HETTA LAKE

SOCKEYE SALMON (*Oncorhynchus nerka)* STOCK ASSESSMENT PROJECT

2001 ANNUAL REPORT

By

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ABSTRACT

Hetta Lake sockeye salmon are an important subsistence resource for the people of Hydaburg. The Hetta Lake Sockeye Salmon Stock Assessment Project was initiated because of concerns about the apparent declines in sockeye salmon returning to Hetta Lake. The project evaluates sockeye salmon production at various life stages and assesses lake productivity. This annual report summarizes work conducted during the first year of project operations, 2001. The mid-water trawl catch was 95% sockeye fry and 5% sticklebacks. The hydroacoustic survey estimated sockeye fry density at 1.202 fry per m^2 and the total lake estimate was 3 million sockeye salmon fry. The total stickleback population was estimated to be 0.17 million fish. The returning adult sockeye salmon population estimate, for the study area only, was 2,400 fish. The subsistence harvest was estimated to be 4,400 sockeye salmon. Hetta Lake had a seasonal mean zooplankton density of 44,000 plankters per m^2 and a seasonal mean weighted biomass of 128 mg per m^2. The seasonal mean euphotic zone depth was 8 m. This year's results provide the foundation for a multiple-year study to assess the health of sockeye salmon stocks in Hetta Lake and to set a range of escapement goals capable of sustaining this population for many generations.

KEY WORDS: sockeye salmon, *Oncorhynchus nerka*, Hetta Lake, Prince of Wales Island, stock assessment, limnology, zooplankton, hatchery, harvest, subsistence, escapement, hydroacoustic

INTRODUCTION

The people of Hydaburg and the ADF&G are concerned by the apparent decline in sockeye salmon escapement to Hetta Lake. Hetta Lake is historically one of the most productive sockeye salmon systems in Southeast Alaska. Numerous activities may have influenced the production of sockeye salmon in this system. In addition to a long history of commercial and subsistence harvest, and an early hatchery operation, the Hetta Lake watershed was extensively logged in the 1950s. Because Hetta Lake is an important sockeye salmon subsistence system to the community of Hydaburg, state and federal agencies in conjunction with the Hydaburg Cooperative Association initiated the Hetta Lake Sockeye Salmon Stock Assessment Project in 2001. The purpose of the study is to begin identifying major factors that may be limiting production. This multiple-year study is intended to gather information about the Hetta Lake sockeye salmon population and habitat in order to set an escapement goal range and monitor the response of the system to this range to determine if it is sustainable.

Records from early harvest, enhancement, and assessment activities provide background information about Hetta Lake sockeye salmon. Over-fishing of Hetta Lake salmon stocks was documented late in the 1800s. In 1898 Moser reported that at that time the Hetta Lake outlet was barricaded every year. It is not known for how long annual barricades were used. Significant harvests were reported starting in 1887 and continuing through to the 1920s. The Klawock cannery harvested Hetta Lake stocks without competition from 1887-1895 with a mean annual harvest of 41,000 sockeye salmon for that period. Harvest pressure increased in 1896 when the Hunter Bay cannery also began operation in the Hetta Lake area. In 1896 and 1897 the two canneries reported a combined annual catch of close to 200,000 sockeye salmon. However, due to the contribution of fish from multiple locations to cannery production it is doubtful that all 200,000 fish were from Hetta Lake. Annual harvests of over 100,000 sockeye salmon were reported for the next five years after which annual harvests never exceeded 65,000 fish. Fisheries agents recognized that the configuration of the Hetta Lake outlet and fishing regulations relating to the distance at which seines may be set resulted in a highly efficient catch. Repeated attempts to implement regulations that would allow for greater escapement met with limited success. In 1914 it was estimated that fewer than 10,000 sockeye salmon reached the lake. As a result of hearings held by the Bureau of Fisheries, Hetta Bay in 1915 was designated as a salmon breeding reserve. This resulted in the closure of fishing within 500 yards of the stream mouth although the bay was not posted until 1920. Commercial fishing presently continues in Hetta Inlet.

A Hatchery was operated at Hetta Lake for 19 years around the turn of the century. The Pacific Steam Whaling Company began operating a hatchery on the southeast shore of Hetta Lake in 1899 after a failed attempt to establish one at the outlet stream the year before. The hatchery operated from 1899 to 1903 and was discontinued until operation resumed in 1908. At this time the Northwestern Fisheries Company assumed ownership and management of the hatchery. A major remodel was conducted in 1912 with an increased capacity of 15,000,000 eggs (Roppel 1982). A review of records show that the hatchery was not operated in an effective manner. Repeated inspections by fisheries officials found that there were continuous problems with the water supply freezing, incomplete egg collection, nursery ponds, personnel, and poor record keeping. A heating system was attempted to address freezing problems but did not remedy the problem. Although fisheries officials made recommendations no further action was implemented. Additional incubation problems resulted in delayed hatch timing so that fry were being released into the lake at the same time next years adults were returning. Further problems associated with premature fry release and inadequate rearing ponds contributed to the poor performance. The hatchery was never operated to capacity and was permanently abandoned in 1918 (Roppel 1982).

Although stock assessment activities have been performed at Hetta Lake intermittently for the last 34 years, data was inconsistently collected. A weir was operated to quantify escapement at Hetta Lake outlet from 1968–1971 and again in 1982. An evaluation of lake productivity was conducted from 1979–1982 as part of a lake fertilization candidate evaluation. That evaluation included zooplankton sampling, light measurement, and water physical and chemical measurements. In 1980 smolt length and age data was collected along with some fish trapping to characterize the lake fish community. These efforts provide background information but do not accurately assess escapement, population age structure, or lake productivity.

Hetta Lake has been, and continues to be, the primary source of subsistence sockeye salmon for the community of Hydaburg. The ADF&G has monitored subsistence harvest through returned permits for 32 years. The reported catch of sockeye salmon from 1969 to present ranged from 500 to 7,800 with an average reported harvest of 2,400. The five-year-mean annual subsistence harvest ranged from 1,200 fish for 1985–1989 to 1,500 for 1990–1994 and down to 1,400 for 1995–2000. The five-year mean catch per unit effort (CPUE; the catch per returned permit) went from 28 for 1985–1989 to 44 for 1990–1994 and down to 33 for 1995–2000.

