THOMS, SALMON BAY, AND LUCK LAKES

SOCKEYE SALMON (*Oncorhynchus nerka*) STOCK ASSESSMENT PROJECT

2001 ANNUAL REPORT

By

Bert A. Lewis
and
Margaret A. Cartwright

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AUTHORS

Bert A. Lewis is a fisheries biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 2030 Sea Level Drive, Suite 205, Ketchikan, Alaska 99901-6073.

Meg Cartwright is a fisheries biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 803 3rd St. Douglas, Alaska, 99824-0020

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The Federal Subsistence Board, managed by U.S. Fish and Wildlife Service — Office of Subsistence Management, approved the Thoms, Salmon Bay, and Luck lakes Subsistence Sockeye Salmon Project (Study Number FIS01-127). The project was funded by the U.S. Forest Service, and is a cooperative project between the U.S. Forest Service (USFS), the Alaska Department of Fish and Game (ADF&G), and the Wrangell Cooperative Association (WCA). This annual report partially fulfills contract obligations for Sikes Act Contract (43-0109-1-0112).

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ABSTRACT

Sockeye salmon (*Oncorhynchus nerka*) returning to Thoms, Salmon Bay, and Luck lakes are an important subsistence resource for the people of Wrangell and Prince of Wales Island. The Thoms, Salmon Bay, and Luck Lakes Sockeye Salmon Stock Assessment Project was initiated because of concerns about the potential increase in harvest of sockeye salmon returning to these lake systems. 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.

In Thoms Lake, a hydroacoustic survey estimated a sockeye fry density of 0.89 fry per m^2 and a total lake population of 914,000 fry. Ninety percent of the sockeye salmon fry captured in the mid-water trawl were age-0 and 10% were age-1 fry. Sockeye salmon fry comprised 97% of the mid-water trawl sample and the remaining 3% were sticklebacks. A mark recapture study of the spawning population estimated the minimum sockeye salmon escapement at 3,000 fish. Thoms Lake had a seasonal mean zooplankton density of 105,000 plankters per m^2 and a seasonal mean weighted biomass of 142 mg per m^2. The seasonal mean euphotic zone depth was 3 m.

In Salmon Bay Lake, a hydroacoustic survey estimated a sockeye fry density of 0.72 fry per m^2 and a total lake population of 221,000 sockeye salmon fry. All the sockeye salmon fry captured in the mid-water trawl were age-0. Sockeye salmon fry comprised 93% of the mid-water trawl sample and the remaining 7% were sticklebacks. A mark recapture study of the spawning population estimated the minimum sockeye salmon escapement at 20,800 fish. Salmon Bay Lake had a seasonal mean zooplankton density of 162,00 plankters per m^2 and a seasonal mean weighted biomass of 347 mg per m^2. The seasonal mean euphotic zone depth was 4.6 m.

In Luck Lake, a hydroacoustic survey estimated a sockeye salmon fry density of 0.10 fry per m^2 and a total lake population of 19,000 sockeye salmon fry. All the sockeye salmon fry captured in the mid-water trawl were age-0. Sockeye salmon fry comprised 80% of the mid-water trawl sample and the remaining 20% were sticklebacks. A mark recapture study of the spawning population estimated the minimum sockeye salmon escapement at 7,900 (range=6,700-9,000, 95% CI) fish. Luck Lake had a seasonal mean zooplankton density of 115,00 plankters per m^2 and a seasonal mean weighted biomass of 233 mg per m^2. The seasonal mean euphotic zone depth was 4.6 m.

This year's results provide the foundation for a multiple-year study to assess the health of the sockeye salmon stocks in Thoms, Salmon Bay, and Luck lakes and to set a range of escapement goals capable of sustaining these populations for many generations.

KEY WORDS: sockeye salmon, *Oncorhynchus nerka*, Thoms Lake, Salmon Bay Lake, Luck Lake, Prince of Wales Island, Wrangell Island, stock assessment, limnology, zooplankton, hatchery, harvest, subsistence, escapement, hydroacoustic

INTRODUCTION

Thoms, Luck, and Salmon Bay lakes produce moderate numbers of sockeye salmon and have a long history of subsistence fishery exploitation. Regulatory proposals before the Federal Subsistence Board for increased possession limits and an extended season show increasing pressure to harvest these subsistence resources. There is some escapement information available from sporadic aerial surveys and a weir operated during the 1980s at Salmon Bay Lake. There is little information on Luck and Thoms lakes. Some or all of these lakes may have been over-harvested in the past and adult sockeye salmon returns may not be at optimum production levels. Due to the importance of these subsistence systems for residents of Wrangell, Prince of Wales Island, and Petersburg and the proposed regulatory changes, the Thoms, Salmon Bay, and Luck Lakes Sockeye Salmon Stock Assessment project was initiated in 2001. Federal funding through the U.S. Fish and Wildlife Service (USFWS) and U.S. Forest Service (USFS), created a cooperative study between Wrangell Community Association (WCA), Alaska Department of Fish and Game (ADF&G), and the United States Forest Service (USFS). The goal of these multiple-year studies is to gather enough information about the sockeye salmon populations and their habitat to set a range of escapement goals and monitor the response of the system to these ranges to determine if they are sustainable. This annual report summarizes the information collected in 2001, the first year of this study.

OBJECTIVES

1. To estimate escapement of sockeye salmon into each lake with a mark-recapture experiment.
2. To estimate rearing density of sockeye salmon fry in each lake through hydroacoustic and trawl surveys.
3. To estimate and evaluate the productivity of each lake.

STUDY SITES

Thoms Lake (Figure 1) in the Thoms Creek system (ADF&G stream #107-30-30) is located on the southwest side of Wrangell Island on lower Zimovia Strait (56^{o}11'01" N., 132^{o}08'81" W.). This dimictic lake is approximately 2.7-km long, has a surface area of 153 hectares, an elevation of 85 meters, and a max depth of 33 meters. The lake water is clear with some seasonal organic staining. The lake empties 9.6 km via Thoms Creek into Thoms Place off of Zimovia Strait. Native fish species include cutthroat trout (*Oncorhynchus 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. There are two main tributaries, East and Little East creeks, on the north end of the lake with several small inflows scattered along the shore. East Creek represents the primary sockeye and coho salmon spawning area.

Salmon Bay Lake (Figure 1) in the Salmon Bay Creek system (ADF&G stream #103-41-010) is located on the northeast side of Prince of Wales Island (56°15'53" N., 133°10'33" W.). This dimictic lake is approximately 4.8-km long, has a surface area of 400 hectares, an elevation of 15 meters, a mean depth of 26.7 meters, and a max depth of 60 meters. The lake water is organically stained and has a volume of 103.9 million cubic meters. The mean euphotic zone depth is 4.7 meters. The lake empties 2 km via Salmon Bay Creek into Salmon Bay on Clarence Straight. Native fish species include cutthroat trout, Dolly Varden, stickleback, cottids, steelhead, and pink, chum, coho, and sockeye salmon. There are three unnamed tributaries at the south end of the lake referred to as southwest head, south head, and east head. These streams represent the primary sockeye and coho salmon spawning areas.

