

Historical Sockeye Salmon Data Inventory Lake Clark, Alaska

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Introduction

Several agencies and numerous individuals have worked in the Lake Clark system since the 1920s. Nearly 80 years of salmon spawning surveys, 20 years of daily sockeye salmon escapement counts, 10 years of weather data and numerous short-term projects have been conducted in the Lake Clark ecosystem. Investigators from different agencies have used different methods to collect, analyze and archive their data. This paper represents an effort to outline existing data sets so that researchers, managers, or the general public can access the information and learn from historic work completed in this system.

This report is currently a work in progress, information and data are added as they are discovered. There is still a significant amount of material missing which will be added through time. I made no effort to mesh similar data collected by different agencies but included notes on efforts they made to do so when possible. Specifics on methodologies were included where available. The information presented here is organized by agency. Data sets, when available, are in attached Excel spreadsheets.

Fisheries Research Institute

The Fisheries Research Institute (FRI) of the University of Washington has been conducting limnological and sockeye salmon research in the Kvichak River system of Bristol Bay since 1961. A variety of data concerning “the ecological conditions and changes that have taken place in the spawning and nursery areas of the...Kvichak system” have been collected in a standardized manner and archived by FRI (Rogers et al.. 1983).

Annual Sampling & Archived Data

Limnological sampling of Lake Clark was done in conjunction with what was an annual trip to townnet the lake in late summer. Sampling was limited by the amount of gear they could haul up the road to Six Mile Lake from the FRI camp at river mile (RM) 22 on the Newhalen River. Sampling typically included taking bathythermograph casts, zooplankton, chlorophyll, and phytoplankton samples. In 1985, FRI began flying their townnetting gear to Lake Clark, which placed a stricter limit on the amount of gear they could bring. This appears to be why annual limnological sampling of Lake Clark was curtailed (Pat Poe, personal communication). Annual townnetting of Lake Clark was also curtailed in the mid 1990s due to budget constraints. The last year of townnetting in Lake Clark appears to have been 1994 (Rogers et al.. 1995, 1997).

Annual surveys of adult spawners were almost entirely aerial, though there were some ground and SCUBA surveys over the years as well. These surveys had a limited amount of age and length sampling associated with them. FRI has also conducted escapement counts from RM 22 annually since 1979.

In 1983, archived data collected by FRI were stored on a series of magnetic tapes collectively known as the Wood River/Kvichak Freshwater Data File. This database was managed by a CYBER computer utility called DATALIB and documents all biological and environmental data taken by FRI in the Nushagak and Kvichak districts through 1982. FRI was founded and funded by the salmon fishing industry of Alaska to study production trends in Bristol Bay stocks of sockeye salmon. This data set reflects this purpose in that it pertains primarily to biological, ecological and climatological data affecting the freshwater spawning and rearing environments of sockeye salmon in these two systems.

Copies of several tapes were found in the FRI archives in January of 1999 and converted to an Excel format. There appears to be data missing that is outlined in the manual but not found on the tapes. The location of this missing data is currently unknown. The data pertaining to Lake Clark specifically has been compiled separately and is outlined below. Details of sample collection and descriptions of the data are from Rogers et al. 1983. Physical data of Lake Clark from USGS or Army Corps of Engineer survey maps as well as chemical and productivity data from a variety of sources and maps of the lake showing FRI sampling stations (limnological, spawning areas, etc.) can also be found in Rogers et al. 1983.

➤ *Limnology*

Filename: KBTF

This file contains water temperatures (°F) of Lake Clark in years 1961-1963, 1974, 1976, and 1979-1982 on dates throughout the summer months (6/10 to 9/13). Temperature profiles were taken by means of vertical bathythermograph hauls in 5 m increments from the surface to either 135 meters or lake bottom, whichever was less. Water temperatures were measured with a precision of $\pm 0.1^{\circ}\text{C}$. Taken at a variable number of stations each year but equally distributed across the lake within the year.

Filename: KCHLRAW

Spectronic 20 readings of filtered water collected in Lake Clark in 1976 and 1979-1982. Samples were taken at stations evenly distributed across the lake (varying between years) and from depths ranging from 10m to 450m. This is the raw data from the process outlined below. The actual chlorophyll a levels at depth are listed in file: KCHLOR which is still missing.

