0.5	1.5	0.4	7.4	5.1
	4	80	64.0	0.5	7.1	0.2	21.1	2.6	0.4	0.2	5.7	2.0	7.0	0.3	1.3	0.2	8.0	5.2

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Appendix M.4 (page 2 of 2)

Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1990	2	1	64.4	2.0	7.5	0.3	22.3	0.8	0.5	0.4	4.9	2.4	7.2	0.7	1.4	0.3	10.7	9.4
	2	30	64.6	0.8	7.2	0.3	22.3	1.1	0.7	1.0	4.7	1.2	6.8	0.6	1.4	0.6	24.4	47.5
	3	1	64.0	0.9	7.4	0.3	22.4	0.8	0.5	0.2	4.0	1.1	6.8	0.7	1.5	0.4	10.3	5.4
	3	40	65.3	1.7	7.3	0.2	22.8	1.3	0.5	0.3	4.6	1.6	7.2	0.5	1.4	0.3	10.8	10.8
	4	1	63.4	2.3	7.4	0.2	22.3	0.9	0.5	0.2	5.4	1.4	7.2	0.5	1.4	0.3	16.9	14.1
	4	80	64.8	0.5	7.3	0.1	21.7	2.6	0.5	0.3	3.7	1.3	7.2	0.3	1.4	0.3	16.2	22.2
1991	2	1	66.6	2.5	7.5	0.4	23.4	2.3	0.9	0.4	4.0	1.2	7.8	1.0	1.5	0.8	49.7	85.1
	2	30	67.0	1.4	7.2	0.1	22.6	2.3	1.1	1.4	10.4	5.8	8.0	0.8	1.1	0.9	17.4	12.0
	3	1	67.3	1.3	7.4	0.1	23.2	1.7	1.7	0.3	5.6	1.7	8.0	0.4	2.4	0.7	21.2	19.9
	3	40	67.0	1.9	7.2	0.3	22.4	3.0	0.8	0.7	5.6	1.7	7.8	0.6	1.4	0.7	23.2	19.8
	4	1	68.0	2.9	7.5	0.4	23.8	2.0	1.1	0.7	7.2	4.7	8.0	0.8	1.6	0.4	71.7	19.5
	4	80	66.6	0.5	7.3	0.1	23.0	1.7	0.8	0.5	8.4	3.6	8.2	0.8	2.7	4.0	16.7	18.9
1992	2	1	65.4	0.5	7.0	0.2	20.5	1.1	0.6	0.2	3.6	0.9	7.4	1.0	2.2	0.7	14.0	6.7
	2	30	65.6	1.1	6.9	0.1	20.3	0.7	0.4	0.1	4.0	0.7	8.4	2.7	1.8	1.0	11.0	0.0
	3	1	64.8	0.8	7.1	0.2	20.5	0.7	0.5	0.1	5.0	0.7	7.4	1.1	1.3	0.9	11.0	0.0
	3	40	65.2	0.8	7.0	0.2	21.1	1.7	0.4	0.2	5.2	2.3	8.1	1.3	1.1	0.8	11.0	0.0
	4	1	65.0	0.7	7.1	0.2	21.1	1.3	0.5	0.1	4.4	0.9	8.5	2.0	1.5	0.8	11.0	0.0
	4	80	65.0	1.0	7.0	0.1	20.6	0.7	1.2	1.7	4.6	2.4	7.7	1.5	1.8	1.1	11.0	0.0
1993	3	1	69.0	3.5	7.0	0.2	22.2	1.3	0.7	0.6	4.0	2.2	8.1	1.3	1.9	0.8	13.4	3.9
	3	40	70.4	1.7	6.9	0.1	21.4	0.5	0.8	0.8	3.8	1.3	8.1	1.2	1.9	0.8	12.6	2.3
1994	3	1	71.3	1.3	7.1	0.2	21.1	1.0	0.8	0.6	9.0	1.2	7.3	0.4	1.4	0.4	29.8	27.9
	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	3	50	71.3	1.5	6.8	0.2	21.1	1.0	1.8	1.9	9.5	1.0	7.8	0.1	1.4	0.4	177.8	181.9

[a] Standard deviations (SD) were not calculated on sample years, 1985-1987.

[b] na - parameters were not analyzed at the 2 meter depth.

Limnology results from 1985-1987 were obtained from Koenings, J.P., and R.D. Burkett. 1988. Limnological Trends at Karluk Lake, Alaska during 1985-1987. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development. Federal Aid in Anadromous. Fish Conservation Annual Report. Juneau

Appendix M.5. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Karluk Lake, 1985-1994.

Year	Station	Depth (m)	Total -P (ug L^{-1})	SD	Total filterable - P (ug L^{-1})	SD	Filterable reactive - P (ug L^{-1})	SD	Total Kjeldahl - N (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+ nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1985 [a]	2	1	7.7	na	2.5	na	1.1	na	119.0	na	8.2	na	40.9	na	138.0	na	190.0	na	1.92	na	1.05	na
	2	35	6.2	na	2.5	na	1.4	na	104.0	na	18.7	na	60.4	na	61.0	na	211.0	na	1.78	na	1.09	na
	3	1	5.9	na	1.0	na	1.0	na	105.0	na	24.3	na	42.6	na	54.0	na	256.0	na	1.88	na	0.96	na
	3	50	6.3	na	1.5	na	1.5	na	107.0	na	14.3	na	69.5	na	58.0	na	228.0	na	1.58	na	0.91	na
	4	1	6.6	na	1.0	na	1.0	na	109.0	na	6.8	na	45.9	na	62.0	na	244.0	na	1.87	na	1.02	na
	4	50	6.9	na	1.6	na	1.6	na	102.0	na	17.1	na	70.0	na	63.0	na	213.0	na	1.30	na	0.90	na
1986 [a]	2	1	8.4	na	5.3	na	0.9	na	95.0	na	3.1	na	69.1	na	132.0	na	229.0	na	1.67	na	0.57	na
	2	35	8.1	na	5.0	na	1.0	na	94.0	na	9.2	na	70.9	na	128.0	na	218.0	na	1.72	na	0.57	na
	3	1	8.7	na	5.6	na	1.1	na	107.0	na	2.3	na	65.2	na	67.0	na	209.0	na	1.48	na	0.64	na
	3	50	6.9	na	3.7	na	0.9	na	80.0	na	8.2	na	80.9	na	78.0	na	178.0	na	1.37	na	0.52	na
	4	1	8.9	na	6.2	na	1.4	na	102.0	na	3.9	na	60.3	na	67.0	na	227.0	na	1.51	na	0.57	na
	4	50	8.0	na	4.5	na	1.2	na	83.0	na	8.7	na	71.9	na	61.0	na	176.0	na	1.92	na	0.68	na
1987 [a]	2	1	9.3	na	4.0	na	0.9	na	133.0	na	8.8	na	68.6	na	184.0	na	NA	na	2.29	na	0.55	na
	2	35	8.1	na	3.8	na	0.8	na	110.0	na	12.8	na	93.6	na	147.0	na	NA	na	2.28	na	0.55	na
	3	1	8.2	na	3.7	na	1.1	na	117.0	na	12.9	na	61.5	na	89.0	na	NA	na	2.36	na	0.62	na
	3	50	7.8	na	3.5	na	0.8	na	104.0	na	15.7	na	90.2	na	53.0	na	NA	na	2.64	na	0.55	na
	4	1	9.1	na	4.1	na	0.9	na	118.0	na	11.5	na	68.3	na	68.0	na	NA	na	2.15	na	0.51	na
	4	50	8.4	na	3.7	na	0.8	na	98.0	na	17.2	na	113.6	na	63.0	na	NA	na	2.12	na	0.59	na
1988	2	1	8.2	1.0	3.6	1.0	1.4	0.4	100.7	32.7	6.2	3.1	106.4	46.2	168.3	68.9	355.4	191.8	2.44	0.8	0.70	0.3
	2	30	8.2	0.6	3.0	0.8	1.7	0.9	85.9	33.2	11.5	9.7	118.3	16.7	95.9	53.2	311.0	245.4	2.35	1.5	0.68	0.2
	3	1	9.0	2.6	4.2	1.6	2.0	0.9	102.1	37.6	4.9	2.6	92.6	39.5	68.5	27.4	399.1	262.2	3.26	3.3	0.83	0.7
	3	40	8.5	0.9	4.8	4.1	1.5	0.4	80.4	22.8	10.3	7.9	121.2	31.7	57.3	37.5	275.6	167.4	2.16	0.7	0.63	0.2
	4	1	8.5	1.2	4.0	1.2	1.6	0.6	94.4	16.7	4.7	2.0	89.5	36.5	57.0	33.2	343.1	151.0	2.50	1.3	0.87	0.5
	4	80	9.2	0.7	3.9	0.8	1.8	0.3	77.1	25.5	7.7	4.9	130.5	17.0	56.8	48.8	321.3	286.2	1.92	0.7	0.59	0.2
1989	2	1	8.0	1.2	4.7	1.4	1.5	0.6	121.3	30.3	3.5	3.0	90.3	46.5	162.6	74.5	na	na	1.37	0.4	0.63	0.3
	2	30	7.4	1.1	4.8	3.5	1.3	0.6	108.1	14.1	11.0	10.8	122.1	16.3	156.9	70.2	na	na	1.44	0.8	0.43	0.1
	3	1	7.1	3.1	4.7	1.7	1.4	0.3	111.0	48.1	2.8	2.4	93.3	41.3	73.3	53.6	na	na	1.64	0.6	0.64	0.2
	3	40	9.1	6.7	3.9	0.6	1.4	0.4	110.6	35.0	6.3	7.2	134.6	24.3	62.0	43.0	na	na	1.06	0.6	0.49	0.2
	4	1	8.3	1.2	5.7	2.6	2.0	1.5	113.8	18.3	3.6	3.9	93.6	48.9	69.3	37.8	na	na	1.22	0.5	0.68	0.2
	4	80	8.2	2.2	6.4	3.3	2.5	2.0	99.6	21.5	5.5	3.9	141.4	25.3	57.4	40.1	na	na	0.89	0.5	0.42	0.1

-Continued-

Appendix M.5. (page 2 of 2)

Year	Station	Depth (m)	Total -P (ug L^{-1})	SD	Total filterable - P (ug L^{-1})	SD	Filterable reactive - P (ug L^{-1})	SD	Total Kjeldahl - N (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+ nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1990	2	1	7.7	3.2	4.0	0.8	1.5	0.5	103.3	22.6	6.2	2.9	67.6	22.9	228.1	161.9	47.7	86.4	1.33	1.3	0.56	0.4
	2	30	8.2	3.6	5.1	1.8	1.9	0.4	96.0	16.0	14.9	16.2	96.7	34.8	205.6	131.9	40.4	45.7	1.20	0.8	0.53	0.3
	3	1	8.8	4.2	3.9	0.6	1.4	0.7	108.0	26.6	6.3	3.2	76.7	47.4	153.6	91.7	26.2	33.8	1.07	1.0	0.51	0.3
	3	40	7.9	3.2	4.0	1.5	1.7	1.2	98.6	21.4	12.7	11.3	95.5	37.0	148.1	105.1	42.6	80.2	1.06	1.1	0.48	0.3
	4	1	8.0	3.0	4.4	1.5	1.8	0.9	98.3	30.4	6.6	2.8	80.6	26.7	134.2	108.6	36.8	71.3	0.94	0.7	0.52	0.4
	4	80	7.5	3.2	4.6	1.3	2.3	1.4	81.4	10.5	13.0	10.8	106.7	43.7	141.8	78.6	19.2	11.7	0.77	0.6	0.42	0.2
1991	2	1	6.1	0.9	3.7	0.6	1.3	0.6	96.7	61.9	4.8	5.0	101.4	36.9	158.0	63.8	0.0	0.0	1.65	0.9	0.94	0.5
	2	30	9.2	5.4	8.0	5.6	3.2	3.1	67.3	66.3	4.7	2.7	155.2	31.8	115.4	117.9	0.0	0.0	1.47	0.6	0.63	0.3
	3	1	8.1	2.3	3.4	0.5	1.1	0.4	78.9	69.5	5.5	5.8	90.0	46.7	107.0	74.9	0.0	0.0	1.54	0.4	0.85	0.2
	3	40	6.0	1.0	3.1	0.6	0.9	0.7	65.4	62.1	3.8	1.8	159.2	23.7	83.6	59.5	0.0	0.0	1.26	0.7	0.52	0.1
	4	1	7.7	2.3	3.5	1.1	1.2	1.2	69.3	66.8	4.4	4.1	107.3	46.1	96.0	48.0	0.0	0.0	1.58	0.4	0.82	0.3
	4	80	7.7	2.6	4.0	1.5	1.8	1.4	68.6	63.0	3.7	3.9	186.4	25.4	82.4	60.5	0.0	0.0	1.14	1.1	0.39	0.2
1992	2	1	8.0	2.8	3.7	1.2	1.0	1.1	138.0	37.2	5.2	2.1	67.5	57.9	220.0	58.5	275.3	78.5	2.28	1.3	0.71	0.6
	2	30	6.7	1.8	3.9	1.3	1.4	1.0	125.9	13.9	13.7	13.1	110.8	18.2	214.0	60.8	196.0	57.2	1.35	0.3	0.74	0.1
	3	1	8.3	2.4	5.4	2.0	2.5	2.6	154.0	37.4	5.5	1.2	66.6	52.2	143.6	62.7	241.6	67.5	2.40	0.9	0.80	0.1
	3	40	6.2	1.8	4.3	2.3	1.7	1.9	113.4	26.7	12.2	9.4	145.1	24.2	190.2	31.9	204.8	72.6	1.07	0.6	0.59	0.2
	4	1	7.5	1.3	4.1	0.5	1.1	0.9	131.8	19.2	5.5	2.8	74.9	54.7	146.2	64.0	291.0	88.6	1.73	0.6	0.78	0.2
	4	80	6.6	2.5	3.6	0.6	0.9	0.7	103.5	16.0	10.3	10.3	136.4	38.9	203.2	48.4	133.0	74.1	0.68	0.4	0.47	0.2
1993	3	1	6.1	1.2	3.3	0.7	1.3	0.9	105.7	22.0	4.1	1.5	91.9	54.9	145.0	83.1	215.2	39.2	2.76	1.3	1.51	1.7
	3	40	8.5	2.8	3.5	0.5	1.3	0.5	111.4	16.7	5.4	4.6	141.1	33.3	127.2	64.0	189.8	56.8	2.69	1.2	0.53	0.4
1994	3	1	5.5	1.6	2.9	1.1	0.9	0.4	114.4	15.0	3.2	1.1	79.6	45.4	139.0	83.5	290.5	158.6	0.97	0.3	0.20	0.1
	3	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.92	0.3	0.23	0.1
	3	50	22.1	2.3	7.3	8.1	5.2	7.9	117.1	45.2	21.1	22.8	138.2	14.8	218.8	93.5	267.5	115.5	0.93	0.3	0.27	0.1

[a] Standard deviations (SD) were not calculated on sample years, 1985-1987.

[b] na - parameters were not analyzed at the 2 meter depth.

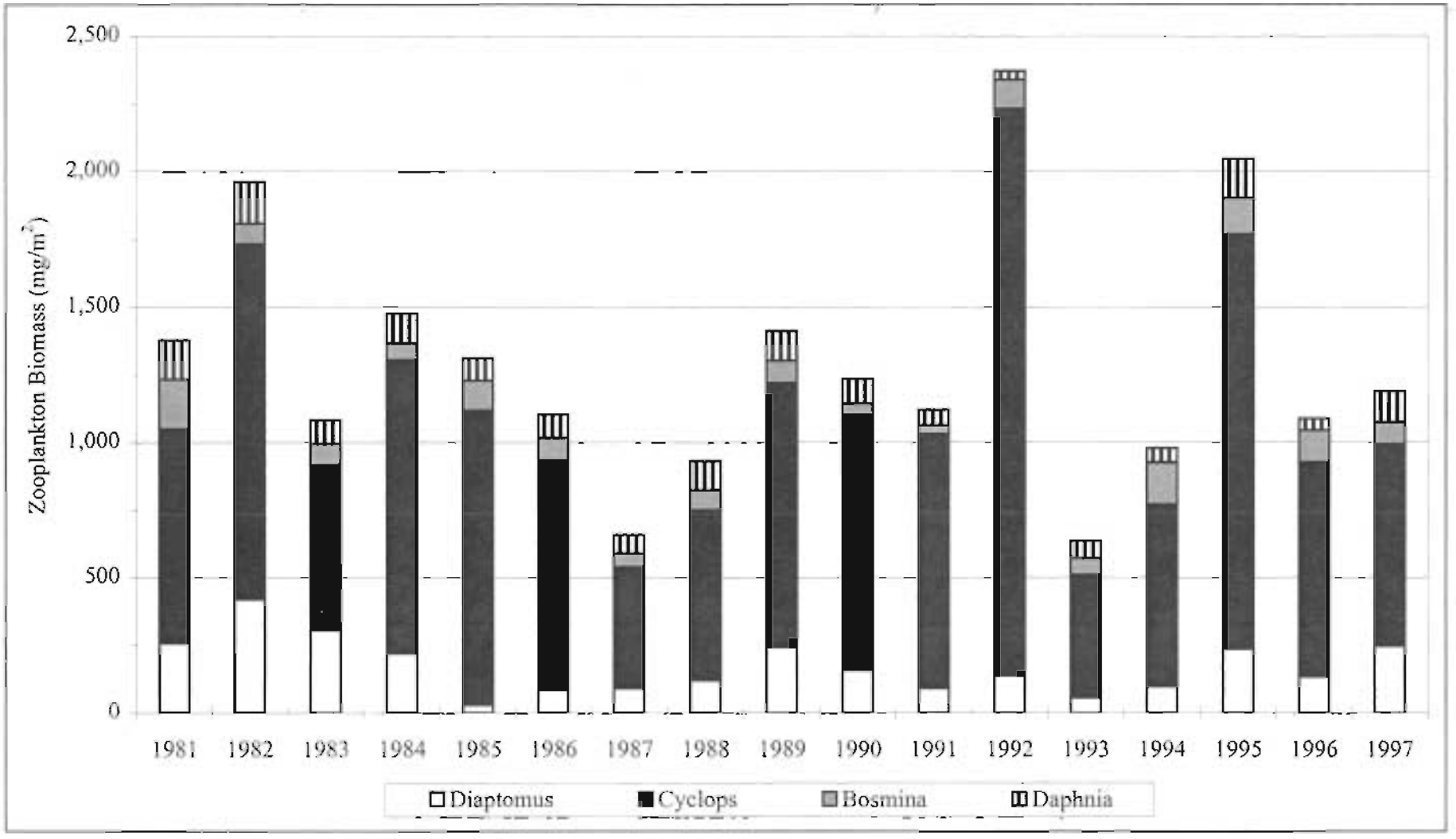
Limnology results from 1985-1987 were obtained from Koenings, J.P., and R.D. Burkett. 1988. Limnological Trends at Karluk Lake, Alaska during 1985-1987. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development. Federal Aid in Anadromous. Fish Conservation Annual Report. Juneau

Appendix M.6. Weighted mean zooplankton density, biomass, and size by genera (stations 3&4 averaged) for Karluk Lake, 1980-1997.

Station 3 & 4	No. of Sample	*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			TOTAL	
Year	Dates	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)	Size (mm)	Density (no/m^2)	Biomass (mg/m^2)
1980	7	16,515	0	0	226,284	0	0.00	22,005	0	0	10,750	0	0	275,553	0
1981	8	76,845	257	0.91	422,695	792	0.74	97,570	183	0.45	66,501	146	0.71	663,610	1,379
1982	6	145,134	421	0.88	647,203	1,313	0.76	41,727	75	0.44	66,620	152	0.72	900,685	1,960
1983	5	91,131	305	0.91	474,953	613	0.62	49,687	76	0.41	47,033	89	0.66	662,804	1,083
1984	7	43,047	220	1.07	354,271	1,086	0.93	27,518	61	0.48	40,977	108	0.78	465,813	1,476
1985	6	9,333	29	0.88	457,216	1,089	0.82	48,910	111	0.50	37,233	84	0.75	552,691	1,313
1986	8	36,950	86	0.80	509,587	849	0.70	45,283	82	0.44	36,558	87	0.74	628,378	1,103
1987	10	29,605	90	0.89	289,251	448	0.68	30,215	50	0.42	36,584	70	0.67	347,001	612
1988	8	33,307	119	0.94	408,027	630	0.67	38,897	74	0.45	41,833	107	0.77	522,063	931
1989	7	73,978	242	0.90	531,781	978	0.73	54,074	82	0.41	56,396	109	0.67	716,229	1,411
1990	9	40,440	157	0.97	488,625	944	0.75	30,682	43	0.39	40,548	92	0.72	600,295	1,236
1991	6	34,368	90	0.84	528,662	940	0.72	23,543	32	0.39	31,913	57	0.64	618,487	1,120
1992	5	25,833	137	1.08	674,148	2,094	0.93	50,218	108	0.48	11,165	31	0.79	761,364	2,370
1993	6[b]	19,259	56	0.87	311,452	453	0.65	48,823	62	0.37	37,650	65	0.64	417,184	636
1994	4	28,696	97	0.92	481,358	673	0.64	103,968	155	0.40	30,288	53	0.64	644,309	978
1995	4	55,904	236	0.99	676,997	1,533	0.80	71,430	131	0.44	68,897	145	0.70	873,229	2,045
1996	4	31,476	133	0.98	452,020	793	0.71	81,516	117	0.40	29,624	45	0.60	594,636	1,088
1997	2	133,572	247	0.73	430,520	746	0.71	57,325	81	0.39	69,613	115	0.62	691,030	1,189
Avg[a]=	6	53,463	172	0.92	478,751	940	0.74	53,023	90	0.43	44,084	91	0.69	627,047	1,290

[a] Average excludes 1980 data set.

[b] No sampling at station 4 in 1993.



Appendix M.7. Weighted mean zooplankton biomass by genera (stations 3&4 averaged) for Karluk Lake, 1981-1997[a].

[a] No biomass data were collected in 1980.

Appendix M.8. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates from Karluk Lake, 1983-1991and 1994-1997.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	Number	Low	High	Number	Low	High	(%)
12-Jul-83	10,204,000	9,261,000	11,147,000	1,418,000	1,286,000	1,550,000	14.0
18-Sep-84	42,705,000	17,074,000	68,336,000	1,989,000	885,000	3,093,000	5.0
2-Oct-85	65,020,000	49,743,000	80,297,000	11,336,000	10,232,000	12,440,000	17.0
7-Jul-86	9,571,000	7,715,000	11,427,000	1,367,000	1,119,000	1,615,000	14.0
15-Sep-86	48,066,000	43,382,000	52,750,000	6,037,000	5,443,000	6,631,000	13.0
19-Sep-87	81,278,000	63,073,000	99,483,000	18,205,000	15,005,000	21,405,000	20.0
Sep-88	81,350,000	na[a]	na[a]	10,924,500	na[a]	na[a]	13.4
Sep-89	80,077,000	na[a]	na[a]	3,989,000	na[a]	na[a]	5.0
10-Sep-90	87,299,500	73,045,681	101,553,319	48,363,923	40,467,307	56,260,539	55.4
25-Sep-91	36,146,550	21,306,133	50,986,967	7,952,241	4,687,349	11,217,133	22.0
20-Apr-94	31,522,425	20,618,469	42,426,381	3,467,467	2,268,032	4,666,902	11.0
15-Sep-94	42,001,613	32,295,370	51,707,856	1,176,045	904,270	1,447,820	2.8
27-Apr-95	36,474,225	27,905,810	45,042,640	9,920,989	7,590,380	12,251,598	27.2
17-Jun-95	6,468,308	5,750,950	7,185,666	556,274	494,581	617,967	8.6
27-Sep-95	51,569,925	33,921,070	69,218,780	1,443,958	949,790	1,938,126	2.8
28-Apr-96	11,564,550	8,102,485	15,026,615	0	na	na	0.0
30-Jun-96	4,210,133	2,882,943	5,537,323	711,512	487,217	935,807	16.9
10-Sep-96	14,820,315	11,434,607	18,206,023	2,178,586	1,680,887	2,676,285	14.7
30-Apr-97	19,504,558	16,806,230	22,202,886	7,957,859	6,856,941	9,058,777	13.6
8-Jul-97	16,849,178	14,799,353	18,899,003	606,570	532,776	680,364	1.2
9-Sep-97	23,649,328	18,448,773	28,849,883	2,057,491	1,605,043	2,509,939	2.9

[a] na - Raw data not available to calculate confidence intervals.

Appendix M.9. Townet catches from Karluk Lake, 1983-1988, 1990-1991, and 1994-1997.

			Catch by Species					
	Number	Total	Sockeye			Stickleback		
Date	of Tows	Minutes	No.	%	CPUE	No.	%	CPUE
12-Apr-83	5	140	16	10.7	0.11	134	89.3	0.96
20-Sep-84	4	100	88	6.3	0.88	1,316	93.7	13.16
2-Oct-85	4	175	28	11.0	0.16	228	89.0	1.30
7-Jul-86	11	330	1,332	17.0	4.04	6,503	83.0	19.71
15-Sep-86	23	690	930	9.0	1.35	9,403	91.0	13.63
19-Sep-87	14	420	120	13.0	0.29	803	87.0	1.91
15-Sep-88	9	270	219	14.0	0.81	1,345	86.0	4.98
10-Sep-90	3	60	90	0.3	1.50	188	0.7	3.13
25-Sep-91	8	160	83	21.3	0.52	307	78.7	1.92
20-Apr-94	11	204	4	11.0	0.02	32	89.0	0.16
15-Sep-94	8	130	169	2.8	1.30	5,968	97.2	45.91
27-Apr-95	11	165	25	27.2	0.15	67	72.8	0.41
21-Jun-95	11	165	13	8.6	0.08	139	91.4	0.84
28-Sep-95	9	139	127	2.8	0.91	4,389	97.2	31.58
28-Apr-96	10	130	0	0.0	0.00	27	100.0	0.21
28-Jun-96	9	135	33	16.9	0.24	162	83.1	1.20
10-Sep-96	7	105	81	14.7	0.77	470	85.3	4.48
30-Apr-97	10	115	6	13.6	0.05	38	86.4	0.33
8-Jul-97	9	135	4	1.2	0.03	334	98.8	2.47
9-Sep-97	10	130	19	2.9	0.15	644	97.1	4.95

Appendix M.10. Mean age, length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townetting at Karluk Lake, 1990-1991, and 1994-1997.

	Age-0					Age-1					Age-2				
			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition
Date	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)
10-Sep-90	86	96.6	44	0.8	0.95	3	3.4	80	4.6	0.90	0	0.0	0.0	0.0	0.00
25-Sep-91	17	70.8	44	0.9	1.06	5	20.8	71	3.8	1.03	2	8.4	96	9.4	1.01
25-Sep-94	110	75.9	60	2.0	0.89	28	19.3	82	5.4	0.90	7	4.8	81	4.9	0.88
27-Apr-95	-	-	-	-	-	3	13.6	90	7.3	0.98	19	86.4	100	10.7	1.06
28-Sep-95	33	29.5	67	3.3	1.03	78	69.6	99	9.6	0.99	1	0.9	113	14.4	1.00
10-Sep-96	23	35.4	40	0.9	1.28	35	53.8	63	2.8	1.11	7	10.8	77	5.3	1.09
30-Apr-97	0	0.0	0.0	0.0	0.00	3	50.0	90	7.9	1.07	3	50.0	100	11.9	1.11
8-Jul-97	0	0.0	0.0	0.0	0.00	1	33.4	93	8.6	1.07	2	66.6	85	7.5	1.23
9-Sep-97	6	5.6	43	0.8	0.98	3	6.5	65	3.2	1.09	0	0.0	0.0	0.0	0.00

Appendix M.11. Age compositions and population estimates of sockeye salmon smolt emigrating from Karluk Lake, 1961-1968, 1980-1984, and 1991-1992.

		Age					Total #	95% Confidence Interval	
Year		0	1	2	3	4	of Smolt	Low	High
1961	Percent	0.4	8.0	85.2	6.4	0.0			
	Number	6,419	134,811	1,444,399	109,132	0	1,694,761	na	na
1962	Percent	0	1.3	70.4	28.3	0.0			
	Number	0	18,653	1,010,144	406,067	0	1,434,864	na	na
1963	Percent	0.0	0.2	46.1	53.7	0.0			
	Number	0	3,079	709,755	826,765	0	1,539,599	na	na
1964	Percent	0.0	0.0	24.7	73.8	1.5			
	Number	0	0	385,593	1,152,095	23,417	1,561,105	na	na
1965	Percent	0.0	0.0	48.8	49.9	1.3			
	Number	0	0	717,022	733,184	19,101	1,469,307	na	na
1966	Percent	0.0	0.0	61.2	36.9	1.9			
	Number	0	0	661,593	398,519	20,838	1,080,950	na	na
1967	Percent	0.0	15.0	83.5	1.5	0.0			
	Number	0	203,736	1,134,127	20,374	0	1,358,237	na	na
1968	Percent	0.0	4.7	61.8	33.5	0.0			
	Number	0	171,158	2,250,549	1,219,958	0	3,641,665	na	na
1980	Percent	0.0	29.3	62.9	7.8	0.0			
	Number	0	494,500	1,060,800	131,200	0	1,686,500	na	na
1981	Percent	0.0	10.8	76.5	12.8	0.0			
	Number	0	219,500	1,561,300	260,900	0	2,041,700	na	na
1982	Percent	0.0	1.7	85.1	13.2	0.0			
	Number	0	14,000	698,800	108,400	0	821,200	na	na
1983	Percent	0.0	1.4	83.0	15.6	0.0			
	Number	0	13,000	781,000	147,000	0	941,000	na	na
1984	Percent	0.0	6.9	79.8	13.3	0.0			
	Number	0	74,000	857,000	143,000	0	1,074,000	na	na
1991	Percent	0.0	2.6	57.8	39.6	0.0			
	Number	0	108,123	2,392,324	1,640,374	0	4,140,821	2,809,914	5,471,727
1992	Percent	0.0	0.8	58.4	40.5	0.3			
	Number	0	28,189	2,039,222	1,415,788	10,797	3,493,996	2,780,674	4,207,319

[a] na - data was not available to determine confidence intervals.

Appendix M.12. Summary of mean length and weight by age class of Karluk Lake sockeye salmon smolt samples, 1925-1936, 1961-1968, and 1979-1997.

	Age-1					Age-2					Age-3					Age-4				
			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition
Year	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)
1925	3	0.4	113	na	na	563	86.7	136	22.8	0.91	84	12.9	145	28.5	0.93	0	0.0	0.0	0.0	0.00
1926	5	0.9	100	na	na	445	73.0	136	22.9	0.91	156	25.6	144	28.5	0.95	3	0.5	164	na	na
1927	5	1.3	116	na	na	212	58.7	134	21.2	0.88	144	40.0	147	27.3	0.86	0	0.0	0.0	0.0	0.00
1928	6	0.8	111	na	na	494	67.7	128	19.9	0.95	225	30.9	141	28.4	1.01	4	0.6	151	na	na
1929	0	0.0	0.0	0.0	0.00	418	40.4	130	20.0	0.91	603	58.4	143	25.2	0.86	12	1.2	155	na	na
1930	24	1.3	110	na	na	1,145	63.1	127	18.5	0.90	625	34.5	137	25.0	0.97	20	1.1	143	na	na
1931	16	0.8	111	na	na	1,795	86.6	130	20.0	0.91	247	11.9	138	26.8	1.02	14	0.7	145	na	na
1932	16	0.8	105	na	na	1,358	67.0	133	20.9	0.89	634	31.2	139	29.5	1.10	20	1.0	146	na	na
1933	43	3.4	114	na	na	685	53.8	136	23.9	0.95	521	40.9	144	29.6	0.99	23	1.8	147	na	na
1934	7	0.8	123	na	na	822	90.3	140	24.8	0.90	75	8.3	148	33.3	1.03	6	0.7	161	na	na
1935	16	0.9	113	na	na	1,520	83.3	142	26.3	0.92	286	15.7	152	26.6	0.76	2	0.1	146	na	na
1936	60	5.8	111	na	na	744	71.1	133	21.3	0.91	233	22.3	143	18.2	0.62	9	0.9	151	na	na
1961	na	7.9	110	13.1	0.98	na	85.4	115	13.7	0.90	na	6.4	124	16.6	0.87	0	0.0	0.0	0.0	0.00
1962	na	1.3	108	11.3	0.90	na	70.4	113	12.4	0.86	na	28.3	123	15.8	0.85	0	0.0	0.0	0.0	0.00
1963	na	0.2	110	14.5	1.09	na	46.1	119	14.6	0.87	na	53.7	129	18.5	0.86	0	0.0	0.0	0.0	0.00
1964	0	0.0	0.0	0.0	0.00	na	24.7	128	21.0	1.00	na	73.8	136	24.1	0.96	na	1.5	149	33.7	1.02
1965	0	0.0	0.0	0.0	0.00	na	48.8	127	19.1	0.93	na	49.9	142	26.7	0.93	na	1.3	145	28.7	0.94
1966	0	0.0	0.0	0.0	0.00	na	61.2	115	13.2	0.87	na	36.9	131	18.9	0.84	na	1.9	137	21.4	0.83
1967	na	15.0	102	10.7	1.01	na	83.5	113	13.8	0.96	na	1.5	133	23.1	0.98	0	0.0	0.0	0.0	0.00
1968	na	4.7	104	9.9	0.88	na	61.8	113	12.4	0.86	na	33.5	124	15.3	0.80	0	0.0	0.0	0.0	0.00
1979	66	23.7	112	14.8	1.07	201	72.3	120	18.5	1.07	11	4.0	147	29.1	0.91	0	0.0	0.0	0.0	0.00
1980	300	34.2	97	8.3	0.90	496	56.6	103	9.4	0.87	80	9.1	113	11.7	0.80	0	0.0	0.0	0.0	0.00
1981	77	10.1	96	9.4	1.05	600	78.9	111	13.4	0.97	83	10.9	119	16.2	0.95	0	0.0	0.0	0.0	0.00
1982	8	1.7	104	10.8	0.96	413	85.2	119	15.1	0.90	64	13.2	132	20.2	0.88	0	0.0	0.0	0.0	0.00
1983	17	1.4	101	9.5	0.92	1,014	85.9	117	14.2	0.89	149	12.6	132	19.9	0.87	0	0.0	0.0	0.0	0.00
1984	165	18.4	108	11.5	0.91	670	74.6	117	13.9	0.87	63	7.0	130	19.3	0.88	0	0.0	0.0	0.0	0.00
1985	227	28.2	103	10.1	0.92	541	67.2	111	12.1	0.87	37	4.6	123	16.4	0.87	0	0.0	0.0	0.0	0.00

na - not available

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	Age-1					Age-2					Age-3					Age-4				
			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition
Year	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)
1986	426	26.0	85	6.2	1.01	1,184	72.3	111	13.0	0.95	28	1.7	118	14.7	0.90	0	0.0	0.0	0.0	0.00
1987	43	2.0	95	7.4	0.82	1,776	83.2	106	10.4	0.86	316	14.8	121	15.6	0.86	0	0.0	0.0	0.0	0.00
1988	8	1.0	82	4.9	0.84	800	97.8	103	9.4	0.86	10	1.2	118	11.9	0.82	0	0.0	0.0	0.0	0.00
1989	5	0.5	92	6.7	0.84	828	84.3	103	9.6	0.86	149	15.2	116	13.4	0.85	0	0.0	0.0	0.0	0.00
1990	30	3.0	96	7.8	0.85	270	26.7	101	8.7	0.82	709	70.2	114	12.2	0.82	1	0.0	121	14.4	0.81
1991	166	6.9	100	8.7	0.84	1,584	65.9	110	11.3	0.84	654	27.2	121	15.0	0.84	0	0.0	0.0	0.0	0.00
1992	59	3.0	101	8.8	0.83	1,340	68.1	106	9.8	0.82	565	28.7	117	13.4	0.83	4	0.0	127	18.0	0.87
1993	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
1994	1	0.3	110	12.0	0.90	167	56.2	112	11.1	0.79	129	43.4	119	13.4	0.79	0	0.0	0.0	0.0	0.00
1995	7	8.0	105	9.5	0.82	79	89.8	113	12.3	0.83	2	2.3	122	16.1	0.89	0	0.0	0.0	0.0	0.00
1996	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00	0	0.0	0.0	0.0	0.00
1997	0	0.0	0.0	0.0	0.00	157	65.5	112	13.0	0.92	83	34.5	114	13.4	0.91	1	0.0	109	12.3	0.95

na - not available

Appendix M.13. Karluk Lake sockeye salmon escapement counts, 1989-1998.

