U.S. Fish and Wildlife Service
Office of Subsistence Management
Fisheries Resource Monitoring Program

# PIKMIKTALIK RIVER SALMON ESCAPEMENT ENUMERATION AND SAMPLING PROJECT, 2006

Annual Report for Study 06-101

Timothy J. Kroeker and Karen M. Dunmall
Kawerak, Inc.
Division of Natural Resources
Fisheries Department
Box 948
Nome, Alaska 99762
(907) 443-4273

December 2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

## ABSTRACT

Much of the salmon subsistence harvest for the communities of Stebbins and St. Michael occurs on the Pikmiktalik River or in the marine waters immediately adjacent to it. The Pikmiktalik River is part of the Yukon Delta National Wildlife Refuge, and is the site of one of few Federal subsistence fisheries in the Norton Sound area. Local residents strongly feel that availability of in- and post-season escapement information would improve management of these fishery resources. Kawerak, Inc., in cooperation with the Stebbins and St Michael IRAs, conducted a salmon escapement enumeration and sampling project on the Pikmiktalik River from 2003 to 2006. The information colleted provided 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. Total estimated escapements in 2006 were 99 Chinook *Oncorhynchus tshawytscha*; 12,683 chum *O. keta*; 45,879 pink salmon *O. gorbuscha* and 8,503 coho salmon (*O. kisutch*). Additionally, a total of 885 Dolly Varden (*Salvelinus malma*) and 701 whitefish (*Coregonus* sp.) were counted. The ratio of chum females to males was almost 1:1. Age, sex and length data collected from chum salmon indicated that most abundant age class in 2006 was 4-year-old fish, which made up 62.6% of chum captured. Males were generally longer than females, and older salmon were generally longer than younger ones for both chum and coho salmon. Of the coho sampled in 2006, the ratio of females to males was 1:2 and the most abundant age class was age 2.1 coho salmon, which comprised 85.6% of the return.



KEY WORDS: Pikmiktalik River, Yukon Delta National Wildlife Refuge, Escapement and Enumeration, chum salmon, *Oncorhynchus keta*, Chinook salmon, *Oncorhynchus tshawytscha*, pink salmon, *Oncorhynchus gorbuscha*, salmon spawning, subsistence.

CITATION: Kroeker, T.J, and K. M. Dunmall. 2007. Pikmiktalik River Salmon Escapement Enumeration and Sampling Project, 2006. Annual Report for Study 06-101. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, Anchorage, Alaska.

## INTRODUCTION

Much of the salmon subsistence harvest for residents of Stebbins and St. Michael is on the Pikmiktalik River stocks. 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 salmon populations crash while under state management. Local residents strongly feel that availability of in and post-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 enumerating salmon has increased yearly, from 7 weeks in 2003 to over 11 weeks in 2005 and 2006.

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 current salmon escapement enumeration and sampling project began in 2003 and was continued in 2004, 2005 (all are FIS 04-105 Phase II) and 2006. 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

The objectives for 2006 were as follows:

- Install tower, weir and flash panel at the counting site.
- Provide daily and total annual estimates of salmon passing the counting site.
- Provide estimates of the age, sex, and length composition of chum and coho salmon passing the counting site.
- Record weather and water conditions at the salmon counting site.

## METHODS

Weir and tower installation occurred on June 20 and had a crew consisting of a Lead Fisheries Technician and three regular Fisheries Technicians. These technicians worked a 3-week on and 1-week off schedule, which enabled technicians to take scheduled breaks. Counting continued until September 12. The utilized tower site was the preferred location identified by Lean et al. (2003; Figure 1).

Design and Construction

The counting tower apparatus consists 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 (Robb 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 panel of steel fence posts connected with cable and sandbags placed on the river bottom. The panel slightly overlapped the toe of the picket weir and continued in a straight line to the bank on which the tower was placed. Cable clamps were periodically placed along the cable so that the fence posts remained spread out and the panel remained straight.

Installation and Operation

An observer counted salmon from the top of the tower for 20 minutes every hour, twenty four hours a day seven days a week. Numbers of salmon and other fish, by species, were recorded on a hand-tally counter. Salmon and other fishes passing downstream were subtracted from the count. Dead or dying fish drifting downstream past the counting site were not subtracted from 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 20-minute counting schedule occurred 24 hours a day, 7 days per week. The expanded daily count was transferred to a daily enumeration sheet and relayed to the Kawerak, Inc. Fisheries Department via satellite phone the following day. Kawerak, Inc. provided data to Alaska Department of Fish and Game and federal managers for their use and public distribution.

Care was taken to inspect, maintain, and clean debris, including salmon carcasses, from the partial weir on a regular basis. This ensured that fish could not pass through the weir undetected, and that debris load did not cause the weir to fail.

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

Biological Sampling

Biological information was collected for chum and coho salmon. Biological information was attempted to be collected from Chinook salmon, however the low number of returning Chinook salmon prevented adequate numbers from being sampled. A pulse sampling design was used to collect this biological information for chum (Molyneaux and DuBois 1999). The sample size goal for each pulse was 200 chum. 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. Chum, Chinook and coho 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 left side. To avoid sampling the same salmon again, the adipose fin was removed prior to release.

Length summary statistics (mean, standard error, range) for each salmon species were reported by sampling stratum and age-sex category. The overall season mean was estimated by weighting stratum mean lengths by total passage of each species during that stratum.

Scales were collected from the left side of 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 checked for damage and regeneration, and to make sure it was not taken from the lateral line, where scales would have pores or holes. If scales from the preferred area on left side of the salmon were missing, damaged, or regenerated, scales from the preferred area on the right side were collected. If scales could not be collected from the preferred area on either side of the fish, scales as close to the preferred area as possible were collected, and this was noted as "non-preferred scale" on the data sheet. 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 transcribed onto data sheets in a binder kept in the camp cabin.

Scales were sent to 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 acetate cards were examined with 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 number of freshwater annuli and a number following the decimal refers to number of marine annuli. Total age, from time of egg deposition (often referred to as brood year) to time of capture, was the sum of these numbers plus one.

## RESULTS

### Chinook Salmon

Chinook salmon migrated past the tower from June 25 to July 25 (Table 1, Figures 2 and 3). Approximately 50% of the total migration occurred by July 9, with the greatest daily passage occurring on July 15. Seven Chinook salmon were sampled for age, sex and length (Table 2). Of the Chinook sampled, five were female, two were male and their ages ranged from 1.2 to 1.4 and their lengths ranged from 570mm to 900mm.

### Chum Salmon

Salmon enumeration encompassed the entire chum run in 2006 and counted 12,683 chum salmon. The chum run started on June 25 and ended on September 2 (Table 1). Fifty percent of the chum run was complete by July 10 (Table 1, Figures 2, 3).

A total of 473 chum salmon had usable scales when sampled for age, sex and length (Table 3). The ratio of males to females was 1:1 and the sex composition was similar between stratum. Of the returning chum sampled for age, sex and length, 3.8% were age-0.2, 62.6% were age-0.3, 33.2% were age-0.4 and 0.4% were age-0.5. Composition varied slightly between time stratum as 54% were age-0.3 and 44.9% were age-0.4 in the first stratum, whereas 78.9% were age-0.3

and 15.4% were age-0.4 in the last stratum. Generally, chum salmon length increased with age and males were larger than the females of similar age. The average length of age-0.2 chum salmon was 540mm, the average length of age-0.3 chum salmon was 573.4mm, the average length of age-0.4 chum salmon was 589.2mm and the average length of age-0.5 chum salmon was 565mm.