Water samples were collected with a Van Doren bottle, subsampled and stored in opaque polyethylene bottles until filtration. Chlorophyll a levels were calculated following the procedure of Parsons and Strickland (1963). Samples were filtered through a 1.2 or 0.8 μm , 47mm diameter HA Millipore filter at 15 inch Hg vacuum after the addition of 2 to 3 drops of magnesium carbonate suspension. The filters were dried in a dessicator, refrigerated and transported to a lab for further processing. Pigments were extracted via exposure to acetone (5 ml of 90 percent acetone). Absorbances were measured at wavelengths of 750, 665, 645, 630, 510, & 480 nm without acid and at 750 & 665 with acid by way of a Bausch and Lomb spectronic 20 spectrophotometer (1cm path length).

Filename: KNPHYTO

Net phytoplankton counts from Lake Clark 1979-1982. Four to 8 hauls (two per station) were made annually in late June and August. Stations were distributed across Lake Clark and within Six Mile Lake. Vertical hauls were made using a No. 20 mesh size, 0.5 m closing net and were made from 10 to zero meters, 30- zero meters, 60-30 meters, 100-60 meters and 130-100 meters.

Filename: KZOOOPS

Standing crop of zooplankton was assessed at Lake Clark in 1961, 1963-1965, 1969-1976 and 1979-1982. Depth and duration as well as time, date and location of tow and densities of zooplankton (per m^3 and m^2) by species are listed in this file.

Samples were collected using a nylon No. 6 mesh conical plankton net with a 0.5m diameter mouth. Hauls were taken vertically at approximately 0.625 m/sec. Two hauls were made per station. Samples were randomly subsampled two to three times when counted. A computer program called FRR 347 (Rogers, 1975) was used to calculate the densities of zooplankton per m^3 and numbers per m^2 of lake surface area for each haul.

**Still Missing:*

KSECDISK	Secchi disk depth readings	1961-1982
KCHLOR	Chlorophyll <u>a</u> concentrations by depth	1961-1982
KZDWTSV	Zooplankton dry weight	1961-1973

➤ ***Spawner Surveys***

Filename: KSGINDX

This file includes spawning ground peak index counts for individual Kvichak spawning areas. Date and type (aerial, ground) are given as well as the spawning area type, the extent of the survey (m) and estimated indices of live, dead and schooled fish and the total. Date of peak spawning is estimated for many of the spawning areas. Newhalen River spawning areas surveyed include: Lover's Creek, Little Bear Creek and Ponds, Alexi Creek and Lakes, Steam Bath Creek, Pickerel Creek and Tazimina River. Those areas surveyed in Lake Clark are: Kijik River, Little Kijik River, Kijik Lake tributaries, Tlikakila River, Priest Rock Creek and Ponds, Chokotonk river, Currant Creek, Tanalian River, 22 Creek, Sucker Bay Lake and beaches of Kijik Lake and Lake Clark. Years reported vary from area to area but span 1920-1982.

**Still Missing:*

KSPRAW	Spawning ground age and length data	1962-1982
KSPAWN	Spawning ground age and length statistics	1962-1982

➤ ***Sampling of Juveniles***

**Still Missing:*

KTNET	Standardized townet catches and length data	1962-1976, 1979-1982
KTOWRAW	Townet log and length frequency data,	1962-1976, 1979-1982

