FINAL REPORT

FALL 2007 FISHERY MONITORING ON THE COLVILLE RIVER

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EXECUTIVE SUMMARY

The Colville River fall harvest of Arctic cisco (*Coregonus autumnalis*), or *qaaktaq* in Iñupiat, is one of the most important subsistence events annually for residents of Nuiqsut. Increasing oil and gas development in the 1970s along the northern Arctic coastal plain, and in particular the construction of offshore causeways near Prudhoe Bay, led to concerns that the migratory and feeding behavior of Arctic cisco would be negatively impacted. As a result, monitoring of harvest on the Colville River has been conducted since the mid-1980s.

In 2007, stakeholders including the residents of Nuiqsut, subsistence fishers, the North Slope Borough (NSB) and ConocoPhillips Alaska Inc. (CPAI), discussed the future of the Colville River fall fishery monitoring program. The result of these discussions led to the decision to continue monitoring, as well as to further define the responsibilities of all stakeholders. A *Qaaktaq* Panel, consisting of subsistence fishers, was created to provide future guidance to the monitoring team on issues affecting Nuiqsut stakeholders. The 2007 fishery monitors continued the program of daily harvest interviews on-ice as in previous years. Logbooks with daily counts for a small number of fishers were also collected to account for harvests events that the monitors missed.

The 2007 fishery began around 4 October, although poor snow conditions on the ice forced most fishers to begin around 20 October. The 2007 harvest was marked by moderate catch rates through most of the season. Catch rates for Arctic cisco were well below those in 2006 (the highest recorded since 1986) but were slightly above the all-time average. Least cisco (*Coregonus sardinella*), harvest rates were the third highest on record.

Harvest rates were greatest for Arctic cisco in the Niġliq Delta and were diminished substantially in upstream locations. Salinity in the Upper Niġliq region never reached the levels typically associated with high numbers of Arctic cisco (i.e., 15–25 ppt).

The presence of high percentages of age-4 through age-6 year classes of Arctic cisco in the 2007 harvest implies that the 2008 harvest will be moderate compared to historical harvest levels, but could diminish further as the 2000 year class leaves the fishery. The 2007 fyke net surveys in Prudhoe Bay monitored an all-time high CPUE for young-of-the-year Arctic cisco, which indicates that 2011 could mark the beginning of an upturn in harvest rates in the Colville River.

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INTRODUCTION

The fall subsistence fishery conducted in the Colville River by the residents of Nuiqsut, Alaska has been monitored annually since 1985 (no data were collected in 1999) by contractors (MJM Research [1985–2005] and LGL Alaska Research Associates [2006]) on behalf of ConocoPhillips Alaska, Inc. (CPAI), and its predecessors (see Daigneault and Reiser 2007 and Moulton et al. 2006). The focus of the monitoring program has been on Arctic cisco (*qaaktaq; Coregonus autumnalis*), which are a staple in the diet of Nuiqsut residents. The impetus for the monitoring program primarily has been concern that oil and gas exploration and development in the nearshore marine environment and, more recently, on the Colville delta could adversely affect these anadromous fish. The main goals of the monitoring program have been to obtain estimates of the total fishing effort and catch and to predict future harvest.

Prior to implementing a monitoring program in 2007, CPAI deemed it necessary to 1) reaffirm that there was support for the monitoring program among the primary stakeholders, which include Nuiqsut fishers, the Kuukpik Subsistence Oversight Panel, Inc. (KSOPI), the North Slope Borough [NSB] Department of Wildlife Management, and CPAI, and 2) to gain consensus on how the monitoring program should be implemented. Hence, the objectives of the monitoring program in 2007 were to:

- Develop stakeholder engagement and monitoring plans (Appendix A) in conjunction with key stakeholders;
- Monitor the harvest of Arctic cisco throughout the fishing season using the agreed upon protocols;
- Estimate the magnitude of the subsistence fishery harvest;
- Collect biological data (e.g., length and weight) for as many fish as possible;
- Measure salinity in primary fishing areas; and
- Compare the 2007 results with those of previous years.

BACKGROUND

Very little was known of Arctic cisco's basic life history characteristics until fish monitoring studies were initiated by the oil industry in the nearshore environment in the Prudhoe Bay region (Gallaway et al. 1983). These studies discovered that Arctic cisco that occur in Alaska originate in the Mackenzie River system in Canada. Young-of-the-year are flushed down river into the Beaufort Sea in early summer, and then prevailing winds, which typically are from the east, and ocean currents transport these young fish along the Beaufort Sea coast. Arctic cisco recruitment strength to Alaska and the Colville River region has been correlated with the consistency and strength of easterly winds in the Beaufort Sea region during summer (Fechhelm and Fissell 1988). This wind- and ocean-current-driven recruitment process largely determines the age structure of Arctic cisco in Alaska (Gallaway and Fechhelm 2000), and recruitment strength at Prudhoe Bay is highly correlated with harvest rates for the Colville fishery 5–7 years later (ABR et al. 2007).