Luck Lake (ADF&G stream #106-10-034) is located at 55°58' N., 132°46' W. on the northeast side of Prince of Wales Island, adjacent to Clarence Strait (Figure 1). This dimictic lake has an area of 210 hectares and is 3.2-km long and 0.8 km wide, with its outlet in Eagle Creek at the north end and one major inlet stream, Luck Creek, at the south end. The total drainage area of the system is about 77 km^2. Eagle Creek is about 2.8-km long. It empties into salt water about 2.9-km south of Luck Point in a steep, rocky inter-tidal zone. Sockeye salmon school and hold in the lake near the mouth of Luck Creek. Luck Creek, the primary spawning area, is about 12-km long and has several tributaries. Cascade falls at about 1.9 and 1.6-km upstream impede migration, but some sockeye salmon do pass the falls and spawn above them. The lower part of the east fork tributary is also heavily used by spawning sockeye salmon, coho salmon, and Dolly Varden. An old landslide on the tributary created a 2.4 m barrier falls at about 1.2 km from the confluence with the mainstem stream.

METHODS

Sockeye Fry Assessment

The distribution and abundance of sockeye salmon fry were estimated by hydroacoustic and mid-water trawl sampling. Each 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 to survey. 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 each lake. A variance

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

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 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 Estimates

A two-sample, mark-recapture program was used to estimate the sockeye salmon population in each of the lakes. 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 escapement index and describe the distribution of spawners. 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 time when possible. Mark recovery surveys were conducted on the spawning grounds of each lake every two weeks. 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. Stream counts of spawning sockeye salmon were also used to describe the spawning distribution in each lake. We used Stratified Population Analysis System (SPAS) software (Arnason et al. 1996) to generate a pooled Petersen estimate of sockeye salmon population for the entire lake.

Sockeye Escapement Age and Length Distribution

Age and size characteristics of the adult sockeye salmon were collected at each 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).

Limnology

Light Regime

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 on each lake 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 (Y-axis) regressed against zooplankter length (X-axis; 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

Thoms Lake

A hydroacoustic survey and two mid-water trawls were conducted on 4 August 2001. A total of 79 fish were caught in two mid-water trawl tows. Both tows were fished at 10 m for 15 minutes. Tow 1 captured 44 sockeye salmon fry and tow 2 captured 33 sockeye salmon fry and two sticklebacks. Sixty-nine sockeye salmon fry (89.6%) were less then 50 mm fork length and assumed to be age 0. The age-0 fry had a mean fork length of 38.5 mm (SE = 0.4 mm) and a mean weight 0.51 g (SE = 0.01 g). Eight fry (10.4%) were greater than 50 mm and were determined to be age 1 with a mean fork length of 73.8 mm (SE = 2.2 mm) and a mean weight of 4.15 g (SE = 0.33g). The bimodal length frequency distribution describes this size separation of the two sockeye salmon age classes (Figure 2). The average fork length of the sticklebacks was 65.0 mm with a mean weight of 2.8 g. The species composition of the hydroacoustic population estimate was assumed to be proportionally the same as the trawl sample. A total lake population of 910,000 sockeye salmon fry (range of repeated measure was 895,000 to 926,000 fry) and 24,000 sticklebacks was estimated from the hydroacoustic survey in Thoms Lake (Table 1). The density of sockeye salmon fry for the lake was 0.89 fry $\cdot$ m^{-2} (range of repeated measure was 0.89 to 0.91 fry $\cdot$ m^{-2}).

Salmon Bay Lake

A hydroacoustic survey and two mid-water trawls were conducted on 18 July 2001. A total of 41 fish were caught between two mid water trawl tows. Both tows were fished at 10 m for 30 minutes. Twenty sockeye salmon fry and one stickleback were captured in tow 1. Eighteen sockeye salmon fry and two sticklebacks were captured in tow 2. The 38 sockeye salmon fry (93% of total catch) had a mean fork length of 41.7 mm (SE = 0.5 mm) and a mean weight of 0.67 g (SE = 0.03 g). The three sticklebacks (7% of total catch) had a mean fork length of 68.7 mm (SE = 0.5 mm) and a mean weight of 3.6 g (SE = 0.1g). All 38 sockeye salmon fry were less then 50 mm and assumed to be age 0. The length frequency (Figure 3) for sockeye salmon fry shows a uniform distribution for age-0 fish. The species composition of the hydroacoustic population estimate was assumed to be proportionally the same as the trawl sample. A total lake population of 223,000 sockeye salmon fry (range of repeated measure was 201,000 to 245,000 fry) and 17,000 sticklebacks were estimated from the hydroacoustic survey in Salmon Bay Lake (Table 1). The density of sockeye salmon fry in the lake was 0.072 fry $\cdot$ m^{-2} (range of repeated measure was 0.065 to 0.079 fry $\cdot$ m^{-2}).

Luck Lake

A hydroacoustic survey and a mid-water trawl were conducted on 17 July 2001. A total of 20 fish were caught in one mid-water trawl tow. The single trawl lasted 15 minutes at a depth of 10 m and captured 16 sockeye salmon fry and four sticklebacks. The 16 sockeye salmon fry (80% of total catch) had a mean fork length of 38.4 mm (SE = 1.6 mm) and a mean weight of 0.51 g (SE = 0.09 g). The four sticklebacks (20% of total catch) have a mean fork length of 68.3 mm (SE = 1.5 mm) and a mean weight of 3.03 g (SE = 0.29 g). All sockeye salmon fry, except one, were less than 50 mm fork length and assumed to be age 0. The single fish greater than 50 mm was also age 0. The length frequency (Figure 4) shows a strong age-0 class this year. The species composition of the hydroacoustic population estimate was assumed to be proportionally the same as the trawl sample. A total lake population of 128,000 sockeye salmon fry (range of repeated measure was 124,000 to 131,000 fry) and 32,000 sticklebacks were estimated from the hydroacoustic survey conducted on Luck Lake (Table 1). The density of sockeye salmon fry for the lake was 0.103 fry $\cdot$ m^{-2} (range of repeated measure was 0.100 to 0.106 fry $\cdot$ m^{-2}).

Sockeye Escapement Estimates

Thoms Lake

A total of 558 sockeye salmon were marked and released in Thoms Lake for the mark-recapture population estimate. There were 456 left round opercle punches, 55 left triangle opercle punches, and 47 left square opercle punches made (Table 2). A total of 560 sockeye salmon were examined in Thoms Creek for marks of which 102 were marked (Table 3). We generated a pooled Petersen minimum escapement estimate of 3,000 (SE = 244, 90% CI 2,600 to 3,400) sockeye salmon for the entire lake. During a foot survey conducted on 22 August 2001 a peak escapement count of 1,800 sockeye salmon was determined (Table 4). We did not observe spawning sockeye salmon in any of the tributaries except Thoms Creek.