Coho Salmon

Coho salmon migrated past the tower from July 17 to September 10. Total estimated passage was 8,503 coho salmon and 50% of the run was past the tower by August 27. The greatest daily passage of 933 coho salmon occurred on September 4.

A total of 283 readable coho scales were collected while sampling coho for age, sex and length. Estimated age composition of the total spawning escapement was 11.6% age-1.1, 85.6% age-2.1 and 2.9% age-3.1 coho salmon. Females represented 37.5% and males 62.5% of the total spawning escapement (Table 4). Generally, coho salmon length increased with age. The mean length of age-1.1 coho salmon was 560.8 mm, age-2.1 was 570 mm, and age-3.1 coho salmon was 590 mm. Males were generally larger than females of similar age.

Pink Salmon

Pink salmon migrated past the tower from June 25 to August 29 with a total escapement of 45,879 (Table 1; Figures 2 and 3). Approximately 50% of the total migration occurred by July 11, with the greatest daily passage of pink salmon occurring on July 12 with an estimated 6,603 individuals.

Dolly Varden/Whitefish

Dolly Varden and whitefish species were observed moving up- and downstream at the tower site throughout the year (Table 1). The greatest daily passage of Dolly Varden occurred on June 3 with an estimated 255 individuals passing the tower. The greatest daily passage of whitefish occurred on June 25 where an estimated 66 individuals migrated downstream of the tower. Cumulative passage for the 2006 season was 885 Dolly Varden and 701 whitefish (Table 1).

Environmental Conditions

Water temperature generally increased from the start of the project until mid-July. Water temperature fluctuated throughout the camp's operation (Table 5, Figure 4). Recorded water temperature ranged from 6$^{o}$C to 19$^{o}$C over the course of the three seasons. Water temperatures measured at 2000 hours were generally higher than those measured at 0800 hours, and daily differences ranged from 0 to 9 $^{o}$C.

Water depth varied day to day, corresponding with the ocean tides. Depths were always greater at 0800 hours than at 2000 (Table 5, Figure 5). A three day period, August 18 - August 21, experienced heavy rains and caused the river to flood, stopped counting operations due to murky, deep water.

## DISCUSSION

The 2006 season represents the fourth year total estimates of chum, Chinook and pink salmon spawning escapements were obtained for the Pikmiktalik River, and the third year that coho salmon passage on the Pikmiktalik River was obtained. The project was also notable because an Alaska Native organization, Kawerak, Inc., in cooperation with the local tribal government,

rather than a government agency, conducted the work during the four seasons the camp has operated. The project also trained and employed local residents as field technicians.

The project documented the entire Chinook, chum and coho salmon runs on the Pikmiktalik River. This project began on June 21, which was 4 days before the first Chinook was counted and 4 days before the first chum was observed moving past the tower, and continued until September 12, when numbers of Chinook, chum, pink and coho salmon were less than 1% of the total run (Figure 3). Generally, chum salmon traveled upstream in schools and seemed to be most abundant about 1 to 2 days after large high-tide events. Coho were also found to migrate after large amounts of precipitation, however coho numbers were generally strong throughout the latter half of the season.

Higher numbers of five-year-old chum 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. This is a trend that has been observed at the Pikmiktalik River in previous years (Kroeker and Dunmall 2005).

The age composition found in Pikmiktalik River coho salmon is common throughout the region. The large difference in the sex ratio of coho salmon was first thought to be due to potential early run timing of male coho salmon and late run timing of female coho salmon. Coho sex ratios have been found to vary in other locations and over several years. For instance, on the Columbia River where sex ratios were 1:1, coho males were found to return earlier in the run (Marr 1943). Some coho sex ratios have been found to have larger male returns throughout the run ranging from 1.2:1 (Logan 1967) to 2.07:1 (Hunter 1949). In 2006, coho were sampled until September 12 when less than 1% of the run was left. It is plausible that the sampling gear used in collecting samples was selecting more males than females, either due to the male's snout getting caught in the seine or the ability of females to move faster.

Whitefish were observed moving past the tower regularly on the Pikmiktalik River. Greater numbers of whitefish were observed moving downstream at the beginning of the season, and were observed in smaller numbers migrating upstream in the last weeks of the project. Although the original proposal did not include enumeration of whitefish, technicians were first trained in counting fish from the tower by observing the movements of the whitefish, which was the only species present when operations began. This data may be useful since whitefish are an important fisheries resource to local communities and has been collected since 2003.

The Pikmiktalik River is located in the Yukon Delta National Wildlife Refuge and is the site of one of few Federal managed fisheries in the Norton Sound area. The Pikmiktalik River is an indicator river for regional rivers and streams that feed the people of St. Michael, Stebbins and Kotlik. Unemployment is common in the region and any available harvest is utilized. Without this resource, residents would be more dependent on outside food sources for survival. For these reasons, management should use escapement data from the Pikmiktalik River as a foundation for decisions to ensure sustainability of these salmon runs. Additional years of escapement data will provide abundance trend information as well as some indication of production. The residents of Stebbins and St. Michael have long been concerned with the absence of salmon monitoring on the rivers they use for subsistence fishing. Therefore, they were very pleased with this project on the Pikmiktalik River, and have offered several ideas for future projects, including studies about the effects of beaver on salmon migration.

## CONCLUSIONS

The success of the Pikmiktalik River enumeration project was due to the productive collaboration of Stebbins IRA, St. Michael IRA, and Kawerak, Inc. The returning and new fisheries technicians created a positive camp environment, and were able to remain focused and ambitious throughout the season and to collect and record highly accurate data. Hiring local residents as field technicians also provided 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.

Without this project, accurate estimates of run size, strength, timing, age composition, sex ratios and lengths would not be known to managers. This information is vital to the successful management of salmon in the southern Norton Sound, salmon that three communities rely on and cannot afford to live without. It is the responsibility of managers to ensure the subsistence resources used by the people of Alaska will be sustainable year after year. The Pikmiktalik River enumeration project is the most effective way of estimating the size, sex composition and age of salmon returning to spawn.

## RECOMMENDATIONS

Salmon enumeration studies on the Pikmiktalik River should continue to obtain data on abundance and production.

## ACKNOWLEDGEMENTS

The Kawerak, Inc. Fisheries Program would like to thank Morris Nashoanak for his time and effort coordinating camp supplies, personnel, and data management. The help of Charlie Lean with the Norton Sound Economic Development Corporation and Richard Cannon with U.S. Fish and Wildlife Service is also greatly appreciated. The Fisheries Technicians in 2006 were Danny Nashoanak, Ryan Nashoanak, Lenny Katcheak, and Vincent Matthias. These gentlemen did outstanding work with minimum 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 Knuepfer. Morris Nashoanak provided and operated the boat and motor used to transport supplies and personnel to and from camp. We greatly appreciate the cooperation of Austin Matthias, for allowing use of his land as the counting site. The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided $356,317 over three years (2003-2005) in funding support for this project through the Fisheries Resource Monitoring Program, under contract number 7010132253, and $140,514 for the 2006 season in funding support for this project, under contract number 701816J616.

## LITERATURE CITED

Bromaghin, J.F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician. 47(3): 203-206.

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission No. 9.

Vancouver British Columbia.INPFC (International North Pacific Fisheries Commission). 1963. Annual Report, 1961. Vancouver, British Columbia.

Hunter, J.G. 1949. Natural propagation of salmon in the central coastal area of British Columbia. II. The 1948 run. Fish. Res. Board Can. Prog. Rep. Pac. Coast Stn. 79:33-34. As reported in the Pacific Salmon Life Histories.

INPFC (International North Pacific Fisheries Commission). 1963. Annual Report, 1961. Vancouver, British Columbia.