➤ ***Newhalen Escapement Counts***

FRI has also maintained a program of escapement enumeration on the Newhalen River since 1980 (with the exception on 1987, no counts; Rogers et al. 1992). Visual counts were made at up to three different areas: the rapids at river mile 6.5, from a tower aboard a 29' research vessel on the left bank and from a cliff on the right bank approximately 1.5 km upstream from the mouth in the lower Newhalen River and from trees on the upper Newhalen River at approximately 3 km below the outlet of Six-Mile Lake, also known as river mile 22 (RM22). The counts at RM22 have been conducted consistently since 1980. Historically counts were made for 10 minutes of every hour on each side of the river between the hours of 0400 and 2300. As the hours of darkness increased throughout the summer, the counts were reduced to 0600-2000 hours. Several night counts were made and used to estimate the percent of the daily passage occurring during the night (Mathisen and Poe 1981). This sampling scheme was modified some time after the 1984 season to the current sampling scheme. Currently, the escapements up the Newhalen are estimated by expanding a 20-minute count from one bank for each of 10 hours of daylight at RM22 (Rogers et al. 1992). Some concern has been raised recently regarding how the data is treated. There is the assumption that night time upstream migration is equal to that of daytime, and that counts on one side of the river may be applied to both. It has been proposed that the location of the counts be changed so as to differentiate between those fish going to Lake Clark proper and those going to spawning areas below it (i.e. Tazimina).

➤ ***Other Data***

Filename: KWEATHER

U.S. Weather Bureau data from Lake Clark and surrounding areas, 1959-1973.

<u>Weather Station</u>	<u>Years</u>
King Salmon	1959-1973
Iliamna	1959-1973
Lake Clark	1960-1973
Intricate Bay	1961-1973
Porcupine Island	1961-1973

This file contains daily maximum and minimum air temperatures (F°), precipitation (inches), snowfall (inches) and ground snow cover (inches) at all the weather stations and for the years listed above. Lake level (on a relative scale) and daily solar radiation (g cal/cm) were recorded at the FRI base camp at Porcupine Island on Iliamna Lake. Daily solar radiation was measured with an 8-day Belfort Pyrheliometer.

**Still Missing:*

KICEUP Dates of Breakup of Iliamna lake ice 1961-1982

Selected Papers and Projects

In addition to the long term data sets listed above, FRI has also conducted several smaller projects in the Kvichak system that were specific to Lake Clark. The results of most of these were reported in theses, dissertations and agency circulars. A summary of each of these studies as well as selected papers pertaining to Lake Clark follows.

➤ Adult Tagging Studies

Smith (1964) recognized that “rehabilitation” of the sockeye salmon runs of Bristol Bay would be “greatly simplified if groups of salmon bound for a well-defined spawning area became segregated and thus recognizable in the fishery” and that this segregation could occur in time or space. Smith noted that Kvichak river fish that were tagged prior to the fishery moved through the fishery and arrived at Igiugig in the same chronological order as they were tagged (Bureau of Commercial Fisheries, 1958). This report summarizes results of the first tagging study (1957-1959) in the Kvichak system, an effort to define “the extent to which recognizable spawning groups are segregated as they pass upriver”.

Sockeye from throughout the run were tagged with Peterson Disk tags as they passed Igiugig and recovered on the spawning grounds. Smith notes that “in ponds and streams where fish could be seen readily tag recovery was relatively easy, but in large rivers and beaches where spawning took place in deep, swift or turbid waters, recovery was frequently difficult. Recoveries from these sources were often at a low level.” Areas surveyed for tags in the Lake Clark area included Newhalen River and the Nondalton Fishery, Six-Mile Lake, Kijik Lake, Kijik River and Little Kijik River. Of these points, only the Newhalen-Nondalton point was included in the analysis for each year of the study.

Smith compared Lake Clark and Iliamna lake, any fish recovered in the Newhalen or above was considered bound for Lake Clark. Results included that the Kijik system had fewer late run fish (higher proportion of its spawners were early migrants) and that “segregation in time of passage at Igiugig is probably minimal”. In 1957 there was a significant difference in the timing of return of Lake Clark and Iliamna lake sockeye, with a higher proportion of early migrants returning to Lake Clark. In 1958 and 1959, the timings of the two lakes was strikingly similar. This difference was attributed to Kijik Lake because in 1957 it had a higher proportion of early migrants than the overall escapement, an observation that was not made in 1958 and 1959. Smith concluded that the Kijik system sockeye population “exhibits somewhat independent but

also inconsistent timing and form” and that “it is not clearly segregated” from the rest of the escapement.

Although Smith concludes that there is little if any difference in the timing and distribution of spawning populations in the Kvichak, he concedes that “some groups that spawn in deep or glacial waters may have been missed on the spawning grounds” and that this could skew results. “Until all spawning grounds in the system are delineated, this problem will persist...tests of high sensitivity in the future may provide a means of differentiating at least the larger groups while they are in the fishery”.