Salmon Bay Lake

A total of 508 sockeye salmon were marked and released in Salmon Bay Lake for the mark-recapture population estimate. All 508 marked fish were marked with a left round opercle punch (Table 2). A total of 938 sockeye salmon were examined in two inlet streams for marks, of which 22 were marked (Table 3). We generated a pooled Petersen minimum escapement estimate of 20,800 (SE = 4,000, 90 % CI 14,000 to 27,600) sockeye salmon. Ryan Hardy (ADF&G, Wrangell) conducted a foot survey 18 September 2001, in which a peak sockeye escapement count of 5,000 sockeye salmon was determined (Table 4).

Luck Lake

A total of 899 sockeye salmon were marked and released in Luck Lake for the mark-recapture population estimate. Jacks (fish <400 mm) were not included in the mark-recapture population estimate. There were 65 left round opercle punches, 45 left triangle opercle punches, and 789 left square opercle punches made (Table 2). A total of 822 sockeye salmon were examined in Luck Creek for marks of which 93 were marked (Table 3). We generated a pooled Petersen minimum escapement estimate of 7,900 (SE = 720, 90% CI 6,700 to 9,000) sockeye salmon. During a foot survey conducted on 30 August 2001 a peak sockeye escapement count of 3,000 sockeye salmon was determined (Table 4).

Sockeye escapement Age and Length Distribution

Thoms Lake

A total of 392 adult sockeye salmon scale samples were analyzed from Thoms Lake during 2001 field activities. Age-1.3 fish dominated both sexes of adult sockeye salmon 64% (n = 252) followed by 20% age-2.2 fish (n = 77) (Table 5). There were 36% age-1.3 females and 28% age-1.3 males. The mean fork length of age-1.3 fish was 572 mm (SE = 1.5 mm, n = 291) and 511 mm (SE = 2.7 mm, n = 77) for age-2.2 fish (Table 6).

Salmon Bay Lake

A total of 392 adult sockeye salmon scale samples were analyzed from Salmon Bay Lake during 2001 field activities. The dominate age class of adult sockeye salmon was 48% (n = 244) age-1.2 fish followed by 39% age-1.3 fish (n = 196) (Table 7). There were 22 % age-1.2 females and 26% age-1.2 males. The mean fork length of age 1.2 fish was 498 mm (SE = 1.9 mm, n = 244) and 566 mm (SE = 2.1 mm, n = 196) for age-1.3 fish (Table 8).

Luck Lake

A total of 555 adult sockeye salmon scale samples were analyzed from Luck Lake during 2001 field activities. The dominate age classes of both sexes of adult sockeye salmon was 64% (n = 356) age-1.3 fish followed by 17% (n = 95) age-1.2 fish (Table 9). There were 53% age-1.3 females and 12% age-1.3 males. The mean fork length of age-1.3 fish was 570 mm (SE = 1.4 mm, n = 354) and 469 mm (SE = 3.4 mm, n = 95) for age-1.2 fish (Table 10).

LIMNOLOGY

Light Regime

Light penetration was measured in Thoms, Salmon Bay, and Luck lakes on 9 May, 8 June, 10 July, 7 August, and 30 September at Station A. In 2001, the euphotic zone depth (EZD) on Thoms Lake ranged from 2.1 to 3.4 m with a season mean of 3.0 m (Table 11). At Salmon Bay Lake the 2001 EZD ranged from 3.8 to 5.0 m with a season mean of 4.6 m (Table 11). The 2001 EZD at Luck Lake ranged from 3.3 to 5.7 m with a season mean of 4.6 m (Table 11).

Secondary Production

Zooplankton samples were collected from Thoms, Salmon Bay, and Luck lakes on 9 May, 8 June, 10 July, 7 August, and 30 September at two stations, A and B, on each lake.

Thoms Lake

In 2001, the macrozooplankton assemblage in Thoms Lake was dominated by a copepod (*Diaptomus* sp.), and a cladoceran (*Bosmina* sp.). The dominant forms by density and biomass were *Diaptomus* sp. and *Bosmina* sp. respectively (Tables 12 and 13). The seasonal mean total macrozooplankton density was 105,000 plankters $\cdot$ m^{-2}. The seasonal mean weighted macrozooplankton biomass was 142 mg $\cdot$ m^{-2} (Table 13). *Diaptomus* sp. was the largest species present (Table 14). The dipteran insect larvae of the family Chaoboridae (phantom midges) were present in most of the samples from Thoms Lake.

Salmon Bay Lake

In 2001, the macrozooplankton assemblage in Salmon Bay Lake was dominated by two species of copepod (*Cyclops* sp. and *Epischura* sp.), and two cladoceran species (*Bosmina* sp. and *Daphnia longiremis*). The dominant forms by density were *Cyclop* sp., *Bosmina* sp., and *Daphnia* sp., respectively. The dominant forms by biomass were *Cyclops* sp., *Epischura* sp., and *Daphnia* sp., respectively (Tables 15 and 16). The seasonal mean total macrozooplankton density was 162,000 plankters $\cdot$ m^{-2}. The seasonal mean weighted macrozooplankton biomass was 347 mg $\cdot$ m^{-2} (Table 16). The largest species was *Epischura* sp. (Table 17). Salmon Bay Lake contains three species of Daphnia; *Daphnia l.*, the large *Daphnia middendorffiana*, and one unidentified species.

Luck Lake

In 2001, the macrozooplankton assemblage in Luck Lake was dominated by two species of copepod (*Cyclops* sp. and *Epischura* sp.), and two cladoceran species (*Bosmina* sp. and *Daphnia longiremis*). The dominant forms by density and biomass were *Cyclops* sp., *Bosmina* sp., and *Epischura* sp., respectively (Tables 18 and 19). The seasonal mean total macrozooplankton density was 115,000 plankters $\cdot$ m^{-2}. The seasonal mean weighted macrozooplankton biomass was 233 mg $\cdot$ m^{-2} (Table 19). *Epischura* sp. was the largest species present (Table 20). Hydracarina (water mites) were also identified in the Luck Lake zooplankton samples.

DISCUSSION

In the first year of operation the Thoms, Salmon Bay, and Luck Lakes Sockeye Salmon Stock Assessment Project objectives to estimate adult sockeye escapement, estimate sockeye salmon fry population, to describe the size and age structure of fry and adult sockeye salmon populations, and the productivity of each lake were completed.

There is a seven-fold difference between the escapement estimate at Salmon Bay Lake (21,000 fish) compared to the closest system to Wrangell, Thoms Lake (3,000 fish). The escapement at Luck Lake falls in the middle with an estimate of 8,000 returning adult sockeye salmon. Although Thoms Lake is the smallest and most stained of the three lakes, fry abundance estimates were 4 to 7 times greater then the estimates in the other two lakes. The degree to which sockeye salmon returns and escapements vary in strength over time and the relationship of juvenile to adult populations will not be known until we have several more years of data. Hopefully, several years of estimating returns, fry abundance, and their influence of zooplankton populations will help describe these relationships.

The sockeye salmon in Thoms, Salmon Bay, and Luck lakes spawned in restricted and easily delimited areas. All spawning occurred in one main lake tributary in both Thoms and Luck lakes. Spawning in Salmon Bay Lake occurred in a pair of tributaries that are located in close proximity to each other. Because the mark recapture was conducted in these areas, the mark-recapture estimate represents a minimum of the total lake escapement for all three lakes.

