Pikmiktalik River Salmon Escapement Enumeration and Sampling Project 2003-2007

Final Report for Study 06-101

Karen M. Dunmall[1] and Timothy J. Kroeker[2]
Kawerak, Inc.
PO Box 948
Nome, Alaska
99762
www.kawerak.org

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[1]Current contact: karen.dunmall@gmail.com
[2]Current contact: timothy.kroeker@gmail.com

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In an effort to have all data easily accessible, this report also summarizes:
Kroeker, T.J and K.M. Dunmall. 2006. Pikmiktalik River Salmon Escapement Enumeration and Sampling Project, 2003-2005. Final Report for Study 04-105 Phase II. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, Anchorage, Alaska.

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Pikmiktalik River Salmon Escapement Enumeration and Sampling Project 2003-2007

ABSTRACT

The communities of Stebbins and St. Michael rely on the Pikmiktalik River, or the immediate adjacent marine waters, for their subsistence salmon harvest. The Pikmiktalik River is part of the Yukon Delta National Wildlife Refuge, and is therefore one of the few Federal subsistence fisheries in the Norton Sound area. This project was proposed to address the concerns of local residents, who believed strongly that improved timely escapement information would improve management of these fishery resources. Kawerak, Inc. collaborated with the Stebbins Community Association to successfully provide baseline data regarding salmon abundance, run-timing and biological (age, sex and length) data to the U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game from 2003-2007. Chum salmon returns increased each year, from 7,707 in 2003 to 21,518 in 2007. Coho salmon experienced higher returns in the odd years (17,424 in 2005 and 13,777 in 2007) as compared to the even years counted (11,799 in 2004 and 8,575 in 2006). Chinook salmon numbers were relatively low in all years counted, however the number of Chinook salmon counted decreased almost every year, from 345 in 2003 to 99 in 2006. In most years sampled, the majority of chum salmon returning to spawn were age 0.3, followed by age 0.4 and the most abundant age class for coho salmon was consistently age 2.1 fish. Biological information was only attempted on Chinook salmon in 2006, and was not overly successful due to difficulties seining the relatively rare Chinook salmon on this river. Without additional funding for this project, managers must, at a minimum, continue to fly aerial surveys and collect post-season salmon harvest information from adjacent communities. It is imperative that managers actually take notice of this important system as an indicator stream for the subsistence resources in the area and formulate a long-term monitoring strategy for the Pikmiktalik River.

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INTRODUCTION

Much of the salmon subsistence harvest for residents of Stebbins and St. Michael is on the Pikmiktalik River. However, until 2003 there were no projects to provide estimates of the number of Chinook, chum (summer and fall), pink or coho salmon entering this river to spawn. In Norton Sound, many rivers have had declines in salmon populations while under state management. Local residents strongly feel that availability of in season escapement information would improve management of these fishery resources. Currently, the Pikmiktalik River salmon enumeration project is the only project estimating salmon run strength on any river for 115 kilometers, and the amount of time spent counting salmon has increased yearly, from 7 weeks in 2003 to over 11 weeks in each season from 2005-2007.

The Stebbins Community Association received funding from the Native American Rights Fund to conduct surveys of local salmon systems during August 1995. Mr. Morris J. Coffey was the principal investigator for this work. Ground and aerial surveys to count salmon in the Pikmiktalik and Kogok Rivers were conducted with the use of boats and a helicopter. Test fishing was also done in the Southern Norton Sound area for pink salmon. Information was sent to the Alaska Department of Fish and Game, Division of Commercial Fisheries, Area Office in Nome for use in the management of the salmon fisheries. The U.S. Fish and Wildlife Service, National Park Service, and Stebbins Community Association conducted a preliminary study (FIS 02-020) in 2002 to assess the feasibility of visually counting salmon and to select possible project sites (Lean et al. 2003). The salmon escapement enumeration and sampling project began in 2003 and was continued in 2004, 2005 (all are FIS 04-105 Phase II), 2006 and 2007 (FIS 06-101). The goal of this salmon escapement enumeration and sampling project is to obtain daily and annual estimates of salmon entering this system to improve management of important fishery resources for local subsistence users.

OBJECTIVES

1. Install tower, weir and flash panel at the counting site.
2. Provide daily and total annual estimates of chum and coho salmon passing the counting site.
3. Provide estimates of the age, sex, and size composition of chum and coho salmon passing the counting site.
4. Record weather and water conditions at the salmon counting site.
5. Participate with the Department of Fish and Game and Office of Subsistence Management in evaluation of exploitation rates of chum and coho salmon stocks for the purpose of developing a long-term monitoring strategy for the Pikmiktalik River.

Objectives 1-4 remained the same throughout 2003-2007. Objective 5 was added in 2006 by agency staff to address the need for an effective management strategy for the Pikmiktalik River while facing budget cuts that prevented the continued operation of this project.

METHODS

Weir and tower installation occurred on June 16, 2003, June 18, 2004, June 21, 2005, June 22, 2006 and June 27, 2007. In 2003 and 2004, the crews consisted of a Lead Fisheries Technician, two regular Fisheries Technicians and an alternate Fisheries Technician to substitute when other Technicians took time off. In 2005, the crew switched to a 3-week on, 1-week off schedule, which enabled the Technicians to take scheduled breaks. This schedule was maintained throughout 2005-2007. Counting continued until August 6, 2003, August 31, 2004, September 7, 2005, September 10, 2006 and September 7, 2007. The tower site used was the preferred location identified by Lean et al. (2003; Figure 1).

Design and Construction

The counting tower apparatus consisted of one 15-foot high scaffold tower. The tower had a counting platform at its uppermost level and was fastened to earth anchors for stability. Construction and installation of this prefabricated, commercially available tower conformed to OSHA standards.

A partial diversion weir was constructed according to the standard portable weir design currently used in Norton Sound (Rob 1995) and consisted of steel tripod supports, aluminum stringers and schedule 40 aluminum structural pipe for pickets. To avoid possible toxic effects on fish and aquatic life, galvanized pipe was not used. Picket spacing was approximately 2 5/8" and the weir was held up with a series of steel fence posts connected into a tripod shape and placed behind the weir in several locations. The weir was cleaned daily with a rake to remove debris and dead fish.

A flash panel was placed on the river bottom in the section of river not blocked by the partial diversion weir. The flash panel was anchored to the river bottom using a cable on the upstream end, and by using sandbags in strategic locations. The flash panel helped the Fisheries Technicians see the salmon as they passed upstream. The flash panel was cleaned with a broom daily to maximize visibility.

Installation and Operation

An observer counted salmon from the top of the tower for 20 minutes every hour, twenty-four hours per day seven days per week. Numbers of salmon and other fish, by species, were recorded on a hand-tally counter. Salmon and other fish passing downstream were subtracted from the count. Dead or dying fish drifting downstream past the counting site were not subtracted from the 20 minute upstream counts, as they were not likely to swim upstream past the site again. Numbers from the hand-tally counter were recorded in a logbook, and at the end of the counting day, were expanded by 3 to estimate total passage for each hour. The expanded daily count was transferred to a daily enumeration sheet and relayed to the Stebbins Community Association office via radio or the Kawerak Fisheries Biologist via satellite phone the following day. Kawerak, Inc. provided data to

the Alaska Department of Fish and Game and federal mangers for their use and public distribution.

River stage height (cm), meteorological observations, and water temperatures were recorded at 0800 and 2000 hours daily. These data were entered on data sheets kept in a binder in the camp cabin.

Biological Sampling

Biological information was collected for chum salmon from 2003-2007, coho salmon from 2004-2007 and attempts were also made to collect biological information from Chinook salmon in 2006. A pulse sampling design was used to collect this information for chum (Molyneaux and DuBois 1999) and the sample size goal for each pulse was 160 chum salmon. This sample size was selected so that simultaneous 95% confidence interval estimates of age composition proportions would be no wider than 0.20 (Bromaghin 1993). Recommended sample size was increased 9% to account for unreadable scales. Each pulse sample was used to estimate the age, sex, and length composition of the run for a given temporal stratum. A weighted mean, using the amount of chum salmon passage during each defined stratum as the weight, was used to estimate age composition of the total season passage. Biological information was also collected from a target sample size of 160 coho salmon.

All salmon were collected using beach seines. For each salmon sampled, sex was determined from external characteristics, length was measured to the nearest 0.5 cm from the middle of the eye to the fork of the tail, and a scale was collected from the left side. To avoid sampling the same salmon again, the adipose fin was removed prior to release. Length summary statistics for each salmon species were reported by sampling stratum and age-sex category.

Scales were collected from the left side of the salmon, approximately two rows above the lateral line in the area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). All scales removed were visually inspected for damage and regeneration. If scales from the preferred area on the left side of the salmon were missing, damaged, or regenerated, scales from the preferred area on the right side of the salmon were collected. Scales were mounted on gum cards with the insertion pointing down and to the right and the sculptured side facing out. All were initially recorded in a rite-in-the-rain field notebook and then later transcribed onto data sheets in a binder kept in the camp cabin.

Scales were sent to the Alaska Department of Fish and Game for age determination. Prior to examination, impressions of scales mounted on gum cards were made on cellulose acetate cards using a heated hydraulic press (Clutter and Whitesel 1956). Scale impressions on the acetate cards were examined by microfiche readers. Ages were determined by examining scale characteristics (Mosher 1968). European notation was used to record ages (Koo 1962). In this system, a number preceding a decimal point refers to the number of freshwater annuli and a number following the decimal point refers

to the number of marine annuli. Total age, from time of egg deposition (brood year) to time of capture, was the sum of these numbers plus one.

Post-Season Salmon Harvest Surveys

The Alaska Department of Fish and Game, Nome Office, collected subsistence salmon harvest information from the communities of Stebbins and St. Michael during 2006 and 2007 using post-season salmon harvest surveys. The 2006 survey tool is included in Appendix A. Peter Nanouk, from Unalakleet, was hired to travel to Stebbins and St. Michael to conduct the surveys. Peter went door-to-door during October and November to interview local residents about their subsistence salmon take from the prior season. The locations of subsistence salmon harvest for the purposes of this survey were defined as the marine waters immediately adjacent to each of the communities, the marine waters immediately adjacent to the Pikmiktalik River, and in the Pikmiktalik River itself. The residents were also asked to define if the salmon were captured by net, or by rod and reel fishing. The information was then compiled and tabulated by the Alaska Department of Fish and Game. The Alaska Department of Fish and Game, Yukon Area office is responsible for conducting post-season salmon harvest surveys in Kotlik, which is the closest community south of the Pikmiktalik River. These surveys were conducted in Kotlik during 2007.