This study replicated by Jensen and Mathisen (1983). The Kvichak run in 1983 was separated into seven time periods and tagged at Igiugig near the outlet of Iliamna Lake. Spawning surveys were conducted throughout the system to retrieve tags. No significant trend was found between run timing and geographic area of spawning, spawning ground type, or spawning time (ie early or late spawning). However, the Newhalen River-Lake Clark complex had a higher proportion of early migrants than Iliamna Lake and Lake Clark itself had a higher proportion of late migrants than did Iliamna Lake. The estimated means of migratory time density were not statistically different, Lake Clark and Iliamna Lake sockeye appear to be mixed in their return to the system. Therefore, there is a partial temporal segregation of migrants destined for Iliamna lake and for the Newhalen River-Lake Clark spawning grounds. Within Lake Clark, major spawning grounds from which recoveries were made were the north shore of Chulitna Bay, shore northwest of Kijik River and the Tanalian River.

Mathiesen reported the results of two tagging studies, one in Nushagak Bay in 1946 and another in the mouth of the Egegik River in 1947. Mathisen found that the daily escapement entering Iliamna Lake and Lake Becharof is comprised of a mixed of sockeye salmon from a variety of spawning grounds. This report mentions but doesn't discuss a third study which was tagging in the Naknek/Kvichak fishery in 1950-51.

➤ *Juvenile Outmigrants*

The first time the smolt outmigration of Lake Clark was sampled in its entirety (1962) was reported by Orrell (1963). Smolts were captured by Fyke net downstream of the Lake Clark shallows and above Six Mile Lake from ice breakup (May 26) to June 18. Age 2 smolts made up 97% of those captured in 1962 suggesting that Lake Clark is sometimes a rearing area for it's juvenile sockeye until the time of outmigration. The authors postulated that few age 1 smolts captured (though the progeny of a huge escapement) suggest that some juveniles leave Lake Clark to rear in Iliamna lake.

A general outline of studies of Lake Clark juvenile sockeye salmon conducted in connection with Dames and Moore was given in Poe et al. 1983. These studies provided evidence that “a major portion of the juvenile salmon produced in the Newhalen River-Lake Clark system rear in Iliamna Lake for part of their freshwater life”. The specifics of the work are given in the Dames and Moore papers outlined below.

➤ *Juveniles, Limnetic*

A series of biannual reports (Kerns 1965, 1966, 1968) were published by FRI following up on a study initiated in 1961 by Dunn. Objectives of these works were to “obtain an index of abundance and determine distribution of red fry and fingerling and major competitor species and to determine the mean length and weight of juvenile red salmon and major competitor species.” Lake Clark was divided into three sections. Catch per tow was calculated and weighted by the surface area of the section for sockeye salmon fry and fingerling, stickleback and least cisco. Two sections were towed in 1962 and all three sections were towed 1963-1967. From these

studies it was determined that mean length of sockeye fry and fingerlings generally increased from east to west across both Iliamna Lake and Lake Clark (the exception being 1967 when this trend was reversed). Sockeye fry utilized all basins of Lake Clark and fingerling and least cisco occupied the central and eastern lake areas.

Schlenger (1996) compared the distribution and feeding ecology of the only two planktivores inhabiting the limnetic zone of Lake Clark, juvenile sockeye salmon and least cisco. Found that sockeye were distributed throughout the lake while least cisco were found primarily in turbid north end of the lake. These distributional differences were stable throughout the summer season and across years. Feeding morphology of least cisco suggested adaptation to use same food resources throughout their lives as juvenile sockeye salmon. The authors suggest the result reflect species specific risk-sensitive foraging with sockeye salmon more willing to risk predation in the clear south end of the lake to obtain food than least cisco.

➤ ***General System Studies***

Bond and Becker developed a key to distinguish between 22 species of resident fishes found in Lake Clark and Iliamna lake (1963). Brief notes on selected species including distribution within the system, behavior and feeding ecology are included.