Koo, T. S. Y. 1962. Age designation in salmon. Pages 37-48 *in* T. S. Y. Koo, editor. Studies of Alaska red salmon. University of Washington Publications in Fisheries, New Series, Volume I, Seattle.

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.

Lean, C. D. Wiswar, T. Roettiger, and S. Fried. 2003. Pikmiktalik River Salmon Counting Site Surveys. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, Final Report for Study 02-020, Anchorage, Alaska.

Logan, S.M. 1967. Silver salmon studies in the Resurrection Bay area. Prog. Rep. Alaska Dep. Fish Game Sport Fish Div. 9(1966-67):83-102. As reported in the Pacific Salmon Life Histories.

Marr, J.C. 1943. Age, length and weight studies of three species of Columbia River salmon (*Oncorhynchus keta, O. gorbuscha, and O. kisutch*). Stanford Ichthyol. Bull. 2:157-197. As cited in the Pacific Salmon Life Histories.

Molyneaux, D. B. and L. DuBois. 1999. Salmon age, sex, and length catalog for the Kuskokwim area, 1998 progress report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A99-15, Anchorage.

Mosher, K.H. 1968. Photographic atlas of sockeye salmon scales. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Fishery Bulletin 2:243-274.

Robb, P.J. 1995. Niukluk River salmon counting tower project summary report 1995. Alaska Department of Fish and Game, Commercial Fish Division, Anchorage Regional Informational Report No. 3A97-04.

Table 1. Expanded daily and cumulative migration of all salmon past the Pikmiktalik River tower, 2006.

| | Daily | | | | | | Cumulative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Chinook** | **Chum** | **Pink** | **Coho** | **Dolly** | **Whitefish** | **Chinook** | **Chum** | **Pink** | **Coho** | **Dolly** | **Whitefish** |
| 6/21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6/22 | 0 | 0 | 0 | 0 | 0 | -30 | 0 | 0 | 0 | 0 | 0 | -30 |
| 6/23 | 0 | 0 | 0 | 0 | 18 | -18 | 0 | 0 | 0 | 0 | 18 | -48 |
| 6/24 | 0 | 0 | 0 | 0 | -6 | -21 | 0 | 0 | 0 | 0 | 12 | -69 |
| 6/25 | 3 | 21 | 57 | 0 | 24 | -66 | 3 | 21 | 57 | 0 | 36 | -135 |
| 6/26 | 3 | 33 | 39 | 0 | 24 | -9 | 6 | 54 | 96 | 0 | 60 | -144 |
| 6/27 | 6 | 108 | 318 | 0 | 9 | -3 | 12 | 162 | 414 | 0 | 69 | -147 |
| 6/28 | 12 | 51 | 30 | 0 | -3 | -18 | 24 | 213 | 444 | 0 | 66 | -165 |
| 6/29 | 3 | 51 | 15 | 0 | 12 | 21 | 27 | 264 | 459 | 0 | 78 | -144 |
| 6/30 | 0 | 105 | 93 | 0 | 12 | -6 | 27 | 369 | 552 | 0 | 90 | -150 |
| 7/1 | 3 | 15 | 90 | 0 | 18 | 3 | 30 | 384 | 642 | 0 | 108 | -147 |
| 7/2 | 6 | 414 | 525 | 0 | 60 | 36 | 36 | 798 | 1167 | 0 | 168 | -111 |
| 7/3 | 0 | 741 | 873 | 0 | 255 | 18 | 36 | 1539 | 2040 | 0 | 423 | -93 |
| 7/4 | 0 | 147 | 388 | 0 | 120 | 12 | 36 | 1686 | 2428 | 0 | 543 | -81 |
| 7/5 | 0 | 249 | 729 | 0 | 54 | 15 | 36 | 1935 | 3157 | 0 | 597 | -66 |
| 7/6 | 3 | 650 | 2590 | 0 | 0 | 36 | 39 | 2585 | 5747 | 0 | 597 | -30 |
| 7/7 | 3 | 2376 | 6171 | 0 | 3 | 3 | 42 | 4961 | 11918 | 0 | 600 | -27 |
| 7/8 | 3 | 510 | 2760 | 0 | 3 | 6 | 45 | 5471 | 14678 | 0 | 603 | -21 |
| 7/9 | 3 | 363 | 2553 | 0 | 3 | 60 | 48 | 5834 | 17231 | 0 | 606 | 39 |
| 7/10 | 9 | 462 | 2805 | 0 | 63 | 24 | 57 | 6296 | 20036 | 0 | 669 | 63 |
| 7/11 | 3 | 519 | 4299 | 0 | 6 | 12 | 60 | 6815 | 24335 | 0 | 675 | 75 |
| 7/12 | 15 | 510 | 6603 | 0 | 54 | 27 | 75 | 7325 | 30938 | 0 | 729 | 102 |
| 7/13 | 0 | 78 | 225 | 0 | 15 | 24 | 75 | 7403 | 31163 | 0 | 744 | 126 |
| 7/14 | 9 | 444 | 1809 | 0 | 0 | 48 | 84 | 7847 | 32972 | 0 | 744 | 174 |
| 7/15 | 0 | 240 | 2979 | 0 | 0 | 18 | 84 | 8087 | 35951 | 0 | 744 | 192 |
| 7/16 | 3 | 114 | -240 | 0 | 0 | 48 | 87 | 8201 | 35711 | 0 | 744 | 240 |
| 7/17 | 6 | 132 | 438 | 3 | 0 | 36 | 93 | 8333 | 36149 | 3 | 744 | 276 |
| 7/18 | -3 | 12 | 87 | 0 | 0 | -3 | 90 | 8345 | 36236 | 3 | 744 | 273 |
| 7/19 | 0 | 291 | 810 | 9 | 3 | 3 | 90 | 8636 | 37046 | 12 | 747 | 276 |
| 7/20 | 0 | 117 | 459 | 18 | 0 | 21 | 90 | 8753 | 37505 | 30 | 747 | 297 |
| 7/21 | 0 | 330 | 1437 | 15 | 0 | 27 | 90 | 9083 | 38942 | 45 | 747 | 324 |
| 7/22 | 6 | 294 | 1893 | 36 | 36 | 36 | 96 | 9377 | 40835 | 81 | 783 | 360 |
| 7/23 | 0 | 687 | 2706 | 48 | 3 | 18 | 96 | 10064 | 43541 | 129 | 786 | 378 |
| 7/24 | 0 | 129 | 690 | 18 | 3 | 15 | 96 | 10193 | 44231 | 147 | 789 | 393 |
| 7/25 | 3 | 136 | 384 | 33 | 3 | 12 | 99 | 10329 | 44615 | 180 | 792 | 405 |
| 7/26 | 0 | 183 | 501 | 26 | 0 | 6 | 99 | 10512 | 45116 | 206 | 792 | 411 |
| 7/27 | 0 | 147 | 288 | 3 | 0 | 18 | 99 | 10659 | 45404 | 209 | 792 | 429 |
| 7/28 | 0 | 75 | 183 | 6 | 0 | 3 | 99 | 10734 | 45587 | 215 | 792 | 432 |
| 7/29 | 0 | 123 | 411 | 30 | 0 | 15 | 99 | 10857 | 45998 | 245 | 792 | 447 |
| 7/30 | 0 | 126 | 163 | 27 | 0 | 0 | 99 | 10983 | 46161 | 272 | 792 | 447 |
| 7/31 | 0 | -18 | 30 | 6 | 0 | 6 | 99 | 10965 | 46191 | 278 | 792 | 453 |
| 8/1 | 0 | -54 | -48 | 18 | 0 | -6 | 99 | 10911 | 46143 | 296 | 792 | 447 |
| 8/2 | 0 | 60 | 3 | 51 | 3 | 3 | 99 | 10971 | 46146 | 347 | 795 | 450 |
| 8/3 | 0 | 6 | -36 | 66 | 12 | 0 | 99 | 10977 | 46110 | 413 | 807 | 450 |
| 8/4 | 0 | 18 | -30 | 33 | 30 | 3 | 99 | 10995 | 46080 | 446 | 837 | 453 |

