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NOATAK RIVER SONAR ESCAPEMENT PROJECT

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by

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ABSTRACT

The Noatak River sonar project was designed to provide timely inseason estimates of chum salmon *Oncorhynchus keta* passage past commercial and subsistence fisheries in the Kotzebue area. In 1993, the fifth year of operation at river km 39, we estimated fish passage using single-beam 120 kHz hydroacoustic gear deployed on the right bank of the river from 18 July through 13 September. We fished drift gillnets and used the data to apportion sonar counts to species. An estimated total of 186,253 fish passed the site. The total included 117,545 chum salmon (s.e.= 4,920), 30,674 char *Salvelinus alpinus* (s.e.= 3,289), 35,025 humpbacked whitefish *Coregonus pidschian* (s.e.= 4,338) and 1,777 pink salmon *O. gorbuscha* (s.e.= 685).

River conditions affected fish passage throughout the season. Fish distribution was clustered during periods of high water clarity (secchi > 1 m) and random during periods of low water clarity (secchi < 1 m). This was consistent with data collected in previous years. Daily patterns of fish passage were observed in 1993 when high water clarity (secchi > 2 m) occurred during periods of low ambient light late in the season. This was consistent with previous years when diel movement of fish occurred late in the migration during periods of high water clarity (secchi > 1 m).

Data was collected on the left bank of the river however, equipment failure throughout most of the season limited data collection to only two weeks late in the season. Radiotelemetry equipment, designed to remotely start and stop equipment, aim the transducer, and transmit acquired data from the left bank to the right bank, did not function in 1993. The successful change from a highly attenuated 420 kHz signal to a 120 kHz signal allowed us to more completely ensonify the river and provided a better estimate of fish passage.

Dual-beam data was collected throughout the season from the right bank. Three types of data were collected; stationary artificial targets, stationary tethered fish, and migrating fish. Analysis of data collected from tethered fish showed an unacceptably high within fish variability of target strength estimates. Data collected during periods of high water clarity (sechhi > 1 m), when fish traveled in groups, showed that target strengths could not be estimated due to data processing restrictions associated with the inability of separating multiple targets.

KEY WORDS: salmon, char, Noatak River, sonar, hydroacoustic, species apportionment, passage, radiotelemetry, dual-beam

INTRODUCTION

Noatak River chum salmon *O. keta* stocks support commercial and subsistence fisheries in Kotzebue Sound and the lower Noatak River. Effective management of these fisheries requires knowledge of wild stock and hatchery passage rates. Inseason passage information is one of several factors which, taken together, provide a basis for fishery management decisions. Estimates of annual passage rates may enable prediction of future year run strength and determination of escapement goals.

The Noatak River flows approximately 680 km from its headwaters in the Schwatka Mountains to Kotzebue Sound. Multiple channels, slow current and unstable banks characterize the lower 30 km. Silty water and the wide, multi-channel river mouth preclude the use of visual fish counting techniques, such as towers and weirs, for estimates of fish passage. These conditions have historically necessitated the use of aerial survey observations from clear water spawning areas as indices of wild stock escapement. The many limitations of aerial surveys, such as lack of timeliness and dependence of accuracy on variable weather and river conditions, prompted investigation into use of hydroacoustic (sonar) techniques of salmon passage estimation on the Noatak River. Feasibility studies that were designed to ascertain the applicability of sonar to this situation began in 1979 on the lower Noatak River (Bird and Bigler 1982; Bigler 1983; Bigler 1984; Berning et al. 1987). The current lower canyon sonar site, located at km 39 (Figure 1) was chosen in 1988 for its favorable features including a single, narrow (240 m) channel, stable banks, proximity to the river mouth, and smooth, v-shaped bottom profile of moderate (20 m maximum) depth. On the right bank there is a gradual slope of approximately 6^0 from shore out 180 m to the thalweg. The substrate is sandy and silty and water velocity is low during medium to low water levels. On the left bank there is a steeper slope of approximately 23^0 from shore out 60 m to the thalweg. The substrate is bedrock and water velocity is higher. A camp was constructed and a 420 kHz sonar system deployed on the right bank at this location during July and August 1989 (Fleischman and Huttunen 1990).

Estimates of fish passage by species were generated for the right bank of the river for years 1990, 1991, and 1992. These data were consistent with other indicators of abundance, and were viewed by area fishery managers as valuable information for consideration in management decisions (Lean and Lingnau 1993). Encouraged by the initial success of the project, we used the 1992 season to improve passage estimates by addressing two aspects of the project. First, we tested deployment and operation of lower (120 kHz) frequency sonar gear. Recent research indicates that attenuation of previously used 420 kHz sound in fresh water confounds fish target strength and transducer beam cross-sectional area estimates. Lower frequencies may not be similarly affected. Secondly, we deployed sonar gear on the left bank of the river in order to increase insonification of the river cross section, and tested radiotelemetry gear as a means of remote data collection control.

Objectives for 1993, in order of priority, were to:

(1) provide estimates of right bank chum salmon passage to fishery managers twice per week,

(2) collect sonar and drift gillnet data on the left bank for the entire season,

(3) collect dual-beam data from both banks, and

(4) test and operate radiotelemetry equipment for remote data collection.

METHODS

Sonar Data Acquisition

Sonar equipment deployed on the right bank included a Biosonics model 102 echo sounder, an International Transducer Company (ITC) model 5398 4° x 10°, 7° x 21° elliptical dual-beam transducer, a Biosonics model 111 thermal chart recorder, and a Hewlett Packard model 54501A digital-storage oscilloscope.[1] The transducer was mounted on a metal tripod placed 2 m to 5 m offshore, and was aimed along the contour of the bottom with a remotely-controlled pan and tilt unit model PT-25 manufactured by Remote Ocean Systems (ROS).

Sonar equipment deployed on the left bank included a Biosonics model 101 echosounder, a Biosonics 10° x 25° circular dual-beam transducer, a Biosonics model 111 thermal chart recorder, and a BK Precision model 1540 analog oscilloscope. The transducer was set up and deployed using procedures consistent with the right bank. Three depth strata, bottom, midwater, and surface were sampled with the narrow (10°) beam of the transducer.

Sound pulses were generated by the echosounders at 120 kHz. Pulse widths of 0.1 and 0.4 ms were used on the right bank and 0.4 ms on the left bank; bandwidth was 10 kHz on the right bank and 5 kHz on the left bank. Pulse repetition frequency was 3.3 Hz; maximum range was 180 m on the right bank and 60 m on the left bank. Each narrow beam signal was routed to an oscilloscope and to a chart recorder. Paper speed was 1/8 mm per pulse. The right bank chart recorder threshold was set at 0.650 V, the left bank at .07 V.

[1] Companies referenced in this report were listed for archival purposes only. Such references do not represent endorsement by the State of Alaska, Department of Fish and Game.

Once each sonar system was setup each bank was operational 24 h per day 7 d per week, except for brief periods at 0800 and 2000 when generators were refueled and serviced. Sonar operation was not monitored continuously but instead was checked by technicians periodically throughout the day.

Fish traces in 20 m range and 15 minute time intervals were tallied daily from chart recordings on the right bank. Technicians counted fish traces and recorded data four times per day. The project leader supervised interpretation and recording of the data each day to ensure interpretive consistency. Fish traces from chart recordings from the left bank were tallied in 10 m range and 15 minute time intervals during post season data processing.

Left bank data collection was planned to be tied to radiotelemetry operation. The telemetry gear would allow for remote control of the sonar equipment from the right bank as well as recording of left bank data on a right bank chart recorder. A radiotelemetry system, developed cooperatively by staff from the Sonar and Technical Services (STS) group of the Alaska Department of Fish and Game (ADF&G) and the University of Alaska Fairbanks-Geophysical Institute (GI-UAF), was successfully tested on the Noatak River in 1992 (LaFlamme et al. 1993). Telemetry equipment on each bank included a custom-manufactured control box, two unidirectional Yagi antennae, one whip antenna, and one antenna tower with base anchor.

Water level, read from a staff gauge in the river, was recorded at 0700, 1200, 1700, and 2200 hours daily. Secchi disk readings and water temperature were taken twice daily while test netting. A log of sonar operations, water and weather conditions was maintained.

Gillnet Data Acquisition

Gillnets were drifted on both banks between the transducer and approximately 70 m range to provide information used to apportion sonar counts to species. The following nets, all 45.7 m (25 fathoms) long and hung at 2:1 ratio, were used:

1) 70 mm (2.75") mesh mono-twist (#1.5 x 10 strand) gillnet, 126 meshes (6.6 m) deep,
2) 102 mm (4") mesh mono-twist (#1.5 x 10 strand) gillnet, 70 meshes (5.3 m) deep,
3) 127 mm (5") mesh mono-twist (#1.5 x 10 strand) gillnet, 56 meshes (5.3 m) deep, and
4) 152 mm (6") mesh mono-twist (#1.5 x 10 strand) gillnet, 47 meshes (5.4 m) deep.

We drifted all mesh sizes of gillnets 7 days per week at 1000 and 1600 hours. The 2.75 in and 6 in mesh nets were drifted twice per day, and the 4 in and 5 in mesh nets were drifted once per day. Nets were fished with one end attached to a boat and the other end attached to a rope which was walked along shore. The distance from shore to the inshore end of the net varied between 5 m and 20 m depending on water level and nearshore distribution of chum salmon. Each drift originated no more than 5 m below the tripod and lasted no longer than 10 minutes on the right bank and 5 minutes on the left bank.

Four times were recorded for each drift: net start out (net starting out of boat, SO), net full out (FO), net start in (SI), and net full in (FI). Fishing time for drift *j* with mesh size *m* during test-fishing period *f* on bank *b* on day *d* was calculated as

$$t_{dbfmj} = SI - FO + \frac{FO-SO}{2} + \frac{FI-SI}{2}. \qquad (1)$$

Drift duration was shortened when necessary to limit catches during periods of high fish passage. Captured fish were disentangled after the net was fully retrieved into the boat, and subsequently identified to species and measured mid-eye to tail fork for salmon; snout to tail-fork for all others. A scale was taken from every chum salmon and provided to area managers for age analysis.

Data Processing

Estimating Total Fish Passage

Sonar counts were tallied by 15 minute intervals except for brief and infrequent periods when the sonar was not operational. Fish passage *y* on day *d* was estimated as

$$\hat{N}_d = 96 \cdot \bar{n}_d , \qquad (2)$$

where $\bar{n}_d$ = average number of targets detected from 0 m to 180 m range during all 15 minute time strata on day *d*.

Species Apportionment

Gillnet Selectivity. Drift gillnet catch per unit effort (CPUE) values, adjusted for net selectivity, were used to estimate species proportions. Because of the size selectivity of gillnets, catches from several nets were used to estimate the relative abundance of each species. Gillnet catches were adjusted for differing relative probability of capture (selectivity) among mesh sizes and fish length classes. We used an indirect method (Fleischman, personal communication) similar to those of McCombie and Fry (1960) and Ishida (1969) to estimate the selectivity of our mesh sizes to different length classes of chum salmon, pink salmon, and char. The method compares, within fish length classes, the relative catches by different mesh sizes and tests for a linear relationship between optimal mesh size and fish length class for each species. If found, it then exploits this relationship to scale the relative catches between length classes. The method assumes equal maximum selectivity for each mesh size but otherwise does not make assumptions about the shape of the individual curves. For a comprehensive discussion of net selectivity see Hamley (1975).

Chum salmon relative abundance was estimated from catches in 5 in and 6 in mesh nets (Appendix A). Arctic char *S. alpinus* relative abundance was estimated from catches in 2.75 in, 4 in, 5 in, and 6 in mesh nets. Humpback whitefish *C. pidschian* relative abundance was estimated from catches in 2.75 in and 4 in mesh nets, and pink salmon *O. gorbuscha* relative abundance was estimated from catches in 2.75 in, 4 in, and 5 in mesh nets. Net selectivity estimates used for 1993, derived from 1991 and 1992 testfishing data, are found in Appendix B. Gillnet data from 1991-92 showed that over 90% of all whitefish were captured with 2.75 in gear. The sample size for length classes in all other nets was too small to develop selectivity curves for paired meshes for whitefish. The mean probability of capture of all mesh sizes for all species was used to adjust for selectivity for whitefish in the 2.75 in mesh.

Species Proportions. To apportion sonar passage estimates to species by bank, catch c of species i and length class l during drift j of mesh m during fishing period f on bank b on day d and fishing period f was first adjusted for selectivity s of species i and length class l in mesh m. Adjusted catch a was calculated as

$$a_{ildbfmj} = \frac{c_{ildbfmj}}{s_{ilm}} . \tag{3}$$

Total effort, in fathom hours, of drift j with mesh size m during fishing period f on bank b on day d was calculated as

$$e_{dbfmj} = \frac{25 \cdot t_{dbfmj}}{60} , \tag{4}$$

since all nets are 25 fathoms long. CPUE, across all drifts j with all mesh sizes m, for length class l of species i during testfishing period f on bank b on day d was total adjusted catch divided by total effort

$$CPUE_{ildbf} = \frac{\sum_m \sum_j a_{ildbfmj}}{\sum_m \sum_j e_{dbfmj}} \quad . \tag{5}$$

CPUE was then summed across all length categories for each species i, and the estimated proportion p of species i during fishing period f on bank b on day d was the ratio of CPUE for species i to the total CPUE for all species

$$\hat{p}_{idbf} = \frac{\sum_l CPUE_{ildbf}}{\sum_i \sum_l CPUE_{ildbf}} \quad . \tag{6}$$

For bank b on day d, the estimated proportion of species i was

$$\hat{p}_{idb} = \frac{\sum_{f=1}^{2} CPUE_{idbf}}{\sum_{f=1}^{2} \sum_i CPUE_{idbf}} \quad , \tag{7}$$

which is equivalent to the mean of the two fishing period proportions, weighted by the total CPUE for all species in each fishing period.

Fish Passage by Species. To generate passage estimates by species, both sonar passage estimates and species proportions are pooled into two reporting periods per week, scheduled to provide the most timely information for fishery managers. The sonar estimate of total fish passage for bank b of report period t containing all days d was calculated as

$$\hat{N}_{bt} = \sum_{d} \hat{N}_{bd} \, , \tag{8}$$

and pooled species proportions P_{it} for bank b for each reporting period t were estimated as

$$\hat{P}_{ibt} = \frac{\sum_{d}\sum_{f}\sum_{b} CPUE_{idfb}}{\sum_{i}\sum_{d}\sum_{f}\sum_{b} CPUE_{idfb}} \, , \tag{9}$$

and the passage $\hat{N}$ of species i on bank b during report period t was estimated as

$$\hat{N}_{ibt} = \hat{N}_{bt} \cdot \hat{P}_{ibt} \, . \tag{10}$$

When we required estimates of passage $\hat{N}$ for species i during individual day d, we used the pooled estimate of species proportion P for bank b for the report period t containing day d, i.e.,

$$\hat{N}_{ibd} = \hat{N}_{d} \cdot \hat{P}_{ibt} \, . \tag{11}$$

Estimating Variance

There are at least two components that contribute to the variance of species passage estimates: (1) the sonar estimate of total fish passage, and (2) the drift gillnet estimates of species proportions. For the purposes of variance calculations, the sonar component of variance is assumed to be zero due to the high sonar sampling intensity, therefore we report only the second component.

To estimate the variance of species proportion i during reporting period t, we treated the drift gillnet catch during day d and fishing period f as a replicate cluster sample and weight each squared deviation by the relative adjusted CPUE (total for all species) for that fishing period (Cochran 1977:64, Fleischman et al. 1990)

$$\hat{Var}(\hat{P}_{it}) = \frac{1}{n_t}\sum_{d}\sum_{f}\left(\frac{m_{df}}{\bar{m}_t}\right)^2\frac{(\hat{P}_{idf}-\hat{P}_{it})^2}{n_t-1} , \qquad (12)$$

where n_t = number of fishing periods in reporting period t,
m_{df} = drift gillnet CPUE (all species) on day d, fishing period f, and
$\bar{m}_t$ = mean drift gillnet CPUE (all species) during all fishing periods in reporting period t.

Estimated variance of species passage estimates N_{it} was

$$\hat{Var}(\hat{N}_{it}) = \hat{N}_t^2 \cdot \hat{Var}(\hat{P}_{it}) . \qquad (13)$$

Finally, variance estimates for species i were summed over all report periods to estimate the variance of the season total passage $\hat{N}_i$, 1.e.,

$$\hat{Var}(\hat{N}_i) = \sum_{t}\hat{Var}(\hat{N}_{it}) . \qquad (14)$$

Sonar and drift gillnet data were entered into Quattro Pro worksheets and an Rbase for DOS database, respectively. Data processing was done with SAS programs (Release 6.04, Appendix C).

Dual-beam Data Acquisition

Dual-beam data was acquired from the right bank using a Biosonics Echo Signal Processor model 281, version 2.1, installed in a Compaq Deskpro 386/20e personal computer. Three varieties of data were collected; stationary artificial targets, tethered fish, and migrating fish. The artificial targets included one 30 mm diameter copper sphere, one 38 mm diameter tungsten carbide sphere, and four 100 mm plastic spheres. The tethered fish included chum salmon, char, and humpbacked whitefish. The artificial targets and tethered fish were suspended with monofilament line from a horizontal pole, with a small rock used as a bottom weight, and deployed from an anchored boat at various ranges (10 m to 50 m) from the transducer (Figure 2). The tethered fish were pithed and positioned vertically in the water column.