The age distribution of adult sockeye salmon returning to Thoms, Salmon Bay, and Luck lakes in 2001 must be viewed with caution because annual age class proportion are controlled by brood year strength and the 2001 results are based on only a single return year. In Thoms Lake, age 1.3 sockeye were the dominant age class in 2001. Past age distribution data shows that the dominant age class is evenly split between age 1.3, 2.2, and 2.3 fish (Table 21). In Salmon Bay Lake age 1.2 sockeye salmon were the dominant age class in 2001. The dominance of the age 1.2 age class suggests that 1997 may be a dominant brood year. Nineteen years of age distribution data from Salmon Bay Lake (Table 22) shows that the mean age distribution was composed of 47% age 1.3 fish. This data applied to a 2002 run prediction shows that sockeye salmon escapement may be composed of a large number of age 1.3 fish from a dominant 1997 cohort. In Luck Lake, age 1.3 sockeye salmon were the dominant age class in 2001. Luck Lake age distribution data (Table 23) shows that the dominant age class is age 1.3 fish. Age 1.1 (jacks) are heavily represented in the past age distribution data (Table 23). Jacks were counted during stream surveys and unusually high numbers were noted. On 30 August 2001 there was a count of 1,500 jacks and 3,000 adult sockeye. Jacks were not included in the escapement estimate due to potential catchability bias in the marking and mark-recovery phases of the project. Jacks were examined to determine if they were potentially spawning kokanee. A sex ratio of 50% female would be expected in a kokanee population. There were no instances of egg expression from any of the small size class fish indicating that they were not kokanee. During the examination, small size class fish either expressed milt or no gametes and were assumed to be jacks.

The mean euphotic zone depth was 1.6 m deeper in Salmon Bay and Luck lakes than in Thoms Lake. The Thoms Lake mean euphotic zone depth (3.0 m) was the lowest of five lakes measured in southern southeast lakes in 2001. This may be due to a higher degree of staining associated with the relatively large percentage of muskeg in the drainage area.

Patterns in mean seasonal zooplankton biomass may be associated with sockeye salmon fry densities. Thoms Lake had the lowest mean seasonal zooplankton biomass of the three lakes. The low zooplankton biomass may be due to the high density of sockeye salmon fry and associated grazing pressure. Thoms Lake had the highest sockeye salmon fry density. Luck Lake had an intermediate mean seasonal zooplankton biomass to Thoms and Salmon Bay lakes. Luck Lake also had an intermediate sockeye salmon fry density. This pattern may demonstrate the top-down ecological control of the zooplankton community by sockeye salmon fry. The presence of *Chaoborus* sp., a zooplanktivorous insect, may also contribute to the low density and biomass of zooplankton in Thoms Lake. Invertebrate predators, such as *Chaoborus* sp., have been shown to regulate the abundance of smaller zooplankton (Carpenter and Kitchell 1993).

This year's results provide information important to the Thoms, Salmon Bay, and Luck Lakes Sockeye Salmon Stock Assessment 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 monitoring, at a minimum, 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 Wrangell. 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 maintaining sockeye returns to Thoms, Salmon Bay, and Luck lakes that are sustainable for many years to come.

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Table 1. Species and age distribution by lake from mid-water trawl, 2001.

Lake	Species	Age	Sample Size	Percent Species	Population	Mean Length (mm)	Mean Weight (g)
Thoms	Sockeye	0	69	87%	819,000	40.3	0.7
	Sockeye	1	8	10%	91,000	73.8	4.2
	Stickleback	No Age	2	3%	24,000	65	2.8
Salmon Bay	Sockeye	0	38	93%	222,000	41.7	0.7
	Stickleback	No Age	3	7%	18,000	68.7	3.3
Luck	Sockeye	0	16	80%	128,000	38.4	0.51
	Stickleback	No Age	4	20%	32,000	68.3	3.03

Table 2. Summary of sockeye salmon marking by lake, date, and mark type, 2001.

Lake	Date	Mark	Count
Thoms	21-Aug	L Circle	456
	5-Sep	L Triangle	55
	20-Sep	L Square	47
			Total 558
Salmon Bay	18-Aug	L Circle	5
	4-Sep	L Circle	505
			Total 508
Luck	4-Aug	L Circle	65
	15-Aug	L Triangle	45
	29-Aug	Left Square	789
			Total 899

Table 3. Mark recovery data by lake, date, and mark type, 2001.

Lake	Date	L Circle	L Triangle	L Square	Unmarked	Total
Thoms	5-Sep	81	0	0	410	491
	6-Sep	4	0	0	17	512
	20-Sep	17	0	0	25	554
	30-Sep	0	1	1	4	560
Salmon Bay	17-Sep	1	0	0	165	166
	18-Sep	1	0	0	138	305
	28-Sep	19	0	0	536	860
	29-Sep	1	0	0	77	938
Luck	14-Sep	17	0	0	198	215
	15-Sep	22	0	0	203	440
	26-Sep	0	2	10	69	521
	27-Sep	5	3	33	245	807
	27-Sep	1	0	0	14	822

Table 4. Peak adult sockeye salmon escapement counts in 2001 from foot surveys listed by location and date.

Creek	Date	Live	Dead
Luck Creek	30-Aug	3,000	5
	4-Sep	1,586	269
	26-Sep	121	116
Salmon Bay	12-Sep	5,000	0
	18-Sep	600	162
	28-Sep	5	555
Thoms	22-Aug	1,800	0
	5-Sep	450	491
	19-Sep	85	22

Table 5. Age composition of sockeye salmon in Thoms Lake escapement by sex, brood year, and age class, 19 August to 6 October 2001.

Brood Year	1997	1997	1996	1996	1995	
Age	1.2	2.1	1.3	2.2	2.3	Total
Male						
Sample Size	14	5	109	33	16	177
Percent	3.6	1.3	27.9	8.5	4.1	45.4
Std. Error	0.9	0.6	2.3	1.4	1	2.5
Female						
Sample Size	8	0	142	44	19	213
Percent	2.1	0	36.4	11.3	4.9	54.6
Std. Error	0.7	0	2.4	1.6	1.1	2.5
All						
Sample Size	22	5	252	77	36	392
Percent	5.6	1.3	64.3	19.6	9.2	100
Std. Error	1.2	0.6	2.4	2	1.4	

Table 6. Mean fork length (mm) of sockeye salmon in Thoms Lake escapement by sex, brood year, and age class, 19 August to 6 October 2001.

Brood Year	1997	1997	1996	1996	1995	
Age	1.2	2.1	1.3	2.2	2.3	Total
Male	498	389	577	511	575	553
Std. Error	7.8	5.6	2.1	5	6.1	3.6
Sample Size	14	5	109	33	16	177
Female	516	0	569	511	571	555
Std. Error	6	0	2	2.8	5.1	2.3
Sample Size	8	0	141	44	19	212
All	505	389	572	511	573	554
Std. Error	5.7	5.6	1.5	2.7	3.8	2.1
Sample Size	22	5	251	77	36	391

Table 7. Age composition of sockeye salmon in Salmon Bay Lake escapement by sex, brood year, and age class, 12 August to 29 September 2001.