RESULTS

Daily and cumulative fish counts for 2007, as well as daily water temperature and depth information, is reported in Appendix B. This information for prior years has been previously reported (Kroeker and Dunmall 2006; Kroeker and Dunmall 2007).

Chum Salmon

The number of chum salmon returning to the Pikmiktalik River to spawn increased each year that the counting project was operating (Figure 2). In 2003, 7,707 chum salmon escaped upriver, while in 2007, a total of 21,518 chum salmon were counted returning to the river. Chum salmon escapement began each year between June 19 (2004) and June 28 (2007). Chum salmon counting ended due to the project ending on August 6, 2003 and August 31, 2004, and the last chum were counted past the tower on August 18, 2005, September 3, 2006 and September 6, 2007. However, 95% of the chum salmon escapement each year was counted by between July 30 (2003) and August 13 (2007).

Chum salmon were sampled for age, sex and length (ASL) information in each of 2003 – 2007. ASL information from 2003-2006 has been previously reported (Kroeker and Dunmall 2006; Kroeker and Dunmall 2007), ASL information from 2007 is in Table 1. The age composition of chum salmon returning to the Pikmiktalik River to spawn varied considerably from year to year (Table 2), however in most years sampled, the majority of chum salmon returning to spawn were age 0.3, followed by age 0.4. Age 0.2 and age 0.5 chum salmon were relatively rare. Age samples were apportioned between two strata in

2003 and three strata in 2004-2007. By separating age class by time during each season in this way, it was determined that older fish (age 0.5) returned to spawn toward the beginning of the season, while younger fish (age 0.2) returned to spawn toward the end of the season. The ASL information also described that chum salmon length increased with age (Figure 3) and male chum salmon were generally longer at a given age than female chum salmon.

Coho Salmon

In the four years, 2004-2007, that coho salmon were counted returning to the Pikmiktalik River to spawn, higher returns were experienced in odd years (2005, 2007) as compared to even years (2004, 2006) (Figure 2). In 2005 and 2007, coho salmon returns reached 17,424 and 13,777 fish, respectively, whereas in 2004 and 2006, a total of 11,799 and 8,575 coho salmon, respectively, returned to the Pikmiktalik River. Coho salmon escapement began each year between July 9 (2005) and July 18 (2007). Coho salmon counting ended due to the project ending each year, however 50% of the coho salmon were counted by between August 14 (2004) and August 27 (2006) and 95% of the coho salmon were counted by between August 29 (2004) and September 6 (2006).

The age composition of coho salmon returning to the Pikmiktalik River to spawn remained relatively consistent between 2004-2007 (Table 3). The majority of coho salmon, between 79.1% (2007) and 85.6% (2006), were age 2.1. Age 1.1 coho salmon ranged from 11.6% (2006) to 16.4% (2007). Age 3.1 coho salmon only accounted for between 1.4% (2005) and 4.5% (2007) of the returning population. The ASL information also described that coho salmon length increased with age in all years sampled except for 2007, and that, interestingly, female coho salmon were generally longer at a given age than male coho salmon in all years sampled except for 2006 (Figure 4). The sex ratio of coho salmon returning to the Pikmiktalik River varied between years. In 2004 and 2005, over 70% of the coho salmon sampled were female, whereas in 2006 and 2007, over 60% of the coho salmon sampled were male (Table 4a-d).

Chinook Salmon

Chinook salmon migrated past the counting tower starting between June 20 (2003) and June 27 (2007), however the first Chinook salmon counted in 2007 were on the first day that the tower was in operation, indicating that the Chinook salmon may have been migrating earlier and were not counted. The last Chinook salmon counted at the tower ranged from July 13 (2004, 2007) to August 5 (2005). Approximately 50% of the total Chinook salmon migration occurred by between June 29 (2004) and July 9 (2006). The total number of Chinook salmon counted decreased each year that the tower was in operation (Figure 5). In 2003, a total of 345 Chinook salmon were counted and this number decreased to 99 Chinook salmon in 2006.

Age, sex and length data was collected from a total of 7 Chinook salmon in 2006. ASL data was not collected for Chinook salmon in any other year. Of the Chinook salmon

sampled in 2006, five were female, two were male and their ages ranged from 1.2 to 1.4 and their lengths ranged from 570 to 900mm.

Pink Salmon

Pink salmon were counted starting between June 20 (2004) and June 29 (2007) and ending between August 22 (2007) and August 31 (2004). Pink salmon escapement was higher in even numbered years (2004 and 2006) than in odd numbered years (2003 and 2007) except for 2005 (Figure 2). The highest ever pink salmon escapement on the Pikmiktalik River was counted in 2005. Interestingly, as pink salmon escapement subsequently decreased in 2006 and 2007 from that counted in 2005, the chum salmon escapement increased (Figure 2). Approximately 50% of the total pink salmon migration occurred by between July 11 (2006) and July 18 (2005).

Dolly Varden / Whitefish Sp.

Dolly Varden and whitefish species were observed moving up- and downstream at the tower site throughout the counting season in 2003-2007 (Figure 2). Whitefish were counted moving downstream in the beginning of the season and upstream toward the end of the season in 2003, 2004 and 2006, mostly downstream in 2005 and upstream in the beginning of the season and downstream toward the end of the season in 2007. Dolly Varden were counted moving upstream in 2003, 2004, 2006, and 2007, and were counting moving downstream initially, and then upstream in 2005.

Environmental Conditions

Water temperature generally increased from the start of the project until late July, and then subsequently decreased until the tower was shut down (Figure 6). The exception to this, however, is in 2007, when the water temperature started off as all other years until late July, when it experienced a sharp increase and remained high relative to other years, only experiencing a slight decline at the end of August until the counting stopped mid-September.

Water depths were almost always greater at 0800 hours than 2000 hours due to daily tidal influence at the tower site. In all years measured, there was a cyclical, rhythmic fluctuation in the daily maximum water depth measured (at 0800 hours) that repeated approximately every 2 weeks (Figure 7). Approximately every 2 weeks, there would be a low maximum water depth value, followed by a rapid increase that remained high for approximately one week, followed by a relatively rapid decrease in maximum water depth to a level approximately equal to the prior low. This cycle would repeat approximately every two weeks throughout the season, however beyond mid-August, the cycle was not as apparent because many years experienced heavy rains during this period.

Post Season Salmon Harvest Surveys

Post-season salmon harvest surveys were conducted in Stebbins and St. Michael in 2006 and 2007. Information from the 2006 and 2007 surveys indicated that the majority of the harvest from the communities of Stebbins and St. Michael was conducted using a net in the marine waters immediately adjacent to the communities themselves (Table 5, Table 6). In 2006, a total of 18,890 salmon were harvested from the areas near the communities, compared to a total of 511 salmon harvested from the Pikmiktalik River area. In 2007, this trend continued as 13,097 salmon were harvested from the areas near the communities, while 964 salmon were harvested from the Pikmiktalik River area. Significantly higher harvest occurs in Stebbins (13,908 salmon in 2006 and 9,630 salmon in 2007) compared to St. Michael (4,982 salmon in 2006 and 3,467 salmon in 2007). The 2006 harvest survey indicated that a total of 626 Chinook salmon were taken from the areas near the communities, and an additional 36 Chinook salmon were harvested from the Pikmiktalik River area. In 2007, 1215 Chinook salmon were taken from the areas near the communities, and an additional 71 were harvested from the Pikmiktalik River area. The majority of the salmon harvested from the Pikmiktalik River area in 2006 were coho salmon, followed by pink and then chum salmon. However, in 2007, an almost equal number of chum and coho salmon were harvested from the Pikmiktalik River area, followed by pink and Chinook salmon. In 2006 and 2007, coho salmon appear to be the target of the rod and reel fishing in Stebbins. In 2006, the residents of St. Michael caught coho and pink, as well as a few Chinook and chum using a rod and reel, however in 2007 St. Michael residents focused on coho salmon with their rod and reel gear. Although a total of 487 sockeye salmon were harvested from the areas near the communities in 2006, none were harvested from the Pikmiktalik River. In 2007, only 9 sockeye salmon were harvested in total. Accordingly, the Fisheries Technicians never counted any sockeye salmon in the Pikmiktalik River in the 5 years of the project.

Post-season salmon harvest surveys were also conducted in Kotlik in 2007 (Table 7). Of the 44 households surveyed, only 2 fished on the Pikmiktalik River, and 1 additional household fished between the Pikmiktalik River and Stebbins. The majority of fish were harvested between Stebbins and the Pikmiktalik River (105 salmon), compared to harvest on the river itself (24 salmon). Two Chinook salmon were harvested from the Pikmiktalik River, and an additional 6 were harvested from the area between Stebbins and the Pikmiktalik River. The majority of the fish harvested from the area between Stebbins and the Pikmiktalik River were chum salmon, while Pikmiktalik River harvest was composed mainly of pink salmon. No coho salmon were harvested by Kotlik residents in the area near the Pikmiktalik River.

DISCUSSION

The Pikmiktalik River Salmon Escapement and Enumeration Project was a successful pairing of an Alaska Native organization, Kawerak, Inc., with a local tribal government, to conduct a meaningful project initially requested by the local people of the region, with the intent of using the information to assist scientists more effectively manage the important subsistence resources in the area. The project was operated by Kawerak and Stebbins Community Association, not a government agency, for 5 years (2003-2007). It employed a total of 4 local people as Fisheries Technicians each year. One of these

Fisheries Technicians, Danny Nashoanak, remained with the project for all 5 years, and was the Lead Fisheries Technician for the last 3 years. An additional Fisheries Technician, Ryan Nashoanak, remained with the project for 4 years. All Fisheries Technicians employed in 2006 returned in 2007 for the entire season. Therefore, the project enjoyed a relatively stable employment base and the data collection methods remained relatively consistent year-to-year. Support from the neighboring villages was high as each year many people from the adjacent villages applied to fill the few vacant Fisheries Technician positions. The project also employed one local person to supply the camp weekly using a boat. Also, one local person in Stebbins was contracted in 2006 and 2007 to transport the groceries from the AC in St. Michael to the boat launch in Stebbins each week. Therefore, this project provided stable employment for several local people in the villages adjacent to the Pikmiktalik River.

