U.S. Fish and Wildlife Service
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Eulachon Subsistence Harvest Opportunities, Final Report

Final Report No. FIS02-075-1

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FINAL REPORT SUMMARY PAGE

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Investigators/Affiliations: Tim Joyce / USDA Forest Service Cordova Ranger District, Michael Lambert / Native Village of Eyak, Steve Moffitt / Alaska Department of Fish and Game

Management Region: Gulf of Alaska

Information types: Subsistence fishery; harvest monitoring; stock status and trends; distribution, abundance and life history of fish species

Issues addressed: (1) Estimate subsistence harvest of eulachon on the Copper River Delta, (2) Determine if sufficient harvest opportunities are available for eulachon.

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EXECUTIVE SUMMARY

The purpose of this study was to determine if sufficient harvest opportunities are available for eulachon, *Thaleichthys pacificus*, on the Copper River Delta to meet the subsistence needs of Cordova residents. The project was conducted by the U.S. Forest Service (USFS), Native Village of Eyak (NVE) and Alaska Department of Fish and Game (ADF&G), and was funded by the U.S. Fish and Wildlife Service (USFWS) through the Office of Subsistence Management (OSM). In-kind funding for staff biologists was provided by the Bureau of Indian Affairs (BIA), and USFS. In-kind funding for a staff social scientist was provided through the USFWS Partners for Fisheries Monitoring Program. This report summarizes results from the two-year (2002, 2003) project. Objectives for the project were to:

(1) Identify key eulachon harvesters in the community;
(2) Obtain information on traditional harvest areas and the presence of eulachon at these areas;
(3) Check local streams and traditional harvest areas on a weekly basis throughout the late winter and spring to check for the presence of eulachon;
(4) Estimate the harvest of eulachon from each location where subsistence fishing occurs, and the number of days that eulachon are present; and
(5) Determine if ample harvest opportunity exists for eulachon on the Copper River Delta using catch data and data from the Community Profile Database

Presence/absence surveys were conducted from mid-January to the end of June in 2002 and from mid-January to early June in 2003. The run timing of eulachon on the Copper River Delta extended later in 2002 than any year since 1998. Eulachon were present in the Copper River, Alaganik Slough and Eyak River at various times from approximately 24 May to 24 June 2002. No eulachon were present in Ibeck Creek in 2002. In 2003, eulachon were present in Ibeck Creek from approximately 15 February to 1 March, in the Alaganik River from approximately 19 February until 27 February as well as in the Copper River in early March. A much larger run of eulachon returned to both the Alaganik and the Copper Rivers in late May and early June. A creel survey of subsistence harvesters was conducted at Flag Point Channel (27-mile) on the Copper River from 25 May to 30 June 2002 and at 35-mile and 37-mile channels from 30 May to 1 June in 2003. A creel survey was also conducted at Ibeck Creek in 2003 from 17 February to 1 March. Estimated eulachon harvest in 2002 was 1,123 kg edible weight, with 95% confidence intervals ranging from 501 to 1,744 kg. The age of eulachon based on otolith samples in 2002 ranged from 3 to 5 years, with the majority being age-4 fish. The majority of eulachon sampled were males (69%), and the average size of eulachon in the 37-Mile channel was significantly different than the average size of eulachon at the Flag Point channel. The estimated eulachon harvest in 2003 was 716 kg edible weight, with 95% confidence intervals ranging from 665 to 767 kg. The age of eulachon ranged from 2 to 5 years in Ibeck Creek, with the majority of the fish being age-3 fish and nearly all (94.6%) of the fish sampled being males. The age of eulachon in the Copper River in 2003 ranged from 3 to 5 years with the majority of the fish sampled being age-5 with 70% being males. As was the case in 2002, the average size of eulachon in the 37-Mile Channel was significantly different than eulachon in the Flag Point Channel.

INTRODUCTION

The U.S Fish and Wildlife Service (USFWS), Office of Subsistence Management (OSM), and the U.S. Forest Service (USFS) funded the Native Village of Eyak (NVE) and the Alaska Department of Fish and Game (ADF&G) to undertake a two-year study to determine if sufficient harvest opportunities are available for eulachon (*Thaleichthys pacificus*) on the Copper River Delta. In-kind funding was provided through the USFS, and the Bureau of Indian Affairs (BIA) for staff biologists. In-kind funding for a social scientist was provided by the USFWS Partners for Fisheries Monitoring Program.

The Copper River Delta eulachon subsistence harvest is of great value to both Alaska Native and non-native participants. The town of Cordova is the closest community to the Copper River Delta and has a population of 2,454 (U.S. Census Bureau, 2000 Census of Population and Housing). The villages of Chenega and Tatitlek located in Prince William Sound have a combined population of 193 (U.S Census Bureau, 2000 Census of Population and Housing). Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA) provides an opportunity for rural residents engaged in a subsistence way of life to do so on public lands. Residents of Cordova, Tatitlek and Chenega qualify as rural under ANILCA.

Alaska Natives in Cordova and surrounding villages have a long history of harvesting the natural resources found on the Copper River Delta for subsistence purposes, including eulachon. Birket-Smith and DeLaguna (1938) indicated that the Eyak Tribe caught eulachon at night using dipnets or fish spears, and attracted the fish using fire carried in their canoes. A historical Eyak village site located on the Alaganik River provided easy access to eulachon in the area. Eulachon oil may have been rendered at this site during the spring months. Eulachon were a primary source of edible oil for many Northwest Coast Indians (Collison 1941; Kuhnlein, et al. 1982; Macnair 1971). The oil was consumed with dried foods, and was also used as a preservative, a medicinal, and a ceremonial item (Betts 1994; Kuhnlein, et al. 1982).

A household survey of Tribal members, conducted in 2001 by NVE and USFS, indicated that 84% of the households interviewed from Cordova, Chenega, and Tatitlek had used eulachon sometime in their life, and that most of the harvest came from Ibeck Creek, Alaganik River and Copper River. Household members either harvested eulachon themselves or received eulachon through sharing. The primary uses of eulachon were identified as food and bait (Joyce et al. 2002).

Thaleichthys pacificus are the largest of the west coast smelts with an average standard length of approximately 20 cm. Common names include eulachon, hooligan, candlefish and oilfish. Distribution is along the West Coast of North America from the Klamath River in California to Bristol Bay and the Pribilof Islands of the eastern Bering Sea (Scott and Crossman 1973). Eulachon are an anadromous smelt that move short distances up coastal rivers to spawn, often just as the river ice is breaking up. Eggs are scattered and adhere to the bottom substrate. Most adult eulachon die after spawning. Eggs hatch in two to three weeks, and larvae are carried downstream and out to sea. Adults are not known to spawn prior to age 3 (Scott and Crossman 1973). Based on recent studies, it appears that the age distribution of eulachon on the Copper River Delta is similar to the standard life history seen in other systems, with the majority of the spawning population being age 3, 4, and 5 (Moffitt et al. 2002). Betts (1994) and Hinrichsen (1998) indicated that spawning runs of eulachon are unpredictable due to shifts in variability of run strength, timing, and location. Eulachon runs on the Copper River Delta have proven to be

unpredictable as well. Eulachon harvest on the Copper River Delta may occur in some drainages and not in others, depending on the year. Eulachon can also be found as early as January and as late as June on the Copper River Delta.