The Hetta Lake Sockeye Salmon Stock Assessment Project is one of eight projects initiated in 2001 and funded through the U.S. Fish & Wildlife Service Fisheries Resource Monitoring Program, to assess significant subsistence sockeye salmon runs in southeast Alaska. The Hetta Lake Project identifies and outlines a set of objectives to begin assessing the state of this sockeye salmon stock. In 2001, staff collected lake ecology, escapement, and subsistence harvest data to support long-term escapement goals that incorporate lake productivity modeling. The study plan includes an assessment of the lake's physical characteristics, which support primary production, and the secondary production of its zooplankton populations. Zooplankton are the main food source for juvenile sockeye salmon, and cladocerans are their preferred food within the zooplankton community. By estimating the biomass and number of zooplankton by species, we can evaluate whether food is a limiting factor for juvenile sockeye salmon. The species composition over the season and between years may provide insight into how the zooplankton community responds to different fry densities and adult escapement levels. Juvenile population parameters were estimated, including density, size, and age composition, as indicators of sockeye salmon response to conditions within the lake. A two-sample mark-recapture study was conducted to provide an estimate of sockeye salmon escapement. We used a creel survey to estimate the subsistence harvest of sockeye salmon from Hetta Lake stock. The subsistence harvest combined with escapement and age-composition data enables us to estimate spawner-recruit relationships. The 2001 season was the first year of the study with the exception of a small pilot study conducted in 2000. This report summarizes the sockeye salmon stock assessment data collected in 2001.

OBJECTIVES

1) Conduct a creel survey to estimate sockeye salmon subsistence harvest at Hetta Lake outlet.
2) Estimate sockeye salmon escapement using mark-recapture methods.
3) Estimate sockeye salmon rearing densities through hydroacoustic and trawl surveys.
4) Evaluate lake productivity.

STUDY SITE

Hetta Lake (ADF&G stream #103-25-047) is located on the southwestern side of the Prince of Wales Island (55°10'10" N., 132°34'02" W.) (Figure 1). The lake has a surface area of 207 hectares, an elevation of 9.4 meters, a mean depth of 48.0 meters, and a maximum depth of 92.0 meters (Figure 2). This dimictic oligotrophic lake has stained water and a volume of 99.4 million cubic meters with a mean residence time of 12.6 months. The mean euphotic zone depth is 11.7 meters. The Hetta Lake watershed is composed of 5,828 acres of steep spruce, cedar, and hemlock forest with alpine habitat above 550 m. Hetta Lake has three main tributaries, Hetta, Hatchery, and Camp creeks. The Outlet Creek, empties into Hetta Cove approximately 600 m from the lake. Native fish species include cutthroat trout (*O. clarki* spp.), Dolly Varden (*Salvelinus malma*), three spine stickleback (*Gasterosteus aculeatus*), cottids (*Cottus* sp.), steelhead (*O. mykiss*), and pink (*O. gorbusha*), chum (*O. keta*), coho (*O. kisutch*), and sockeye (*O. nerka*) salmon.

METHODS

Sockeye Fry Assessment

The distribution and abundance of sockeye salmon fry were estimated by hydroacoustic and mid-water trawl sampling. Hetta Lake was divided into ten sampling areas based on surface area for the hydroacoustic portion of the survey. Prior to conducting a survey, one orthogonal transect was randomly chosen within each sampling area. These cross-lake transects started and ended at a depth of 10 m and each transect was surveyed twice to get a repeated measure. Sampling was conducted in the darkest part of the night. A constant boat speed of about 2.0 m $\cdot$ sec^{-1} was attempted for all transects. The acoustic equipment consisted of a Biosonics[2] DT-4000™ scientific echosounder[2] (420 kHz, 6° single beam transducer) and Biosonics Visual Acquisition© version 4.0.2 software was used to record the data. Ping rate was set at 5 pings $\cdot$ sec^{-1} and pulse width at 0.4 ms. A target strength of –50 dB to –68 dB was used to represent fish within the size range of juvenile sockeye salmon and other small pelagic fish. Data were analyzed using Biosonics Visual Analyzer© version 4.0.2 software. Echo integration was used to generate a fish density (fish $\times$ m^{-2}) for each of the ten sample areas (MacLennand and Simmonds 1992). A population estimate for each of the ten sample areas was calculated as the product of fish density and the surface area of each of the ten sample areas. Summing the ten sampling area population estimates generated a total population estimate for the lake. A second estimate was calculated using the repeated measure of transects. The average between these two estimates was used as the total population estimate for Hetta Lake. A variance around the mean estimate was not possible because the survey was a repeated measures design instead of a true replicate design. We are revising our study design for hydroacoustic survey in accordance with a replicate sample design and will report a variance in the future.

Trawl sampling was conducted in conjunction with hydroacoustic surveys to determine the species composition of targets. A 2 m $\times$ 2 m elongated trawl net was used for pelagic fish sampling. Trawl depths

[2] Product names used in this publication are included for scientific completeness but do not constitute product endorsement.

and duration were determined by fish densities and distributions observed during the hydroacoustic survey. All captured fish were euthanized with MS-222 and preserved in 90% ethanol. In the laboratory, fish were soaked in water for 60 minutes before sampling. The snout-fork length was measured to the nearest millimeter (mm) and weight was measured to the nearest tenth gram (0.1g) on each fish. All sockeye salmon fry under 50 mm were assumed to be age-0. Scales were collected from fish over 50 mm for further age analysis. Sockeye salmon fry scale patterns were examined through a Carton microscope with a video monitor and aged using methods outlined in Mosher 1968. Two trained technicians independently aged each sample. The results of each independent scale ageing were compared. In instances of discrepancy between the two age determinations, a third independent examination was conducted.