RESULTS

River Conditions

River conditions and fish behavior varied throughout the season. Water level remained relatively constant changing a total of 2 m during the season (Figure 3). The highest levels occurred twice during the season, during the periods from 5 to 8 August and 9 to 13 September. Water temperature decreased 14 °C over the entire season. Water clarity was variable, with secchi readings ranging from 0.15 m to 3.26 m.

We observed fish schooling coincident with high water clarity. This behavior was apparent from drift gillnet catches and from fish trace distribution on the sonar chart recordings (figure 4). This was consistent with observations made in previous years (Fleischman et al 1990, LaFlamme et al. 1992). Gillnet catches and fish traces were spread across temporal and spatial ranges during periods of low water clarity (secchi < 1 m), and were clustered in both dimensions during periods of high water clarity (secchi > 1 m). Schools of 10-15 fish were frequently observed.

Right Bank Fish Passage

Sonar equipment was fully operational on the right bank on 18 July and data collection continued through 13 September. The equipment ran continuously, 24 hours per day, 7 days per week, excluding two daily 15 minute periods, 12 hours apart, required for generator refueling and maintenance. Data acquisition was occasionally interrupted when changing river conditions necessitated moving the tripod or re-aiming the transducer.

We counted 176,104 traces from 20-180 m on the chart recordings. From those data we estimated a total passage of 186,253 fish by the right bank sonar through 13 September (Table 1). The difference resulted in an average daily expansion factor for equipment downtime of 1.001 and an overall seasonal expansion factor of 1.058. Estimates of fish passage by species include 117,545 chum salmon (s.e.= 4,920), 30,674 char (s.e.= 3,289), 35,025 whitefish (s.e.= 4,338) and 1,777 pink salmon (s.e.= 685). Peak daily passage was 21 August for chum salmon and char, and 6 August for whitefish (Figure 5). Mean date of passage was 18 August for chum salmon, 17 August for char, and 11 August for whitefish (Table 2).

We examined the hourly fish count data for evidence of daily patterns of movement during two separate 7 day periods of data collection. During the time period from 5 August through 11 August water clarity was low (secchi < 1 m) and there was no indication of diel passage (Figure 6). Between 26 August and 1 September water clarity was high (secchi > 2 m) and fish passage was highest between 0800 and 2200 hrs. Overall seasonal range distributions of targets that passed the site peaked at 80 m (Figure 7).

We drifted gillnets 350 times on the right bank from 18 July through 13 September. Fishing effort totaled 405, 210, 221, and 390 fathom-hours for the 2.75 in, 4 in, 5 in, and 6 in mesh. The catch included 993 chum salmon, 356 char, 228 whitefish, and 14 pink salmon (Appendix D).

Gillnet catches indicated that chum salmon passage was concentrated beyond 20 m from the transducer. Therefore, results from 20-180 m were processed for species apportionment. These data indicate that 64% of the estimated fish passage for the time period observed were chum salmon, 16% were char, 19% were whitefish, and 1% were pink salmon. Daily passage estimates were as high as 89% for chum salmon, 36% for char, 90% for whitefish, and 15% for pink salmon (Figure 8). A comparison of daily testnet CPUE and total estimated passage is presented in Figure 9.

Length distributions of captured chum salmon and whitefish were normal and were well separated in 1993 (Figure 10). Chum salmon mean length was 579 mm (s.d.=40.26, n=1044) (Table 3). Whitefish mean length was 348 mm (s.d.=35.07, n=229). The separation of the means is 231 mm. Char length classes were widely distributed and overlapped with whitefish and to a lesser degree with chum salmon distributions. Mean length was 419 mm (s.d.=115.21, n=362).

Left Bank Data Acquisition

Sonar equipment was first installed on the left bank on 28 July. Frequent sounder and chart recorder failure precluded any consistent data collection until 28 August. Fish passage was then monitored through 9 September. We compared counts during the same sampling times for both banks. A comparative total of 1,424 fish targets were tallied on the left bank and

14,865 on the right bank. Fish passage through the bottom oriented stratum accounted for less than 10 % of the total passage on the left bank, while over 90 % of left bank passage occurred through the mid-river and surface oriented strata.

We intended to use radiotelemetry equipment to remotely control all aspects of sonar data collection on the left bank. Equipment malfunction preempted any data collection via radiotelemetry.

We drifted gillnets on the left bank 25 times from 4 August through 13 August. Fishing effort totaled 19.55, 12.97, 9.34, and 28.41 fathom-hours for the 2.75 in, 4 in, 5 in, and 6 in mesh. The catch included 50 chum salmon, 6 char , 1 whitefish and 1 pink salmon.

Dual-beam Data Acquisition

Dual-beam data was collected on the right bank from 9 August through 5 September. Analysis of data collected from the copper and tungsten carbide spheres resulted in target strength estimates of -43.65 dB (s.d. = 1.87; range = 21 m) and -43.60 dB (s.d. = 1.28; range = 12 m), respectively (Table 4). Target strength estimates for the four plastic targets ranged between -27.43 dB and -33.26 dB (s.d. between 1.63 and 4.15). Deployment ranges were between 13 and 47 m. Data collected from tethered fish consisted of 1 whitefish, 1 char, and 21 chum salmon. The fork length was 350 mm for the whitefish, 370 mm for the char, and ranged from 524 mm to 617 mm for the chum salmon. Target strength estimates were -39.38 dB (s.d. = 4.63; range = 25 m) for the whitefish, -34.79 dB (s.d. = 4.91; range = 22 m) for the char, and between -27.28 dB and -38.39 dB for the chum salmon (s.d. between 3.20 and 6.38; ranges between 11 and 22 m).

Data collected from 110 migrating fish resulted in target strength estimates between -18.21 dB and -35.95 dB (s.d. between 0.78 and 6.93), with an average target strength of -27.66 dB (s.d. = 3.85). These results were from 3 days (9-10 August, and 5 September) of data collected when river secchi measurements were less than 1 m and individual fish were well separated. Estimated chum salmon proportions based on drift gillnets were 65% for 9-10 August and 72% for 5 September. Analysis of data collected on days when secchi measurements were greater than 1 m showed that target strength estimates could not be determined. This was due to problems resolving and tracking single fish targets in passing groups.

DISCUSSION

River Conditions

We have recorded daily measures of water level, clarity, and temperature over four summers beginning in 1990. These data show an inverse relationship between relative water level and water clarity. There is no consistent seasonal pattern of variation in our observations of river conditions. They are affected primarily by ambient temperature and precipitation, which vary dramatically between and within years. There is, however, a consistent pattern of fish behavior which we believe is a function of river conditions.

Four years of data (1990-1993) indicate that Noatak River fish pass the sonar site in groups or schools during periods of low (clear) water. When the river level is high and water is turbid, fish pass singly. The 1993 data indicate that schooling behavior ends when secchi disk readings are less than 1 m. Data from 1990, 1991, and 1992 data support this observation. Water clarity met or exceeded this level 65 to 87 percent of the season in the four years observed.

Schooling behavior directly affects our ability to visually differentiate individual fish targets within a group. The sonar chart recordings are only two-dimensional displays. We currently do not have the capabilities of displaying or tracking how many fish may be stacked vertically within these groups of fish. Schooling behavior may also decrease the precision of species composition estimates by increasing sample variance. Since variance increases when sampling a clumped distribution, we may need to increase drift gillnet sampling during clear water periods in order to maintain relative precision levels.

Right Bank Fish Passage

Fish exhibited pronounced daily patterns of movement as the season progressed into increased hours of darkness in 1993. During this time period (between 26 August and 1 September) water clarity was high (secchi > 2 m) and fish passage was lowest between 2300 and 0700 hrs. This behavior was consistent with that of 1990 and 1991, during which fish passage slowed between 0100 and 0500 hours (the period of lowest ambient light intensity) when water clarity was high (sechhi > 1.5 m) over the same part of the season.

The drift gillnet data was used for apportionment of sonar counts to species over the entire range ensonified. Chum salmon estimates were 62% in 1990, 75% in 1991, 48% in 1992, and 64% in 1993, of the total fish passage. Char percentages were 24% in 1990, 9% in 1991, 30% in 1992, and 16% in 1993, and whitefish percentages were 9% in 1990, 12% in 1991, 18% in 1992, and 19% in 1993.

The precision of estimates was, as in prior years, poor for individual reporting periods, but much better for the season estimates. Standard error as a percent of the estimate within a reporting period ranged from 6 to 100 percent. These are comparable to the relative precision in prior years. For the entire 1993 season, standard error as a percentage of the estimate was 4 percent for chum salmon, 11 percent for char, 12 percent for whitefish, and 39 percent for pink salmon.

The most critical area of the species composition program in which we have made an untested assumption is that fish species composition is the same inside and outside the sampling range of the gillnets. The nets sample the area from surface to 6.7 m (2.75 in mesh) or to 5.5 m (4 in, 5 in, and 6 in mesh). The bottom slope on the right bank is about 6°, so the entire water column is sampled to approximately 47 m from the transducer. From 47 m to the 70 m maximum range fished, the gillnets did not extend to the river bottom. There was as much as 1.3 m of water beneath the maximum depth of the three larger mesh nets at the offshore end. In addition, the maximum range sampled was 70 m from shore, yet fish captured in that range were used to apportion sonar counts to species at ranges up to 180 m from the transducer.

In the future more gillnet fishing will be required to test for homogeneity of species distributions. Water along the river's left bank should be sampled for the entire season with gillnets to test for differences in species composition between banks. The midriver area should be sampled with drift nets for comparison with right and left bank drift net data in order to test the appropriateness of expanding right bank species composition beyond the range actually sampled.

Nearshore passage of chum salmon on the right bank has been monitored with set gillnets in the past (1991 and 1992). Nets were deployed during the entire season in 1991 and during the early part of the 1992 season. No gillnets were set in the later part of 1992 or during the 1993 season due to high water levels. Due to the unpredictability of water levels, set gillnetting should be eliminated. Drift gillnetting effort could be redirected toward midriver sampling. If we forgo nearshore deployment of set gillnets, sonar estimates from 0-20 m range should be excluded from final processed passage estimates. Counts over this range have been included in final estimates only during 1992. Prior year data indicates that 16%, 9%, and 17% of total right bank fish passage occurred between 0-20 m in 1991, 1992, and 1993, and that chum salmon made up 30% and 40% of the set gillnet catch in 1991 and 1992, respectively. Interpretation of recorded data can be very difficult at this range due to the compressed display of the chart recorder and the narrowness of the transducer beam.

Left Bank Data Acquisition

Sonar equipment was installed and operating on the left bank on 28 July. Frequent equipment failure precluded consistent data collection until late in the season. The echo sounder was the most prominent piece of equipment to malfunction. It was sent out for repair and was received back in late August. The chart recorder also failed on numerous occasions due to print head failure. The radiotelemeter system failed completely. Communication between control boxes was never established due to frequency interferences within the modem-linking radios. Recent redesign of the control boxes should reduce problems encountered with establishing communication between left and right banks.

The left bank sonar system was fully operational on 28 August and worked consistently through 9 September. Of the three strata sampled, the bottom oriented stratum accounted for less than 10% of the total estimated passage on the left bank. The upper two strata, midriver and surface, accounted for more than 90% of the total estimated passage on the left bank. Because the sonar beam is 10° vertical in the water column and the bottom contour slopes approximately 23°, over 90% of the estimated passage occurred in the upper half of the water column. The bottom and surface oriented strata were well defined in 1993. The midriver column stratum overlapped with each of the other two strata. In future years the left bank should be stratified into two strata, surface oriented and one beam width down in the water column.

Gillnets were drifted successfully on the left bank. We used the same technique of controlling the in-shore end of the net from shore that is implemented on the right bank. Fish were captured along the entire length and depth of the net. We will be able to physically sample the maximum ensonified range on the left bank but the vertical dimension will be sampled less effectively due to restrictions imposed by the depth of each net and the depth and slope of the river bottom on the left bank.

Dual-beam Data Acquisition

With the recent change of operating frequency from 420 kHz to 120 kHz, we collected data with which we may be able to determine the feasibility of setting display thresholds using target strength estimates. If feasible, this technique would reduce the labor intensive test gillnet fishery, and could result in significant cost savings to the project.

Length distributions of chum salmon, whitefish and char caught in gillnets in the Noatak River appear favorable for separating some species by target strength. The technique requires sufficiently large differences in target strength (a correlate of fish size) between species for statistical differentiation. Data from 1990 through 1993 consistently show that chum salmon and whitefish lengths are normally distributed, with large (231 mm) differences between mean lengths. The bimodal distribution of arctic char lengths overlaps with chum salmon, particularly between 470 and 570 mm, however relatively low frequencies of char in chum salmon size ranges is indicative of a relatively small population. If this component of the char population is small, it is likely that failure to distinguish between the two species would not significantly impact the accuracy or precision of the chum salmon passage estimate.

Analysis of stationary tethered fish has shown that there is great variability of target strength estimation within individual fish (MacLennan and Simmonds 1992) as well as between chum salmon of different length classes (between 524 and 617 mm). Several factors may have had an affect on our target strength estimations. First, the deployment techniques we used were unlike those implemented in other recent studies (MacLennan and Simmonds 1992). We pithed live fish and tethered them vertically in the water column. Along with being an unnatural orientation for these fish, we do not know what changes might occur to the physical characteristics of the swim bladder once the fish is killed. We did attempt to x-ray each fish immediately after dual-beam data collection was completed but we failed to operate the x-ray machine correctly. Second, the true orientation of each fish was not known. Aspect (tilt and roll angle) is an important characteristic to consider in determining target strength estimates (MacLennan and Simmonds). Slight changes in aspect can result in considerable changes in target strength and increase variability around those estimates. Third, low signal-to-noise ratios forced us to use relatively high collection thresholds to eliminate unwanted noise. This threshold bias results in ignoring low signal echoes from a target and ultimately biases target strength estimates.

At this time it does not appear that total chum salmon passage estimates will not be able to be determined solely by using dual-beam data as we once had hoped. Multiple targets at coinciding ranges cannot be differentiated because of tracking problems associated with dual-beam data processing. Fish have travelled past the sonar site in groups 65 to 87 percent of the time over the past four years. The current drift gillnet program will have to be maintained in order to apportion sonar estimates between species. Display thresholds may be able to be determined by *in situ* dual-beam processing of stationary artificial target data.

CONCLUSIONS AND RECOMMENDATIONS

This was the fifth season of operation for the Noatak River sonar project, and the third year of providing in-season estimates of right bank chum salmon passage for fishery management. Right bank sonar deployment and operation using a single-beam system has been successful for the past four years and estimates of species passage and variance have been generated.

We currently have an effective means of estimating chum salmon passage (right bank only) using a single-beam sonar system. Efficient data processing allows reporting of timely inseason passage estimates and associated sampling error to fishery managers. The drift gillnet program is functioning at a level that is effective for providing species apportionment estimates with the current resources available.

Results from the 1993 field season have shown that:

1) The current level of temporal sonar sampling has provided acceptably precise passage estimates and we feel that we should continue this level of sampling in the future.

2) The suite of nets used effectively samples targeted populations of chum salmon, whitefish and char.

3) Species differentiation based soley on dual-beam data will not likely occur at this site due to low signal-to-noise ratios, inadequate separation of targets, and high variability of target strength estimates within individual fish.

Future changes to operations should include:

1) An increase of spatial sonar sampling to include the left bank and virtually the entire cross-sectional river area needs to be accomplished to achieve a better passage estimate.

2) The gillnet sampling program needs to be expanded to include the left bank, and possibly midriver areas, to determine the differences in spatial distributions of species.

3) Dual-beam data collection and analysis should be continued as an inseason check of each calibrated sonar system and as a further verification of chart recorder threshold levels.

LITERATURE CITED

Berning, R.L., D.C. Mesiar, and D.M. Gaudet. 1987. Sonar Enumeration of Migrating Fish in the Noatak River, 1984. Norton Sound/Kotzebue Salmon Escapement Report # 44. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau, AK.

Bigler, B.S. 1983. Noatak River Salmon Studies, 1982. AYK Region: Norton Sound/Kotzebue, Salmon Escapement Report # 33. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kotzebue, AK.

Bigler, B.S. 1984. Noatak River Salmon Studies, 1983. AYK Region: Norton Sound/Kotzebue, Salmon Escapement Report # 39. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kotzebue, AK.

Bird, F., and B.S. Bigler. 1982. Norton Sound-Kotzebue Salmon Studies. AYK Region: Norton Sound/Kotzebue State/Federal Report # 9. Alaska Department of Fish and Game, P.O. Box 3-200, Juneau, AK 99802.

Cochran, W.G. 1977. Sampling Techniques. New York: John Wiley and Sons. 488 pp.