Each year, the project attempted to document the entire salmon return on the Pikmiktalik River, however due to unforeseen circumstances, this was not possible on occasion. In 2004, a 5-day flood prevented counting August 15-20 and in 2006, the flash panel broke on August 18 and counting did not resume until August 21. In 2005, a total of 5124 coho salmon were counted from August 15-20, and 3330 of those fish were counted from August 18-20. In 2006, only 168 coho salmon were counted from August 18-20. In 2007, 1290 coho salmon were counted from August 15-20 and 405 of those were counted from August 18-20. Therefore, total coho salmon passage was likely underestimated in 2004 and in 2006. In addition, the coho salmon counting ended due to the project ending each year. If counting continued throughout more of September, undoubtedly more coho salmon would have been counted. However, the number counted late in the season is relatively low, and is therefore keeping the camp operating later in the season is not cost effective, and is not logistically possible most years due to turbulent weather that moves into the region in the fall. In 2007, issues involving land use resulted in a delay to the start date of the project, resulting in a likely underestimate of the number of Chinook and chum salmon returning to the river that year. The number of chum salmon missed is not thought to be high as by June 28 in 2003 only 24 chum salmon had been counted, 42 had been counted in 2005 and 213 had been counted in 2006. A total of 1023 chum salmon had been counted by that date in 2004, however that year the fish returned to the rivers "early" in Norton Sound, which was not the case in 2007. Similarly, the number of Chinook salmon counted in 2007 is likely an underestimate of the total Chinook salmon escapement on the Pikmiktalik River that year. In 2003 and 2005, by June 28, 6 Chinook salmon had been counted, in 2004, 66 were counted by June 28, and in 2006, 24 Chinook salmon had been counted by June 28. Although these numbers are low, when compared to the total number of Chinook salmon counted in a season, 29% of the total Chinook salmon return was counted prior to June 28 in 2004, 24% in 2006, 4% in 2005 and 2% in 2003.

Interestingly, there is some evidence of a competitive interaction between chum salmon and pink salmon on the Pikmiktalik River. The highest escapement counted for pink salmon occurred in 2005, and then each year subsequent to that saw a smaller pink salmon escapement than the previous year. Chum salmon escapement increased substantially following 2005. In 2003, the counting tower was shut down on August 6,

and as pink salmon were counted up to that date, and well past in subsequent years, it is inferred that the final pink salmon escapement in 2003 would have been higher if counting had continued into August. Pink and chum salmon may be competing for spawning locations on the Pikmiktalik River, and an investigation into the available spawning habitat, or carrying capacity of the Pikmiktalik River, would provide information regarding the extent of this competitive interaction between these two species, if an interaction does exist.

The total number of Chinook salmon counted decreased each year at the Pikmiktalik River. In fact, Chinook salmon returns to the entire Eastern Norton Sound have experienced sharp declines in recent years. The Board of Fisheries acted on this decline in 2007 by adopting a more conservative management plan for Chinook salmon for Norton Sound Subdistricts 5 and 6 (Shaktoolik and Unalakleet) (5 AAC 04.395). Many people in Stebbins, St. Michael and Kotlik set nets in the ocean early to catch Chinook salmon as they migrate by. Few people fish for Chinook salmon in the Pikmiktalik River due to the relatively low abundance of these fish in river. However, the relatively low numbers of Chinook salmon returning to the Pikmiktalik River should not take away from the importance of these fish to the residents of Stebbins and St. Michael, nor should it negate the decline in Chinook salmon experienced in this river, similar to all other rivers in Eastern Norton Sound. Management action was taken to protect these fish in the Unalakleet River, which is the closest river to the Pikmiktalik that has a counting project and managers need to be aware of these similar declines on the Pikmiktalik River so that they can be in a position to take necessary management action to conserve these fish.

Age, sex and length (ASL) information was collected from chum salmon during 2003-2007, coho salmon during 2004-2007 and Chinook salmon during 2006. ASL information was collected from Chinook salmon only opportunistically in 2006 as part of a project funded through the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative to collect tissue samples for genetic analysis from several area rivers (Olsen, J., FY06, Project 617: Landscape Genetics of AYK Salmon Populations). Chinook salmon proved exceedingly difficult to catch using a seine net, especially considering their small numbers on the Pikmiktalik River. The age information collected from chum salmon remained relatively consistent year-to-year with the largest age class being age 0.3, followed by age 0.4, age 0.2 and age 0.5 (Table 2). The exception to this, however, was the chum salmon sampled in 2004 which exhibited an almost equal proportion of age 0.3 and age 0.4 fish, and an unusually large proportion of age 0.2 fish compared to other years (Table 2). Higher numbers of five-year-old fish (age 0.4) may indicate conditions in either the freshwater or marine system that delayed development or growth, and therefore resulted in a higher proportion of chum salmon returning to spawn as 5-year-old fish in 2004. The large numbers of age 0.2 chum salmon in 2004 were an indication of the large run of four-year-old chum salmon that returned in 2005. The coho salmon age data remained very consistent year-to-year, as age 2.1 salmon were always the most common coho salmon sampled, followed distantly by age 1.1 and age 3.1 coho salmon (Table 3).

Chum and coho salmon length information showed that, generally, salmon increased in length with increasing age (Figure 3, Figure 4). This trend, however, was not the case for age 0.5 chum salmon in two of the four years that age 0.5 chum salmon were measured. In fact, in 2004 and 2006, age 0.5 chum salmon were shorter, on average, than age 0.4 chum salmon sampled in that same year. This could be due to the relatively small sample size of the age 0.5 chum salmon measured in all years, and also to the fact that the larger salmon may be too fast to catch in a seine net. The female coho salmon sampled were longer at a given age than male coho salmon sampled in all years except 2006. This suggests, perhaps, that the female salmon put more energy into growth, rather than fecundity, in the Pikmiktalik River, and may be related to competitive interaction between salmon for spawning sites. Further investigation into available spawning habitat and carrying capacity of the Pikmiktalik River may yield interesting information that could explain this unexpected size difference in coho salmon. The coho salmon measured in 2007 decreased in size with age, which is also an unusual finding. This could be an indication of good ocean rearing conditions for the younger fish, as they returned in 2007 larger, on average, than any coho salmon of their age class in any prior year (Table 4d). Good ocean rearing condition could therefore indicate a relatively strong return for coho salmon in subsequent years.

The Pikmiktalik River water level is tidally influenced. Initially, the tidal influence was noticed in the twice daily water depth recordings as the morning depth was almost always deeper than the evening depth recording. However, over the course of the season, these twice-daily water depth measurements demonstrated a cyclical 2-week long pattern of alternating low and high maximum depth recordings. This cyclical pattern can likely be attributed to the lunar influence on the tides.

The post-season salmon harvest survey conducted in 2006 and 2007 indicated that the majority of the harvest from the communities of Stebbins and St. Michael is immediately adjacent to the communities themselves. This could be a consequence of the extremely high cost of fuel in these communities, which forces families to set nets near town to reduce the expense for subsistence fishing. Similarly, there is a greater proportion of rod and reel harvest in St. Michael as compared to Stebbins, which may also indicate that rod and reel fishing makes subsistence harvest more accessible to families without the means to set nets. In 2006, a total of 99 Chinook salmon escaped past the counting tower. The post-season salmon harvest survey shows that 36 additional Chinook salmon were harvested from the Pikmiktalik River area. In 2007, a total of 126 Chinook salmon escaped past the counting tower. The post-season salmon harvest survey from Stebbins and St. Michael shows that an additional 71 Chinook salmon were harvested from the Pikmiktalik River area, and the survey from Kotlik adds 2 more Chinook salmon harvested from the Pikmiktalik River. Considering the low Chinook salmon escapement, there is a significant harvest of Chinook salmon from this river. An additional 626 Chinook salmon were harvested in 2006 and 1,215 (plus an additional 2 by Kotlik residents) Chinook salmon were harvested in 2007 from the areas near the communities. Some of these salmon were bound for the Yukon and other rivers however some may have also been bound for the Pikmiktalik River. Genetic analysis of these salmon would indicate their origin, and assist managers in enacting harvest restrictions that would allow

conservation of the Chinook salmon on the Pikmiktalik River and other rivers in Southern Norton Sound that are experiencing similar declines in Chinook salmon numbers.

Although agency staff were well-intentioned when adding an objective to evaluate exploitation rates for the purpose of developing a long-term monitoring strategy for the Pikmiktalik River, this is not a reachable goal within the purposes of this escapement sampling project. The flaw is that Kawerak has absolutely no control over whether or not data collected for the purpose of establishing exploitation rates is ever actually collected, and Kawerak can only strongly urge State and Federal managers to develop a long-term monitoring strategy given current priorities and funding restrictions. The Alaska Department of Fish and Game did conduct post-season salmon harvest surveys in 2006 and 2007 in Stebbins and St. Michael and in 2007 in Kotlik. All agencies are experiencing budget restrictions, and it is highly unlikely that sufficient funds will be available to continue any type of intensive monitoring on the Pikmiktalik River. However, it is imperative that monitoring continue and a long-term monitoring strategy be developed. As the Pikmiktalik River lies within a National Wildlife refuge it is the responsibility of Federal managers to initiate this process to ensure the sustainable harvest of these resources.

CONCLUSIONS

The success of the Pikmiktalik River Salmon Enumeration Project was due to the productive cooperation and collaboration of Stebbins, St. Michael and Kawerak, Inc. The project provided much appreciated employment for several local people, and was well received within the communities. The stable employment base and low Fisheries Technician turn-over is due, in part, to hosting a “Fisheries Technician Orientation” in Nome at the beginning of each season, which allowed face-to-face communication regarding rules and expectations and hands-on training for scale sampling, weir set-up and camp maintenance. Regular daily contact via VHF radio and satellite phone with the camp continued this open communication concept and was instrumental in maintaining camp morale as well as allowing data transfer to managers and interested parties. A regular, weekly supply schedule and scheduled time-off also contributed to this positive camp environment for the technicians, who were able to remain focused and ambitious throughout the season and collect and record accurate data. Hiring local residents as Fisheries Technicians also allowed a valuable source of traditional knowledge of the area. Kawerak, Inc. was able to provide the technical and administrative expertise needed for overall planning, operations, data analysis and reporting.

A salmon escapement enumeration and sampling project is the most effective way of estimating the number, size, sex composition and age of salmon returning to a river to spawn, and the Pikmiktalik River project was a very successful project in that regard. From 2003-2007, managers were provided with timely, accurate information regarding the salmon populations on the Pikmiktalik River. Without this project, managers would only have cursory knowledge of the salmon in this river through aerial surveys, completed only as budget and time allowed. Although it is the responsibility of the

managers to ensure subsistence resources used by the people of Alaska will be sustainable year after year, managers are often limited by knowledge of population trends and harvest information. Without additional funding for this project, it is imperative that managers, at a minimum, continue to collect information regarding harvest trends through post-season harvest surveys, and fly regular aerial surveys of the river.