Brood Year	1998	1997	1997	1996	1996	1995	1994	
Age	1.1	1.2	2.1	1.3	2.2	2.3	3.3	Total
Male								
Sample Size	2	131	1	74	1	23	1	233
Percent	0.4	25.9	0.2	14.7	0.2	4.6	0.2	46.1
Std. Error	0.3	1.9	0.2	1.6	0.2	0.9	0.2	2.2
Female								
Sample Size	0	113	0	122	5	27	5	272
Percent	0	22.4	0	24.2	1	5.3	1	53.9
Std. Error	0	1.8	0	1.9	0.4	1	0.4	2.2
All								
Sample Size	2	244	1	196	6	50	6	505
Percent	0.4	48.3	0.2	38.8	1.2	9.9	1.2	100
Std. Error	0.3	2.2	0.2	2.1	0.5	1.3	0.5	

Table 8. Mean fork length (mm) of sockeye salmon in Salmon Bay Lake escapement by sex, brood year, and age class, 12 August to 29 September 2001.

Brood Year	1998	1997	1997	1996	1996	1995	1994	
Age	1.1	1.2	2.1	1.3	2.2	2.3	3.3	Total
Male	405	503	445	582	440	584	620	535
Std. Error		2.9		3.5		5.7	3.4	
Sample Size	2	131	1	74	1	23	1	233
Female		493		556	516	560	570	530
Std. Error		2.4		2.2	6.8	4.8	15.2	2.4
Sample Size		113		122	5	27	5	272
All	405	498	445	566	503	571	578	532
Std. Error		1.9		2.1	13.8	4	15	2.1
Sample Size	2	244	1	196	6	50	6	505

Table 9. Age composition of sockeye salmon in Luck Lake escapement by sex, brood year, and age class, 29 July to 29 September 2001.

Brood Year	1998	1997	1997	1996	1996	1995	
Age	1.1	1.2	2.1	1.3	2.2	2.3	Total
Male							
Sample Size	58	83	5	64	17	0	227
Percent	10.5	15	0.9	11.5	3.1	0	40.9
Std. Error	1.3	1.5	0.4	1.3	0.7	0	2.1
Female							
Sample Size	0	12	0	292	9	15	328
Percent	0	2.2	0	52.6	1.6	2.7	59.1
Std. Error	0	0.6	0	2.1	0.5	0.7	2.1
All							
Sample Size	58	95	5	356	26	15	555
Percent	10.5	17.1	0.9	64.1	4.7	2.7	100
Std. Error	1.3	1.6	0.4	2	0.9	0.7	

Table 10. Mean fork length (mm) of sockeye salmon in Luck Lake escapement by sex, brood year, and age class, 29 July to 29 September 2001.

Brood Year	1998	1997	1997	1996	1996	1995	
Age	1.1	1.2	2.1	1.3	2.2	2.3	Total
Male	330	465	359	589	469	0	463
Std. Error	4.2	3.5	16.7	4	5.2	0	6.7
Sample Size	58	83	5	63	17	0	226
Female	0	496	0	566	527	555	562
Std. Error	0	9.2	0	1.3	5.5	6.6	1.5
Sample Size	0	12	0	291	9	15	327
All	330	469	359	570	489	555	521
Std. Error	4.2	3.4	16.7	1.4	6.7	6.6	3.6
Sample Size	58	95	5	354	26	15	553

Table 11. Euphotic zone depth in meters for each lake by date, 2001.

Date	4-May	8-Jun	10-Jul	7-Aug	30-Sep	Mean
Thoms	2.8	3.3	3.3	3.4	2.1	3.0
Salmon Bay	4.3	4.9	5.0	4.8	3.8	4.6
Luck	4.3	4.9	5.0	5.8	3.3	4.6

Table 12. Thoms Lake zooplankton species density (No./m^2) by station, date, season mean, and percent, 2001.

Station A	4-May	8-Jun	10-Jul	23-Aug	16-Oct	Mean	Percent
Diaptomus	20,717	1,783	2,445	2,038	68	5,410	5.5%
Ovig. Diaptomus	0	0	102	1,325	68	299	0.3%
Cyclops	68	679	1,121	1,528	1,426	964	1.0%
Bosmina	9,849	47,037	103,006	149,058	19,698	65,730	67.1%
Ovig. Bosmina	340	425	102	306	408	316	0.3%
Daphnia l.	3,192	2,038	4,687	3,464	7,200	4,116	4.2%
Ovig. Daphnia l.	1,087	1,104	713	509	1,155	914	0.9%
Diaphanosoma		509	408	42,486	679	11,021	11.2%
Holopedium	611	4,840	15,079	6,011	68	5,322	5.4%
Ovig. Holopedium		425	1,732	102	68	582	0.6%
Polyphemus		170	611	2,547	0	832	0.8%
copepod nauplii	9,849	2,208	0	0	543	2,520	2.6%
Station B							
Diaptomus	19,494	4,160	5,909	2,038	340	6,388	5.6%
Ovig. Diaptomus	0	0	204	0	272	95	0.1%
Cyclops	68	849	306	2,038	1,019	856	0.7%
Bosmina	7,879	61,640	99,440	194,600	54,407	83,593	72.6%
Ovig. Bosmina	136	0	306	340	1,426	442	0.4%
Daphnia l.	3,192	4,245	3,770	6,113	5,638	4,592	4.0%
Ovig. Daphnia l.	815	764	306	1,358	1,970	1,043	0.9%
Diaphanosoma	0	934	1,121	59,093	1,155	12,461	10.8%
Holopedium	815	3,396	15,283	2,038	0	4,306	3.7%
Ovig. Holopedium	68	340	1,936	0	0	469	0.4%
Polyphemus	0	0	1,834	2,377	0	842	0.7%

Table 13. Thoms Lake zooplankton seasonal mean weighted biomass (mg/m^2) by station, species, mean, and percent, 2001.

Species	Station A	Percent	Station B	Percent	Mean	Percent
Diaptomus	24.86	19%	38.92	25%	31.89	22%
Ovig. Diaptomus	7.92	6%	2.48	2%	5.20	4%
Cyclops	1.56	1%	1.46	1%	1.51	1%
Bosmina	61.89	48%	84.51	54%	73.20	51%
Ovig. Bosmina	0.35	0%	0.64	0%	0.49	0%
Daphnia l.	6.31	5%	6.39	4%	6.35	4%
Ovig. Daphnia l.	2.16	2%	2.87	2%	2.51	2%
Diaphanosoma	7.93	6%	10.68	7%	9.30	7%
Holopedium	13.52	11%	8.26	5%	10.89	8%
Ovig. Holopedium	1.28	1%	1.22	1%	1.25	1%
Polyphemus	0.21	0%	0.26	0%	0.23	0%
Total	127.98		157.68		142.83	

Table 14. Thoms Lake zooplankton species mean length (mm) by date and season mean, 2001.