Correct bathymetric measurements for Lake Clark were presented for the first time by Anderson (1969). It also presents corrected measurements of Iliamna lake and gives a summary of previous measurements made by various agencies since 1957. All measurements for Lake Clark are based on USGS maps published in 1946.

➤ ***Escapement Enumeration***

Poe and Mathisen (1981) made the first attempts to enumerate escapement into the Newhalen River-Lake Clark complex in response to observed changes in cyclic dominance in the Kvichak system in preceding years. Prior to 1960, the Kvichak had peak cycles of three years in a row, beginning in 1960, the five year cycle we see now began, with large runs occurring only once every five years (years ending in zero or five). Poe and Mathiesen hypothesized that the previous pattern was due to Iliamna and Lake Clark having a similar cycle but offset by one year, they sought to determine the escapement to Lake Clark and determine if it displayed cyclic dominance in this fashion.

Objectives were to determine 1) the escapement into the Newhalen River-Lake Clark system, 2) the relative abundance of juvenile salmon in the lake Clark nursery area, 3) the timing and extent of juvenile salmon migrations from lake Clark to Iliamna lake and 4) the distribution of the escapement on the spawning grounds.

Escapement enumeration as outlined in this study proved to be problematic. Difficulties were encountered with the number of fish “washing back” downstream after being counted as well as with fish schooling below the rapids made impassable by high water. In this year, the escapement curve lagged 5 days behind the Iguig curve.

➤ ***Spawner Studies and Surveys***

FRI compiled the results of their stream surveys (Demory, 1964). This large volume includes the name, location, physical description, dimensions, bottom quality, flow, barriers, description of sockeye run including magnitude, timing and distribution of spawning for all streams and beaches surveyed by FRI since 1955. Also includes a summary of survey notes. Claims to contain all stream and pond areas in Kvichak system proper utilized by fish with one or two possible and minor exceptions. As of 1964, 71 streams and ponds and 23 beach areas had been surveyed and catalogued. Beach surveys began in 1960 and some may be omitted from this

catalog. Includes maps. Newhalen River and Lake Clark spawning grounds listed in this catalog are listed below.

Newhalen River and Six-Mile Lake:

- Little Bear Creek and Pond
- Alexi Creek
- Alexi Lake
- Tazimina

Lake Clark:

- Chulitna River
- Kijik inlet system including:
 - Kijik Lake
 - Kijik River
 - Little Kijik River
 - Kijik Lake Tributaries
- Tlikakila River
- Chokotonk River
- Currant Creek
- Tanalian River
- 22 Creek
- Sucker Bay Lake

FRI also produced a series of annual reports that detail the annual estimation of escapement to the various spawning grounds and sampling for age, sex, and size composition of spawners to specific spawning habitats (Anderson 1968, Anderson and Poe 1969, Poe 1970). FRI began these surveys in 1947 to determine distribution and enumeration of spawners and to sample selected spawning populations for size and age composition.

Escapement was estimated by aerial and ground surveys. A small sample of spawners was taken from most populations surveyed, age compositions were determined with otoliths. For most of these reports, the only sample sites included from the Lake Clark-Newhalen River complex were the Tazimina River, Kijik Lake and the Nondalton subsistence fishery. Lengths were taken from mid-eye to hypural plate and were transformed to mid-eye to fork length for comparisons. Aerial surveys were more extensive in Lake Clark-Newhalen and included Bear, Alexi, 22, and Currant Creeks, Newhalen, Tazimina, Tanalian, Little Kijik, and Big Kijik Rivers, and shoreline spawners in Alexi, Sucker Bay and Kijik Lakes. Survey data includes: survey date, estimated numbers of live, dead, and schooled sockeye and estimated peak date of spawning for each of these spawning areas in each year 1965-1969. Length compositions are given for the Newhalen River and the Nondalton fishery. Age distributions from the Newhalen River.

The 1968 survey resulted in an addendum to the FRI Spawning Ground Catalog of the Kvichak River System, Bristol Bay (Anderson 1968). Those spawning grounds added were Steam Bath Creek, Priest Rock Creek and Lake Clark beaches. All sampling for age and length in Lake Clark continued to be from Nondalton fishery and Newhalen River. The 1969 survey of Six Mile Lake added Pickerel Lake and Little Bear Creek and Ponds. Sampling for length and age from Alexi Creek was conducted in addition to the sampling of the Nondalton fishery and the Newhalen River. Fecundity samples were taken 1964-1966 as well as egg size from four types of spawning grounds in 1965-1967 (this data may be found in Mathisen and Gunnerod 1969).