	-----YEAR-----									
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/13						1				
5/14						0				
5/15						0				
5/16						0				
5/17						0				
5/18						9				
5/19						0			3	
5/20						1	0		3	
5/21						0	1		2	
5/22						2	2		4	
5/23						4	3		6	
5/24	3					0	3		8	10
5/25	0				10	0	0		26	0
5/26	0				47	1	3	2	41	10
5/27	14		10		193	6	6	1	146	65
5/28	3		1	8	112	4	9	4	175	90
5/29	39		6	14	861	6	1	5	71	13
5/30	23	147	0	8	1,721	2	2	3	979	45
5/31	87	176	0	37	7,574	5	4	2	1,313	3,956
6/1	18	40	2	202	5,097	5	6	2,434	1,299	3,953
6/2	1,128	126	3	67	3,982	3	55	5,625	3,662	3,952
6/3	2,967	89	57	12	8,681	27	32	19,036	154	3,953
6/4	1,323	325	20	36	10,643	9	68	4,345	300	3,953
6/5	10,015	1,140	433	175	12,782	326	182	8,790	1,094	4,000
6/6	15,474	5,023	450	741	4,949	93	189	920	4,178	18,118
6/7	21,198	7,259	1,240	705	7,232	24	43	147	2,479	14,500
6/8	8,303	4,699	216	7,554	18,110	41	42	31	87	15,598
6/9	27,053	7,673	340	9,177	22,864	112	1,941	25	143	11,502
6/10	33,221	13,010	2,041	9,690	15,558	435	45,804	143	27,943	9,904
6/11	19,061	16,206	7,425	6,923	15,001	140	31,981	164	52,839	10,061
6/12	4,181	13,518	12,570	4,742	15,626	46,292	15,570	17	12,377	22,086
6/13	8,000	14,199	18,890	11,808	22,277	28,627	6,907	8,242	11,365	11,356
6/14	1,895	9,815	6,482	12,248	21,498	31,452	393	61,170	17,010	3,178
6/15	13,848	7,559	5,107	13,266	19,911	24,451	851	33,557	5,421	8,316
6/16	11,993	8,975	6,632	12,703	5,878	17,821	2,389	15,000	7,454	5,802
6/17	3,944	5,954	5,388	18,921	5,267	18,289	4,509	161	3,468	8,089
6/18	27,765	8,851	11,734	9,776	1,143	16,997	5,384	95	4,054	4,135
6/19	15,259	10,005	8,449	10,464	3,689	1,141	7,311	15,326	6,970	4,553
6/20	3,595	6,981	6,575	11,571	2,282	6,160	23,661	6,108	7,203	13,111

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DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
6/21	10,132	2,386	17,011	6,545	1,866	6,140	23,911	23,478	2,382	567
6/22	24,392	4,135	12,833	13,121	522	6,651	6,922	2,680	4,165	4,922
6/23	3,973	2,340	8,487	12,621	1,893	568	3,469	2,747	7,083	241
6/24	10,535	2,351	7,327	6,341	2,125	1,010	9,541	2,365	10,000	26,319
6/25	12,169	2,043	12,210	1,179	1,140	2,839	5,124	979	7,702	9,227
6/26	9,225	8,282	9,516	5,753	295	832	5,693	1,835	2,181	6,873
6/27	11,062	4,657	8,186	5,036	1,062	4,301	1,006	8,118	322	2,341
6/28	8,554	10,282	11,461	3,645	1,271	470	2,920	1,305	697	3,101
6/29	4,021	3,532	8,790	3,173	117	5,848	3,084	349	53	1,169
6/30	2,790	1,703	6,424	1,098	155	3,110	940	2,796	1,313	2,162
7/1	2,170	2,024	7,900	549	364	2,352	6,250	318	4,437	2,540
7/2	1,131	1,121	6,015	142	2,434	2,180	2,931	1,930	8,147	1,225
7/3	427	1,377	5,571	331	954	1,133	2,699	2,455	1,316	128
7/4	606	405	2,511	237	1,310	3,669	1,777	3,092	201	172
7/5	1,005	448	5,282	240	540	279	773	740	624	739
7/6	2,374	757	3,893	76	1,094	3,035	342	710	647	551
7/7	1,300	629	2,431	835	1,242	1,517	340	1,209	2,827	91
7/8	489	308	1,093	1,345	1,744	2,989	1,605	3,736	968	713
7/9	1,642	231	1,666	79	1,802	2,279	175	537	735	691
7/10	2,714	297	1,677	799	384	1,385	1,588	534	882	734
7/11	1,458	502	927	1,600	1,483	1,639	480	518	3,901	973
7/12	722	164	1,091	1,642	923	332	138	623	2,066	571
7/13	289	171	1,043	559	354	2,176	205	258	2,377	1,075
7/14	340	141	1,383	1,193	682	3,779	366	1,021	2,621	133
7/15	1,391	165	850	524	512	591	435	458	3,695	102
7/16	1,729	85	861	692	574	282	1,091	1,246	3,616	51
7/17	996	410	284	1,075	372	213	2,176	1,776	819	21
7/18	665	776	710	2,042	416	651	1,100	185	356	121
7/19	242	1,419	222	1,751	161	202	540	266	674	11
7/20	85	710	843	1,131	184	116	827	555	24	38
7/21	715	576	547	950	204	5,717	2,279	184	3,754	387
7/22	103	684	667	1,850	408	654	2,851	2,515	1,177	218
7/23	336	377	309	532	362	177	678	1,222	93	228
7/24	95	445	109	396	32	749	920	22	4,533	428
7/25	237	409	261	1,035	64	2,324	5,162	1,441	100	57
7/26	284	831	78	960	249	205	797	281	137	103
7/27	2,027	937	979	1,333	170	1,358	103	22	993	151
7/28	549	1,703	404	455	100	2,801	95	58	4,680	216
7/29	1,522	2,088	350	48	285	322	5,317	103	3,997	1,896
7/30	570	846	1,440	39	52	95	936	4	1,543	530
7/31	1,006	629	799	232	478	619	331	192	4,339	1,002

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DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/1	593	2,230	27	149	4,673	410	1,115	168	3,963	670
8/2	379	539	648	122	294	88	593	358	1,888	3,051
8/3	238	2,609	193	214	33	199	5,350	629	2,579	331
8/4	5,332	1,705	303	125	89	1,686	341	4,142	899	24
8/5	3,215	1,211	112	146	94	470	89	7,319	940	1,704
8/6	2,408	1,186	3,148	314	223	230	342	898	5,118	1,507
8/7	1,770	2,028	9,467	1,745	2,263	178	236	704	839	419
8/8	675	2,455	8,747	4,210	811	507	301	124	1,542	1,533
8/9	3,034	7,807	8,974	1,837	236	733	315	5,482	1,810	1,529
8/10	10,138	2,880	7,620	2,096	225	1,096	2,807	7,451	174	2,028
8/11	20,627	2,538	6,993	1,133	163	1,790	153	7,289	586	787
8/12	7,172	12,434	7,562	5,910	97	661	952	10,875	616	815
8/13	4,946	9,222	12,068	3,360	63	136	87	344	2,367	1,506
8/14	1,644	3,335	9,291	1,750	365	404	117	560	2,413	1,301
8/15	368	3,576	7,766	248	151	294	175	295	430	1,163
8/16	80	1,378	7,686	1,370	8,347	1,143	641	244	206	5,432
8/17	64	739	35,595	1,076	328	620	31	775	1,616	6,104
8/18	471	661	6,033	2,543	1,120	404	662	246	751	1,001
8/19	136	666	18,220	994	13,641	598	176	784	212	168
8/20	218	870	3,616	8,858	2,563	611	80	404	141	732
8/21	506	4,629	10,546	3,975	297	6,430	132	3,749	545	126
8/22	322	3,710	12,633	2,598	56	663	143	6,148	1,677	546
8/23	17,434	1,265	5,025	26,322	15,678	9,722	9,301	4,200	503	62
8/24	17,746	428	280	9,564	899	571	7,997	11,926	99	419
8/25	17,410	394	318	3,858	893	222	3,568	2,485	65	160
8/26	18,218	461	239	38,460	674	146	286	2,426	108	77
8/27	1,183	3,029	154	14,084	1,596	37	10,424	34	10,182	301
8/28	2,124	892	355	7,284	14,383	85,206	45,478	315	2,220	773
8/29	2,232	650	179	483	18,373	33,097	6,093	352	3,151	2,241
8/30	18,011	241	9,923	331	16,943	3,880	21,170	274	477	1,372
8/31	1,904	21,969	34,521	287	20,160	1,478	2,065	365	33,741	1,118
9/1	5,332	20,691	22,601	223	1,903	216	2,301	320	23,547	8,489
9/2	9,692	46,696	1,250	138	2,488	243	2,213	791	5,302	500
9/3	28,384	87,690	22,621	19,145	818	113	2,484	1,090	1,102	30,000
9/4	53,967	24,431	133,633	9,453	800	113	5,148	925	763	9,716
9/5	89,716	27,113	46,753	62,116	4,868	83	14,518	566	9,093	2,183
9/6	90,256	1,630	50,915	43,422	2,388	281	13,567	2,192	8,449	1,684
9/7	60,406	1,011	18,407	84,060	27,716	100	7,026	69,062	1,175	547
9/8	10,015	943	2,914	50,165	13,502	150	773	9,330	2,672	530
9/9	31,942	225,000	692	15,268	7,704	159	141	4,027	23,530	91
9/10	30,077	0	1,817	332	3,775	749	360	2,041	5,044	226

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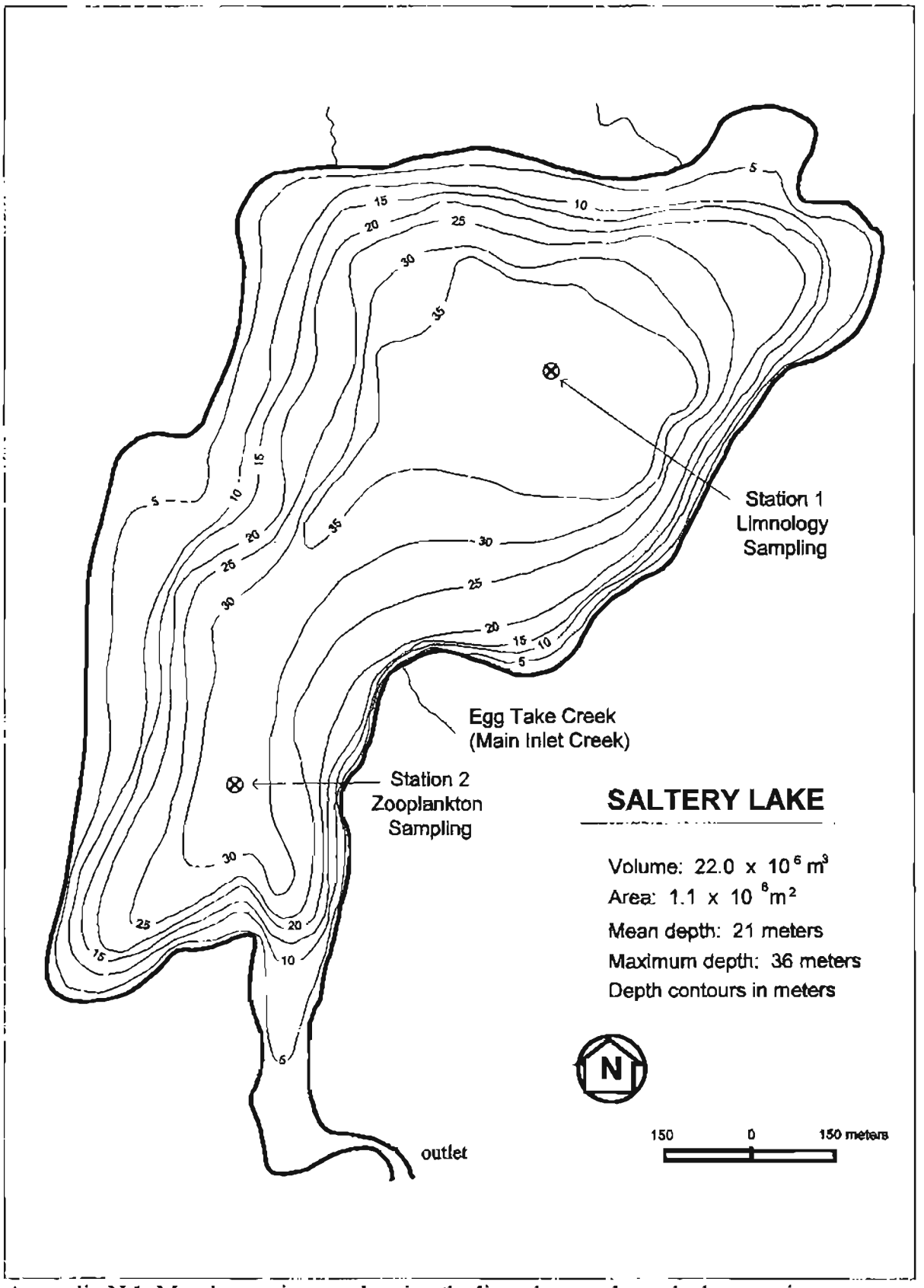
					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
9/11	42,910	0	772	393	7,721	1,586	26,791	315	3,323	3,447
9/12	42,877	0	264	44,393	47,578	1,446	18,194	15,000	14,703	1,385
9/13	28,489	0	42	4,454	20,710	243	6,092	53,000	9,201	5,914
9/14	14,556	0	161	1,642	12,980	265	388	675	6,891	24,348
9/15	7,035	0	148	231	5,063	159,960	9,374	357	8,306	65,051
9/16	5,912	0	53,440	2,453	14,629	65,901	513	5	29,983	21,042
9/17	40,000	0	76,831	131	4,206	24,564	7,588	957	7,372	8,131
9/18	0	0	16,052	57	1,200	691	20,381	175	7,932	39,673
9/19	0	0	14,373	113	1,688	206	17	2,011	4,628	19,660
9/20	0	0	63,336	22,931	32,800	56,116	95,108	4,216	3,910	40,445
9/21	0	0	44,489	32,709	4,434	56,097	11,706	7,579	708	11,416
9/22	0	0	26,821	369	4,068	19,812	6,921	2,013	4,720	964
9/23	0	0	35,000	6,222	4,813	26,505	9,377	3,631	11,029	515
9/24	0	0	20,000	13,122	2,581	8,645	2,586	468	12,720	62
9/25	0	0	3,000	894	2,538	0	25,000	5,998	2,344	45,000
9/26	0	0	1,000	11,250	6,861	0	78,000	20,000	0	0
9/27	0	0	0	11,250	497	0	0	30,000	0	0
9/28	0	0	0	11,250	20,528	0	0	0	0	0
9/29	0	0	0	11,250	7,500	0	0	0	0	0
9/30	0	0	0	2,500	0	0	0	0	0	0
Total:	1,108,646	738,088	1,134,086	831,414	657,455	848,029	743,056	574,325	564,759	637,146

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.



Appendix N.1. Morphometric map showing the limnology and zooplankton stations on Saltery Lake.

Appendix N.2. Limnological sampling stations and sampling frequencies for Saltery Lake, 1994-1998.

Year	Sampling	
	Stations	Frequency
1994	1,2	4
1995	1,2	4
1996	1,2	4
1997	1,2	5
1998	1	4

Appendix N.3. Summary of seasonal mean water chemistry parameters by station and depth for Saltery Lake, 1994 and 1997.

Year	Station	Depth (m)	Sp. Conductivity (umhos cm^{-1})	SD[a]	pH (Units)	SD	Alkalinity (mg L^{-1})	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (mg L^{-1})	SD	Magnesium (mg L^{-1})	SD	Iron (ug L^{-1})	SD
1994	1	1	64.3	20.6	6.7	0.3	18.0	2.0	2.3	1.6	8.0	6.1	6.3	3.0	0.6	0.2	94.8	54.7
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	33	65.3	18.0	6.6	0.3	18.0	0.8	5.0	1.8	5.0	2.7	8.0	0.1	0.7	0.5	185.0	32.2
1997	1	1	52.8	3.3	7.2	0.1	19.6	0.6	3.5	2.3	7.2	5.0	6.3	0.2	0.7	0.3	52.4	17.2
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1997	1	34	60.4	2.1	6.8	0.2	22.4	1.4	5.4	2.7	4.2	0.4	7.2	0.5	0.5	0.2	41.0	21.9

[a]SD - standard deviation

[b]na - parameters were not analyzed at the 2 meter depth.

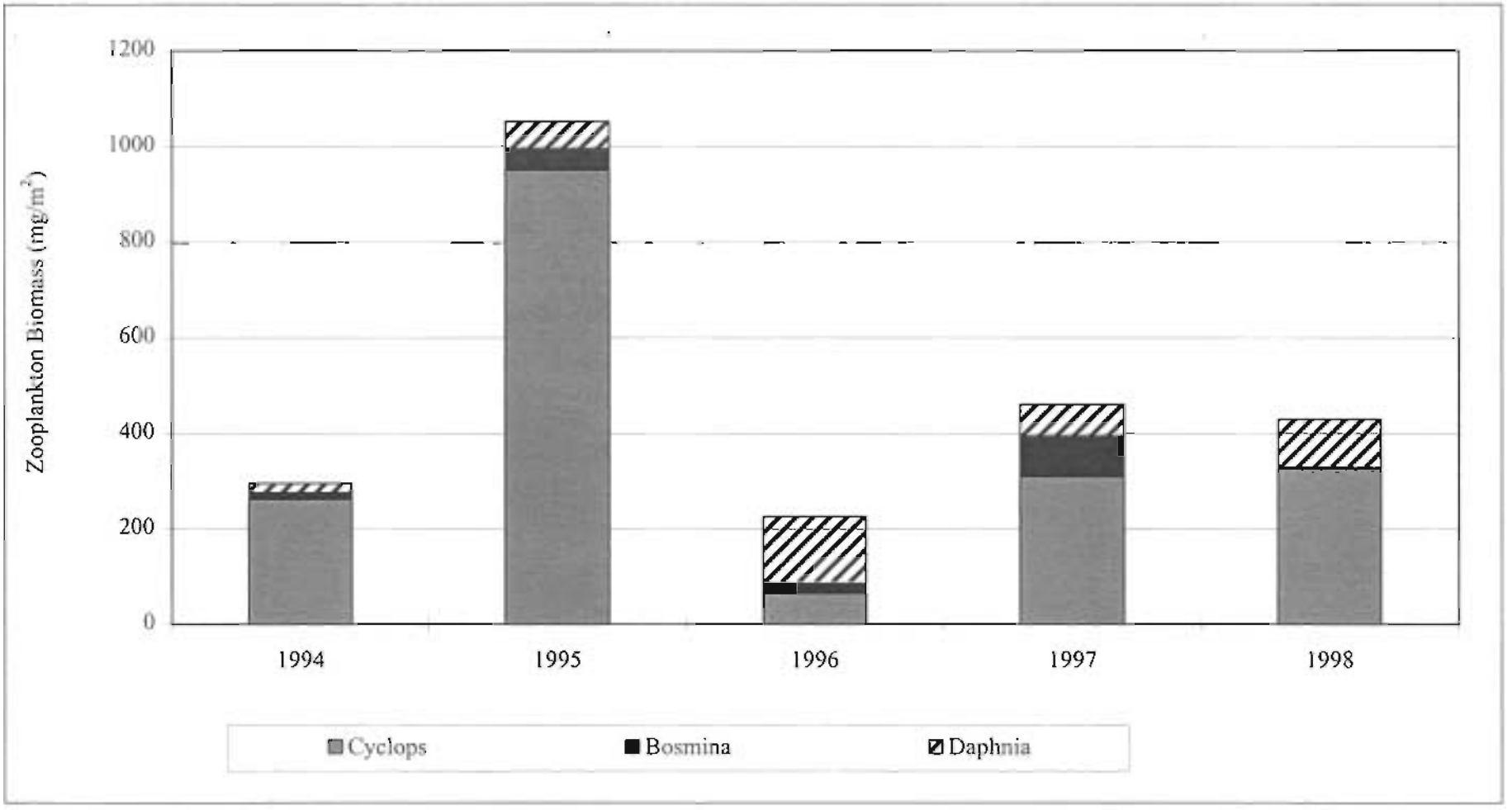
Appendix N.4. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Saltery Lake, 1994 and 1997.

			Total Phosphorus		Total filterable-P		Filterable reactive-P		Total Kjeldahl-N		Ammonia		Nitrate + nitrite		Reactive silicon		Organic carbon		Chlorophyll *a*		Phaeophytin *a*	
Year	Station	Depth (m)	(ug L^{-1})	SD[a]	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD
1994	1	1	6.7	1.3	4.4	3.2	3.4	3.4	100	45	5.3	4.6	123.7	91.5	2104.3	661.4	151.0	78.6	1.38	1.3	0.33	0.0
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.67	1.3	0.35	0.2
1994	1	33	10.9	2.7	4.4	2.2	3.2	1.7	70	9	8.8	3.1	221.2	22.6	2074.8	92.7	148.8	40.7	1.00	0.1	0.44	0.1
1997	1	1	8.8	4.6	4.4	2.2	4.2	2.3	75	22	2.7	2.7	70.7	56.5	1766.8	190.9	194.8	68.4	1.65	0.8	0.90	0.4
1997[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.59	0.8	0.98	0.5
1997	1	34	9.9	1.4	3.0	1.3	2.3	0.8	90	32	12.0	16.3	192.3	36.3	2160.8	270.9	206.8	132.3	0.97	1.0	0.60	0.3

[a]SD - standard deviation
[b]na - parameters were not analyzed at the 2 meter depth.

Appendix N.5. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Saltery Lake, 1994-1998.

Station 1 & 2 Year	No. of Sample Dates	*Cyclops* Density no/m^2	*Cyclops* Biomass mg/m^2	*Cyclops* Size mm	*Bosmina* Density no/m^2	*Bosmina* Biomass mg/m^2	*Bosmina* Size mm	*Daphnia* Density no/m^2	*Daphnia* Biomass mg/m^2	*Daphnia* Size mm	TOTALS Density no/m^2	TOTALS Biomass mg/m^2
1994	4	119,169	262	0.79	9,329	14	0.40	6469	20	0.81	134,966	295
1995	4	358,887	950	0.86	23,620	44	0.45	27,535	58	0.70	410,041	1,053
1996	4	29,578	64	0.79	17,436	21	0.36	97,213	141	0.59	144,228	227
1997	5	124,140	309	0.85	61,083	85	0.40	44,289	68	0.64	229,512	461
1998	4	165,898	326	0.73	1,911	2	0.35	44,586	102	0.69	212,395	430
Avg =	4	159,534	382	0.80	22,676	33	0.39	44,018	78	0.69	226,228	493



Appendix N.6. Weighted mean zooplankton biomass by genera (averages for station 1 and 2) for Saltery Lake, 1994-1998.

Appendix N.7. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Saltery Lake, 1997-1998.

	Total Fish Estimates			Sockeye Estimates			Sockeye
	Number	95% C. I.		Number	95% C. I.		Composition
Date		Low	High		Low	High	(%)
16-Sep-97	458,696	382,513	534,879	456,403	380,601	532,205	99.5
16-Sep-98	686,598	611,227	761,969	680,419	609,690	751,148	99.1

Appendix N.8. Townet catches from Saltery Lake, 1997-1998.

			Catch by Species					
	Number	Total	Sockeye			Stickleback		
Year	of Tows	Minutes	No.	%	CPUE	No.	%	CPUE
16-Sep-97	4	43	215	99.5	5.0	1	0.5	0.0
16-Sep-98	2	27	229	99.1	8.5	2	0.9	0.1

Appendix N.9. Mean length, weight, and condition coefficient by age of juvenile sockeye salmon by townet at Saltery Lake, 1997-1998.

	Age-0					Age-1					Age-2				
Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
16-Sep-97	25	15.1	39.0	0.6	1.04	131	78.9	42.6	0.9	1.04	10	6.0	67.4	3.5	1.12
16-Sep-98	10	4.8	49.7	1.4	1.09	198	94.3	56.8	2.0	1.08	2	0.9	56.0	1.9	1.07

Appendix N.10. Summary of mean length, weight, and condition coefficient of Saltery Lake sockeye salmon smolt samples by age, 1997.

	Age-2					Age-3				
Sampling Dates	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
22-May-97	2	33	83.0	4.1	0.71	4	67	87.5	5.2	0.77

Appendix N.11. Saltery Lake sockeye salmon escapement counts, 1989-1998.

					----YEAR----					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
6/10		1								
6/11	1	2								
6/12	2	32	8							
6/13	0	11	41	9						
6/14	3	3	30	17						
6/15	4	2	182	22						
6/16	11	0	61	35						
6/17	19	14	22	0						
6/18	114	20	54	33						
6/19	46	15	59	132						
6/20	70	87	60	48		35				
6/21	123	31	20	108		95				
6/22	29	47	8	42	450	132	3	12		
6/23	14	30	8	24	213	116	107	10		
6/24	24	151	16	135	1,012	212	62	58		
6/25	65	12	32	97	587	22	312	110	81	
6/26	121	60	57	96	797	96	483	129	308	
6/27	155	856	125	325	345	80	620	257	911	
6/28	250	187	554	0	1,407	316	351	78	371	
6/29	135	433	344	48	2,460	746	548	225	600	
6/30	411	341	841	481	2,215	460	164	495	947	
7/1	38	1,082	1,940	468	5,548	1,943	132	168	624	
7/2	360	318	432		3,804	277	359	125	1,038	
7/3	89	96	1,163		1,254	332	1,342	1,250	1,081	
7/4	60	586	7,166		1,584	227	1,108	900	1,203	
7/5	115	514	2,188		4,606	807	1,880	452	874	
7/6	71	886	1,633		8,557	763	240	750	1,144	2,000
7/7	171	663	1,574		799	573	1,045	305	935	502
7/8	111	354	1,237		445	509	1,340	252	916	490
7/9	60	2,235	3,310		337	321	1,001	1,325	781	976
7/10	516	271	2,217		2,006	300	2,129	630	651	1,043
7/11	1,025	530	951		1,515	1,141	1,564	458	162	461
7/12	766	293	1,468		2,542	230	1,529	480	862	1,519
7/13	457	705	1,330		2,536	647	1,373	1,220	631	330
7/14	805	532	1,168		1,342	2,150	200	3,431	601	755
7/15	819	982	825		1,221	1,019	2,396	2,701	110	563

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Appendix N.11. (page 2 of 3)

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DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
7/16	743	112	2,241		1,116	3,659	755	410	214	275
7/17	205	155	1,666		815	2,335	484	2,038	3,064	1,000
7/18	1,744	178	702		1,426	3,000	2,292	1,905	1,000	943
7/19	1,045	569	1,253		2,378	318	1,716	2,350	500	1,708
7/20	963	2,543	398		1,962	2,030	2,321	1,225	500	2,000
7/21	412	2,356	861		1,208	2,104	483	35	650	1,289
7/22	717	929	2,133		2,022	538	1,528	670	48	893
7/23	2,553	142	1,773		1,186	943	1,041	67	385	773
7/24	1,503	1,209	728		726	2,843	1,046	440	232	712
7/25	1,639	353	1,193		1,904	2,953	795	530	404	97
7/26	1,351	777	804		1,102	2,782	1,404	800	750	450
7/27	969	415	409		860	1,594	1,489	1,751	264	300
7/28	966	1,078	1,157		2,165	1,569	772	761	504	568
7/29	1,608	99	756		1,294	901	1,461	1,117	300	502
7/30	714	298	609		1,051	685	903	94	555	709
7/31	654	322	423		1,342	638	351	1,045	372	53
8/1	705	3,950	371		833	1,221	539	420	414	804
8/2	548	1,315	296		703	848	766	640	536	317
8/3	249	0	392		919	1,329	537	271	232	132
8/4	569	0	229		351	1,744	211	211	239	68
8/5	505	0	239		515	1,171	162	1,020	308	1,200
8/6	375	0	287		505	378	360	478	703	417
8/7	324	0	220		421	860	447	228	183	109
8/8	222	5	107		921	1,101	539	240	1,004	98
8/9	259	0	113		1,879	974	169	921	417	116
8/10	259	4	184			598	1,000		105	122
8/11	138	0	229			526			255	209
8/12	152	0	57			765			330	343
8/13	155	52	141			553			158	138
8/14	92	56	76			570			115	194
8/15	46	7	86			463			102	156
8/16	42	15	53			330			121	205
8/17	14	24	48			194			99	139
8/18	111	29	44			354			106	113
8/19	38	8	169			229			100	48
8/20	112	24	110			134			87	77
8/21	11	9	53			103			132	69
8/22	20	20	88			39			87	84

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Appendix N.11. (page 3 of 3)

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DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/23	1	0	72			18			93	41
8/24	1	2	63			73			79	50
8/25	100	0	110			18			72	51
8/26	101	1	69			44			46	18
8/27	28	0	46			22			52	10
8/28	14	5	33			66			58	7
8/29	27	0	16			35			46	2
8/30	4	1	23			87			35	15
8/31	2	1	12			37			21	
9/1	20	7	9			22			23	
9/2	20	4	8			27			22	
9/3	6	14	259			15			31	
9/4	18	12	35			122			11	
9/5	7	4	15			54			7	
9/6	0	11				33			14	
9/7	1	3				8				
9/8	4	89				17				
9/9	4	22				23				
9/10	5	31				45				
9/11	5	8				21				
9/12	6	14				13				
9/13	4	7				4				
9/14	3	65				4				
9/15	1	17				110				
9/16	0	14				20				
9/17	1					120				
9/18	1					91				
9/19	7					51				
9/20	2					375				
9/21	5					134				
9/22	14					341				
9/23	16					0				
9/24	9					0				
9/25	8					0				
Total:	30,237	29,767	52,592	2,120	77,186	58,975	43,859	35,488	31,016	26,263

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix N.12. Estimated age composition of the Saltery Lake sockeye salmon escapement, 1995-1998.

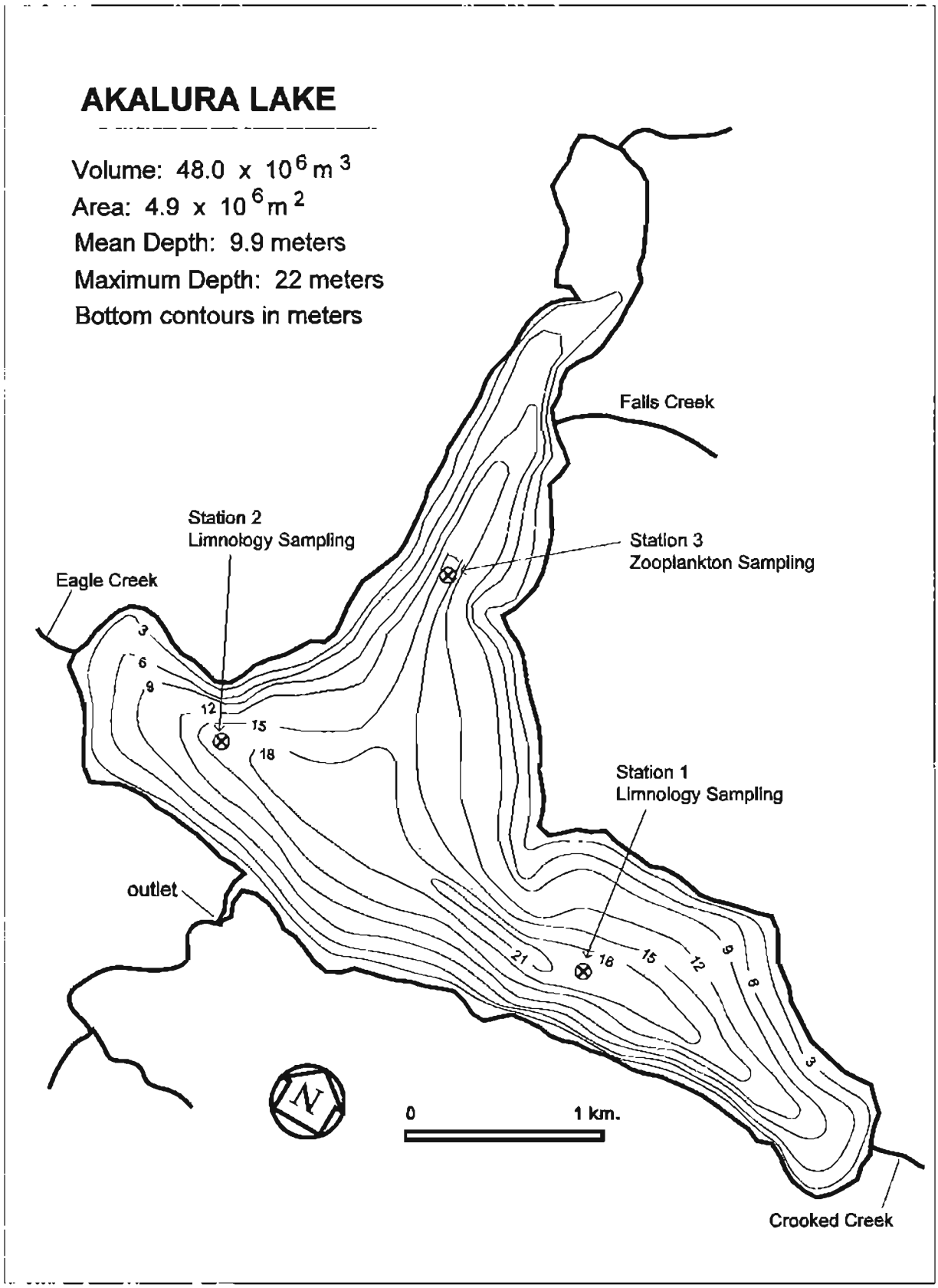
Year	Sample Size		Ages												Total
			0.2	0.3	1.1	1.2	1.3	2.1	2.2	1.4	2.3	3.1	3.2	3.3	
1995	437	Numbers	0	300	0	702	36,027	0	3,212	300	3,311	0	0	0	43,856
		Percent	0.0	0.7	0.0	1.6	82.1	0.0	7.3	0.7	7.5	0.0	0.0	0.0	100
1996	418	Numbers	0	0	0	1,020	10,699	0	1,530	254	21,989	0	0	0	35,488
		Percent	0.0	0.0	0.0	2.9	30.1	0.0	4.3	0.7	62.0	0.0	0.0	0.0	100
1997	316	Numbers	0	68	68	608	4,596	203	3,378	135	11,962	0	203	135	21,355
		Percent	0.0	0.3	0.3	2.8	21.5	1.0	15.8	0.6	56.0	0.0	1.0	0.6	100
1998	337	Numbers	158	79	394	8,877	4,832	1,182	5,384	0	4,754	473	263	158	26,263
		Percent	0.6	0.3	1.5	33.8	18.4	4.5	20.5	0.0	18.1	1.8	1.0	0.6	100

Appendix N.13. Saltery Lake sockeye salmon weir counts, excess number of the escapement goal, broodstock number, and estimated freshwater age composition, 1994-1998.

	Escapement Counts		Broodstock		Estimated Freshwater Age Composition					Number
Year	Total	Excess[a]	Number		0	1	2	3	Totals	of samples
1994[b]	58,975	38,975	4,238	Number	-	-	-	-	-	
				Percent						
1995[b]	43,859	23,859	122	Number	-	-	-	-	-	
				Percent						
1996[b]	35,488	15,488	103	Number	-	-	-	-	-	
				Percent						
1997	31,016	11,016	2,700	Number	0	621	1,944	135	2,700	80
				Percent	0	23	72	5	100	
1998	26,263	6,263	2,560	Number	0	995	1,389	176	2,560	363
				Percent	0	39	54	7	100	

[a] The number of sockeye in excess of the optimum escapement goal of 20,000.

[b] Freshwater ages were not determined from 1994-1996.



Appendix O.1. Morphometric map showing limnology and zooplankton stations on Akalura Lake.

Appendix O.2. Limnological sampling stations and sampling frequencies for Akalura Lake, 1986-1996.

Year	Sampling Stations	Sampling Frequency
1986	3	2
1987	1	5
1988	1	3
1989	1	4
1990	2	6
1991	2	6
1992	2	6
1993	2	5
1994	3	5
1995	3	6
1996	2	4

Appendix O.3. Summary of seasonal mean water chemistry parameters by station and depth for Akalura Lake, 1990-1991 1993-1996.

		Depth	Sp. Conductivity		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(umhos cm^{-1})	SD[a]	(Units)	SD	(mg L^{-1})	SD	(NTU)	SD	(Pt units)	SD	(mg L^{-1})	SD	(mg L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	60	2.0	7.2	0.2	14.8	1.1	1.0	0.3	7.0	2.1	4.9	0.5	1.5	0.5	136.2	53.0
1990	1	16	60	2.8	6.9	0.3	16.0	1.5	2.2	1.2	8.5	2.4	5.1	0.9	1.5	0.9	381.8	449.6
1990	2	1	59	1.6	7.1	0.2	15.0	0.8	1.0	0.4	6.6	2.4	5.6	2.7	1.2	0.6	435.4	757.8
1990	2	15	58	4.1	6.8	0.2	15.8	1.5	1.6	0.3	7.0	2.9	4.8	0.5	1.5	0.2	288.2	338.5
1991	1	1	58	1.8	7.1	0.1	13.9	2.2	1.7	1.4	5.5	1.4	4.8	0.7	1.5	0.7	66.7	33.4
1991	1	16	59	2.2	6.9	0.2	14.3	2.1	1.4	0.5	6.8	2.8	5.1	0.8	1.1	0.7	102.6	172.6
1991	2	1	58	1.3	7.1	0.1	14.2	1.9	1.3	0.5	8.7	3.4	5.0	0.8	1.2	0.6	61.0	34.6
1991	2	15	58	2.8	6.9	0.2	14.4	2.0	1.3	0.5	6.7	2.9	4.6	0.5	1.6	0.4	91.6	216.4
1993	1	1	59	0.0	6.8	0.1	14.9	0.2	1.2	0.5	7.4	7.4	4.8	0.1	1.6	0.2	52.4	15.8
1993	1	16	61	2.3	6.6	0.2	15.7	1.2	1.8	0.8	5.0	2.7	4.6	0.5	1.6	0.2	300.8	289.9
1993	2	1	60	2.3	6.9	0.1	15.0	0.4	1.5	0.4	5.6	3.6	4.7	0.6	1.5	0.2	90.4	45.5
1993	2	13	61	2.3	6.6	0.2	15.0	0.7	1.6	0.3	4.4	2.2	4.9	0.1	1.5	0.2	244.6	241.3
1994	1	1	59	2.3	6.9	0.1	14.3	0.5	3.5	2.9	5.5	1.0	5.0	0.1	1.3	0.4	77.0	15.1
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	1	16	61	2.3	6.8	0.3	14.8	0.8	2.2	0.8	7.6	3.6	5.0	0.1	1.3	0.4	470.0	461.7
1994	2	1	59	2.3	7.0	0.1	14.3	0.7	4.5	4.8	5.0	2.2	4.8	0.4	1.3	0.4	109.0	69.1
1994[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1994	2	14	60	2.3	6.7	0.3	14.4	0.9	2.2	0.9	6.6	1.8	5.0	0.1	1.3	0.4	225.0	147.3
1995	1	1	59	2.3	6.9	0.2	15.2	0.6	1.6	0.6	4.3	1.2	4.7	0.3	1.4	0.6	113.0	36.2
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	1	15	60	2.3	6.8	0.3	15.6	0.8	1.5	0.5	6.5	3.7	4.4	0.4	1.4	0.6	185.7	103.5
1995	2	1	60	2.3	6.8	0.3	15.0	0.9	1.8	0.7	6.0	2.6	4.6	0.2	1.4	0.6	240.2	311.6
1995[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1995	2	15	60	2.3	6.7	0.3	15.2	0.8	1.8	0.9	6.2	2.5	4.6	0.2	1.2	0.3	277.7	197.8
1996	1	1	59	2.3	7.2	0.4	16.9	1.2	0.9	0.2	5.3	0.6	na	na	1.5	0.4	53.7	26.5
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	1	15	59	2.3	6.9	0.4	16.7	1.1	1.3	0.3	7.7	1.5	4.5	0.1	1.5	0.4	232.7	50.8
1996	2	1	60	2.3	7.0	0.2	16.5	0.7	1.0	0.4	9.3	4.7	4.5	0.1	1.4	0.3	93.5	21.1
1996[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
1996	2	14	59	2.3	6.9	0.2	16.5	1.2	1.3	0.3	6.7	1.0	4.5	0.1	1.5	0.3	150.7	42.6

[a]SD - standard deviation

[b]na - parameters were not analyzed at the 2 meter depth.

Appendix O.4. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Akalura Lake, 1990-1991, 1993-1996.