Moffitt et al. (2002) estimated the 2001 biomass of eulachon to be between 2,359 and 8,074 metric tons in the Flag Point Channel of the Copper River. The total estimated egg and larval abundance was used to calculate the spawning biomass of adults similar to Pederson et al. (1995). Biomass estimates of eulachon in other channels of the Copper River and Copper River Delta river systems have not been made.

The Alaska State Board of Fisheries (BOF) has made a customary and traditional use determination for subsistence smelt in the Prince William Sound area, which includes the Copper River Delta. The BOF did not make a determination of the amount of smelt needed to insure subsistence needs are met (Alaska Administrative Code, 2000; 5 AAC 01.616(c)(d)). The Federal Subsistence Board has not made a customary and traditional finding for eulachon on the Copper River Delta. Results from this project will aid in determining the timing, location and amount of subsistence eulachon harvest on the Copper River Delta, and may assist both Boards in future determinations.

Objectives

Overall objectives for this two-year project were to:

(1) Identify key eulachon harvesters in the community;
(2) Obtain information on traditional harvest areas and the presence of eulachon at these areas;
(3) Check local streams and traditional harvest areas on a weekly basis throughout the late winter and spring to check for the presence of eulachon;
(4) Estimate the harvest of eulachon from each location where subsistence fishing occurs and the number of days that eulachon are present;
(5) Determine if existing runs provide sufficient harvest opportunities; and
(6) Work with user groups and ADF&G to develop a harvest management plan for the Copper River that incorporates subsistence needs.

The first year of this study addressed the first four objectives, and all of the objectives are addressed in this final project report. Although this study attempts to estimate the timing, location, and the amount of eulachon harvested for subsistence use, it does not address eulachon biomass. The age, length, and sex of eulachon were collected to document biological differences among river systems.

Study Area

The Copper River drains an area of more than 62,100 km^2 with an annual mean discharge from 1988 to 1995 of 1,625 m^3/sec (Brabets 1997). The Copper River Delta is an expansive alluvial floodplain and lies at the base of this watershed.

The study area was on the Copper River Delta, and ranged from Eyak River (6-Mile Bridge, Copper River Highway) to the Copper River Highway 38-Mile Channel. Several traditional eulachon harvest areas were identified on the Copper River Delta and sampling

targeted these sites (Figure 1). Most of the research effort and harvest surveys focused on the Copper River at the 27-mile bridge in Flag Point Channel, Ibeck Creek, and the Alaganik River.

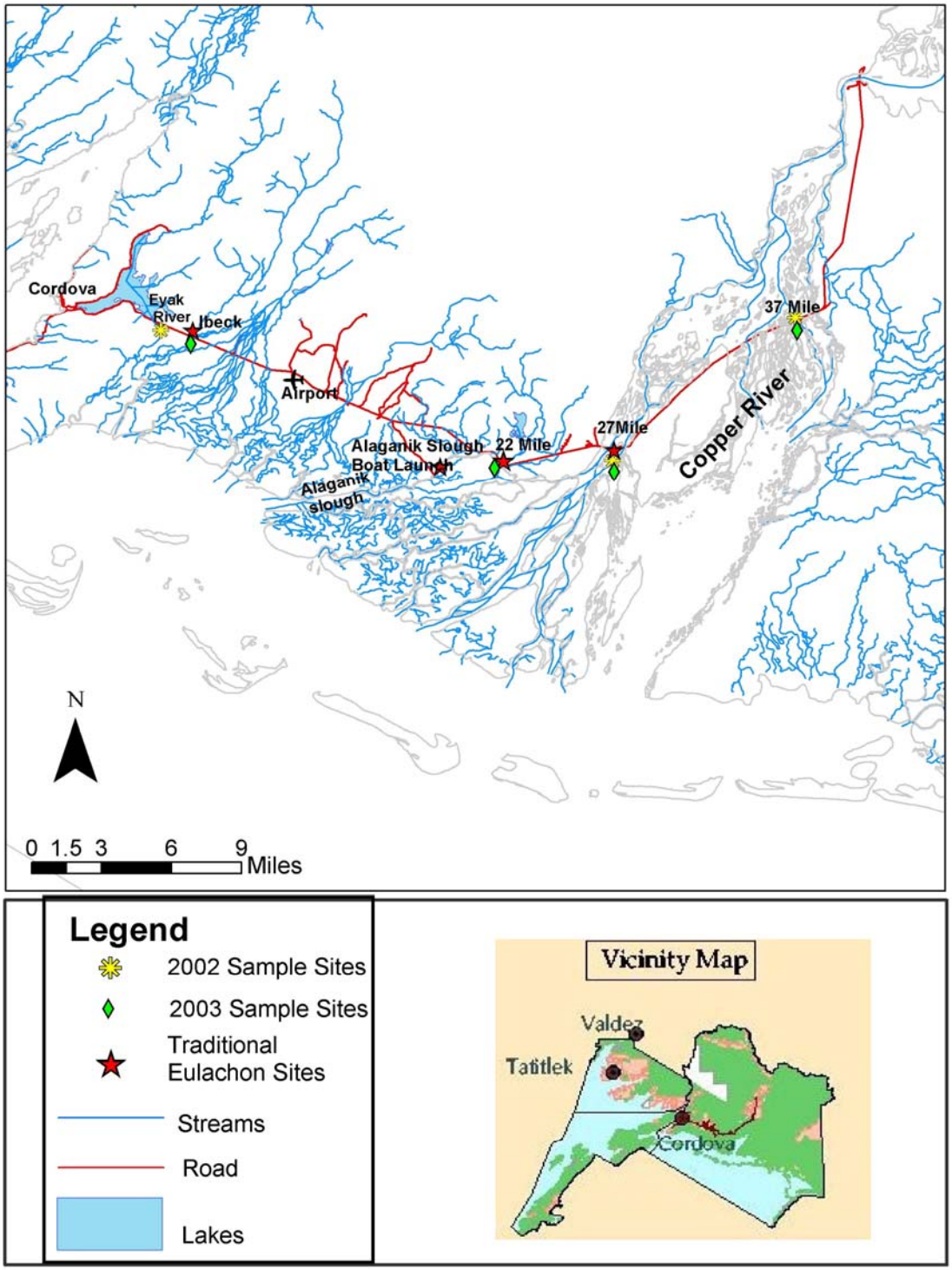

Figure 1. Copper River Delta study area and traditional eulachon subsistence harvest areas.