Arctic cisco in the Colville River spend their summers feeding in deltas and nearshore brackish waters before returning to deep pools in the river for over-wintering (Craig 1984, Moulton et al. 1986). After achieving maturity (females age 7–8, males age 6–7), Arctic cisco migrate during summer to their source rivers within the Mackenzie River system to spawn in the fall. These fish do not return to rearing streams in Alaska, but rather stay in the Mackenzie region where they continue to spawn well into their teen-aged years (Craig and Halderson 1981, Gallaway et al. 1983, Bond and Erickson 1985, Bickham et al. 1989, Moulton 1989, Bond and Erickson 1997).

The Arctic cisco fishery on the Colville delta is an under-ice fishery that has yielded an average of 8,743 kg (19,200 lbs) of Arctic cisco annually between 1985 and 2003 (Moulton and Seavey 2003). Until recently, a commercial Arctic cisco fishery operated by the Helmericks family also was active on the main channel of the Colville River. In 1993, the year with the highest combined harvest from these two fisheries, ~78,254 fish (31,340 kg) were taken on the Colville delta (Moulton and Seavey 2003). In contrast, only 5,859 fish (2,799 kg) were harvested in 2001, which was the lowest harvest on record. This substantial annual variability in harvest rates, coupled with increased development by the oil and gas industry within the range of the Arctic cisco, have raised concerns among subsistence users and other stakeholders about the population status of Arctic cisco in Alaska. In 2003, the Minerals Management Service (MMS) convened a workshop in Nuiqsut to review the issue of *qaaktaq* variability, both from the perspective of the subsistence community and scientists who have conducted research on this species (MBC Applied Environmental Sciences 2004). Following the workshop, MMS commissioned a study to review and synthesize all available information from scientific studies and subsistence users to assess the status of the Arctic cisco population in Alaska and to evaluate the effects of anthropogenic disturbance on the fish (ABR et al. 2007). That study relied heavily on the data that have been collected since 1985 on the subsistence fishery in Nuiqsut (i.e., this long-term monitoring program).

METHODS

STAKEHOLDER AND MONITORING PLAN

Prior to the commencement of fishery monitoring activity in 2007, two meetings were held in Nuiqsut (September 17 and October 15) to discuss the future of the monitoring program. All members of the community were invited to attend these meetings. The meetings also were attended by representatives of ABR, Inc. and Stephen R. Braund & Associates. Stephen Braund convened the meetings and ABR representatives provided biological expertise as necessary.

The goals of the meetings were: 1) to identify whether there was support for continuation of the monitoring program among stakeholders, which include Nuiqsut fishers, the Kuukpik Subsistence Oversight Panel (KSOP), the North Slope Borough (NSB) Department of Wildlife and Management, and CPAI and 2) to gain consensus on how the monitoring program would be implemented. As such, the community was asked what types of information were important to them in monitoring their fishery and how this information could be best obtained by the scientists. To facilitate this collaboration between the scientists and the community and to establish long-term cooperation, a group of subsistence fishers was convened (the *Qaaktaq* Panel) and members were invited to recommend fishers most likely to participate in logbook keeping. Details of this first stage of the project are given in Appendix A and include a full report of the proceedings.

FISHERY EFFORT AND HARVEST

In the past, the majority of harvest information had been collected by means of direct interviews of subsistence fishers conducted by scientists. Beginning in 2005 and continuing through 2006, logbooks were also given to primary fishing families interested in keeping track of their daily fishing effort and catch records.

Prior to the beginning of on-ice surveys by the monitoring team in the fall of 2007, logbooks were distributed to 10 of the most intensive fishers in town. These fishers were recommended after consultation with the *Qaaktaq* Panel. Fishers were asked to record net location, harvest date, set duration, net length, net mesh size, and harvest numbers for Arctic cisco and other species. Logbooks were collected at regular intervals to transcribe data.