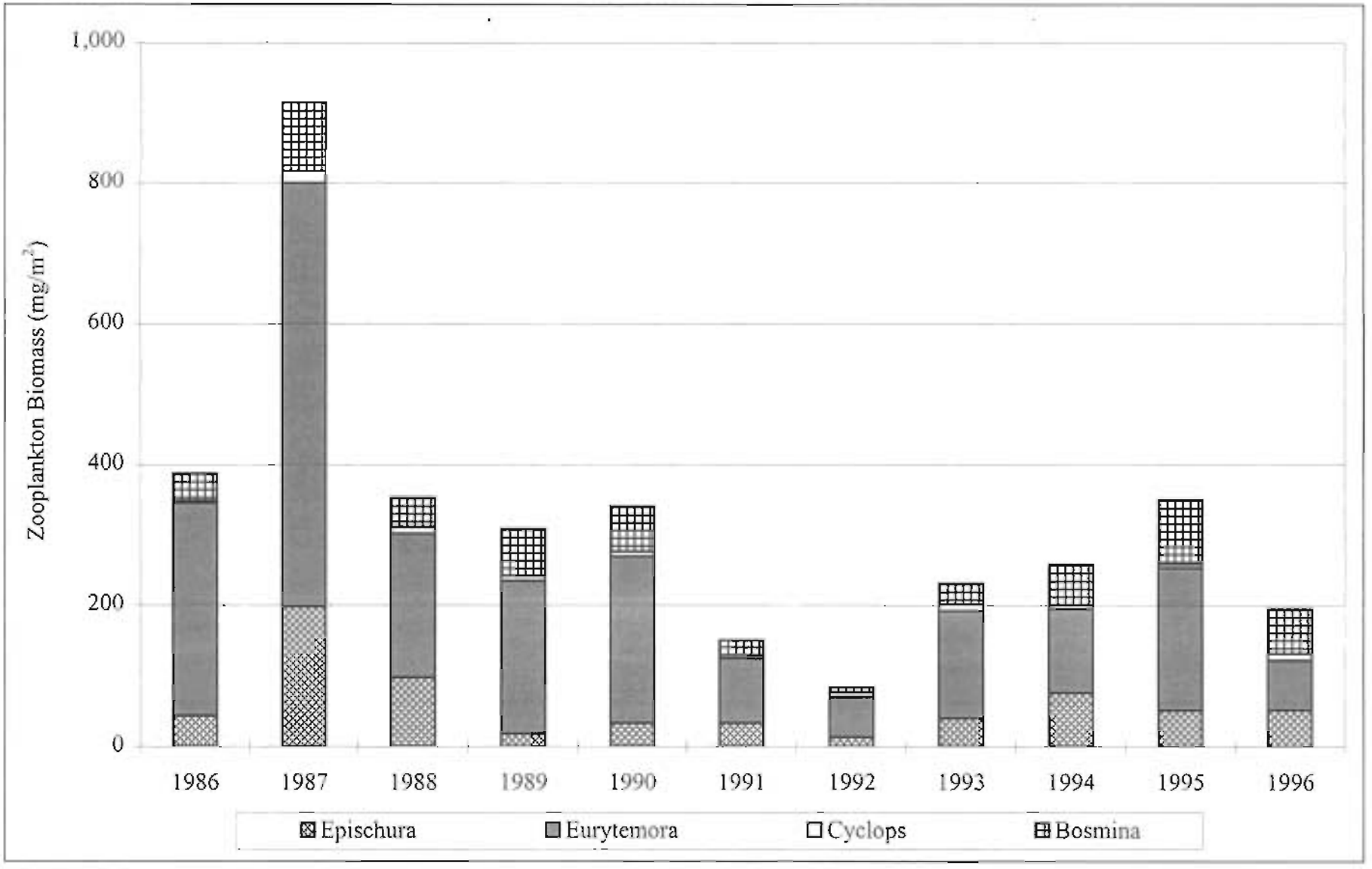
		Depth	Total-P		Total filterable-P		Filterable reactive-P		Total Kjel--dahl nitrogen		Ammonia		Nitrate + nitrite		Reactive silicon		Organic Carbon		Chlorophyll *a*		Phaeophytin *a*	
Year	Station	(m)	(ug L^{-1})	SD[a]	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	11.4	3.2	3.2	1.5	1.5	0.4	173.7	28.9	15.6	21.4	29.7	26.8	441	244.7	469	43.9	3.93	1.8	1.40	0.5
1990	1	16	15.0	3.9	4.5	1.1	2.1	0.9	278.7	106.1	86.8	109.4	35.3	15.5	576	433.6	647	289.5	3.01	2.4	1.50	0.5
1990	2	1	11.3	2.2	3.6	2.3	1.4	1.1	159.1	19.7	15.9	20.1	21.3	19.6	316	198.0	401	83.7	4.32	1.7	1.41	0.5
1990	2	15	13.7	3.3	3.6	2.8	1.6	0.6	261.6	93.0	101.1	96.4	29.3	4.1	535	291.5	456	167.9	3.56	3.8	1.38	0.4
1991	1	1	11.8	1.6	3.9	0.7	1.5	0.7	160.8	23.2	11.5	12.2	19.8	26.8	285	252.3	na	na	5.07	5.1	1.32	1.5
1991	1	16	13.2	3.1	4.3	1.2	1.9	1.2	166.1	32.4	38.5	27.3	36.6	29.0	427	311.3	na	na	4.35	3.3	1.50	0.8
1991	2	1	11.9	3.1	5.7	6.8	3.2	3.7	157.9	16.7	12.6	12.4	18.6	26.5	284	244.4	na	na	3.61	2.2	1.54	0.9
1991	2	15	13.7	4.5	4.5	1.3	2.0	1.3	165.5	38.6	26.9	37.4	36.0	30.0	426	351.3	na	na	4.19	3.3	1.26	0.4
1993	1	1	14.1	3.0	7.1	4.0	4.8	4.3	195.0	16.2	9.9	14.0	8.6	13.1	656	400.9	365	80.3	5.18	2.5	0.80	0.5
1993	1	16	20.0	7.6	5.9	2.2	3.2	1.3	235.2	56.7	51.3	46.9	16.7	17.2	880	581.6	367	107.9	4.41	4.1	1.13	0.5
1993	2	1	14.1	3.5	6.2	3.4	3.3	2.1	196.7	20.7	9.0	13.9	8.1	12.0	615	429.4	377	87.9	4.67	1.9	1.10	0.7
1993	2	13	17.7	6.3	5.0	1.8	2.7	1.4	214.2	49.3	42.2	41.0	17.4	16.9	984	525.3	336	134.5	4.07	3.4	0.92	0.6
1994	1	1	15.5	6.9	3.9	1.9	2.9	1.4	294.0	123.3	25.8	43.7	14.8	21.6	911	360.2	601	426.4	6.18	5.8	0.61	0.4
1994[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	5.72	4.7	0.57	0.4
1994	1	16	24.2	15.4	6.5	4.4	4.2	2.8	285.8	109.9	95.1	69.9	37.2	27.4	1234	381.5	390	157.3	2.74	2.7	0.95	0.4
1994	2	1	12.5	3.5	6.0	4.7	4.0	2.9	245.4	92.5	21.3	38.5	17.6	18.3	875	332.5	546	306.1	5.78	4.8	0.51	0.3
1994[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	5.54	4.1	0.58	0.4
1994	2	14	16.1	4.2	4.7	1.8	3.5	1.2	238.5	38.6	55.4	34.2	42.7	49.0	1085	373.8	335	148.0	3.09	2.1	0.88	0.5
1995	1	1	11.9	3.2	4.1	0.6	1.4	0.5	165.4	16.4	13.4	8.9	38.6	35.3	525	334.3	312	111.7	5.15	3.1	1.41	0.7
1995[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	5.56	3.8	1.71	0.9
1995	1	15	13.5	5.8	4.7	1.5	2.2	1.2	176.0	26.9	37.4	44.7	37.8	31.5	653	403.9	281	105.1	4.74	3.6	1.76	0.7
1995	2	1	12.6	4.7	4.2	0.6	1.7	0.6	201.2	69.2	51.2	71.1	28.7	28.5	621	341.2	344	94.3	4.75	3.2	1.57	0.7
1995[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	5.42	3.6	1.59	0.8
1995	2	15	11.4	2.8	4.5	1.2	2.1	0.7	180.2	28.6	59.2	31.5	35.5	30.2	688	334.9	274	94.7	4.62	3.4	1.46	0.4
1996	1	1	11.0	0.9	3.6	1.7	1.4	0.9	163.3	23.9	8.8	3.6	4.1	0.0	160	105.0	303	27.6	1.01	0.4	0.36	0.2
1996[b]	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.73	0.2	0.30	0.1
1996	1	15	14.6	7.2	3.6	1.6	1.4	1.7	197.4	65.5	53.4	50.6	2.8	2.3	408	310.3	279	64.2	0.98	0.3	0.54	0.1
1996	2	1	10.0	3.6	6.0	3.5	2.9	2.7	167.9	23.5	19.3	8.8	4.1	0.6	305	241.9	281	64.6	0.82	1.1	0.32	0.1
1996[b]	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	1.37	1.1	0.35	0.2
1996	2	14	11.7	2.2	2.8	0.7	0.3	0.3	171.2	24.7	25.2	13.9	4.1	0.6	298	265.8	288	130.3	1.62	1.0	0.57	0.2

[a] SD - standard deviation

[b] na - parameters were not analyzed.

Appendix O.5. Weighted mean zooplankton density, biomass, and size by genera (stations 1, 2, & 3 averaged) for Akalura Lake, 1986-1996.

Station	No. of	*Epischura*			*Eurytemora*			*Cyclops*			*Bosmina*			*Chydorinae*			TOTALS	
1, 2, 3	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1986	2	7,528	43	1.11	73,470	302	0.84	2,505	3	0.60	48,424	39	0.30	0	0	0.00	131,927	387
1987	5	41,242	198	0.99	108,386	601	0.97	16,242	18	0.57	122,452	98	0.30	743	1	0.00	289,065	916
1988	3	25,035	97	0.95	45,471	204	0.85	7,741	10	0.63	59,934	42	0.28	0	0	0.00	138,181	353
1989	4	10,152	18	0.71	49,662	216	0.84	6,403	7	0.56	80,912	67	0.30	266	0	0.00	147,395	308
1990	6	4,282	33	1.21	51,522	235	0.87	6,847	8	0.59	79,977	65	0.30	792	1	0.26	143,419	341
1991	6	6,675	33	1.03	18,728	91	0.60	3,776	4	0.39	27,757	21	0.20	354	0.2	0.13	57,290	150
1992	6	4,472	13	0.92	10,642	57	0.94	4,370	7	0.67	8,338	7	0.31	314	1	0.36	28,136	84
1993	5	11,720	40	0.90	33,737	152	0.86	8,658	10	0.59	38,265	30	0.30	1,451	1	0.25	93,829	232
1994	5	16,723	75	1.00	23,298	119	0.92	6,702	6	0.53	76,037	57	0.29	0	0	0.00	122,760	257
1995	6	15,010	51	0.91	45,023	201	0.85	4,895	5	0.61	124,546	92	0.29	514	0	0.25	189,988	350
1996	3	15,444	52	0.93	13,483	70	0.95	7,774	10	0.61	82,523	64	0.29	743	0.6	0.29	119,967	195
Avg =	5	14,389	59	0.97	43,038	204	0.86	6,901	8	0.58	68,106	53	0.29	471	0.3	0.11	132,905	325



Appendix O.6. Weighted mean zooplankton biomass by genera (stations 1, 2, & 3 averaged) for Akalura Lake, 1986-1996.

Appendix O.7. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic total fish population estimates for Akalura Lake, 1990-1991 and 1995.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		Composition
Date	Number	Low	High	Number	Low	High	(%)
29-Sep-90	3,950,101	3,155,384	4,744,818	209,355	167,287	251,424	5.3
5-Oct-91	3,171,881	2,631,498	3,712,264	41,234	39,013	43,456	1.3
14-Oct-95	3,637,001	2,834,510	4,439,492	461,899	359,267	564,531	12.7

Appendix O.8. Townet catches from Akalura Lake, 1990, 1991, and 1995.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Year	No.	Min.	No.	%	CPUE	No.	%	CPUE
29-Sep-90	3	70	237	5.3	3.4	4,252	94.7	60.7
11-May-91	3	72	54	12.2	0.8	387	87.8	5.4
5-Oct-91	3	70	147	1.3	2.1	10,765	98.7	153.8
14-Oct-95	4	40	87	12.7	2.2	590	87.3	14.8

Appendix O.9. Mean age, length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Akalura Lake, 1991 and 1995.

	Age-0					Age-1					Age-2				
Year[a]	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
11-May-91	3	6.8	29.0	0.2	0.79	24	54.5	50.0	1.0	0.78	17	38.6	68	2.4	0.74
5-Oct-91	54	36.7	52.0	1.4	0.95	93	63.3	74.0	3.8	0.93	0	0	-	-	-
14-Oct-95	43	49.5	61.0	2.7	1.14	44	50.5	82.0	6.0	1.10	0	0	-	-	-

[a] Preserved sockeye salmon captured 29 September 1990 spoiled prior to sampling for AWL.

Appendix O.10. Age compositions and population estimates of sockeye salmon smolt out-migrating from Akalura Lake, 1990-1997.

Year		Age 0	1	2	3	4	Population Estimate	95% Confidence Interval Low	High
1990	Percent	0.0	14.0	86.0	0.0	0.0			
	Number	0	66,460	408,330	0	0	474,790	318,734	630,846
1991	Percent	0.0	2.9	96.7	0.4	0.0			
	Number	0	9,085	299,591	1,251	0	309,928	237,981	381,875
1992	Percent	0.0	0.9	94.7	4.3	0.0			
	Number	0	1,921	182,963	8,315	0	193,199	153,765	232,638
1993	Percent	0.0	3.7	82.3	13.9	0.1			
	Number	0	3,259	73,062	12,315	238	88,874	35,943	141,802
1994	Percent	0.0	42.6	53.2	4.2	0.0			
	Number	0	72,474	90,467	7,141	0	170,172[a]	130,910	209,433
1995	Percent	0.0	47.2	52.6	0.2	0.0			
	Number	0	63,356	70,496	265	0	134,117	125,523	142,712
1996	Percent	0.0	6.4	93.1	0.6	0.0			
	Number	0	15,639	228,776	1,416	0	245,821	[a]	
1997	Percent	0.1	7.7	92.2	0.0	0.0			
	Number	196	14,874	178,680	0	0	193,750	[a]	

[a] 1996 and 1997 outmigrations were enumerated via a counting weir. Estimates, thus, are assumed total counts.

1990-1995 data obtained from Swanton et al. 1996. Sockeye Smolt Population Estimates, Outmigration Timing, and Size At Age Characteristics for Red, Akalura, and Frazer Lakes, 1995. RIR No. 4K96-16, Kodiak.

1996-1997 data obtained from Coggins and Sagalkin. 1999. Akalura Lake Sockeye Smolt Restoration. RIR 4K99-64. Kodiak.

Appendix O.11. Akalura Lake sockeye salmon smolt emigration by age class, 1990-1997.

Year	Statistical Week	Dates	Age Class 0	1	2	3	4
1990	18	4/26-5/02	0	0	0	0	0
	19	5/03-5/09	0	0	0	0	0
	20	5/13-5/16	0	1,951	230,326	0	0
	21	5/17-5/23	0	1,822	137,769	0	0
	22	5/24-5/30	0	9,473	18,837	0	0
	23	5/31-6/06	0	38,072	19,431	0	0
	24	6/07-6/13	0	7,540	3,258	0	0
	25	6/14-6/20	0	8,877	1,230	0	0
	26	6/21-6/27	0	2,253	0	0	0
	27	6/28-7/04	0	0	0	0	0
	Total		0	69,988	410,851	0	0
1992	18	5/01-5/02	0	0	49	0	0
	19	5/03-5/09	0	0	48,780	3,157	0
	20	5/10-5/16	0	1,378	93,065	4,512	0
	21	5/17-5/23	0	313	9,865	303	0
	22	5/24-5/30	0	74	16,786	239	0
	23	5/31-6/06	0	74	12,175	103	0
	24	6/07-6/13	0	49	2,387	0	0
	25	6/14-6/20	0	34	170	0	0
	26	6/21-6/27	0	0	21	0	0
	27	36,339	0	0	7	0	0
	Total		0	1,922	183,305	8,314	0
1994	18	4/26-5/02	0	0	0	0	0
	19	5/03-5/09	0	7	583	292	0
	20	5/10-5/16	0	13	567	278	0
	21	5/17-5/23	0	13	457	137	0
	22	5/24-5/30	0	221	14,377	2,436	0
	23	5/31-6/06	0	12,529	57,339	3,832	0
	24	6/07-6/13	0	39,051	16,253	166	0
	25	6/14-6/20	90	14,065	776	0	0
	26	6/21-6/27	0	6,573	114	0	0
	27	6/28-7/04	0	0	0	0	0
	Total		90	72,472	90,466	7,141	0
1996	18	4/26-5/02	0	0	5	0	0
	19	5/03-5/09	0	895	43,356	128	0
	20	5/10-5/16	0	4,294	114,231	1,288	0
	21	5/17-5/23	0	624	20,657	0	0
	22	5/24-5/30	0	3,468	34,214	0	0
	23	5/31-6/06	0	2,842	15,810	0	0
	24	6/07-6/13	0	3,017	487	0	0
	25	6/14-6/20	0	498	6	0	0
	26	6/21-6/27	0	0	0	0	0
	27	6/28-7/04	0	0	0	0	0
	Total		0	15,638	228,766	1,416	0

Year	Statistical Week	Dates	Age Class 0	1	2	3	4
1991	18	4/26-5/02	0	0	0	0	0
	19	5/08-5/09	0	491	9,281	0	0
	20	5/10-5/16	0	7,461	205,521	0	0
	21	5/17-5/23	0	509	64,210	663	0
	22	5/24-5/30	0	22	794	11	0
	23	5/31-6/06	0	12	1,399	65	0
	24	6/07-6/13	0	415	13,170	400	0
	25	6/14-6/20	0	64	1,254	0	0
	26	6/21-6/27	0	74	3,640	98	0
	27	6/28-7/01	0	39	324	13	0
	Total		0	9,087	299,593	1,250	0
1993	18	4/26-5/02	0	0	0	0	0
	19	5/03-5/09	0	0	2,516	968	0
	20	5/10-5/16	0	0	3,848	2,633	0
	21	5/17-5/23	0	2,384	20,387	6,796	238
	22	5/24-5/30	0	143	31,988	1,865	0
	23	5/31-6/06	0	301	11,601	43	0
	24	6/07-6/13	0	283	2,287	10	0
	25	6/14-6/20	0	148	435	0	0
	26	6/21-6/27	0	0	0	0	0
	27	6/28-7/01	0	0	0	0	0
	Total		0	3,259	73,062	12,315	238
1995	18	4/26-5/02	0	0	0	0	0
	19	5/03-5/09	0	100	4,577	66	0
	20	5/10-5/16	0	795	19,820	199	0
	21	5/17-5/23	0	1,078	10,280	0	0
	22	5/24-5/30	0	2,426	12,524	0	0
	23	5/31-6/06	0	6,607	17,110	0	0
	24	6/07-6/13	0	38,896	6,184	0	0
	25	6/14-6/20	0	12,499	0	0	0
	26	6/21-6/27	0	957	0	0	0
	27	6/28-7/04	0	0	0	0	0
	Total		0	63,358	70,495	265	0
1997	18	4/26-5/02	0	0	21	0	0
	19	5/03-5/09	0	238	53,536		0
	20	5/10-5/16	0	1,681	71,003		0
	21	5/17-5/23	0	656	26,352	0	0
	22	5/24-5/30	0	7,648	26,572	0	0
	23	5/31-6/06	151	2,918	981	0	0
	24	6/07-6/13	32	1,223	202	0	0
	25	6/14-6/20	11	434	11	0	0
	26	6/21-6/27	2	76	2	0	0
	27	6/28-7/04	0	0	0	0	0
	Total		196	14,874	178,680	0	0

Appendix O.12. Summary of mean length, weight, and condition coefficient by age class of Akalura Lake sockeye salmon smolt samples, 1969-1977 and 1990-1997.

	Age-0					Age-1					Age-2					Age-3					Age-4				
			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition			Length	Weight	Condition
Year	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)	n	%	(mm)	(g)	(K)
1969	-	-	-	-	-	575	100.0	80.0	4.2	0.82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	78	8.5	94.0	7.6	0.92	845	91.5	99.0	8.4	0.87	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	541	86.8	77.0	3.8	0.83	82	13.2	96.0	7.3	0.83	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	835	97.1	83.0	4.8	0.84	25	2.9	95.0	7.2	0.84	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	485	51.0	90.0	6.7	0.92	466	49.0	98.0	8.6	0.91	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	53	5.6	88.0	6.2	0.91	890	94.4	96.0	8.2	0.93	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	106	14.8	78.0	3.9	0.82	611	85.2	92.0	6.4	0.82	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	10	3.3	81.0	5.2	0.98	297	96.7	92.0	7.7	0.99	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	2	0.4	75.0	4.2	1.00	462	99.6	94.0	7.3	0.88	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	577	43.5	73.9	3.6	0.89	748	56.5	85.9	5.3	0.84	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	41	2.8	77.2	4.3	0.93	1382	95.6	77.5	4	0.86	22	1.5	97.3	8.9	0.97	-	-	-	-	-
1992	1	0.0	59.0	1.5	0.73	25	1.2	75.7	3.7	0.85	2014	95.9	78.8	3.9	0.80	61	2.9	86.4	4.9	0.76	-	-	-	-	-
1993	-	-	-	-	-	74	6.4	61.8	2.2	0.93	992	85.4	85.8	5.7	0.90	94	8.1	90.8	6.8	0.91	2	0.2	101.5	10.1	0.97
1994	2	0.1	73.0	3.4	0.87	721	44.2	87.5	6.1	0.91	763	46.8	93.1	7.3	0.90	146	8.9	95.8	7.7	0.88	-	-	-	-	-
1995	-	-	-	-	-	644	34.5	81.7	4.8	0.88	1216	65.2	92.1	6.6	0.84	6	0.3	99	7.6	0.78	-	-	-	-	-
1996	-	-	-	-	-	400	21.6	82.6	4.8	0.85	1451	78.2	91.0	6.2	0.82	4	0.2	97.5	7.5	0.81	-	-	-	-	-
1997	10	0.7	58.0	1.7	0.87	361	24.6	81.9	4.7	0.86	1094	74.7	91.9	6.3	0.81	-	-	-	-	-	-	-	-	-	-

Appendix O.13. Akalura Lake sockeye salmon escapement counts, 1989-1997.

					------YEAR------				
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997
5/27				7					
5/28				0					
5/29				3					
5/30				3					17
5/31				3					98
6/1		5		26				30	20
6/2	2	21		0				97	77
6/3	0	0	6	9				137	97
6/4	0	0	4	1	193			47	49
6/5	0	21	161	223	107		2	0	0
6/6	0	301	0	3	1		0	253	460
6/7	0	33	0	3	309		0	0	0
6/8	0	328	111	19	19	9	0	0	426
6/9	0	1	145	5	398	8	16	3	0
6/10	0	154	6	142	259	13	12	0	135
6/11	0	82	282	461	108	34	20	275	0
6/12	0	0	37	6	28	0	101	1	0
6/13	0	246	34	186	31	8	65	0	253
6/14	0	1	181	110	4	0	33	77	0
6/15	0	86	17	294	76	48	31	5	189
6/16	0	49	0	0	16	65	79	7	0
6/17	0	249	0	5	19	28	32	17	356
6/18	0	0	21	259	27	41	15	0	141
6/19	0	111	27	20	63	28	7	0	46
6/20	0	224	130	310	0	12	0	153	0
6/21	0	131	98	0	13	28	37	0	59
6/22	0	164	2	10	13	2	64	5	13
6/23	0	129	170	6	0	4	0	5	0
6/24	0	211	183	19	0	1	0	0	0
6/25	0	148	28	30	15	0	94	0	0
6/26	0	66	24	104	0	6	52	82	7
6/27	0	87	26	38	25	8	16	11	6
6/28	0	35	132	0	4	23	0	200	1
6/29	0	58	136	12	0	0	0	0	6
6/30	0	46	82	0	0	0	0	0	0
7/1	0	53	220	2	25	0	0	0	0
7/2	0	50	89	45	36	0	0	0	64

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	----YEAR------								
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997
7/3	0	2	39	10	0	0	0	0	0
7/4	0	1	75	12	1	0	0	0	0
7/5	0	7	9	0	0	0	0	0	0
7/6	0	160	0	0	2	0	0	0	0
7/7	0	0	0	11	3	0	0	0	0
7/8	0	0	13	16	8	0	0	0	0
7/9	0	0	75	2	0	0	0	0	0
7/10	0	1	3	4	0	0	0	0	0
7/11	0	23	1	2	2	0	0	0	0
7/12	0	0	0	1	1	0	0	0	0
7/13	0	0	23	10	0	0	0	0	0
7/14	0	0	0	0	1	0	0	0	0
7/15	0	1	1	1	0	0	0	0	0
7/16	0	0	0	0	0	0	0	0	0
7/17	0	35	0	0	0	0	0	0	0
7/18	0	18	0	0	0	0	0	0	0
7/19	0	0	0	21	0	0	0	0	0
7/20	0	0	0	20	0	0	0	0	0
7/21	0	0	0	10	0	0	0	0	0
7/22	0	108	0	40	0	0	0	0	0
7/23	0	2	0	10	0	0	0	0	0
7/24	0	0	0	11	0	0	0	0	0
7/25	0	0	0	8	0	0	0	0	0
7/26	0	0	0	5	0	0	0	0	0
7/27	0	0	0	13	0	0	0	0	0
7/28	0	1	0	196	0	0	0	0	0
7/29	1,753	2,482	0	30	1	0	0	0	0
7/30	913	13	1	11	0	0	0	0	0
7/31	1,241	347	0	16	1	0	0	0	0
8/1	2,257	840	200	16	0	0	0	0	0
8/2	348	1	0	0	1	0	1	0	0
8/3	2,108	3	0	75	0	47	0	0	14
8/4	159	0	0	56	1	80	1	0	0
8/5	343	20	0	61	35	171	1	0	0
8/6	6	0	1,234	114	1	208	0	0	0
8/7	169	0	0	873	0	105	0	0	0
8/8	0	8	23	2	25	3	0	0	0
8/9	2,447	0	315	2,568	6	0	5	0	0

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	-------YEAR-------								
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997
8/10	4,248	7	45	57	24	138	75	16	0
8/11	3,656	32	3,564	77	284	4	0	0	282
8/12	4,145	0	814	9,625	16	31	37	0	0
8/13	541	316	5,800	4,431	15	14	0	0	439
8/14	5,012	124	118	87	3,562	87	0	0	0
8/15	3,626	78	80	2,469	19	168	11	0	3
8/16	4,645	11,050	61	785	0	1,401	20	1	4
8/17	359	329	1,485	15,661	17	3,865	2	0	0
8/18	6,729	480	380	385	173	266	4	0	139
8/19	76	1,802	410	52	3,451	74	3	10	16
8/20	6,711	80	30	9,390	3,312	20	3	190	121
8/21	4,094	333	0	13	294	0	15	62	208
8/22	2,530	194	4,184	490	2,018	143	3	57	580
8/23	1,050	127	1,520	10,885	3,479	114	13	623	1,004
8/24	1,441	169	4,669	172	86	460	16	17	1,076
8/25	16,186	1,225	149	24	141	1,123	2	4	280
8/26	102	3,788	1,651	0	1,741	1,037	0	156	204
8/27	468	5,612	230	0	405	55	1	13	168
8/28	1,957	102	203	1,062	682	64	2	2	159
8/29	3,376	519	495	151	3,387	86	3	15	28
8/30	4,889	69	2,612	35	2,301	57	37	4	118
8/31	1,558	2,193	82	149	626	99	32	35	904
9/1	10,866	137	177	41	425	27	56	19	33
9/2	2,719	928	2,246	67	854	104	36	5	22
9/3	391	3,711	1,235	83	109	131	13	4	33
9/4	3,732	336	712	240	682	2,057	6	10	4
9/5	1,840	124	451	167	236	449	14	5	34
9/6	1,386	110	317	7	300	127	32	794	23
9/7	1,500	54	410	60	100	500	8	3,237	2,552
9/8	1,000	2,872	1,426	42	50	0	209	190	4,040
9/9	750	2,110	1,728	0	25	0	20	14	505
9/10	0	9	510	0	0	0	303	1,010	85
9/11	0	376	137	0	0	0	350	0	42
9/12	0	385	124	0	0	0	0	0	2,500
9/13	0	73	281	0	0	0	0	0	0
9/14	0	100	1,067	0	0	0	0	0	0
9/15	0	0	172	0	0	0	0	0	0
9/16	2,500	0	250	0	0	0	0	0	0

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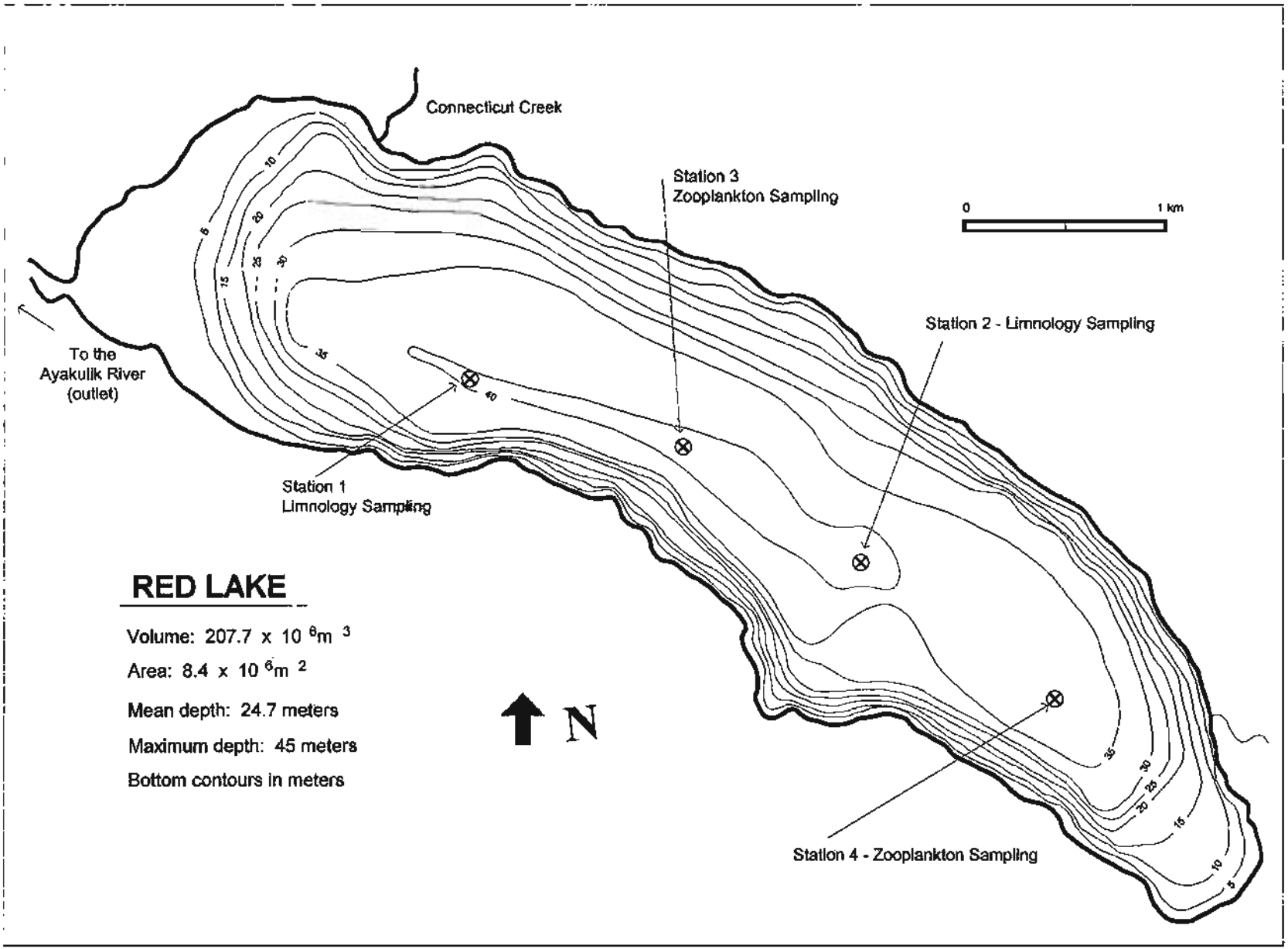
					——YEAR——				
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997
9/17	0	0	0	0	0	0	0	0	0
9/18	0	13	0	0	0	0	0	0	0
9/19	0	33	0	0	0	0	0	0	0
9/20	0	18	0	0	0	0	0	0	0
9/21	0	0	0	0	0	0	0	0	0
9/22	0	0	0	0	0	0	0	0	0
9/23	200	0	0	0	0	0	0	0	0
Total:	116,029	47,181	44,189	63,296	30,692	13,681	2,010	7,898	18,140

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Coun Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commerci Fisheries, RIR 4K99-54. Kodiak.



Appendix P.1. Morphometric map showing the limnology and zooplankton stations on Red Lake.

Appendix P.2. Limnological sampling stations and frequencies for Red Lake, 1990-1996.

Year	Sampling	
	Stations	Frequency
1990	1,2	5
1991	1,2	6
1992	1,2	6
1993	1,2	6
1994	1-4	6
1995	1-4	6
1996	1-4	4

Appendix P.3. Summary of seasonal mean water chemistry parameters by station and depth for Red Lake, 1990-1996.

		Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(umhos cm^{-1})	SD	(Units)	SD	(mg L^{-1})	SD	(NTU)	SD	(Pt units)	SD	(mg L^{-1})	SD	(mg L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	56.0	9.1	7.2	0.3	14.7	2.8	0.7	0.6	7.6	5.9	7.9	5.8	3.7	5.3	18.7	7.2
	1	32	60.4	7.3	7.0	0.4	15.9	0.9	0.7	0.4	4.0	1.4	8.1	7.2	1.6	0.6	60.6	64.1
	2	1	54.2	15.3	7.3	0.2	16.3	1.1	0.6	0.4	3.8	1.8	6.8	4.2	1.6	0.6	36.3	24.1
	2	34	60.8	1.1	7.0	0.1	15.9	1.2	1.3	1.6	4.8	2.3	7.9	5.4	1.5	0.5	75.0	72.6
1991	1	1	60.7	0.8	7.2	0.1	15.3	2.6	1.0	0.5	5.2	2.2	5.2	0.6	1.3	0.3	45.8	38.1
	1	32	61.3	1.0	7.1	0.1	15.5	2.3	1.4	0.9	7.0	1.5	5.2	0.6	1.2	0.4	95.0	80.9
	2	1	61.0	0.6	7.1	0.1	15.4	1.8	1.0	0.5	4.8	1.6	5.3	0.5	1.0	0.3	47.0	17.2
	2	32	61.0	0.6	7.0	0.1	15.6	2.3	1.1	0.3	7.2	4.1	5.4	0.5	1.1	0.4	75.3	35.8
1992	1	1	60.0	0.6	7.0	0.1	15.0	0.3	0.7	0.4	4.2	0.8	5.2	0.7	1.3	0.6	22.0	5.7
	1	35	60.0	1.8	6.8	0.3	14.8	0.4	0.8	0.4	3.8	0.8	5.2	0.8	1.5	0.6	68.8	79.3
	2	1	58.8	1.8	7.0	0.1	14.9	0.2	0.9	0.7	4.2	0.8	5.3	0.8	1.7	0.5	18.0	5.7
	2	34	60.0	2.5	6.8	0.3	14.9	0.5	0.7	0.3	5.0	3.1	4.9	1.0	1.7	0.7	117.8	149.9
1993	1	1	63.2	3.6	7.0	0.7	15.9	2.0	1.4	0.7	5.5	3.2	5.8	1.6	1.4	0.3	114.2	211.8
	1	38	65.3	5.3	6.9	0.9	16.3	2.4	1.7	1.0	6.2	3.9	6.3	3.3	1.4	0.3	259.0	331.0
	2	1	64.3	7.3	6.9	0.1	15.4	0.4	0.9	0.4	6.8	4.8	5.0	0.5	1.4	0.3	43.5	33.2
	2	38	67.2	8.0	6.6	0.2	17.0	3.9	2.3	0.9	4.8	1.8	5.8	1.6	1.2	0.3	474.2	405.7
1994	1	1	62.2	2.1	6.9	0.3	15.0	1.5	0.8	0.3	5.0	3.6	5.3	0.5	1.1	0.3	37.8	22.9
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	38	63.0	1.7	6.6	0.4	15.7	0.8	1.7	0.6	5.3	2.1	5.1	0.4	1.6	0.6	388.3	336.7
	2	1	62.3	0.8	6.8	0.3	15.8	0.8	1.0	0.6	3.8	1.2	5.3	0.5	1.2	0.3	43.5	22.0
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	37	66.5	5.0	6.7	0.5	16.8	2.2	2.0	0.7	3.7	1.4	5.3	0.5	1.4	0.6	481.3	477.6
1995	1	1	59.2	9.7	7.0	0.2	16.8	1.6	0.8	0.3	3.6	1.3	5.3	1.5	1.3	0.2	35.5	10.9
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	37	64.0	3.4	6.5	0.4	16.3	2.1	1.7	0.6	4.8	3.6	4.9	0.6	1.6	0.5	397.2	314.0
	2	1	61.2	0.8	7.0	0.1	16.0	0.3	0.9	0.4	6.0	4.6	4.9	0.5	1.4	0.6	31.8	22.9
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	37	62.6	0.5	6.5	0.3	15.8	0.8	1.9	0.9	4.8	2.4	4.9	0.3	1.8	0.6	540.6	493.1
1996	1	1	60.3	4.7	7.1	0.5	17.0	0.9	0.6	0.1	4.7	1.5	4.5	0.1	1.6	1.3	22.0	11.8
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	1	37	61.0	3.6	6.9	0.6	16.9	0.6	0.8	0.2	4.5	2.1	4.5	0.1	1.1	0.3	107.3	109.3
	2	1	48.0	21.9	7.2	0.6	13.2	5.5	0.9	0.5	5.0	2.6	3.9	1.0	0.9	0.6	23.3	23.4
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	2	34	61.3	4.0	6.8	0.6	16.2	0.6	1.1	0.3	5.0	1.0	4.5	0.1	1.1	0.3	157.7	139.0

SD - standard deviation; na - not analyzed

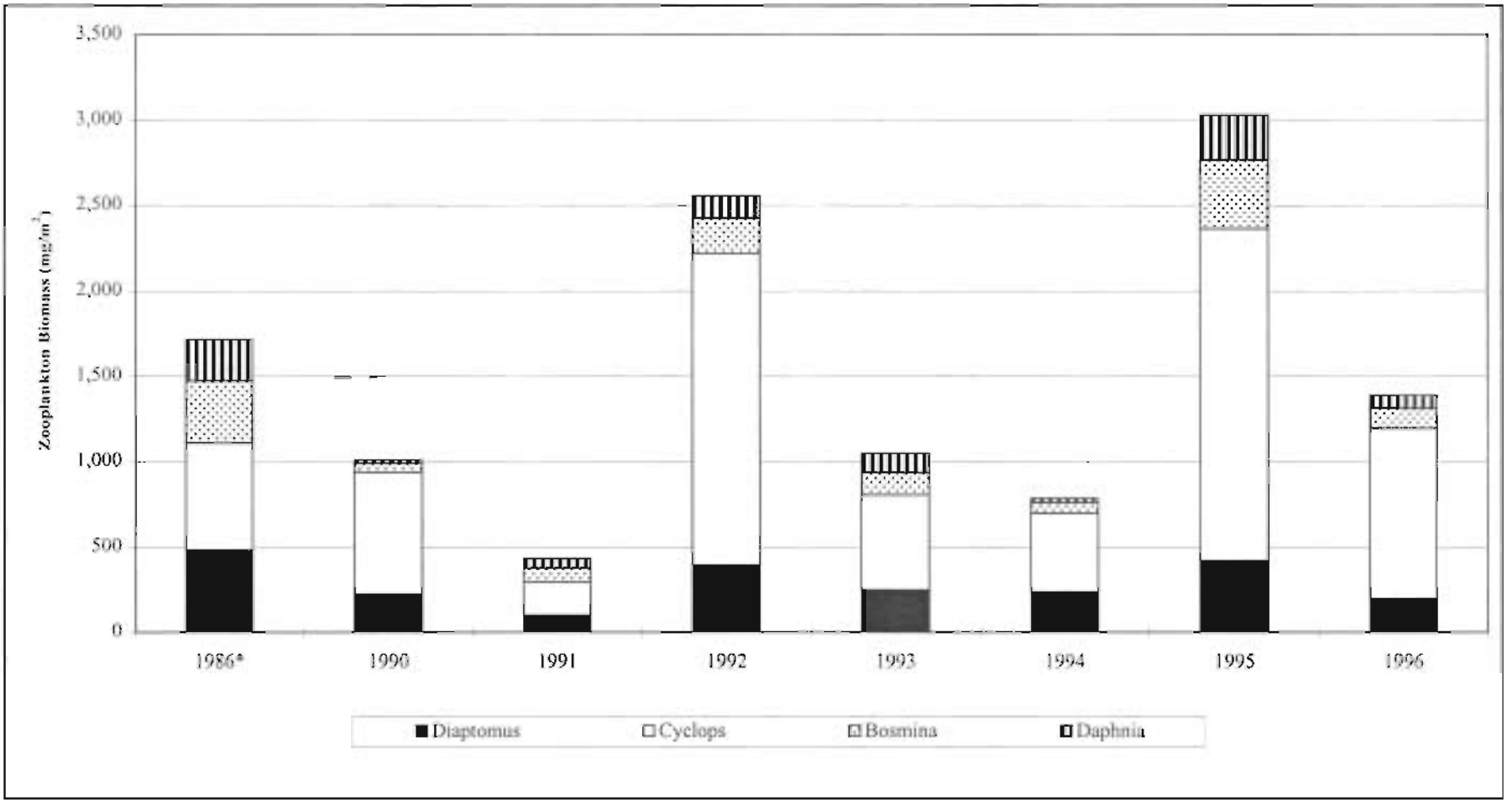
Appendix P.4. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Red Lake, 1990-1996.