Fleischman, S.J., and D.C. Huttunen. 1990. Noatak River Sonar Progress Report. Alaska Department of Fish and Game Regional Information Report No. 3A90-01. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

Fleischman, S.J., P. Skvorc, and D. Huttunen. 1990. Noatak River Sonar 1990 Progress Report. Alaska Department of Fish and Game Regional Information Report No. 3A90-34. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

Hamley, J.M. 1975. Review of gillnet selectivity. J.Fish. Res. Board Can. 32:1943-1969.

Ishida, T. 1969. The salmon gillnet mesh selectivity curve. Int. North Pac. Fish. Comm. Bull. 26:1-11.

LaFlamme. T.R., D.C. Mesiar, and P.A. Skvorc, II. 1992. Noatak River Sonar 1991 Progress Report. Alaska Department opf Fish and Game Regional Information Report No. 3A92-11. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

LaFlamme, T.R., D.C. Mesiar, and P.A. Skvorc, II. 1993. Noatak River Sonar Escapement Project 1992. Alaska Department of Fish and Game Regional Information Report No. 3A93-17. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

Lean, C. and T. Lingnau. 1993. 1993 Salmon Fisheries Management Plan, Kotzebue Area. Alaska Department of Fish and Game Regional Information Report No. 3A93-07. Alaska Department of Fish and Game, Division of Commercial Fisheries, A-Y-K Region, 333 Raspberry Road, Anchorage, AK 99518.

MacLennan, D.E., and E.J. Simmonds. 1992. Fisheries Acoustics. London: Chapman & Hall.

McCombie, A.M. and F.E.J. Fry. 1960. Selectivity of gill nets for lake whitefish, *Coregonus clupeaformis*. Trans. Am. Fish. Soc. 89:176-184.

Table 1. Estimated right bank (20-180 m range) fish passage, total and by species, (chum and pink salmon, Arctic char, and whitefish) at the Noatak River sonar site from 18 July through 13 September, 1993.

Report Period Ending[1]	Period Total Passage	Estimated Percent (s.e.) of Total				Estimated Report Period Passage			
		Chum	Char	Pink	Whitefish	Chum	Char	Pink	Whitefish
20JUL93	4,380	20(12)	1(1)	6(6)	73(12)	892	31	268	3,189
23JUL93	1,742	5(5)	2(2)	4(5)	90(7)	79	29	70	1,564
25JUL93	1,496	17(13)	14(12)	5(4)	64(21)	249	210	76	961
27JUL93	3,227	23(23)	10(13)	15(15)	52(40)	735	310	499	1,683
30JUL93	3,744	60(26)	12(11)	4(5)	23(17)	2,261	445	159	879
03AUG93	4,260	80(9)	1(2)	0	15(9)	3,396	59	0	643
06AUG93	18,939	64(15)	2(2)	2(1)	28(12)	12,041	393	368	5,391
10AUG93	29,293	65(8)	10(3)	1(1)	24(8)	18,932	3,042	226	7,093
13AUG93	20,390	68(5)	24(6)	0	8(3)	13,789	4,976	0	1,625
17AUG93	15,858	49(6)	34(6)	1(1)	16(7)	7,747	5,458	110	2,543
20AUG93	9,440	84(6)	9(6)	0	8(2)	7,886	838	0	716
24AUG93	30,715	55(5)	36(8)	0	10(4)	16,828	10,940	0	2,947
27AUG93	10,445	70(11)	27(11)	0	4(2)	7,281	2,768	0	396
29AUG93	5,208	89(9)	7(6)	0	4(3)	4,625	383	0	200
31AUG93	5,405	79(15)	7(6)	0	14(14)	4,279	378	0	748
03SEP93	5,769	88(3)	2(2)	0	8(3)	5,102	121	0	471
07SEP93	8,539	72(13)	2(2)	0	23(13)	6,128	189	0	1,971
10SEP93	6,221	70(8)	0	0	30(8)	4,334	0	0	1,887
13SEP93	1,181	81(5)	9(6)	0	10(4)	961	104	0	116
	-----	---	---	----	---	------	------	-----	------
Total	186,253					117,545	30,674	1,777	35,025
s.e.						4,920	3,289	685	4,338
s.e./total						0.042	0.107	0.386	0.124
Overall %		64	16	1	19				

[1] Fish passage and estimated species percentages are calculated by multiple day reporting periods. Periods were decided upon by the area staff for timely inseason use.

Table 2. Historical migratory run timing statistics for chum salmon, char, and whitefish caught at the Noatak River sonar site for years 1990 through 1993.

Species	Year	Mean date	Median date
Chum salmon	1990	09 Aug	11 Aug
	1991	12 Aug	14 Aug
	1992	15 Aug	17 Aug
	1993	18 Aug	16 Aug
Arctic char	1990	17 Aug	21 Aug
	1991	15 Aug	17 Aug
	1992	18 Aug	20 Aug
	1993	17 Aug	19 Aug
Whitefish	1990	06 Aug	05 Aug
	1991	01 Aug	28 Jul
	1992	07 Aug	05 Aug
	1993	11 Aug	08 Aug

Table 3. Historical catch-length statistics of chum salmon, char, and whitefish caught at the Noatak River sonar site. Statistics which are included are mean length, standard deviation, and sample size of each species for years 1990 through 1993.

Species	Year	Mean Length (mm)	Standard deviation	n
Chum salmon	1990	593	39.21	398
	1991	594	37.25	707
	1992	564	36.69	686
	1993	579	40.26	1044
Arctic char[1]	1990	421	77.92	172
	1991	465	99.62	52
	1992 <430mm	356	40.43	161
	1992 >430mm	528	47.65	139
	1993	419	115.21	362
Whitefish	1990	334	20.40	93
	1991	347	31.33	129
	1992	345	30.63	185
	1993	348	35.07	229

[1] All three species had a single mode length distribution for all yaers except 1992. Length distributions of Arctic char had a pronounced bimodal distribution in 1992.

Table 4. Results from dual-beam data collected from copper (Cu), tungsten carbide (Tn), and plastic (PT) spheres, and tethered fish at Noatak River sonar, 1993.

Artificial targets

Target	Dia. (mm)	mean Range (m)	mean TS (dB)	s.d. (dB)	n
Cu	30	20.65	-43.65	1.87	1261
PT1	100	25.48	-33.26	1.88	354
PT1	100	34.74	-27.92	3.06	506
PT1	100	13.07	-29.16	2.49	1070
PT2	100	13.05	-30.53	2.67	1329
PT2	100	34.66	-29.90	4.15	377
PT2	100	25.53	-31.97	2.19	48
PT3	100	25.90	-32.45	1.63	350
PT3	100	33.93	-30.11	2.99	482
PT3	100	13.46	-28.72	2.49	987
PT3	100	47.09	-27.43	2.64	385
PT4	100	47.30	-32.90	1.67	694
PT4	100	13.48	-30.60	2.90	910
PT4	100	25.66	-32.24	2.16	360
Tn	38	12.32	-43.60	1.28	367

Tethered Fish

Species	Length (mm)	mean Range (m)	mean TS (dB)	s.d. (dB)	n
CHUM	566	10.77	-36.88	3.20	214
CHUM	524	10.98	-36.36	4.11	248
CHUM	548	11.05	-38.39	3.52	204
CHUM	609	12.14	-31.75	5.44	222
CHUM	563	14.82	-35.42	4.24	463
CHUM	577	14.84	-35.21	4.76	254
CHUM	545	15.26	-35.59	6.38	167
CHUM	531	17.59	-27.30	4.13	479
CHUM	537	17.00	-28.43	6.15	560

-Continued-

Table 4. (page 2 of 2).

Species	Length (mm)	mean Range (m)	mean TS (dB)	s.d. (dB)	n
		Tethered Fish			
CHUM	551	17.80	-31.39	5.93	99
CHUM	555	17.49	-29.70	4.49	347
CHUM	573	17.66	-30.70	4.27	322
CHUM	580	17.07	-30.52	5.14	530
CHUM	580	17.30	-32.41	5.53	89
CHUM	582	17.56	-28.89	4.35	265
CHUM	582	17.58	-30.98	4.43	257
CHUM	617	17.73	-30.21	5.64	431
CHUM	578	18.27	-32.03	4.63	45
CHUM	581	18.43	-29.88	6.19	383
CHUM	576	19.04	-27.28	5.58	427
CHUM	600	22.29	-29.14	3.62	418
CHAR	370	21.67	-34.79	4.91	497
WF	350	24.82	-39.38	4.63	96

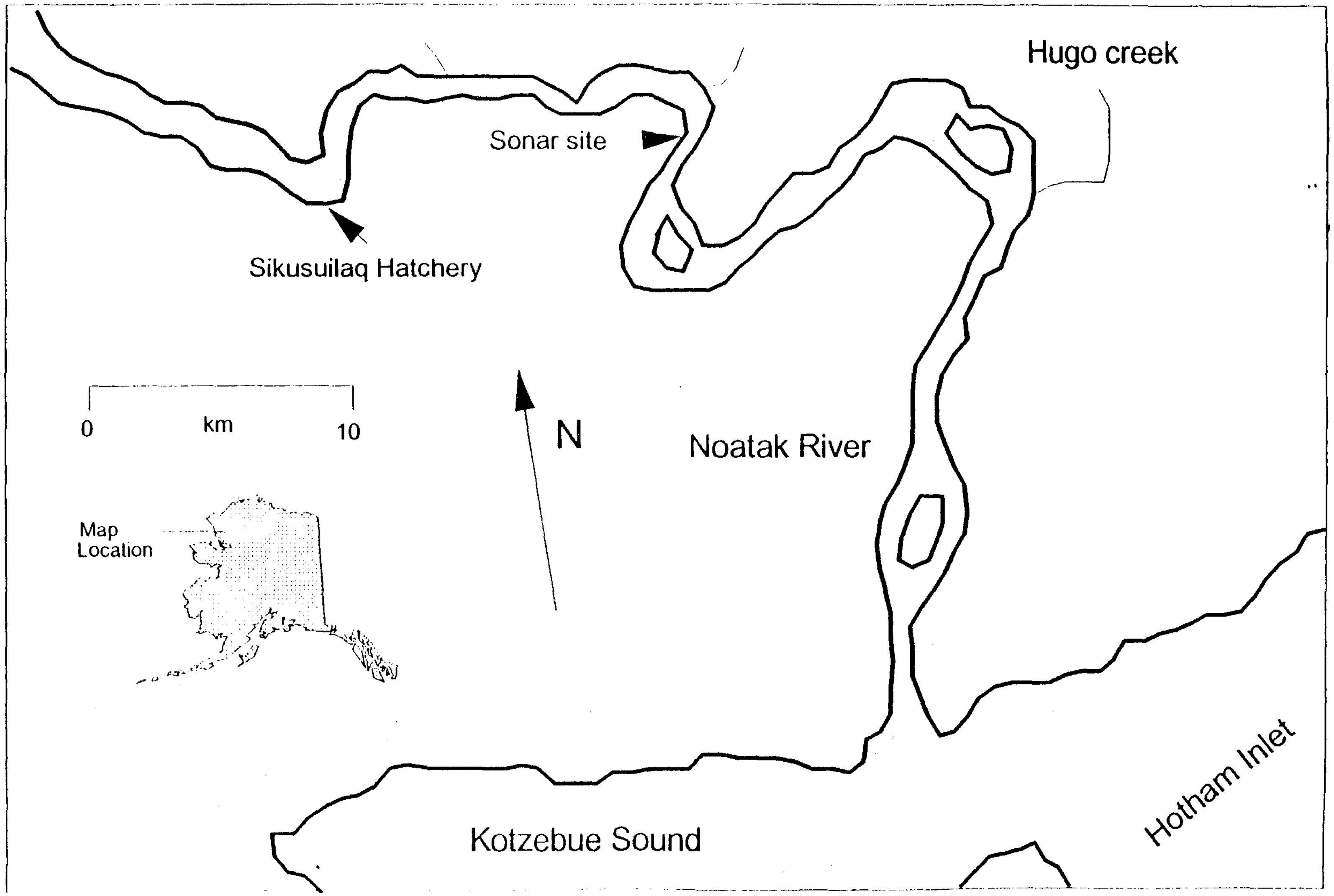


Figure 1. Location of Noatak River sonar at km 39, 1989 to present.

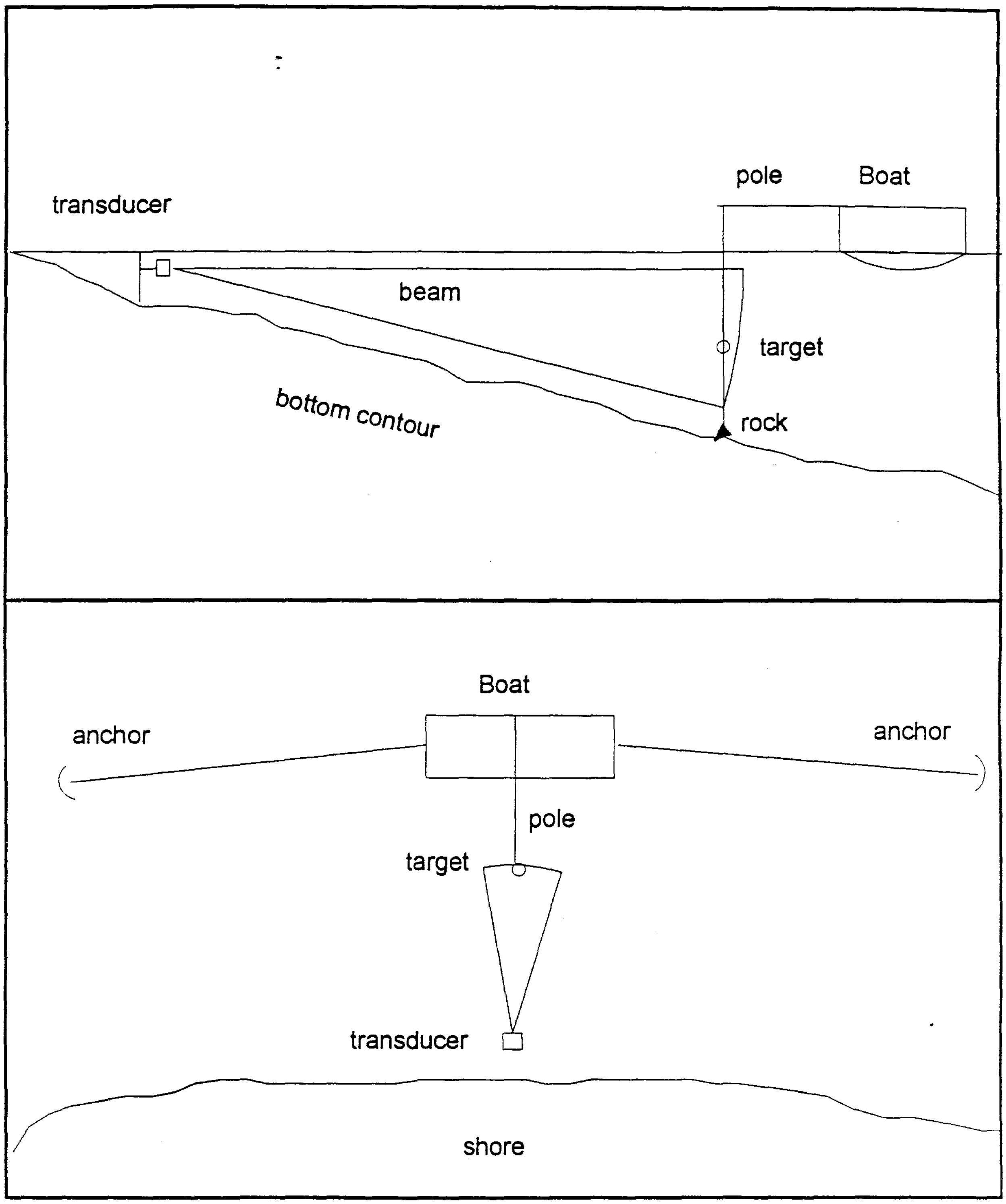


Figure 2. Two schematic views of artificial target deployment at Noatak River sonar.