The entire on-ice fishery monitoring effort in 2007 was conducted on the Niġliq channel of the Colville River (Figure 1). Until recently (~2002), there also was a commercial fishery in the Kupigruak channel in the eastern Colville River Delta conducted by the Helmericks family. The fishery monitoring team was unaware of any fishing on the Kupigruak channel in 2007. Four traditional fishing areas hosted the majority of concentrated fishing efforts within the Niġliq channel: the Upper Niġliq channel adjacent to the town of Nuiqsut, the Uyagagviq area just down stream, the Nanuk area, and the Niġliq Delta (Figure 2).

The Harvest Monitoring Team was composed of at least two scientists from ABR at all times. A third member of the team was a local resident of Nuiqsut. Each day the team traveled by snow machine to the more intensively fished areas of the Colville River to conduct interviews for harvest assessment. When a member of the monitoring team witnessed a fisher on their way to or from a

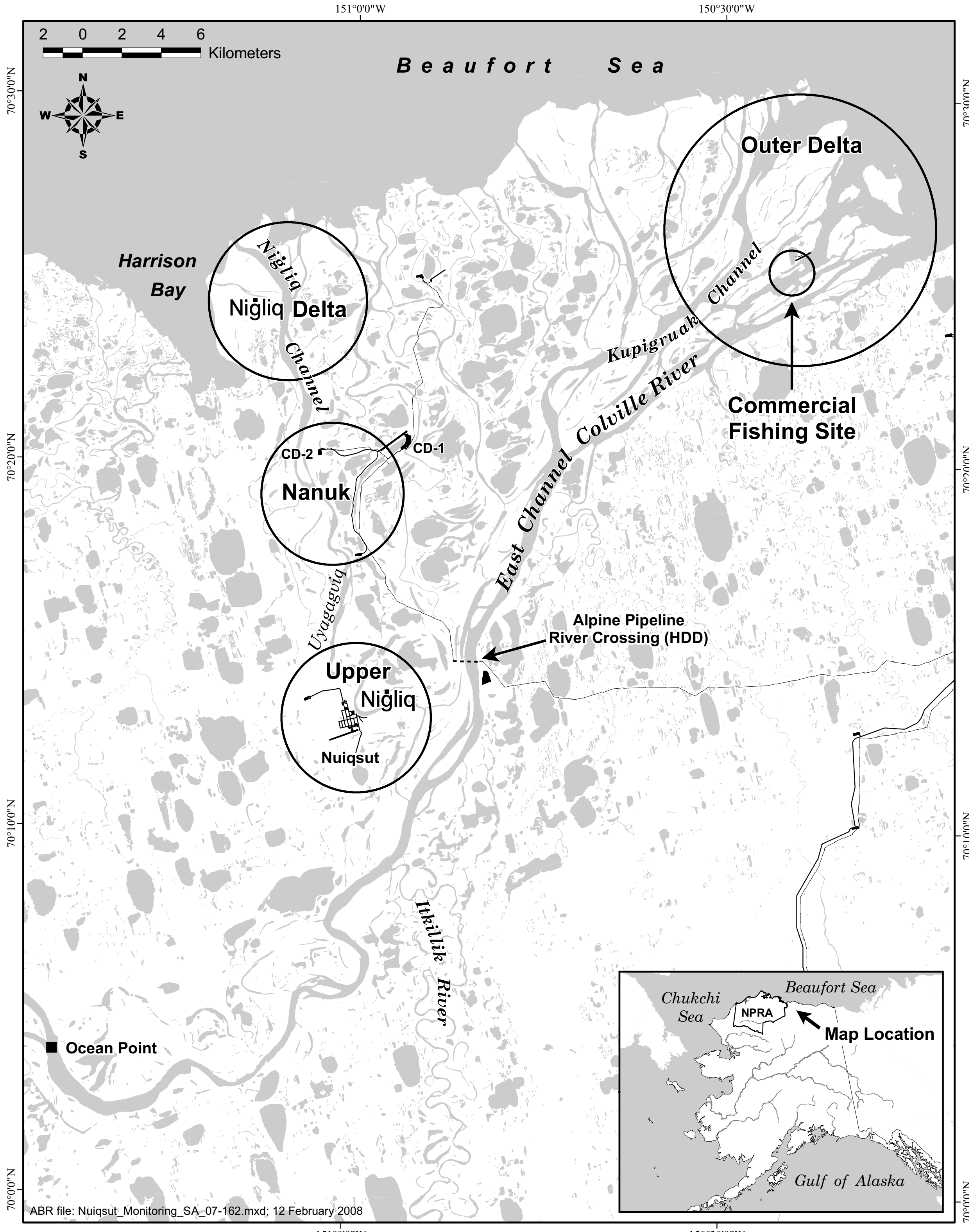

Figure 1. The Colville delta and major subsistence and commercial fishing areas used for harvesting Arctic cisco (After Moulton and Seavey 2004).