Year	Station	Depth (m)	Total-P (ug L^{-1})	SD	Total filterable-P (ug L^{-1})	SD	Filterable reactive-P (ug L^{-1})	SD	Total Kjeldahl nitrogen (ug L^{-1})	SD	Ammonia (ug L^{-1})	SD	Nitrate+nitrite (ug L^{-1})	SD	Reactive silicon (ug L^{-1})	SD	Organic carbon (ug L^{-1})	SD	Chlorophyll *a* (ug L^{-1})	SD	Phaeophytin *a* (ug L^{-1})	SD
1990	1	1	10.1	4.2	6.0	2.9	3.3	3.7	129.8	28.4	4.0	0.7	50.9	18.2	227.3	146.8	265.4	117.3	1.77	1.0	2.59	4.2
	1	32	16.6	2.6	7.7	5.9	3.5	5.2	148.8	49.6	25.5	25.1	102.4	70.8	314.3	342.4	213.2	130.3	1.76	1.6	1.07	0.4
	2	1	10.6	4.3	4.0	0.7	0.8	0.1	132.8	26.9	4.2	1.9	55.2	12.2	167.0	147.9	243.6	92.8	2.74	1.6	1.18	0.7
	2	34	26.1	15.9	6.6	3.1	1.6	1.0	180.7	72.1	29.1	30.1	82.4	53.5	323.8	242.1	247.2	171.8	2.06	2.5	1.81	2.0
1991	1	1	13.8	11.4	8.0	7.6	4.7	8.2	112.7	28.5	13.3	5.1	21.0	27.1	122.8	141.7	169.8	96.3	2.06	1.3	1.18	1.0
	1	32	32.2	25.6	13.7	11.0	10.4	11.1	152.6	55.7	22.2	14.0	50.5	62.6	196.6	210.2	253.2	177.5	3.70	3.1	3.17	5.8
	2	1	12.8	3.7	7.5	7.2	4.3	7.2	116.5	6.2	11.3	3.7	25.8	29.6	96.2	113.6	223.5	110.2	2.57	1.0	0.97	0.7
	2	32	18.2	12.1	11.1	8.2	8.3	7.7	114.1	17.5	20.2	13.2	45.9	45.8	413.4	460.7	203.2	102.3	2.59	1.7	1.40	1.2
1992	1	1	14.1	5.0	6.4	4.3	3.2	4.5	130.9	19.3	7.4	3.0	24.6	16.3	208.6	67.8	1.6	1.0	1.17	0.6	1.17	0.6
	1	35	33.4	26.7	17.1	15.1	14.0	14.9	138.0	29.5	17.0	15.3	80.3	65.7	338.0	225.8	1.0	0.9	1.06	0.5	1.06	0.5
	2	1	15.7	6.3	6.1	4.8	2.9	4.5	134.8	28.7	6.8	2.4	20.0	23.2	214.8	94.9	2.1	1.0	1.22	0.8	1.22	0.8
	2	34	43.1	39.7	23.1	22.8	19.1	21.1	159.6	33.3	31.0	35.0	69.2	73.7	394.6	275.5	1.1	1.2	1.25	0.6	1.25	0.6
1993	1	1	23.5	14.0	12.9	8.7	8.4	7.7	160.9	32.6	21.7	26.4	71.2	81.5	274.2	214.1	282.3	121.1	3.38	1.0	1.51	0.9
	1	38	49.3	45.7	22.9	17.5	19.8	18.8	157.7	43.6	25.9	27.9	84.6	83.0	492.0	451.5	231.8	51.3	1.99	1.5	1.13	0.8
	2	1	15.2	8.6	11.5	7.4	8.2	8.3	136.7	32.9	8.5	5.1	87.5	84.4	229.5	197.4	210.8	66.8	2.48	1.1	1.26	0.7
	2	38	68.7	53.7	25.2	16.7	22.2	16.7	184.2	64.9	41.3	49.1	58.4	51.8	589.5	415.0	325.7	82.7	3.36	3.2	2.46	1.6
1994	1	1	17.8	9.3	8.4	4.7	4.7	4.8	167.3	47.1	6.3	6.0	15.8	18.4	151.0	97.5	279.7	110.3	3.43	2.0	0.53	0.4
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	4.04	3.0	0.58	0.6
	1	38	66.9	44.9	27.9	20.9	24.4	21.2	224.2	98.3	46.9	54.3	64.0	70.4	394.3	329.9	319.0	139.9	2.53	3.0	0.47	0.3
	2	1	15.7	9.6	8.1	5.5	4.3	5.3	157.2	31.8	6.4	6.6	17.0	19.3	142.5	92.8	266.8	58.0	3.94	2.7	0.61	0.5
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	3.66	2.7	0.68	0.3
	2	37	72.4	55.1	24.9	17.4	23.0	18.5	228.5	72.6	53.8	62.4	61.2	70.2	399.0	360.8	364.7	97.5	3.29	3.5	0.76	0.4
1995	1	1	9.3	5.0	5.7	2.2	2.4	2.5	139.6	25.1	2.0	0.8	13.3	14.4	212.6	164.4	249.8	26.5	3.52	1.5	0.89	0.3
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	3.36	1.6	0.91	0.3
	1	37	106.9	106.1	42.4	34.4	37.5	34.0	171.6	69.7	64.6	60.8	110.4	106.2	718.0	574.0	270.0	na	0.95	1.1	1.16	0.2
	2	1	9.7	2.8	5.6	2.6	2.3	2.3	127.8	11.6	3.9	3.0	12.8	17.5	173.2	160.1	245.2	52.9	3.30	1.6	0.86	0.3
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	3.26	1.5	0.90	0.3
	2	37	136.7	134.8	53.2	49.7	48.3	47.8	209.4	90.0	78.0	72.3	105.7	99.6	738.0	580.8	248.0	na	1.04	1.1	1.31	0.4
1996	1	1	13.2	1.2	6.4	0.4	2.0	0.3	159.0	23.4	8.6	7.0	4.1	0.0	128.3	55.8	262.7	42.8	0.71	0.1	0.30	0.1
	1	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.78	0.3	0.27	0.0
	1	37	36.0	21.9	22.5	13.6	20.1	13.4	158.5	24.1	29.6	20.9	72.0	100.2	293.7	300.7	238.7	108.3	0.44	0.3	0.38	0.0
	2	1	14.2	1.3	5.5	1.7	1.8	1.3	162.7	43.0	7.8	3.6	4.1	0.0	80.3	72.6	268.3	88.7	0.70	0.3	0.34	0.2
	2	2	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.86	0.3	0.35	0.1
	2	34	50.4	37.0	16.5	12.8	14.7	13.5	191.5	41.8	33.7	13.3	53.3	85.7	355.7	414.0	344.7	129.5	0.51	0.3	0.43	0.1

SD - standard deviation; na - not analyzed

Appendix P.5. Weighted mean zooplankton density, biomass, and size by genera (stations 1, 2, 3, & 4 averaged) for Red Lake, 1986 and 1990-1996.

Stations	Number	*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Epischura*			TOTALS	
1, 2, 3, 4	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Dates	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)	(mm)	(no/m^2)	(mg/m^2)
1986	1	70,470	483	1.20	151,979	628	1.06	140,941	361	0.54	64,528	244	0.93	-	-	-	427,917	1,715
1990	5	70,674	222	0.91	303,026	715	0.79	55,573	54	0.34	11,519	19	0.63	-	-	-	440,791	1,010
1991	6	23,587	98	1.00	115,139	198	0.83	57,946	80	0.42	40,364	59	0.64	646	1	0.59	237,681	435
1992	6	85,612	393	1.09	516,432	1,828	1.00	113,279	202	0.46	57,281	132	0.79	-	-	-	772,603	2,554
1993	6	74,642	247	0.90	256,878	558	0.78	92,954	129	0.41	68,471	117	0.70	-	-	-	492,945	1,050
1994	6	60,548	235	0.98	218,190	461	0.73	51,818	63	0.41	15,303	25	0.62	-	-	-	345,857	784
1995	6	124,513	421	0.96	609,950	1,941	0.88	239,584	404	0.45	128,517	265	0.68	-	-	-	1,102,564	3,030
1996	4	48,636	197	0.97	289,777	1,001	0.92	61,837	115	0.46	36,986	78	0.69	-	-	-	437,237	1,392
Avg. =	5	69,835	287	1.00	307,671	916	0.87	101,741	176	0.44	52,871	117	0.71	646	1	0.59	532,199	1,496



Appendix P.6. Weighted mean zooplankton biomass by genera (stations 1, 2, 3, & 4 averaged) for Red Lake, 1986 and 1990-1996.

* one sample date only

Appendix P.7. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Red Lake, 1990-1991.

	Total Fish Estimates			Sockeye Estimates			Sockeye Composition
		95% C. I.			95% C. I.		
Date	No.	Low	High	No.	Low	High	(%)
30-Sep-90	7,227,742	6,079,520	8,375,964	101,188	85,188	117,189	1.4
5-Oct-91	9,430,782	10,131,244	12,334,284	631,862	437,083	826,641	6.7

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix P.8. Townet catches from Red Lake, 1990 - 1994.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Year	No.	Min.	No.	%	CPUE	No.	%	CPUE
1-Oct-90	3	90	20	1.4	0.2	1,452	98.6	16.1
12-May-91	3	82	34	2.7	0.4	1,228	97.3	15.0
6-Oct-91	3	90	91	6.7	1.0	1,277	93.3	14.2
23-Sep-92	3	92	62	1.9	0.7	3,190	98.1	34.7
24-Sep-92	3	120	149	nd	1.2	nd	nd	nd
26-Sep-93	3	62	41	8.8	0.7	425	91.2	6.9
27-Sep-93								
23-Oct-94	3	60	86	4.3	1.4	1,909	95.7	31.8

nd - no data

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix P.9. Mean age, length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Red Lake, 1991-1994.

	Age-0					Age-1					Age-2				
Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
12-May-91	12	35.3	29.0	0.2	0.83	6	17.6	69.0	2.4	0.74	16	47.1	95.0	6.0	0.69
6-Oct-91	27	29.7	51.0	1.2	0.85	64	70.3	81.0	4.4	0.81	-	-	-	-	-
23-Sep-92 24-Sep-92	137	64.9	68.5	2.6	0.79	74	35.1	97.0	8.2	0.84	-	-	-	-	-
26-Sep-93 27-Sep-93	1	25.0	63.0	2.3	0.92	3	75.0	79.3	5.1	1.01	-	-	-	-	-
23-Oct-94	6	7.4	60.0	1.4	0.65	74	91.4	85	4.4	0.72	1	1.2	103.0	7.7	0.70

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix P.10. Age compositions and population estimates of sockeye salmon smolt emigrating from Red Lake, 1990-1996.

Year		Age 1	Age 2	Age 3	Population Estimate	95% Confidence Interval Low	95% Confidence Interval High
1990	Percent	32.5	66.6	0.9			
	Number	240,500	493,026	6,427	739,953	402,905	1,077,044
1991	Percent	40.0	45.5	14.5			
	Number	105,467	119,849	38,184	263,500	178,221	348,782
1992	Percent	2.1	96.1	1.8			
	Number	29,482	1,365,082	25,792	1,420,356	1,117,748	1,722,965
1993	Percent	52.0	33.2	14.8			
	Number	303,462	193,884	86,644	583,990	436,166	731,804
1994	Percent	7.2	92.5	0.3			
	Number	40,404	520,391	1,895	562,690	472,305	647,655
1995	Percent	3.3	93.1	3.6			
	Number	11,337	317,903	12,250	341,490	315,923	367,056
1996	Percent	72.0	26.0	2.0			
	Number	665,104	240,787	18,504	924,396	872,720	976,071

1990-1995 data from Swanton et al. 1996. Sockeye Smolt Population Estimates, Outmigration Timing, and Size At Age Characteristics Characteristics for Red, Akalura, and Frazer Lakes, 1995. RIR No. 4K96-16, Kodiak. 1996 data from N. Sagalkin, personal communication, 1999.

Appendix P.11. Mean length, weight, and condition coefficient by age for sockeye salmon smolt emigrating from Red Lake, 1990-1996.

Sampling Year	Age-1 n	Age-1 %	Age-1 Length (mm)	Age-1 Weight (g)	Age-1 Condition (K)	Age-2 n	Age-2 %	Age-2 Length (mm)	Age-2 Weight (g)	Age-2 Condition (K)	Age-3 n	Age-3 %	Age-3 Length (mm)	Age-3 Weight (g)	Age-3 Condition (K)
1990	342	24.2	106.5	10.0	0.83	1,052	74.4	111.8	11.0	0.79	20	1.4	117.9	13.0	0.79
1991	1,135	45.1	88.2	5.0	0.73	977	38.8	106.7	9.5	0.78	407	16.1	113.0	11.3	0.78
1992	85	4.7	99.5	8.8	0.89	1,667	91.8	110.2	11.8	0.88	63	3.5	119.7	15.2	0.89
1993	1,409	60.7	91.7	7.3	0.94	516	22.2	108.6	11.0	0.84	397	17.1	120.1	14.5	0.82
1994	225	11.5	86.2	5.1	0.79	1,718	88.1	98.7	7.6	0.79	7	0.4	104.9	9.0	0.78
1995	151	8.2	92.1	6.4	0.80	1592	86.5	103.2	9.3	0.80	97	5.3	115.7	13.3	0.80
1996	1,027	59.0	103.0	8.9	0.80	601	34.5	113.0	12.1	0.82	112	6.5	122.0	15.4	0.83

Data obtained from:
Barrett et al. 1993. Years 1990-1992. RIR 4K93-1.
Barrett et al. 1993. Year 1993. RIR 4K93-32..
Swanton et al. 1995. Year 1994. RIR 4K95-26.
Swanton et al. 1996. Year 1995. RIR 4K96-16.
Coggins. 1997. Year 1996. RIR 4K97-50.

Appendix P.12. Ayakulik River sockeye salmon escapement counts, 1989-1998.

	-------YEAR-------									
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/22				1						
5/23				2	10				5	
5/24				22	2			4	11	
5/25			3	5	2	73		1	25	
5/26			7	5	1	18		1	201	
5/27		1,700	9	41	225	105		3	124	
5/28		810	106	22	948	25	13	414	143	
5/29		1,248	161	52	1,879	135	711	292	0	84
5/30		831	121	242	3,291	4	1,034	29	931	1,190
5/31	6	561	191	1,408	6,368	1,072	460	5,566	1,587	926
6/1	86	2,440	202	634	7,074	240	2,165	10,205	191	951
6/2	386	2,442	292	2,025	9,971	114	4,485	9,398	2,036	3,729
6/3	289	10,748	54	2,303	2,693	1,608	5,776	7,261	1,610	42,547
6/4	1,360	9,887	969	481	4,366	138	12,140	3,777	4,385	35,701
6/5	1,158	12,102	11,045	971	2,950	2,129	12,444	4,549	5,467	38,614
6/6	20,187	8,965	3,485	11,888	75	663	6,022	5,495	2,231	10,222
6/7	17,199	394	9,002	12,278	926	1,193	1,036	3,840	4,548	11,858
6/8	2,065	26,056	4,640	4,464	26	3,551	6,667	5,791	2,073	19,954
6/9	6,301	17,182	22,817	7,336	15,784	12,324	4,549	794	14,157	14,448
6/10	30,378	3,404	14,102	3,808	27,131	3,027	3,617	3,261	5,917	5,919
6/11	20,590	4,384	10,274	854	16,853	7,009	4,808	3,403	5,712	6,492
6/12	18,098	228	13,090	12,011	15,916	3,874	3,897	3,493	5,296	6,086
6/13	13,127	1,813	235	20,327	9,505	10,487	14,299	2,641	4,736	1,474
6/14	25,373	235	4,810	3,144	740	456	2,367	487	1,195	6,419
6/15	19,025	117	2,064	10,602	1,626	3,568	4,504	1,763	12,792	1,464
6/16	17,278	750	261	3,078	2,691	1,702	3,019	1,471	11,750	3,722
6/17	14,511	750	1,342	1,285	826	3,315	14,533	899	13,316	28,650
6/18	35,703	750	1,141	53	2,126	8,608	6,037	634	5,521	1,088
6/19	206	750	490	347	3,704	14,061	2,062	4	9,831	3,594
6/20	18,412	34	111	38	720	13,888	11,286	370	10,186	3,267
6/21	12,497	488	261	829	747	2,472	2,106	1,251	4,125	1,971
6/22	6,528	214	407	224	1,356	1,971	1,250	1,025	2,109	219
6/23	3,896	338	288	2,269	671	4,092	1,624	9,421	13,745	661
6/24	31,415	1,055	5,114	2,919	308	4,205	6,893	1,932	11,447	1,015
6/25	16,502	1,422	1,392	12	12,252	9,529	6,351	3,593	4,886	507
6/26	44,670	259	1,596	744	2,793	6,582	3,258	1,450	1,632	642
6/27	4,411	1,195	459	833	430	12,885	5,528	2,587	1,866	226
6/28	12,175	94	15,446	833	1,312	14,231	3,465	2,916	1,144	1,589

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					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
6/29	19,836	9,616	58,042	834	42	2,020	774	12,489	255	13,969
6/30	4,705	17,027	38,329	2,187	295	4,511	12,983	8,441	1,167	2,832
7/1	2,095	15,365	15,026	12,841	0	6,338	1,409	2,040	901	6,005
7/2	2,727	10,430	28,522	8,703	846	8,593	5,223	4,737	1,842	3,117
7/3	15,716	10,363	6,852	34,212	657	3,236	892	45,497	1,630	1,500
7/4	7,770	324	15,515	9,015	684	6,639	747	8,846	1,368	6,000
7/5	14,428	157	13,306	4,624	548	4,604	1,605	6,671	2,225	4,000
7/6	3,102	7,703	5,280	4,372	1,707	1,365	570	15,013	2,534	1,500
7/7	22,395	1,249	4,256	13,090	1,839	3,406	7,005	3,548	2,201	7,700
7/8	11,020	2,572	3,089	6,574	1,829	7,637	794	2,025	2,464	135
7/9	50	476	1,044	1,214	2,156	6,192	959	1,126	3,259	2,370
7/10	96	2,297	3,026	1,113	6,657	7,607	2,680	112	4,759	1,500
7/11	1,688	50	182	4,295	3,352	7,912	876	1,244	3,746	50
7/12	18,305	92	142	1,978	2,517	4,934	887	89	4,019	2,700
7/13	12,130	61	2,677	1,345	2,680	3,588	915	43	2,757	83
7/14	557	1,941	649	2,361	2,915	3,121	492	141	2,710	3,628
7/15	2,614	3,326	61	2,575	8,679	10,754	1,647	1,146	1,578	1,421
7/16	4,065	2,982	93	4,815	4,080	3,674	1,904	3,180	2,393	378
7/17	3,088	466	348	8,220	3,361	7,301	8,780	528	3,437	1,156
7/18	122	48	483	3,000	7,821	6,249	935	3,330	1,486	5,683
7/19	21,057	82	155	4,338	4	2,547	18,189	203	2,388	8,604
7/20	4,575	431	284	2,545	127	169	4,923	566	3,711	8,790
7/21	6,603	3,084	1,649	6,980	172	5,433	378	3,204	1,908	8,883
7/22	3,540	174	3,961	6,271	29	5,433	1,248	10,579	3,260	8,699
7/23	7,235	83	1,164	582	18	5,434	6,092	8,506	1,170	2,551
7/24	15,361	1,008	3,524	3,257	2,971	3,022	2,137	3,818	366	1,628
7/25	202	185	533	17,324	519	10,654	3,231	491	1,120	301
7/26	50,532	81	91	12,122	2,319	6,198	1,171	769	1,266	888
7/27	13,945	247	8,278	2,270	9,857	9,483	3,991	202	9,066	166
7/28	446	17,446	2,620	6,552	9,048	2,305	2,739	811	9,626	4,435
7/29	251	27,522	2,547	1,062	332	1,955	1,522	302	2,393	506
7/30	2,958	12,689	5,005	287	381	1,678	657	3,105	3,633	2,762
7/31	2,240	2,231	1,557	144	2,288	3,315	5,300	4,507	5,064	9,803
8/1	3,567	6,395	67	593	6,547	2,037	10,484	2,491	2,752	5,262
8/2	1,454	5,009	92	175	586	2,630	2,414	3,881	2,619	6,672
8/3	1,884	18,733	258	566	2,133	2,060	1,579	6,702	1,511	2,407
8/4	4,380	24,826	3,819	932	6,741	5,475	1,085	4,503	4,247	126
8/5	10,586	18,483	1,060	1,940	862	3,687	1,228	5,019	2,311	4,146
8/6	31,565	8,497	2,278	581	366	2,618	330	295	2,134	2,436

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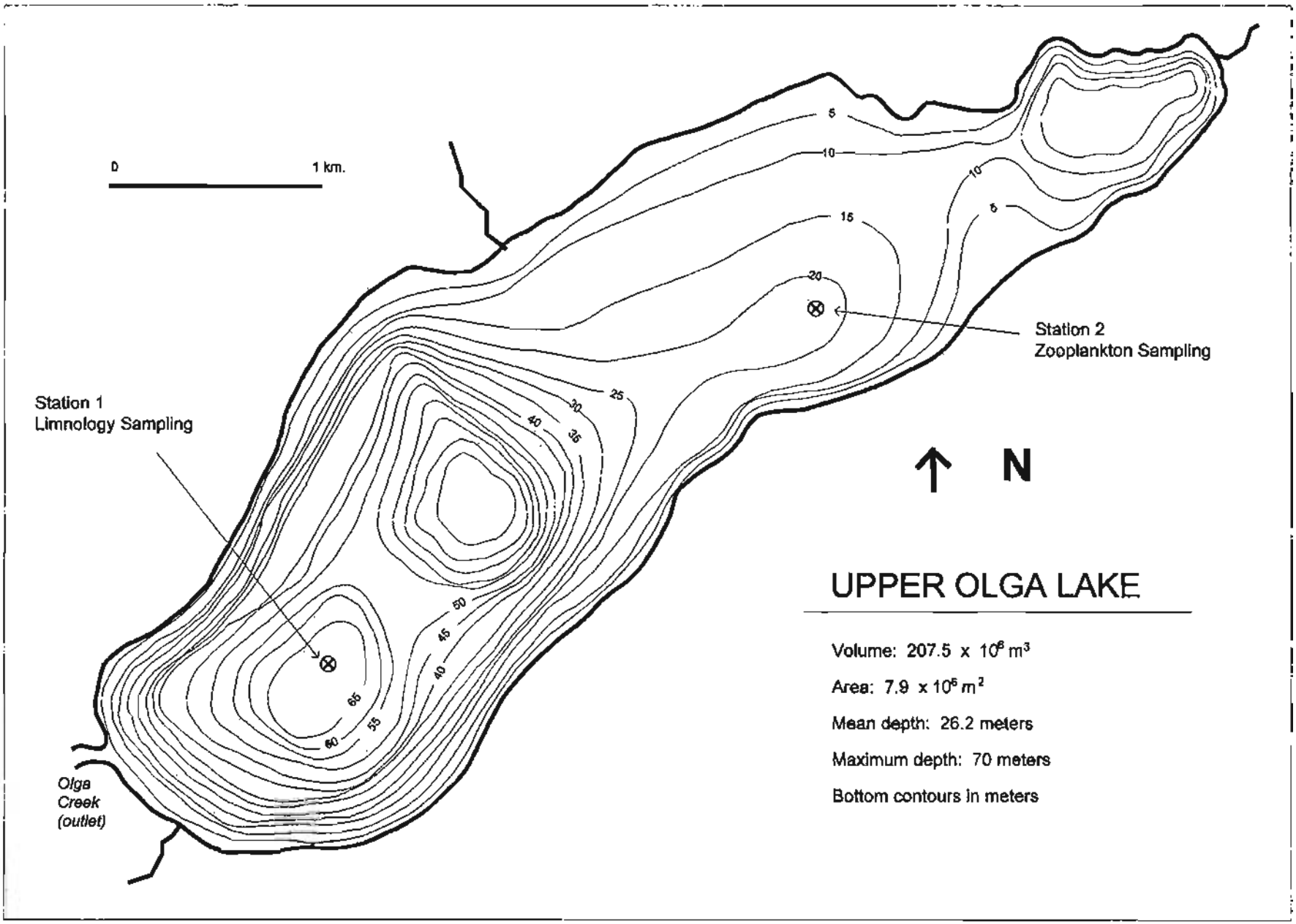
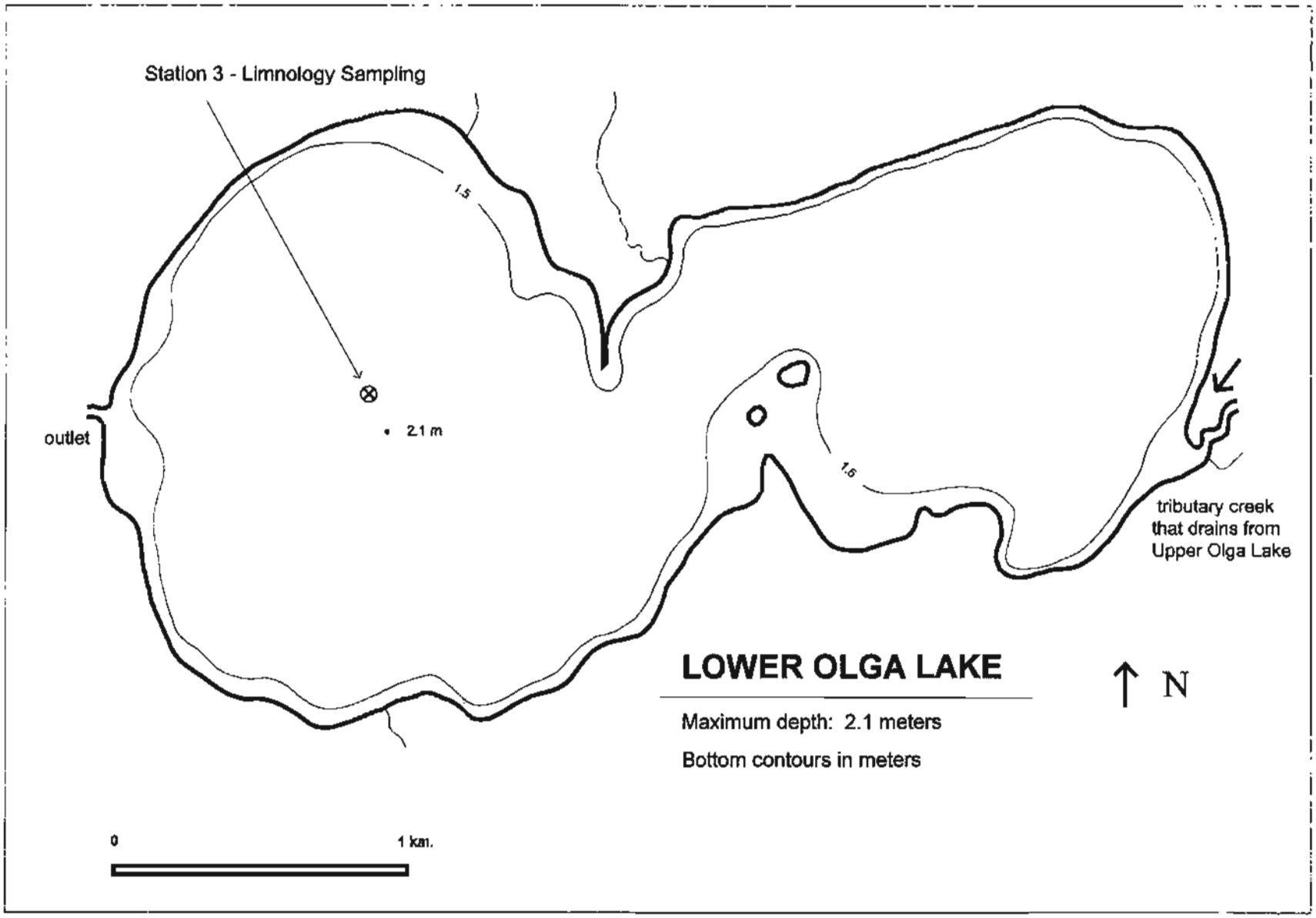
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/7	6,553	6,450	3,023	701	2,214	3,605	2,845	540	1,214	1,527
8/8	6,601	4,932	321	951	395	2,117	4,138	2,344	1,039	2,944
8/9	4,460	1,463	249	3,904	917	697	1,042	8,936	363	3,554
8/10	1,373	2,697	961	4,409	12,005	1,927	2,426	10,586	745	4,261
8/11	2,881	453	1,970	1,855	667	1,126	749	11,925	1,618	5,434
8/12	3,136	554	2,709	1,176	45	3,401	687	7,607	1,144	1,558
8/13	2,508	541	1,275	749	1,929	2,596	707	4,898	1,245	3,773
8/14	5,451	458	2,500	2,851	243	2,522	1,480	5,798	467	1,238
8/15	2,941	105	0	1,480	953	7,464	2,413	1,327	1,015	485
8/16	384	719	0	1,892	2,510	3,469	4,413	449	4,770	771
8/17	1,619	306	0	1,977	726	2,829	3,385	194	3,086	497
8/18	1,731	309	0	2,573	222	3,210	5,491	137	1,253	760
8/19	793	514	0	1,869	252	2,685	1,077	178	1,004	385
8/20	776	843	0	3,018	252	1,484	543	406	879	0
8/21	584	217	0	2,000	251	1,119	1,167	705	4,644	0
8/22	502	454	0	2,000	419	629	1,792	394	1,740	0
8/23	30	581	0	1,500	452	662	895	160	234	0
8/24	1,205	268	0	1,500	207	191	1,798	152	296	0
8/25	400	223	0	1,000	2,516	648	1,229	198	974	0
8/26	400	258	0	1,000	1,883	586	306	0	881	0
8/27	284	310	0	1,000	315	448	68	0	1,298	0
8/28	199	96	0	500	424	448	0	0	1,682	0
8/29	189	67	0	0	110	83	0	0	1,280	0
8/30	78	95	0	0	0	343	0	0	1,136	0
8/31	301	312	0	0	0	217	0	0	0	0
9/1	0	63	0	0	0	96	0	0	0	0
9/2	0	92	0	0	0	85	0	0	0	0
9/3	0	120	0	0	0	89	0	0	0	0
9/4	0	109	0	0	0	70	0	0	0	0
9/5	0	86	0	0	0	27	0	0	0	0
9/6	0	56	0	0	0	70	0	0	0	0
9/7	0	84	0	0	0	70	0	0	0	0
9/8	0	50	0	0	0	0	0	0	0	0
Total:	768,101	371,282	374,859	344,184	286,170	380,181	317,832	337,155	308,214	427,208

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.



Appendix Q.1. Morphometric map showing the limnology and zooplankton stations on Upper Olga Lake (Upper Station).



Appendix Q.2. Morphometric map showing the limnology station on Lower Olga Lake (Upper Station).

Appendix Q.3. Limnological sampling stations and frequencies for the Upper Station Lakes, 1990-1995.

	Sampling	
Year	Stations	Frequency
1990	2	5
1991	2	5
1992	3	6
1993	3	6
1995	1	4

Appendix Q.4. Summary of seasonal mean water chemistry parameters by station and depth for Upper Station Lakes, 1990-1991 and 1993.

		Depth	Specific Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(umhos cm^{-1})	SD	(Units)	SD	(mg L^{-1})	SD	(NTU)	SD	(Pt units)	SD	(mg L^{-1})	SD	(mg L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	46.0	0.9	6.9	0.1	9.0	0.7	0.5	0.1	9.4	3.4	3.8	1.1	0.6	0.7	23.0	16.6
	1	60	46.0	1.1	6.8	0.2	8.7	0.8	0.5	0.1	8.8	0.8	3.5	0.5	1.1	1.3	36.0	23.0
	2	1	46.0	0.9	6.9	0.1	9.0	0.6	0.5	0.1	7.8	3.3	3.6	0.7	1.0	1.1	24.0	11.1
	2	14	46.0	0.9	6.9	0.1	8.5	1.1	0.6	0.2	6.8	2.2	3.1	0.7	1.1	1.4	31.0	11.1
1991	1	1	46.0	2.6	6.9	0.1	9.0	1.8	0.8	0.3	7.8	3.3	3.2	0.6	0.4	0.2	23.8	22.8
	1	60	46.0	3.2	6.8	0.1	8.7	1.2	0.8	0.3	9.3	5.5	3.0	0.6	0.5	0.4	19.3	17.9
	2	1	46.0	2.5	6.9	0.2	8.7	1.8	0.7	0.2	8.0	2.8	3.3	0.9	0.7	0.5	14.0	15.4
	2	20	46.0	2.2	6.9	0.1	8.9	1.5	0.8	0.4	8.7	3.7	3.4	0.6	0.4	0.2	19.3	16.9
	3	1	48.0	3.5	7.0	0.1	9.5	1.1	1.5	0.6	9.8	2.6	3.0	0.4	0.9	0.4	49.2	27.0
	3	2	48.0	4.1	6.9	0.1	9.4	1.5	1.3	0.5	10.2	3.0	3.3	0.5	0.7	0.3	46.4	20.3
1993	1	1	46.0	2.9	6.8	0.3	9.6	3.4	1	0.7	2.8	0.8	2.9	13.8	0.7	39.0	21.0	9.1
	1	50	49.0	2.7	6.5	0.2	8.4	0.8	0.7	0.3	3.8	2.3	3.2	0.5	1.2	0.8	18.0	8.4
	2	1	49.0	4.9	7.0	0.9	9.3	2.8	0.7	0.2	3.2	0.8	3.6	1.2	0.9	0.4	15.0	3.9
	2	24	49.0	4.4	6.8	0.4	9.3	1.6	0.7	0.3	3.2	1.2	3.6	0.8	0.9	0.4	17.0	11.3
	3	1	49.0	1.9	6.7	0.2	8.7	1.0	1.8	1.0	3.7	1.2	3.1	0.4	0.8	0.1	41.0	43.7

Appendix Q.5. Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Upper Station Lakes, 1990, 1991, and 1993.