Table 1 continued.

| | Daily | | | | | | Cumulative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Chinook** | **Chum** | **Pink** | **Coho** | **Dolly** | **Whitefish** | **Chinook** | **Chum** | **Pink** | **Coho** | **Dolly** | **Whitefish** |
| 8/5 | 0 | 237 | -75 | 45 | 3 | 0 | 99 | 11232 | 46005 | 491 | 840 | 453 |
| 8/6 | 0 | 66 | -66 | 54 | 0 | 0 | 99 | 11298 | 45939 | 545 | 840 | 453 |
| 8/7 | 0 | 93 | -117 | 129 | 6 | 30 | 99 | 11391 | 45822 | 674 | 846 | 483 |
| 8/8 | 0 | 141 | -45 | 150 | 0 | 15 | 99 | 11532 | 45777 | 824 | 846 | 498 |
| 8/9 | 0 | 81 | 6 | 135 | 0 | 15 | 99 | 11613 | 45783 | 959 | 846 | 513 |
| 8/10 | 0 | 363 | 30 | 111 | 6 | 9 | 99 | 11976 | 45813 | 1070 | 852 | 522 |
| 8/11 | 0 | 162 | 36 | 231 | 0 | 6 | 99 | 12138 | 45849 | 1301 | 852 | 528 |
| 8/12 | 0 | 60 | -9 | 84 | 0 | 0 | 99 | 12198 | 45840 | 1385 | 852 | 528 |
| 8/13 | 0 | 51 | 18 | 249 | 0 | -6 | 99 | 12249 | 45858 | 1634 | 852 | 522 |
| 8/14 | 0 | 29 | -6 | 75 | 0 | 0 | 99 | 12278 | 45852 | 1709 | 852 | 522 |
| 8/15 | 0 | 198 | 0 | 102 | 6 | 3 | 99 | 12476 | 45852 | 1811 | 858 | 525 |
| 8/16 | 0 | 45 | 3 | 42 | 0 | 6 | 99 | 12521 | 45855 | 1853 | 858 | 531 |
| 8/17 | 0 | 15 | 3 | 24 | 0 | 6 | 99 | 12536 | 45858 | 1877 | 858 | 537 |
| 8/18 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 12536 | 45858 | 1877 | 858 | 537 |
| 8/19 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 12536 | 45858 | 1877 | 858 | 537 |
| 8/20 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 12536 | 45858 | 1877 | 858 | 537 |
| 8/21 | 0 | 30 | -3 | 174 | 15 | 0 | 99 | 12566 | 45855 | 2051 | 873 | 537 |
| 8/22 | 0 | 15 | -3 | 129 | 3 | 9 | 99 | 12581 | 45852 | 2180 | 876 | 546 |
| 8/23 | 0 | 24 | 3 | 870 | 3 | 15 | 99 | 12605 | 45855 | 3050 | 879 | 561 |
| 8/24 | 0 | 15 | 6 | 267 | 0 | 21 | 99 | 12620 | 45861 | 3317 | 879 | 582 |
| 8/25 | 0 | 9 | 9 | 168 | 3 | 12 | 99 | 12629 | 45870 | 3485 | 882 | 594 |
| 8/26 | 0 | 6 | 0 | 156 | 0 | 15 | 99 | 12635 | 45870 | 3641 | 882 | 609 |
| 8/27 | 0 | 24 | 3 | 693 | 0 | 15 | 99 | 12659 | 45873 | 4334 | 882 | 624 |
| 8/28 | 0 | 9 | 0 | 213 | 0 | 6 | 99 | 12668 | 45873 | 4547 | 882 | 630 |
| 8/29 | 0 | 3 | 6 | 138 | 3 | 27 | 99 | 12671 | 45879 | 4685 | 885 | 657 |
| 8/30 | 0 | 3 | 0 | 795 | 0 | 12 | 99 | 12674 | 45879 | 5480 | 885 | 669 |
| 8/31 | 0 | 3 | 0 | 165 | 0 | 5 | 99 | 12677 | 45879 | 5645 | 885 | 674 |
| 9/1 | 0 | 3 | 0 | 336 | 0 | 0 | 99 | 12680 | 45879 | 5981 | 885 | 674 |
| 9/2 | 0 | 3 | 0 | 666 | 0 | 6 | 99 | 12683 | 45879 | 6647 | 885 | 680 |
| 9/3 | 0 | 0 | 0 | 50 | 0 | 6 | 99 | 12683 | 45879 | 6697 | 885 | 686 |
| 9/4 | 0 | 0 | 0 | 933 | 0 | 3 | 99 | 12683 | 45879 | 7630 | 885 | 689 |
| 9/5 | 0 | 0 | 0 | 471 | 0 | 0 | 99 | 12683 | 45879 | 8101 | 885 | 689 |
| 9/6 | 0 | 0 | 0 | 147 | 0 | 0 | 99 | 12683 | 45879 | 8248 | 885 | 689 |
| 9/7 | 0 | 0 | 0 | 111 | 0 | 12 | 99 | 12683 | 45879 | 8359 | 885 | 701 |
| 9/8 | 0 | 0 | 0 | 90 | 0 | 9 | 99 | 12683 | 45879 | 8449 | 885 | 710 |
| 9/9 | 0 | 0 | 0 | 54 | 0 | -9 | 99 | 12683 | 45879 | 8503 | 885 | 701 |
| 9/10 | 0 | 0 | 0 | 72 | 3 | -6 | 99 | 12683 | 45879 | 8575 | 888 | 695 |
| 9/11 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 12683 | 45879 | 8575 | 888 | 695 |
| 9/12 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 12683 | 45879 | 8575 | 888 | 695 |
| | **99** | **12,683** | **45,879** | **8,503** | **885** | **701** | **99** | **12,683** | **45,879** | **8,575** | **888** | **695** |

Table 2. Age, sex and length of seven Chinook salmon sampled at the Pikmiktalik River, 2006.

| Date | Sex | Length | Age |
|---|---|---|---|
| 7/2 | Male | 870 | 1.3 |
| 7/8 | Female | 800 | 1.3 |
| 7/10 | Female | 570 | 1.2 |
| 7/19 | Female | 850 | 1.4 |
| 7/19 | Male | 580 | 1.2 |
| 7/19 | Female | 840 | 1.3 |
| 7/19 | Female | 900 | 1.4 |

Table 3. Age, sex, length of chum salmon sampled, and estimated contribution to escapement, weighted by sample period, Pikmiktalik River, 2006.