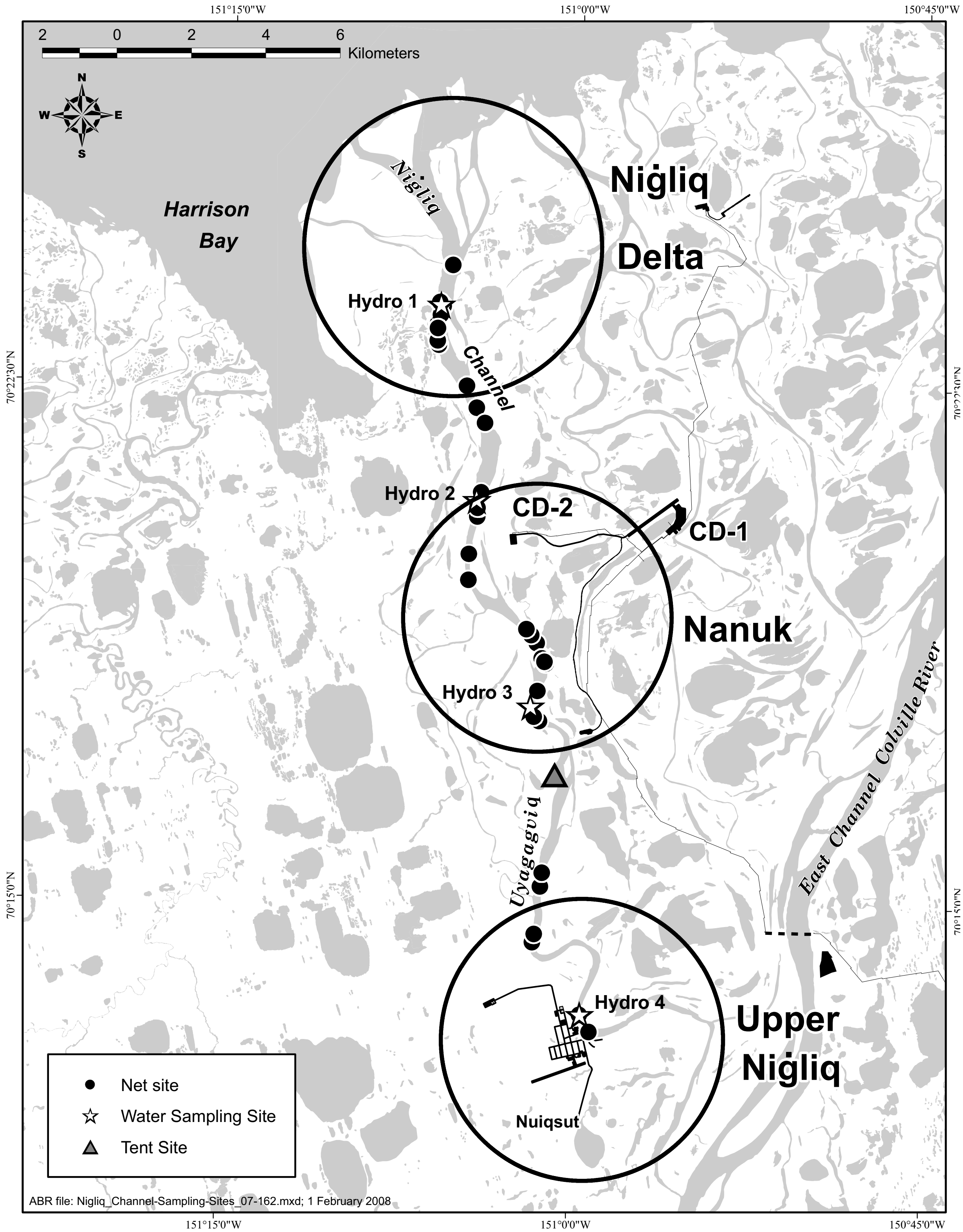

Figure 2. Detailed view of the Niġliq channel of the Colville River, depicting water sampling sites (Hydro 1–4), the major fishing areas and net locations during the 2007 fall subsistence fishery.

harvest, permission was asked to assist in the harvest or to conduct an interview of the recently completed harvest.