Moffitt et al. (2002) has identified six known eulachon spawning systems: Copper River, Martin River, Alaganik Slough, Scott River, Ibeck Creek and Eyak River. Eulachon are thought to use the Sheridan River as well (Figure 2). The Martin River was not one of the systems surveyed as it is not accessible by road.

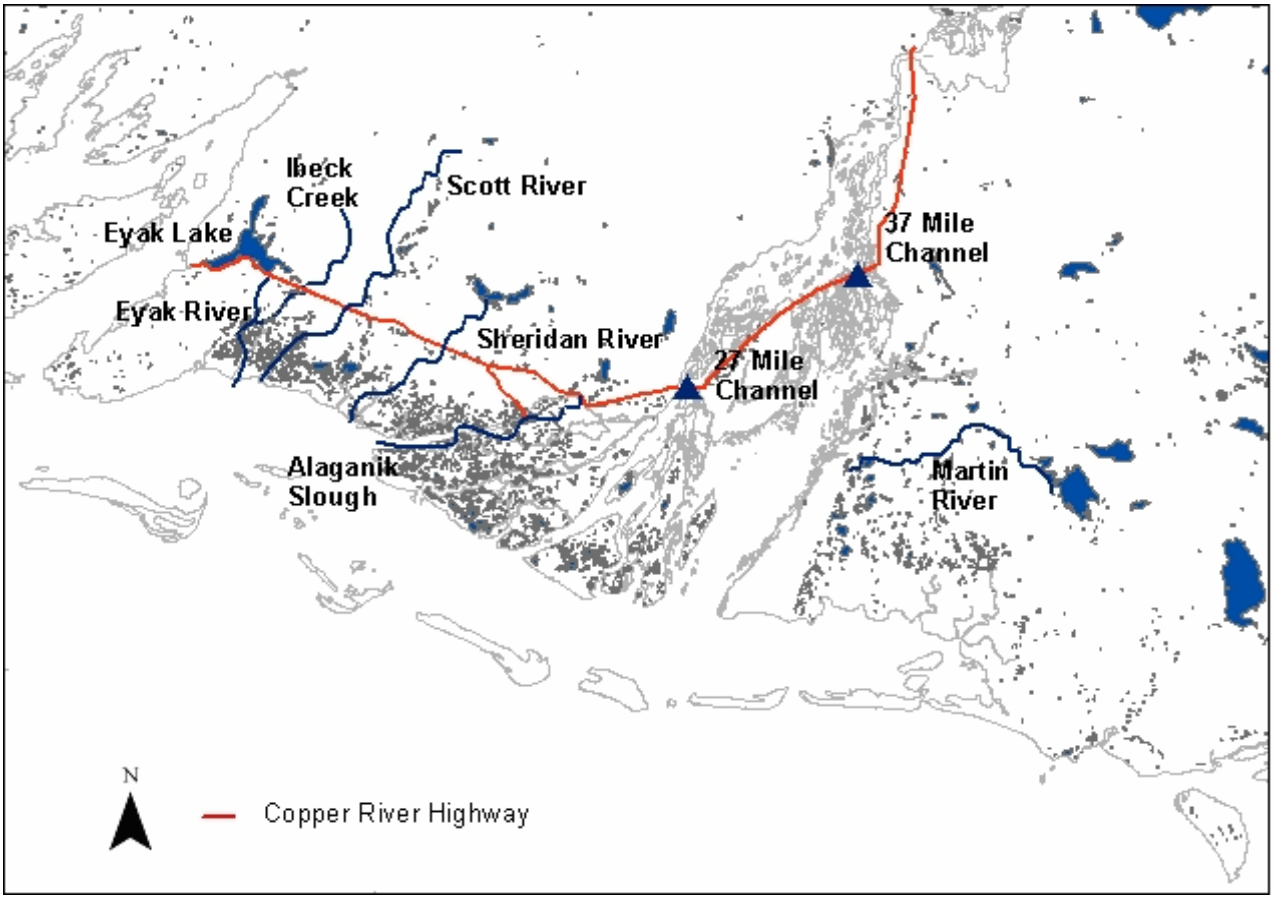

Figure 2. Copper River Delta and drainage systems with eulachon runs.

METHODS

Presence/Absence and Creel Surveys

NVE technicians began presence/absence eulachon surveys in January on Ibeck Creek. Surveys were expanded to include Alaganik Slough and the Copper River as they became accessible by road. Traditional knowledge of run timing and harvest location, which was obtained through interviews with long-term eulachon harvesters in 2001, assisted in determining survey times and locations (Joyce et al. 2002). Eulachon typically enter Ibeck Creek in late

winter, and then enter river systems farther east in the Delta later in the year as drainages open up from ice thaw.

Presence/absence surveys were conducted by driving the Copper River Highway to each river system. Technicians would check accessible rivers for the presence of eulachon twice each week, both visually and with a dip net. Other signs that indicated the presence of eulachon included increased bird activity along the river or the presence of subsistence harvesters. Technicians often walked down to the mouth of Ibeck Creek to get an early indication of the presence/absence of eulachon. Reported sightings by commercial salmon harvesters of large quantities of eulachon off the mouth of the Copper River were also used by technicians to check for the presence of eulachon.

Once the presence of eulachon was confirmed, a direct-access creel survey was implemented to estimate the quantity of eulachon harvested by dip net. All subsistence harvesters exiting the access site during the sampling period were surveyed. A stratified random sample design was used to develop the creel schedule for the survey in 2002. Harvest obtained from stratified random sampling was then expanded for periods not sampled.

In May and June of 2002, each fishing day was assigned to be 16 h (0700-2300) long, consisting of four 4-h periods: (1) 0700-1100 hours, (2) 1100-1500 hours, (3) 1500-1900 hours, and (4) 1900-2300 hours. Each fishing week consisted of 28 or 37 periods. Periods were randomly sampled within a fishing week. The number of sampling periods within a fishing week varied from 7 to 15. Due to crew scheduling problems, some sampling periods were dropped and others added in a non-random fashion.

On Ibeck Creek, in February and March of 2003, each fishing day was considered to be 10 h (0800-1800) long, consisting of two 5-h periods: (1) 0800-1300 hours, and (2) 1300-1800 hours. Each fishing week consisted of 14 periods. Every period was sampled during the harvest and continued until no fish were remaining to be harvested.

In 2003, sampling in May and June on the Copper River consisted of an 18-h day (0500-2300) with two sample periods that were assigned to be 9-h in length: (1) 0500-1400, and (2) 1400-2300. The fishing week consisted of 14 periods. Only 4 periods were sampled because of the short duration of the run and all four periods were afternoon periods.