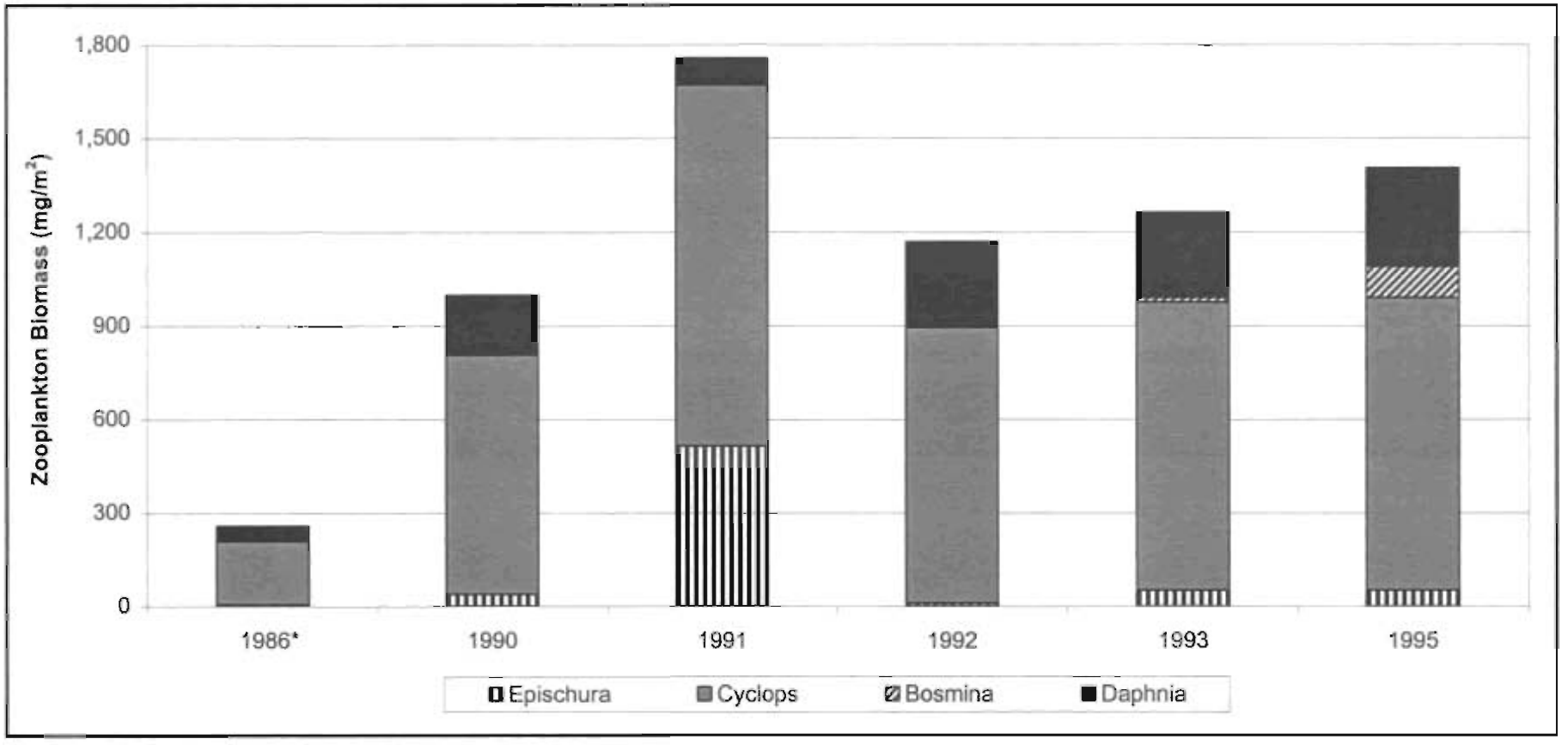
		Depth	Total-P		Total filterable-P		Filterable reactive-P		Total Kjel-dahl nitrogen		Ammonia		Nitrate + nitrite		Reactive silicon		Organic carbon		hlorophyll *a*		Phaeophytin *a*	
Year	Station	(m)	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD	(ug L^{-1})	SD
1990	1	1	6.7	0.7	5.9	3.6	3.4	2.8	91.4	11.6	5.2	1.0	25.5	32.1	107.0	108.2	260.0	107.4	1.68	0.7	0.85	0.3
	1	60	8.4	3.2	3.6	1.1	1.8	1.0	99.4	21.3	27.3	26.0	32.6	14.6	100.0	98.0	174.0	81.7	1.68	1.1	1.09	0.6
	2	1	7.0	1.1	3.6	0.8	1.5	1.0	94.7	7.8	4.0	0.9	9.5	8.3	101.0	102.5	267.0	89.9	1.74	0.8	0.86	0.3
	2	14	8.2	2.6	3.3	0.6	1.3	0.5	99.0	10.2	5.2	1.2	10.7	7.8	97.0	111.6	273.0	92.7	1.92	0.7	1.12	0.3
1991	1	1	8.7	2.5	3.6	1.0	1.7	1.2	108.0	57.3	6.1	4.2	5.1	3.4	94.2	50.0	na	na	2.00	1.0	0.43	0.2
	1	60	9.3	2.4	4.1	1.9	2.0	1.7	102.7	54.5	11.1	17.4	20.9	21.1	120.3	39.2	na	na	1.98	0.8	0.42	0.2
	2	1	7.5	3.4	3.4	0.5	1.4	0.5	94.4	51.0	4.9	3.2	5.3	4.5	85.8	37.1	na	na	1.79	1.2	0.48	0.2
	2	20	8.2	1.5	4.7	2.1	1.6	1.1	95.7	52.2	9.0	7.7	8.5	8.1	91.5	27.9	na	na	2.17	1.0	0.61	0.2
	3	1	17.5	3.8	5.5	1.4	2.1	0.8	170.0	38.1	7.4	4.9	3.4	1.2	544.2	291.6	na	na	1.56	0.8	0.56	0.2
	3	2	14	2.5	6.4	1.9	3	0.9	170.9	39.0	7.7	6.4	3.4	1.2	542.8	293.6	na	na	1.78	0.5	0.67	0.2
1993	1	1	6.6	11.5	2.9	4.5	0.8	3.3	131.6	29.3	3.3	1.7	9.6	6.9	165.7	102.1	299.0	100.7	2.42	1.0	0.66	0.3
	1	50	7.7	2.4	3.5	1.1	1.3	1.0	117.8	21.3	6.1	7.0	28.9	18.2	89.8	58.8	338.0	52.4	3.64	0.8	1.07	0.4
	2	1	6.9	1.9	3.7	0.8	1.2	0.4	120.9	12.5	2.8	2.2	9.4	7.3	128.2	87.6	286.3	97.6	2.74	1.5	0.81	0.5
	2	24	7.7	1.8	3.5	1.0	1.1	0.5	119.6	7.9	6.3	3.4	15.9	5.3	131.2	114.5	277.5	107.8	3.96	1.1	1.12	0.7
	3	1	14.9	5.2	5.4	1.3	1.6	0.4	199.1	53.1	4	1.9	5.5	0.0	472.3	310.7	475.2	172.8	2.96	3.5	1.41	1.4

na - not analyzed

Appendix Q.6. Weighted mean zooplankton density, biomass, and size by genera (stations 1&2 averaged) for Upper Olga Lake, 1986 and 1990-1995.

Station 1 & 2	Number	*Epischura*			*Cyclops*			*Bosmina*			*Daphnia*			TOTALS	
Upper Lake	Sample	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	Days	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1986*	1	5,943	6	0.60	161,742	202	0.61	30,990	51	0.42	0	0	0	198,675	259
1990	5	3,318	39	1.26	321,577	769	0.77	95,329	192	0.45	186	0	0.67	420,409	999
1991	6	77,820	517	1.09	376,849	1,154	0.93	62,799	88	0.40	0	0	0	517,467	1,759
1992	6	819	11	1.46	410,753	884	0.77	137,208	275	0.45	0	0	0	548,780	1,170
1993	6	7,095	53	1.19	575,871	923	0.68	173,554	274	0.41	7,418	15	0.68	763,938	1,264
1995	4	6,668	52	1.14	489,955	937	0.71	144,871	316	0.48	44,818	100	0.69	686,312	1,406
Avg =	5	16,944	113	1.12	389,458	811	0.75	107,458	199	0.43	8,737	19	0.34	522,597	1,143

* one sample date only

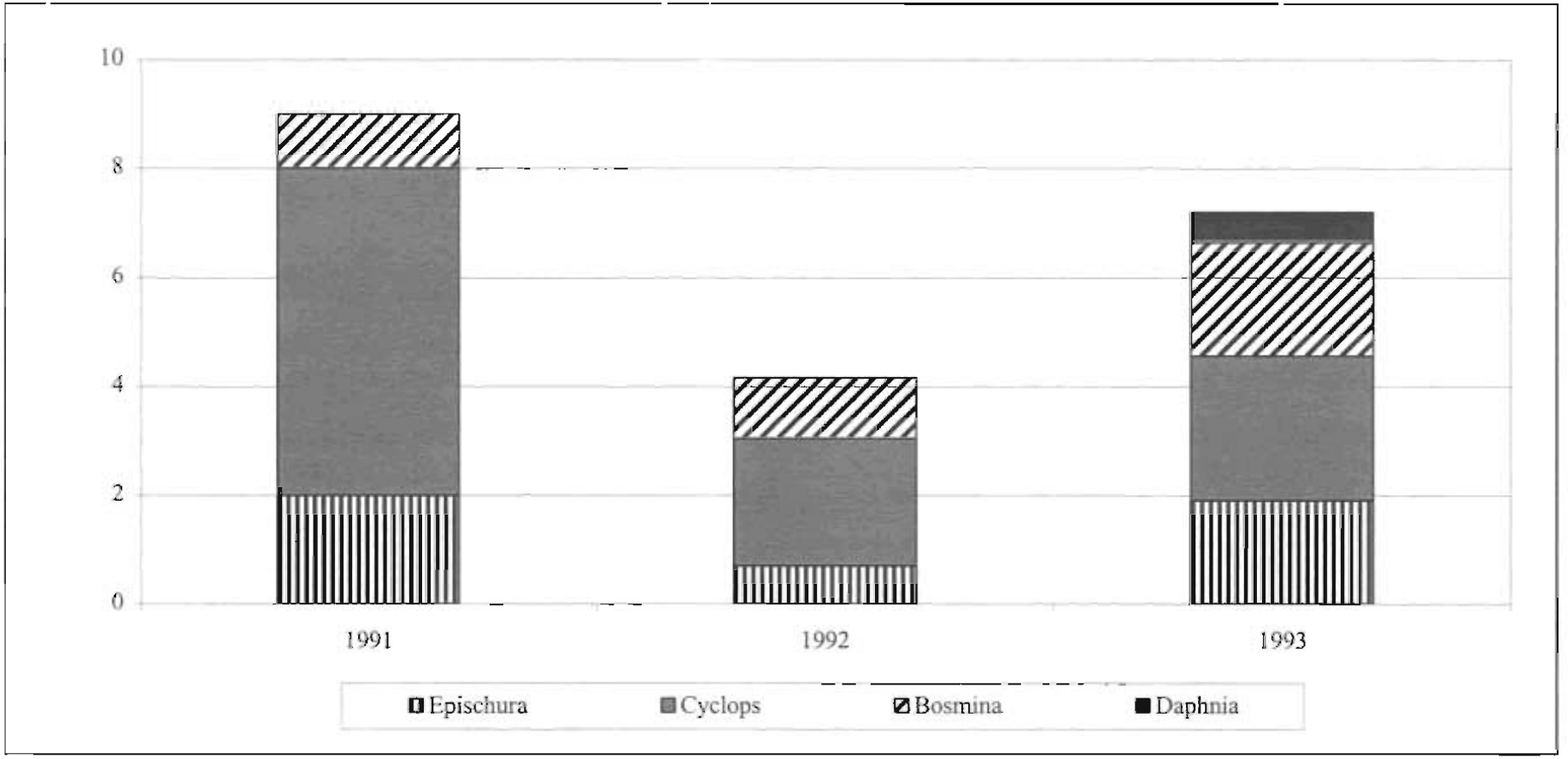


Appendix Q.7. Weighted mean zooplankton biomass by genera for Upper Olga Lake (stations 1&2 averaged), 1986 and 1990-1995.

* one sample date only

Appendix Q.8. Weighted mean zooplankton density, biomass, and size by genera (days sampled were averaged) for Lower Olga Lake, 1991-1993.

Station 3	Number of Sample	*Epischura*			*Cyclops*			*Bosmina*			*Daphnia*			TOTALS	
Year	Dates	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2
1991	6	411	2.0	0.96	3,285	6.0	0.76	603	1.0	0.32	19	0.0	0.58	4,318	9.0
1992	6	398	0.7	0.72	1,208	2.3	2.34	536	1.1	0.47	8	0.0	0.00	2,150	4.2
1993	6	866	1.9	0.77	2,214	2.7	2.66	1,987	2.1	0.34	377	0.6	0.59	5,444	7.2
Avg =	6	558	1.5	0.82	2,236	3.7	1.92	1,042	1.4	0.38	135	0.2	0.39	3,971	6.8



Appendix Q.9. Weighted mean zooplankton biomass by genera for Lower Olga Lake, 1991-1993.

Appendix Q.10. Juvenile sockeye salmon estimates based on fall townet catch species composition and hydroacoustic fish population estimates for Upper Station Lakes, 1990-1991.

	Total Fish Estimates			Sockeye Estimates			Sockeye
		95% C. I.			95% C. I.		omposition
Date	Number	Low	High	Number	Low	High	(%)
28-Sep-90	3,843,823	3,376,317	4,311,329	1,172,366	1,029,643	1,315,089	30.5
4-Oct-91	3,987,459	3,431,754	4,543,164	386,784	333,009	440,558	9.7

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix Q.11. Townet catches from Upper Station Lakes, 1990 - 1992.

	Tow		Catch by Species					
			Sockeye			Stickleback		
Date	No.	Min.	No.	%	CPUE	No.	%	CPUE
28-Sep-90	3	91	174	30.5	1.9	397	69.5	4.4
8-May-91	3	90	14	1.0	0.2	1,353	99.0	15.0
4-Oct-91	3	94	160	9.8	1.7	1,480	90.2	15.7
21-Sep-92	3	93	275	33.6	3.0	543	66.4	5.8

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix Q.12. Mean age, length, weight, and condition coefficient by age for juvenile sockeye salmon captured by townet at Upper Station Lakes, 1991-1992.

	Age-0					Age-1					Age-2				
Date	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
8-May-91	4	30.8	31	0.3	0.87	2	15.4	73	3.3	0.87	7	53.8	109	10.4	0.79
4-Oct-91	116	72.5	56	1.7	0.85	44	27.5	91	7.0	0.91	-	-	-	-	-
21-Sep-92	213	77.5	67	2.9	0.89	62	22.5	90	8.4	1.03	-	-	-	-	-

Source: Honnold, S.G. 1993. Summary of Hydroacoustic and townetting surveys conducted at Red, Akalura, and Upper Station Lakes in response to the 1989 Exxon Valdez Oil Spill, 1990-1992. FRED Report No. 131.

Appendix Q.13. Upper Station Lakes sockeye salmon smolt emigration by age class, 1990-1993.

Year	Statistical Week	Dates	Age Class 0	1	2	3	4	Population Estimate
1990	19	5/03-5/09	0	0	0	0	0	0
	20	5/10-5/16	0	211	4,607	211	0	5,031
	21	5/17-5/23	0	3,653	69,281	4,457	0	77,391
	22	5/24-5/30	0	73,093	1,004,363	30,294	0	1,107,755
	23	5/31-6/06	0	24,170	78,855	3,469	0	106,492
	24	6/07-6/13	0	58,354	213,955	11,603	0	283,912
	25	6/14-6/20	0	29,304	116,251	5,174	0	150,728
	26	6/21-6/27	2,346	40,350	34,188	490	0	77,372
	27	6/28-7/04	18,687	16,445	35,401	1,069	0	71,602
	28	7/05-7/11	2,176,129	6,321	42,214	2,032	0	2,226,695
	29	7/12-7/18	2,994,481	0	0	0	0	2,994,481
	30	7/19-7/25	297,022	0	0	0	0	297,022
	31	7/26-8/01	22,809	0	0	0	0	22,809
	32	8/02-8/08	0	0	0	0	0	0
	33	8/09-8/15	0	0	0	0	0	0
	Total		5,511,474	251,901	1,599,115	58,799	0	7,421,290
1991	19	5/03-5/09	0	0	0	0	0	0
	20	5/10-5/16	0	126	47	0	0	173
	21	5/17-5/23	0	109	93	16	0	218
	22	5/24-5/30	0	1,630	10,085	1,136	0	12,849
	23	5/31-6/06	0	5,274	11,833	595	0	17,702
	24	6/07-6/13	0	7,724	7,693	430	0	15,846
	25	6/14-6/20	0	159,232	183,386	11,942	0	354,559
	26	6/21-6/27	0	19,145	19,108	1,082	0	39,334
	27	6/28-7/04	29	12,032	7,335	190	0	19,586
	28	7/05-7/11	580,798	5,185	3,682	0	0	589,665
	29	7/12-7/18	647,285	9,766	2,413	0	0	659,464
	30	7/19-7/25	538,692	4,226	0	0	0	542,918
	31	7/26-8/01	167,013	173	0	0	0	167,186
	32	8/02-8/08	25,606	0	0	0	0	25,606
	33	8/09-8/15	0	0	0	0	0	0
	Total		1,959,423	224,622	245,675	15,391	0	2,445,106
1992	19	5/03-5/09	0	0	210	0	0	210
	20	5/10-5/16	0	315	1,995	210	0	2,520
	21	5/17-5/23	0	1,770	126,481	1,095	0	129,346
	22	5/24-5/30	0	10,366	92,905	0	0	103,271
	23	5/31-6/06	0	13,983	69,705	121	0	83,809
	24	6/07-6/13	0	7,403	33,043	0	0	40,446
	25	6/14-6/20	0	9,284	16,154	19	0	25,457
	26	6/21-6/27	1,696	14,818	11,663	0	0	28,176
	27	6/28-7/04	376,527	18,542	10,832	0	0	405,901
	28	7/05-7/11	611,128	3,760	0	0	0	614,888
	29	7/12-7/18	369,996	0	0	0	0	369,996
	30	7/19-7/25	479,082	0	0	0	0	479,082
	31	7/26-8/01	79,658	0	0	0	0	79,658
	32	8/02-8/08	29,626	0	0	0	0	29,626
	33	8/09-8/15	2,530	0	0	0	0	2,530
	Total		1,950,243	80,241	362,988	1,445	0	2,394,916
1993	19	5/03-5/09	0	0	0	0	0	0
	20	5/10-5/16	0	7,814	31,583	1,302	0	40,700
	21	5/17-5/23	0	23,161	67,470	3,021	0	93,652
	22	5/24-5/30	0	56,545	124,084	2,618	0	183,247
	23	5/31-6/06	0	224,994	82,705	1,779	0	309,478
	24	6/07-6/13	0	71,346	15,716	249	0	87,312
	25	6/14-6/20	7,323	133,765	27,827	976	0	169,891
	26	6/21-6/27	159,993	33,801	3,380	0	0	197,174
	27	6/28-7/04	351,377	8,268	2,067	0	0	361,712
	28	7/05-7/11	1,136,309	3,256	0	0	0	1,139,565
	29	7/12-7/18	271,915	0	0	0	0	271,915
	30	7/19-7/25	264,190	5,392	0	0	0	269,582
	31	7/26-8/01	210,453	0	0	0	0	210,453
	32	8/02-8/08	103,688	0	0	0	0	103,688
	33	8/09-8/15	23,689	0	0	0	0	23,689
	Total		2,528,937	568,342	354,832	9,945	0	3,462,058

Data obtained from:

Barrett, B.M., P.A. Roche, and C.O. Swanton. 1993. Sockeye salmon *Oncorhynchhus nerka* smolt investigations at Red, Akalura, and Upper Station Lakes conducted in response to the 1989 M/V Exxon Valdez oil spill, 1990-1992. ADF&G, Commercial Fish Division, RIR 4K93-1, Kodiak.

Barrett, B.M., C.O. Swanton, and P.A. Roche. 1993. Sockeye salmon smolt abundance, timing, and growth characteristics for Red, Akalura, Upper Station, and Frazer Lakes, 1993. ADF&G, Commercial Fish Division, RIR 4K93-32, Kodiak.

Appendix Q.14. Mean length, weight, and condition coefficient by age for sockeye smolt migrating from Upper Station Lakes, 1990-1993.

	Age-0					Age-1					Age-2					Age-3				
Sampling Year	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)	n	%	Length (mm)	Weight (g)	Condition (K)
1990	939	32.6	54.5	1.5	0.93	325	11.3	81.4	4.9	0.91	1,539	53.5	99.7	8.3	0.84	74	2.6	109.7	11.1	0.84
1991	1,622	49.2	59.3	2.0	0.96	658	19.9	94.0	7.1	0.85	947	28.7	102.3	9.3	0.87	72	2.2	115.0	12.8	0.84
1992	1,813	43.8	57.5	1.8	0.95	477	11.5	93.7	7.9	0.96	1,841	44.5	103.3	10.1	0.92	8	0.2	112.6	13.6	0.95
1993	2,311	53.7	60.5	2.1	0.91	1,113	25.9	92.0	6.3	0.80	853	19.8	111.4	11.7	0.82	27	0.6	119.6	14.9	0.84

Data obtained from:

Barrett, B.M., P.A. Roche, and C.O. Swanton. 1993. Sockeye salmon *Oncorhynchhus nerka* smolt investigations at Red, Akalura, and Upper Station Lakes conducted in response to the 1989 M/V Exxon Valdez oil spill, 1990-1992. ADF&G, Commercial Fish Division, RIR 4K93-1, Kodiak.

Barrett, B.M., C.O. Swanton, and P.A. Roche. 1993. Sockeye salmon smolt abundance, timing, and growth characteristics for Red, Akalura, Upper Station, and Frazer Lakes, 1993. ADF&G, Commercial Fish Division, RIR 4K93-32, Kodiak.

Appendix Q.15. Upper Station Lakes sockeye salmon escapement counts, 1989-1998.

	——YEAR——									
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/24										24
5/25										66
5/26										48
5/27										168
5/28									86	323
5/29					5				285	250
5/30					596		109	500	172	89
5/31	41				391		325	2,009	942	806
6/1	71		20		797	208	644	1,352	51	302
6/2	121	5	65		831	103	1,054	2,301	1,002	231
6/3	378	148	155		908	171	821	3,933	622	637
6/4	138	320	63		147	320	1,521	1,610	124	238
6/5	65	573	77		1,656	46	2,855	2,384	2,830	614
6/6	154	1,698	59	46	900	126	1,555	3,555	522	1,777
6/7	183	2,246	2,213	89	2,563	372	6,050	3,564	522	0
6/8	152	2,137	1,633	75	1,300	1,242	1,083	8,120	55	5,064
6/9	1,967	2,817	1,436	112	682	578	5,419	7,046	0	1,343
6/10	3,248	3,221	899	1,216	1,916	361	3,460	4,851	843	930
6/11	1,775	539	417	2,270	3,529	112	1,192	2,008	1,234	732
6/12	3,013	527	4,574	474	2,204	272	1,470	1,445	1,141	876
6/13	3,546	3,190	477	36	804	349	4,113	904	56	1,346
6/14	4,145	145	523	324	521	188	1,625	256	5,146	754
6/15	3,452	126	383	505	325	4,774	518	1,203	557	2,205
6/16	3,297	170	342	2,092	36	3,091	443	641	674	2,120
6/17	4,706	1,140	451	2,533	45	3,167	227	330	5,172	1,705
6/18	2,757	1,001	585	129	115	2,222	1,403	366	6,077	1,900
6/19	5,440	2,566	1,469	278	83	1,713	685	233	3,452	358
6/20	4,032	196	847	1,307	1,303	417	231	25	4,209	183
6/21	633	4,469	116	295	628	453	67	156	2,011	64
6/22	342	8,495	702	132	131	1,001	147	144	1,482	219
6/23	340	6,613	1,529	627	2,474	1,083	455	548	425	17
6/24	115	3,254	1,142	333	119	113	517	166	108	153
6/25	1,015	2,991	561	78	184	233	159	1,115	240	495
6/26	568	895	1,171	702	1,012	5,230	277	3,134	106	948
6/27	4,005	308	19	770	37	1,241	74	1,117	72	348
6/28	2,361	201	3,185	119	95	920	68	678	72	569
6/29	1,915	693	6,282	104	177	133	94	341	53	214
6/30	1,227	369	4,359	221	171	1,217	300	150	49	264
7/1	1,516	856	4,186	437	1,138	490	1	117	143	339
7/2	1,050	230	3,233	616	820	265	222	309	112	677
7/3	430	145	2,127	127	668	275	83	234	63	172
7/4	554	448	2,196	755	520	28	131	0	10	12

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Appendix Q.15. (page 2 of 3)

					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
7/5	130	99	114	214	5	743	275	129	112	24
7/6	947	73	1,613	137	210	1,584	348	524	234	0
7/7	513	97	172	35	3	767	987	432	532	4
7/8	97	406	82	28	16	1,040	134	155	761	15
7/9	324	81	23	8	37	91	32	361	923	0
7/10	91	138	12	10	61	345	37	19	321	137
7/11	267	134	111	17	149	91	50	168	448	72
7/12	813	70	38	203	72	13	85	22	846	95
7/13	131	88	12	201	62	14	23	6	1,039	0
7/14	520	54	5	80	28	316	1	1	1,126	660
7/15	185	181	47	83	16	127	122	0	593	126
7/16	39	33	36	122	32	6	7	0	412	17
7/17	1,474	4	23	230	54	15	66	11	386	9
7/18	194	0	14	228	135	2	424	13	312	142
7/19	10	83	2	193	1,562	183	2,978	50	115	40
7/20	2	1,109	62	228	955	1,984	1,126	412	336	245
7/21	93	777	164	257	1,624	221	1,025	591	453	318
7/22	130	44	1,152	251	3,532	472	3,443	1,753	1,308	19
7/23	3,846	6	388	29	1,926	9	537	330	147	38
7/24	785	15	3	45	2,631	4	0	3,202	487	63
7/25	3,704	0	3	61	731	134	280	200	215	56
7/26	1,080	2,463	15	663	560	2,395	52	0	209	230
7/27	449	2,515	7	815	820	887	219	0	45	1,856
7/28	3,615	4,288	58	4,102	1,261	1,854	62	0	584	1,914
7/29	20,013	717	1,955	1,549	9,473	1,902	3	0	1,097	808
7/30	5,539	14	4,899	82	1,607	1,325	2	2,299	3,000	823
7/31	2,122	4,933	1,403	61	1,389	2	185	4,817	1,861	382
8/1	15,799	1,957	6,259	48	1,307	227	6,690	19,269	287	940
8/2	2,346	820	87	294	707	777	6,280	6,635	296	5,456
8/3	946	932	4,349	4,326	1,033	9,368	2,369	713	1,289	4,107
8/4	2,750	1,061	3,361	1,509	1,476	5,291	3,384	300	1,190	1,982
8/5	1,838	1,512	5,407	3,074	2,930	6,223	2,356	7,209	1,027	3,492
8/6	1,583	871	12,589	5,942	2,514	6,673	2,101	12,197	1,576	1,274
8/7	690	700	7,106	5,511	2,520	165	6,059	10,771	1,195	2,762
8/8	476	2,931	3,950	6,386	1,075	3,332	5,995	13,041	3,125	6,002
8/9	711	3,007	2,562	11,189	1,516	189	4,756	13,986	781	7,294
8/10	1,351	12,451	2,623	6,206	3,703	5,514	1,601	23,127	389	12,484
8/11	1,570	10,047	8,480	4,927	10,837	9,508	1,782	31,677	346	9,986
8/12	348	1,943	13,372	9,228	7,877	8,513	7,668	9,406	3,147	1,979
8/13	4,541	1,553	16,041	5,781	11,010	10,075	5,205	8,841	4,112	1,723
8/14	5,367	9,390	3,608	13,489	1,332	11,399	11,133	5,515	4,154	865
8/15	5,323	14,188	1,966	10,255	3,998	13,588	7,532	5,005	13,721	1,172
8/16	8,107	25,801	1,044	13,181	4,135	6,890	1,677	2,134	12,352	6,494

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					——YEAR——					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/17	3,898	5,446	2,055	15,026	5,614	12,610	20,283	1,785	3,034	906
8/18	1,309	3,202	1,710	4,204	2,358	17,530	14,716	1,121	6,517	3,031
8/19	1,439	1,615	6,207	19,554	16,319	12,534	13,383	2,413	14,592	3,915
8/20	7,002	626	11,221	9,400	5,506	12,180	7,502	563	5,987	9,035
8/21	9,179	1,434	18,865	13,048	7,646	6,537	4,048	2,045	8,122	13,107
8/22	5,358	4,599	21,305	8,381	8,132	10,911	1,760	1,124	20,706	8,334
8/23	11,027	10,026	3,437	5,008	4,886	9,463	855	1,524	11,517	5,097
8/24	3,834	10,845	2,864	2,734	7,157	3,516	877	884	13,048	6,895
8/25	12,482	8,354	4,731	1,093	4,222	378	1,374	412	6,058	8,963
8/26	4,022	22,426	12,492	1,469	3,249	2,527	842	4,582	10,535	13,044
8/27	16,329	4,236	8,024	1,053	3,036	2,403	2,824	4,152	19,683	8,512
8/28	14,151	2,688	5,195	1,027	3,448	2,658	4,392	14,017	16,492	5,641
8/29	11,106	799	5,823	431	4,240	6,010	7,061	11,806	4,710	961
8/30	1,095	1,404	9,289	610	2,498	169	12,506	5,795	4,623	853
8/31	101	1,039	10,005	559	3,549	1,900	9,289	1,632	1,993	1,384
9/1	2,618	1,564	5,469	615	3,627	378	4,868	1,229	2,362	39
9/2	4,885	1,562	3,773	428	4,244	1,522	1,212	1,430	2,977	2,231
9/3	3,435	30	1,360	447	3,592	481	429	1,513	2,109	513
9/4	2,595	245	870	207	2,847	1,812	1,111	634	2,854	750
9/5	240	61	226	206	2,159	606	868	1,220	2,621	1,253
9/6	3,523	962	2,291	266	2,000	170	2,029	1,000	1,724	835
9/7	1,542	1,364	784	712	500	1,980	975	0	1,126	943
9/8	760	5,127	677	522	1,500	2,196	760	0	2,446	0
9/9	1,511	1,431	1,500	76	2,000	1,077	1,508	0	2,403	0
9/10	2,270	503	0	26	1,000	500	575	0	1,600	0
9/11	570	979	0	318	300	500	615	0	1,000	0
9/12	396	541	0	101	0	0	0	0	0	0
9/13	0	1,020	0	558	0	0	0	0	0	0
9/14	0	0	0	461	0	0	0	0	0	0
9/15	0	0	0	306	0	0	0	0	0	0
9/16	0	0	0	135	0	0	0	0	0	0
9/17	0	0	0	187	0	0	0	0	0	0
9/18	0	0	0	240	0	0	0	0	0	0
9/19	0	0	0	55	0	0	0	0	0	0
9/20	0	0	0	20	0	0	0	0	0	0
9/21	0	0	0	80	0	0	0	0	0	0
9/22	0	0	0	500	0	0	0	0	0	0
Total:	286,288	254,446	292,886	218,143	222,381	259,320	245,151	303,047	278,448	201,927

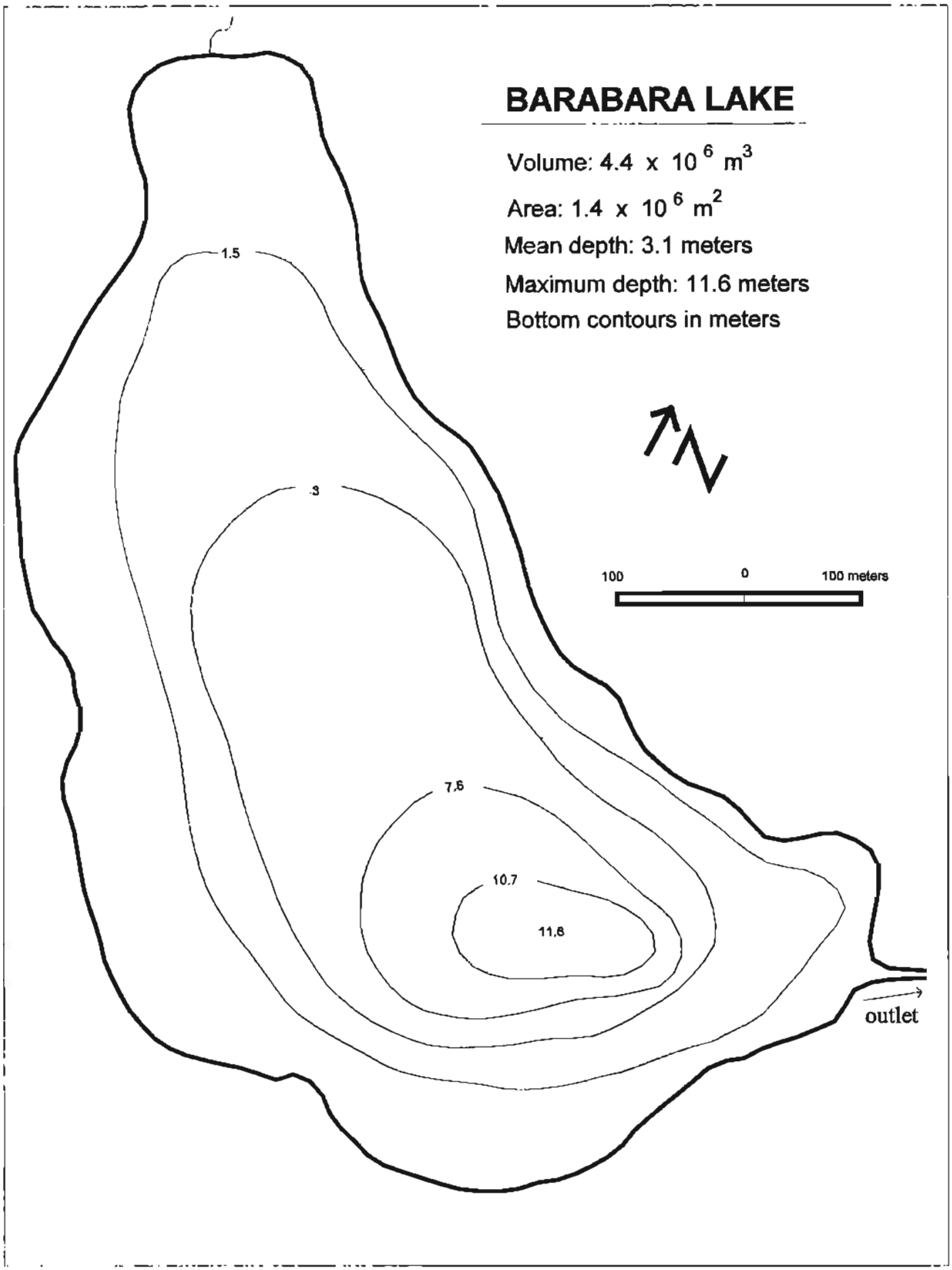
Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix Q.16. Upper Station Lakes sockeye salmon escapements, broodstock used and estimated freshwater age composition, 1988-1996.

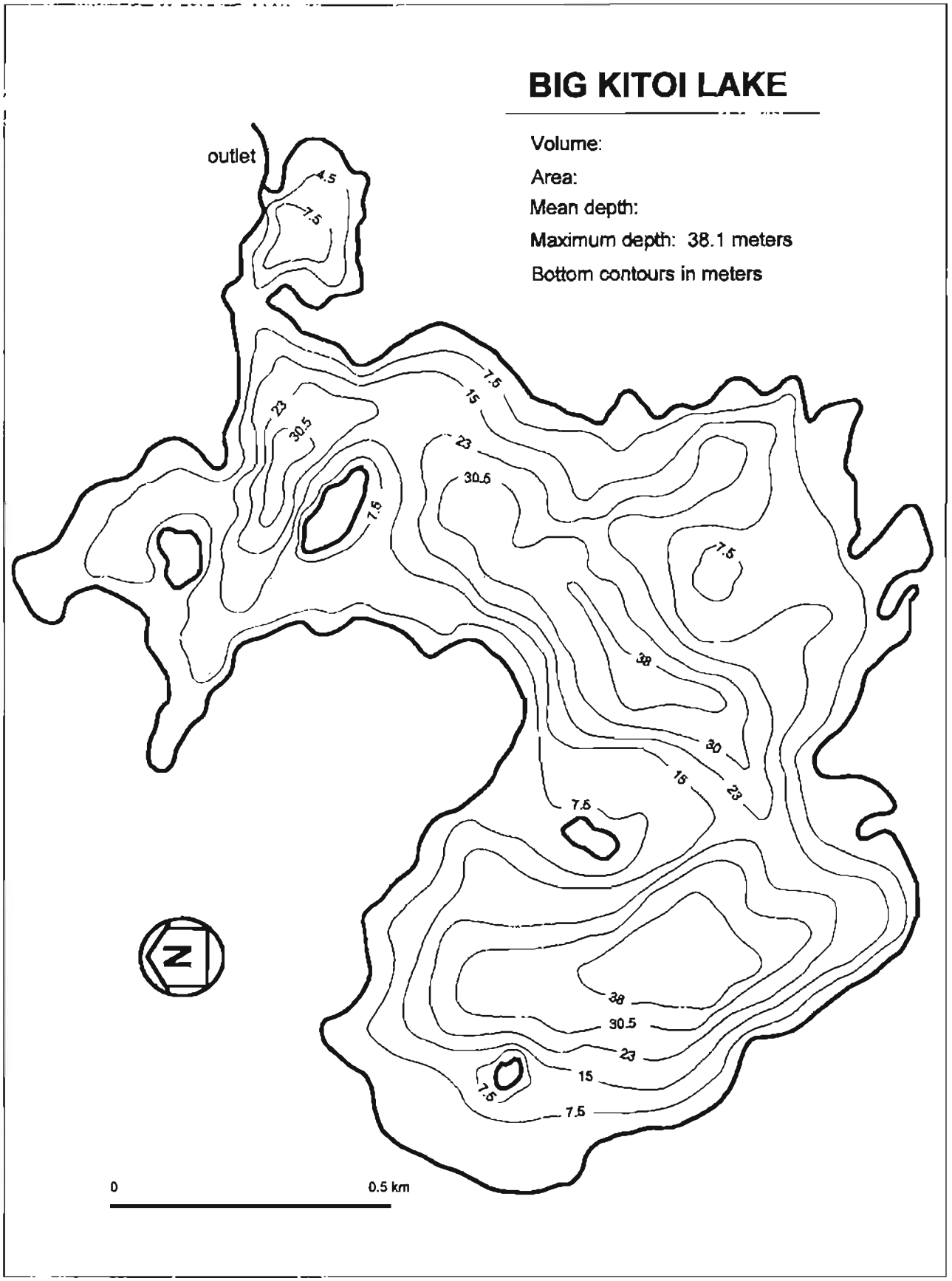
Year	Escapement Counts		Broodstock	Percent Late		Estimated Fresh Water Age Composition					Number
	Total[a]	Excess[b]	Number	Run Escapement		0	1	2	3	Totals	of samples
1988	249,844	49,844	120	0.05	%	92	9	0	0	100	80
					#	110	10	0	0	120	
1989	223,518	23,518	3,000	1.34	%	80	12	7	1	100	152
					#	2,406	357	216	21	3,000	
1990	200,293	293	3,700	1.85	%	25	56	19	0	100	535
					#	914	2,068	718	0	3,700	
1991	243,161	43,161	3,800	1.56	%	8	21	71	0	100	201
					#	285	794	2,702	0	3,781	
1992	200,325	325	6,816	3.40	%	31	11	58	0	100	196
					#	2,133	757	3,926	0	6,816	
1993	191,891	0	5,551	2.89	%	68	6	23	2	100	220
					#	3,786	350	1,288	128	5,552	
1994	221,675	21,675	240	0.17	%	87	5	8	0	100	62
					#	209	12	19	76	240	
1995	203,659	3,659	3,668	1.80	%	2	22	76	0	100	254
					#	87	794	2,773	14	3,668	
1996	243,385	43,385	4,810	1.98	%	3	18	79	0	100	313
					#	154	847	3,795	14	4,810	

[a] a portion of the escapement occurs after the weir is removed (>July 15).