During interviews, net length and mesh size were recorded, as well as a start and end time for that particular fishing effort. As in years past, fishers used a variety of net lengths and mesh sizes depending on individual preferences. For this reason, fishing effort (net days) was standardized to 18 m (60 ft) net length and 24-hour set durations. As a result, nets of length greater than 18 m account for a greater amount of fishing effort per 24-hour set (i.e., for an 80 ft net, (80/60) × 24 = 32 hours adjusted effort for a 24-hour set). Catch per unit of effort (CPUE) estimates were calculated using these adjusted data. It should be noted, however, that it is difficult to accurately standardize different mesh sizes to one another because each net type catches different sizes of fish at different rates. Consequently, we specified the presentation of many of the results for this survey as being from either "all mesh sizes" or the more traditionally reported mesh of "7.6 cm."

In the event that the monitors did not actually witness a harvest, they conducted oral interviews with fishers the next time they met (usually within 24–48 hours). Interview questions asked were:

- How long was your net in the water?
- What were your net dimensions?
- How many *qaaktaq* did you harvest?
- How many fish of other species did you harvest?
- How often are you checking your nets?
- Are there other people checking your nets?
- Where is your net and has it been moved recently?

LENGTH, WEIGHT, AND AGE OF CATCH

When monitors were present while a net was being pulled, they typically helped remove fish from the net and then counted all of the fish by species. A sub-sample of fish was then measured for fork length (to the nearest mm). The standard routine for sub-sampling involved laying the total harvest of each species on the ice side-by-side in a random fashion without preference for size. Depending on the number of fish in the harvest and the amount of time available for conducting the interview, every 2nd, 3rd or 4th fish was measured. The Monitoring Team always performed this task for Arctic cisco first, and for other species as time permitted.

The total number of fish measured on a given day varied depending on several factors, including a fisher's availability for having his/her fish measured at that time, the total number of fish harvested for a given net, and the number of fishers in the area harvesting at any one time. When there were several fishers harvesting simultaneously in the same area, monitors made every effort to obtain a sub-sample of measurements from every fisher they encountered. If time permitted, monitors made every attempt to measure other species harvested in a fisher's net, including least cisco (*Coregonus sardinella*), and humpback whitefish (*Coregonus pidschian*).

On most days, a sub-sample of fish (~10/day) was purchased from fishers. These fish were harvested from nets with a variety of mesh sizes. The fish were preserved in a frozen state and transported to Anchorage for processing. For these fish, fork length was measured (mm), weight was recorded using a top loading electronic scale (g), and otoliths were removed for ageing at a later date.

Otoliths were cleaned using tap water and stored in 96-well trays. The break-and-burn technique was used for preparation of otoliths for ageing (Chilton and Beamish 1982). Otoliths were broken in half through the center along the transverse axis using either a sharp scalpel or by pressing the otolith between a fingernail and forefinger. The broken edge of each otolith was held over an open flame for several seconds until it began to take on an amber color. The otolith half was then placed broken-edge up in putty and the surface was brushed with mineral oil to bring out the growth rings under magnification. The sample was then viewed under reflected light on a dissecting scope with varying magnification between 10× and 30×. Alternating bands of dark and light correspond to winter and summer growth respectively in otoliths and together represent one year's growth. Following previous year's methodologies, the central core region of the otolith, composed of a dark and light region, was recognized as the first summer and winter growth of an age-0 fish. Accordingly, all annuli after this region were counted.

SALINITY MEASUREMENTS

Water salinity was measured every other day at four water sampling stations (Hydro Stations 1–4 in Figure 2) that corresponded to areas of intense fishing. At these stations, a plug of ice was removed and the sampling probe from a YSI Model 85 monitor was lowered into the water. Salinity was measured in parts per thousand (ppt) and recorded at the surface and at 0.5 m increments along the water depth profile. At the end of each sampling event, a small piece of insulation was used to cover the hole where the ice plug was removed. In this way, the water sampling station was only partially frozen upon return 48 hours later.

RESULTS

FISHERY EFFORT AND HARVEST

Fishing effort and harvest rates are assessed each year and then standardized to allow for interannual comparisons and trend analyses. In 2007, the Arctic cisco subsistence harvest began on approximately 4 October (Table 1). Cloud cover was reduced in late September/early October of 2007, which resulted in low temperatures and an earlier freeze-up than in 2006 (Daigneault and Reiser 2007). However, snowfall was minimal until the 3rd week of October; thus, many fishers were slow to deploy nets because ground conditions were unsafe for long-distance snow machine travel. Accordingly, a number of nets in the Niġliq Delta (area 670) were relatively late in being deployed (~3rd week of October) (Table 2). Twenty-six fishing families deployed 55 nets during the fall fishery in 2007 (Table 2). This level of effort represents a slight decrease in the number of nets from 2006 to 2007, although the number of nets is slightly above the average and median number deployed since 1986 (Figure 3). All 55 nets were deployed in the Niġliq channel.