| | | Brood Year and Age Group | | | | |
|---|---|---|---|---|---|---|
| | | 2003 | 2002 | 2001 | 2000 | |
| | | 0.2 | 0.3 | 0.4 | 0.5 | Total |
| Sampling Date(s): | 6/22 - 7/18 | | | | | |
| Sample Size: | 283 | | | | | |
| Female | Percent of Sample | 0.0 | 24.0 | 21.9 | 0.7 | 46.6 |
| | Number in Escapement | 0 | 2003 | 1828 | 58 | 3889 |
| | Average Length (mm) | - | 557.7 | 571.8 | 565.0 | 564.4 |
| Male | Percent of Sample | 0.4 | 30.0 | 23.0 | 0.0 | 53.4 |
| | Number in Escapement | 33 | 2504 | 1919 | 0 | 4456 |
| | Average Length (mm) | 530.0 | 592.5 | 603.0 | - | 596.6 |
| Total | Percent of Sample | 0.4 | 54.0 | 44.9 | 0.7 | 100.0 |
| | Number in Escapement | 33 | 4506 | 3747 | 58 | 8345 |
| | Average Length (mm) | 530.0 | 577.0 | 587.7 | 565.0 | 581.6 |
| Sampling Date(s): | 7/19 - 7/31 | | | | | |
| Sample Size: | 138 | | | | | |
| Female | Percent of Sample | 3.6 | 39.1 | 5.1 | 0.0 | 47.8 |
| | Number in Escapement | 94 | 1024 | 134 | 0 | 1252 |
| | Average Length (mm) | 532.0 | 554.3 | 557.1 | - | 552.9 |
| Male | Percent of Sample | 6.5 | 34.8 | 10.9 | 0.0 | 52.2 |
| | Number in Escapement | 170 | 912 | 286 | 0 | 1368 |
| | Average Length (mm) | 545.6 | 590.0 | 605.3 | - | 587.6 |
| Total | Percent of Sample | 10.1 | 73.9 | 16.0 | 0.0 | 100.0 |
| | Number in Escapement | 265 | 1936 | 419 | 0 | 2620 |
| | Average Length (mm) | 540.7 | 571.1 | 590.0 | - | 571.0 |
| Sampling Date(s): | 8/1 - 8/30 | | | | | |
| Sample Size: | 52 | | | | | |
| Female | Percent of Sample | 3.8 | 38.5 | 5.8 | 0.0 | 48.1 |
| | Number in Escapement | 65 | 661 | 100 | 0 | 826 |
| | Average Length (mm) | 520.0 | 543.5 | 573.3 | - | 545.2 |
| Male | Percent of Sample | 1.9 | 40.4 | 9.6 | 0.0 | 51.9 |
| | Number in Escapement | 33 | 694 | 165 | 0 | 892 |
| | Average Length (mm) | 580.0 | 586.2 | 632.0 | - | 594.4 |
| Total | Percent of Sample | 5.7 | 78.9 | 15.4 | 0.0 | 100.0 |
| | Number in Escapement | 98 | 1356 | 265 | 0 | 1718 |
| | Average Length (mm) | 540.0 | 565.4 | 610.0 | - | 570.8 |

Table 3 continued.

| | | Brood Year and Age Group | | | | |
|---|---|---|---|---|---|---|
| | | 2003 | 2002 | 2001 | 2000 | |
| | | 0.2 | 0.3 | 0.4 | 0.5 | Total |
| Sampling Date(s): | Season (Weighted by Strata) | Season Total | | | | |
| Sample Size: | 473 | | | | | |
| Female | Percent of Sample | 1.3 | 29.1 | 16.2 | 0.5 | 47.1 |
| | Number in Escapement | 160 | 3689 | 2061 | 58 | 5967 |
| | Average Length (mm) | 528.6 | 554.4 | 570.4 | 565.0 | 558.8 |
| Male | Percent of Sample | 1.9 | 32.4 | 18.7 | 0.0 | 52.9 |
| | Number in Escapement | 236 | 4109 | 2370 | 0 | 6716 |
| | Average Length (mm) | 547.3 | 590.9 | 605.1 | - | 593.8 |
| Total | Percent of Sample | 3.1 | 61.5 | 34.9 | 0.5 | 100.0 |
| | Number in Escapement | 396 | 7798 | 4431 | 58 | 12683 |
| | Average Length (mm) | 540.0 | 573.4 | 589.2 | 565.0 | 577.3 |
| Sampling Date(s): | Season (Un-weighted) | Season Total | | | | |
| Sample Size: | 473 | | | | | |
| Female | percent of sample | 1.5 | 30.0 | 15.2 | 0.4 | 47.1 |
| | Number in Escapement | 190 | 3805 | 1928 | 51 | 5974 |
| Male | percent of sample | 2.3 | 32.6 | 18.0 | 0.0 | 52.9 |
| | Number in Escapement | 292 | 4135 | 2283 | 0 | 6709 |
| Total | percent of sample | 3.8 | 62.6 | 33.2 | 0.4 | 100.0 |
| | Number in Escapement | 482 | 7940 | 4211 | 51 | 12683 |

Table 4. Age, sex, length of coho salmon sampled, and estimated contribution to escapement, weighted by sample period, Pikmiktalik River, 2006.

| | | Brood Year and Age Group | | | |
|---|---|---|---|---|---|
| | | 2003 | 2002 | 2001 | |
| | | 1.1 | 2.1 | 3.1 | Total |
| Sample Size: | 283 | | | | |
| Female | Percent of Sample | 2.9 | 34.6 | 0.0 | 37.5 |
| | Number in Escapement | 249 | 2967 | 0 | 3216 |
| | Average Length (mm) | 553.3 | 565.8 | - | 564.9 |
| Male | Percent of Sample | 8.7 | 51.0 | 2.9 | 62.5 |
| | Number in Escapement | 746 | 4373 | 249 | 5359 |
| | Average Length (mm) | 563.3 | 572.8 | 590.0 | 572.3 |
| Total | Percent of Sample | 11.6 | 85.6 | 2.9 | 100.0 |
| | Number in Escapement | 995 | 7340 | 249 | 8575 |
| | Average Length (mm) | 560.8 | 570.0 | 590.0 | 569.5 |

Table 5. Daily temperature (°C) and stream stage measured at 0800 and 2000 hours at the Pikmiktalik River, 2006.