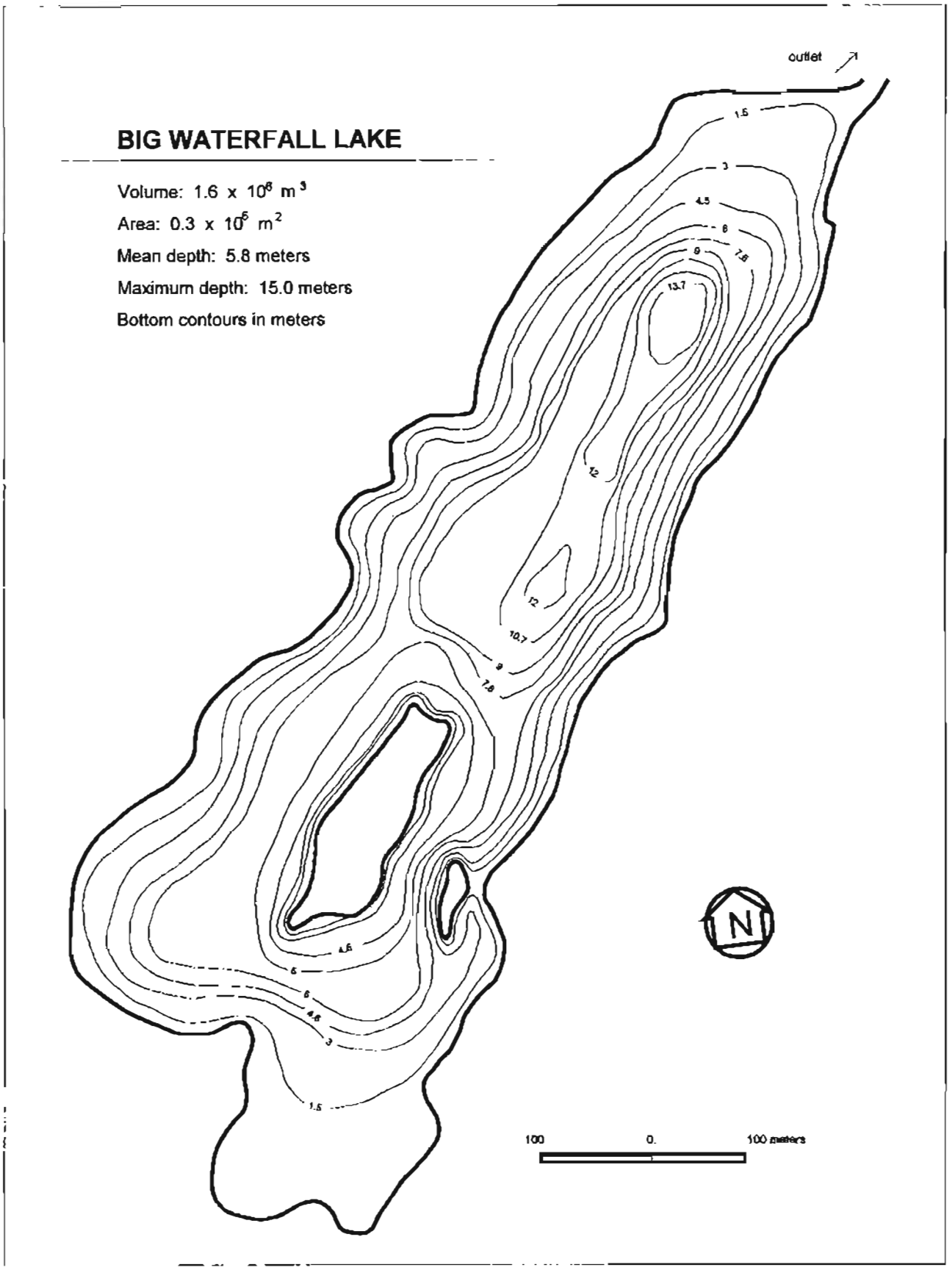
[b] number in excess of late run optimum escapement goal of 200,000 sockeye salmon.



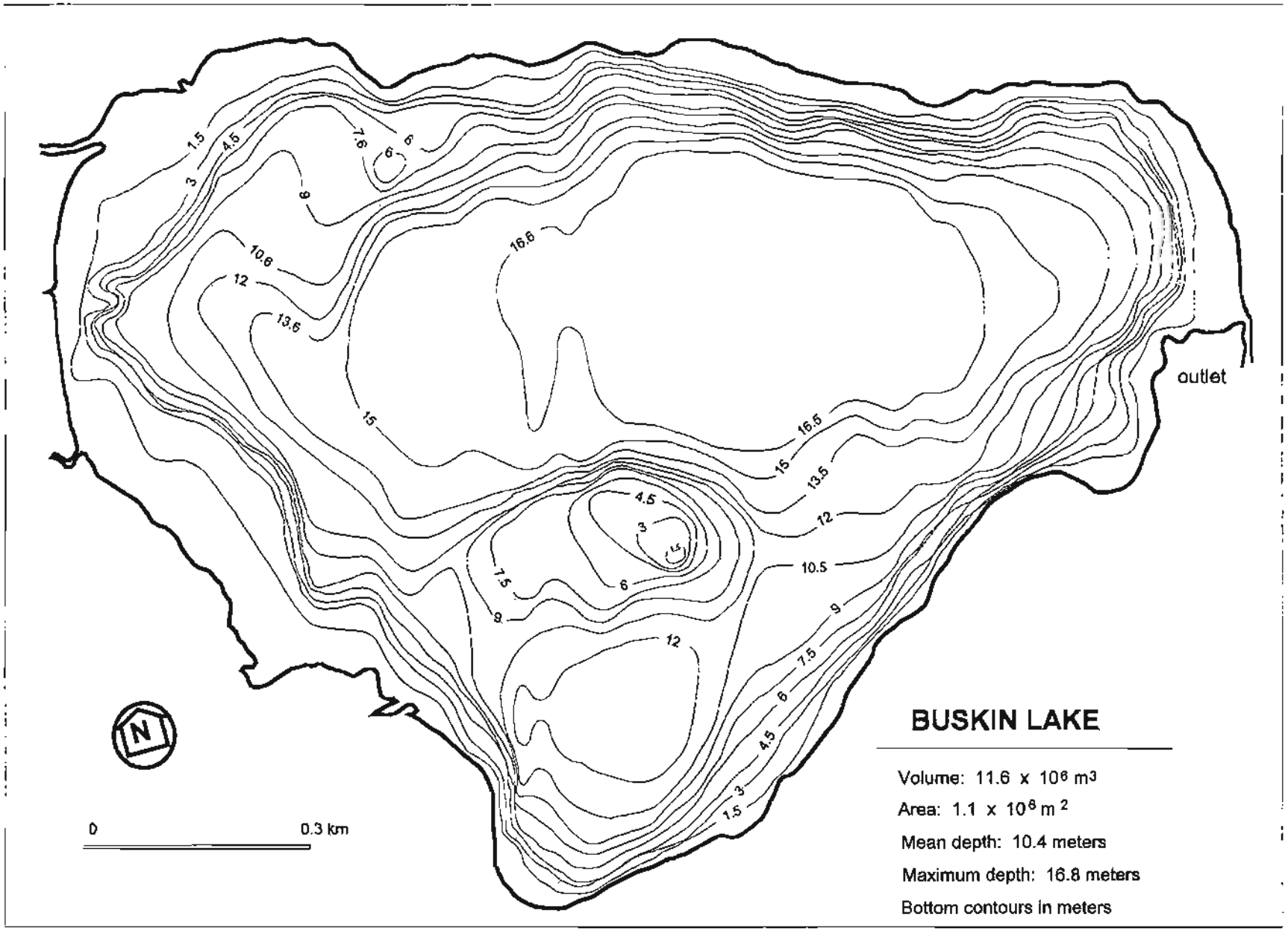
Appendix R.1. Morphometric map of Barabara Lake.



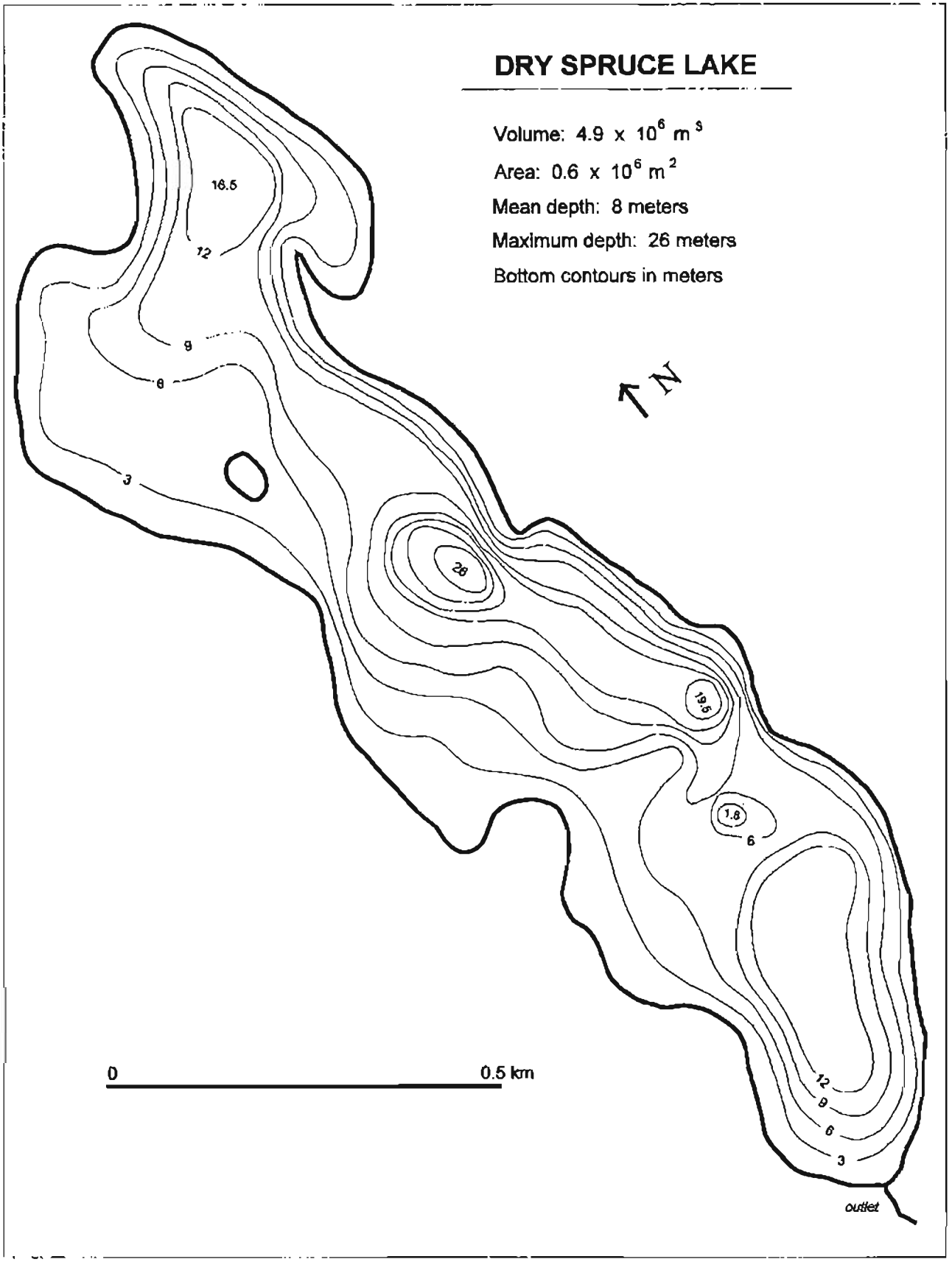
Appendix R.2. Morphometric map of Big Kitoi Lake.



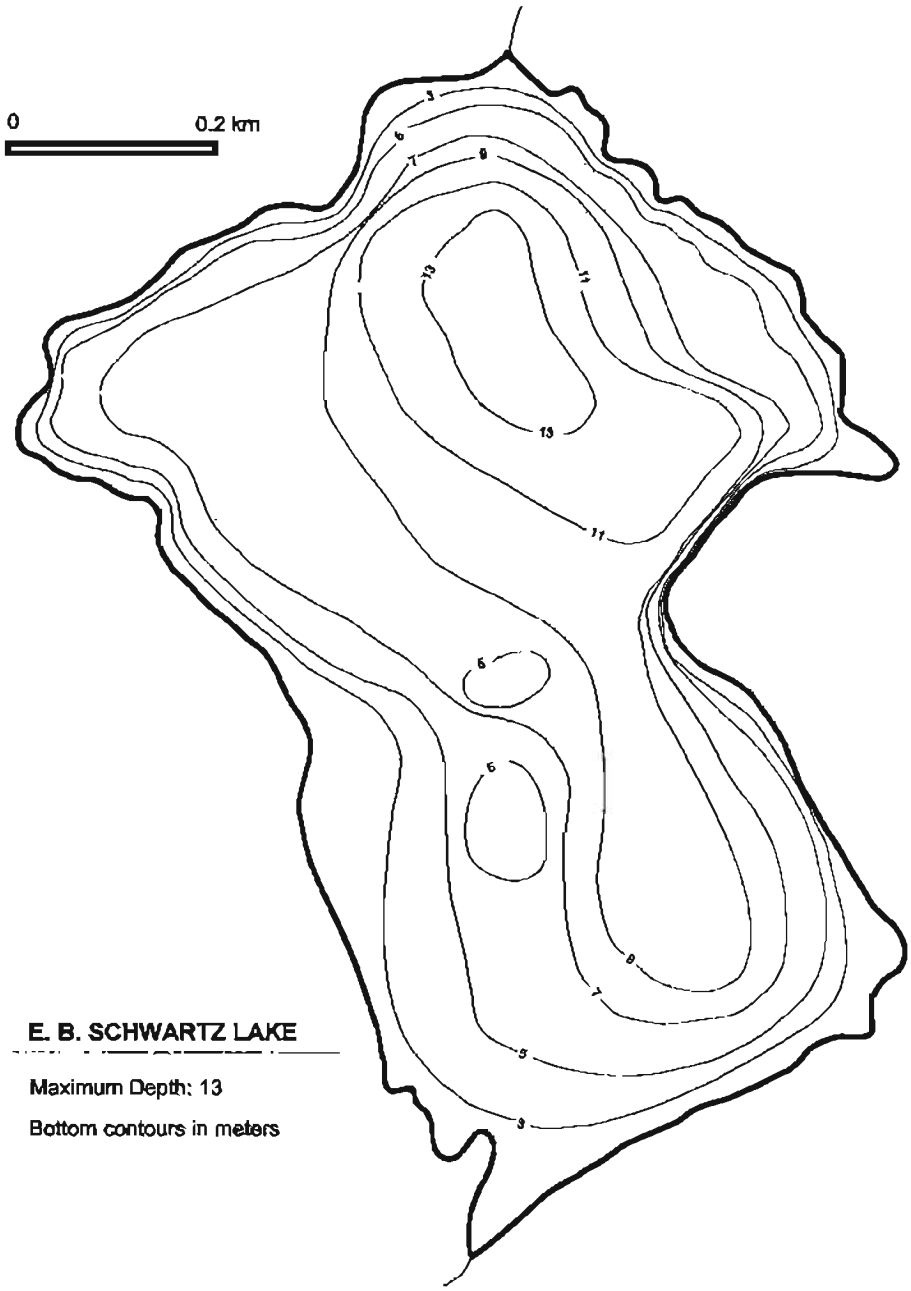
Appendix R.3. Morphometric map of Big Waterfall Lake.



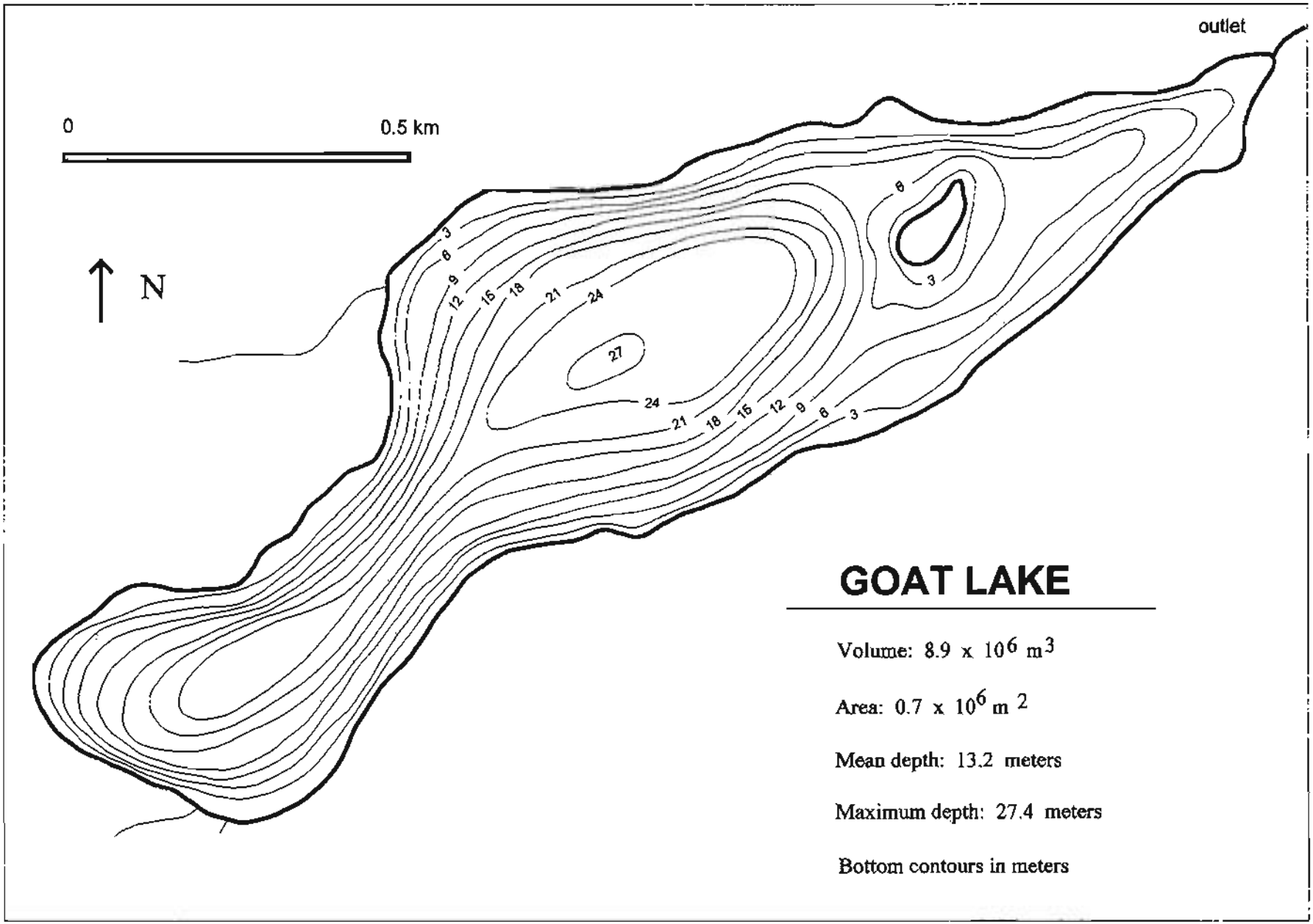
Appendix R.4. Morphometric map of Buskin Lake.



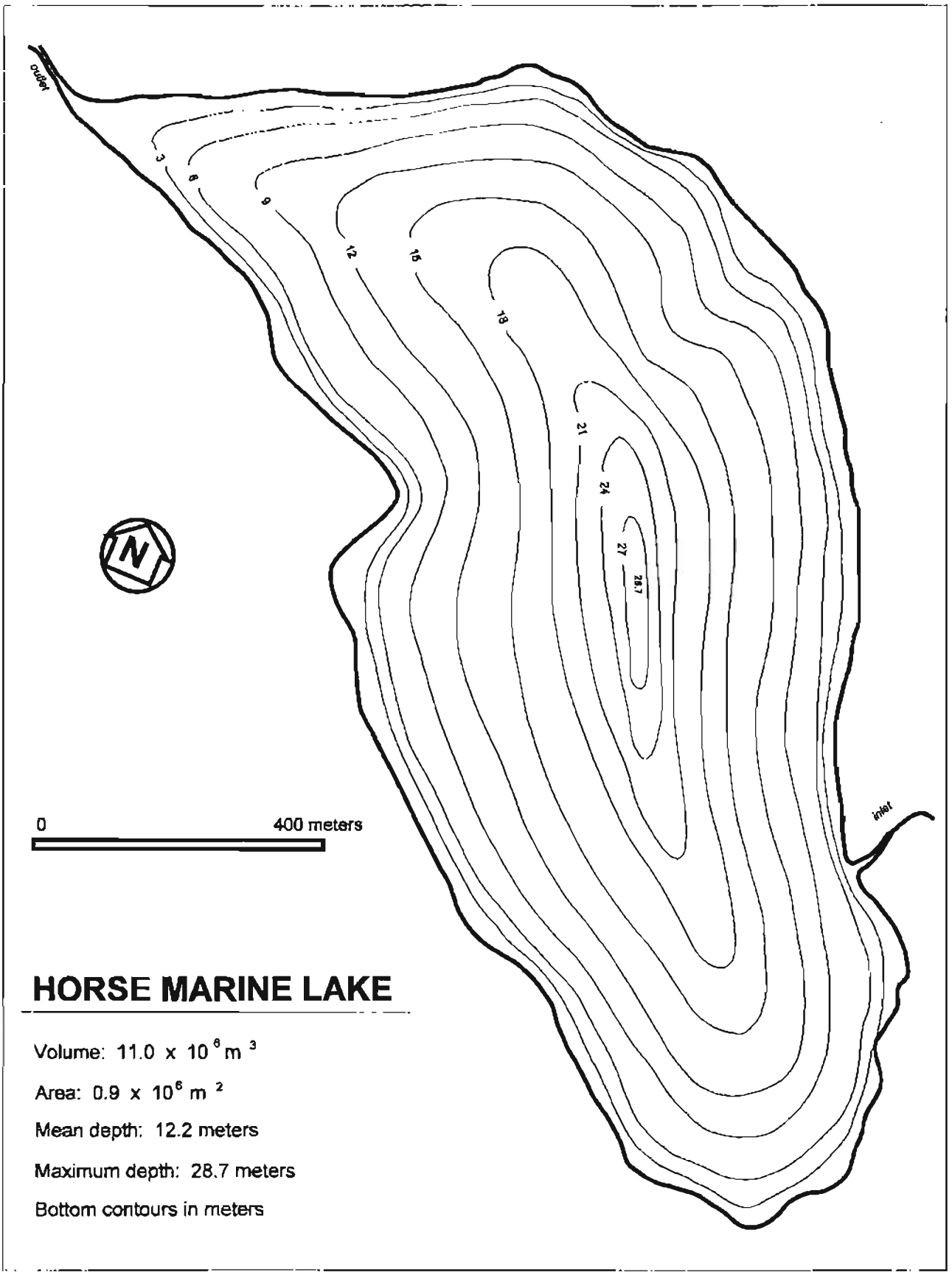
Appendix R.5. Morphometric map of Dry Spruce Lake.



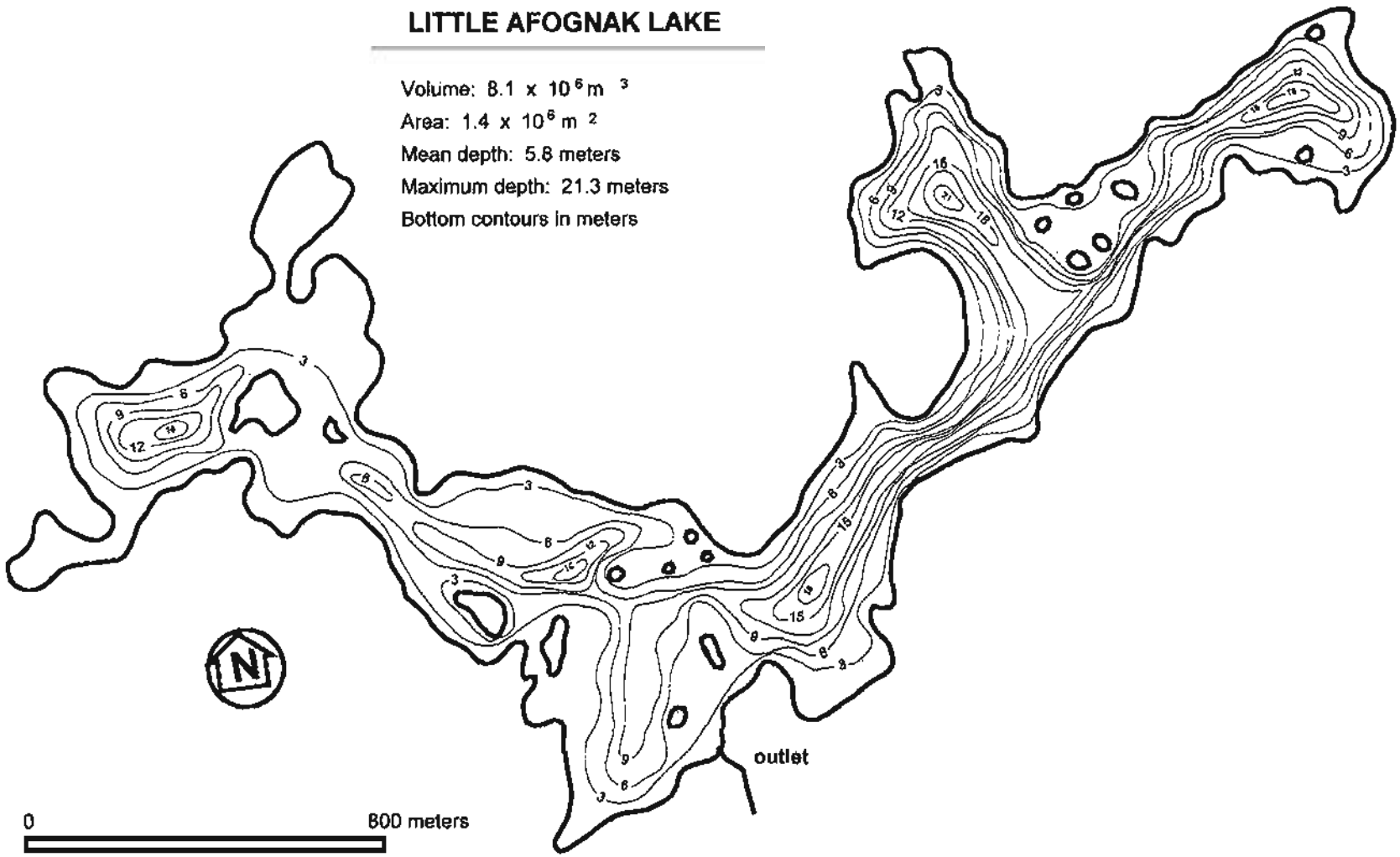
Appendix R.6. Morphometric map of E.B. Schwartz Lake.



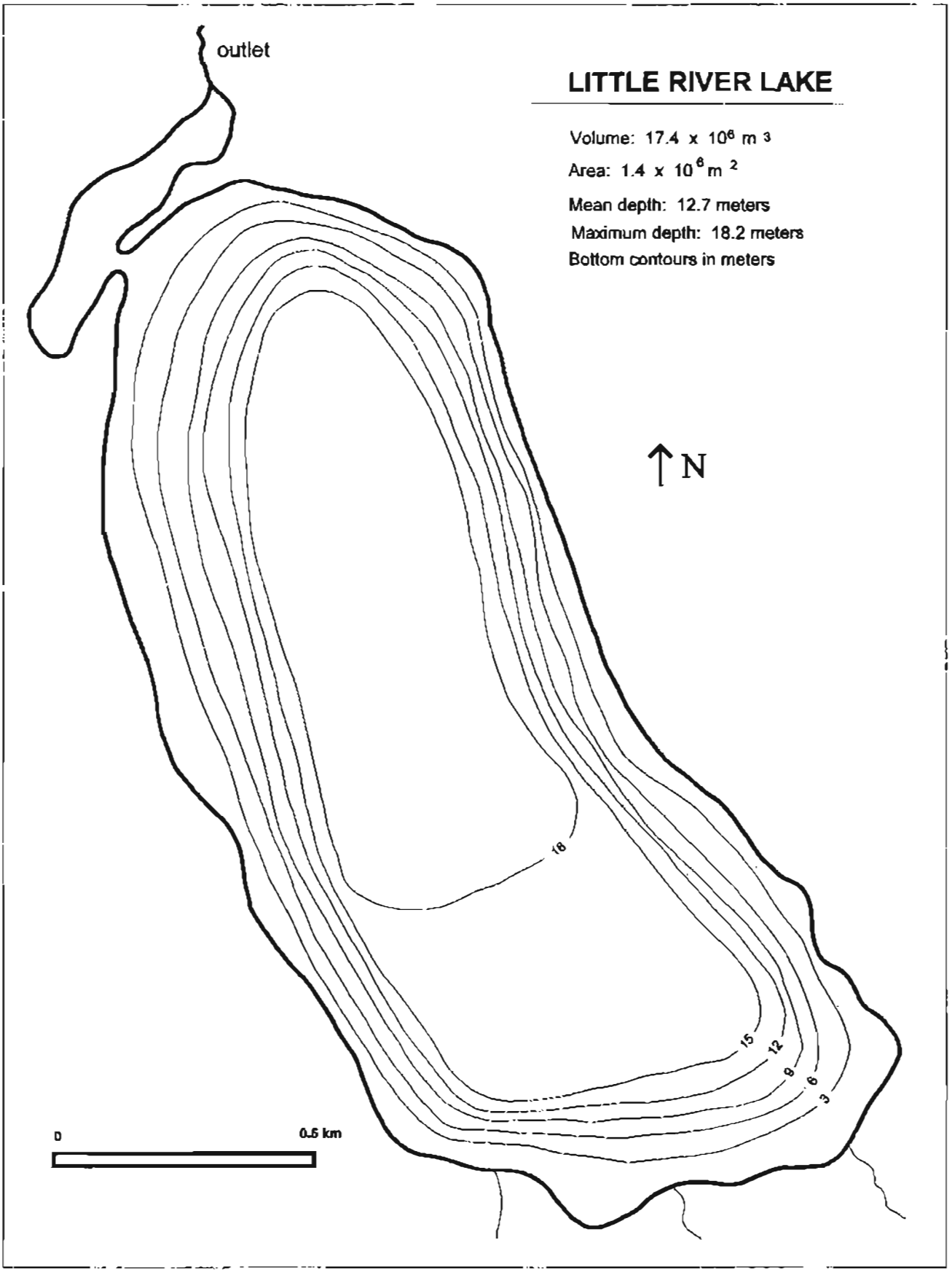
Appendix R.7. Morphometric map of Goat Lake.



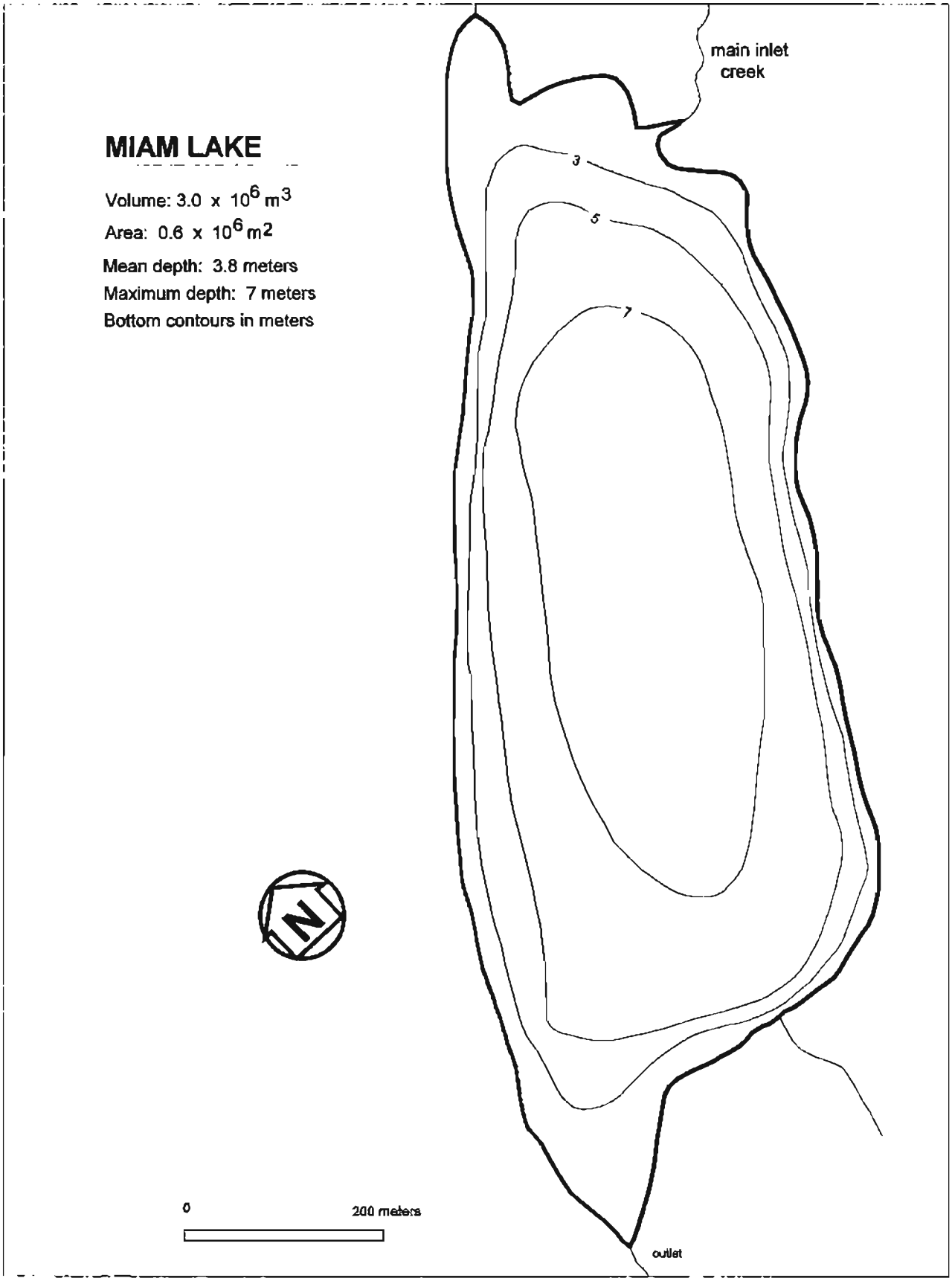
Appendix R.8. Morphometric map of Horse Marine Lake.



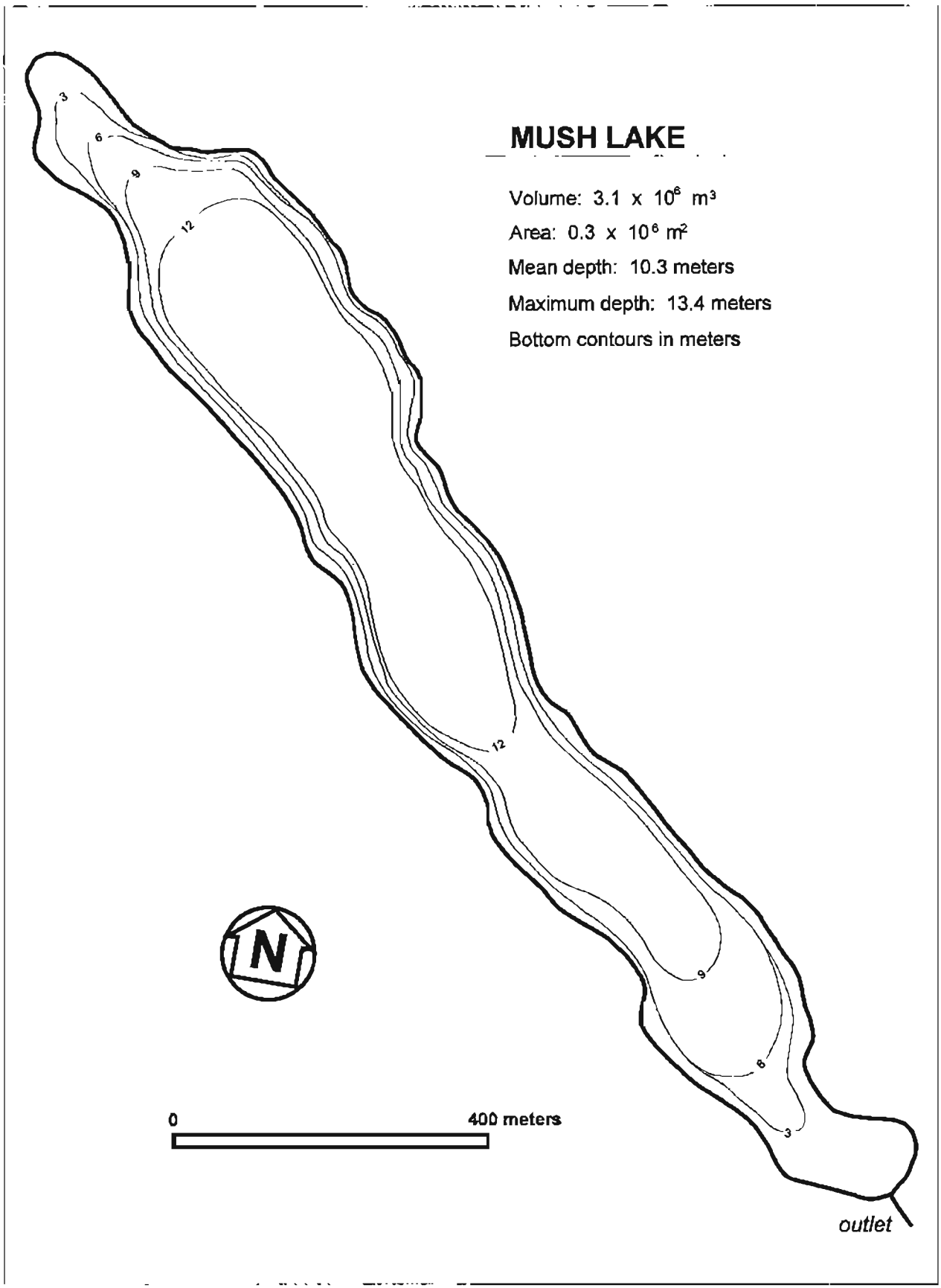
Appendix R.9. Morphometric map of Little Afognak Lake.



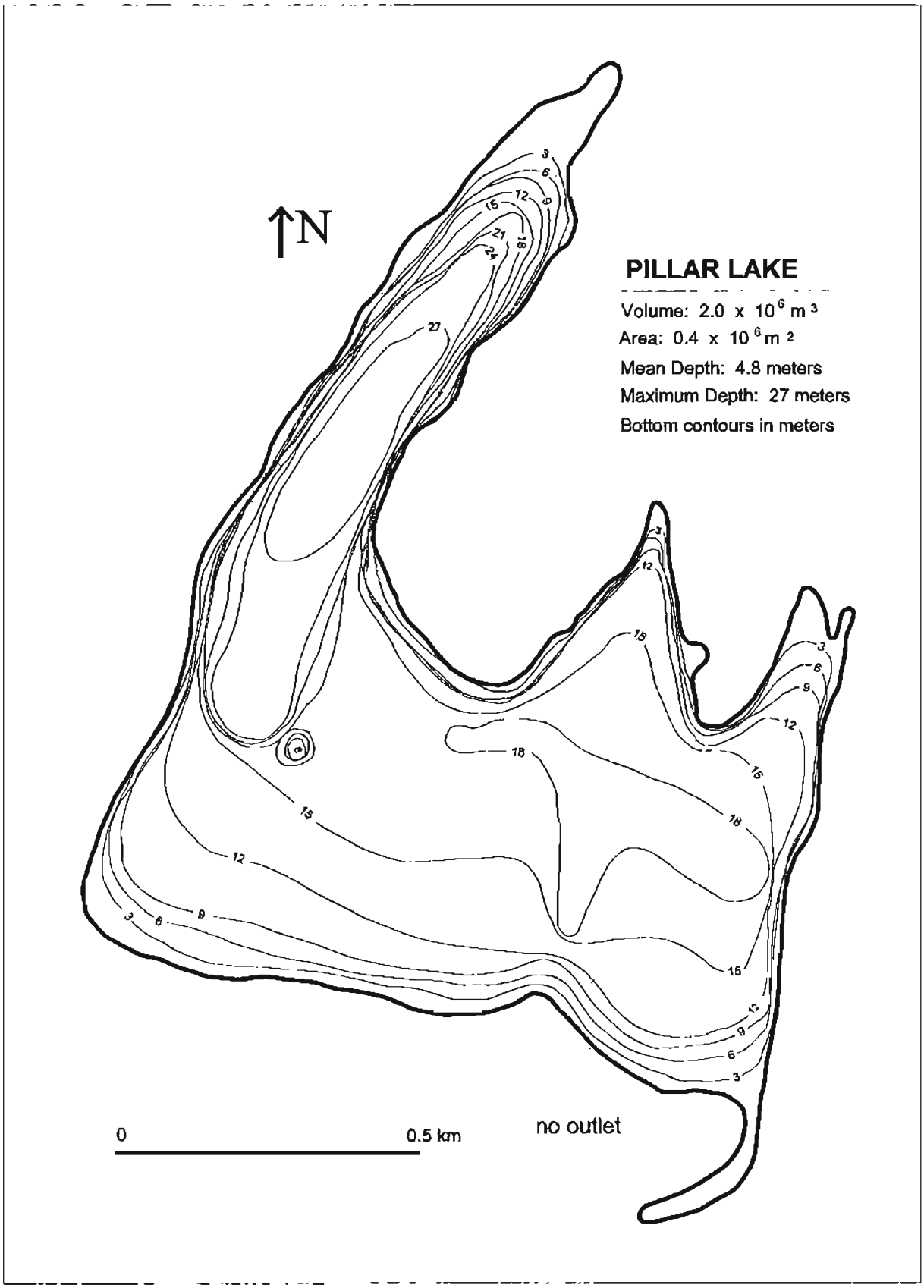
Appendix R.10. Morphometric map of Little River Lake.