Gillnets are manufactured in a wide variety of lengths and mesh sizes. Nets of different lengths and different mesh sizes catch different age and size-classes of fish at different rates. Subsistence fishers in the Niġliq channel frequently alternate between nets within a season as they target Arctic cisco. Estimates of CPUE are difficult to compare among nets of different mesh sizes, although CPUE can be easily standardized for net length. As described in Methods, net lengths were standardized to 18 m (60 ft). Because there is no reliable method for standardizing mesh sizes to one another, we frequently report data from either 7.6 cm (3 in) nets or from all nets regardless of mesh size.

Table 1. Estimated onset of fishing in the Colville River fall subsistence fishery, 1985 to 2007.

Year	Start Date
1985	2-Oct
1986	3-Oct
1987	8-Oct
1988	14-Oct
1989	22-Oct
1990	6-Oct
1991	12-Oct
1992	26-Sep
1993	3-Oct
1994	3-Oct
1995	16-Oct
1996	28-Sep
1997	13-Oct
1998	28-Sep
1999	--
2000	3-Oct
2001	6-Oct
2002	14-Oct
2003	16-Oct
2004	9-Oct
2005	7-Oct
2006	14-Oct
2007	4-Oct
Average	7-Oct

Table 2. Total adjusted fishing effort recorded for the 2007 fall fishery on the Niġliq channel. All fishers are included along with all mesh sizes, net lengths and fishing areas. Net days were standardized to 18 m net length in order to adjust for effort.

Fisher Code	Fishing Area	Net	Net Code	Net Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net Days	Adjusted Net Days
3	670	A	07003A	24.4	7.6	10/25/07	10/28/07	3	4.0
4	650	A	07004A	24.4	7.6	10/16/07	11/18/07	33	44.0
4	650	B	07004B	18.3	7.0	10/16/07	11/18/07	33	33.0
4	650	C	07004C	18.3	7.6	10/16/07	11/18/07	33	33.0
4	670	D	07004D	18.3	7.6	10/17/07	11/18/07	32	32.0
4	670	E	07004E	18.3	7.6	10/17/07	11/18/07	32	32.0
4	670	F	07004F	18.3	8.9	10/17/07	11/18/07	32	32.0
4	610	G	07004G	18.3	7.6	10/6/07	10/28/07	22	22.0
7	670	A	07007A	24.4	7.6	10/18/07	10/29/07	11	14.7
7	670	B	07007B	24.4	7.6	10/18/07	10/29/07	11	14.7
24	650	A	07024A	24.4	7.6	10/4/07	11/18/07	45	60.0
25	650	A	07025A	30.5	7.6	10/7/07	10/17/07	10	16.8
25	650	B	07025B	24.4	8.9	10/8/07	11/12/07	35	46.7
25	650	C	07025C	18.3	8.9	10/7/07	11/7/07	31	31.0
27	610	A	07027A	24.4	8.9	10/21/07	10/28/07	7	9.3
27	610	B	07027B	24.4	7.6	10/28/07	11/1/07	4	5.3
27	610	C	07027C	24.4	8.3	11/1/07	11/6/07	5	6.7
27	610	D	07027D	18.3	7.6	11/6/07	11/15/07	9	9.0
32	650	A	07032A	24.4	7.6	10/14/07	10/28/07	14	18.7
32	650	B	07032B	24.4	7.6	10/14/07	10/28/07	14	18.7
33	670	A	07033A	24.4	7.6	10/24/07	11/27/07	34	45.3
33	670	B	07033B	30.5	6.4	10/24/07	11/27/07	34	57.0
33	650	C	07033C	24.4	7.6	10/28/07	11/18/07	21	28.0
33	650	D	07033D	30.5	6.4	10/28/07	11/3/07	6	10.1
37	670	A	07037A	24.4	6.4	10/12/07	11/4/07	23	30.7
41	670	A	07041A	24.4	7.6	11/1/07	11/6/07	5	6.7
51	670	A	07051A	24.4	7.6	10/20/07	11/1/07	12	16.0
54	670	A	07054A	18.3	7.6	10/20/07	11/11/07	22	22.0
54	670	B	07054B	24.4	7.0	10/21/07	11/8/07	18	24.0
56	630	A	07056A	24.4	7.6	10/6/07	11/7/07	32	42.7
56	630	B	07056B	18.3	7.6	10/6/07	11/7/07	32	32.0
64	670	A	07064A	24.4	7.6	11/12/07	11/15/07	3	4.0
65	670	A	07065A	18.3	7.6	10/18/07	11/18/07	31	31.0
65	670	B	07065B	18.3	7.6	10/20/07	11/18/07	29	29.0
66	650	A	07066A	24.4	7.6	10/14/07	11/2/07	19	25.3
66	650	B	07066B	24.4	8.9	10/14/07	11/2/07	19	25.3

Table 2. Continued.