Species	4-May	8-Jun	10-Jul	23-Aug	16-Oct	Mean
Diaptomus	0.865	1.185	1.755	1.735	1.56	1.42
Ovig. Diaptomus	NA	NA	1.935	1.89	1.835	1.89
Cyclops	0.48	0.63	0.62	0.815	0.58	0.63
Bosmina	0.345	0.305	0.32	0.33	0.375	0.34
Ovig. Bosmina	0.34	0.375	0.34	0.38	0.4	0.37
Daphnia l.	0.7	0.59	0.56	0.61	0.54	0.60
Ovig. Daphnia l.	0.835	0.755	0.665	0.825	0.715	0.76
Diaphanosoma	NA	0.47	0.5	0.465	0.51	0.49
Holopedium	0.515	0.435	0.51	0.61	0.61	0.54
Ovig. Holopedium	0.6	0.55	0.55	NA	0.7	0.60

Table 15. Salmon Bay Lake zooplankton species density (No./m^2) by station, date, season mean, and percent, 2001.

Station A	4-May	8-Jun	10-Jul	18-Aug	28-Sep	Mean	Percent
Epischura	0	340	6,113	43,089	20,377	13,984	6.4%
Cyclops	99,168	86,263	59,263	142,002	122,007	101,741	46.3%
Ovig. Cyclops	0	8,151	849	0	0	1,800	0.8%
Bosmina	19,969	23,603	132,281	55,188	53,235	56,855	25.9%
Ovig. Bosmina	679	849	1,019	212	1,783	908	0.4%
Daphnia l.	16,302	22,415	35,999	22,712	16,047	22,695	10.3%
Ovig. Daphnia l.	2,309	4,075	1,358	425	2,038	2,041	0.9%
Daphnia sp.	0	340	509	1,486	1,783	824	0.4%
Ovig. Daphnia sp.	0	509	0	0	1,019	306	0.1%
Daphnia m.	136	0	0	425	255	163	0.1%
Copepod nauplii	1,902	1,019	2,717	9,339	2,547	3,505	1.6%
Epischura	32,476	2,547	29,886	9,255	0	14,833	6.8%
Station B							
Cyclops	NA	67,286	55,357	50,807	71,235	61,171	56.2%
Ovig. Cyclops	NA	15,707	679	0	0	4,097	3.8%
Bosmina	NA	21,863	25,132	57,463	18,424	30,721	28.2%
Ovig. Bosmina	NA	849	0	136	509	374	0.3%
Daphnia l.	NA	10,188	8,830	3,260	1,953	6,058	5.6%
Ovig. Daphnia l.	NA	2,759	425	0	170	839	0.8%
Daphnia sp.	NA	212	85	1,223	1,358	720	0.7%
Ovig. Daphnia sp.	NA	0	85	0	170	64	0.1%
Holopedium	NA	212	0	0	0	53	0.0%
Daphnia m.	NA	0	0	0	85	21	0.0%
Copepod nauplii	NA	3,821	2,377	9,917	2,547	4,666	4.3%

Table 16. Salmon Bay Lake zooplankton seasonal mean weighted biomass (mg/m^2) by station, species, mean, and percent, 2001.

Species	Station A	Percent	Station B	Percent	Mean	Percent
Epischura	65.67	16%	90.81	33%	78.24	23%
Cyclops	176.48	42%	107.00	39%	141.74	41%
Ovig. Cyclops	4.80	1%	10.99	4%	7.90	2%
Bosmina	63.32	15%	38.22	14%	50.77	15%
Ovig. Bosmina	1.22	0%	0.55	0%	0.88	0%
Daphnia l.	88.34	21%	22.35	8%	55.35	16%
Ovig. Daphnia l.	9.11	2%	3.19	1%	6.15	2%
Daphnia sp.	2.90	1%	1.79	1%	2.34	1%
Ovig. Daphnia sp.	1.46	0%	0.35	0%	0.90	0%
Holopedium	0	0%	0.15	0%	0.08	0%
Daphnia m.	4.93	1%	0.45	0%	2.69	1%
Total	418.22		275.86		347.04	

Table 17. Salmon Bay Lake zooplankton species mean length (mm) by date and season mean, 2001.

Species	4-May	8-Jun	10-Jul	18-Aug	28-Sep	Mean
Epischura	1.01	1.34	1.21	1.03	1.11	1.14
Cyclops	0.76	0.77	0.68	0.67	0.69	0.71
Ovig. Cyclops	0.87	0.89	0.86	0.98	NA	0.90
Bosmina	0.38	0.36	0.36	0.36	0.34	0.36
Ovig. Bosmina	0.41	0.39	0.37	0.37	0.38	0.38
Daphnia l.	0.85	0.93	0.92	0.96	1.03	0.94
Ovig. Daphnia l.	0.90	0.99	1.14	1.13	1.16	1.06
Daphnia sp.	0.89	1.01	0.79	0.84	0.91	0.89
Ovig. Daphnia sp.	1.00	1.08	1.04	1.02	1.06	1.04
Holopedium	0.57	NA	NA	NA	NA	0.57
Daphnia m.	2.16	NA	1.93	2.19	2.53	2.20

Table 18. Luck Lake zooplankton species seasonal mean biomass (mg/m^2) by station and mean seasonal weighted biomass and percent for both stations, 2001.

Station A	4-May	8-Jun	10-Jul	16-Aug	27-Sep	Mean	Percent
Epischura	0	10,800	16,726	23,561	3,872	10,992	9.2%
Cyclops	45,780	27,305	20,462	78,961	75,599	49,621	41.4%
Ovig. Cyclops	68	1,155	0	0	0	245	0.2%
Bosmina	5,434	24,317	78,027	97,003	45,033	49,963	41.7%
Ovig. Bosmina	0	68	425	212	102	161	0.1%
Daphnia l.	7,472	7,268	8,660	1,274	5,604	6,056	5.1%
Ovig. Daphnia l.	2,174	408	340	849	713	897	0.7%
Chydorinae	0	0	85	0	0	17	0.0%
Copepod nauplii	272	4,143	0	4,670	0	1,817	1.5%
Station B							
Epischura	0	6,860	10,392	15,894	5,706	7,770	7.0%
Cyclops	45,492	17,388	25,471	79,334	74,716	48,480	43.7%
Ovig. Cyclops	51	3,057	408	0	0	703	0.6%
Bosmina	3,821	6,317	69,689	90,202	61,674	46,341	41.8%
Ovig. Bosmina	51	68	408	679	136	268	0.2%
Daphnia l.	4,636	4,483	8,864	2,038	1,902	4,385	4.0%
Ovig. Daphnia l.	917	747	713	951	543	774	0.7%
Chydorinae	0	0	0	0	0	0	0.0%
Copepod nauplii	1,528	611	1,019	5,706	1,902	2,153	1.9%

Table 19. Luck Lake zooplankton seasonal mean weighted biomass (mg/m^2) by station, species, and mean, 2001.

Species	Station A	Percent	Station B	Percent	Mean	Percent
Epischura	62.27	25%	55.45	25%	58.86	25%
Cyclops	79.42	32%	77.34	35%	78.38	34%
Ovig. Cyclops	0.68	0%	1.85	1%	1.26	1%
Bosmina	81.24	33%	68.13	31%	74.68	32%
Ovig. Bosmina	0.26	0%	0.42	0%	0.34	0%
Daphnia l.	18.67	8%	14.43	7%	16.55	7%
Ovig. Daphnia l.	3.50	1%	3.06	1%	3.28	1%
Chydorinae	0.08	0%	0.00	0%	0.04	0%
Total	246.12		220.67		233.40	

Table 20. Luck Lake zooplankton species mean length (mm) by date and season mean, 2001.