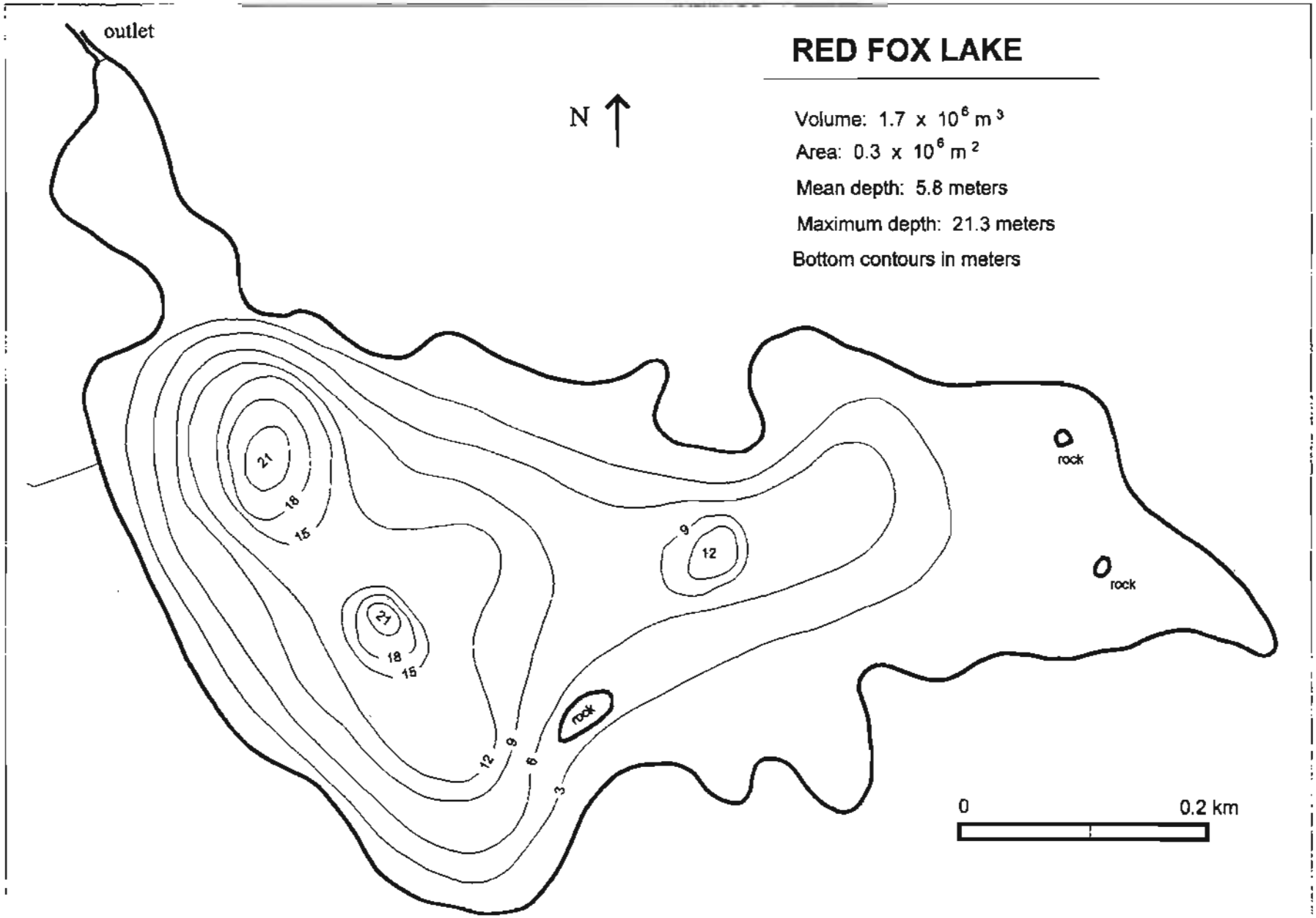
Appendix R.11. Morphometric map of Miam Lake.



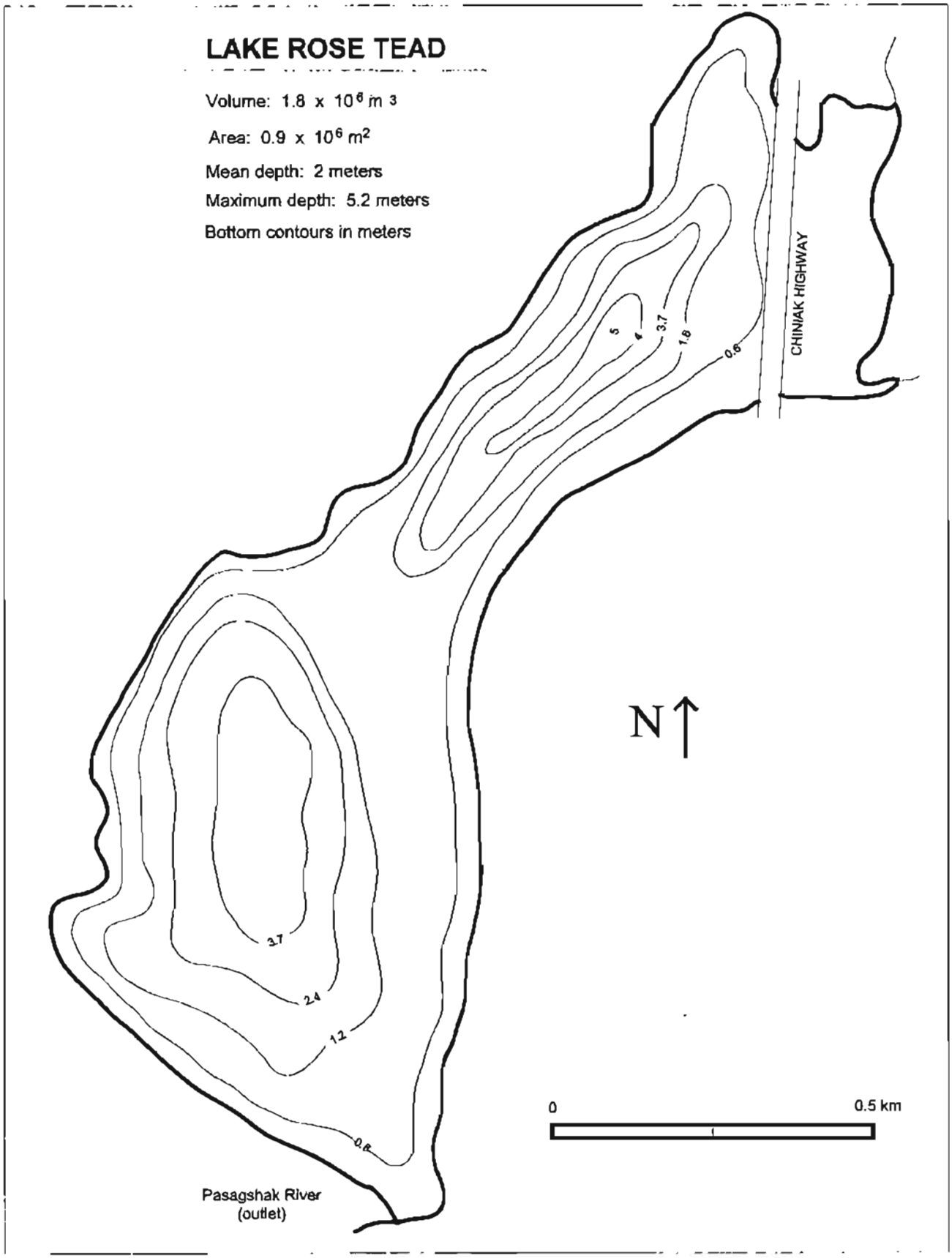
Appendix R.12. Morphometric map of Mush Lake.



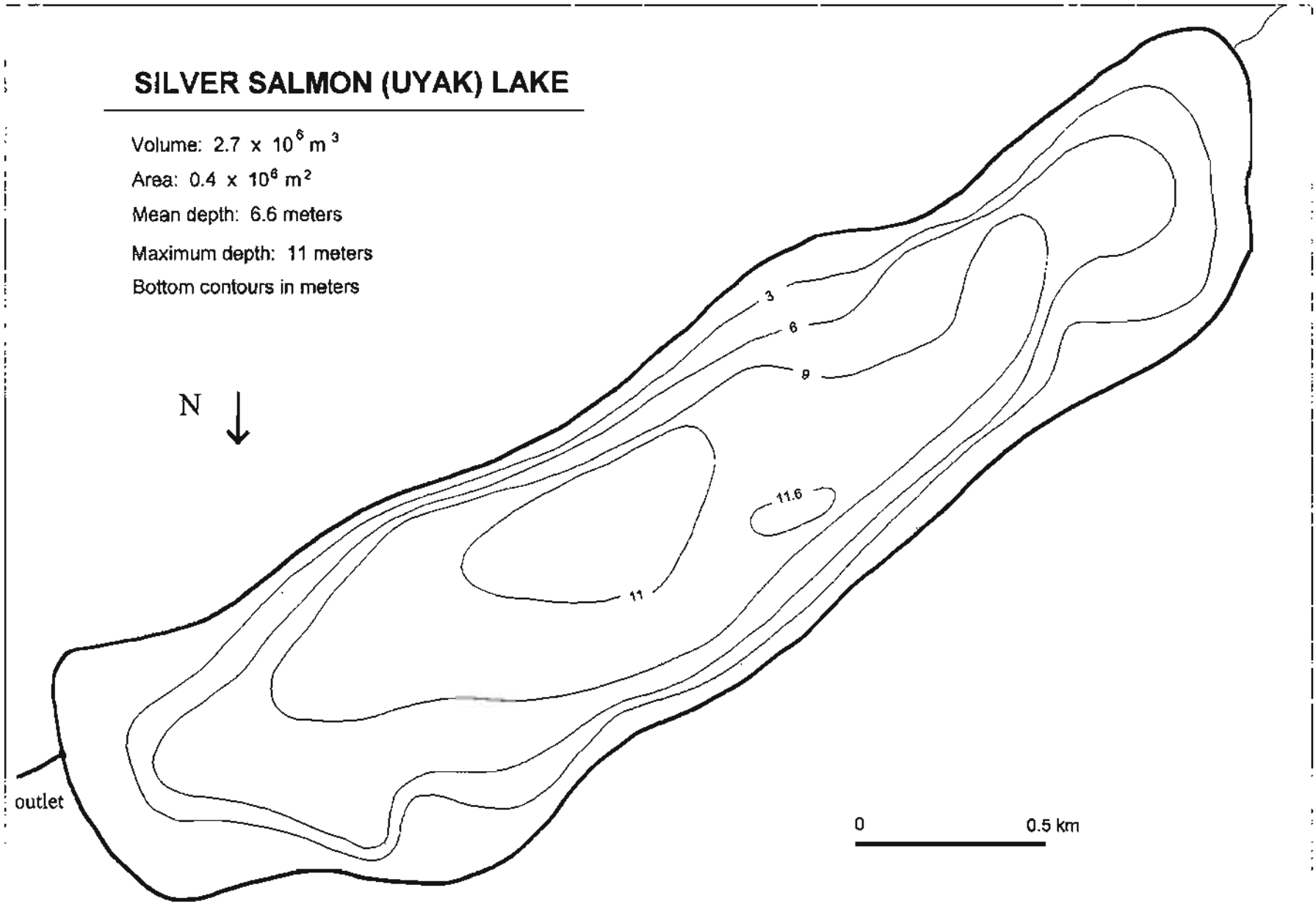
Appendix R.13. Morphometric map of Pillar Lake.



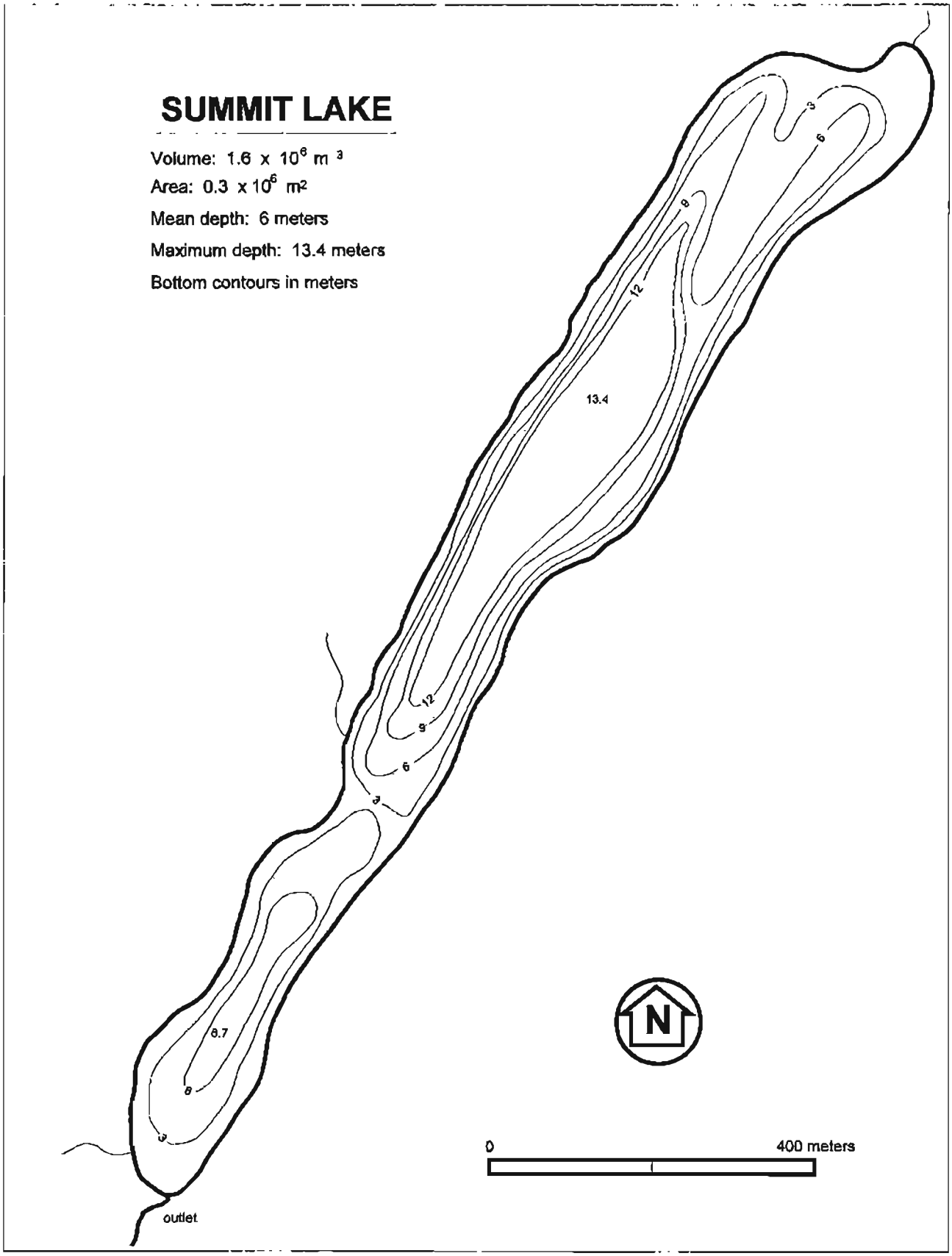
Appendix R.14. Morphometric map of Red Fox Lake.



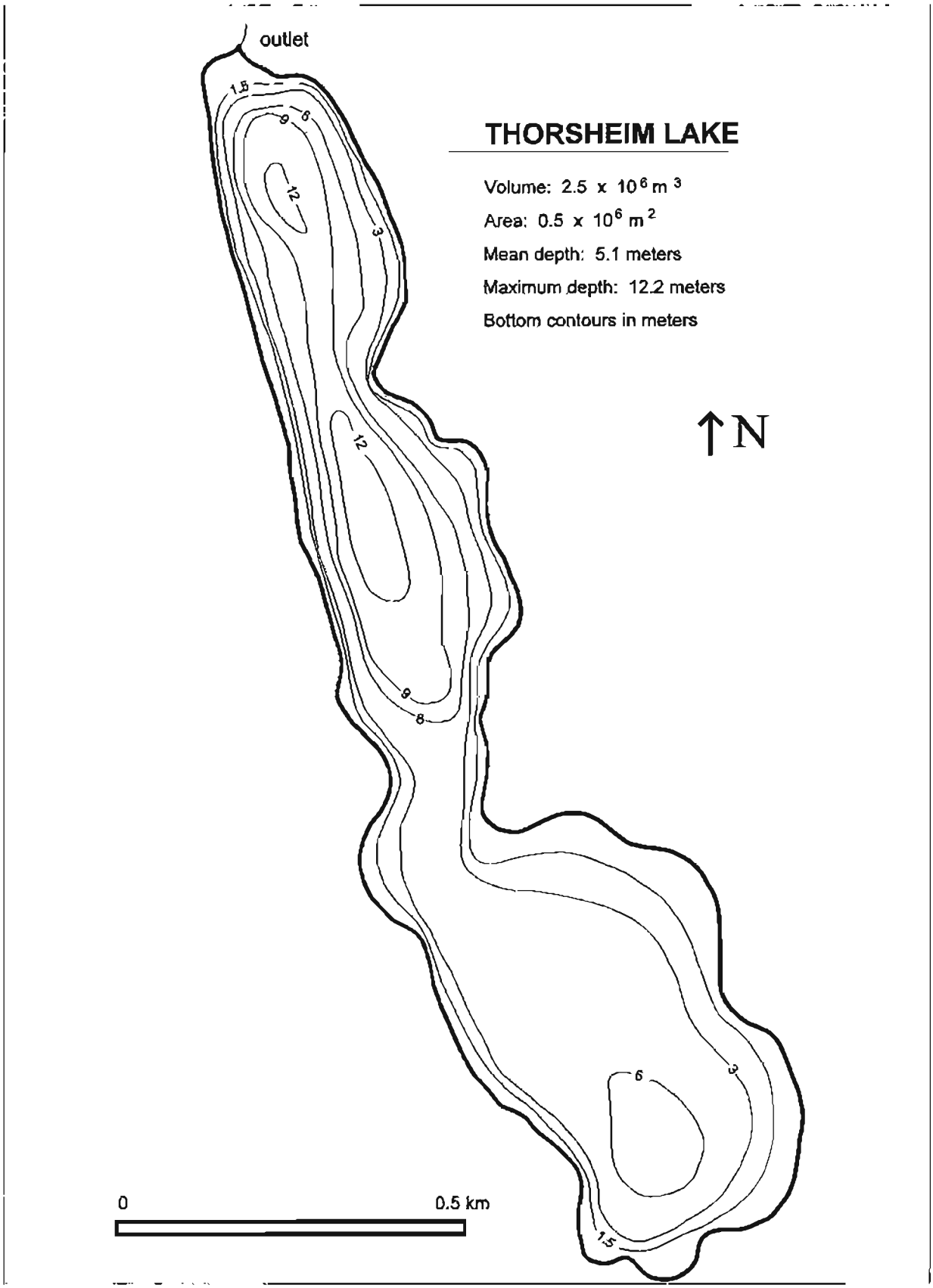
Appendix R.15. Morphometric map of Rose Tead Lake.



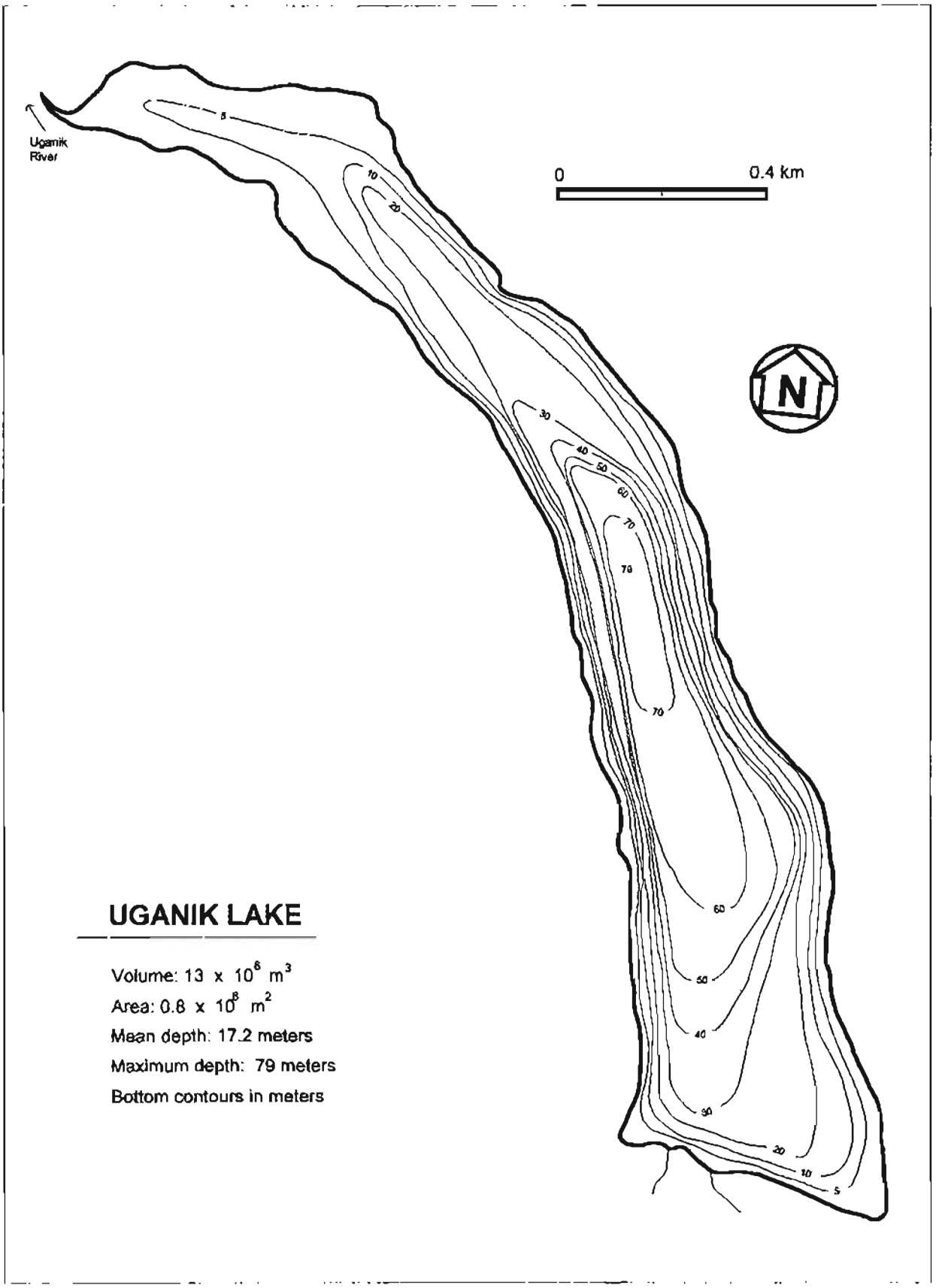
Appendix R.16. Morphometric map of Silver Salmon (Uyak) Lake.



Appendix R.17. Morphometric map of Summit Lake.



Appendix R.18. Morphometric map of Thorsheim Lake.



Appendix R.19. Morphometric map of Uganik Lake.

Appendix R.20. Limnological and sampling frequencies for Kodiak and Afognak Island Lakes.

Lake	Year	Frequency
Barabara	1990	4
	1991	4
Big Kitoi	1991	5
	1992	5
	1993	5
	1994	4
Dry Spruce	1991	5
Goat	1991	4
Horse Marine	1991	4
Little Afognak	1991	4
	1992	4
Little River	1990	4
	1991	4
Mush	1991	4
Pillar	1995	4
Red Fox	1990	4
Rose Tead	1995	1
Salmon (Uyak)	1990	3
Sitkaladik	1990	1
Summit	1990	4
Thorsheim	1991	4
Uganik	1990	4
	1991	4
	1996	4

Appendix R.21. Summary of seasonal mean water chemistry parameters by station for Kodiak and Afognak Island Area Lakes.

Lake	Year	Station	Depth (m)	Sp. Cond. (umhos cm^{-1})	pH (Units)	Alkalinity (mg L^{-1})	Turbidity (NTU)	Color (Pt units)	Calcium (mg L^{-1})	Magnesium (mg L^{-1})	Iron (ug L^{-1})
Barabara	1990	1	1	36.0	6.9	8.1	0.8	11.8	3.0	0.7	154.3
		1	10	35.5	6.9	8.3	1.0	15.8	3.0	0.5	196.3
	1991	1	1	36.0	6.9	9.0	0.8	14.0	2.9	0.3	220.3
		1	10	35.8	6.8	9.1	1.0	13.5	2.7	0.3	251.5
Buskin	1990	1	1	51.3	7.1	13.7	0.9	6.3	6.5	0.5	76.7
		1	16	41.7	7.0	13.5	1.1	11.0	6.2	0.3	65.7
Goat	1991	1	1	16.8	6.1	5.3	0.6	4.0	2.2	0.3	23.0
		1	20	16.5	6.1	5.1	0.6	6.8	1.7	0.3	27.0
Horse	1991	1	1	29.6	6.6	7.5	0.8	9.9	2.7	0.4	132.5
Marine		1	24	29.3	6.6	7.5	0.8	12.0	2.5	0.4	158.3
E.B.	1993	1	1	76.0	7.3	19.0	0.5	6.0	6.7	1.6	27.0
Schwartz		1	11	85.0	6.8	17.0	0.2	12.0	6.7	1.6	14.0
Little	1992	1	1	77.5	6.9	19.8	1.2	12.3	6.2	2.2	64.0
Afognak		1	15	80.3	6.7	19.9	0.8	13.0	6.9	2.2	71.8
Little	1990	1	1	56.3	7.4	18.0	3.1	6.3	4.6	2.4	224.0
River		1	17	58.5	7.0	19.0	2.6	6.3	5.8	1.2	197.8
	1991	1	1	59.3	7.2	17.3	4.3	8.8	5.1	1.8	91.8
		1	15	61.3	7.0	17.1	3.0	10.5	4.6	1.8	186.8
Mush	1991	1	1	61.7	7.3	17.4	2.5	7.2	5.3	1.8	115.4
		1	12	65.8	6.9	17.1	1.9	9.7	5.5	1.5	134.4
Red Fox	1990	1	1	55.3	7.1	15.4	2.2	7.7	4.8	1.5	118.8
		1	14	58.5	6.8	15.2	1.7	10.2	4.9	1.2	139.2
Thorsheim	1991	1	1	58.1	7.2	17.0	3.0	7.5	4.9	1.9	137.5
		1	10	61.0	6.9	17.1	2.3	9.2	5.2	1.4	164.5
Uganik	1990	1	1	58.6	7.2	16.8	3.0	7.8	5.0	1.8	115.9
		1	50	61.6	6.9	16.6	2.2	9.9	5.0	1.5	156.2
	1991	1	1	58.4	7.2	16.7	2.7	7.5	5.0	1.8	121.9
		1	50	61.7	6.9	16.5	2.0	9.7	5.1	1.4	148.6

NA - not analyzed

Appendix R.22. Summary of seasonal mean nutrient and algal pigment concentrations by station for Kodiak and Afognak Island Area Lakes.

Lake	Year	Station	Depth (m)	Total-P (ug L^{-1})	Total filterable-P (ug L^{-1})	Filterable reactive-P (ug L^{-1})	Total Kjeldahl-N (ug L^{-1})	Ammonia (ug L^{-1})	Nitrate+ nitrite (ug L^{-1})	Reactive silicon (ug L^{-1})	Organic carbon (ug L^{-1})	Chlorophyll *a* (ug L^{-1})	Phaeophytin *a* (ug L^{-1})
Barabara	1990	1	1	5.2	3.6	2.6	164.5	8.4	85.3	3530	254.0	0.45	0.24
		1	10	5.5	5.4	5.0	161.3	14.0	98.3	3510	226.3	0.44	0.38
	1991	1	1	8.0	4.7	4.0	0.0	6.3	80.9	2776	NA	1.29	0.35
		1	10	7.8	3.7	3.1	0.0	8.3	88.6	2917	NA	0.92	0.41
Buskin	1990	1	1	5.5	3.2	2.2	92.6	4.7	155.6	1412	237.3	1.41	0.55
		1	16	4.5	7.9	6.8	76.8	6.8	174.4	1316	212.0	1.18	1.45
Goat	1991	1	1	1.7	3.2	2.2	26.8	4.2	51.2	984	NA	0.30	0.20
		1	20	2.1	3.8	2.8	27.7	4.2	50.8	982	NA	0.36	0.21
Horse	1991	1	1	5.0	3.8	2.9	63.8	6.3	72.4	2430	254.0	0.68	0.26
Marine		1	24	5.1	4.3	3.6	63.0	8.8	79.2	2470	226.3	0.57	0.33
E.B.	1993	1	1	2.4	1.9	0.8	90.8	<1.7	21.8	1597	262.0	0.58	0.24
Schwartz		1	11	3.8	6.2	2.6	95.3	7.6	<4.0	1571	224.0	0.66	0.54
Little	1992	1	1	3.6	1.9	1.7	106.3	2.3	33.4	1991	128.0	0.43	0.82
Afognak		1	15	3.3	2.4	2.3	104.8	6.9	29.3	2488	76.0	0.60	0.48
Little	1990	1	1	13.8	3.0	2.2	286.5	5.0	34.8	1986	487.5	4.09	2.06
River		1	17	29.6	5.1	3.1	324.4	118.1	56.0	2295	503.0	2.39	1.49
	1991	1	1	21.3	6.0	4.2	305.7	26.4	28.4	2394	0.0	9.88	0.76
		1	15	27.6	9.9	7.2	312.9	145.9	55.5	2730	0.0	4.54	0.87
Mush	1991	1	1	12.0	3.6	2.4	217.4	14.6	31.1	2020	250.1	4.59	0.97
		1	12	19.4	6.9	4.2	232.9	85.4	58.3	2216	241.3	2.41	0.93
Red Fox	1990	1	1	10.6	3.7	2.5	186.7	12.6	39.4	2102	250.9	3.81	0.83
		1	14	16.5	6.4	4.1	198.9	70.1	63.6	2266	238.3	2.04	0.81
Thorsheim	1991	1	1	14.4	4.1	2.8	249.1	14.6	33.4	2125	247.1	5.59	1.15
		1	10	23.3	7.1	4.7	267.3	104.9	58.3	2377	245.7	2.85	1.02
Uganik	1990	1	1	14.6	4.3	3.0	239.7	17.1	33.1	2160	187.0	5.97	0.93
		1	50	21.7	7.6	5.1	253.0	101.6	58.9	2397	181.3	2.96	0.91
	1991	1	1	12.9	3.9	2.7	223.2	14.7	34.2	2102	233.8	4.99	0.97
		1	50	20.2	7.0	4.5	238.0	90.5	59.8	2314	226.7	2.56	0.92

NA - not analyzed

Appendix R.23. Weighted mean zooplankton density, biomass, and size by genera for Kodiak and Afognak Island Area Lakes.

			Epischura			*Diaptomus*			*Cyclops*			*Bosmina*			*Daphnia*			*Holopedium*			TOTALS	
Lake	Sample Year	No. of Sample Days	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2	Size mm	Density no/m^2	Biomass mg/m^2
Barabara	1990	4	25,345	141	1.08	-	-	-	564	-	-	24,834	26	0.34	418	-	-	690	2	0.62	51,851	169
Big Kitoi	1991	5	1,380	17	1.44	10,000	38	0.95	164,979	331	0.76	57,946	84	0.40	21,799	56	0.77	1,380	8	0.76	257,484	534
	1992	5	1,221	9	1.18	2,272	15	1.17	79,331	135	0.70	22,495	34	0.40	8,026	16	0.67	828	4	0.67	114,173	213
	1993	5	637	7	1.38	13,248	84	1.15	143,291	316	0.80	71,974	115	0.42	25,775	59	0.73	2,335	15	0.79	257,260	596
	1994	4	372	4	1.38	5,627	35	1.14	136,278	305	0.80	59,103	114	0.45	9,899	24	0.70	7,352	24	0.56	218,631	506
Big Waterfall	1990	3	1,592	28	1.62	-	-	-	163	1	0.94	11,909	33	0.54	69,537	161	0.73	7,224	76	0.97	90,425	299
Buskin	1990	3	-	-	-	-	-	-	5,995	6	0.51	63,217	55	0.31	-	-	-	1,398	3	0.53	70,610	64
Dry Spruce	1991	5	987	13	1.47	12,866	62	1.04	33,940	74	0.79	53,068	84	0.41	11,348	23	0.69	-	-	-	112,209	256
Goat	1991	4	19	0.1	1.08	-	-	-	41	0	0.91	338	0	0.36	8	0	1.01	4	0	0.69	410	1
Horse Marine	1991	4	66,116	168	0.82	-	-	-	4,843	6	0.61	75,571	73	0.33	-	-	-	33,340	87	0.55	179,870	334
Little Afognak	1992	4	398	1	0.75	849	1.5	0.72	8,731	9	0.57	18,126	18	0.33	2,521	3	0.57	398	1	0.44	31,023	34
Little River	1990	4	-	-	-				168,458	353	0.76	301,951	301	0.33	206,741	210	0.53	-	-	-	677,150	864
	1991	4	-	-	-	385	2	1.04	136,492	332	0.83	287,142	326	0.35	137,169	193	0.58	-	-	-	561,188	853
Mush	1991	4	-	-	-	-	-	-	71,995	189	0.86	85,550	64	0.29	-	-	-	-	-	-	157,545	253
Pillar	1995	4	-	-	-	14,995	68	1.02	74,310	210	0.88	18,737	52	0.54	25,611	79	0.79	8,360	88	0.97	142,013	497
Red Fox	1990	4	159	0.4	0.85	1,725	6	0.96	48,713	105	0.77	8,108	18	0.49	34,369	106	0.86	955	13	1.07	94,029	248
Rose Tead	1994	1	2,654	1.3	0.46	10,191	7	0.53	3,822	4	0.59	2,123	2	0.37	106	0	0.73	-	-	-	18,896	15
Salmon (Uyak)	1990	3	-	-	-	123,496	823	1.18	239,915	936	1.04	53,786	130	0.51	84,395	221	0.80	-	-	-	501,592	2110
Summit	1990	4	-	-	-	102,375	410	0.98	26,805	33	0.58	11,080	29	0.52	130,242	217	0.66	995	9	0.90	271,497	698
Thorsheim	1991	4	4,120	31	1.20	-	-	-	5,633	6	0.56	36,492	34	0.32	-	-	-	22,393	55	0.53	68,638	126
Uganik	1990	4	-	-	-	239	1	1.03	73,700	150	0.77	212	0	0.45	478	1	0.63	-	-	-	74,629	152
	1991	4	-	-	-	53	-	-	106,728	162	0.67	3,211	3	0.30	-	-	-	-	-	-	109,992	165
	1996	4	-	-	-	-	-	-	39,835	73	0.70	452	0	0.33	-	-	-	-	-	-	40,287	73

Appendix R.24. Buskin Lake sockeye salmon escapement counts, 1989-1998.