Fisher Code	Fishing Area	Net	Net Code	Net Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net Days	Adjusted Net Days
66	650	C	07066C	24.4	8.9	10/26/07	11/2/07	7	9.3
69	670	A	07069A	24.4	7.6	10/25/07	11/1/07	7	9.3
71	610	A	07071A	24.4	7.6	10/6/07	10/20/07	14	18.7
72	650	B	07072B	24.4	8.9	10/18/07	11/18/07	31	41.3
72	670	C	07072C	24.4	7.6	10/18/07	11/18/07	31	41.3
72	670	D	07072D	24.4	7.6	10/18/07	11/18/07	31	41.3
73	670	A	07073A	24.4	7.6	11/9/07	11/15/07	6	8.0
76	650	A	07076A	24.4	7.6	10/17/07	10/30/07	13	17.3
79	650	A	07079A	18.3	7.6	10/16/07	11/19/07	34	34.0
79	650	B	07079B	24.4	7.6	11/17/07	11/19/07	2	2.7
82	670	A	07082A	18.3	8.9	10/13/07	10/20/07	7	7.0
82	670	B	07082B	24.4	8.3	10/13/07	10/20/07	7	9.3
82	670	C	07082C	18.3	8.9	11/12/07	11/17/07	5	5.0
87	670	A	07087A	30.5	6.4	10/22/07	11/18/07	27	45.3
88	630	A	07088A	24.4	7.6	10/20/07	11/3/07	14	18.7
88	630	B	07088B	24.4	7.6	10/20/07	11/3/07	14	18.7
89	650	A	07089A	18.3	7.0	10/17/07	11/2/07	16	16.0
89	670	B	07089B	18.3	7.0	11/3/07	11/11/07	8	8.0
89	670	C	07089C	24.4	7.6	10/26/07	10/27/07	1	1.3
					Total Adjusted Net Days				1,264.9

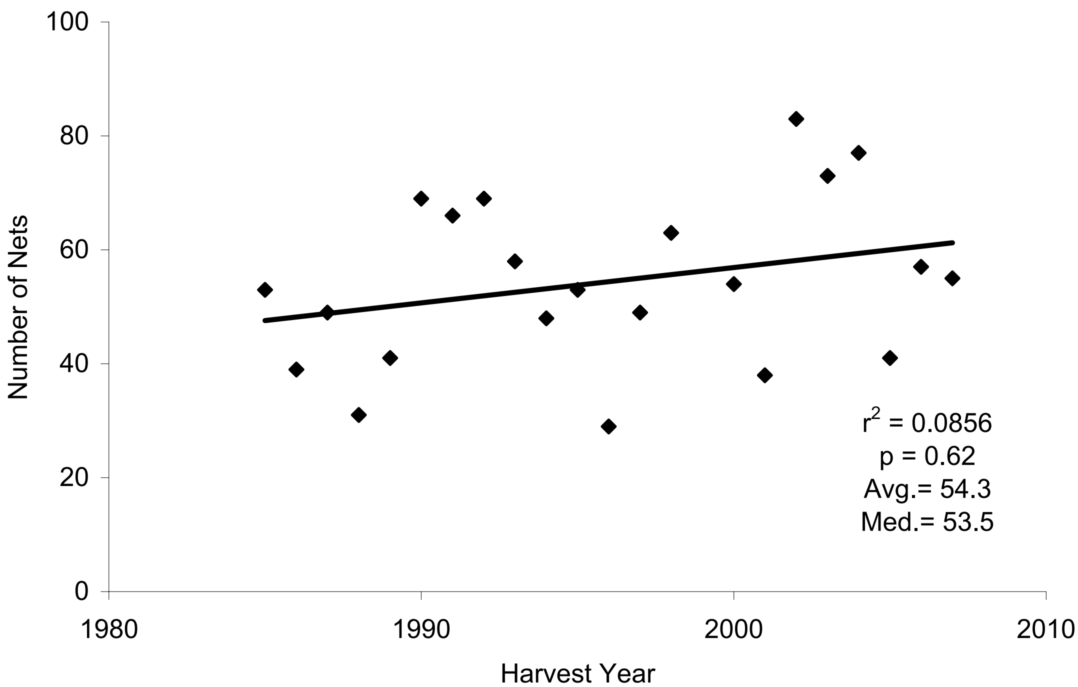

Figure 3. Annual number of gill nets deployed in the Colville River fall subsistence fishery, 1986–2007.