RECOMMENDATIONS

With current funding limitations, the Pikmiktalik River Salmon Escapement Enumeration and Sampling project will remain a five-year project, spanning 2003-2007. It would be ideal to continue this project and collect accurate information regarding salmon numbers, as well as age, sex and length information. However, given that a continuation of this project is not realistic in the near future, managers must continue to complete regular aerial surveys of the river during the chum and coho salmon returns to obtain a population estimate for each of those species every year. Because Chinook salmon populations are doing poorly elsewhere in Eastern Norton Sound, it is recommended to continue closely monitoring Chinook salmon populations on the Pikmiktalik River. An annual post-season salmon harvest survey, using locally hired people as surveyors, will provide useful information regarding population trends, as well as valuable local knowledge of salmon populations.

It is imperative that managers actually take notice of this important system as an indicator stream for the subsistence resources in the area and formulate a long-term monitoring strategy for the Pikmiktalik River. To assist managers with this task, all information obtained from the Pikmiktalik River salmon escapement projects is contained within this one report. This area is outside the Subdistricts managed by the Alaska Department of Fish and Game as it only borders the Arctic and Yukon Regions. The area is also often overlooked by Federal managers. Without this salmon escapement project, this area is in jeopardy of being forgotten. As in all other areas of Alaska, the people of the neighboring villages of Stebbins, St. Michael and Kotlik rely on the salmon returning to these rivers to support their subsistence way-of-life, which is vital to their culture and essential to their survival especially considering the high cost of living in these small villages. Managers can use the information obtained from this project, combine it with on-going surveys, and maintain a cursory knowledge of salmon population strength in this region.

ACKNOWLEDGEMENTS

Kawerak appreciates the foresight, concern and recommendations by the residents of Stebbins and St. Michael, who were instrumental in identifying the issues, proposing this project and making people aware of their concerns. We thank Morris Nashoanak for his time and effort coordinating supplies and personnel in Stebbins. The assistance of Charlie Lean, with National Park Service, and Steven Fried and Richard Cannon with the U.S. Fish and Wildlife Service, is also greatly appreciated. The Fisheries Technicians from 2003-2007 were Paul Agibinik Sr., Rennie Jack, Justin Katcheak, Kellen Katcheak, Lenny Katcheak, Lawrence Lockwood, Vincent Matthias, Danny Nashoanak, and Ryan

Nashoanak. These Technicians did outstanding work with minimal supervision to ensure the success of this project. Expertise and some project materials were provided by the Alaska Department of Fish and Game, with special thanks to Jim Menard, Wes Jones and Gary Knuefer. The Alaska Department of Fish and Game also aged all scales for this project, and entered the age, sex and length data into Excel. The Alaska Department of Fish and Game also generously provided free use of the bunkhouse in Nome for the Fisheries Technician orientation each year. The National Park Service also allowed Fisheries Technicians to stay at their bunkhouse for Fisheries Technician orientation. Morris Nashoanak provided and operated the boat and motor used to transport supplies and personnel to and from camp. From 2003-2005, Andrew Foxie Sr. graciously allowed the use of his cabin to house the Fisheries Technicians. Austin Matthias generously provided use of his land for the counting site from 2003-2007. The Kawerak Land Management Services Department and Realty Department of Association of Village Council Presidents assisted with identifying and addressing land ownership questions for the counting tower site. The U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, provided $356,317 from 2003-2005 (contract number 7010132253) and $283,013 from 2006-2007 (contract number 701816J616) in funding support for this project.

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Table 1. Age, sex, and length of **chum salmon** sampled, and estimated contribution to spawning escapement, Pikmiktalik River, 2007.

		Brood Year and Age Group [a]				
		2004	2003	2002	2001	Total
		0.2	0.3	0.4	0.5	
Stratum Dates:	6/28 - 7/14					
Sample Size:	156					
Female	Percent of Sample	0.0	30.1	17.3	0.6	48.1
	Number in Escapement	0	2891	1661	62	4613
	Average Length	-	565	577	560	569
Male	Percent of Sample	0.0	32.7	17.9	1.3	51.9
	Number in Escapement	0	3137	1722	123	4982
	Average Length	-	587	605	640	595
Total	Percent of Sample	0.0	62.8	35.3	1.9	100.0
	Number in Escapement	0	6027	3383	185	9594
	Average Length	-	577	591	613	583
Stratum Dates:	7/15- 7/29					
Sample Size:	136					
Female	Percent of Sample	0.0	35.3	10.3	0.0	45.6
	Number in Escapement	0	1902	555	0	2456
	Average Length	-	554	561	-	556
Male	Percent of Sample	0.0	41.2	12.5	0.7	54.4
	Number in Escapement	0	2219	674	40	2932
	Average Length	-	586	596	600	588
Total	Percent of Sample	0.0	76.5	22.8	0.7	100.0
	Number in Escapement	0	4120	1228	40	5388
	Average Length	-	571	581	600	573
Stratum Dates:	7/30- 9/7					
Sample Size:	119					
Female	Percent of Sample	0.0	42.0	4.2	0.0	46.2
	Number in Escapement	0	2746	275	0	3021
	Average Length	-	564	574	-	565
Male	Percent of Sample	0.8	47.1	5.9	0.0	53.8
	Number in Escapement	55	3076	384	0	3515
	Average Length	540	591	623	-	593
Total	Percent of Sample	0.8	89.1	10.1	0.0	100.0
	Number in Escapement	55	5822	659	0	6536
	Average Length	540	578	603	-	580

Table 1. Continued.

Stratum Dates:	Season (Weighted by Strata)					
Sample Size:	411					
Female	Percent of Sample	0.0	35.0	11.6	0.3	46.9
	Number in Escapement	0	7538	2490	62	10090
	Average Length	-	561	572	560	564
Male	Percent of Sample	0.3	39.2	12.9	0.8	53.1
	Number in Escapement	55	8431	2780	163	11428
	Average Length	540	588	604	627	592
Total	Percent of Sample	0.3	74.2	24.5	1.0	100.0
	Number in Escapement	55	15969	5270	224	21518
	Average Length	540	575	589	610	579
Stratum Dates:	Season (Un-Weighted)					
Sample Size:	411					
Female	Percent of Sample	0.0	35.3	11.2	0.2	46.7
	Number in Escapement	0	7592	2408	52	10052
Male	Percent of Sample	0.2	39.7	12.7	0.7	53.3
	Number in Escapement	52	8534	2722	157	11466
Total	Percent of Sample	0.2	74.9	23.8	1.0	100.0
	Number in Escapement	52	16125	5131	209	21518

[a] The number of fish in each stratum age and sex category are derived from the sampling percentages; discrepancies in sums are attributed to rounding.

Table 2. A comparison of **chum salmon** age composition (%) from entire season, un-weighted by strata, 2003-2007.

	Age			
Year Sampled	0.2	0.3	0.4	0.5
2003	0.0	82.8	16.9	0.3
2004	10.2	41.5	47.9	0.4
2005	1.0	92.8	6.2	0.0
2006	3.8	62.6	33.2	0.4
2007	0.2	74.9	23.8	1.0

Table 3. A comparison of **coho salmon** age composition from entire season, 2004-2007.

	sample	Age		
Year Sampled	size	1.1	2.1	3.1
2004	189	14.3	83.6	2.1
2005	142	14.8	83.8	1.4
2006	283	11.6	85.6	2.9
2007	110	16.4	79.1	4.5

Table 4a. Age, sex, and length of **coho salmon** sampled, and estimated contribution to spawning escapement, Pikmiktalik River, 2004.

		Brood Year and Age Group [a]			
		2001	2000	1999	Total
		1.1	2.1	3.1	
Sample Size:	189				
Female	Percent of Sample	10.1	59.8	2.1	72.0
	Number in Escapement	1186	7054	250	8490
	Average Length	550	577	623	575
Male	Percent of Sample	4.2	23.8	0.0	28.0
	Number in Escapement	499	2809	0	3309
	Average Length	560	570	-	568
Total	Percent of Sample	14.3	83.6	2.1	100.0
	Number in Escapement	1685	9863	250	11799
	Average Length	553	575	623	573

Table 4b. Age, sex, and length of **coho salmon** sampled, and estimated contribution to spawning escapement, Pikmiktalik River, 2005.

		Brood Year and Age Group [a]			
		2002	2001	2000	Total
		1.1	2.1	3.1	
Sample Size:	142				
Female	Percent of Sample	12.7	61.3	1.4	75.4
	Number in Escapement	2263	10922	249	13434
	Average Length	593	602	620	601
Male	Percent of Sample	2.1	22.5	0.0	24.6
	Number in Escapement	374	4009	0	4383
	Average Length	587	585	-	585
Total	Percent of Sample	14.8	83.8	1.4	100.0
	Number in Escapement	2637	14931	249	17817
	Average Length	592	597	620	597

Table 4c. Age, sex, and length of **coho salmon** sampled, and estimated contribution to spawning escapement, Pikmiktalik River, 2006.

		Brood Year and Age Group [a]			
		2003	2002	2001	Total
		1.1	2.1	3.1	
Sample Size:	283				
Female	Percent of Sample	2.9	34.6	0.0	37.5
	Number in Escapement	249	2967	0	3216
	Average Length	553	566	-	565
Male	Percent of Sample	8.7	51.0	2.9	62.5
	Number in Escapement	746	4373	249	5359
	Average Length	563	573	590	572
Total	Percent of Sample	11.6	85.6	2.9	100.0
	Number in Escapement	995	7340	249	8575
	Average Length	561	570	590	570

Table 4d. Age, sex, and length of **coho salmon** sampled, and estimated contribution to spawning escapement, Pikmiktalik River, 2007.

		Brood Year and Age Group [a]			
		2004	2003	2002	Total
		1.1	2.1	3.1	
Sample Size:	110				
Female	Percent of Sample	5.5	26.4	0.9	32.7
	Number in Escapement	751	3632	125	4509
	Average Length	603	603	590	603
Male	Percent of Sample	10.9	52.7	3.6	67.3
	Number in Escapement	1503	7264	501	9268
	Average Length	604	602	588	601
Total	Percent of Sample	16.4	79.1	4.5	100.0
	Number in Escapement	2254	10896	626	13777
	Average Length	604	602	588	602

Table 5. Expanded Number of Salmon Harvested for Subsistence at St. Michael, Stebbins and near the Pikmiktalik River, Norton Sound, 2006. Data courtesy of the Alaska Department of Fish and Game.