A report by Parker and Blair (1987) describes the FRI aerial survey techniques of Lake Clark in detail ("should they be performed by other individuals or agencies"). The authors note that aerial surveys generally account for 0.8-9% of the total estimated escapement in Lake Clark due to the

difference in timing of the aerial surveys relative to the peak spawning times of Lake Clark spawning populations. Traditional survey routes and durations ("Lake Clark can be thoroughly surveyed in about 2 hours") are given as well as suggestions for timing of surveys (within the day, within the season). Notes on spawner distribution and timing and clear outlines of their sections for survey are also outlined. Specific suggestions for implementing suggested aerial survey routes are given as well as a list of information routinely recorded by FRI. Finally, a summary of aerial survey results (1920-1985) of the Lake Clark-Tazimina River area is given.

➤ ***Tagging Adults in the Newhalen and General Summary of FRI Work in Lake Clark***

Tagging experiments conducted in 1967-8 in the Newhalen River are documented in Mathisen and Poe (1969). The objectives of this study were to determine the time and speed of ascent of Lake Clark sockeye salmon and to assess the length distribution, sex ratio, and age composition of Lake Clark spawners. Comparisons were made to the same years' escapements to Iliamna lake. This report also provides a summary of conclusions regarding primary and secondary production and the ecology of juvenile salmon and other fishes of Lake Clark and a comparison to Iliamna lake. General findings are review below.

The authors concluded that production is lower in Lake Clark than in Iliamna Lake. Primary production of Lake Clark is less than that of Iliamna Lake. Secchi disk readings in Lake Clark (1.47-2m) were much lower than in Iliamna Lake (9-15m) due to glacial influence. The value of carbon assimilated per square meter of surface area of Lake Clark was found to be approximately one fifth of the value for Iliamna, 13 mg and 54 mg per four hour period respectively. Secondary production in Lake Clark was similarly less than that of Iliamna Lake. The two lake had different zooplankton species compositions. Calanoid and cyclopoid copepods were dominant in Lake Clark and Bosmina were not, this does not appear to have been the case in Iliamna.

Two primary differences were found between the lakes in their resident fish communities. No three spine stickleback were found in the limnetic zone of Lake Clark though they are dominant in Iliamna. Conversely, Lake Clark has a large number of least cisco whereas Iliamna Lake generally lacks this species. Regarding juvenile sockeye, the authors noted that Lake Clark sockeye fry had a wider size range than those of Iliamna indicating a prolonged spawning period or an extended hatching and/or emergence period in Lake Clark relative to Iliamna Lake. And, as suspected from earlier studies, some portion of Lake Clark juvenile salmon migrate to Iliamna Lake to rear either in late fall as age zero fish or in their first spring as age 1 fish

Results of the tagging studies suggest that spawners bound for Lake Clark are mixed with those bound for Iliamna at time of return as migration times of the two through the Kvichak River were found to be closely coupled. In 1967 and 1968, the Newhalen river escapement curve lagged 6-9 days behind the Igiugig escapement curve. Mean passage time through the Newhalen River was 24.3 days in 1967 and 15.5 days in 1968. Differences in passage time were largely related to flow of the Newhalen River, swift water appeared to drastically delay salmon passage. Speed of passage through the Newhalen River decreased as the season progressed. Migration speeds were less within the Newhalen River than within the lake.

Alaska Department of Fish and Game

Aerial Spawning Surveys

The Bureau of Commercial Fisheries (BCF) recorded the first observations of spawning grounds in the Kvichak system. Ground, boat and a limited number of aerially surveys were conducted in years 1920-1955 (with the exception of 1942 and 1943). A program of systematic surveying of index areas was developed to obtain an escapement index for the Kvichak system. FRI conducted spawning ground surveys in the system 1955-1987 (minus 1984). Aerial surveys of the system were taken over by ADF&G in 1988 and have been done every year since. This report summarizes data from 1955 to present (Regnart 1998).