The following information was collected during each interview and recorded on a data form: hours fished, amount of eulachon harvested, number in fishing party, number of dip nets used, harvest utilization, percent of harvest shared, ethnicity, residency, and whether they will fish again that year (Appendix A).

Total harvest in 2002, based on stratified random sampling, was estimated using the following equations. First, mean harvest was estimated across all sample periods within a fishing week (Cochran 1977):

$$\bar{y}_w = \frac{\sum_{i=1}^{n_w} y_{wi}}{n_w}, \text{ where} \qquad (1)$$

i = sampling period
w = fishing week
y_{wi} = harvest obtained from the i^{th} sampling period in the w^{th} fishing week
n_w = number of sampling periods in a fishing week.

The mean harvest was then expanded by the number of periods in a fishing week to obtain an estimate of the total harvest for that week:

$$\hat{y}_w = N_w \bar{y}_w \text{, where} \quad (2)$$

N_w = total number of periods in a fishing week.

Finally, total harvest across all fishing weeks was calculated by summing the individual fishing week harvest estimates:

$$\hat{y}_{total} = \sum_{w=1}^{T} \hat{y}_w \text{, where} \quad (3)$$

T = total number of fishing weeks.

The variance of the total harvest was estimated using the following equation:

$$V(\hat{y}_{total}) = \sum_{w=1}^{T} N_w^2 \left(\frac{N_w - n_w}{N_w}\right)\left(\frac{s_w^2}{n_w}\right) \quad (4)$$

$$\text{where} \quad s_w^2 = \sum_{i=1}^{n_w} \frac{(y_{wi} - \bar{y}_w)^2}{n_w - 1} \quad (5)$$

Fishing effort and its variance were estimated by substituting the appropriate fishing effort statistics in place of harvest in equations 1 through 5 above.

Total harvest in 2003 was estimated using the same equations except that daily estimates were made instead of by week. Thus harvest and the associated variances were calculated for Ibeck Creek and the 37-Mile area by substituting the appropriate harvest by day in equations 1 through 5 above.

Age, Weight, Length, and Sex Ratio

Three samples (early, middle, and late) were collected from each run when a sufficient number of fish were available. Each sample (n = 450) was set to simultaneously estimate all the age proportions within ± 5% of the true proportion 90% of the time (Thompson 1992). This assumed random sampling from a multinomial population with less than 5% of the otoliths being unreadable.

Samples were collected near the beginning, middle and end of large eulachon runs in the Flag Point Channel on the Copper River in 2002 and Ibeck Creek in 2003. Samples from other

systems were taken as opportunities arose since most of the runs were too small to support a harvest or were of a short duration.

Fish collected for biological sampling were measured for standard length (mm) and weight (g). No adjustments were made to the size measurements from fish samples that were frozen 1-3 months prior to measuring. The sex of each fish was determined by examination of the gonads or by external characteristics. Male eulachon have much longer pectoral and pelvic fins, as well as breeding tubercules on the head, fins, and scales (Morrow 1980). In most cases, the presence of eggs or milt in spawning fish confirmed the sex.

If a sufficient number of fish were available, 300 fish were sampled for sex composition. This sample size allowed the proportion of females to be estimated within ± 5% of the proportion 90% of the time (Cochran 1977). Sex ratios were estimated daily for most of the run at the Flag Point Channel in 2002 and Ibeck Creek in 2003. Fish were generally sexed live using the external, secondary sexual characteristics. If external characteristics were not sufficient, fish were squeezed to check gonad products for evidence of sex. Fish were captured with dip nets and either counted and sexed out of the net, or placed in a tote with water and counted back into the river. This may have violated the sampling without replacement assumption; however, given the size of the run, the probability of sampling a fish again is small

From the eulachon samples, ages were determined by examining the sagittae otolith bones. Scales, otoliths, and vertebrae were examined for age; however, otoliths had the only easily discernible circuli patterns. The otoliths were removed by making a ventral cut through the transverse plane just posterior of the preoperculum. They were removed with forceps, cleaned of the saccule membrane, and dried. All otoliths were stored dry in depressions of black plastic trays covered with masking tape. The file name, harvest date, tray number, and fish numbers were written on the masking tape on each tray.

Binocular dissecting scopes with 10x eyepieces and variable objective lenses (0.8 to 4.0) were used to examine the otoliths. Whole otoliths were read in water, convex side up, on black plastic trays under reflected light. Submerging the otoliths in water reduces the glare and improves the contrast between the translucent (hyaline) and opaque zones. Translucent zones appear dark when using reflected light and a black background. Both otoliths were examined if possible; however, sometimes one otolith was missing, or both otoliths were crystallized or too transparent for age determination.

Many otoliths tended to clear out quickly under water and became so transparent that they would have to be cleaned and dried before attempting to read again. Therefore, otoliths were read by placing water on no more than 10 otoliths at a time. All otoliths were examined by two readers. The first reader would examine the 10 otoliths and then the next reader. The two readers did not compare ages until between-reader differences were examined.

To assign an age to a fish, the translucent zones were counted out from the primordium or core. Readers counted the number of translucent zones in regions that were the easiest to read and had the highest count. At least two regions were counted, and if the counts from the first two regions did not agree, a third was counted. If two of the three areas had the same count, this count became the assigned age; otherwise the reader started again with area one. A translucent zone should be formed before spring spawning runs later than May. Therefore, the otolith edge was generally counted as a year; however, the timing of translucent zone deposition in eulachon has not been validated.

After all samples were examined, readers re-examined otoliths that were interpreted for age differently. The consensus age was used for any further analysis. If no consensus was reached, an error code was assigned and the fish was not included in the age composition.

RESULTS

Presence/Absence and Creel Surveys

Eulachon run timing on the Copper River Delta can vary. The run in 2002 extended later than runs documented from 1998 to 2001 (Moffitt et al. 2002). River systems were examined intermittently so timing information was imprecise. Eulachon were present during this study period in the Copper River, Alaganik Slough, Ibeck Creek, and Eyak River at various times each year. Table 1 provides the approximate dates when eulachon were present in the West Copper River Delta systems. No eulachon returned to Ibeck Creek in 2002.

In 2003, eulachon returned to all of the systems traditionally known to have eulachon runs. The return timing contrasted sharply with that of 2002. Many systems had fish as early as February as well as in May and June (Table 1). The May run of fish in the Copper River was several days late arriving and concentrated in different locations.

Table 1. Run timing of eulachon on the Copper River Delta, 2002.