					---------YEAR---------					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
5/23	1									
5/24	0			2						
5/25	0	1		1						
5/26	10	0		1						
5/27	14	0	20	3			34			
5/28	40	15	15	0			0			
5/29	7	0	0	0			0	99	93	99
5/30	34	0	119	0	69		0	114	124	55
5/31	27	1	0	0	51		0	19	10	352
6/1	14	0	11	4	18		2	102	53	74
6/2	50	0	156	0	210	5	6	262	115	202
6/3	100	11	581	1	233	183	241	270	278	408
6/4	150	707	10	0	392	252	740	261	466	114
6/5	176	248	0	109	448	155	1,062	266	121	302
6/6	240	935	306	21	144	155	697	249	271	375
6/7	395	131	47	459	44	649	256	435	640	1,233
6/8	782	443	115	22	602	305	670	352	211	200
6/9	615	337	98	137	234	118	818	186	240	680
6/10	206	108	366	962	183	127	172	264	125	273
6/11	891	241	625	36	308	107	644	1,096	190	871
6/12	185	349	241	244	492	350	506	471	237	387
6/13	216	472	721	513	501	352	971	257	1,866	203
6/14	474	336	704	16	66	336	718	123	488	265
6/15	307	296	595	345	21	272	1,053	83	339	177
6/16	603	229	14	87	292	469	150	86	29	807
6/17	1,013	280	50	25	353	121	572	152	343	597
6/18	220	112	231	263	199	387	701	854	94	305
6/19	9	252	230	348	377	612	577	502	132	361
6/20	221	144	230	292	158	790	1,253	99	50	389
6/21	500	259	230	151	259	1,130	236	71	651	188
6/22	232	149	141	338	147	367	207	51	178	198
6/23	168	236	58	850	78	357	112	57	96	1,143
6/24	404	152	166	34	253	683	535	294	35	231
6/25	480	408	114	202	176	133	56	0	70	121
6/26	400	158	174	129	93	228	0	51	111	516
6/27	306	40	45	332	176	231	55	28	178	557
6/28	340	72	60	823	89	161	69	18	37	38
6/29	343	3	37	91	18	129	209	138	13	376
6/30	263	434	128	46	15	23	261	772	27	157
7/1	403	62	54	10	128	814	11	58	24	115
7/2	284	162	348	117	38	36	35	5	76	881
7/3	154	110	144	28	41	304	72	6	7	417
7/4	174	16	81	84	5	74	165	42	52	0
7/5	187	0	77	42	92	132	13	279	0	10
7/6	82	4	60	37	1	101	188	321	6	157
7/7	154	20	78	31	11	15	74	0	0	71
7/8	222	30	23	12	32	17	26	100	47	15
7/9	425	238	96	71	20	38	8	46	0	11

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					-------YEAR-------					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
7/10	185	4	15	26	3	6	12	7	8	0
7/11	84	0	66	29	65	320	15	2	14	40
7/12	51	0	8	40	67	107	58	10	0	12
7/13	191	1	5	52	7	99	21	13	0	28
7/14	30	135	14	61	45	25	2	2	0	20
7/15	614	40	41	58	112	1	42	0	14	26
7/16	255	32	77	12	22	23	278	0	0	2
7/17	110	240	0	1	246	106	31	43	925	3
7/18	218	0	125	86	45	78	3	90	37	0
7/19	164	15	5	161	2	114	4	0	99	4
7/20	76	50	16	29	0	2	0	38	6	381
7/21	298	85	27	33	0	1	1	120	11	170
7/22	101	96	29	31	12	2	0	2	0	11
7/23	270	18	131	81	11	3	0	4	3	4
7/24	252	18	63	185	3	0	3	193	7	6
7/25	111	19	27	49	52	0	26	5	8	0
7/26	119	3	0	15	12	0	2	7	14	0
7/27	42	51	0	1,443	1	1	1	1	21	2
7/28	97	291	0	0	20	1	0	1	0	19
7/29	122	87	0	0	66	0	0	0	205	0
7/30	300	38	0	0	429	0	8	0	0	0
7/31	115	51	0	0	1,239	0	5	0	0	0
8/1	146	280	0	0	0	0	0	0	0	0
8/2	49	57	0	0	0	0	0	0	0	0
8/3	222	161	0	0	0	0	0	0	0	0
8/4	23	60	0	0	0	0	0	0	0	0
8/5	102	49	0	0	0	0	0	0	0	0
8/6	72	55	0	0	0	0	0	0	0	0
8/7	89	59	0	0	0	0	0	0	0	0
8/8	125	53	0	0	0	0	0	0	0	0
8/9	65	41	0	0	0	0	0	0	0	0
8/10	43	36	0	0	0	0	0	0	0	0
8/11	55	55	0	0	0	0	0	0	0	0
8/12	72	33	0	0	0	0	0	0	0	0
8/13	32	19	0	0	0	0	0	0	0	0
8/14	49	19	0	0	0	0	683	0	0	0
8/15	49	16	0	0	0	0	9	16	18	4
8/16	144	11	0	0	0	38	0	18	9	0
8/17	13	3	0	0	0	0	10	4	41	2
8/18	28	0	0	0	0	2	17	12	18	8
8/19	22	3	0	0	0	5	13	13	30	0
8/20	7	1	0	0	0	4	11	15	13	4
8/21	8	0	0	0	0	6	18	41	28	8
8/22	6	0	0	0	0	1	15	22	46	0
8/23	2	1	1,477	0	0	7	2	8	4	14
8/24	0	0	2	0	0	2	9	2	6	3
8/25	26	0	18	0	0	5	9	7	10	0
8/26	7	0	4	5	0	4	5	1	11	1
8/27	3	0	7	1	0	3	4	1	45	0
8/28	24	0	7	1	0	0	8	2	11	0

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					———YEAR———					
DAY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
8/29	1	0	1	2	0	0	1	1	3	10
8/30	8	0	2	4	0	5	3	6	1	26
8/31	2	7	0	3	0	4	1	2	9	7
9/1	8	2	0	3	0	1	1	2	4	4
9/2	3	1	7	3	0	5	1	3	1	0
9/3	0	6	0	1	0	2	6	1	0	0
9/4	0	8	0	4	0	11	0	3	2	6
9/5	1	4	1	0	0	4	0	0	2	0
9/6	0	3	0	1	0	0	0	4	2	2
9/7	1	1	0	1	0	3	0	0	0	6
9/8	0	4	0	2	0	2	0	0	4	0
9/9	10	1	0	6	0	4	0	0	2	0
9/10	0	0	4	0	0	14	0	0	2	0
9/11	1	1	2	0	0	15	5	0	1	0
9/12	0	1	0	1	0	3	2	0	0	0
9/13	0	0	6	0	0	1	0	0	4	0
9/14	0	1	0	1	0	8	0	0	3	0
9/15	1	0	0	1	0	7	0	0	4	0
9/16	0	0	0	1	0	2	0	0	0	0
9/17	1	0	0	22	0	5	0	0	0	0
9/18	2	0	0	0	0	1	0	0	0	0
9/19	0	0	0	0	0	2	0	0	0	2
9/20	1	0	0	0	0	0	0	0	2	0
9/21	1	0	0	0	0	0	0	0	0	1
9/22	1	0	0	0	0	0	0	0	0	0
9/23	0	1	0	0	0	0	0	0	0	0
9/24	0	0	0	0	0	0	0	0	0	0
9/25	1	0	0	0	0	0	0	0	0	0
9/26	1	0	3	0	0	0	0	0	0	0
9/27	0	0	0	3	0	0	0	0	2	0
9/28	0	0	0	2	0	0	0	0	4	0
9/29	0	0	0	0	0	0	0	0	1	0
9/30	0	0	0	0	0	0	0	0	1	0
10/1	0			0					0	
10/2	0			1					0	
10/3				0					0	
10/4				1					0	
10/5				0					1	
10/6				1					0	
Total:	17,853	10,528	9,789	9,782	9,526	11,783	15,520	9,661	9,840	14,767

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish-Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix R.25. Thorsheim Lake sockeye salmon escapement counts, 1989 and 1998.

	---YEAR---	
DAY	1989	1998
6/4		27
6/5	1	11
6/6	2	119
6/7	7	5
6/8	0	32
6/9	0	2
6/10	51	8
6/11	9	18
6/12	0	45
6/13	0	39
6/14	0	12
6/15	0	0
6/16	0	0
6/17	889	442
6/18	840	148
6/19	7	73
6/20	30	101
6/21	3,220	49
6/22	31	34
6/23	80	7
6/24	21	38
6/25	1	32
6/26	1	1
6/27	0	0
6/28	0	5
6/29	2	5,000
6/30	24	0
7/1	1,085	0
7/2	0	0
7/3	0	0
7/4	0	0
7/5	0	0
7/6	0	0
7/7	0	0
7/8	0	0
7/9	0	0
7/10	0	0
7/11	0	0
7/12	17	0
7/13	44	0
7/14	50	0
7/15	1,164	0
7/16	453	0
7/17	177	0
Total:	8,206	6,248

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish-Weirs, 1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix R.26. Uganik Lake sockeye salmon escapement counts, 1990-1992.

	---YEAR---		
DAY	1990	1991	1992
5/25		8	
5/26		0	
5/27		0	
5/28		0	
5/29		0	
5/30		0	
5/31		1	
6/1		0	16
6/2		1	19
6/3		36	0
6/4		3	0
6/5		0	0
6/6		0	0
6/7		444	0
6/8		1,285	0
6/9		5,865	71
6/10		6,210	727
6/11		2,274	569
6/12		1,286	0
6/13		433	0
6/14		82	0
6/15		2,471	0
6/16		682	278
6/17		544	143
6/18		1,454	572
6/19		0	90
6/20		0	212
6/21		0	2,042
6/22		0	2,943
6/23		0	1,152
6/24		0	582
6/25	1,012	0	11
6/26	1,782	0	66
6/27	1,227	0	89
6/28	1,647	0	0

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	-—YEAR-—		
DAY	1990	1991	1992
6/29	1,896	0	0
6/30	3,287	17,484	59,433
7/1	2,592	4,960	79
7/2	4,150	2,103	21
7/3	1,576	175	32
7/4	0	152	41
7/5	2,279	12,969	12
7/6	3,514	6,669	16
7/7	6,179	4,770	22
7/8	4,970	1,365	37
7/9	7,552	2,265	3
7/10	2,542	190	10
7/11	1,157	18	5
7/12	84	20	31
7/13	87	487	25
7/14	1,274	653	135
7/15	4,637	749	448
7/16	946	520	91
7/17	46	58	372
7/18	18	17	198
7/19	37	22	382
7/20	33	254	427
7/21	457	504	667
7/22	1,180	204	978
7/23	991	6,095	4
7/24	180	260	12
7/25	18	1	177
7/26	21	119	103
7/27	212	154	85
7/28	1,391	92	549
7/29	393	41	206
7/30	239	139	15
7/31	126	149	75
8/1	3,411	37	54
8/2	18	101	49
8/3	19	67	129
8/4	246	45	119

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	----YEAR----		
DAY	1990	1991	1992
8/5	51	333	33
8/6	9	256	23
8/7	65	143	128
8/8	55	248	49
8/9	25	371	113
8/10	22	285	70
8/11	429	188	60
8/12	67	36	88
8/13	19	19	35
8/14	19	92	27
8/15	165	44	103
8/16	3	32	21
8/17	25	31	25
8/18	62	18	24
8/19	11	39	40
8/20	24	54	77
8/21	47	19	25
8/22	4	12	24
8/23	36	5	25
8/24	41	5	20
8/25	46	2	16
8/26	61	9	14
8/27	28	9	9
8/28	7	2	26
8/29	27	6	12
8/30	0	2	17
8/31	23	4	5
9/1	5	5	4
9/2	19	4	7
9/3	21	8	1
9/4	26	3	11
9/5	26	2	7
9/6	3	0	5
9/7	5	2	5
9/8	26	3	6
9/9	6	9	6
9/10	1	4	6

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	---YEAR---		
DAY	1990	1991	1992
9/11	7	1	6
9/12	230	2	1
9/13	0	1	8
9/14	23	0	7
9/15	0	0	4
9/16	22	0	2
9/17	300	0	1
9/18	1	0	3
9/19	1	0	2
9/20	32	0	1
9/21	0	1	1
9/22	0	2	5
9/23	0	0	7
9/24	0	0	10
9/25	0	1	8
9/26	0	0	8
9/27	0	2	13
9/28	0	0	8
9/29	0	0	1
9/30	0	1	0
10/1	0	0	1
10/2	0	2	0
10/3	0	0	0
10/4	0	0	0
10/5	0	0	0
10/6	0	0	0
10/7	0	0	2
10/8	0		4
Total:	65,551	89,304	75,894

Taken from: Brodie, J.R. 1999. Kodiak Management Area Salmon Escapement Cumulative Counts for Fish-Weirs,1989-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, RIR 4K99-54. Kodiak.

Appendix S. Kodiak area commercial salmon harvest by statistical area, 1998.

STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
251-40	15-Jun	1	0	0	303	1,245	0	0	0	0	0	0
Outer	13-Jul	2	0	0	1,061	6,110	15	140	3,802	15,211	44	363
Foul Bay	14-Jul	2	11	101	526	3,093	26	244	3,784	15,132	48	465
	15-Jul	3	0	0	1,553	9,322	44	396	8,163	32,652	104	964
	27-Jul	1	0	0	21	110	59	340	906	3,210	4	30
	28-Jul	3	19	196	512	2,745	582	3,849	33,957	124,357	139	1,004
	30-Jul	3	16	180	3,504	21,604	966	5,809	34,178	124,608	216	1,512
	31-Jul	2	3	58	1,136	6,812	180	1,816	14,338	57,327	58	518
	1-Aug	3	3	63	1,434	7,503	292	2,186	16,262	58,906	83	599
	2-Aug	6	3	46	1,650	7,940	913	5,946	28,552	105,530	205	1,538
	3-Aug	2	33	661	610	3,321	412	3,857	24,011	96,031	114	980
	4-Aug	4	0	0	512	2,565	153	965	5,133	20,170	33	257
	5-Aug	2	0	0	353	1,769	102	820	4,316	17,245	48	390
	6-Aug	3	0	0	17	80	39	313	7,752	29,584	3	23
	7-Aug	4	0	0	215	1,077	133	808	6,900	24,154	44	305
	8-Aug	4	0	0	205	1,025	121	723	7,788	27,260	56	395
	9-Aug	3	0	0	56	291	146	868	5,734	21,080	27	196
	10-Aug	5	0	0	25	151	123	1,107	7,766	30,393	14	133
	11-Aug	4	2	23	37	223	161	1,452	7,626	30,849	16	155
	12-Aug	4	1	11	18	96	118	964	8,870	34,156	5	43
	13-Aug	2	0	0	22	142	80	730	4,755	19,048	8	80
	14-Aug	2	0	0	41	203	235	1,649	5,125	17,938	36	210
	15-Aug	3	0	0	56	284	195	1,370	5,276	18,466	19	113
	16-Aug	1	0	0	84	504	54	531	2,891	11,187	21	146
	23-Aug	1	0	0	16	84	10	87	230	891	1	8
	TOTAL	70	91	1,339	13,967	78,299	5,159	36,970	248,115	935,385	1,346	10,427
	AVG.WT.			14.7		5.6		7.2		3.8		7.8
251-41	9-Jun	2	0	0	567	2,423	0	0	0	0	0	0
Foul Bay	10-Jun	5	0	0	1,770	7,432	0	0	0	0	0	0
THA	11-Jun	6	4	30	1,431	7,157	0	0	0	0	43	347
	12-Jun	6	0	0	958	4,306	0	0	0	0	0	0
	13-Jun	2	0	0	425	1,612	0	0	0	0	0	0
	15-Jun	1	0	0	661	2,891	0	0	0	0	0	0
	17-Jun	1	4	34	362	1,446	0	0	0	0	0	0
	18-Jun	3	0	0	682	1,879	0	0	0	0	0	0
	19-Jun	1	0	0	235	965	0	0	0	0	0	0
	21-Jun	1	0	0	712	1,902	0	0	0	0	0	0
	27-Jun	1	9	105	421	1,156	0	0	47	189	12	92
	30-Jun	2	0	0	46	182	0	0	8	26	2	12
	TOTAL	31	17	169	8,270	33,351	0	0	55	215	57	451
	AVG.WT.			9.9		4.0		0.0		3.9		7.9
251-82	8-Aug	1	0	0	31	141	1,728	16,418	546	1,911	2	9
Inner	20-Aug	1	0	0	0	0	319	2,558	57	201	0	0
Perenosa	23-Aug	1	0	0	22	111	135	1,152	2,565	10,262	0	0
	24-Aug	1	0	0	0	0	800	6,403	0	0	0	0
	25-Aug	2	0	0	0	0	542	4,589	0	0	0	0
	29-Aug	5	0	0	19	76	6,442	60,084	0	0	2	12
	10-Sep	1	0	0	0	0	166	1,167	0	0	0	0
	TOTAL	12	0	0	72	328	10,132	92,371	3,168	12,374	4	21
	AVG.WT.			0.0		4.6		9.1		3.9		5.3

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
251-83	25-Aug	1	0	0	1	3	977	7,816	0	0	0	0
Outer	27-Aug	2	0	0	0	0	489	4,936	62	217	0	0
Perenosa	28-Aug	2	0	0	5	16	930	10,104	0	0	0	0
	TOTAL	5	0	0	6	19	2,396	22,856	62	217	0	0
	AVG.WT.			0.0		3.2		9.5		3.5		0.0
251-84	9-Jun	7	1	16	3,186	12,580	0	0	0	0	0	0
Waterfall	10-Jun	3	1	17	676	2,786	0	0	0	0	0	0
THA	11-Jun	1	0	0	28	124	0	0	0	0	0	0
	12-Jun	2	0	0	320	1,450	0	0	0	0	0	0
	13-Jun	3	0	0	869	3,161	0	0	0	0	0	0
	17-Jun	3	9	99	1,991	6,781	0	0	0	0	0	0
	19-Jun	1	0	0	907	2,505	0	0	0	0	0	0
	21-Jun	1	0	0	712	1,902	0	0	0	0	0	0
	22-Jun	1	0	0	900	1,844	0	0	90	220	100	490
	24-Jun	2	0	0	418	1,671	0	0	0	0	0	0
	25-Jun	3	110	777	240	641	0	0	25	80	20	135
	27-Jun	1	20	230	610	1,231	0	0	29	88	7	49
	30-Jun	2	0	0	200	798	0	0	0	0	0	0
	TOTAL	30	141	1,139	11,057	37,474	0	0	144	388	127	674
	AVG.WT.			8.1		3.4		0.0		2.7		5.3
252-30	10-Jun	1	0	0	0	0	0	0	0	0	30	224
Izhut Bay	11-Jun	1	0	0	429	1,730	0	0	0	0	22	165
	12-Jun	2	2	72	378	1,190	0	0	0	0	434	3,050
	8-Jul	1	6	80	668	3,001	243	1,820	451	1,575	1,201	9,330
	24-Jul	1	0	0	483	2,415	374	2,617	13,515	40,545	207	1,449
	26-Jul	1	7	118	140	533	3	23	3,700	12,900	7	47
	27-Jul	4	2	51	501	2,196	182	1.208	17,359	66,474	37	264
	28-Jul	8	0	0	515	2,270	152	1,158	36,433	120,198	20	154
	29-Jul	12	1	13	1,189	5,172	235	1,823	57,407	219,453	44	258
	30-Jul	17	9	202	1,967	8,621	470	4,055	101,454	362,357	193	1,523
	31-Jul	10	6	79	636	3,380	423	3,399	46,244	169,171	38	273
	1-Aug	19	10	182	1,026	4,268	614	5,417	118,551	460,242	103	769
	2-Aug	34	10	128	1,202	5,104	1,354	11,122	186,561	708,699	196	1,398
	3-Aug	26	7	71	1,105	5,366	1,074	9,383	180,476	671,090	295	2,485
	4-Aug	39	4	122	748	3,599	1,495	12,533	173,878	609,399	179	1,403
	5-Aug	39	14	159	914	4,099	1,719	14,311	210,841	772,057	129	913
	6-Aug	33	3	26	729	3,299	1,118	9,663	141,411	505,321	194	1,524
	7-Aug	29	2	16	278	1,308	763	6,405	94,179	340,820	178	1,572
	8-Aug	13	2	43	177	798	411	3,802	41,336	152,563	33	204
	14-Aug	11	2	19	61	316	634	5,630	36,208	136,367	10	87
	15-Aug	4	0	0	32	140	135	1,273	9,987	38,781	2	20
	16-Aug	27	3	60	265	975	2,749	21,986	109,273	396,060	29	225
	17-Aug	23	0	0	220	961	2,038	18,086	99,219	378,399	30	258
	18-Aug	29	1	10	426	1,869	3,227	28,363	107,521	409,522	20	132
	19-Aug	25	0	0	230	1,051	2,400	18,821	60,757	229,714	15	115
	20-Aug	22	0	0	231	847	1,787	15,292	68,493	236,789	39	246
	21-Aug	13	0	0	302	1,195	2,627	21,808	72,355	238,082	16	123
	22-Aug	13	0	0	100	403	1,004	10,277	51,730	186,515	4	31
	23-Aug	11	0	0	59	223	1,241	12,157	30,151	106,040	1	8
	24-Aug	14	0	0	89	411	1,660	13,376	36,627	137,607	2	14
	25-Aug	10	0	0	41	166	842	6,523	14,733	56,605	0	0
	26-Aug	11	0	0	64	316	2,260	16,883	17,877	71,526	1	13

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
252-30	27-Aug	15	0	0	206	1,035	2,619	26,073	34,558	127,805	5	34
Izhut Bay	28-Aug	10	0	0	138	838	4,294	34,379	23,084	80,809	8	65
(Cont.)	29-Aug	9	0	0	194	853	4,437	37,735	18,985	68,833	5	38
	30-Aug	4	0	0	107	427	1,733	14,721	8,630	31,886	0	0
	2-Sep	1	0	0	36	162	1,360	12,922	0	0	0	0
	3-Sep	3	0	0	52	261	1,912	16,202	0	0	0	0
	4-Sep	5	0	0	153	739	4,826	35,993	3,136	10,977	1	9
	5-Sep	4	0	0	29	149	1,526	12,452	272	1,010	0	0
	6-Sep	2	0	0	18	64	409	3,084	0	0	0	0
	7-Sep	5	0	0	82	292	4,201	36,472	0	0	0	0
	8-Sep	2	0	0	0	0	358	3,811	0	0	0	0
	10-Sep	1	0	0	7	20	250	2,496	0	0	0	0
	12-Sep	1	0	0	0	0	62	579	0	0	0	0
	13-Sep	1	0	0	0	0	57	576	0	0	0	0
	TOTAL	566	91	1,451	16,227	72,062	61,278	516,709	2,227,392	8,156,191	3,728	28,423
	AVG.WT.			16.0		4.4		8.4		3.7		7.6
252-31	10-Jun	1	0	0	86	359	0	0	2	5	24	163
Duck Bay	16-Jul	2	0	0	612	2,515	136	1,092	1,296	4,144	72	454
	21-Jul	1	0	0	350	1,615	128	1,018	2,245	7,954	29	310
	22-Jul	2	0	0	1,619	6,631	284	2,245	12,471	39,268	175	1,208
	23-Jul	6	8	160	3,234	13,676	831	6,709	36,183	122,135	232	2,029
	24-Jul	14	29	682	3,640	15,569	1,283	9,955	67,850	241,344	439	3,338
	25-Jul	7	11	175	899	4,354	411	3,404	31,730	108,953	75	535
	26-Jul	11	16	215	1,325	5,674	818	7,051	35,860	137,167	138	1,317
	27-Jul	11	42	974	1,273	5,939	547	4,390	40,800	154,394	79	612
	28-Jul	7	2	30	719	3,425	403	3,472	33,585	123,981	38	281
	29-Jul	4	0	0	362	1,658	381	3,081	16,022	64,039	42	321
	30-Jul	9	3	72	731	2,831	517	3,873	57,337	223,560	52	341
	31-Jul	9	2	34	441	1,881	365	2,793	42,238	163,030	10	65
	1-Aug	18	0	0	847	4,808	936	7,190	127,254	466,541	65	417
	2-Aug	19	10	153	624	3,207	897	7,282	121,392	459,081	63	460
	3-Aug	17	1	20	423	2,008	834	6,113	88,767	322,981	47	334
	4-Aug	16	2	30	552	2,599	1,785	11,386	95,523	335,564	80	545
	5-Aug	14	2	50	691	2,901	2,053	15,068	117,245	399,500	4,643	19,076
	6-Aug	14	3	64	468	2,143	1,340	11,046	90,880	318,228	71	500
	7-Aug	17	1	22	497	2,082	1,831	14,914	112,982	420,594	88	671
	8-Aug	29	0	0	751	2,846	2,068	16,738	176,982	642,482	183	1,296
	9-Aug	31	1	10	669	2,964	3,340	27,479	234,742	808,485	98	638
	10-Aug	39	1	24	523	2,350	3,096	25,974	295,643	1,074,546	164	1,101
	11-Aug	47	6	127	379	1,638	2,915	25,372	223,191	799,551	124	895
	12-Aug	39	0	0	264	1,252	2,920	24,876	161,794	569,458	37	241
	13-Aug	44	2	24	375	1,546	3,484	30,670	237,941	812,450	67	467
	14-Aug	44	2	43	328	1,444	3,366	29,651	194,570	700,648	56	423
	15-Aug	32	3	31	592	2,513	3,273	27,351	145,820	525,889	36	260
	16-Aug	26	2	47	248	1,161	2,609	20,317	90,931	339,712	34	250
	17-Aug	14	0	0	183	916	1,849	15,443	80,324	281,524	22	167
	18-Aug	10	0	0	189	761	2,046	16,593	45,897	159,741	51	301
	19-Aug	23	0	0	286	1,164	2,943	26,600	77,854	270,335	18	136
	20-Aug	15	0	0	123	542	1,862	14,837	35,871	129,267	23	156
	21-Aug	16	0	0	129	458	2,523	23,212	47,917	173,585	7	42
	22-Aug	6	0	0	84	373	1,529	11,704	29,315	113,394	6	38
	23-Aug	14	0	0	141	627	3,246	24,294	51,661	188,008	11	83
	24-Aug	6	0	0	35	137	686	5,909	15,614	56,851	1	13

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
252-31	25-Aug	8	0	0	80	371	2,009	17,159	11,998	47,998	3	24
Duck Bay	26-Aug	8	0	0	116	480	1,369	11,639	14,592	58,380	0	0
(Cont.)	27-Aug	7	1	34	154	826	3,181	24,521	15,915	61,077	6	48
	29-Aug	6	0	0	176	686	1,781	17,801	13,965	50,498	5	38
	30-Aug	1	0	0	50	202	1,105	8,839	0	0	0	0
	3-Sep	1	0	0	100	338	1,930	19,308	0	0	0	0
	5-Sep	5	0	0	39	143	1,612	13,246	0	0	0	0
	7-Sep	1	0	0	0	0	710	7,144	0	0	0	0
	8-Sep	1	0	0	1	3	99	888	0	0	0	0
	TOTAL	672	150	3,021	25,408	111,616	73,331	609,647	3,334,199	11,976,342	7,414	39,594
	AVG.WT.			20.1		4.4		8.3		3.6		5.3
252-32	9-Jun	2	0	0	1,022	5,575	0	0	0	0	73	662
Kitoi Bay	10-Jun	6	4	59	621	2,833	0	0	3	10	734	5,776
	11-Jun	1	0	0	249	925	0	0	0	0	352	2,429
	12-Jun	3	0	0	419	1,969	0	0	0	0	1,055	6,852
	14-Jun	1	0	0	488	1,953	0	0	0	0	674	4,046
	8-Jul	9	21	311	8,971	38,812	215	1,557	1,043	3,749	21,090	136,968
	20-Jul	10	1	28	12,195	53,582	66	466	4,981	16,956	975	7,172
	21-Jul	3	0	0	2,731	10,506	0	0	1,345	3,722	995	6,962
	22-Jul	2	0	0	520	2,598	1	9	2,173	6,912	251	1,460
	23-Jul	2	1	30	364	1,897	0	0	1,518	5,018	236	1,767
	24-Jul	2	0	0	505	2,526	5	36	2,615	10,726	48	259
	25-Jul	2	1	13	536	2,763	13	106	7,515	24,054	30	274
	26-Jul	4	0	0	1,153	5,293	27	210	21,093	68,949	91	643
	27-Jul	3	0	0	495	2,162	21	155	12,406	43,424	16	114
	28-Jul	6	0	0	566	2,466	59	520	27,289	86,028	25	210
	29-Jul	8	3	51	449	1,865	91	729	22,646	87,841	12	80
	30-Jul	7	0	0	445	1,673	134	1,115	45,683	151,055	104	491
	31-Jul	1	0	0	109	360	8	58	6,448	22,571	47	192
	1-Aug	1	0	0	59	208	5	36	4,558	15,955	17	73
	2-Aug	6	0	0	364	1,239	42	311	26,141	103,823	50	230
	3-Aug	9	0	0	238	1,087	263	2,067	39,697	141,756	28	218
	4-Aug	9	0	0	292	1,464	264	1,947	54,717	160,096	7	46
	5-Aug	8	0	0	178	835	218	1,660	49,821	166,407	12	79
	6-Aug	5	0	0	67	346	132	1,146	21,329	78,164	15	128
	7-Aug	2	0	0	16	70	29	253	3,838	13,433	0	0
	8-Aug	4	0	0	70	320	182	1,317	19,146	57,799	7	46
	17-Aug	12	0	0	132	565	912	7,988	58,735	207,077	3	22
	18-Aug	18	5	127	266	1,259	1,420	12,961	95,335	331,076	20	151
	19-Aug	8	0	0	35	152	1,170	8,175	21,290	76,058	0	0
	20-Aug	8	0	0	63	303	633	5,931	24,718	89,664	8	45
	21-Aug	13	0	0	63	260	392	3,405	44,479	162,545	0	0
	22-Aug	8	0	0	26	124	389	3,310	39,024	149,059	0	0
	23-Aug	6	0	0	17	76	231	1,890	50,852	173,714	0	0
	4-Sep	3	0	0	63	270	2,101	20,325	0	0	0	0
	6-Sep	1	0	0	21	76	935	8,887	0	0	0	0
	8-Sep	1	0	0	15	51	896	8,510	0	0	0	0
	10-Sep	1	0	0	20	98	664	5,581	0	0	1	6
	11-Sep	3	0	0	22	78	1,505	14,317	0	0	0	0
	12-Sep	1	0	0	6	18	158	1,563	0	0	0	0
	16-Sep	1	0	0	0	0	543	5,377	0	0	0	0
	TOTAL	200	36	619	33,871	148,657	13,724	121,918	710,438	2,457,641	26,976	177,401
	AVG.WT.			17.2		4.4		8.9		3.5		6.6

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
254-40	9-Jun	8	7	102	443	2,229	0	0	2	7	15	129
Spiridon	10-Jun	12	50	555	2,930	13,934	0	0	3	10	176	1,228
Bay	14-Jun	8	54	682	345	1,606	0	0	3	11	24	164
	15-Jun	11	44	398	1,131	5,703	1	5	9	42	208	1,571
	16-Jun	10	24	281	381	1,931	0	0	6	22	65	457
	17-Jun	8	32	351	649	3,339	0	0	14	54	79	562
	18-Jun	10	11	145	804	4,183	0	0	24	108	110	794
	19-Jun	10	7	81	401	2,104	0	0	18	82	22	165
	20-Jun	10	22	272	734	3,787	0	0	49	212	42	301
	21-Jun	10	26	337	902	4,519	0	0	44	190	48	371
	22-Jun	9	33	252	292	1,483	0	0	23	104	24	181
	23-Jun	9	33	445	534	2,581	0	0	50	210	51	383
	24-Jun	9	9	104	1,130	5,674	1	6	237	948	244	1,727
	25-Jun	11	10	157	695	3,583	0	0	203	798	131	920
	26-Jun	9	7	120	326	1,652	0	0	118	472	73	545
	27-Jun	9	5	96	430	2,221	0	0	99	400	44	302
	28-Jun	7	1	5	158	831	0	0	66	267	14	105
	29-Jun	10	4	68	434	2,191	1	8	280	1,125	89	651
	30-Jun	10	8	151	455	2,353	1	9	310	1,259	98	711
	1-Jul	9	15	107	273	1,413	0	0	191	786	90	647
	2-Jul	6	0	0	61	308	0	0	42	178	33	235
	3-Jul	10	8	113	253	1,286	2	16	399	1,622	101	772
	4-Jul	10	10	170	646	3,281	3	25	505	2,059	185	1,397
	5-Jul	11	10	224	2,918	15,175	13	102	1,307	5,080	382	2,796
	6-Jul	15	26	370	3,222	16,653	17	163	2,205	8,937	576	4,486
	7-Jul	12	8	146	820	4,195	6	52	418	1,657	208	1,597
	8-Jul	12	2	38	837	4,121	6	45	358	1,372	94	707
	13-Jul	10	4	84	1,012	5,540	28	246	2,055	9,293	165	1,247
	14-Jul	12	5	113	1,337	7,230	51	381	4,631	20,026	253	1,974
	15-Jul	11	3	76	2,204	11,590	32	266	3,495	15,346	292	2,333
	16-Jul	18	9	202	4,335	22,618	79	666	15,880	56,502	472	3,491
	20-Jul	10	4	74	397	2,119	1,239	5,731	4,949	22,009	286	2,287
	21-Jul	24	7	125	2,423	11,333	208	1,599	24,008	100,952	715	5,730
	22-Jul	12	13	194	1,450	7,439	157	1,268	26,785	98,081	619	4,450
	23-Jul	14	9	206	875	4,608	54	465	19,666	78,525	435	3,504
	24-Jul	10	6	114	947	4,829	51	392	8,340	35,648	311	2,426
	27-Jul	17	11	155	5,842	28,320	49	398	31,285	127,706	258	2,069
	28-Jul	36	27	572	5,422	28,224	261	2,336	100,401	396,750	867	6,745
	29-Jul	34	5	120	2,383	12,076	190	1,447	64,762	250,992	608	4,810
	30-Jul	18	23	453	1,208	6,142	88	695	26,494	106,890	313	2,148
	31-Jul	16	5	113	656	3,398	93	765	24,674	101,071	199	1,536
	1-Aug	16	5	97	624	3,045	66	580	19,498	82,747	163	1,302
	2-Aug	15	4	73	864	4,539	205	1,722	38,456	154,614	241	1,919
	3-Aug	15	7	126	3,620	19,007	387	3,208	40,499	164,781	329	2,499
	4-Aug	26	2	47	3,628	18,770	215	1,762	57,257	232,490	333	2,652
	5-Aug	15	0	0	1,160	6,086	127	1,093	27,930	101,760	155	1,326
	6-Aug	10	2	35	324	1,615	71	547	46,202	161,600	72	556
	7-Aug	15	0	0	832	4,025	86	694	38,198	148,555	98	725
	8-Aug	24	5	111	1,069	5,366	259	2,336	61,280	235,598	104	869
	9-Aug	24	24	373	980	4,638	553	5,017	76,643	293,944	209	1,784
	10-Aug	23	11	220	1,533	7,638	803	7,292	78,687	325,891	212	1,878
	11-Aug	36	4	64	3,627	17,222	775	6,773	83,290	316,182	174	1,368
	12-Aug	23	10	163	3,471	17,822	658	5,702	79,595	290,234	229	1,899

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
254-40	13-Aug	26	4	80	2,787	14,999	809	6,888	86,679	323,383	256	2,095
Spiridon	14-Aug	33	17	225	5,030	24,642	794	6,386	92,796	317,978	184	1,311
Bay	15-Aug	37	6	106	3,980	19,709	585	5,130	87,247	344,281	265	1,919
(Cont.)	16-Aug	37	3	60	3,693	19,237	541	4,589	87,445	321,140	211	1,708
	17-Aug	15	3	40	1,143	5,541	227	1,856	32,433	109,479	69	464
	18-Aug	27	3	46	2,261	11,752	440	4,251	59,658	226,831	150	1,188
	19-Aug	9	4	30	473	2,331	392	3,446	5,554	21,205	20	142
	20-Aug	7	1	13	600	3,248	231	2,181	2,519	11,346	34	267
	21-Aug	9	0	0	929	4,816	139	1,342	3,510	15,533	14	103
	22-Aug	9	3	34	958	4,881	277	2,673	16,084	59,423	35	303
	23-Aug	6	0	0	373	2,045	145	1,435	945	4,262	8	56
	24-Aug	2	0	0	53	292	6	63	36	168	1	5
	25-Aug	2	0	0	335	1,850	60	576	0	0	4	27
	TOTAL	968	715	10,314	97,042	492,918	11,482	94,628	1,486,849	5,711,228	12,589	97,019
	AVG.WT.			14.4		5.1		8.2		3.8		7.7
254-50	2-Jul	13	7	125	4,752	20,453	0	0	228	731	9	70
Spiridon	3-Jul	6	2	45	1,790	7,675	0	0	89	269	3	22
Lake	4-Jul	2	0	0	723	3,177	0	0	53	159	2	20
THA	7-Jul	7	28	526	2,354	10,731	0	0	170	523	1	9
Telrod	8-Jul	3	7	98	511	2,557	0	0	77	236	10	78
Cove	9-Jul	6	3	51	2,073	8,935	0	0	250	956	68	656
	10-Jul	8	0	0	1,718	8,027	0	0	230	846	49	461
	11-Jul	9	4	74	2,002	9,407	0	0	324	1,169	90	871
	12-Jul	14	12	228	4,854	22,862	5	49	2,415	8,170	121	998
	13-Jul	7	1	16	2,367	11,093	0	0	1,244	4,309	77	717
	14-Jul	8	6	112	1,878	8,881	0	0	1,764	6,040	70	568
	15-Jul	6	2	47	1,090	5,040	0	0	921	3,139	39	319
	16-Jul	6	1	16	2,127	9,591	0	0	2,219	7,848	89	816
	17-Jul	8	1	28	1,851	8,743	3	46	1,868	6,190	108	913
	18-Jul	7	3	41	5,716	22,588	1	8	2,181	6,876	121	864
	19-Jul	8	8	144	5,056	23,517	0	0	4,032	14,547	114	1,008
	20-Jul	9	9	139	6,716	33,494	1	7	9,006	31,722	571	4,682
	21-Jul	4	2	35	1,109	5,274	0	0	1,823	6,648	234	1,639
	22-Jul	2	0	0	351	1,595	0	0	707	2,837	26	204
	23-Jul	4	0	0	880	4,402	0	0	7,135	26,820	40	288
	24-Jul	3	1	20	3,123	15,614	0	0	5,655	16,545	194	1,356
	25-Jul	9	0	0	2,487	11,291	1	5	2,328	9,183	227	1,936
	26-Jul	10	0	0	1,948	8,470	0	0	747	3,065	69	614
	27-Jul	3	0	0	1,529	6,547	0	0	2,364	10,043	81	780
	28-Jul	6	0	0	4,559	21,836	9	85	6,907	22,227	121	973
	29-Jul	7	1	20	2,776	12,803	0	0	3,992	13,669	128	1,021
	30-Jul	7	0	0	510	2,406	6	51	2,629	8,713	28	220
	31-Jul	3	1	5	462	2,315	95	860	4,940	15,448	19	136
	1-Aug	1	0	0	136	679	0	0	968	2,905	12	87
	2-Aug	3	0	0	436	2,173	0	0	4,275	13,008	31	221
	3-Aug	1	0	0	411	1,891	0	0	873	3,321	0	0
	5-Aug	1	0	0	265	1,326	18	153	4,484	15,471	14	120
	6-Aug	1	0	0	549	2,637	0	0	1,869	6,541	15	106
	8-Aug	1	0	0	195	975	0	0	263	1,054	1	7
	10-Aug	1	0	0	505	2,234	0	0	852	2,731	0	0
	11-Aug	1	0	0	915	3,605	0	0	1,581	5,555	0	0
	12-Aug	3	0	0	2,668	12,837	1	7	2,513	9,729	2	15

-Continued-

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STAT			CHINOOK		SOCKEYE		COHO		PINK		CHUM	
AREA	DATE	LNDGS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS	No.	POUNDS
254-50	13-Aug	2	0	0	1,209	6,045	9	69	2,345	9,386	5	39
Spiridon	14-Aug	3	0	0	2,042	10,806	1	6	3,927	13,839	6	44
Lake	15-Aug	2	0	0	1,300	6,058	3	25	2,230	6,961	2	8
THA	16-Aug	4	0	0	2,311	10,322	4	33	2,036	7,903	0	0
Telrod	17-Aug	4	0	0	1,253	6,049	3	28	2,325	8,110	5	40
Cove	18-Aug	2	0	0	150	749	9	82	2,721	8,162	11	78
(Cont.)	19-Aug	1	0	0	745	2,979	1	10	1,144	3,660	1	7
	23-Aug	2	0	0	630	2,279	9	84	736	2,355	0	0
	24-Aug	2	0	0	513	2,451	2	17	277	886	0	0
	26-Aug	2	0	0	738	3,499	4	39	0	0	0	0
	27-Aug	4	0	0	518	2,477	10	92	0	0	0	0
	28-Aug	5	0	0	1,368	6,439	3	34	0	0	0	0
	29-Aug	2	0	0	608	2,868	2	18	0	0	0	0
	30-Aug	3	0	0	1,244	5,534	10	75	0	0	0	0
	31-Aug	2	0	0	320	1,361	1	7	0	0	0	0
	1-Sep	1	0	0	108	495	2	20	0	0	0	0
	TOTAL	239	99	1,770	88,449	408,092	213	1,910	101,717	350,505	2,814	23,011
	AVG.WT.			17.9		4.6		9.0		3.5		8.2
259-35	10-Jun	4	1	8	869	4,441	0	0	0	0	20	152
Settler	15-Jun	1	0	0	499	2,500	0	0	0	0	0	0
Cove	16-Jun	1	0	0	716	2,584	0	0	0	0	0	0
THA	18-Jun	1	0	0	523	1,881	0	0	0	0	0	0
	20-Jun	1	0	0	195	1,066	0	0	0	0	0	0
	22-Jun	1	0	0	283	912	0	0	0	0	0	0
	TOTAL	9	1	8	3,085	13,384	0	0	0	0	20	152
	AVG.WT.			8.0		4.3		0.0		0.0		7.6

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