	Chum	Chinook	Pink	Sockeye	Coho	Unknown	All Salmon
St Michaels							
Net Harvest	2,619	265	455	347	1,218	0	4,904
R&R Harvest	9	6	25	0	38	0	78
Retained CF	0	0	0	0	0	0	0
Total	2,628	271	480	347	1,256	0	4,982
Stebbins							
Net Harvest	4,236	355	4,321	140	4,802	0	13,854
R&R Harvest	0	0	0	0	54	0	54
Retained CF	0	0	0	0	0	0	0
Total	4,236	355	4,321	140	4,856	0	13,908
Pikmiktalik River							
St. Michaels	7	2	23	0	11	0	43
Stebbins	0	0	0	0	15	0	15
Total	7	2	23	0	26	0	58
Marine Waters Near Pikmiktalik River							
St. Michaels	0	1	0	0	0	0	1
Stebbins	35	33	81	0	303	0	452
Total	35	34	81	0	303	0	453
Pikmiktalik Area Harvest							
St. Michaels	7	3	23	0	11	0	44
Stebbins	35	33	81	0	318	0	467
Total	42	36	104	0	329	0	511

Table 6. Expanded Number of Salmon Harvested for Subsistence at St. Michael, Stebbins and near the Pikmiktalik River, Norton Sound, 2007. Data courtesy of the Alaska Department of Fish and Game.

	Chum	Chinook	Pink	Sockeye	Coho	Unknown	All Salmon
St Michaels							
Net Harvest	2118	452	258	9	512	0	3,349
R&R Harvest	1	0	7	0	110	0	118
Retained CF	0	0	0	0	0	0	0
Total	2,119	452	265	9	622	0	3,467
Stebbins							
Net Harvest	4,957	740	1,881	0	1,899	0	9,477
R&R Harvest	23	23	0	0	107	0	153
Retained CF	0	0	0	0	0	0	0
Total	4,980	763	1,881	0	2,006	0	9,630
Pikmiktalik River							
St. Michaels	169	7	152	0	223	0	551
Stebbins	175	64	23	0	151	0	413
Total	344	71	175	0	374	0	964
Marine Waters Near Pikmiktalik River							
St. Michaels	0	0	0	0	0	0	0
Stebbins	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Pikmiktalik Area Harvest							
St. Michaels	169	7	152	0	223	0	551
Stebbins	175	64	23	0	151	0	413
Total	344	71	175	0	374	0	964

Table 7. Expanded Number of Salmon Harvested for Subsistence by Kotlik households in and near the Pikmiktalik River, Norton Sound, 2007. Data courtesy of the Alaska Department of Fish and Game.

Kotlik	**# Households**
Total Identified households in Kotlik	97
# Pre-selected households to be interviewed	44
# Pre-selected households contacted	40
# Pre-selected households surveyed	39
# Pre-selected households that fished	31
# Pre-selected households that did not fish	8
# Pre-selected households that refused to be surveyed	1
# non-selected households surveyed that fished	3
# non-selected households surveyed that did not fish	1
Total # households surveyed	**44**
# of Kotlik households indicated they fished on the Pikmiktalik River	2
# of Kotlik households indicated they fished between the Pikmiktalik River and Stebbins	1

	Chum	**Chinook**	**Pink**	**Sockeye**	**Coho**	**Unknown**	**All Salmon**
Kotlik							
Harvest on Pikmiktalik River	2	2	20	0	0	0	24
Harvest between Pikmiktalik River and Stebbins	99	6	0	0	0	0	105
							0
Total	101	8	20	0	0	0	129

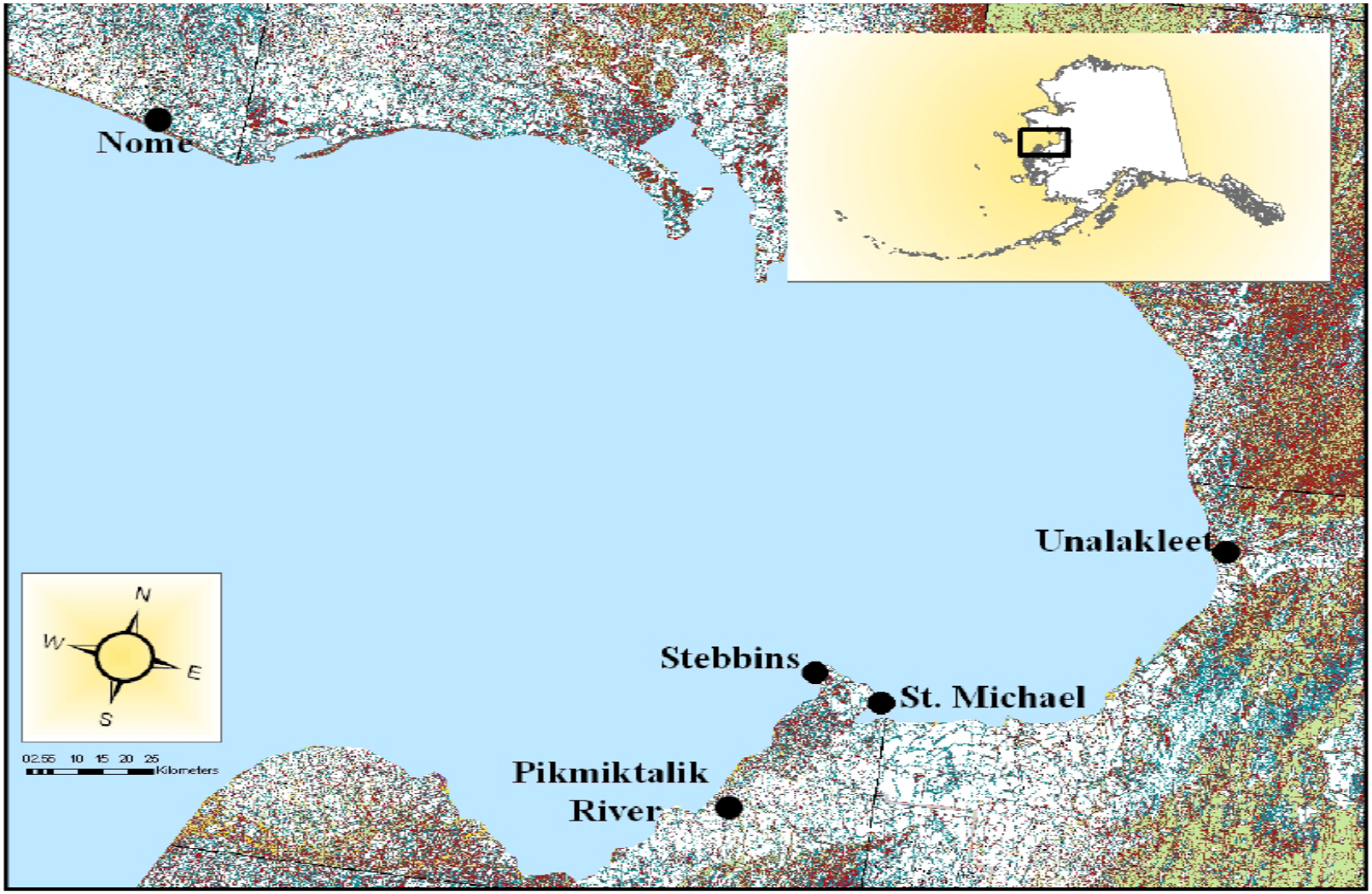

Figure 1. The location of the Pikmiktalik River salmon counting project in relation to neighboring communities.

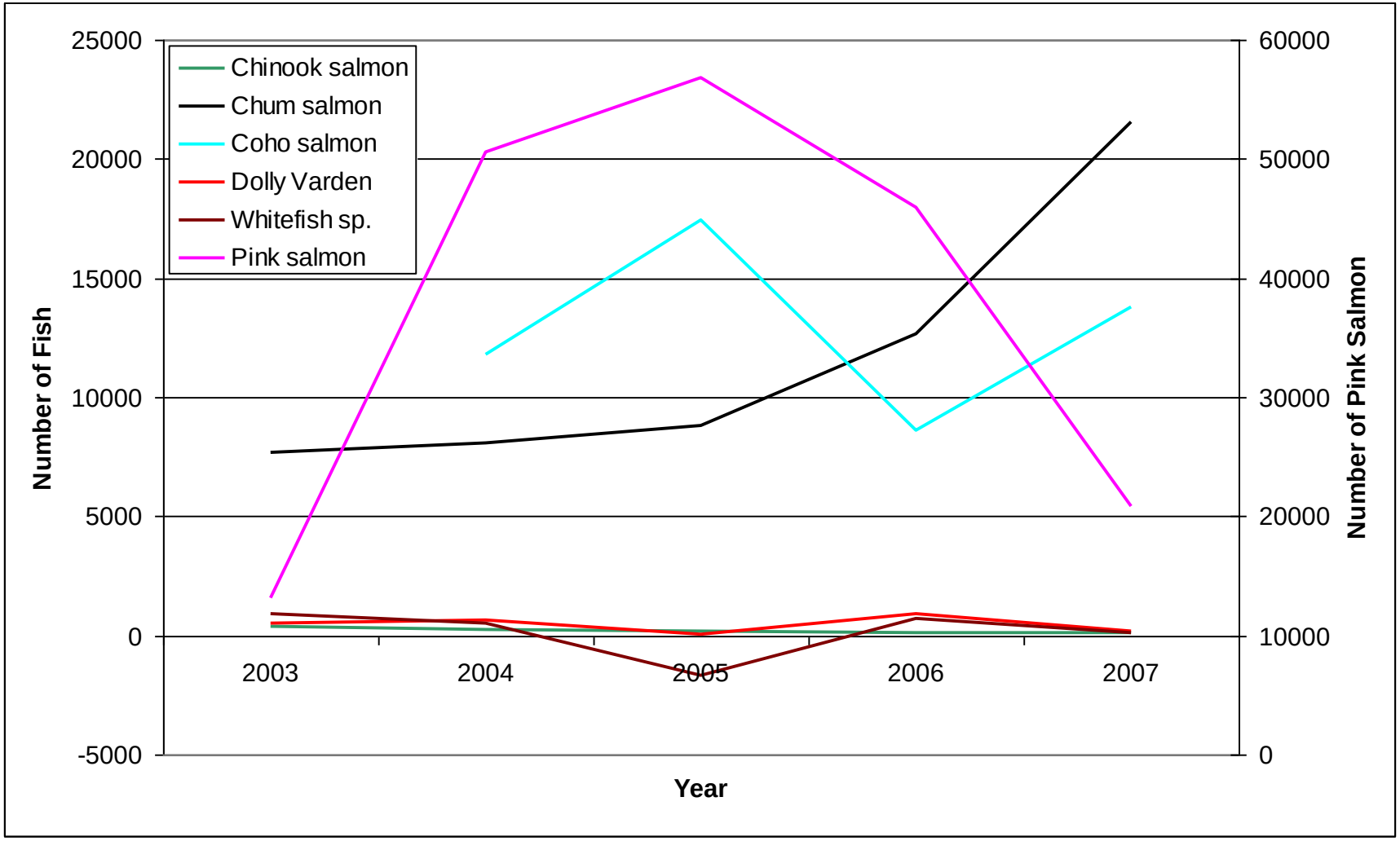

Figure 2. A comparison of the escapement of salmon, Dolly Varden and whitefish sp. to the Pikmiktalik River from 2003-2007.