| | Temperature (°C) | | Depth (cm) | | | Temperature (°C) | | Depth (cm) | |
|---|---|---|---|---|---|---|---|---|---|
| Date | AM | PM | AM | PM | Date | AM | PM | AM | PM |
| 6/21 | | | | | 8/1 | 9 | 10 | 54 | 55 |
| 6/22 | - | 7 | 100 | 58 | 8/2 | 9 | 12 | 55 | 48 |
| 6/23 | 6 | 9 | 128 | 53 | 8/3 | 9 | 10 | 51 | 54 |
| 6/24 | 6 | 9 | 120 | 50 | 8/4 | 10 | 12 | 70 | 46 |
| 6/25 | 7 | 10 | 115 | 50 | 8/5 | 10 | 12 | 78 | 46 |
| 6/26 | 8 | 12 | 136 | 49 | 8/6 | 10 | 12 | 80 | 42 |
| 6/27 | 9 | 10 | 150 | 40 | 8/7 | 10 | 10 | 100 | 42 |
| 6/28 | 8 | 8 | 140 | 42 | 8/8 | 10 | 11 | 120 | 41 |
| 6/29 | 6 | 7 | 96 | 40 | 8/9 | 8 | 10 | 135 | 47 |
| 6/30 | 6 | 7 | 87 | 56 | 8/10 | 9 | 10 | 146 | 35 |
| 7/1 | 8 | 9 | 100 | 50 | 8/11 | 9 | 10 | 138 | 43 |
| 7/2 | 8 | 10 | 77 | 45 | 8/12 | 9 | 9 | 134 | 47 |
| 7/3 | 9 | 15 | 62 | 53 | 8/13 | 10 | 10 | 110 | 41 |
| 7/4 | 10 | 13 | 65 | 40 | 8/14 | 9 | 10 | 60 | 40 |
| 7/5 | 10 | 19 | 70 | 40 | 8/15 | 9 | 13 | 47 | 40 |
| 7/6 | 10 | 12 | 80 | 40 | 8/16 | 11 | 15 | 39 | 49 |
| 7/7 | 7 | 15 | 90 | 40 | 8/17 | 10 | 11 | 39 | 48 |
| 7/8 | 10 | 11 | 120 | 40 | 8/18 | 10 | 11 | 52 | 50 |
| 7/9 | 10 | 12 | 130 | 30 | 8/19 | - | - | - | - |
| 7/10 | 10 | 11 | 145 | 30 | 8/20 | - | - | - | - |
| 7/11 | 10 | 11 | 128 | 40 | 8/21 | 7 | 9 | 118 | 50 |
| 7/12 | 10 | 12 | 138 | 38 | 8/22 | 8 | 8 | 112 | 51 |
| 7/13 | 9 | 10 | 140 | 39 | 8/23 | 7 | 7 | 140 | 60 |
| 7/14 | 9 | 10 | 130 | 38 | 8/24 | 7 | 9 | 106 | 48 |
| 7/15 | 8 | 8 | 130 | 43 | 8/25 | 7 | 10 | 87 | 47 |
| 7/16 | 8 | 9 | 100 | 48 | 8/26 | 8 | 7 | 78 | 49 |
| 7/17 | 8 | 9 | 63 | 58 | 8/27 | 9 | 11 | 58 | 47 |
| 7/18 | 9 | 11 | 95 | 46 | 8/28 | 9 | 11 | 50 | 49 |
| 7/19 | 9 | 8 | 60 | 50 | 8/29 | - | - | 49 | 50 |
| 7/20 | 10 | 11 | 90 | 47 | 8/30 | - | - | 120 | 107 |
| 7/21 | 10 | 15 | 83 | 51 | 8/31 | 9 | 10 | 50 | 47 |
| 7/22 | 10 | 15 | 125 | 48 | 9/1 | 7 | 9 | 111 | 61 |
| 7/23 | 11 | 15 | 145 | 40 | 9/2 | 8 | 10 | 100 | 61 |
| 7/24 | 11 | 12 | 152 | 40 | 9/3 | 11 | 7 | 91 | 56 |
| 7/25 | 10 | 15 | 160 | 42 | 9/4 | - | - | 110 | 48 |
| 7/26 | 10 | 12 | 163 | 40 | 9/5 | - | - | 107 | 106 |
| 7/27 | 10 | 10 | 115 | 40 | 9/6 | - | - | 94 | 36 |
| 7/28 | 10 | 10 | 130 | 40 | 9/7 | 6 | 9 | 90 | 60 |
| 7/29 | 10 | 10 | 168 | 40 | 9/8 | 7 | 9 | 134 | 55 |
| 7/30 | 9 | 9 | 89 | 52 | 9/9 | 8 | 9 | 100 | 55 |
| 7/31 | 9 | 10 | 58 | 53 | 9/10 | 7 | 7 | 75 | 43 |

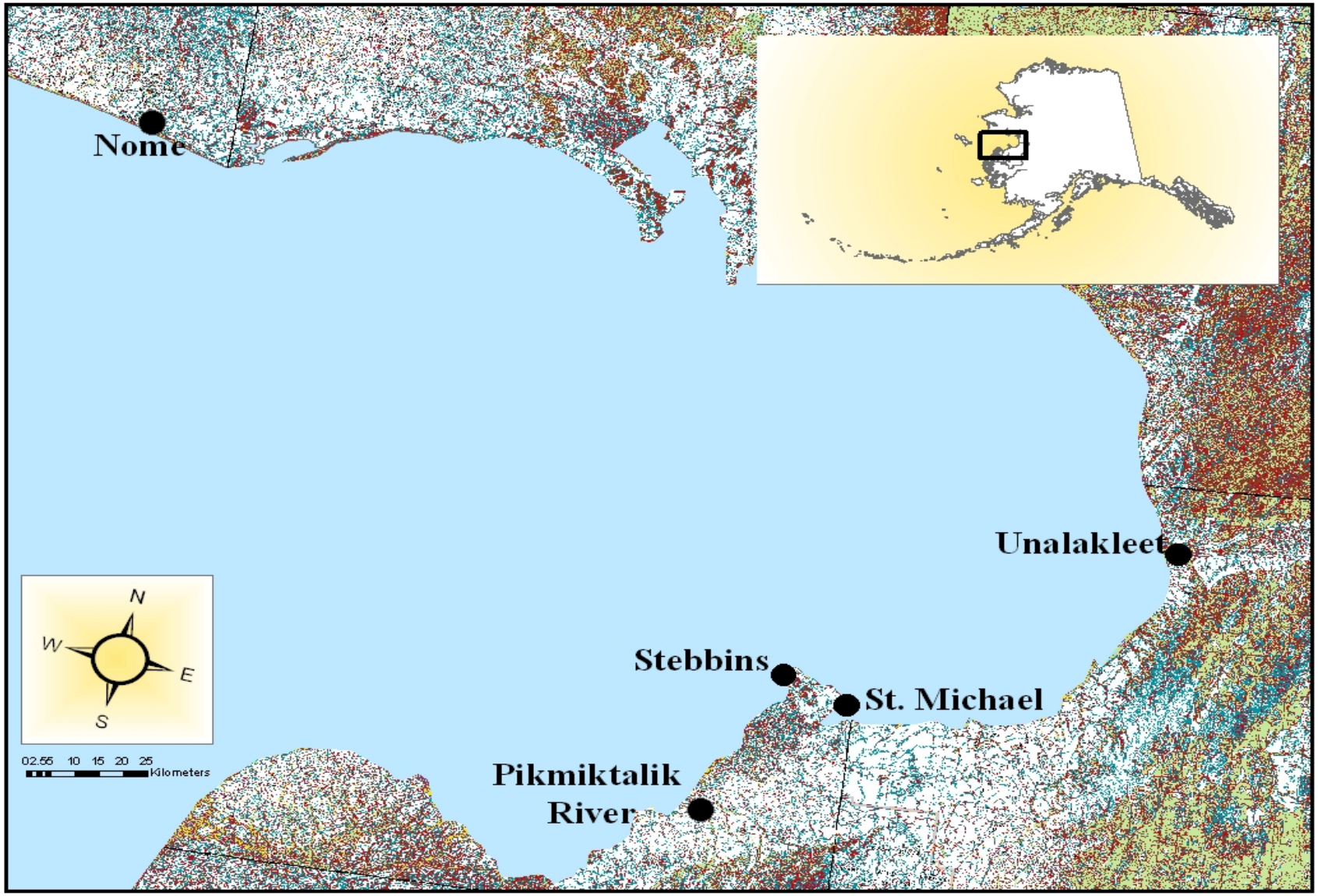


Figure 1. Location of the Pikmiktalik River enumeration camp.