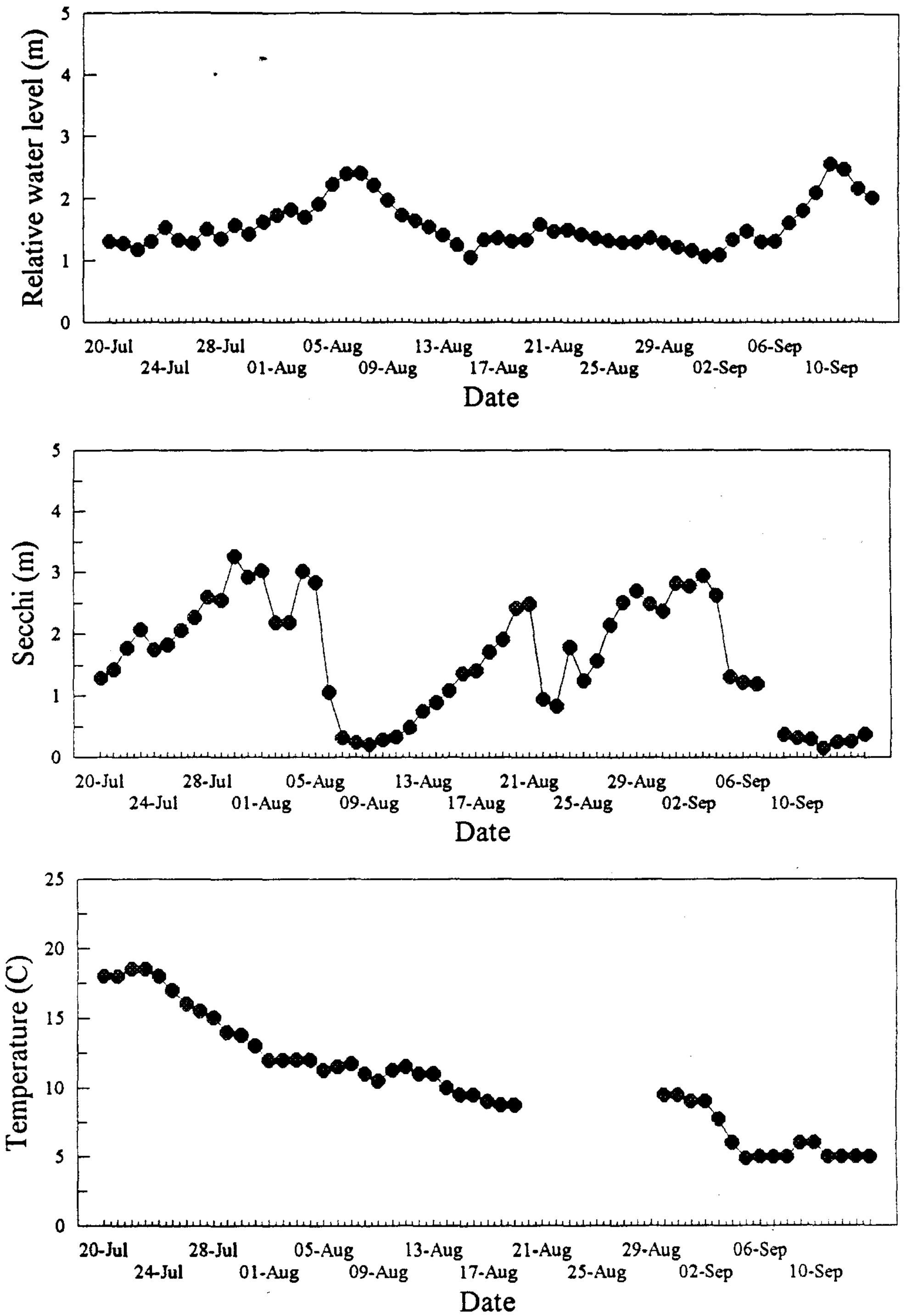


Figure 3. Mean daily water level, water clarity, and water temperature from 20 July through 13 September, Noatak River sonar, 1993.

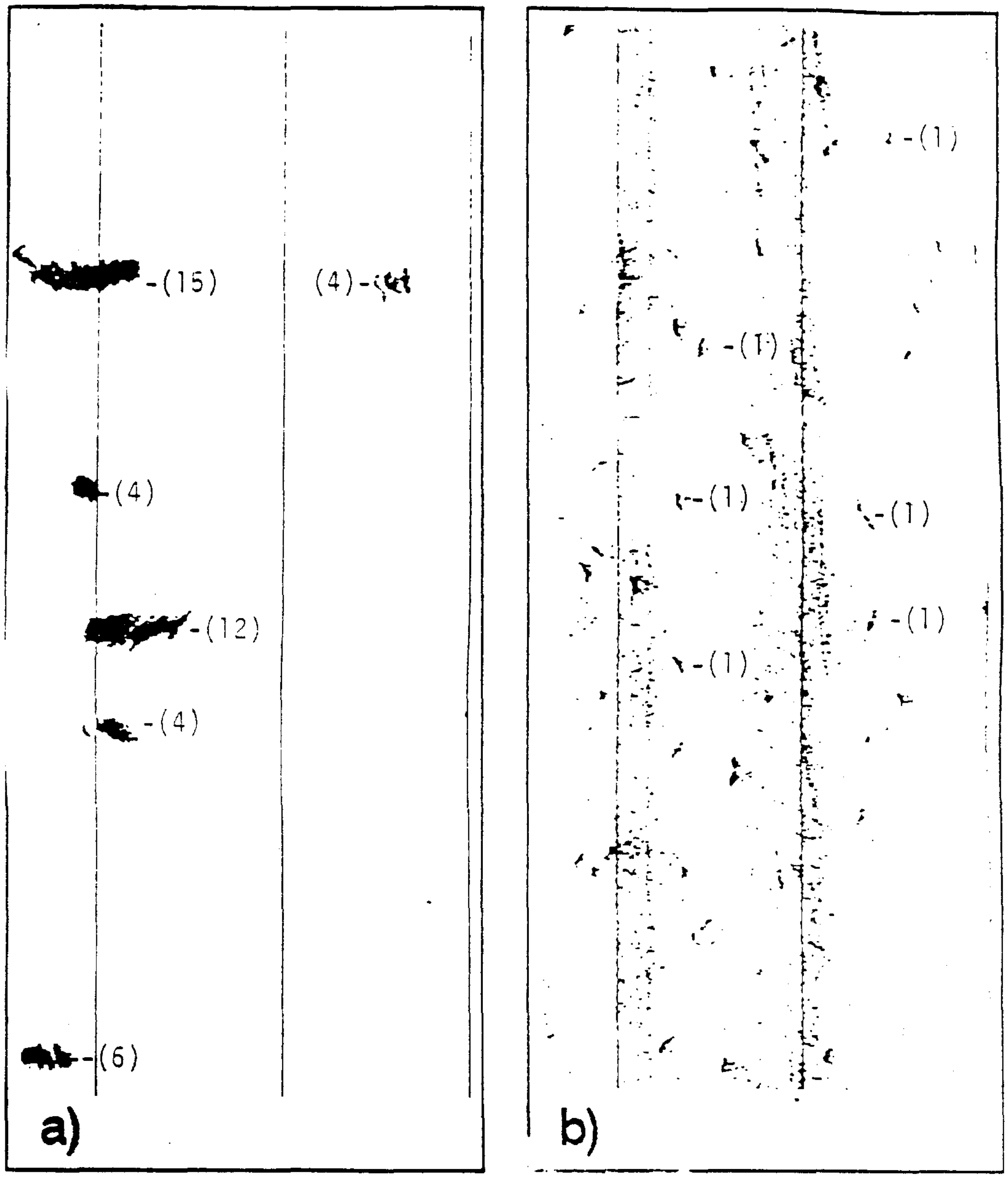


Figure 4. Chart recordings showing a) clustered traces during high water clarity and b) random traces during low water clarity, Noatak River sonar, 1993.

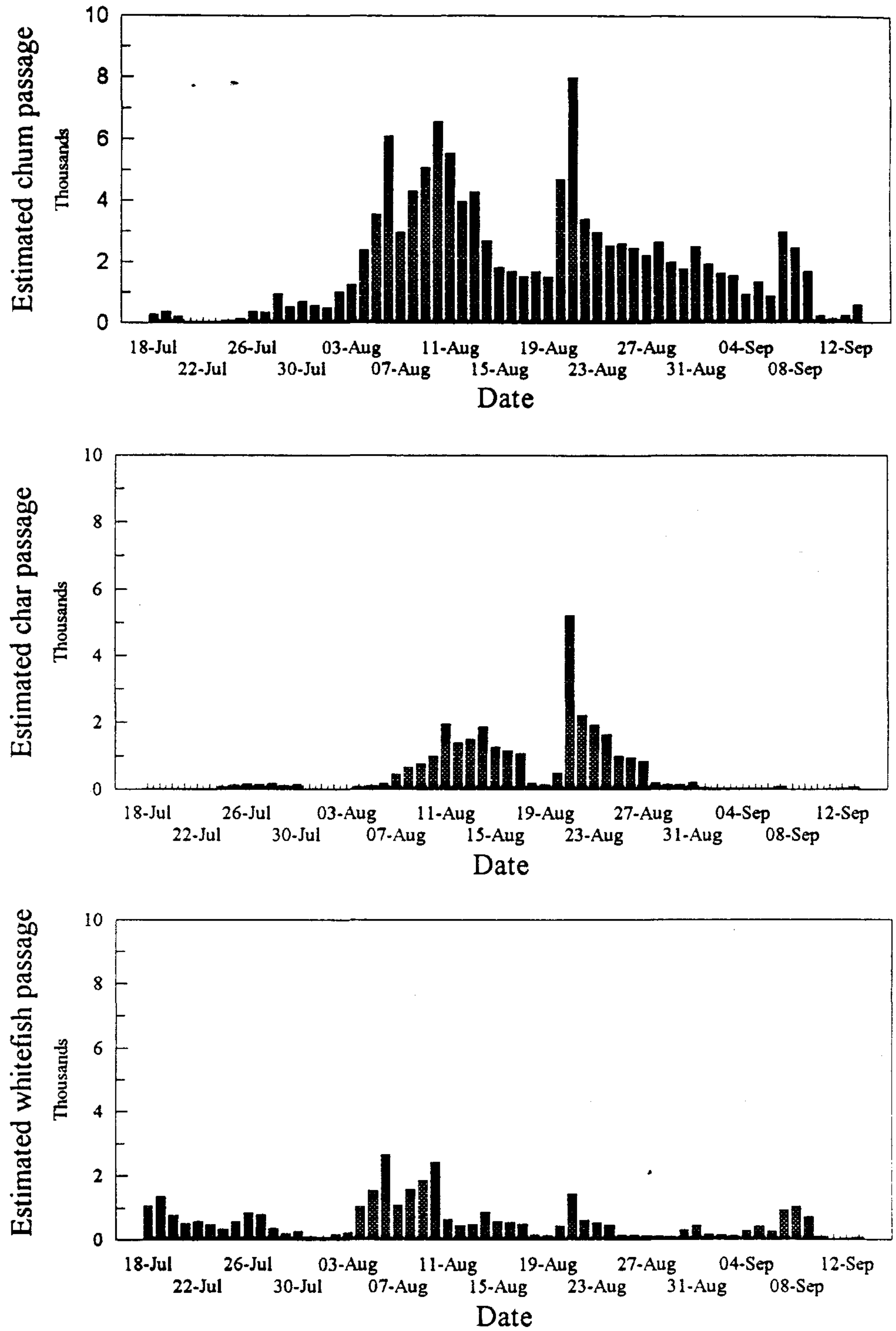
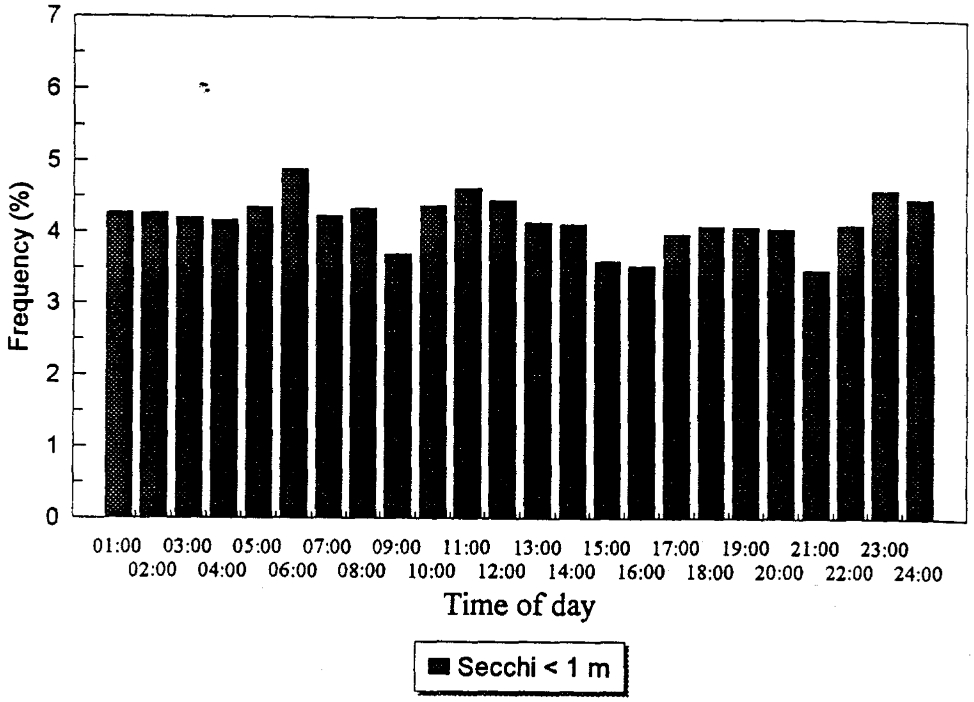


Figure 5. Daily passage estimates of chum salmon, char, and whitefish from 18 July through 13 September, Noatak River sonar, 1993.



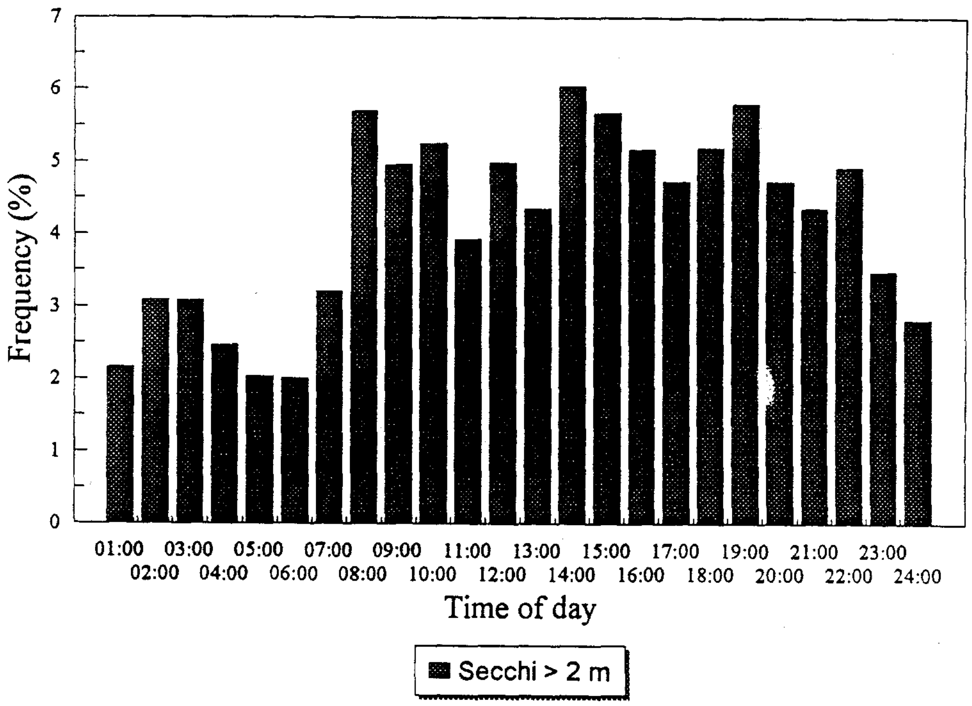


Figure 6. Diel distribution of fish migration during two periods of water clarity measurements, < 1 m and > 2m. Both sets of data are from two 7 d periods of contiguous 24 h data in August, Noatak River sonar, 1993.

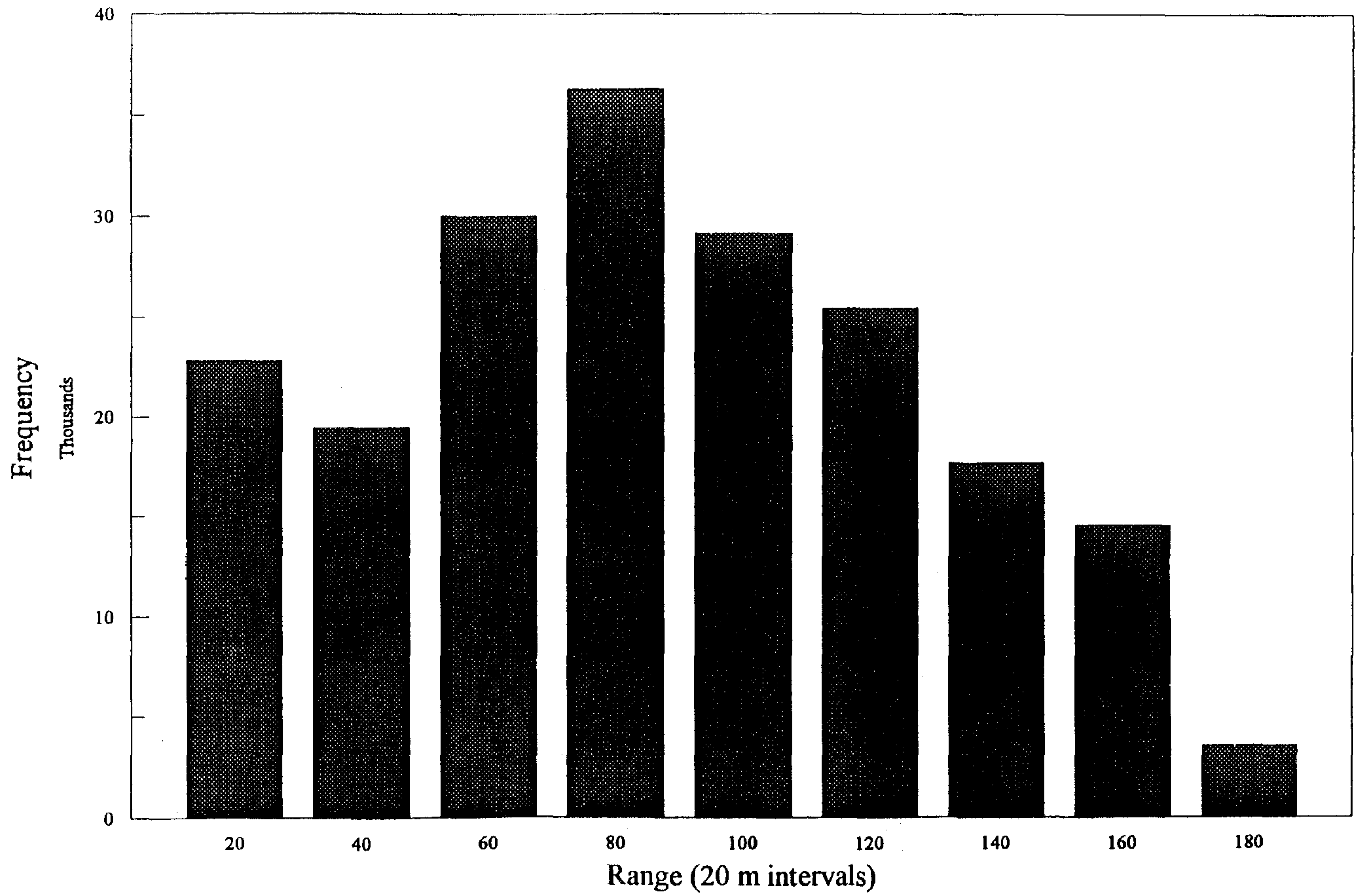


Figure 7. Range distribution of raw count data collected on the right bank at the Noatak River sonar site from 18 July through 13 September, 1993.