Sockeye Escapement Assessment

A two-sample mark-recapture study was conducted to estimate the sockeye salmon escapement to the study area in Hetta Lake. The study area was defined as Hetta Creek and approximately 500 m of beach to the east of the creek. The field crew conducted five mark-recapture sampling efforts, approximately every two weeks over the entire spawning period. At the beginning of each trip, the number of spawners around the lake and in tributary streams was estimated to provide an index of escapement. Beach seines 20 m long and 4 m deep were used to surround sockeye salmon, pulled by a small skiff with outboard motor and crewmembers on foot. All sockeye salmon caught were first inspected for previous marks, then marked with an opercle punch or pattern of punches indicating the trip and day number, and released with a minimum of stress. The total sample size, the number of new fish marked, and the number of recaptured fish with each type of mark were recorded. Marking was stratified through by trip. Four mark recovery surveys were conducted on the spawning grounds at two-week intervals. Live and dead fish were counted and examined for marks and given a second mark (opercle punch) to prevent duplicate sampling at a later time. We generated a Darroch estimate of the number of sockeye salmon in the study area using Stratified Population Analysis System (SPAS) software (Arnason et al. 1996). The data was stratified by trip for the first three trips and the pooled for the last two trips due to small sample sizes. A minimum total lake escapement estimate was calculated as the ratio of fish counted in the study area to the fish counted outside the study area multiplied by the Darroch study area population estimate.

Escapement Age and Length Distribution

Age and size characteristics of the adult sockeye salmon were collected at Hetta Lake during the mark-recapture study to describe the biological structure of the population. The goal was to collect 600 samples through the spawning season. Three scales were taken from the preferred area of each fish (INPFC 1963), and prepared for analysis as described by Clutter and Whitesel (1956). Scale samples were aged at the ADF&G salmon aging laboratory in Douglas, Alaska. Age classes were designated following the European aging system where freshwater and saltwater years are separated by a period (e.g. 1.3 denotes 1 year freshwater and 3 years saltwater). Brood year tables were compiled by sex and brood year to describe the age structure of the returning adult sockeye salmon population. The length of each fish was measured from mid eye to tail fork to the nearest millimeter (mm).

Subsistence Harvest Estimate

The study design for the Hetta Lake subsistence fishery was originally based on a stratified two-stage direct expansion (Bernard et al. 1998; Cochran 1977). The nature of the subsistence fishery did not allow interviewers to follow the study design because of multiple exits between the harbor and the fishery. However, since one of the HCA technicians was able to independently interview all participants, all that was required was summation of catches.

The total harvest (by species) ($\hat{H}$) was estimated as:

$$\hat{H} = \sum_{i=1}^{d} \sum_{i=1}^{m_i} h_{ij}$$

where h_{ij} = harvest on boat group j, sampling day (period) i; m_i = number of boat groups interviewed on day i; M_i = number of boat groups completing trips on day i (in case where all boats are interviewed, M_i = m_i); d = number of days sampled ; and D = number of all days the fishery is open (in case where all days are sampled, $D = d$).

The HCA technician, Robert Sanderson, sampled every day that the fishery was open, and interviewed every party that fished. If the technician was unable to interview participants in the fishery or at the boat harbor, he would contact participants at their homes. The technician was certain that he had interviewed all participants in the fishery.

Limnology

Limnology sampling was conducted at two stations on Hetta Lake every six weeks throughout the summer to measure euphotic zone depth, and to collect zooplankton samples.

Light Regime

The depth at which 1% of the surface light attenuates under water defines the area of the lake capable of photosynthesis. Measurements of under-water light penetration (footcandles) were taken at 0.5 m intervals, from the surface to a depth equivalent to one percent of the subsurface light reading (5 cm), using a Protomatic International Light submarine photometer. Vertical light extinction coefficients (K_d) were calculated as the slope of the light intensity (natural log of percent subsurface) versus depth. The euphotic zone depth (EZD) is defined as the depth to which 1% of the subsurface light (phototsynthetically available radiation [400-700 nm]) penetrates the lake surface (Schindler 1971). EZD was calculated from the equation: EZD = 4.6205/ K_d (Kirk 1994).

Secondary Production

Zooplankton are the primary food for sockeye salmon and cladocerans are their preferred food within the zooplankton community. By estimating the biomass and number of zooplankton by species throughout the season, we can observe how the species composition changes over the season and between years. This information may provide insight into how the zooplankton community responds to different fry densities and adult escapement levels. Zooplankton samples were collected at two stations with a 0.5 m diameter, 153 um mesh, 1:3 conical net. Vertical zooplankton tows were pulled from 1 m above the station depth at a constant speed of 0.5 m sec^{-1}. The net was rinsed prior to removing the organisms, and all specimens were preserved in neutralized 10% formalin (Koenings et al. 1987). Zooplankton samples were analyzed at the ADF&G, commercial fisheries limnology laboratory in Soldotna, Alaska. Cladocerans and copepods were identified using the taxonomic keys of Brooks (1957), Pennak (1978), Wilson (1959), and Yeatman (1959). Zooplankton were counted from three separate 1 ml subsamples taken with a Hensen-Stemple pipette and placed in a 1 ml Sedgewich-Rafter counting chamber. Zooplankton body length was measured to the nearest 0.01 mm from at least 10 organisms of each species along a transect in each of the 1 ml subsamples using a calibrated ocular micrometer (Koenings et al. 1987). Zooplankton biomass was estimated using species-specific dry weight regressed against zooplankter length (Koenings et al. 1987). The seasonal mean density and body size was used to calculate the seasonal zooplankton biomass (ZB) for each species. Marco-zooplankters were further separated by sexual maturity where ovigorous (egg bearing) zooplankters were also identified.

RESULTS

Sockeye Fry Assessment

A hydroacoustic survey and a mid-water trawl were conducted on 11 July 2001. A total of 120 sockeye salmon fry and 7 sticklebacks were caught in the single mid-water trawl conducted in conjunction with the hydroacoustic survey (Table 1). The trawl consisted of a single 10-minute tow at a depth of 10 m. All sockeye salmon fry were less then 50 mm fork length and assumed to be age-0. The length frequency for sockeye salmon fry similarly shows one age class uniformly distributed (Figure 3). The mean snout-fork length of the sockeye salmon fry was 34.4 mm (SE = 0.3mm) and a mean weight of 0.32 g (SE = 0.01g). The mean snout-fork length of sticklebacks was 39.7 mm (SE=2.2 mm) and a mean weight of 0.60 g (SE = 0.08g). All targets that fell within target strength range of –50 dB to –68 dB during hydroacoustics were assumed to be represented by 95% sockeye salmon fry and 5% sticklebacks. The hydroacoustic survey conducted on Hetta Lake provided a total lake population estimate of 2,909,000 sockeye salmon fry (range of repeated measure was 2,734,000 to 3,083,000 fry) and 170,000 sticklebacks. The sockeye salmon fry density for the lake was 1.20 fry $\cdot m^{-2}$ (range of repeated measure was 1.12 to 1.27 fry $\cdot m^{-2}$) (Table 1).