	Run Timing	
Location	Beginning date	End date
2002		
Copper River		
Flag Point – 37-Mile Bridge	24 May	6 June
Flag Point	16 June	24 June
Alaganik Slough	9 June	16 June
Eyak River	16 June	23 June
2003		
Copper River[a]		
Flag Point	1 March	5 March
Flag Point	17 April	19 April
37-Mile Bridge	30 May	3 June
Ibeck Creek	15 February	1 March
Alaganik River	23 February	26 February
	29 May	15 June
Eyak River	15 February	22 February
	9 June	13 June

[a] Eulachon were present in the Flag Point channel in March and April as evidenced by birds capturing fish from the river, but actual start and end dates are estimated as fish were not captured by dip net.

Copper River

Two separate runs of eulachon were detected on the Copper River from 24 May to 24 June 2002 (Table 1). The creel survey began on 25 May and continued until 30 June and was stratified into five fishing weeks. The first four weeks consisted of 7-days starting on Saturday

and continuing through Friday. The fifth week consisted of 9-days starting on Saturday and continuing through Sunday. Since the eulachon run ended two days into what would have been the sixth fishing week the two extra days were combined with the fifth fishing week. A total of 59 people were interviewed at Flag Point Channel and all harvest occurred within the first two weeks of the eulachon run (Table 2).

In 2002, total fishing effort was estimated at 35.0 dipnet hours (SE = 10.4). A total of 152.3 buckets (SE = 43.0) of eulachon were harvested (Table 2). A 19 L (5 gal) bucket is estimated to hold approximately 15.9 kg (35 lbs) of eulachon round weight. Using that conversion, the total estimated harvest is 2,418 kg [5,330 lbs] (95% C.I. = 1,080 – 3,756 kg; 2,380 – 8,281 lbs).

Table 2. Estimated total harvest and fishing effort of eulachon by dip net at Flag Point Channel on the Copper River in 2002.

Date	Total Harvest (buckets)	SE	95% CI	Fishing Effort (hours)	SE	95% CI
May 25-31	112.9	28.3	57.4 - 168.4	21.9	4.3	13.5 - 30.3
June 2-7	39.4	32.4	0[a] - 103.0	13.1	9.5	0[a] - 31.7
June 8-14	0.0	0.0	0.0	0.0	0.0	0.0
June 15-21	0.0	0.0	0.0	0.0	0.0	0.0
June 22-30	0.0	0.0	0.0		0.0	0.0
Total	152.3	43.0	68-236.6	35.0	10.4	14.6-55.4

[a] The harvest and fishing effort from 2 June to 7 June produced lower confidence intervals of less than zero, but were written as zero for that period since harvests and effort amounts less than zero cannot occur.

Deviation from the sampling schedule in 2002 resulted from difficulties in crew scheduling as some sampling periods were dropped and others added throughout the sample weeks. Unfortunately, due to this non-random selection of sampling periods, estimates may be biased to an unknown degree.

Of the 59 subsistence harvesters interviewed in 2002, 29 (49%) indicated they were going to share their harvest with others. According to survey results, food and bait were the primary uses of eulachon harvested by subsistence fishers. Not all harvesters surveyed answered all of the questions. One question that occasionally went unanswered was the city of residence; however, 86% of those that answered this question were Cordova residents. Most of the eulachon harvesters at Flag Point Channel in 2002 were either of Filipino or Russian decent.

In 2003, eulachon were present in the river in March and April, but in unknown quantities. River and ice conditions prevented the direct capture of fish and no harvest effort occurred. Eulachon arrived at the 35-mile and 37-mile channels on 28 May, but had left by 1 June. Nearly all of the subsistence harvest on the Copper River occurred on 30 – 31 May. Some eulachon were present in Flag Point channel in early June, but the quantity was not large enough to attract harvesters.

In 2003, total fishing effort was estimated at 7.2 dipnet hours (SE = .40). A total of 49.35 buckets (SE = 1.03) of eulachon were harvested (Table 3). Using the same conversions listed

above, the total estimated harvest is 785 kg [1730 lbs] (95% C.I. = 752 – 817 kg; 1,658 – 1,802 lbs.).

Table 3. Estimated total harvest and fishing effort of eulachon by dip net on the Copper River and Ibeck Creek in 2003.

Location	Total Harvest (buckets)	SE	95% CI	Fishing Effort (hours)	SE	95% CI
37-Mile	49.35	1.03	47.3 – 51.4	7.2	.40	6.4 – 8.0
Ibeck Ck	72.39	3.31	65.8 – 79.0	36.5	1.81	32.8 - 40.1
Total	121.74	4.33	113.1-130.4	43.7	2.21	39.2-48.1

In 2003, 30 harvesters were interviewed on the Copper River between the 36-mile and 38-mile channels. Most of those interviewed indicated that they would share their harvest with others (83%), and most of the harvesters were from Cordova (93%). The biggest change in 2003 over 2002 was the ethnic composition of the harvesters. In 2003, nearly all of the harvesters were of Filipino decent (Table 4).

Table 4. Ethnic groups that harvested eulachon in the Copper River.

Ethnic decent	Filipino	Russian	AK Native	Caucasian	Mexican	Other
2002 Percentage	48	26	9	9	4	4
2003 Percentage	93	0	7	0	0	0

Eyak River

In 2002, eulachon were found in the Eyak River from 16 June to 23 June, while in 2003 eulachon were present from 15 February to 22 February and 9 June to 13 June. No harvest was recorded in either year as technicians did not document subsistence fishers during randomly scheduled surveys, nor did other staff when sampling eulachon for age, length and sex.

Ibeck Creek

Eulachon did not return to Ibeck Creek in 2002 and no harvest was observed. Eulachon did return in 2003 and were harvested from 15 February to 1 March. A total of 191 people were interviewed during this period. The total fishing effort was estimated at 36.47 dip net hours (S.E. = 1.81) A total of 72.4 buckets (SE = 3.31) of eulachon were harvested (Table 3). The total harvest estimate was 1,151 kg. (2,537 lbs.).

Of the 191 subsistence harvesters interviewed in 2003, 129 (68%) indicated they were going to share their harvest with others. According to survey results, food was the primary use of eulachon harvested for subsistence from Ibeck Creek (97%). All of those interviewed were

residents of Cordova. The ethnic groups that harvested eulachon from Ibeck Creek are listed in Table 5.

Table 5. Ethnic groups that harvested eulachon in Ibeck Creek, 2003.

Ethnic Decent	Filipino	Russian	AK Native	Caucasian	Mexican	Other
Percentage	43	0	20	37	0	0

Age, Weight, Length, and Sex Ratio

Copper River

In 2002, most of the age, sex, and size samples were collected from the Flag Point Channel of the Copper River. The age of eulachon based on otolith samples ranged from 3 to 5. The majority of the fish sampled in 2002 were age-4 fish (96.1%) with a few age-3 (1.4%), and age-5 fish (1.2%). A small number of fish could not be aged (1.3%).