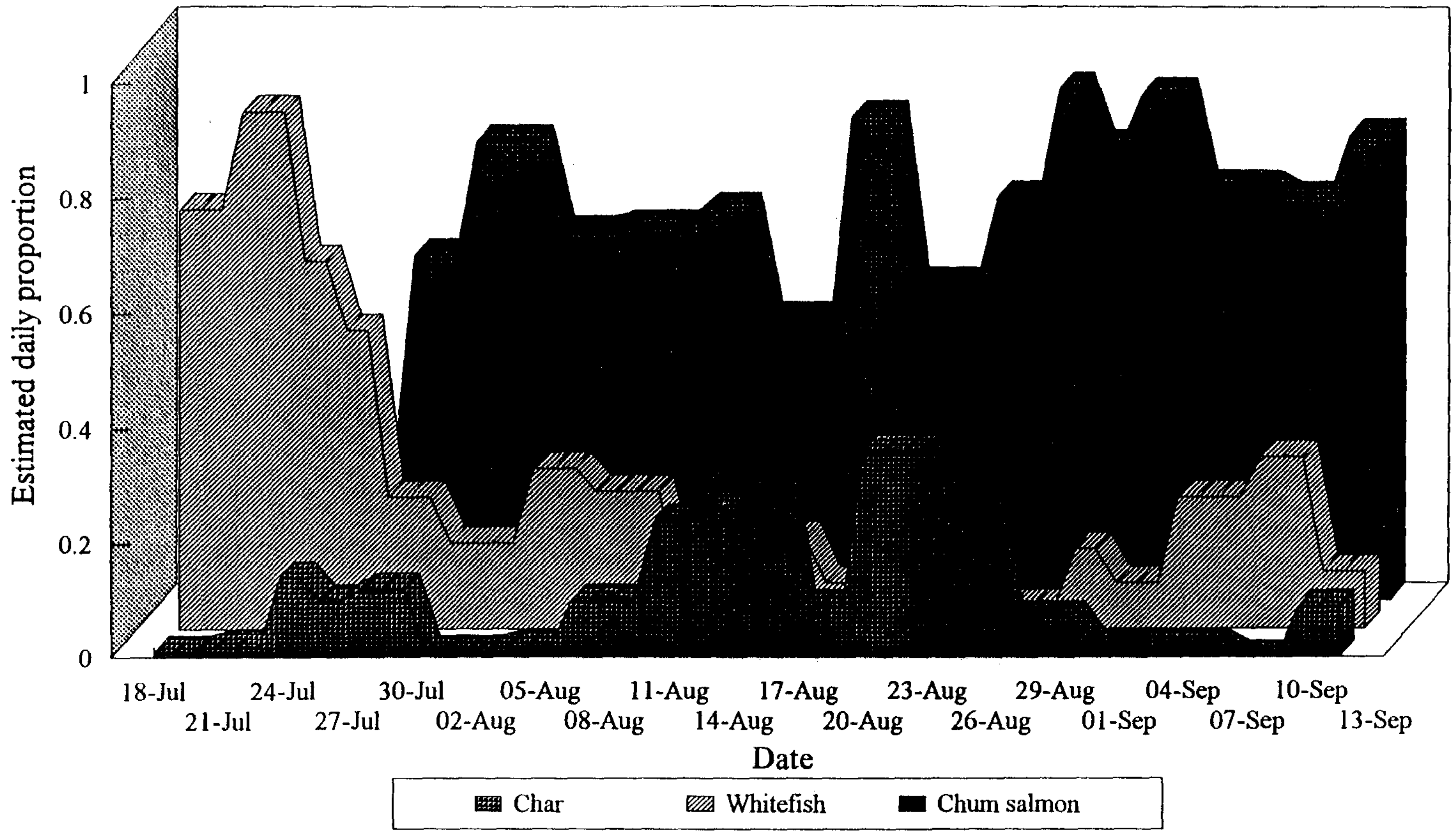


Figure 8. Estimated daily proportions of chum salmon, char, and whitefish from 18 July through 13 September, Noatak River sonar, 1993.

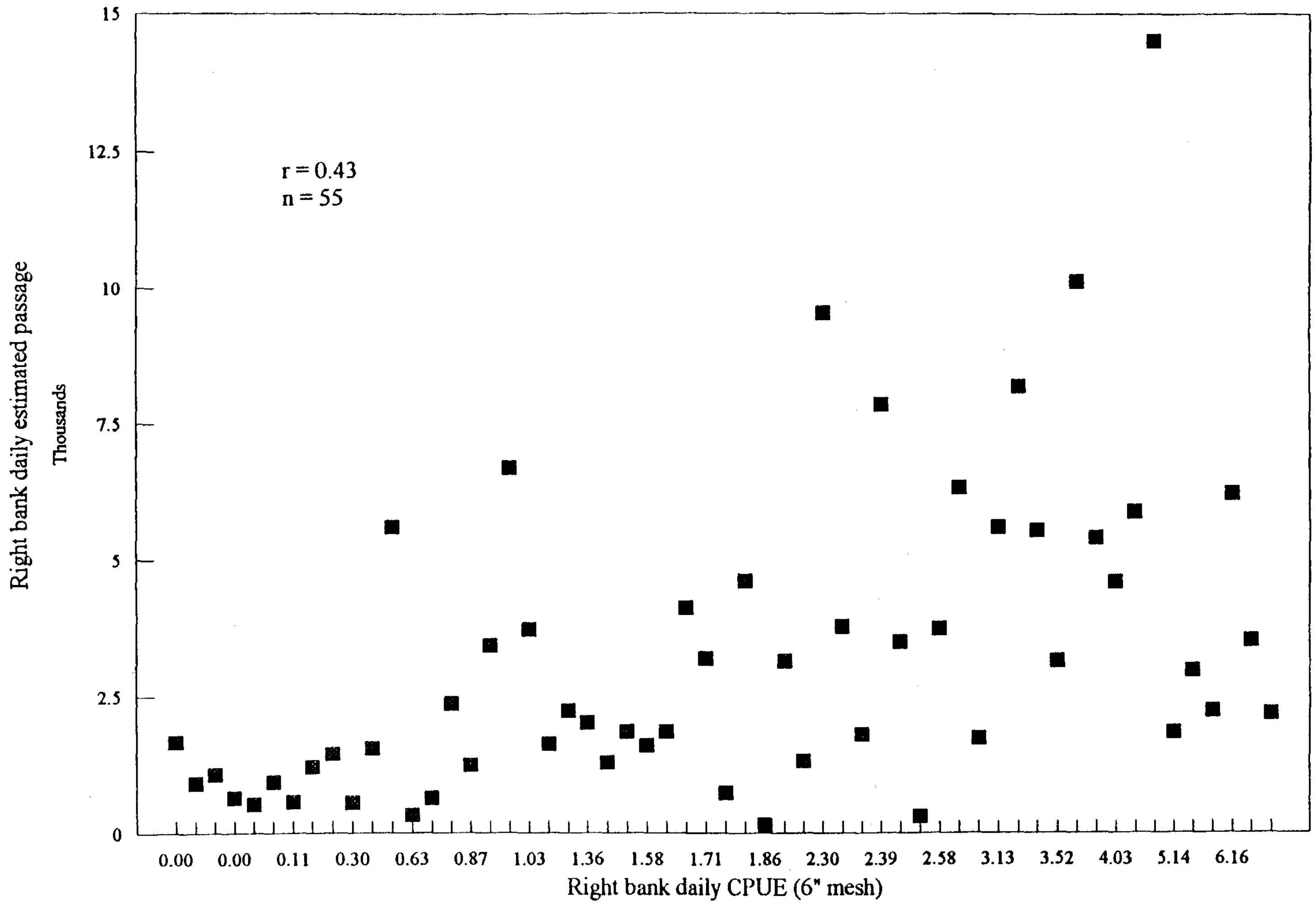


Figure 9. Comparison of daily chum salmon CPUE from the 6" mesh net versus daily total estimated fish passage from the right bank of the Noatak River, 18 July through 13 September, 1993.

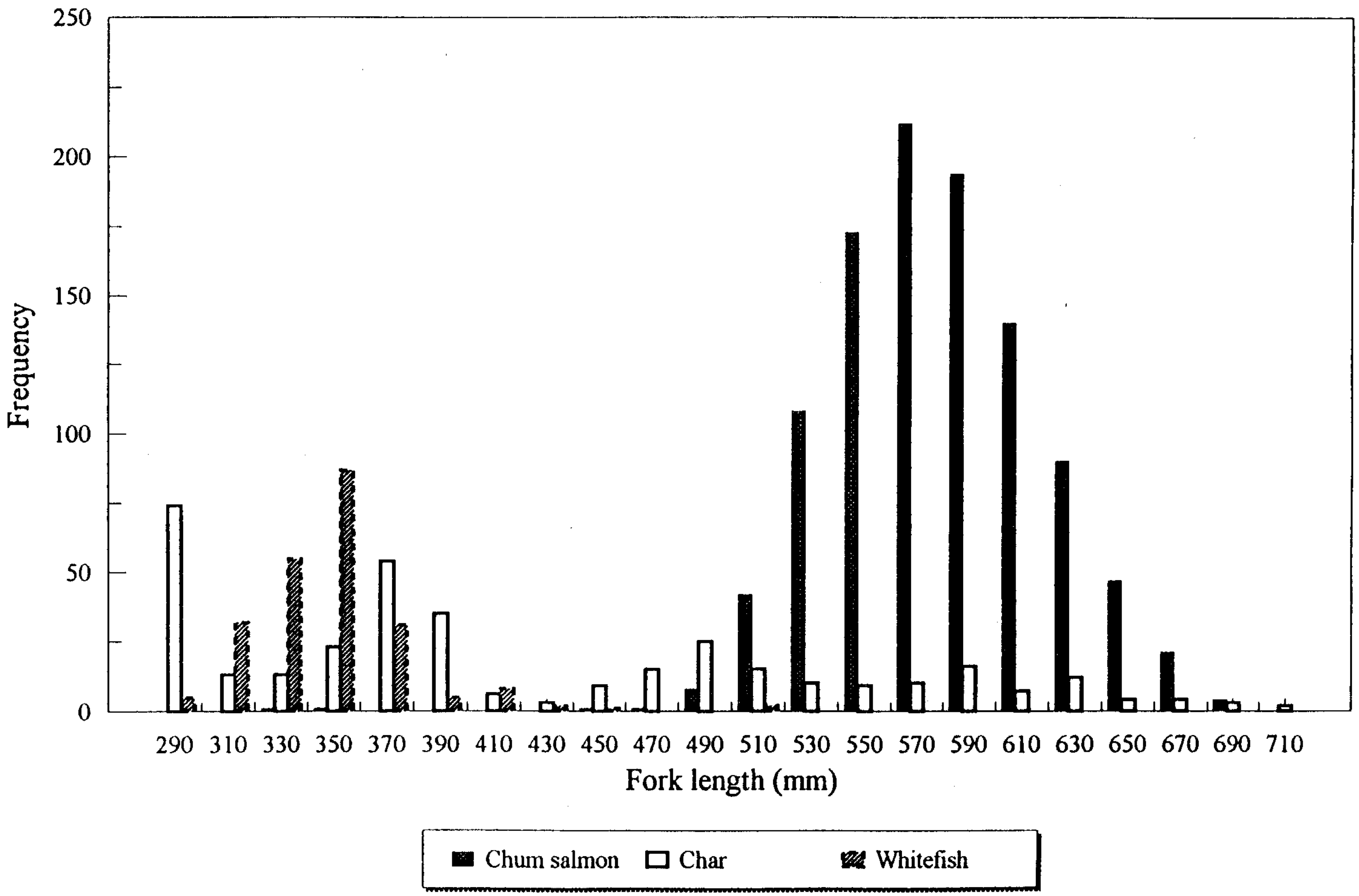


Figure 10. Length distributions of chum salmon, char, and whitefish caught in drift nets at the Noatak River sonar, 1993.

APPENDIX

Appendix A. Mesh size parameter file used by SAS program to determine relative abundance of fish species present in the Noatak River.

SPECME93.NTK: sets which meshes will be used (by NOATAK.SAS) to estimate CPUE for each species and also sets which species' catches will be adjusted for net selectivity.

A "1" in the column for a given mesh indicates that fish of that species caught in that mesh will be used to calculate relative CPUE and in turn allocate sonar counts to species.

A "Y" in the ADJUST column will cause the program to adjust catches of that species for net selectivity, a "N" will cause the program to not adjust.

	2.75	4.0	5.0	5.5	6.0	ADJUST?
CHINOOK	0	0	0	0	1	N
CHUM	0	0	1	0	1	Y
CHARR	1	1	1	0	1	Y
PIKE	0	0	1	0	1	N
PINK	0	1	1	0	0	Y
SHEEFISH	1	1	0	0	0	N
WHITE	1	0	0	0	0	N
FLOUNDER	0	0	1	0	1	N
OTHER	1	1	0	0	0	N
CISCO	1	0	0	0	0	N
NONE	0	0	0	0	0	N

Appendix B. Net selectivity parameter file used by SAS program.