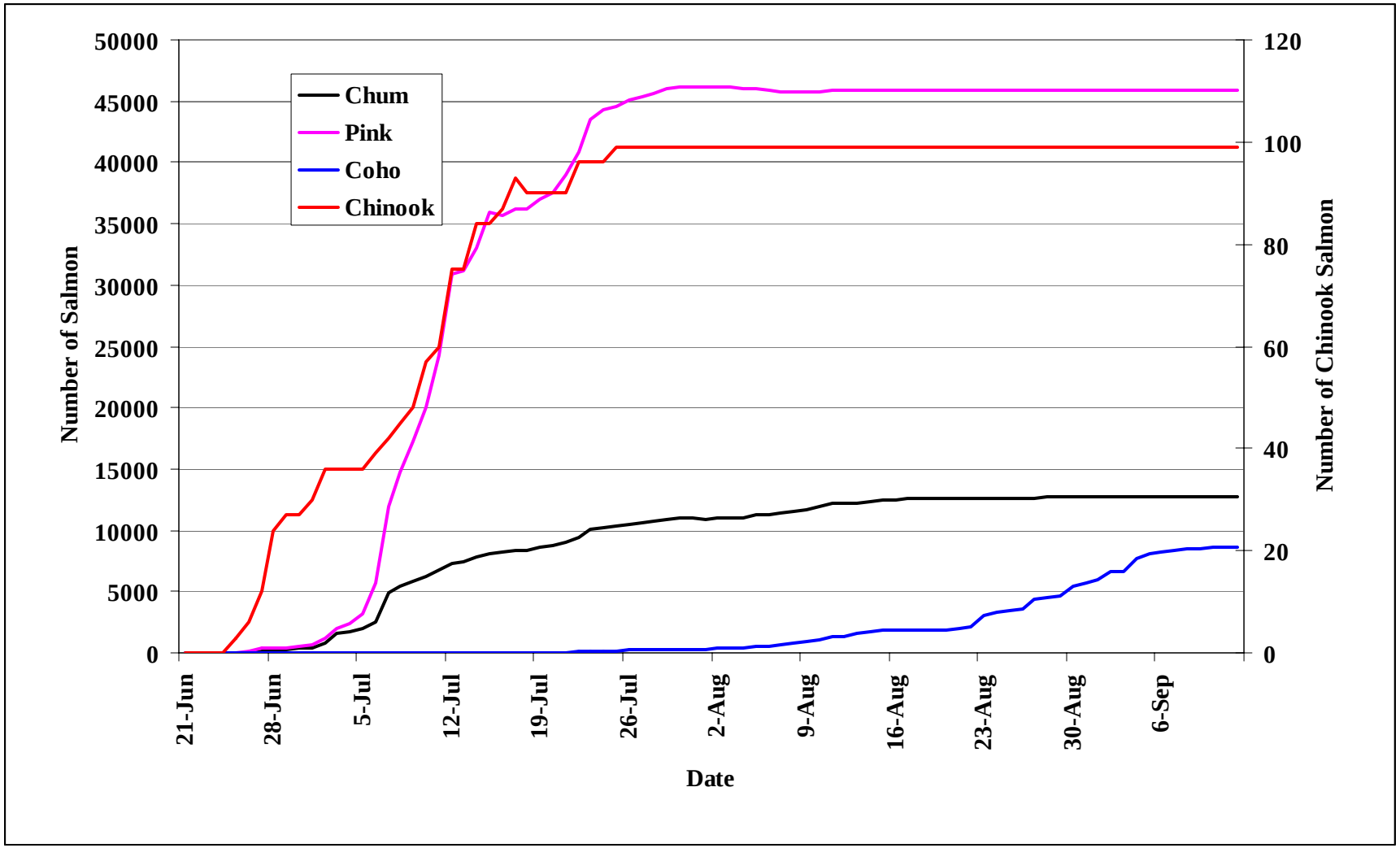


Figure 2. Cumulative number of Chinook, chum, coho and pink salmon migrating past Pikmiktalik River tower site, 2006.

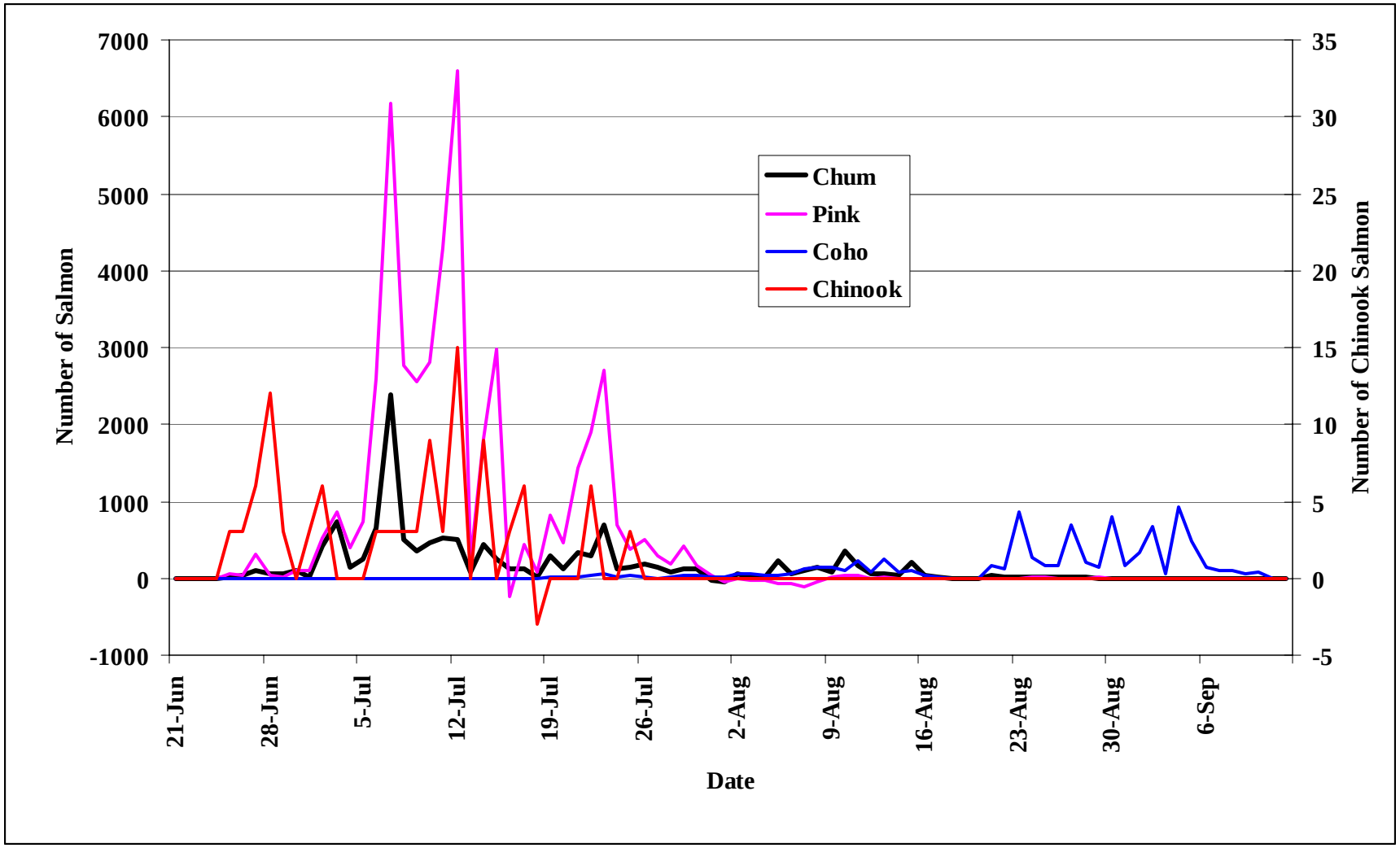


Figure 3. Daily movements of salmon at Pikmiktalik River tower site, 2006. A negative number indicates net downriver movement for that day.