The mean lengths of males and females from the Flag Point Channel can be found in Table 6. Length-at-age was smaller for females by 4-8 mm for age classes with sample sizes > 30 fish (nonstatistical comparison = NSC). Male and female 4-year old fish from Flag Point Channel in 2002 were significantly smaller than male and female 4-year old fish from the 37-Mile Channel further east along the Copper River Highway (male mean lengths = 183 mm, n = 1,128; and 187 mm, n = 593 respectively; $t = 6.495$, $P < 0.0001$), (Female mean lengths = 178 mm, n = 179; and 181 mm, n = 226 respectively; $t = 2.694$, $P = 0.004$) (all P values are one-tailed).

Table 6. Length of eulachon captured at Flag Point Channel of the Copper River.

2002		Standard length (mm)					2003		Standard length (mm)		
Sex	*N*	Mean	SE	min	max		*N*	Mean	SE	min	max
Male	1,128	183	9	153	222		224	188	7	170	208
Female	179	178	9	151	203		226	184	8	160	202
Total	1,307	182	9	151	222		450	186	8	160	208

The mean weights of males and females captured in Flag Point Channel can be found in Table 7.

Table 7. Weight of eulachon captured at Flag Point Channel of the Copper River.

2002		Weight (g)					2003		Weight (g)		
Sex	*N*	Mean	SE	min	max		*N*	Mean	SE	min	max
Male	1,128	57	9	31	94		132	55	7	39	72
Female	179	52	8	35	92		186	45	6	30	59
Total	1,307	57	9	31	94		318	49	8	30	72

The percentage of males in 2002 was 69% (1,479 males; 668 females) as determined from daily samples. The run started with approximately equal proportions of males and females, but shifted to mostly males about the midpoint of the run (Table 8).

Table 8. Sex ratio of eulachon in the Flag Point Channel of the Copper River, 2002.

Date	Male	Female	Sample size
24-May	50.7%	49.3%	138
25-May	52.0%	48.0%	50
26-May	33.3%	66.7%	258
27-May	74.2%	25.8%	271
28-May	59.9%	40.1%	312
29-May	58.5%	41.5%	313
30-May	88.0%	12.0%	283
31-May	93.4%	6.6%	228
1-Jun	90%	10%	294
Total	68.9%	31.1%	

Eulachon age, weight and length samples were collected in the 38-Mile Channel of the Copper River on 29 and 31 May 2002. In 2003, samples were taken at 34-Mile and 37-Mile Channels on 28 and 29 May. The mean length of males and females sampled from these channels can be found in Table 9. The age was based on otolith samples and ranged from 3 to 5. The majority of the fish in 2003 were predominately age-5 (86.5%), with smaller numbers of age-4 (9.8%) and age-3 (3.7%). As was the case in 2002, male and female eulachon in 2003 of similar age class (age-5) were significantly smaller in the Flag Point Channel than fish in the 37-Mile Channel (male mean lengths = 188 mm, n = 224; and 193 mm, n = 512 respectively; t = 5.463, $P < 0.0001$), (female mean lengths = 184 mm, n = 226; and 188 mm, n = 200 respectively; t = 2.335, $P = 0.010$).

Table 9. Length of eulachon captured at 34-Mile, 37-Mile and 38 Mile Channels of the Copper River.

2002	38-Mile	Standard length (mm)				2003	34&37-Mile	Standard length (mm)		
Sex	*N*	Mean	SE	min	max	*N*	Mean	SE	min	max
Male	602	186	8	162	214	512	193	7	174	219
Female	228	180	8	159	207	200	188	7	170	211
Total	830	184	8	159	214	712	192	7	170	219

The mean weights of males and females captured at the sample locations in 2002 and 2003 can be found in Table 10.

Table 10. Weight of eulachon captured at 34-Mile, 37-Mile and 38-Mile Channels of the Copper River.

2002	38-Mile	Weight (g)				2003	34&37-Mile	Weight (g)		
Sex	*N*	Mean	SE	min	max	*N*	Mean	SE	min	max
Male	599	63	9	39	100	511	64	7	46	96
Female	227	58	10	36	92	199	60	8	41	95
Total	826	61	9	36	100	710	63	8	41	96

In 2002, samples collected from the 37-Mile channel were composed of 61% males on 29 May and 85% males on 31 May. In 2003, sex samples were collected from several locations: Flag Point, 34-Mile, 35-Mile, 37-Mile, and 38-Mile channels. The percentage of males in 2003 was 70.2% (1090 males; 463 females) as determined from daily samples. The run in the 34/38-Mile area started with approximately equal proportions of males and females, but shifted quickly to mostly males. The sample taken in the Flag Point Channel, while a few days later, indicated almost equal numbers of each sex (Table 11).

Table 11. Sex ratio of eulachon at different locations on the Copper River, 2003.

Date	Location	Male	Female	Sample Size
28-May	37-Mile	60.0%	40.0%	290
29-May	38-Mile	86.0%	14.0%	200
29-May	34-Mile	80.3%	19.7%	416
31-May	35-Mile	94.5%	5.5%	200
3-June	27-Mile	49.4%	50.6%	447
Total		70.2%	29.8%	

Eyak River

One sample was collected in the Eyak River on 18 June 2002. This sample was predominantly age-4 fish (96%). Males composed 99.5% of the sample.

Ibeck Creek

No samples were collected from Ibeck Creek in 2002 since eulachon did not return to that system that year. In 2003, eulachon did run up Ibeck Creek and samples were collected. The age of eulachon based on otolith samples ranged from 2 to 5. The majority of the fish sampled in 2003 were age-3 fish (66.6%) with a fewer age-4 (26.2%), and age-5 fish (7.2%), and less than 0.01% age-2 fish.

The mean lengths and weights of males and females sampled in 2003 can be found in Table 12.

Table 12. Length and weight of eulachon captured at Ibeck Creek, 2003.

2003		Standard length (mm)					Standard Weight (g)			
Sex	*N*	Mean	SE	min	max		Mean	SE	min	max
Male	1,249	179	10	138	207		56	10	23	89
Female	101	173	9	154	206		47	9	31	82
Total	1,350	178	10	138	207		55	10	23	89

All of the samples collected in Ibeck Creek had a very high number of males. Table 13 provides a summary of the sex composition of eulachon in Ibeck Creek in 2003.

Table 13. Sex ratio of eulachon in Ibeck Creek, 2003.