Sockeye Escapement Assessment

Mark-recapture trips were performed in Hetta Lake on 22 August, 4 September, 19 September, 3 October, and 17 October. Hetta Creek was initially chosen as the study area prior to any spawning because the largest concentration of fish in the lake were staged at the mouth that creek. We used the stream mark-recapture design based on this observation. Sockeye holding off the mouth of Hetta Creek were marked on the first trip on the assumption that they would go up the creek to spawn. However, during the second trip, fish had dispersed not only into the creek but also on to the adjacent beach. The recapture of fish marked on the first trip both in the creek and along the beach indicated that sockeye salmon used both the stream and adjacent beach to spawn. Consequently, we treated the stream and this beach as one closed population. A total of 949 sockeye salmon were marked and released in the lake for the mark-recapture population estimate. Fish were marked with a total of 307 circle, 352 triangle, and 270 square punches (Table 2). During mark recovery efforts a total of 706 sockeye salmon were examined in the study area. A total of 259 marks (81 circle, 116 triangle, and 62 square) were recorded in the recovery phase of the mark-recapture study throughout the season (Table 3). The estimated sockeye salmon escapement in the study area was 2,400 (SE = 133, 95% CI ±200). The minimum sockeye escapement for the total lake was approximately 6,000 fish.

Four escapement surveys were completed between 6 September and 16 October to create an index of the number of spawners (Table 4). Escapement surveys in Hetta Lake yielded a peak sockeye salmon count of 1,800 fish on 6 September (Table 4). Reported counts consist of the sum of all fish counted in the lake and tributaries. Hetta Creek was the only tributary that had spawning sockeye salmon.

Escapement Age and Length Distribution

A total of 508 total adult sockeye salmon scale samples were collected in 2001. The dominant age class of adult sockeye salmon, weighted by the number sampled per statistical week, was age-1.3 (80.7%) followed by age-1.2 (16.7%: Table 5). There were 45.3% age-1.3 females and 35.4% age-1.3 males. The mean fork length of age-1.3 fish was 556 mm (SE = 1 mm; $n = 410$) and 514 mm (SE = 3 mm; $n = 85$) for age-1.2 fish (Table 6).

Subsistence Harvest Estimate

The sockeye salmon subsistence fishery harvest estimated by creel survey was 4,400 fish. Since all participants in the fishery were interviewed, the variance was 0. Sixty creel survey interviews were conducted during the open subsistence-fishing season. The pattern of harvest for each sample day varied through time throughout the fishery (Figure 4). The reported harvest from returned subsistence permits is not available at this time.

Limnology

Light Regime

Limnology sampling was conducted at two stations on Hetta Lake on 9 May, 12 June, 25 July, 6 September, and 17 October to measure euphotic zone depth and to collect zooplankton samples. The 2001 Hetta Lake euphotic zone depth (EZD) ranged from 5.48 to 11.54 m with a season mean of 7.94 m (Table 7). Typical of other Southeast lakes, this lake was clearest in the late spring, becoming more stained throughout the season with some minor variability. The zooplankton results for Hetta Lake are not available at this time.

Secondary Production

Zooplankton samples were collected at two stations on Hetta Lake on 9 May, 12 June, 25 July, 6 September, and 17 October. In 2001, the macrozooplankton assemblage in Hetta Lake was dominated by a species of cladoceran (*Bosmina* spp.), and a copepod (*Cyclops* spp.). The dominant species by density and biomass was *Bosmina* spp. (Tables 8 and 9). The seasonal mean total macro-zooplankton density was 44,000 plankters $\cdot$ m^{-2}. The seasonal mean weighted macro-zooplankton biomass was 128 mg $\cdot$ m^{-2} (Table 9). Ovigorous *Cyclops* spp. was the largest species present followed by *Daphnia* sp. (Table 10).

DISCUSSION

In the first year of the Hetta Lake sockeye salmon stock assessment, the project completed the objectives to estimate the subsistence harvest and the sockeye fry population as well as describe the size and age structure of fry and adult sockeye populations and the productivity of Hetta Lake. We successfully estimated the number of fish in the study index area. However, an expansion of this estimate to a whole estimate was problematic. The minimum total escapement estimate expanded using the mark-recapture estimate in the study and lake counts must be considered a very approximate estimate of the true escapement because the bias is unknown. The exchange of fish between the stream and adjacent beach required combining two different habitats to estimate the number of fish present in the study area. Consequently, the detectability of fish in two different habitats may be different and we are unsure of how this difference might bias the estimate. An expansion of this estimate based on counts only in beach areas most likely is not as accurate as expanding a study estimate to a whole lake that has only stream or beach but not both habitats. However, this is the best estimate of the minimum escapement that we could make with the available data. We will redesign the sampling protocol for this system in an attempt to estimate the beach portion of the study area separate from the stream area. The escapement counts document that Hetta Creek and the adjacent beach were the primary spawning area for sockeye salmon in 2001. Other tributaries in Hetta Lake had small number of sockeye spawners staged at the mouths but no sockeye adults were observed in these streams. An additional objective to produce an historical report of Hetta Lake sockeye salmon is in progress.