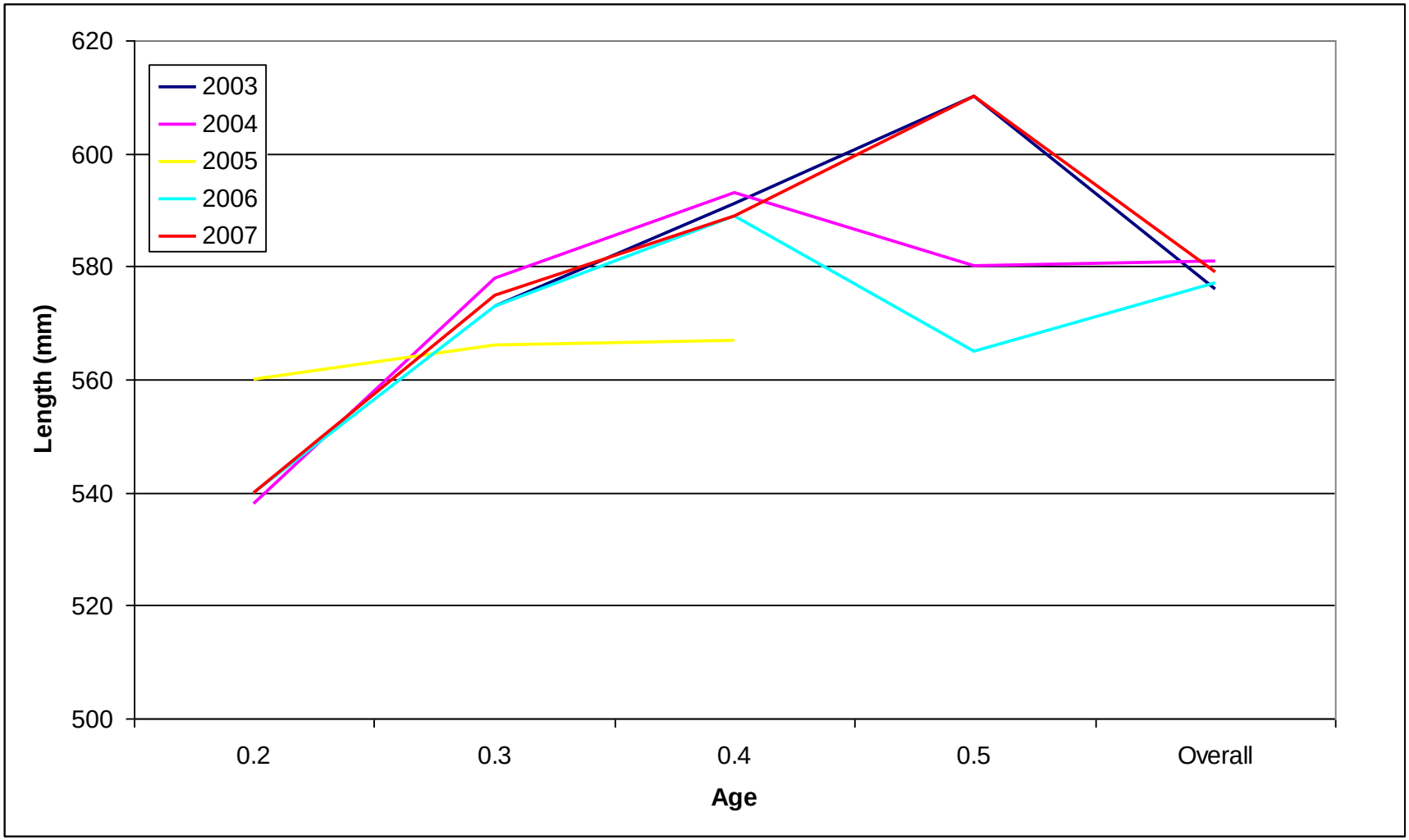

Figure 3. A comparison of length from chum salmon sampled during 2003-2007 on the Pikmiktalik River.

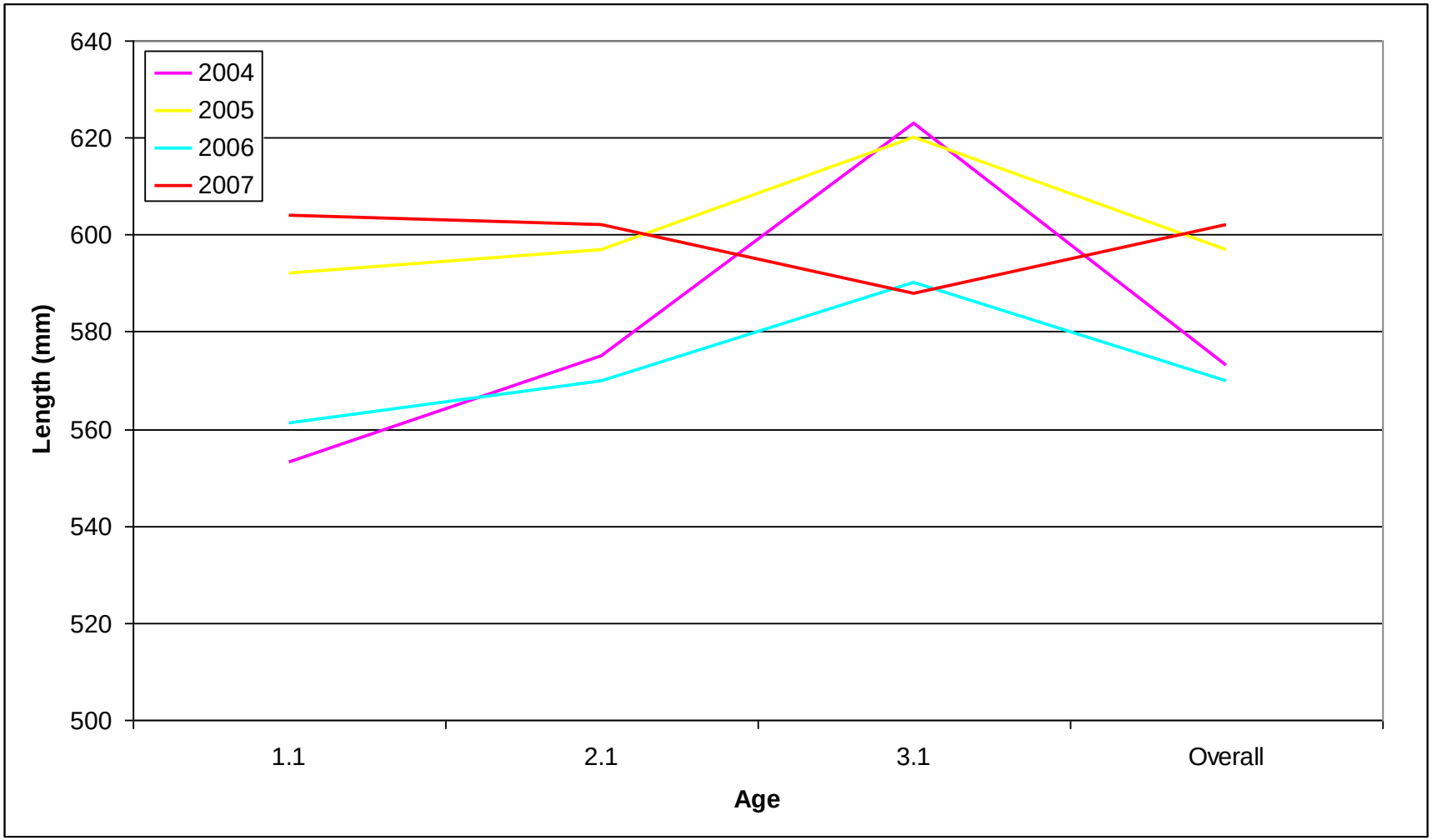

Figure 4. A comparison of length from coho salmon sampled during 2004-2007 on the Pikmiktalik River.