Date	Male	Female	Sample Size
16-Feb	97.3%	2.7%	445
17-Feb	90.7%	9.3%	300
18-Feb	86.9%	13.1%	647
20-Feb	92.0%	8.0%	200
21-Feb	96.3%	3.7%	641
22-Feb	99.0%	1.0%	200
23-Feb	99.25%	0.75%	400
25-Feb	99.0%	1.0%	200
27-Feb	100%	0%	200
28-Feb	89.0%	11.0%	200
1-Mar	99.5%	0.5%	200
Total	94.6%	5.4%	

Alaganik River

One sample was collected from eulachon in the Alaganik River on February 25, 2003. The sample contained 96.5% male eulachon from 202 fish examined.

DISCUSSION

Presence/Absence and Creel Surveys

In recent years, eulachon have been found as early as January and as late as June on the Copper River Delta. The majority of the eulachon subsistence harvest on the Copper River Delta is done by residents of Cordova. Local residents harvest eulachon from several locations: Copper River, Alaganik Slough, and Ibeck Creek. The harvesters take advantage of the different run timings to have fresh fish throughout the spring. In 2002, an early run of eulachon were not present in Ibeck Creek and Alaganik Slough, so an early traditional harvest did not occur. The lack of eulachon in the early spring reinforced the unpredictable nature of these fish. Eulachon did return to the Copper River in large numbers in late May through late June and some subsistence harvest did occur when fish were initially present. The subsistence harvest may not

have met all of the needs that year because of the extra travel distance to the Copper River and the late timing may have conflicted with other subsistence activities.

In 2003, eulachon did return to Ibeck Creek in February in large enough numbers to provide a subsistence harvest and harvest surveys were also conducted. A few eulachon did return to the Alaganik River in February, but their quantities were not large enough to attract harvesters. A small number of eulachon returned to the Copper River in March and April, but river conditions prevented any subsistence harvest.

In May 2003, eulachon in the Copper River returned a few days later than normal and not at the traditional harvest location. Water flows had shifted to more easterly channels and most of the eulachon ran up those channels with fewer numbers returning to the more traditional Flag Point Channel. Eulachon were very abundant in the easterly channels for a short period of time and most of those subsistence harvesters that discovered the fish at this location were able to satisfy their needs based on their negative response to the question in the harvest survey asking if they would fish again. Eulachon ran up the Alaganik and Eyak rivers in June, but no subsistence harvest was documented. The eulachon return in June in the Alaganik River in both years overlapped to a large extent with the Copper River eulachon return. Subsistence harvesters appeared to prefer to take eulachon from the Copper River at this time possibly because of the greater abundance of fish concentrated along the shore.

Copper River

Access to the Copper River is 43.5 km from Cordova, and the last 3 km of road easily becomes blocked by drifting snow during the winter. The river is generally frozen over in the winter and break-up usually starts in May. Variability in weather conditions and run timing may greatly affect the subsistence harvest of eulachon on the Copper River. Eulachon in sufficient numbers for harvest have been available by 21 May in four out of the last six years at Flag Point Channel (Moffitt et al. 2002). In 2002, eulachon arrived in Flag Point Channel in harvestable numbers on 25 May. The lack of eulachon in other river systems earlier that year may have increased the amount of effort on the Copper River in 2002. Conversely, the lack of eulachon in the other river systems may have prevented some subsistence harvesters from meeting their needs because of the greater distance to the Copper River. The late arrival of eulachon may have also reduced the annual harvest as subsistence priorities may have shifted to other species.

The winter of 2003 had mild temperatures, a lack of snow, and an abundance of rain, which was quite different from the winter of 2002. In 2003, some eulachon were in the Copper River in the early spring, but water and ice conditions prevented sampling to get an indication of run strength and composition. These same conditions also prevented subsistence harvest from occurring. Additionally, because of the mild winter conditions, it is possible that some eulachon entered the Copper River on tide cycles from March through June. However, when the large run entered the Copper River in May, they bypassed the Flag Point channel and arrived at the 37-Mile bridge on 28 May therefore, few fish were available in the Flag Point Channel where harvest traditionally occurs. This change in migration pattern may have affected the run timing and harvest since the fish were available later than usual, at a location farther upriver, and only for a very short period of time.

The lack of an early return of eulachon in 2002 may have biased the ethnic composition of harvesters. Most of the harvesters interviewed on the Copper River were of Filipino or

Russian decent. Substantial portions of the Russian population in Cordova are transient and reside in Cordova only for the salmon gill net fishery, which starts in mid-May. These transient workers may exploit the eulachon population in late May and June as a matter of convenience and proximity. Although most of those interviewed indicated they lived in Cordova at the time of the interview, the interview answer may not reflect the location of their primary residence. Transient worker populations are not generally present in Cordova in February and March and harvest surveys conducted during those months may better represent the ethnicity of local residents using this resource. The harvest that occurred in Ibeck Creek in February of 2003 was probably more indicative of the local ethnic use.

Of special interest was the lack of the transient Russian population participating in the subsistence fishery in 2003 on the Copper River. As previously stated, the harvest did not occur at the traditional location and time, and the primary harvesters tended to be from the local Filipino community. The Russian community may not have participated in the fishery because they did not know the location of the eulachon return. According to Joyce, et al. (2002) most people learn where and when eulachon are present by word-of-mouth, therefore, the three days that eulachon were available at the 37-Mile Bridge may not have been long enough for most of the community to receive the information in time to participate.

The eulachon that were harvested in the eastern channels of the Copper River (37-Mile) were predominately males. The female eulachon were initially available, but rapidly disappeared. A possible explanation for the reduced number of female eulachon in these eastern channels could be that they are close to the upper range of the spawning ground and fewer females may migrate that distance. Also, the shift in water volume to the eastern channels of the river has created both an attractant and a velocity barrier. At the highway bridges where the river is constricted, we speculate that eulachon may not be able to advance up the river and female eulachon laden with eggs may tire and fall back to lower areas to spawn.

The age composition of returning eulachon in 2002 and 2003 indicates that the 1998 brood year had very good survivals and was supporting the run in the Copper River. It may be possible that inter-year competition creates alternating year class strength in eulachon in some systems.

The commercial eulachon test fishery on the Copper River did not occur in 2002 or 2003. The market for Copper River eulachon was greatly reduced when abundant supplies of eulachon from the Columbia River became available. The lack of a market curtailed this commercial fishery in these years.

Eyak River

The Eyak River is approximately 9.6 km east of Cordova and 1.5 km west of Ibeck Creek. Eulachon rarely travel up this river to a point where they are accessible from the Copper River Highway. However, in 2002, eulachon were present in the river in mid-June above and below the highway bridge. Technicians surveyed this system for harvest, but no harvest was documented. Even though eulachon were available in this system, the deep, clear water and moderate stream flows of the upper river did not concentrate the fish near the shoreline where they could be readily harvested. Furthermore, the non-traditional return location coupled with the late run timing may not have attracted many subsistence harvesters. Finally, subsistence users may have already acquired sufficient fish from the more traditional harvest location on the Copper River.