Hetta Lake had the largest sockeye salmon fry population estimate and the highest density of fry among eleven lakes surveyed this year in Southeast Alaska (Table 11). This large cohort of 3 million age-0 sockeye salmon fry is the progeny of the 2000 escapement. Anecdotal information from Hydaburg residents, that the 2000 sockeye salmon return was one of the strongest in recent years, supports the hypothesis that there was a large sockeye salmon escapement in 2000. The deep euphotic zone depth (8 m) most likely provides a substantial photogenic area in the lake that, in turn, provides high levels of primary and secondary productivity capable of sustaining high fry densities. The 2001 escapement appears to be low compared to historic return estimates. Robert Sanderson, a long-time resident of Hydaburg, stated that it was one of the worst runs he can remember. As we collect more years of data, we will determine if the Hetta Lake sockeye escapements are cyclic and adjust harvest pressure accordingly.

The high density of sockeye salmon fry in Hetta Lake may effect zooplankton density, biomass, and species composition. In 2001, Hetta Lake zooplankton seasonal mean density and biomass were low. The low density and biomass may be the result of intense zooplankton grazing pressure by the high density of sockeye salmon fry. The species composition is dominated by smaller bodied zooplankton. The dominance of smaller bodied zooplankton species and the low density of *Daphnia* sp. is typical of zooplankton assemblages subjected to high levels of grazing pressure (Carpenter and Kitchell 1993). The low density of zooplankton in 2001 could negatively influence the survival rate of this year's fry.

The nature of the subsistence fishery did not allow interviewers to follow the original study design. Hetta Lake is located approximately 25 km from Hydaburg. During the study design it was assumed that a person stationed at the Hydaburg harbor would be able to interview all returning subsistence fishers. Multiple exits between the harbor and the fishery were subsequently identified and it became apparent that the interview location was inadequate. However, the HCA technician, Robert Sanderson, recognized that the study design was not working and took it upon himself to independently interview all participants. He conducted interviews on the fishing grounds when weather permitted and contacted all fishery participants in person or by phone on days when travel to the fishing grounds was prohibited by weather.

In 2001, the Hetta Lake sockeye salmon population age structure was dominated by age-1.3 fish followed by age-1.2 fish. This result should be viewed with caution because annual age class proportions are controlled by brood year strength, and the 2001 results are based on only a single return year data. However, the 16-year-mean brood year data is dominated by age-1.3 (58.1%) and age-1.2 (30.1%; Table 12). Other age classes are present but generally do not represent a significant portion of the population.

This year's results provide information important to the Hetta Lake project but they represent only the preliminary step in the construction of a complete sockeye salmon stock assessment. We think that management objectives must be supported by information gathered from a complete stock assessment. A complete stock assessment requires, at a minimum, monitoring through a five-year-life cycle of sockeye salmon. Additionally, we will continue to develop cooperative partnerships, jobs, and training opportunities with the community of Hydaburg. None of these research and project directions can be completed in a few years. Instead, they require consistent attention, on going re-evaluation and coordination with the community to work toward managing sockeye salmon returns to Hetta Lake for sustainability for many years to come.

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Table 1. Summary of hydroacoustic population and mid-water trawl abundance estimates of rearing sockeye salmon fry in Hetta Lake, 2001.

Species	Age	Sample size	Percent Species	Population	Mean length (mm)	Mean weight (g)
Sockeye	0	120	94%	2,909,000	34.4	0.32
Stickleback	No Age	7	6%	170,000	39.7	0.60

Table 2. Summary of sockeye salmon marking at Hetta Creek by date and mark type, 2001.

Date	Mark	Marked
22-23 Aug	Left Circle	307
4-7 Sept	Left Triangle	352
19-21 Sept	Left Square	270
Total		949

Table 3. Mark recovery data at Hetta Creek by date and mark type, 2001.

Date	Left circle	Left triangle.	Left square	Unmarked
7-Sep	21	10		87
18-Sep	8	9		27
19-Sep	8	27		136
20-Sep	33	40	1	104
21-Sep	3	11	24	30
3-Oct	3	9	19	35
4-Oct	5	9	14	26
5-Oct		1	3	
17-Oct			1	2

Table 4. Sockeye salmon surveys in Hetta Lake by date, 2001.

Date	Study Area	Outside Study Area	Lake Total
24 Aug	NA	NA	NA
6-Sept	NA	NA	1800
18-Sept	634	330	964
3-Oct	233	562	795
16-Oct	108	512	620

Table 4. Age composition of sockeye salmon by brood year age and percent sample size, 2001.

Brood year	1998	1997	1996	1996	1995	
Age	1.1	1.2	1.3	2.2	2.3	Total
Percent	1%	16.7%	80.7%	0.2%	1.4%	100%
Std. Error	0.4	1.6	1.7	0.2	0.5	
Sample Size	5	85	410	1	7	508

Table 5. Mean fork length (mm) of sockeye salmon in Hetta lake escapement by sex, brood year, and age class.

Brood Year	1998	1997	1996	1996	1995	
Age	1.1	1.2	1.3	2.2	2.3	Total
Male	327	521	565	0	549	555
Std Error	8.8	3.8	1.6	0	10.4	
Sample Size	5	22	180	0	4	211
Female	0	512	548	525	547	540
Std Error	0	3.3	1.3	11.9	1.5	
Sample Size	0	63	230	1	3	297
All Fish	327	514	556	525	548	546
Std Error	8.8	2.6	1.1	7.2	1.5	
Sample Size	5	85	410	1	7	508

Data from ADF&G scale age lab.

Table 6. Euphotic zone depth in meters in Hetta Lake.

2001	EZD
9-May	11.54
12-Jun	9.54
25-Jul	5.48
6-Sep	7.33
17-Oct	5.81
MEAN	7.94

Table 7. Hetta Lake zooplankton species density (No./m^2) by station, date, and season mean, 2001.

Station A	9-May	12-Jun	25-Jul	6-Sep	17-Oct	Mean	Percent
Cyclops	23,230	14,875	1,291	4,245	9,849	10,698	24.7%
Ovig. Cyclops	0	136	0	0	0	27	0.1%
Bosmina	1,970	5,434	12,430	10,053	43,726	14,723	33.9%
Ovig. Bosmina	272	475	645	204	679	455	1.0%
Daphnia l.	0	0	34	34	255	65	0.1%
Copepod nauplii	34,233	1,732	849	7,030	43,301	17,429	40.2%
Station B							
Cyclops	22,007	16,947	1,358	3,396	6,198	9,981	22.7%
Ovig. Cyclops	34	68	0	0	0	20	0.0%
Bosmina	2,140	8,015	10,392	23,264	57,905	20,343	46.2%
Ovig. Bosmina	34	68	713	951	2,123	778	1.8%
Daphnia l.	34	68	136	238	170	129	0.3%
Daphnia r.	0	68	0	0	0	14	0.0%
Copepod nauplii	15,996	1,664	849	11,038	34,301	12,770	29.0%

Table 8. Hetta Lake zooplankton mean weighted biomass (mg/m^2) by station, species, and season mean, 2001.