Species	4-May	8-Jun	10-Jul	16-Aug	27-Sep	Mean
Epischura	NA	0.90	1.40	1.03	1.25	1.14
Cyclops	0.79	0.82	0.73	0.60	0.66	0.72
Ovig. Cyclops	0.86	0.88	0.88	NA	NA	0.87
Bosmina	0.46	0.38	0.40	0.41	0.44	0.42
Ovig. Bosmina	0.34	0.39	0.42	0.42	0.51	0.42
Daphnia l.	0.80	0.82	0.82	0.86	1.01	0.86
Ovig. Daphnia l.	0.91	0.87	0.86	0.96	1.08	0.93

Table 21. Thoms Lake sockeye salmon percent age distribution by brood year.

Brood Year	Age 1.1	Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3
1977	12%	0%	0%	36%	6%	46%
1978	4%	1%	4%	18%	11%	61%
1979	0%	7%	6%	63%	4%	20%
1980	1%	9%	1%	46%	19%	23%
1981	4%	3%	0%	2%	57%	33%
1982	NA	7%	28%	24%	29%	13%
1983	0%	6%	11%	0%	46%	37%
1984	7%	3%	1%	2%	71%	17%
1985	2%	17%	15%	15%	51%	0%
1986	NA	18%	48%	0%	0%	34%
1987	5%	NA	NA	10%	54%	31%
1988	0%	13%	11%	37%	38%	0%
1989	0%	48%	16%	0%	0%	35%
1990	17%	2%	22%	1%	26%	32%
1991	1%	NA	NA	16%	42%	41%
1992	3%	16%	14%	47%	18%	3%
1993	10%	4%	12%	42%	7%	26%
1994	10%	17%	1%	20%	29%	23%
1995	8%	37%	10%	39%	6%	NA
Mean	5%	12%	12%	22%	27%	26%

Table 22. Salmon Bay Lake sockeye salmon percent age distribution by year.

Brood Year	Age 1.1	Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3
1979	2%	30%	1%	50%	0%	18%
1980	4%	19%	0%	69%	2%	6%
1981	0%	11%	0%	69%	6%	13%
1982	1%	16%	0%	76%	4%	2%
1983	0%	35%	5%	45%	13%	2%
1984	7%	71%	0%	20%	1%	0%
1985	13%	44%	1%	0%	0%	42%
1986	3%	0%	0%	82%	9%	6%
1987	0%	47%	4%	26%	4%	19%
1988	5%	17%	0%	43%	23%	12%
1989	2%	25%	6%	49%	5%	13%
1990	18%	8%	5%	42%	17%	11%
1991	4%	31%	4%	51%	5%	5%
1992	10%	8%	4%	58%	8%	12%
1993	5%	36%	1%	51%	3%	4%
1994	3%	12%	2%	67%	7%	9%
1995	9%	30%	5%	46%	11%	NA
1996	16%	83%	1%	0%	0%	0%
Mean	6%	29%	2%	47%	7%	10%

Table 23. Luck Lake sockeye salmon age distribution by brood year.

Brood Year	Age 1.1	Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3
1979	21%	36%	5%	31%	4%	2%
1980	30%	22%	8%	18%	11%	11%
1981	15%	36%	12%	24%	13%	0%
1982	42%	36%	11%	9%	2%	NA
1983	38%	21%	2%	19%	19%	NA
1984	37%	34%	NA	NA	NA	29%
1985	NA	NA	NA	10%	70%	20%
1986	NA	61%	7%	18%	6%	8%
1987	12%	28%	15%	19%	8%	17%
1988	13%	20%	23%	23%	13%	8%
1989	24%	28%	10%	30%	4%	4%
1990	14%	18%	16%	26%	18%	9%
1991	23%	30%	5%	30%	9%	4%
1992	28%	32%	9%	23%	3%	5%
1993	9%	27%	14%	24%	21%	6%
1994	22%	25%	12%	28%	8%	6%
1995	17%	38%	6%	29%	10%	0%
Mean	23%	31%	10%	23%	14%	9%

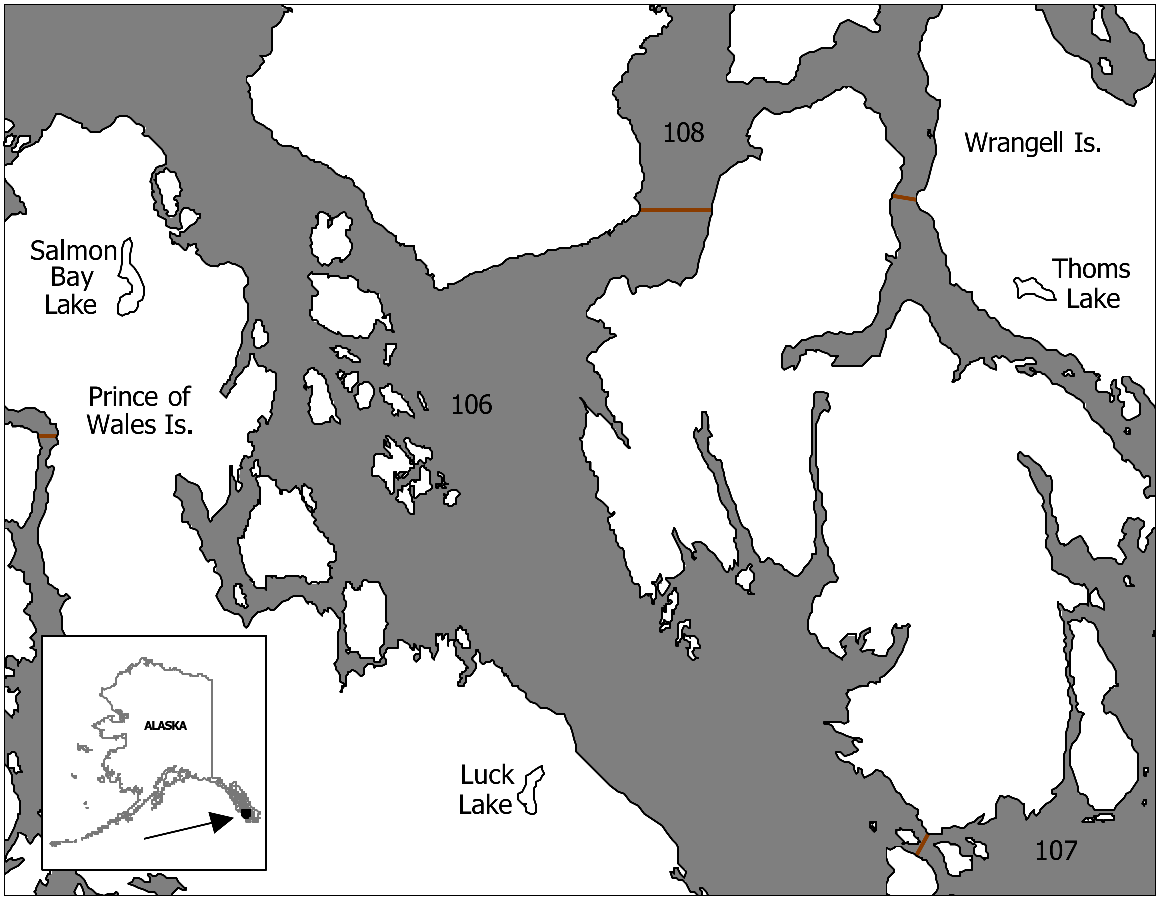

Figure 1. The geographic location of Thoms, Luck, and Salmon Bay lakes within the State of Alaska, and relative to commercial fishing districts.