NETSEL93.NTK: source of net selectivity estimates for NOATAK93.SAS
Values are read from specific columns:

SPECIES	LENGTH	2.75"	4.0"	5.0"	5.5"	6.0"
CHUM	440			0.768		
CHUM	480		0.256	0.950		
CHUM	520			0.957		0.564
CHUM	560			0.452		0.866
CHUM	600			0.279		1.000
CHUM	640					0.887
CHUM	680					0.633
CHUM	720					0.633
CHARR	320	0.941				
CHARR	360	0.758	0.794			
CHARR	400	0.248	0.967			
CHARR	440	0.175	0.993	0.676		
CHARR	480		0.792	0.915		
CHARR	520		0.836	0.995		0.374
CHARR	560		0.615	0.908		0.981
CHARR	600		0.645	0.967		0.530
CHARR	640					1.000
PINK	320		0.723			
PINK	360		0.662			
PINK	400		0.979			
PINK	440		0.855	0.912		0.160
PINK	480		0.892	0.892		0.382

Appendix C. SAS data processing program.

```
titlel 'Noatak Sonar In-Season Data Processing Program, 1993';

*IDENTIFY PATH OF DIRECTORY IN WHICH TO STORE PERMANENT SAS DATA SETS;
libname save '\sassave';

*SET PAGE LENGTH AND WIDTH FOR OUTPUT;
options linesize=79;
options pagesize=60;

*READ IN RAW DATA FROM FILE PRINTED FROM LOTUS 123;
*CALCULATE DURATION OF COUNTS IN HOURS;
*CALCULATE 15 MINUTE PASSAGE ESTIMATE;
data sonarcts;
        infile 'nlcounts.prn';
        length counter $3;
        informat startime endtime time5.;
        input month 1 day 3-4 year 6-7 @9 startime @15 endtime @21 counter $
         count1 25-27 count2 29-31 count3 33-35 count4 37-39 count5 41-43
         count6 45-47 count7 49-51 count8 53-55 count9 57-59;
        count=sum(of count2-count9);
        date=mdy(month,day,year);
        hour=hour(startime);
        dstime=dhms(date,hour(startime),minute(startime),0);
        detime=dhms(date+DATEPART(ENDTIME),hour(endtime),minute(endtime),0);
        hrsdur=(detime-dstime)/3600;
        hourpsg=count/hrsdur;
        min15psg=hourpsg/4;
        dst2hr=round(dstime,7200);
        dst6hr=round(dstime,21600);
        format startime endtime time5. date date7. dst2hr dst6hr
           datetime10.;
        label hour ='HOUR STARTING AT:' hourpsg='HOURLY PASSAGE';
        run;
*NOTE:  MIN15PSG= ESTIMATED COUNT FOR 15 MINUTES;

data rperiod;
        infile 'rperiod.dat' firstobs=7;
        informat date mmddyy8.;
        input reportno date;  *minrange maxrange;
        run;

*MERGE REPORT PERIOD INFO WITH THE SONAR DATA FILE;
proc sort data=sonarcts; by date; run;
data sonarcts; merge sonarcts(in=a) rperiod; by date; if a; run;
```

-Continued-

```
*OPTIONAL BAR CHARTS OF HOURLY SONAR COUNTS BY DAY;
proc chart data=sonarcts;
        vbar hour / type=mean sumvar=hourpsg discrete;
        by date;
        run;

*CALCULATE MEAN ESTIMATED 15 MIN PASSAGE RATES OVER 2, 6, AND 24 HOUR PERIODS;
proc summary data=sonarcts;
        var min15psg;
        by dst2hr;
        output out=pass2hr mean=meanpass;
        run;

proc summary data=sonarcts;
        var min15psg;
        by dst6hr;
        output out=pass6hr mean=meanpass;
        run;

proc summary data=sonarcts;
        var min15psg;
        by reportno date;
        output out=pass24hr mean=meanpass;
        run;

*CREATE FILES OF ESTIMATED PASSAGE EVERY 2 AND 6 HOURS FOR CONSTRUCTION OF
GRAPHS IN LOTUS 123;
data print; set pass2hr;
file 'n2hrcts.out';
        sumpass=8*meanpass;
        month=month(datepart(dst2hr));
        year=year(datepart(dst2hr));
        day=day(datepart(dst2hr));
        hour=hour(dst2hr);
        put year month day hour sumpass;
        format sumpass 9.0;
        run;

data print; set pass6hr;
file 'n6hrcts.out';
        sumpass=24*meanpass;
        year=year(datepart(dst6hr));
        month=month(datepart(dst6hr));
        day=day(datepart(dst6hr));
```

-Continued-

```
        hour=hour(dst6hr);
        format sumpass 9.0;
        put year month day hour sumpass;
        run;

title2 'Sonar estimates of daily fish passage';
title3 '20m to 180m range';
data dailypsg; set pass24hr (drop= _type_ _freq_);
        dailypsg=96*meanpass;
        format meanpass 8.1 dailypsg 9.0;
        label meanpass='MEAN 15 MIN PASSAGE RATE' dailypsg='DAILY PASSAGE';
        run;
proc print label noobs;
        var reportno date meanpass;
        sum dailypsg;
        run;

proc summary data=dailypsg;
        by reportno;
        var dailypsg;
        output out=reptpasg sum=passage;
        run;
*
*
*THIS CONCLUDES CALCULATIONS FOR THE SONAR DATA, NOW BEGIN TESTFISH DATA
 PROCESSING;
*
*
*


*READ DATA FROM RBASE EXPORT FILE, ONE LINE FOR EACH FISH, PLUS ONE LINE FOR
 ANY DRIFTS DURING WHICH NO FISH WERE CAUGHT;
*CALCULATE EFFORT IN FATHOM HOURS;
*NOTE THERE IS NO CONTINGENCY FOR DRIFTS SPANNING MIDNIGHT;
data nltfish;
  length qmeth qsex $3;
  length meth sex $1;
  length species $8;
  infile 'e:\rbfiles\nltfish.dlm' delimiter=',';                  *PATH;
  informat date mmddyy.  startout fullout startin fullin time8.;
  format date date7. startout fullout startin fullin time5.;
  input date tfperiod site mesh fathoms qmeth range1 range2
    startout fullout startin fullin spcode qsex length;
  meth=upcase(substr(qmeth,2,1));
```

-Continued-

```
  sex=upcase(substr(qsex,2,1));
  drifsecs = (startin-fullout) + (fullout-startout)/2 + (fullin-startin)/2;
  fathhrs= fathoms*drifsecs/3600;
  IF LENGTH=0 THEN LCLASSMP=0; ELSE LCLASSMP= ROUND(LENGTH,40);
  if spcode=0 then catch=0; else catch=1;
  drop qmeth qsex fullout startin fullin drifsecs;
  if spcode = 1 then  species = 'CHINOOK ';
  if spcode = 2 then  species = 'CHUM';
  if spcode = 3 then  species = 'CHARR';
  if spcode = 4 then  species = 'PIKE';
  if spcode = 5 then  species = 'PINK';
  if spcode = 6 then  species = 'SHEEFISH';
  if spcode = 7 then  species = 'WHITE';
  if spcode = 8 then  species = 'FLOUNDER';
  if spcode = 9 then  species = 'OTHER';
  if spcode = 10 then species = 'CISCO';
  if spcode = 0 or spcode = . then species = 'NONE';
  if mesh=2.75 then meshcode=1;
  if mesh=4    then meshcode=2;
  if mesh=5    then meshcode=3;
  if mesh=5.5  then meshcode=4;
  if mesh=6    then meshcode=5;
  run;

*MERGE REPORT PERIOD INFO WITH TESTFISH DATA FILE;
proc sort data=nltfish; by date; run;
data nltfish; merge nltfish(in=a) rperiod; by date; if a; run;

*GENERATE CPUE DATA FOR COMPARISON WITH DOWNRIVER TESTFISH PROJECT;
data tfishrpt; set nltfish;
  if spcode eq 1 then delete;
  if spcode gt 2 then delete;
  if meshcode eq 5 or meshcode eq 3;
  run;

proc sort data=tfishrpt; by mesh date startout;
proc summary data=tfishrpt;
  var fathhrs catch;
  output out=drifcpue mean(fathhrs)=drifteff sum(catch)=drifctch;
  by mesh date startout; run;

proc summary data=drifcpue;
  var drifteff drifctch;
  output out=daycpue sum=dayeff daycatch;
```

-Continued-

```
  by mesh date; run;

data daycpue; set daycpue;
  if dayeff gt 0 then daycpue=daycatch/dayeff;
  else daycpue=0;
  format date date7. dayeff daycpue 7.2 daycatch 7.0;
  label dayeff='FATHOM HOURS' daycatch='NUMBER CAUGHT' daycpue='CPUE';
  run;

title2 'DAILY CHUM SALMON CATCH, EFFORT, AND CPUE, BY MESH';
title3 'no adjustments made for net selectivity';
proc print data=daycpue noobs label;
  var date daycatch dayeff daycpue;
  by mesh;
  run;

*CALCULATE EFFORT PER MESH;
proc sort data=nltfish; by date tfperiod mesh startout species; run;
proc summary data=nltfish;
  var fathhrs; id meth rangel range2;
  output out=drifsets mean(fathhrs)=effort;
  by date tfperiod mesh startout;
  run;

*AND CATCH PER MESH PER SPECIES;
proc summary data=nltfish;
  var catch; id meth rangel range2;
  output out=ds2 sum(catch)=sppcatch;
  by date tfperiod mesh startout species;
  run;

proc sort data=ds2; by date tfperiod mesh startout meth rangel range2; run;
proc transpose data=ds2 out=tfsummar;
  by date tfperiod mesh startout meth rangel range2;
  var sppcatch;
  id species;
  run;

data tfsummar; merge tfsummar drifsets; by date tfperiod mesh startout;
        drftmins=effort*60/25;
        run;

data spplist;
        chum=0; charr=0; pink=0; white=0; run;
```

-Continued-

```
data tfsummar; set tfsummar (in=a drop=_type_ _freq_) spplist;
  if a;
  format date date7. startout time5. effort 8.2;
  label effort='FATHOM HOURS' drftmins='MINUTES DEPLOYED';
  run;

proc sort data=tfsummar; by date meth mesh startout; run;
title2 'SUMMARY OF TESTFISH RESULTS';
title3 'only major species listed';
proc print data=tfsummar label noobs;
  var date tfperiod startout meth mesh;
  sum drftmins chum charr pink white;
  run;

*AND THEN BY SUMMING EFFORT FOR ALL DRIFTS IN A TFPERIOD WITH A GIVEN MESH;
data drifsets; set drifsets; if meth='D'; run;
proc sort data=drifsets; by date tfperiod mesh; run;
proc summary data=drifsets;
  var effort;
  output out=effort1 sum=meffort;  *(MESH EFFORT);
  by date tfperiod mesh;
  run;
*FINALLY, REARRANGE DATA TO PUT EFFORTS FOR ALL MESHES ON A SINGLE LINE;
proc transpose data=effort1 out=effort2;
  var meffort; id mesh;
  by date tfperiod;
  run;
data effort2; set effort2(drop=_name_);
  rename _2d75   =effort1;
  rename _4      =effort2;
  rename _5      =effort3;
  rename _5d5    =effort4;
  rename _6      =effort5;
  format date date7.;
  run;

/*
TITLE2 'WORK.EFFORT2';
PROC PRINT; RUN;
*/

*READ IN AN EXTERNAL FILE WHICH SETS WHICH MESHES WILL BE USED TO ESTIMATE
 CPUE FOR EACH SPECIES, AND WHICH SPECIES CATCHES WILL BE ADJUSTED FOR NET
```

-Continued-

```
 SELECTIVITY;
data specmesh;
  infile 'specme93.ntk' firstobs=17;                          *PATH;
  length species $ 8;
  length adjust $ 3;
  input species usemesh1-usemesh5 adjust;
  run;

*MERGE SPECIES-MESH PAIRING DATA INTO TESTFISH DATA SET;
*DELETE FISH WHICH WERE NOT CAUGHT IN MESHES TARGETING THAT SPECIES;
proc sort data=nltfish; by species; run;
proc sort data=specmesh; by species; run;
data tfsm;
  merge nltfish(in=a) specmesh;
  by species;
  if a;
  array usemesh{5} usemesh1-usemesh5;
  if usemesh{meshcode}=0 then delete;
  run;

/*proc datasets library=work; delete testfish; run;*/

*MERGE NET SELECTIVITY CURVE DATA INTO TESTFISH (+SM) DATA SET;
data netselec;
  infile 'netsel93.ntk' missover firstobs=5;
  length species $7.;
  input @5 species lclassmp 13-16 prob1 18-22 prob2 24-28
                                  prob3 30-34 prob4 36-40 prob5 42-46;
  run;

proc sort data=tfsm; by species lclassmp; run;
proc sort data=netselec; by species lclassmp; run;
data tfsmns; merge tfsm(in=b drop=fathhrs) netselec; by species lclassmp;
  if b;
  run;
/*
*PRINT SELECTIVITY FILE;
title2 'NET SELECTIVITY ESTIMATES USED TO ADJUST CATCHES';
proc print label noobs data=netselec; run;
*/

/*proc datasets library=work; delete tfsm; run;*/

*MERGE EFFORT DATA INTO TESTFISH (+SM+NS) DATA SET;
```

-Continued-

```
*DECLARE ARRAYS;
proc sort data=tfsmns; by date tfperiod; run;
data tfsmnsef; merge tfsmns(in=c) effort2; by date tfperiod;
  if meth='D';
  if c;
  array usemesh{5} usemesh1-usemesh5;
  array prob{5} prob1-prob5;
  array effort{5} effort1-effort5;
  *FOR MAJOR SPECIES, ADJUST CATCH (I.E., 1 FISH) FOR NET SELECTIVITY;
  *IF NET SELECTIVITY IS NOT KNOWN FOR THIS SIZE CLASS, SET CATCH TO ZERO;
  meanprob=0.7;
  if adjust='N' then adjcatch=1/meanprob;
  else if adjust='Y' then do;
    if prob{meshcode} ne . then adjcatch=1/prob{meshcode};
    else if prob{meshcode} eq . then adjcatch=0;
    end;
  *SUM EFFORT FOR ALL MESHES TARGETING THIS SPECIES DURING THIS TF PERIOD;
  *IF SPECIES IS ADJUSTED FOR NET SELECTIVITY, THEN DO NOT CONSIDER THOSE
   MESHES FOR WHICH NET SELECTIVITY IS NOT KNOWN FOR THIS FISH;
  *FINALLY, CALCULATE ADJUSTED CPUE FOR EACH FISH;
  sumeff=0;
  do imesh=1 to 5;
    if adjust='Y' then do;
      if prob{imesh} = . then usemesh{imesh} = 0;
      end;
    if effort{imesh}=. then effort{imesh}=0;
    sumeff=sumeff+effort{imesh}*usemesh{imesh};
    end;
  adjcpue=adjcatch/sumeff;
  format date date7. startout time5. prob1-prob5 3.2 adjcpue 4.3
    effort1-effort5 sumeff 4.1 adjcatch 5.2;
  run;

/*proc datasets library=work; delete tfsmns; run;*/

*OPTIONAL PRINTOUT FOLLOWS: SHOWS INTERMEDIARY CALCULATIONS ON TESTFISH DATA;
options linesize=120;
data print; set tfsmnsef;
title2 'PART OF DATA SET TFSMNSEF';
title3 'ONE LINE PER FISH, EACH LINE ALSO HAS INFORMATION ON NET SELECTIVITY';
title4 'CURVE PARAMETERS AND EFFORT FOR EACH MESH DRIFTED DURING THAT PERIOD';
  run;
  proc print data=print;
  var date startout mesh species length lclassmp adjcatch
```

-Continued-

```
     prob1-prob5 usemesh1-usemesh5 effort1-effort5 sumeff adjcpue;
  run;

*SUM ADJUSTED CPUE FOR EACH SPECIES DURING EACH TESTFISH PERIOD;
proc sort data=tfsmnsef; by reportno date tfperiod spcode;
proc summary data=tfsmnsef;
  var adjcpue adjcatch; id startout species;
  output out=spcpue sum=spcpue spcatch;
  by reportno date tfperiod spcode;
  run;

*TRANSPOSE BY ALL BUT SPECIES (CODE), CREATING A SEPARATE VARIABLE FOR CPUE OF
 EACH SPECIES;
proc transpose data=spcpue out=spcpwide;
  by reportno date tfperiod;
  var spcpue;
  id spcode;
  run;

proc summary data=spcpue;
  by reportno date tfperiod;
  var spcatch startout;
  output out=catch sum(spcatch)=adjcatch mean(startout)=avestart;
  run;

*SUM CPUE'S FOR ALL SPECIES DURING A GIVEN TESTFISH PERIOD;
data spcpwide; merge spcpwide catch; by reportno date tfperiod;
  array cpue{10} _1-_10;
  sumcpue=0;
  do i=1 to 10;
    if cpue{i} = . then cpue{i} = 0;
    sumcpue= sumcpue + cpue{i};
    end;
  format date date7. avestart time5. _1-_10 adjcatch sumcpue 6.2;
  run;

/*
*OPTIONAL PRINTOUT FOLLOWS;
title2 'INTERMEDIARY DATA SET WORK.SPCPWIDE: CPUE BY SPECIES CODES'; run;
proc print data=spcpwide noobs label;
  var reportno date tfperiod adjcatch _1-_10 sumcpue;
  run;
*/
/*
```