Species	Station A	Percent	Station B	Percent	Mean	Percent
Cyclops	19.32	55.7%	13.06	40.0%	16.19	48.1%
Ovig. Cyclops	0.13	0.4%	0.10	0.3%	0.11	0.3%
Bosmina	14.60	42.1%	18.45	56.5%	16.52	49.1%
Ovig. Bosmina	0.47	1.4%	0.74	2.3%	0.61	1.8%
Daphnia l.	0.14	0.4%	0.23	0.7%	0.19	0.6%
Daphnia g	0.00	0.0%	0.07	0.2%	0.03	0.1%
Total	34.67		32.65		33.66	

Table 9. Hetta Lake zooplankton species length (mm) by date and season mean, 2001.

Species	9-May	12-Jun	25-Jul	6-Sep	17-Oct	Mean
Cyclops	0.645	0.65	0.73	0.79	0.74	0.71
Ovig. Cyclops	1.13	1.145	1.26	1.32	1.21	1.21
Bosmina	0.36	0.365	0.31	0.335	0.32	0.34
Ovig. Bosmina	0.37	0.385	0.305	0.33	0.34	0.35
Daphnia l.	0.6	0.52	0.59	0.715	0.72	0.63
Ovig. Daphnia l.	NA	NA	NA	NA	1.14	1.14
Daphnia g	NA	1.14	NA	NA	NA	1.14
Chydorinae	NA	NA	0.26	NA	0.3	0.28

Table 10. The 2001 hydroacoustic fry density estimates (fry*m^{-2}) for 12 sockeye salmon lakes important to subsistence users in Southeast Alaska.

Lake	Density
Kanalku	<0.01
Mahoney	<0.01
Redoubt	0.01
Chilkat	0.01
Kook	0.03
Klawock	0.07
Salmon Bay	0.07
Chilkoot	0.09
Falls	0.09
Luck	0.10
Sitkoh	0.14
Klag	0.14

Table 11. Hetta Lake sockeye escapement age class representation by brood year and mean of all available data.

Age	1.1	1.2	1.3	1.4	2.1	2.2	2.3
1982	0.0%	7.0%	92.6%	0.1%	0.0%	0.0%	0.3%
1983	11.4%	26.3%	62.3%	0.0%	0.0%	0.0%	0.0%
1984	21.1%	50.3%	28.1%	0.0%	0.0%	0.5%	0.0%
1985	12.2%	27.3%	56.7%	0.0%	0.0%	0.5%	3.4%
1986	0.7%	50.0%	45.2%	0.0%	0.0%	2.2%	1.9%
1987	0.8%	1.9%	95.6%	0.0%	0.0%	0.0%	1.7%
1988	5.7%	49.1%	43.1%	0.3%	0.0%	1.6%	0.3%
1990	3.0%	39.5%	55.0%	0.0%	0.2%	1.3%	1.1%
1991	11.8%	26.1%	60.3%	0.0%	0.2%	0.5%	1.1%
1992	4.1%	41.8%	51.7%	0.0%	0.0%	1.5%	0.9%
1993	0.0%	24.3%	68.5%	0.0%	0.0%	0.8%	6.5%
1994	8.3%	7.4%	82.4%	0.0%	0.2%	0.4%	1.4%
1995	32.3%	48.8%	12.1%	0.2%	5.4%	0.4%	0.9%
1996	0.0%	32.7%	66.2%	0.0%	0.0%	1.1%	0.0%
1997	0.4%	3.6%	94.3%	0.0%	0.0%	0.6%	1.1%
1998	48.1%	13.9%	34.2%	0.0%	1.7%	0.9%	1.3%
1999	2.0%	71.2%	22.6%	0.0%	0.0%	3.7%	0.5%
2000	0.0%	20.7%	74.9%	0.0%	0.0%	1.0%	3.4%
Mean	9.0%	30.1%	58.1%	0.0%	0.4%	0.9%	1.4%

Data from ADF&G scale age lab.