While I found no information on how figures recorded by different agencies may have been manipulated to make them comparable. The aerial spawning surveys appear to have been quite standardized (Parker and Blair 1987) and it is likely that differences in methodology were slight. In addition, Pat Poe of FRI has reviewed this manuscript and noted that it generally agreed with his recollections of spawning surveys and spawner distributions in Lake Clark (Pat Poe, pers. comm.). There was one notable exception that nearly doubled the amount of beach spawners noted in 1979, however. The correction is noted in the data files accompanying this report.

An attempt was made to survey spawning populations during their historical time of peak abundance. Survey flights were conducted from small fixed wing, high-wing, wheeled aircraft at 300-500 feet of altitude and at speeds of 60 to 90 mph (Regnart 1998). This data set includes spawner counts by year and index as percent of escapement by year and area.

➤ *Newhalen River, 1955-1998*

Newhalen River
Lover's Creek
Little Bear Creek/Ponds
Alexi Creek and Lakes
Steam Bath Creek
Tazimina River
Six Mile Lake Beaches
Pickerel Creek & Lakes

➤ *Lake Clark, 1955-1998*

Priest Rock Creek & Ponds
Kijik river
Little Kijik river
Kijik Lake Tributaries
Kijik Lake Beaches
Tlikakila River
Chonkotonk River
Currant Creek
Tanalian River
22 Creek
Sucker Bay Lake
Lake Clark Beaches

Lake Clark Fisheries Inventory, 1978-1979

Surveys were conducted in the summers of 1978 and 1979 by the ADF&G Sport Fish Division in LCNPP to "provide baseline fisheries and human use data for State and Federal agencies

involved in formulating land, water, and resource policies within the boundaries of the proposed Lake Clark National Park and Preserve” (Russell, 1980). Efforts were focused on determining resident and adult anadromous fish species composition and abundance at specific sites in LCNPP. The results are reported by area within the park and by species. Some specific findings of interest include: at least 19 species of fish inhabit Lake Clark including lake trout, Arctic char, Arctic grayling, burbot, northern pike, Dolly Varden, humpback, whitefish, round whitefish, pygmy whitefish, least cisco, rainbow trout, sockeye, chinook, pin salmon, longnose sucker, slimy and coastrange sculpin, three and nine spine stickleback.

Area specific observations within Lake Clark included the following.

Chokotank River –general paucity of species; nine spine stickleback, slimy and coast range sculpin and a limited number of sockeye salmon were observed.

Kijik Lake and River – had high numbers of Arctic grayling and Arctic char. In fact, the largest individuals and greatest catch rates for Arctic char of the survey were found here.

Little Kijik river-high densities of Arctic grayling (one of highest hook and line capture rates)

Long Lake/Chuitna River and Bay – producer of large Northern pike (individuals in excess of 20 lbs and 18 years of age) and many Arctic grayling (one of highest hook and line capture rates for grayling)

Within Lake Clark itself, large numbers of lake trout and least cisco were found.

U.S. Geological Survey

Streamflow Records

Limited discharge records are available for the Newhalen, Tazimina, Tanalian and Kvichak Rivers. These rivers are monitored by remote water gauging stations maintained by the U.S. Geological Survey. Daily discharge and peak discharge information is listed in the Excel file "Discharge.xls" accompanying this report. A list of codes used in the peak discharge files and the years of data available for each of these rivers is listed below. Records are not complete for much of the rivers and years listed below.