In 2003, eulachon were present in the Eyak River in February and June. No harvest was recorded at either time. The February return did not reach areas accessible to harvesters and the timing coincided with a return to Ibeck Creek. Since Ibeck Creek empties into the Eyak River it is possible that the same run utilizes both rivers. If both rivers support the same run of fish then a spawning reservoir may exist in the less accessible Eyak River.

Ibeck Creek

Ibeck Creek is a shallow, generally clear, meandering stream with a sand to fine gravel bottom and is located approximately 11 km east of Cordova along the paved, maintained Copper River Highway. The presence of eulachon in this river system would be readily noticed and is heavily used by local residents when eulachon are present. Ibeck Creek is a traditional harvest location for Cordova residents and eulachon were harvested from this river system in February of 2003. Annual variability in run timing and biomass affects the amount of harvest by local residents. In 2003, all of the fishers interviewed on this river were Cordova residents harvesting eulachon for food. Many of the harvesters left with just a few gallons of eulachon, and most indicated that they would return to fish again. Access to fresh fish in February, even in small amounts appears to be an important subsistence activity in Cordova.

The age composition of the eulachon run into Ibeck Creek was considerably different from the eulachon that entered the Copper River later that same year. The early return timing and the different age composition could indicate that a different stock of eulachon spawn in this system compared to the Copper River eulachon run. Genetic testing of these two runs could determine if they are two distinct stocks.

The sex composition of eulachon harvested in Ibeck Creek started out with a very high male percentage and remained that way through out the return. One explanation for the high male count could be that the harvest area is near the upper end of the spawning ground and the female eulachon are concentrated farther downriver or in the Eyak River.

Alaganik Slough

Alaganik Slough is located about 35 km from Cordova, approximately 16 km past the state airport. Once past the airport, the road becomes gravel and people are able to access the river by road most of the time, although the road is minimally maintained in the winter months. The Alaganik River is a traditional harvest location for eulachon on the Copper River Delta. Subsistence eulachon harvests tends to occur in this area in early spring and in years when few eulachon are available in Ibeck Creek.

Although some subsistence harvest may have occurred on the Alaganik River, no subsistence harvest surveys were conducted for this system. In both 2002 and 2003, eulachon did arrive in June but they were not discovered until the fish were spawned out and dying. Additionally, many subsistence harvesters had already taken fish from other locations on the Copper River Delta and thus, it is speculated that this June run attracted little or no harvest effort. In late February 2003, the small run of eulachon in Alaganik Slough did not attract any known subsistence harvesters. Perhaps the larger run of eulachon at Ibeck Creek, a system 24 km closer to Cordova, was able to meet the harvest need at that time.

CONCLUSIONS

Of those who harvested eulachon, most were satisfied they had adequate numbers of fish available for harvest. Using the conversion of 1.47 kg (3.25 lbs) edible weight per 3.785 L (1 gal) of eulachon harvested (Brown et al. 2000), the total edible weight harvested in 2002 was 1,123 kg [2,475 lbs] (95% C.I. = 501 – 1,744 kg; 1,105 – 3,845 lbs). The edible weight of eulachon harvested in 2003 was 716 kg [1,578 lbs] (95% C.I. = 665 – 767 kg; 1,466 – 1,690lbs). Table 14 lists the edible weight of eulachon harvested for subsistence between the years of 1984 and 1997 as indicated in the ADF&G Community Profile Database for Cordova (Brown et al. 2000). The edible weight of eulachon harvested in 2002 and 2003 is in line with those previous harvests. Eulachon are a source of fresh fish in the late winter and early spring months, and are a valued harvest. However, in years when eulachon do not return until late May (e.g., 2002), several other sources of fresh fish are available, such as salmon and halibut. This may result in a smaller harvest of eulachon by local residents, but harvest by transient peoples may increase the total harvest.

Table 14. Subsistence use of smelt in edible pounds, 1984 – 1997.

	Year									
Location	1984	1985	1987	1988	1989	1990	1991	1992	1993	1997
Chenega	35	67	NS	NS	0	0	0	0	0	0
Cordova	NS	3,130	NS	1,889	NS	NS	4,234	2,029	1,803	9,389
Tatitlek	NS	NS	0	28	45	0	0	NS	0	38

NS = No Survey

The first year of this harvest survey on the Copper River Delta illustrated the variability in run timing and location that has been documented in other West Coast systems (Betts, 1994; Hinrichsen, 1998). The second year of this study had returns closer to the normal return timings although some traditional harvest locations did not have abundant supplies of fish. Subsistence harvest opportunities vary each year, but during the two years of this study, the harvest amounts appear to be within the harvest amounts indicated in the Community Profile Database and appear to have met the household needs.

The commercial fishery did not occur during this study so the impacts of that fishery on subsistence use could not be measured. ADF&G estimates from 2,300 to 8,000 metric tons of eulachon migrated up the Flag Point Channel in 2001. No estimate was made from other channels or systems or in other years. The population estimated by ADF&G in the Copper River would provide sufficient fish to meet the community's subsistence needs. The community subsistence needs range up to 5 tons, often spread through out the spring months. In years when eulachon are available from mid-winter to late spring the harvest is spread among several river systems as well. Some of the smaller systems, Ibeck Creek and Alaganik River, do not always produce eulachon runs, whereas the Copper River almost always has a return in late May and can be counted on to meet some of the subsistence needs. Since the small systems do not support large returns in the early spring, only subsistence harvesting of eulachon by local residents should be allowed in these systems.

It appears that a spawning reservoir for the Ibeck Creek run may exist in the Eyak River. Harvest is nonexistent in the Eyak River probably because of the lack of access to the fish. The harvest in Ibeck Creek is consistently high in males possibly because the area of harvest is near the upper reaches of the spawning migration. If the Eyak River and Ibeck Creek runs are of the same stock, a high exploitation subsistence harvest of eulachon could occur in Ibeck Creek, which is more accessible, and leave the Eyak River portion of the run as an unexploited brood source. Additional studies should be completed on the Ibeck Creek/Eyak River stock to confirm the single stock concept.

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APPENDIX A.

EULACHON HARVEST SURVEY FORM

Sampler: **Stream Name:** **Date:**

Sample Period: **No. of Groups not Sampled:**

Time	Party Number	Number In Party	Hours Fished	Buckets Harvested	Sample Location	Will Fish Again? Where	% Catch Shared	Use	Number Dip Nets Fished	Ethnic Group	City of Residence	Comments
AM - PM			1/4,1/2,3/4,1	1/4 - 100	See map	yes/no-location	0%-100%	food,bait,oil		N/F/R/C/O		
	1											
	2											
	3											
	4											
	5											
	6											
	7											
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Ethnic Group: N = Native; F = Filipino; R = Russian: C = Caucasian; O = Other

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