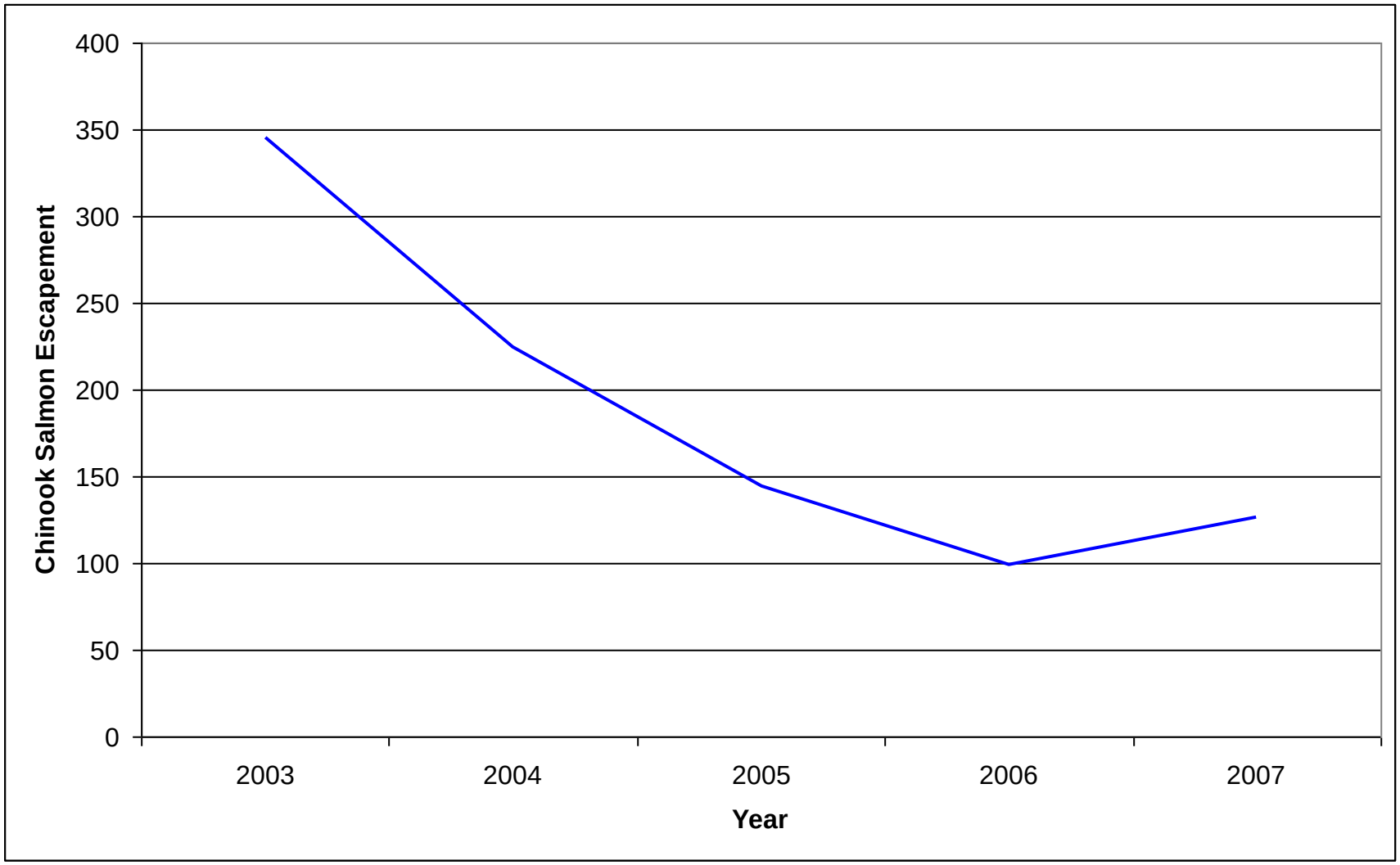

Figure 5. Chinook salmon escapement to the Pikmiktalik River, 2003-2007.

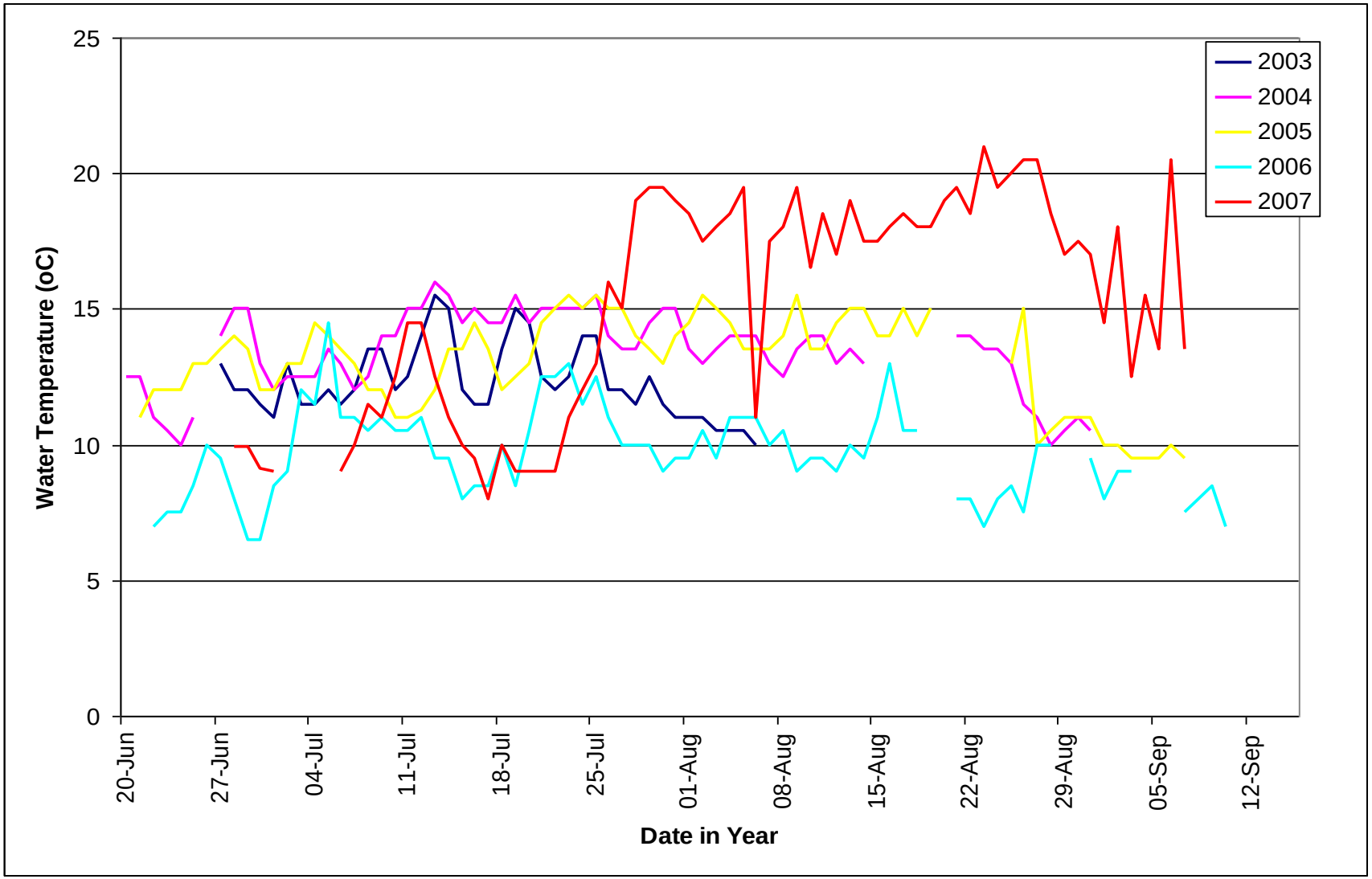

Figure 6. A comparison of average daily water temperature measured at the counting tower site, Pikmiktalik River, 2003-2007.

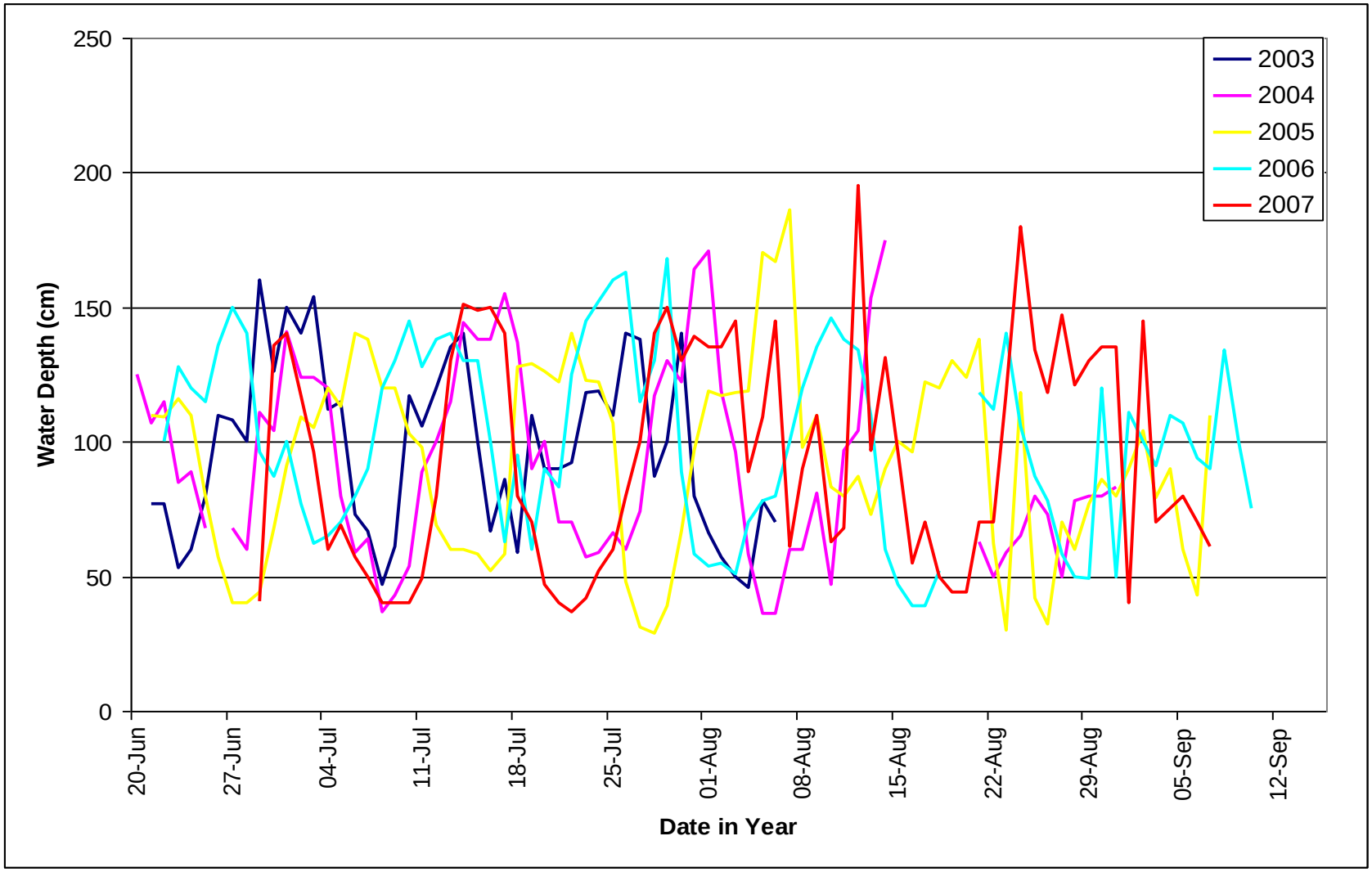

Figure 7. A comparison of daily maximum water depth measured at the counting tower site at 0800 hours, Pikmiktalik River, 2003-2007.

Appendix A. Post-season salmon harvest survey tool used by the Alaska Department of Fish and Game in Stebbins and St. Michael, 2006

NORTON SOUND 2006 SUBSISTENCE SALMON HARVEST SURVEY

Alaska Department of Fish and Game-

Community ID#_____

Household ID#_____

Community: _____

Survey Date: _____

Interviewer: _____

Household Size: _____

(If new household) PO Box:_____

Household participation is voluntary. Individual household data will not be released without permission of household head.