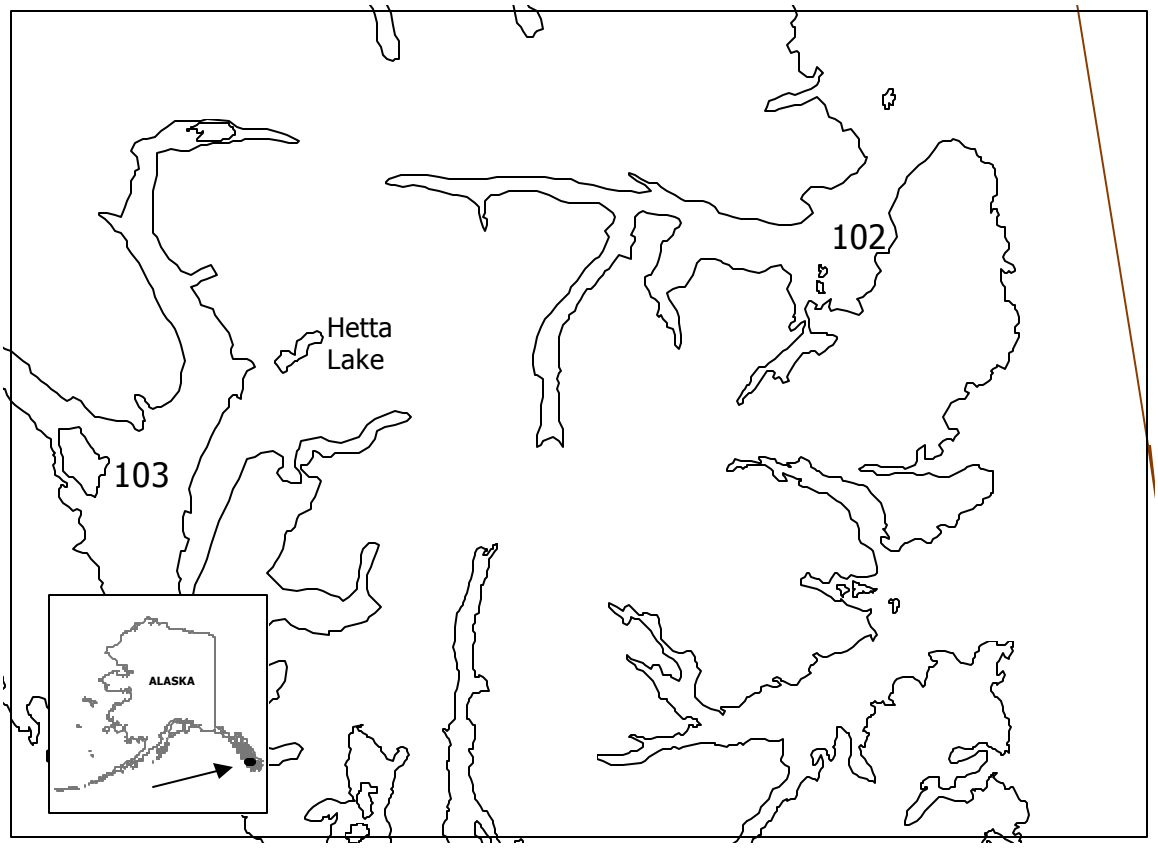

Figure 1. The geographic location of Hetta Lake, within the State of Alaska, and relative to commercial fishing districts on southwest Prince of Wales Island.

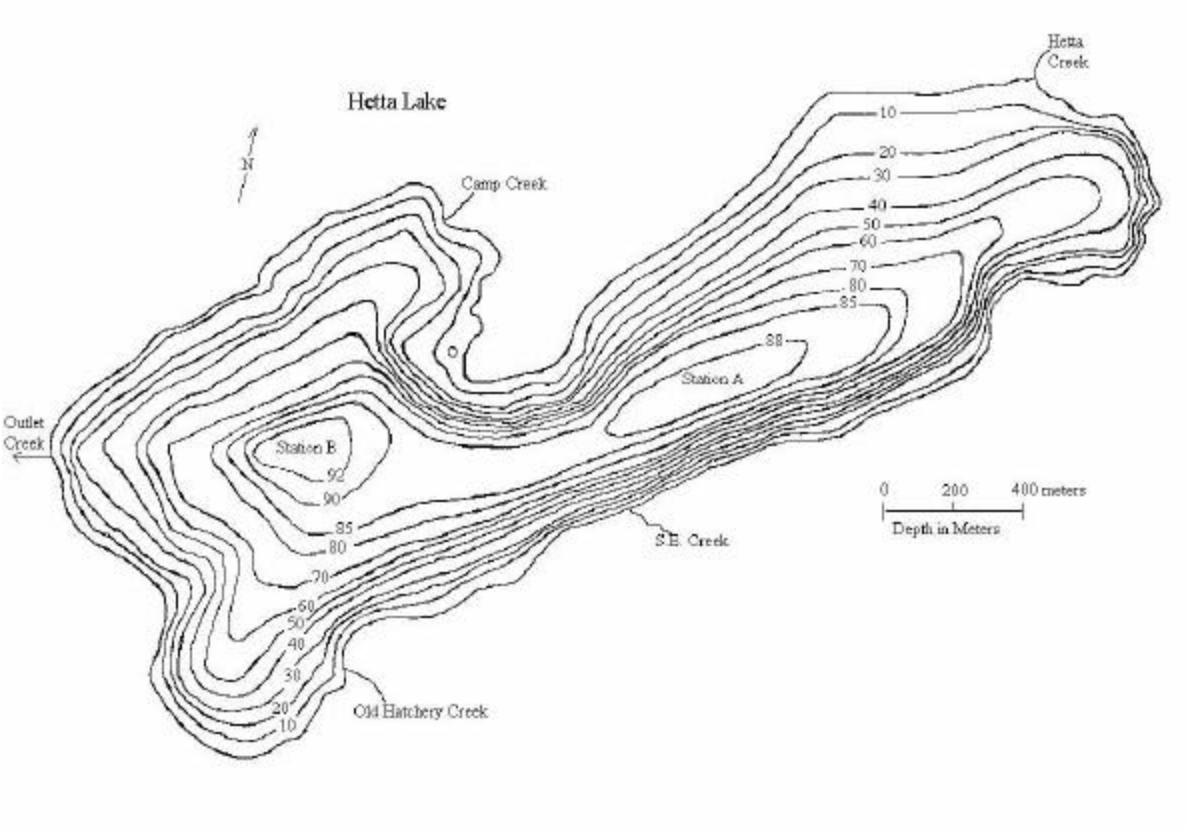

Figure 2. Bathymetric map of Hetta Lake with limnological sampling stations and inlet stream references.

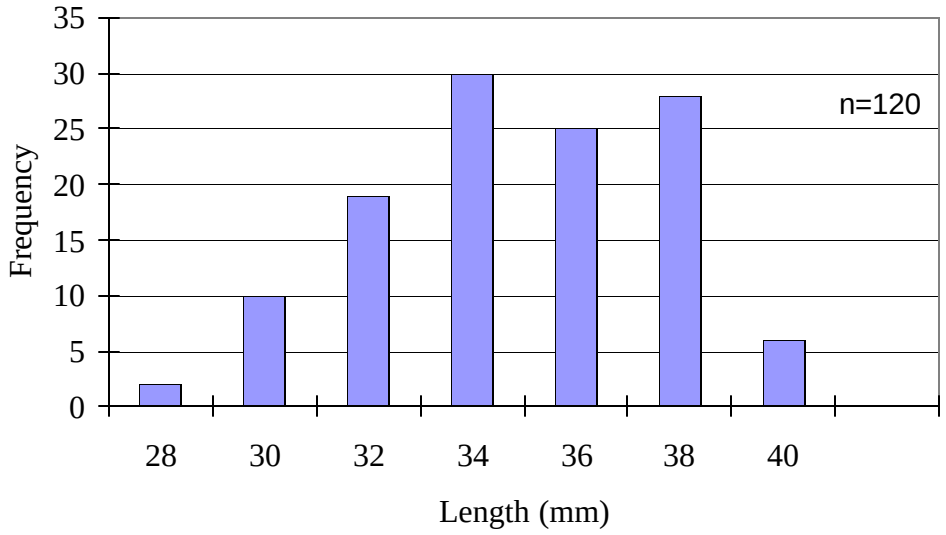

Figure 3. Length frequency of sockeye salmon fry from hydroacoustic trawl catch. Because all fry were less than 50 mm, all were assumed to be age-0.