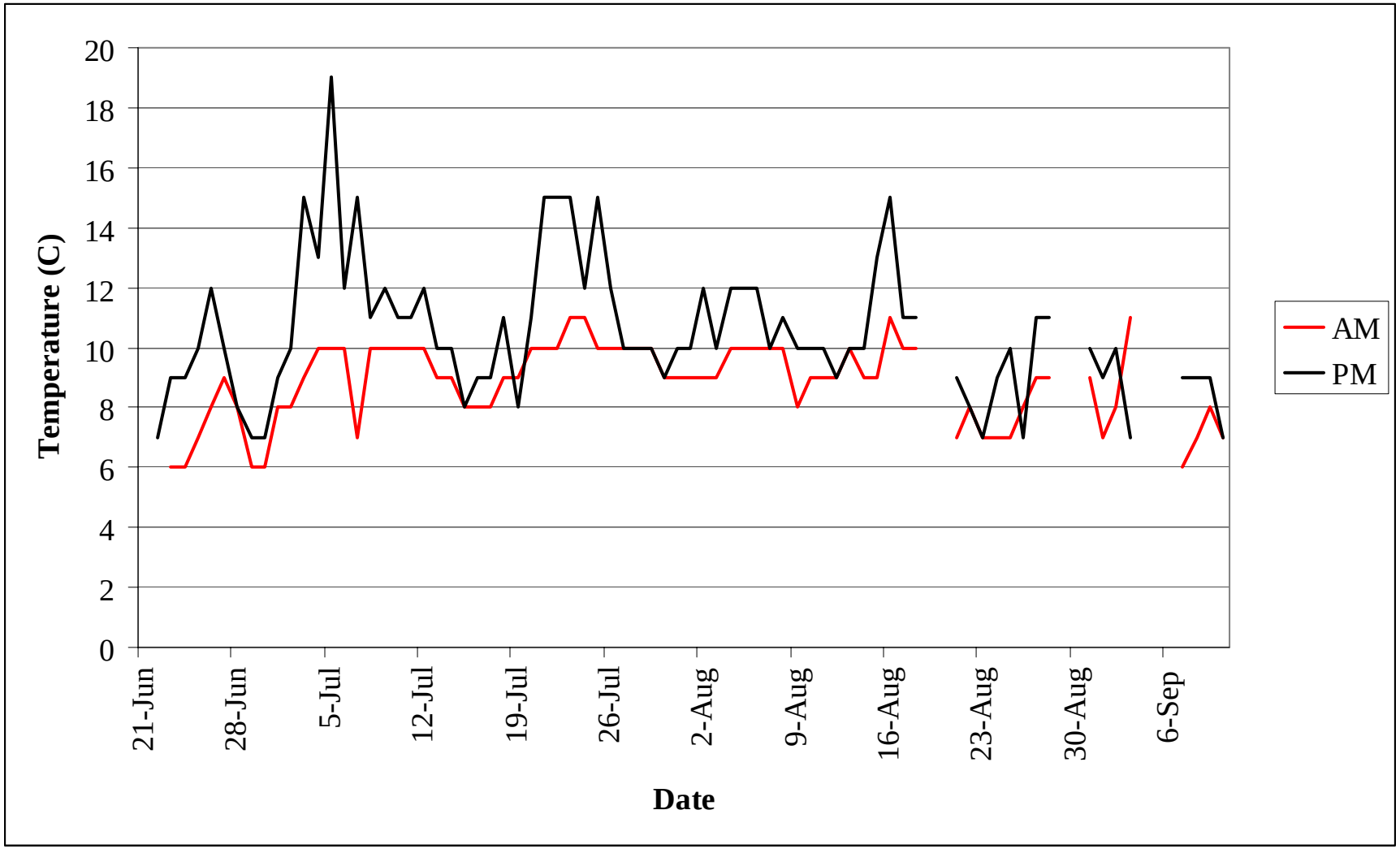


Figure 4. Water temperature recorded at 0800 (AM) and 2000 (PM) hours each day at Pikmiktalik River tower site, 2006.

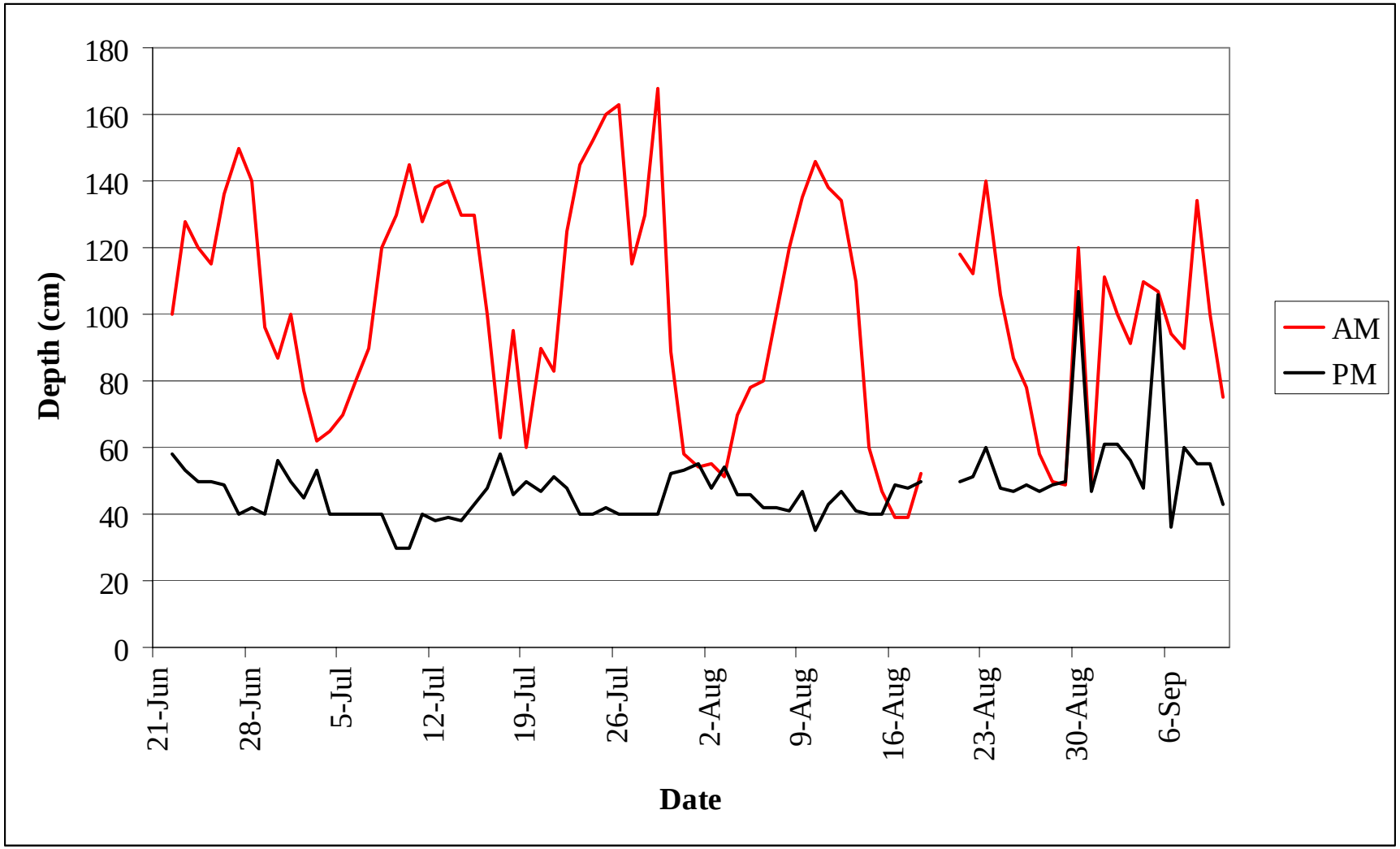


Figure 5. Water depth recorded at 0800 (AM) and 2000 (PM) hours each day at Pikmiktalik River tower site, 2006.