1. Did your household fish for salmon for subsistence use this year? (Include fishing with a rod and reel) ☐ YES ☐ NO

2. Does your household usually subsistence fish for salmon? ☐ YES ☐ NO

FOR SALMON FISHING HOUSEHOLDS ONLY ("Yes" to #1)

3. Please estimate how many salmon your household caught for subsistence use this year, including with a rod and reel. It is important not to double count fish harvests. Report only your share of the catch if fishing with others. Include salmon you gave away, ate fresh, fed to dogs, lost to spoilage, or obtained from helping others process fish.

	NUMBER OF SALMON YOUR HOUSEHOLD HARVESTED (BY GEAR TYPE)			Of your TOTAL HARVEST how many salmon were caught JUST for dog food?	Of TOTAL HARVEST how many salmon were caught	
SPECIES	SUBSISTENCE GILL NET or SEINE (Number of fish)	ROD & REEL (Number of fish)	KEPT FROM COMMERCIAL FISHING (Number of fish)	(Number of fish)	In the Pikmiktalik River (Number of fish)	In Marine W. adjacent to the Pikmik. R. (Number of fish)
CHUM SALMON Dog						
CHINOOK SALMON King						
PINK SALMON Humpy						
SOCKEYE SALMON Red						
COHO SALMON Silver						

4. How was subsistence chum salmon fishing for your household this year ?

☐ VERY GOOD ☐ AVERAGE ☐ POOR **IF POOR, why?**_____

5. Does anyone in your household trade or barter subsistence-caught fish with people in other households or communities?

☐ YES ☐ NO

6. Comments or Suggestions?

_____

_____

_____

_____

Appendix B. Expanded daily and cumulative migration of all fish species past the Pikmiktalik River tower, as well as daily water temperature and depth information, for 2007.

		Daily Counts						Cumulative Counts						Water temp (oC)		Water Depth (cm)	
Date	Hours Counted	King	Chum	Pink	Coho	Whitefish	Dolly	King	Chum	Pink	Coho	Whitefish	Dolly	A.M.	P.M.	A.M.	P.M.
27-Jun	8	12	0	0	0	0	0	12	0	0	0	0	0				
28-Jun	24	0	3	0	0	0	3	12	3	0	0	0	3	9.9			
29-Jun	24	9	48	3	0	6	30	21	51	3	0	6	33	9.9		41	39
30-Jun	24	3	30	0	0	0	12	24	81	3	0	6	45	9.1		136	
01-Jul	24	9	456	0	0	18	24	33	537	3	0	24	69	9		140	40
02-Jul	24	6	147	0	0	12	-3	39	684	3	0	36	66			117	40
03-Jul	24	9	591	27	0	-6	15	48	1275	30	0	30	81			96	38
04-Jul	24	6	282	27	0	-15	18	54	1557	57	0	15	99			60	30
05-Jul	24	3	495	33	0	-69	15	57	2052	90	0	-54	114			69	37
06-Jul	24	0	138	0	0	18	15	57	2190	90	0	-36	129	8	10	57	32
07-Jul	24	6	747	153	0	12	6	63	2937	243	0	-24	135	8	12	50	34
08-Jul	24	3	351	36	0	-3	-3	66	3288	279	0	-27	132	8	15	40	34
09-Jul	24	9	561	102	0	78	6	75	3849	381	0	51	138	8	14	40	30
10-Jul	24	6	1209	192	0	3	6	81	5058	573	0	54	144	8	17	40	35
11-Jul	24	18	3291	4110	0	3	18	99	8349	4683	0	57	162	9	20	49	62
12-Jul	24	18	882	2070	0	21	0	117	9231	6753	0	78	162	9	20	80	39
13-Jul	24	3	321	1470	0	3	6	120	9552	8223	0	81	168	8	17	130	35
14-Jul	24	0	42	96	0	0	0	120	9594	8319	0	81	168	8	14	151	35
15-Jul	24	0	159	90	0	0	0	120	9753	8409	0	81	168	8	12	149	35
16-Jul	24	0	180	114	0	9	0	120	9933	8523	0	90	168	8	11	150	35
17-Jul	24	6	795	2439	0	3	0	126	10728	10962	0	93	168	8	8	140	39
18-Jul	24	0	9	-177	3	6	0	126	10737	10785	3	99	168	11	9	80	33
19-Jul	24	0	0	15	0	0	0	126	10737	10800	3	99	168	10	8	70	34
20-Jul	24	0	468	876	0	3	0	126	11205	11676	3	102	168	10	8	47	36
21-Jul	24	0	438	1173	0	6	0	126	11643	12849	3	108	168	10	8	40	35
22-Jul	24	0	963	3018	15	6	0	126	12606	15867	18	114	168	9	9	37	40
23-Jul	24	0	48	450	0	-6	0	126	12654	16317	18	108	168	10	12	42	40
24-Jul	24	0	408	699	12	0	0	126	13062	17016	30	108	168	10	14	52	40

Appendix B. Continued.

Date	Hours Counted	Daily Counts King	Daily Counts Chum	Daily Counts Pink	Daily Counts Coho	Daily Counts Whitefish	Daily Counts Dolly	Cumulative Counts King	Cumulative Counts Chum	Cumulative Counts Pink	Cumulative Counts Coho	Cumulative Counts Whitefish	Cumulative Counts Dolly	Water temp (oC) A.M.	Water temp (oC) P.M.	Water Depth (cm) A.M.	Water Depth (cm) P.M.
25-Jul	24	0	708	720	6	0	0	126	13770	17736	36	108	168	11	15	60	37
26-Jul	24	0	726	921	30	0	0	126	14496	18657	66	108	168	11	21	80	36
27-Jul	24	0	231	318	36	0	0	126	14727	18975	102	108	168	11	19	100	30
28-Jul	24	0	177	479	39	0	0	126	14904	19454	141	108	168	19	19	140	30
29-Jul	24	0	78	147	12	0	3	126	14982	19601	153	108	171	19	20	150	35
30-Jul	24	0	105	45	66	9	12	126	15087	19646	219	117	183	19	20	130	36
31-Jul	24	0	903	288	81	-3	6	126	15990	19934	300	114	189	19	19	139	39
01-Aug	24	0	153	228	111	0	0	126	16143	20162	411	114	189	18	19	135	42
02-Aug	24	0	200	138	90	-3	0	126	16343	20300	501	111	189	17	18	135	35
03-Aug	24	0	333	216	66	0	0	126	16676	20516	567	111	189	18	18	145	34
04-Aug	24	0	1338	177	183	3	0	126	18014	20693	750	114	189	17	20	89	34
05-Aug	24	0	198	135	75	0	3	126	18212	20828	825	114	192	19	20	109	40
06-Aug	24	0	87	-3	87	-3	0	126	18299	20825	912	111	192	12	10	145	48
07-Aug	24	0	48	-57	168	6	0	126	18347	20768	1080	117	192	17	18	61	45
08-Aug	24	0	39	-15	42	0	0	126	18386	20753	1122	117	192	17	19	90	45
09-Aug	24	0	1654	45	645	-15	0	126	20040	20798	1767	102	192	19	20	110	42
10-Aug	24	0	159	-3	255	0	0	126	20199	20795	2022	102	192	12	21	63	40
11-Aug	24	0	126	9	220	-15	0	126	20325	20804	2242	87	192	17	20	68	42
12-Aug	24	0	78	12	492	0	0	126	20403	20816	2734	87	192	15	19	195	48
13-Aug	24	0	51	24	102	3	0	126	20454	20840	2836	90	192	19	19	97	65
14-Aug	24	0	27	-9	168	-12	0	126	20481	20831	3004	78	192	17	18	131	48
15-Aug	24	0	48	15	201	-3	0	126	20529	20846	3205	75	192	16	19	96	50
16-Aug	24	0	82	-9	108	3	0	126	20611	20837	3313	78	192	17	19	55	41
17-Aug	24	0	255	15	576	0	0	126	20866	20852	3889	78	192	17	20	70	51
18-Aug	24	0	33	6	117	0	0	126	20899	20858	4006	78	192	17	19	50	46
19-Aug	24	0	33	6	159	0	0	126	20932	20864	4165	78	192	17	19	44	45
20-Aug	24	0	27	0	129	0	0	126	20959	20864	4294	78	192	19	19	44	45
21-Aug	24	0	33	0	327	0	0	126	20992	20864	4621	78	192	19	20	70	43

Appendix B. Continued.

Date	Hours Counted	Daily Counts King	Daily Counts Chum	Daily Counts Pink	Daily Counts Coho	Daily Counts Whitefish	Daily Counts Dolly	Cumulative Counts King	Cumulative Counts Chum	Cumulative Counts Pink	Cumulative Counts Coho	Cumulative Counts Whitefish	Cumulative Counts Dolly	Water temp (oC) A.M.	Water temp (oC) P.M.	Water Depth (cm) A.M.	Water Depth (cm) P.M.
22-Aug	24	0	18	36	534	0	0	126	21010	20900	5155	78	192	18	19	70	36
23-Aug	24	0	27	0	180	0	0	126	21037	20900	5335	78	192	22	20	118	36
24-Aug	24	0	126	0	1011	6	0	126	21163	20900	6346	84	192	18	21	180	39
25-Aug	24	0	57	0	1998	0	0	126	21220	20900	8344	84	192	19	21	134	37
26-Aug	24	0	42	0	1209	0	0	126	21262	20900	9553	84	192	20	21	118	43
27-Aug	24	0	36	0	1071	0	0	126	21298	20900	10624	84	192	19	22	147	39
28-Aug	24	0	36	0	696	0	0	126	21334	20900	11320	84	192	18	19	121	37
29-Aug	24	0	-48	0	525	3	0	126	21286	20900	11845	87	192	17	17	130	38
30-Aug	24	0	3	0	387	0	0	126	21289	20900	12232	87	192	17	18	135	32
31-Aug	24	0	54	0	432	0	0	126	21343	20900	12664	87	192	16	18	135	40
01-Sep	24	0	150	0	215	0	0	126	21493	20900	12879	87	192	11	18	40	40
02-Sep	24	0	18	0	328	0	0	126	21511	20900	13207	87	192	18	18	145	35
03-Sep	24	0	-27	0	282	9	0	126	21484	20900	13489	96	192	15	10	70	30
04-Sep	24	0	10	0	21	6	0	126	21494	20900	13510	102	192	12	19	75	40
05-Sep	24	0	15	0	84	3	0	126	21509	20900	13594	105	192	12	15	80	35
06-Sep	24	0	9	0	90	0	0	126	21518	20900	13684	105	192	19	22	70	30
07-Sep	24	0	0	0	93	0	0	126	21518	20900	13777	105	192	12	15	61	40