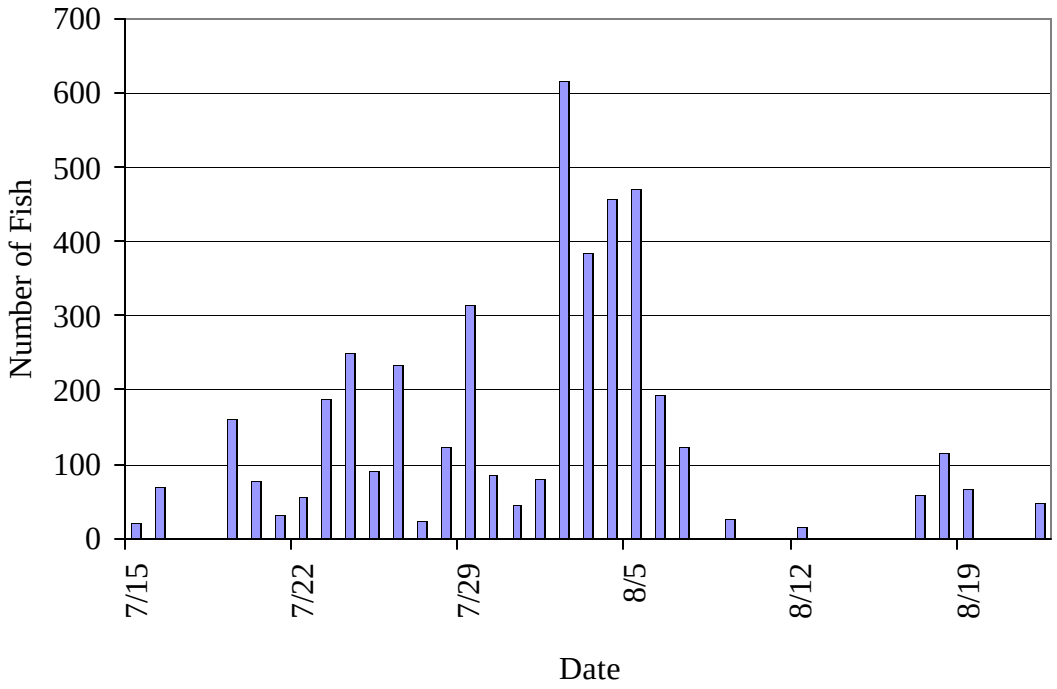

Figure 4. Estimated Hetta Lake subsistence harvest of sockeye salmon on sampled dates in 2001.

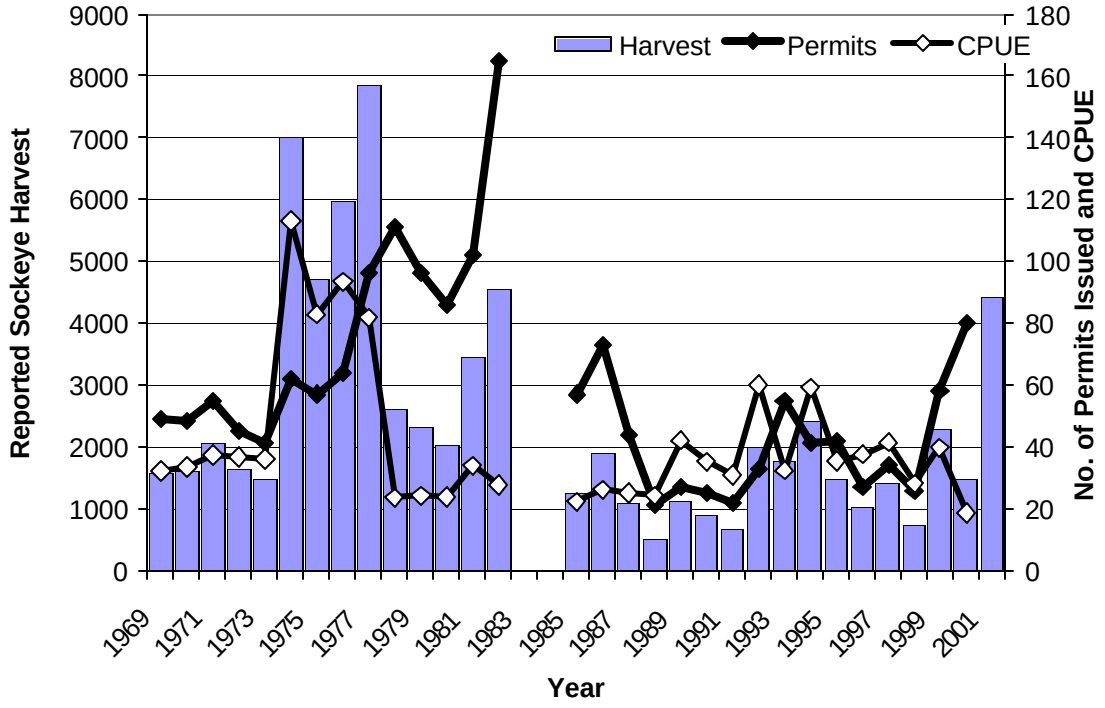

Figure 5. The reported harvest, number of permits, and catch per unit effort (CPUE) for the Hetta Lake sockeye salmon subsistence fishery for 1969 to 2000. (Data retrieved from ADF&G ALEX/IFDB database)

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