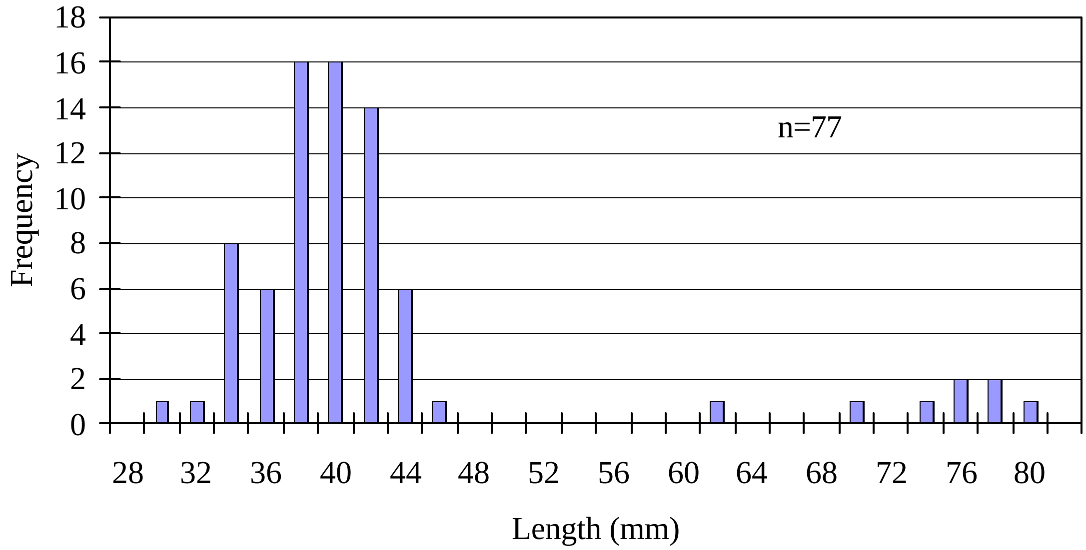

Figure 2. Length frequency distribution of Thoms Lake sockeye salmon fry caught in the mid-water trawl.

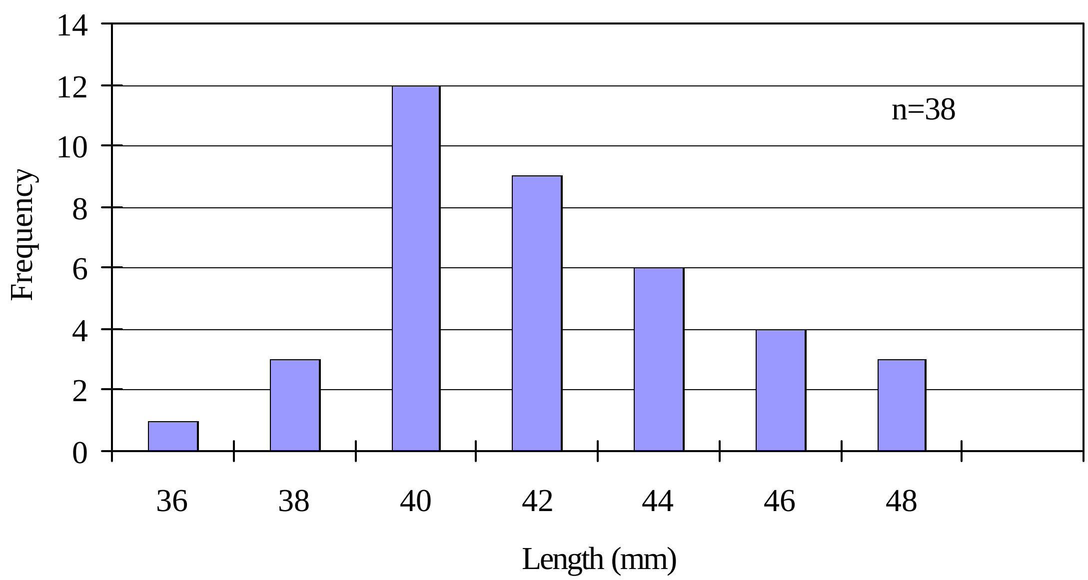

Figure 3. Length frequency distribution of Salmon Bay Lake sockeye salmon fry caught in the mid-water trawl.

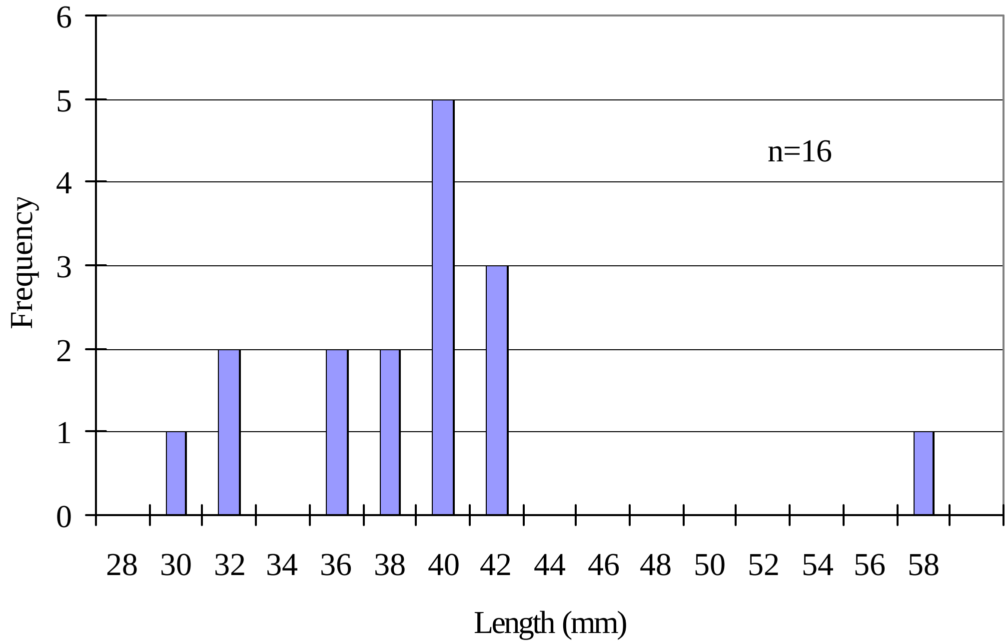

Figure 4. Length frequency distribution of Luck Lake sockeye salmon fry caught in the mid-water trawl.