-Continued-

```
*CREATE OPTIONAL BAR CHART OF SPECIES CPUE BY TESTFISH PERIOD;
data chartcp; merge spcpue catch; by reportno date tfperiod;
  datetime=dhms(date,hour(avestart),minute(avestart),0);
  format datetime datetime10.;
  label datetime='DATE AND HOUR';
  if spcode<2 or spcode=4 or spcode=6 or spcode>7 then delete;
  run;
title2 'TESTFISH CPUE, BY SPECIES, IN ALL TESTFISH PERIODS';
proc chart data=chartcp;
  vbar datetime / sumvar=spcpue subgroup=species discrete;
  run;
*/
*SUM CPUE, FOR EACH SPECIES AND FOR ALL SPECIES, ACROSS ALL TESTFISH PERIODS
 WITHIN EACH REPORTING PERIOD;
*CALCULATE THE AVERAGE TOTAL (ALL SPECIES) CPUE IN EACH REPORT PERIOD;
*COUNT THE NUMBER OF TESTFISH PERIODS IN EACH REPORT PERIOD;
proc sort data=spcpwide; by reportno; run;
proc summary data=spcpwide;
  var _1-_10 sumcpue;
  output out=rncpue sum=rnspcp1-rnspcp10 rnsmcp
                    mean(sumcpue)=rnmncp
                    n=n;
  by reportno;
  run;

*MERGE THE ORIGINAL DATA SET WITH THE SUMMARIZED DATA SET, THEN CALCULATE:
 ESTIMATED PROPORTION OF EACH SPECIES DURING EACH TESTFISH PERIOD,
 ESTIMATED PROPORTION OF EACH SPECIES DURING EACH REPORT PERIOD,
 AND A WEIGHTED SQUARED DEVIATION OF THE TESTFISH PERIOD PROPORTION FROM
 THE REPORT PERIOD PROPORTION;
data varcalc;
  merge spcpwide rncpue;
  by reportno;
  array cpue{10} _1-_10;
  array rnspcp{10} rnspcp1-rnspcp10;
  array phatpr{10} phatpr1-phatpr10;
  array phatrp{10} phatrp1-phatrp10;
  array sqrdev{10} sqrdev1-sqrdev10;
  weight=sumcpue/rnmncp;
  do i=1 to 10;
    phatpr{i}=cpue{i}/sumcpue;
    phatrp{i}=rnspcp{i}/rnsmcp;
    sqrdev{i}=(weight**2)*(phatpr{i}-phatrp{i})**2;
    end;
```

```
  label phatprl='CHINOOK' phatpr2='CHUM' phatpr3='CHARR' phatpr4='PIKE'
  phatpr5='PINK' phatpr6='SHEEFISH' phatpr7='WHITE' phatpr8='FLOUNDER'
  phatpr9='OTHER' phatprl0='CISCO';
  format phatprl-phatprl0 3.2;
  format adjcatch 5.0;
  format date date7. avestart time5.;
  run;

*OPTIONAL PRINTOUT OF SPECIES PROPORTIONS BY TESTFISH PERIOD;
proc sort data=varcalc; by reportno date tfperiod;
title2 'ESTIMATED SPECIES PROPORTIONS AND TOTAL ADJUSTED CATCH BY TESTFISH
PERIOD';
run;
proc print label data=varcalc;
  var reportno date adjcatch
      phatprl phatpr2 phatpr3 phatpr4 phatpr5
      phatpr6 phatpr7 phatpr8 phatpr9 phatprl0;
  run;

*SUM THE SQUARED DEVIATIONS BY REPORT PERIOD;
proc sort data=varcalc; by reportno; run;
proc summary data=varcalc;
  var sqrdevl-sqrdevl0 adjcatch;
  id phatrpl-phatrpl0 n date;
  output out=varprop sum=smsqdvl-smsqdvl0 adjcatch;
  by reportno;
  run;

*AND CALCULATE THE VARIANCE OF THE REPORT PERIOD PROPORTION (COCHRAN 1977);
data varprop; set varprop (drop = _type_ _freq_);
  phatoth=phatrpl+phatrp4+phatrp6+phatrp8+phatrpl0+phatrp9;
  format phatrpl-phatrpl0 phatoth stdprpl-stdprpl0 3.2;
  format adjcatch 4.0 date date7.;
  label phatrpl='CHINOOK' phatrp2='CHUM' phatrp3='CHARR' phatrp4='PIKE'
      phatrp5='PINK' phatrp6='SHEEFISH' phatrp7='WHITE' phatrp8='FLOUNDER'
      phatrp9='OTHER' phatrpl0='CISCO' phatoth='OTHER';
  label stdprp2='CHUM S.E.' stdprp3='CHARR S.E.' stdprp5='PINK S.E.'
      stdprp7='WHITE S.E.';
  array varprp{10} varprpl-varprpl0;
  array smsqdv{10} smsqdvl-smsqdvl0;
  array stdprp{10} stdprpl-stdprpl0;
  array cvprop{10} cvpropl-cvpropl0;
  array phatrp{10} phatrpl-phatrpl0;
  do i = 1 to 10;
```

-Continued-

```
    varprp{i}=smsqdv{i}/(n*(n-1));
    stdprp{i}=sqrt(varprp{i});
    if phatrp{i} gt 0 then cvprop{i}=stdprp{i}/phatrp{i};
    else cvprop{i}=0;
    end;
  run;

title2 'ESTIMATED SPECIES PROPORTIONS AND STANDARD ERRORS';
title3 'BY REPORT PERIOD';
title4 'major species only';
proc print label data=varprop noobs;
  var reportno date adjcatch phatrp2 phatrp3 phatrp5 phatrp7 phatoth
                             stdprp2 stdprp3 stdprp5 stdprp7;
  run;

*
*
*NOW MERGE DATA SET CONTAINING COUNTS WITH DATA SET CONTAINING PROPORTIONS,
 AND CALCULATE SPECIES PASSAGE ESTIMATES AND THEIR ESTIMATED VARIANCE;
*
*;

data reptstat;
  merge varprop reptpasg;
  by reportno;
  array phatrp{10} phatrp1-phatrp10;
  array varpsg{10} varpsg1-varpsg10;
  array varprp{10} varprp1-varprp10;
  array psg{10} psg1-psg10;
  do i=1 to 10;
    psg{i}=phatrp{i}*passage;
    varpsg{i}=(passage**2)*varprp{i};
    end;
  format passage psg1-psg10 8. varprp1-varprp10
         varpsg1-varpsg10 e9. phatrp1-phatrp10 5.3;
  run;


*OPTIONAL PRINTOUT FOLLOWS;
/*
title2 'Dataset reptstat';
proc print data=reptstat label;
  var reportno date passage phatrp1-phatrp10
      varprp1-varprp10 psg1-psg10 varpsg1-varpsg10;
```

-Continued-

```
  run;
*/

data reptstat; set reptstat (drop = _type_ _freq_);
*  file 'nlrepsht.dat';                                          *PATH;
  label reportno='REPORTING PERIOD' date='ENDING ON';
  label psg1='CHINOOK' psg2='CHUM' psg3='CHARR' psg4='PIKE' psg5='PINK'
      psg6='SHEEFISH' psg7='WHITE' psg8='FLOUNDER' psg9='OTHER' psg10='CISCO';
  format psg1-psg10 7. varpsg1-varpsg10 e9.;
*  put reportno date psg1-psg10 / varpsg1-varpsg10;
  run;

title2 'ESTIMATED FISH SPECIES PASSAGE BY REPORTING PERIOD';
proc print label noobs data=reptstat;
  var reportno date;
  sum psg2 psg3 psg5 psg7 psg1 psg4 psg6 psg8 psg10 psg9;
  run;

proc summary data=reptstat;
  var psg1-psg10 varpsg1-varpsg10 date;
  output out=cumstat sum(psg1-psg10)=cumpsg1-cumpsg10
                     sum(varpsg1-varpsg10)=varcp1-varcp10
                     max(date)=enddate;
  run;

data cumstat; set cumstat (drop=_type_);
  rename _freq_=nreports;
  run;

proc transpose data=cumstat out=cs1;
  by nreports;
  var cumpsg1-cumpsg10; run;
data cs1; set cs1;
  label col1='PASSAGE TO DATE';
  rename col1=cumulpsg;
  length species $ 11;
  if _name_ = 'CUMPSG1 ' then  species = ' 9 CHINOOK ';
  if _name_ = 'CUMPSG2 ' then  species = ' 1 CHUM';
  if _name_ = 'CUMPSG3 ' then  species = ' 2 CHARR';
  if _name_ = 'CUMPSG4 ' then  species = ' 8 PIKE';
  if _name_ = 'CUMPSG5 ' then  species = ' 3 PINK';
  if _name_ = 'CUMPSG6 ' then  species = ' 6 SHEEFISH';
  if _name_ = 'CUMPSG7 ' then  species = ' 4 WHITE';
  if _name_ = 'CUMPSG8 ' then  species = ' 7 FLOUNDER';
```

-Continued-

```
  if _name_ = 'CUMPSG9 ' then  species = '10 OTHER';
  if _name_ = 'CUMPSG10' then  species = ' 5 CISCO';
  drop _name_;
  run;

proc transpose data=cumstat out=cs2;
  var varcp1-varcp10; run;
data cs2; set cs2;
  rename col1=variance;
  run;

data cumstat2; merge cs1 cs2;
  stderr=sqrt(variance);
  cv=stderr/cumulpsg;
  format cumulpsg 8. variance e10. stderr 7. cv 4.3;
  label nreports='REPORTS TO DATE'
    stderr='ESTIMATED STANDARD ERROR' cv='COEFFICIENT OF VARIATION';
  run;

proc sort data=cumstat2; by species; run;
title2 'CUMULATIVE STATISTICS BY SPECIES';
proc print noobs label;
  var nreports species cumulpsg stderr cv;
  run;
```

Appendix D. Summary of drift gillnetting results on the right bank from 18 July through 13 September, Noatak River sonar, 1993.

DATE	PERIOD[a]	STARTOUT	METHOD	MESH[b]	MINUTES DEPLOYED	Number Caught CHUM	CHAR	PINK	WF[c]
18JUL93	1	11:18	D	2.75	11.5417	.	.	.	7
18JUL93	2	18:40	D	2.75	11.1000	.	.	.	3
18JUL93	1	10:55	D	4.00	11.1917	.	.	4	.
18JUL93	2	19:03	D	5.00	11.0000	.	.	.	.
18JUL93	1	10:22	D	6.00	10.8500	2	.	.	.
18JUL93	2	19:21	D	6.00	11.4667	.	.	.	.
19JUL93	1	11:04	D	2.75	11.5167	.	.	.	6
19JUL93	2	16:20	D	2.75	11.5000	.	.	.	10
19JUL93	2	16:46	D	4.00	11.1833	.	.	.	1
19JUL93	1	10:43	D	5.00	11.3750	.	1	.	.
19JUL93	1	10:11	D	6.00	11.2417	13	.	.	.
19JUL93	2	17:07	D	6.00	11.3000	1	.	.	.
20JUL93	1	10:42	D	2.75	11.2083	.	.	.	7
20JUL93	2	16:12	D	2.75	11.4500	.	.	.	3
20JUL93	1	10:23	D	4.00	10.9833	.	.	.	.
20JUL93	2	16:36	D	5.00	11.3167	.	.	.	.
20JUL93	1	10:05	D	6.00	11.0333	.	.	.	.
20JUL93	2	16:54	D	6.00	11.1000	.	.	.	.
21JUL93	1	10:47	D	2.75	11.7167	.	.	.	6
21JUL93	2	16:13	D	2.75	11.2583	.	.	.	.
21JUL93	2	16:33	D	4.00	10.9917	.	.	2	.
21JUL93	1	10:26	D	5.00	11.2417	1	.	.	.
21JUL93	1	10:05	D	6.00	11.3333	1	.	.	.
21JUL93	2	16:53	D	6.00	11.1000	.	.	.	.
22JUL93	1	10:49	D	2.75	11.3417	.	.	.	9
22JUL93	2	16:25	D	2.75	11.9083	.	.	.	6
22JUL93	1	10:28	D	4.00	11.1667	.	.	.	.
22JUL93	2	16:55	D	5.00	11.3417	.	2	.	.
22JUL93	1	10:08	D	6.00	11.2250	.	.	.	.
22JUL93	2	17:23	D	6.00	11.3333	.	.	.	.
23JUL93	1	10:41	D	2.75	11.2167	.	.	.	12
23JUL93	2	16:57	D	2.75	11.1000	.	.	.	8
23JUL93	2	17:19	D	4.00	11.0250	.	.	.	.
23JUL93	1	10:22	D	5.00	11.0250	.	.	.	.
23JUL93	1	10:04	D	6.00	10.9833	.	.	.	.
23JUL93	2	17:45	D	6.00	10.9833	.	.	.	.
24JUL93	1	10:59	D	2.75	12.3167	.	.	.	2
24JUL93	2	16:11	D	2.75	11.7583	.	.	.	.
24JUL93	1	10:34	D	4.00	11.7583	.	4	1	.

-Continued-

24JUL93	2	16:33	D	5.00	11.7583	.	.	.	.
24JUL93	1	10:03	D	6.00	11.8917	1	.	.	.
24JUL93	2	16:54	D	6.00	12.0000	2	.	.	.
25JUL93	1	10:53	D	2.75	11.7083	.	.	.	3
25JUL93	2	16:10	D	2.75	11.5583	.	.	.	4
25JUL93	2	16:34	D	4.00	11.1417	.	.	.	.
25JUL93	1	10:32	D	5.00	11.4500	.	.	.	.
25JUL93	1	10:13	D	6.00	11.4583	.	.	.	.
25JUL93	2	16:53	D	6.00	11.1167	.	.	.	.
26JUL93	1	10:43	D	2.75	11.0500	.	.	.	2
26JUL93	2	16:30	D	2.75	11.0167	.	.	.	.
26JUL93	1	10:25	D	4.00	10.9417	.	.	.	.
26JUL93	2	16:49	D	5.00	10.8500	.	1	.	.
26JUL93	1	10:06	D	6.00	10.8917	.	.	.	.
26JUL93	2	17:08	D	6.00	10.8833	.	.	.	.
27JUL93	2	18:52	D	2.75	14.1083	.	.	.	.
27JUL93	2	18:30	D	4.00	13.3333	.	.	1	.
27JUL93	2	18:06	D	5.00	13.2417	1	.	.	.
27JUL93	2	17:34	D	6.00	13.7333	2	.	.	.
28JUL93	1	10:59	D	2.75	11.4250	.	.	.	.
28JUL93	2	16:08	D	2.75	11.6000	.	.	.	.
28JUL93	1	10:39	D	4.00	11.3250	.	.	.	.
28JUL93	2	16:30	D	5.00	11.2917	.	.	.	.
28JUL93	1	10:16	D	6.00	11.3583	1	.	.	.
28JUL93	2	16:49	D	6.00	11.4583	10	.	.	.
29JUL93	1	11:16	D	2.75	11.5000	.	.	.	.
29JUL93	2	16:12	D	2.75	11.0917	.	.	.	3
29JUL93	2	16:31	D	4.00	10.9333	3	3	.	.
29JUL93	1	10:50	D	5.00	11.7417	1	.	1	.
29JUL93	1	10:27	D	6.00	11.2667	.	.	.	.
29JUL93	2	16:52	D	6.00	10.9083	.	.	.	.
30JUL93	1	10:41	D	2.75	11.2167	.	.	.	.
30JUL93	2	15:59	D	2.75	11.0917	.	.	.	1
30JUL93	1	10:22	D	4.00	10.9083	.	.	.	.
30JUL93	2	16:18	D	5.00	10.9833	.	.	.	.
30JUL93	1	9:56	D	6.00	11.4333	2	.	.	.
30JUL93	2	16:37	D	6.00	10.9417	.	.	.	.
31JUL93	1	11:44	D	2.75	11.4000	.	.	.	1
31JUL93	2	16:02	D	2.75	11.2667	.	.	.	.
31JUL93	2	16:21	D	4.00	11.2750	.	.	.	.
31JUL93	1	11:23	D	5.00	11.4750	4	.	.	.
31JUL93	1	10:17	D	6.00	11.5083	15	.	.	.
31JUL93	2	16:41	D	6.00	10.5833	1	.	.	.
01AUG93	1	11:23	D	2.75	11.4250	.	.	.	5
01AUG93	2	16:22	D	2.75	11.2083	.	.	.	2

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01AUG93	2	16:43	D	5.00	11.1250	2	.	.	.
01AUG93	1	10:26	D	6.00	11.3917	6	.	.	.
01AUG93	2	17:05	D	6.00	11.1583	.	.	.	.
02AUG93	1	11:22	D	2.75	11.1500	.	.	.	.
02AUG93	2	16:02	D	2.75	11.1583	.	.	.	.
02AUG93	2	16:24	D	4.00	10.8750	.	.	.	.
02AUG93	1	10:55	D	5.00	11.0000	1	.	.	.
02AUG93	1	10:25	D	6.00	10.9333	5	1	.	.
02AUG93	2	16:42	D	6.00	11.1333	8	.	.	.
03AUG93	1	11:15	D	2.75	11.6583	.	.	.	.
03AUG93	2	16:05	D	2.75	11.6833	.	.	.	.
03AUG93	1	10:55	D	4.00	11.1417	.	.	.	.
03AUG93	2	16:25	D	5.00	11.3583	12	.	.	.
03AUG93	1	10:18	D	6.00	11.3750	6	.	.	.
03AUG93	2	17:04	D	6.00	11.4500	9	.	.	.
04AUG93	1	11:19	D	2.75	11.2333	1	.	.	3
04AUG93	2	16:31	D	2.75	11.3750	.	.	.	11
04AUG93	2	17:36	D	4.00	11.4333	.	1	1	2
04AUG93	1	10:46	D	5.00	11.1583	9	.	.	.
04AUG93	1	10:09	D	6.00	11.1667	14	.	.	.
04AUG93	2	18:39	D	6.00	11.3250	6	.	.	.
05AUG93	1	11:36	D	2.75	11.9833	.	.	.	5
05AUG93	2	16:21	D	2.75	12.0083	.	.	.	1
05AUG93	1	10:51	D	4.00	12.0250	.	1	1	2
05AUG93	2	16:58	D	5.00	11.3417	1	1	.	.
05AUG93	1	10:15	D	6.00	11.5083	.	.	.	.
05AUG93	2	17:42	D	6.00	11.6167	7	1	.	.
06AUG93	1	12:00	D	2.75	11.2917	.	.	.	2
06AUG93	2	16:07	D	2.75	11.2417	.	.	.	.
06AUG93	2	16:36	D	4.00	10.9333	.	.	.	2
06AUG93	1	11:07	D	5.00	11.3333	14	.	.	2
06AUG93	1	10:02	D	6.00	11.3417	22	.	.	.
06AUG93	2	17:10	D	6.00	10.7667	5	.	.	.
07AUG93	1	12:03	D	2.75	11.7417	.	.	.	.
07AUG93	2	16:03	D	2.75	12.1167	.	.	.	1
07AUG93	1	11:19	D	4.00	11.2333	.	2	.	1
07AUG93	2	16:42	D	5.00	11.6333	1	2	.	.
07AUG93	1	10:07	D	6.00	11.6250	12	3	.	.
07AUG93	2	17:28	D	6.00	11.6667	5	1	.	.
08AUG93	1	11:20	D	2.75	5.6750	.	.	.	.
08AUG93	2	16:07	D	2.75	5.7583	.	.	.	.
08AUG93	1	11:04	D	4.00	5.6583	.	1	.	.
08AUG93	2	16:22	D	4.00	6.1167	.	.	.	.
08AUG93	1	10:45	D	5.00	5.4667	2	.	.	.
08AUG93	2	16:37	D	5.00	6.1417	1	.	.	.