Newhalen River	1951-1986
Tazimina River	1981-1986
Tanalian River	1951-1956
Kvichak River	1967-1987

Peak Discharge Qualification Codes

- 1** - discharge is a maximum daily average
- 2** - discharge is an estimate
- 3** - discharge affected by dam failure
- 4** - discharge less than indicated value, which is minimum recordable discharge at this site
- 5** - discharge affected to unknown degree by regulation or diversion
- 6** - discharge affected by regulation or diversion
- 7** - discharge is an historic peak
- 8** - discharge actually greater than indicated value
- 9** - discharge due to snowmelt, hurricane, ice-jam or debris dam breakup
- A** - year of occurrence is unknown or not exact
- B** - month or day of occurrence is unknown or not exact
- C** - all or part of the record affected by urbanization, mining, agricultural changes, channelization, or others
- D** - base discharge changed during this year
- E** - only annual maximum peak available for this year

Gage Height Qualification Codes

- 1** - gage height affected by backwater
- 2** - gage height not the maximum for the year
- 3** - gage height at different site and/or datum
- 4** - gage height below minimum recordable elevation
- 5** - gage height is an estimate
- 6** - gage datum changed during this year

Annual Peak Gage Height Qualification Codes

- 1** - gage height affected by backwater
- 3** - gage height at different site and/or datum
- 5** - gage height is an estimate
- 6** - gage datum changed during this year

Dames & Moore

Dames and Moore began studies on the Newhalen River in 1982 in conjunction with the Alaska Power Authority to assess the feasibility of a proposed run-of-the-river hydroelectric project that would remove water from the Newhalen River at river mile 7. The original report included a chapter on "Biological Resources" which included a summary of existing characteristics of, and potential impacts on, terrestrial communities (birds and mammals) and aquatic habitats (including sockeye salmon and resident fish) for the Lake Clark and Lower Tazimina areas. Studies of sockeye focused primarily on those spawning in the Tazimina River and the relationship between geomorphologic and hydraulic characteristics and spawning and incubation success. This report also contained summaries of historic and archaeological resources as well as socioeconomic conditions and considerations.

Dames and Moore conducted a study of the spatial distribution of sockeye salmon outmigrants at RM 7 on the Newhalen River at the request of Stone and Webster Engine Corporation and with the assistance of Pat Poe of FRI. Fry were collected from May 3rd to June 18th. Originally, the study plan relied heavily on sonar data with net sampling as a secondary technique for backup and confirmation. This was reversed and sonar was used as a backup to net sampling as the available sonar systems were unable to adequately detect fish as small as fry and smolts. Three net types were used: a cable operated wingless fyke net, shore mounted wingless fyke nets and an inclined plan trap. The use of these nets together allowed for sampling of the horizontal and vertical distribution of sockeye outmigrants. Sampling was continued by FRI at RM 22 through August 12th using only inclined plane traps installed mid-channel.

Results indicated that smolt and fry show a preference for migrating through the Newhalen River at night and through the mid-channel. Smolt outmigrating during the day tended to be in the deeper mid-channel. Fry were found near the surface in the peak outmigration and seemed to be sharply cued to increased flows. The peak of the smolt outmigration was from (beginning of study) May 18th to May 26th.

The ratio of age 2 to age 1 smolt was greatest at beginning of the season and decreased dramatically near end of sampling ("age 2 smolt almost disappear"). Length frequency data indicate age 2 smolt reappeared late in the spring and possibly represent a separate stock of age 2 smolt from that seen in early spring.

Additional data on the spatial distribution of fry and the total numbers of fry and smolt captured as well as age and length frequencies are given in this report. The data suggest there is a "fall fry outmigration in the Newhalen River [as] these fish leave the Lake Clark system to enter Iliamna Lake" and that some form (s) of juvenile sockeye salmon may be moving from Lake Clark to Iliamna Lake through much or all of the open water period.

A second year of similar studies at RM 13 was requested to compliment data collected at RM 7 the year before. This was completed by FRI under subcontract to Dames and Moore in 1983. Smolt and fry were collected from May 11th to June 22nd. Results were similar to those of the previous year. Mid-channel was still the preferred route of outmigration and fry still favored near surface movement. Smolt outmigrated at greater depths than fry and than the previous year at RM 7. The peak of the smolt outmigration was May 23rd to 26th, fry peaked June 7th to 10th and were cued to increased flows. Unlike 1982, age 2 smolts dominated. This was likely due to a large escapement to Newhalen River system in 1980.

A limited amount of sampling with a single fyke net was conducted at river mile 2 for ten nights between May 14th to June 6th, 1984. The objective was to catch and age 2,000 smolt and obtain length frequency data. As in 1982, age 1+ smolt made up the majority of the catch (65%).

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