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08AUG93	1	10:16	D	6.00	6.1250	3	.	.	.
08AUG93	2	16:55	D	6.00	6.0667	2	1	.	.
09AUG93	1	11:16	D	2.75	6.3917	.	.	.	3
09AUG93	2	16:05	D	2.75	7.2500	.	.	.	7
09AUG93	1	10:56	D	4.00	6.4167	1	1	.	1
09AUG93	2	16:27	D	4.00	6.6417	.	2	.	.
09AUG93	1	10:35	D	5.00	6.4167	3	.	.	.
09AUG93	2	16:49	D	5.00	7.2667	1	1	.	1
09AUG93	1	10:04	D	6.00	6.7500	7	2	.	.
09AUG93	2	17:09	D	6.00	7.2833	7	.	.	.
10AUG93	1	11:20	D	2.75	8.6500	.	.	.	.
10AUG93	2	18:01	D	2.75	9.3250	.	.	.	7
10AUG93	2	18:23	D	4.00	9.8750	1	.	1	1
10AUG93	1	10:47	D	5.00	7.9583	8	4	.	.
10AUG93	1	10:09	D	6.00	8.4167	12	.	.	.
10AUG93	2	18:44	D	6.00	9.5833	16	1	.	.
11AUG93	1	11:01	D	2.75	11.1167	2	1	.	2
11AUG93	2	16:06	D	2.75	11.4000	.	1	.	1
11AUG93	1	10:37	D	4.00	10.8583	3	1	.	.
11AUG93	2	16:24	D	5.00	10.8250	1	2	.	.
11AUG93	1	10:01	D	6.00	10.9583	22	2	.	.
11AUG93	2	16:45	D	6.00	10.9417	7	.	.	.
12AUG93	1	12:57	D	2.75	6.1333	.	2	.	.
12AUG93	1	11:07	D	5.00	6.0333	9	8	.	.
12AUG93	1	10:05	D	6.00	8.0167	16	2	.	.
13AUG93	1	11:07	D	2.75	6.0000	.	2	.	1
13AUG93	2	16:26	D	2.75	6.1000	1	.	.	2
13AUG93	1	10:52	D	4.00	5.8750	.	3	.	.
13AUG93	2	16:42	D	5.00	5.9750	6	1	.	.
13AUG93	1	10:28	D	6.00	5.9917	11	7	.	.
13AUG93	2	16:59	D	6.00	5.9333	2	1	.	.
14AUG93	1	11:00	D	2.75	8.6917	.	.	.	.
14AUG93	2	16:24	D	2.75	8.6500	.	7	.	1
14AUG93	2	16:50	D	4.00	8.3833	.	1	.	.
14AUG93	1	10:38	D	5.00	8.4000	1	3	.	.
14AUG93	1	10:10	D	6.00	8.7333	6	4	.	.
14AUG93	2	17:11	D	6.00	8.5833	17	2	.	.
15AUG93	1	10:46	D	2.75	6.1500	.	.	.	.
15AUG93	2	16:04	D	2.75	8.0250	.	6	.	.
15AUG93	1	10:32	D	4.00	5.9750	.	4	.	.
15AUG93	2	16:22	D	5.00	7.9083	.	.	.	.
15AUG93	1	10:11	D	6.00	6.0667	4	1	.	.
15AUG93	2	16:36	D	6.00	7.9667	2	.	.	.
16AUG93	1	11:03	D	2.75	8.1667	.	.	.	2
16AUG93	2	16:06	D	2.75	8.2000	.	.	.	.

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16AUG93	1	10:47	D	4.00	8.0333	.	.	.	.
16AUG93	2	16:21	D	4.00	8.0417	.	3	.	.
16AUG93	1	10:27	D	5.00	8.0167	2	.	.	.
16AUG93	2	16:38	D	5.00	7.9833	5	1	.	.
16AUG93	1	10:06	D	6.00	8.0167	3	.	.	.
16AUG93	2	16:59	D	6.00	7.9083	3	.	.	.
17AUG93	1	11:44	D	2.75	11.5417	1	6	.	5
17AUG93	2	16:08	D	2.75	8.4333	1	4	.	10
17AUG93	1	11:16	D	4.00	11.2833	1	18	.	.
17AUG93	2	16:32	D	4.00	8.3583	3	.	1	.
17AUG93	1	10:43	D	5.00	11.4167	10	4	.	.
17AUG93	2	16:53	D	5.00	9.2333	4	6	.	.
17AUG93	1	10:13	D	6.00	11.2250	8	2	.	.
17AUG93	2	17:31	D	6.00	8.5500	21	5	.	.
18AUG93	1	11:12	D	2.75	8.1167	.	.	.	.
18AUG93	2	16:08	D	2.75	8.2250	.	.	.	.
18AUG93	1	10:54	D	4.00	7.9250	1	.	.	.
18AUG93	2	16:23	D	4.00	7.9750	.	.	.	.
18AUG93	1	10:35	D	5.00	7.9833	3	.	.	.
18AUG93	2	16:38	D	5.00	7.9167	3	.	.	.
18AUG93	1	10:13	D	6.00	7.9250	7	1	.	.
18AUG93	2	16:59	D	6.00	8.0000	2	.	.	.
19AUG93	1	10:48	D	2.75	6.0333	.	3	.	.
19AUG93	2	16:04	D	2.75	6.0000	1	.	.	1
19AUG93	1	10:35	D	4.00	5.9417	.	.	.	.
19AUG93	2	16:19	D	5.00	6.3583	13	1	.	.
19AUG93	1	10:14	D	6.00	5.9000	3	.	.	.
19AUG93	2	16:55	D	6.00	6.1583	9	.	.	.
20AUG93	1	11:04	D	2.75	8.1250	.	.	.	2
20AUG93	2	16:04	D	2.75	8.0417	.	2	.	1
20AUG93	1	10:48	D	4.00	8.0583	1	.	.	.
20AUG93	2	16:20	D	4.00	7.9750	1	.	.	.
20AUG93	1	10:29	D	5.00	8.1000	6	1	.	.
20AUG93	2	16:35	D	5.00	7.9333	4	.	.	.
20AUG93	1	10:01	D	6.00	8.08333	19	.	.	.
20AUG93	2	16:53	D	6.00	8.02500	2	1	.	.
21AUG93	1	11:22	D	2.75	6.38333	1	4	.	.
21AUG93	2	16:38	D	2.75	6.28333	.	9	.	.
21AUG93	1	11:00	D	4.00	5.00000	4	1	.	.
21AUG93	2	17:00	D	4.00	6.38333	1	10	.	.
21AUG93	1	10:35	D	5.00	6.32500	9	1	.	.
21AUG93	2	17:26	D	5.00	6.30000	5	2	.	1
21AUG93	1	10:05	D	6.00	6.21667	13	.	.	.
21AUG93	2	17:54	D	6.00	6.25000	12	.	.	.
22AUG93	1	11:02	D	2.75	6.10833	.	13	.	3

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22AUG93	2	16:07	D	2.75	6.04167	1	4	.	.
22AUG93	2	16:24	D	4.00	5.97500	1	10	.	.
22AUG93	1	10:47	D	5.00	4.03333	2	.	.	.
22AUG93	1	10:08	D	6.00	6.14167	23	1	.	.
22AUG93	2	16:44	D	6.00	5.93333	8	1	.	.
23AUG93	1	10:59	D	2.75	6.54167	.	4	.	2
23AUG93	2	16:16	D	2.75	6.24167	.	4	.	1
23AUG93	1	10:40	D	4.00	6.29167	4	.	.	.
23AUG93	2	16:32	D	5.00	6.08333	2	1	.	.
23AUG93	1	10:07	D	6.00	6.36667	17	1	.	.
23AUG93	2	16:49	D	6.00	6.15833	3	1	.	.
24AUG93	1	11:31	D	2.75	6.30833	.	.	.	7
24AUG93	2	16:08	D	2.75	6.21667	.	.	.	1
24AUG93	2	16:23	D	4.00	6.10833	1	18	.	.
24AUG93	1	11:01	D	5.00	6.18333	8	1	.	.
24AUG93	1	10:20	D	6.00	6.35000	16	1	.	.
24AUG93	2	16:48	D	6.00	6.15833	5	.	.	.
25AUG93	1	10:43	D	2.75	4.27500	.	.	.	.
25AUG93	2	16:07	D	2.75	4.14167	.	1	.	.
25AUG93	1	10:31	D	4.00	4.09167	.	1	.	.
25AUG93	2	16:20	D	5.00	4.17500	.	.	.	.
25AUG93	1	10:05	D	6.00	4.17500	9	.	.	.
25AUG93	2	16:31	D	6.00	4.20833	.	.	.	.
26AUG93	1	10:42	D	2.75	6.25833	.	.	.	1
26AUG93	2	16:00	D	2.75	8.36667	.	3	.	2
26AUG93	2	16:26	D	4.00	4.94167	2	17	.	.
26AUG93	1	10:28	D	5.00	6.15833	.	.	.	.
26AUG93	1	10:04	D	6.00	4.16667	11	.	.	.
26AUG93	2	16:46	D	6.00	3.37500	10	.	.	.
27AUG93	1	10:41	D	2.75	6.49167	.	30	.	.
27AUG93	2	16:08	D	2.75	7.40833	.	.	.	.
27AUG93	1	10:27	D	4.00	7.25000	.	1	.	.
27AUG93	2	16:21	D	5.00	5.91667	12	.	.	.
27AUG93	1	10:06	D	6.00	7.30833	5	.	1	.
27AUG93	2	16:41	D	6.00	5.35000	4	.	.	.
28AUG93	1	11:10	D	2.75	6.40833	.	2	.	.
28AUG93	2	16:55	D	2.75	8.30833	1	.	.	1
28AUG93	2	17:19	D	4.00	4.15000	11	2	.	.
28AUG93	1	10:52	D	5.00	5.24167	1	.	.	.
28AUG93	1	10:03	D	6.00	6.31667	29	.	.	.
28AUG93	2	17:44	D	6.00	7.90000	4	.	.	.
29AUG93	1	10:58	D	2.75	6.28333	1	.	.	.
29AUG93	2	16:23	D	2.75	6.19167	.	15	.	1
29AUG93	1	10:42	D	4.00	6.10000	1	.	.	.
29AUG93	2	16:44	D	5.00	6.00000	2	.	.	.

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29AUG93	1	10:06	D	6.00	6.37500	18	.	.	.
29AUG93	2	17:03	D	6.00	6.07500	12	.	.	.
30AUG93	1	10:42	D	2.75	7.95833	.	.	.	3
30AUG93	2	16:04	D	2.75	8.08333	1	15	.	.
30AUG93	2	16:26	D	4.00	7.90000	.	1	.	.
30AUG93	1	10:28	D	5.00	7.91667	.	.	.	.
30AUG93	1	10:05	D	6.00	7.88333	6	.	.	.
30AUG93	2	16:40	D	6.00	7.85833	2	.	.	.
31AUG93	1	10:44	D	2.75	8.15833	.	.	.	.
31AUG93	2	16:14	D	2.75	6.22500	.	.	.	.
31AUG93	1	10:22	D	4.00	8.13333	2	2	.	.
31AUG93	2	16:27	D	5.00	6.20833	7	.	.	.
31AUG93	1	10:05	D	6.00	8.05833	1	.	.	.
31AUG93	2	16:48	D	6.00	6.81667	12	.	.	.
01SEP93	1	11:00	D	2.75	8.30833	.	.	.	.
01SEP93	2	16:10	D	2.75	8.19167	.	.	.	3
01SEP93	2	16:28	D	4.00	8.24167	2	.	.	.
01SEP93	1	10:39	D	5.00	8.09167	3	.	.	.
01SEP93	1	10:12	D	6.00	4.62500	13	.	.	.
01SEP93	2	16:45	D	6.00	5.02500	15	.	.	.
02SEP93	1	10:51	D	2.75	6.05833	1	4	.	1
02SEP93	2	16:05	D	2.75	8.05833	.	1	.	.
02SEP93	1	10:33	D	4.00	5.96667	3	.	.	.
02SEP93	2	16:21	D	5.00	7.91667	5	.	.	.
02SEP93	1	10:09	D	6.00	5.91667	9	.	.	.
02SEP93	2	16:42	D	6.00	3.88333	12	.	.	.
03SEP93	1	10:45	D	2.75	8.05000	.	.	.	.
03SEP93	2	16:01	D	2.75	8.08333	.	.	.	2
03SEP93	2	16:16	D	4.00	7.93333	1	.	.	.
03SEP93	1	10:24	D	5.00	7.88333	5	.	.	.
03SEP93	1	10:04	D	6.00	7.86667	8	.	.	.
03SEP93	2	16:33	D	6.00	7.91667	11	.	.	.
04SEP93	1	10:41	D	2.75	8.31667	.	.	.	1
04SEP93	2	18:08	D	2.75	8.52500	1	.	.	.
04SEP93	1	10:23	D	4.00	8.20000	1	.	.	.
04SEP93	2	18:25	D	5.00	8.23333	2	1	.	.
04SEP93	1	10:02	D	6.00	8.26667	3	.	.	.
04SEP93	2	18:45	D	6.00	8.09167	12	.	.	.
05SEP93	1	10:39	D	2.75	8.08333	.	1	.	1
05SEP93	2	16:17	D	2.75	8.02500	1	.	.	.
05SEP93	2	16:39	D	4.00	7.89167	1	.	.	.
05SEP93	1	10:24	D	5.00	7.91667	.	.	.	.
05SEP93	1	10:03	D	6.00	7.91667	2	.	.	.
05SEP93	2	16:54	D	6.00	8.00000	9	.	.	.
07SEP93	1	10:48	D	2.75	8.25833	.	1	.	5

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07SEP93	2	16:02	D	2.75	8.29167	1	2	.	1
07SEP93	2	16:23	D	4.00	8.15833	.	.	.	.
07SEP93	1	10:28	D	5.00	8.10833	1	.	.	.
07SEP93	1	10:02	D	6.00	8.16	4	.	.	.
07SEP93	2	16:40	D	6.00	8.43	2	.	.	.
08SEP93	1	10:51	D	2.75	8.38	.	1	.	4
08SEP93	2	17:32	D	2.75	7.45	1	1	.	.
08SEP93	1	10:30	D	4.00	8.43	1	.	.	.
08SEP93	2	17:51	D	5.00	6.26	1	.	.	.
08SEP93	1	10:04	D	6.00	8.39	7	.	.	.
08SEP93	2	18:06	D	6.00	5.61	3	.	.	.
09SEP93	1	10:42	D	2.75	5.42	.	1	.	3
09SEP93	2	16:08	D	2.75	5.15	.	1	.	.
09SEP93	2	16:21	D	4.00	5.08	1	.	.	.
09SEP93	1	10:29	D	5.00	5.12	.	.	.	.
09SEP93	1	10:06	D	6.00	5.77	7	.	.	.
09SEP93	2	16:35	D	6.00	4.94	4	.	.	.
10SEP93	1	10:58	D	2.75	4.25	.	.	.	1
10SEP93	2	20:40	D	2.75	4.22	.	1	.	.
10SEP93	1	10:46	D	4.00	4.43	.	.	.	.
10SEP93	1	10:29	D	6.00	4.89	3	.	.	.
10SEP93	2	20:52	D	6.00	4.20	.	.	.	.
11SEP93	1	10:32	D	2.75	4.93	.	1	.	.
11SEP93	2	16:05	D	2.75	3.98	.	1	.	.
11SEP93	2	16:17	D	4.00	3.86	.	.	.	.
11SEP93	1	10:18	D	5.00	4.05	1	.	.	.
11SEP93	1	10:03	D	6.00	3.86	2	.	.	.
11SEP93	2	16:29	D	6.00	3.81	.	.	.	.
12SEP93	1	10:41	D	2.75	5.12	.	1	.	1
12SEP93	2	18:14	D	2.75	4.47	.	1	.	.
12SEP93	1	10:26	D	4.00	5.17	.	.	.	.
12SEP93	2	18:29	D	5.00	4.63	1	1	.	.
12SEP93	1	10:07	D	6.00	4.33	4	.	.	.
12SEP93	2	18:47	D	6.00	4.70	3	.	.	.
13SEP93	1	10:37	D	2.75	8.38	.	3	.	1
13SEP93	1	10:21	D	5.00	5.51	2	.	.	.
13SEP93	1	10:04	D	6.00	5.58	6	.	.	.
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TOTAL					2949.31	993	356	14	228

(a) Two fishing periods daily, 1000-1200 = 1, 1600-1800 = 2.

(b) Gillnet stretched mesh (in inches).

(c) Whitefish.