After standardizing for net length, we calculated 1,265 adjusted net days of fishing effort for all mesh sizes in 2007 (Table 2). Most of fishing effort occurred in the Niġliq Delta (45% of total), followed closely by the Nanuk area (40% of total). The Upper Niġliq area (Uyagagviq results were included with Upper Niġliq results in this survey) of the channel accounted for just 15% of the calculated effort in 2007 (Figure 4).

The most frequently deployed mesh size in the Nuiqsut fall fishery has traditionally been 7.6 cm. Of 55 nets deployed, 36 were of 7.6 cm mesh size, representing 65% of total adjusted net days for all nets monitored in 2007 (see Table 2). The actual number of Arctic cisco counted in 7.6 cm mesh nets in 2007 was 5,855. The majority of these fish (4,422; 76%) were caught in the Niġliq Delta area (Table 3, Figure 5). Because 7.6 cm is the dominate net mesh size used by fishers, estimates of CPUE in the Niġliq channel are reported for 7.6 cm mesh nets only (standardized to 18 m length). CPUE for Arctic cisco in the Niġliq Delta was 22 fish/adjusted net day, whereas the Nanuk (9 fish/adjusted net day) and Upper Niġliq (8 fish/adjusted net day) areas produced much lower CPUEs (Table 3). The total CPUE for Arctic cisco in the Niġliq channel (16 fish/adjusted net day in 7.6 cm mesh nets) was similar to the average of observed 1986–2007 (Table 3, Figure 6). The Niġliq channel CPUE was heavily influenced by the high numbers of fish caught in the Niġliq Delta (CPUE = 22 fish/net day) (Table 3). The daily average CPUE was extremely variable over the fishing season, with peaks of 42 fish per adjusted net day on the 24 October and 56 on the 11 November (Figure 7).

In addition to Arctic cisco, 5 other species of fish were recorded in the harvest records in 2007 (Table 4). A total of 14,686 fish (all species and mesh sizes) were counted in interviews and logbooks, with Arctic cisco, least cisco and humpback whitefish comprising the vast majority of the recorded harvest in 2007 (Table 4). Saffron cod (*Eleginus gracilis*) and broad whitefish (*Coregonus nasus*) were represented in the harvest in small quantities. Least cisco comprised ~22% of the total catch and were harvested in greatest numbers in the Upper Niġliq, even though the greatest effort was recorded in the Niġliq Delta. The total CPUE for least cisco caught in 7.6 cm mesh nets (standardized to 18 m) in the Niġliq channel was the 3rd highest on record (Table 5).

Four of 10 fishermen who were provided with logbooks returned them to the monitoring team. Information obtained from these logbooks was included in this analysis. These logbooks were examined on a regular basis by the monitoring team throughout the season. Where data gaps occurred for any given harvest event, monitors employed the oral interview process outlined in Methods, to ensure complete data for that harvest. Two of the four fishermen kept logs on a daily basis, whereas the other two kept data sporadically throughout the season.

LENGTH, WEIGHT, AND AGE OF CATCH

A subsample of fish were measured daily at net sites to calculate the relative proportion of size classes present in the fishery. We measured fork lengths of 3,694 Arctic cisco. These fish ranged in length from 225 to 403 mm, with 50% of fish measuring between 329 and 362 mm (median = 350 mm). The length distribution of Arctic cisco appeared normal, but was skewed slightly towards smaller lengths between 230 and 300 mm (Figure 8). The frequency of length classes differed among mesh sizes, with nets with mesh smaller than 7.6 cm catching a higher proportion of fish in this smaller length range (Figure 9). We also measured fork lengths on 430 least cisco. Length distribution for least cisco also appeared normal and ranged between 237 and 396 mm (median = 301 mm). Lengths between 290 and 310 mm represented 50% of the measured harvest.

We regularly purchased a small number of fish from active fishers for additional analyses. These fish were frozen and shipped to Anchorage where we measured fork length (mm) and weight (g) to analyze the relationship between the two variables (n = 135). The length/weight relationship can be used as an indicator of fish health or condition of the fish. Length and weight were strongly correlated (r^2 = 0.73) in Arctic cisco in 2007, and weight appeared to increase considerably from 320 to 360 mm (Figure 10). Three outliers appeared to lower the r^2 value considerably.

Otoliths were removed from these same fish and aged to estimate age structure for the 2007 harvest. Arctic cisco caught in all mesh sizes

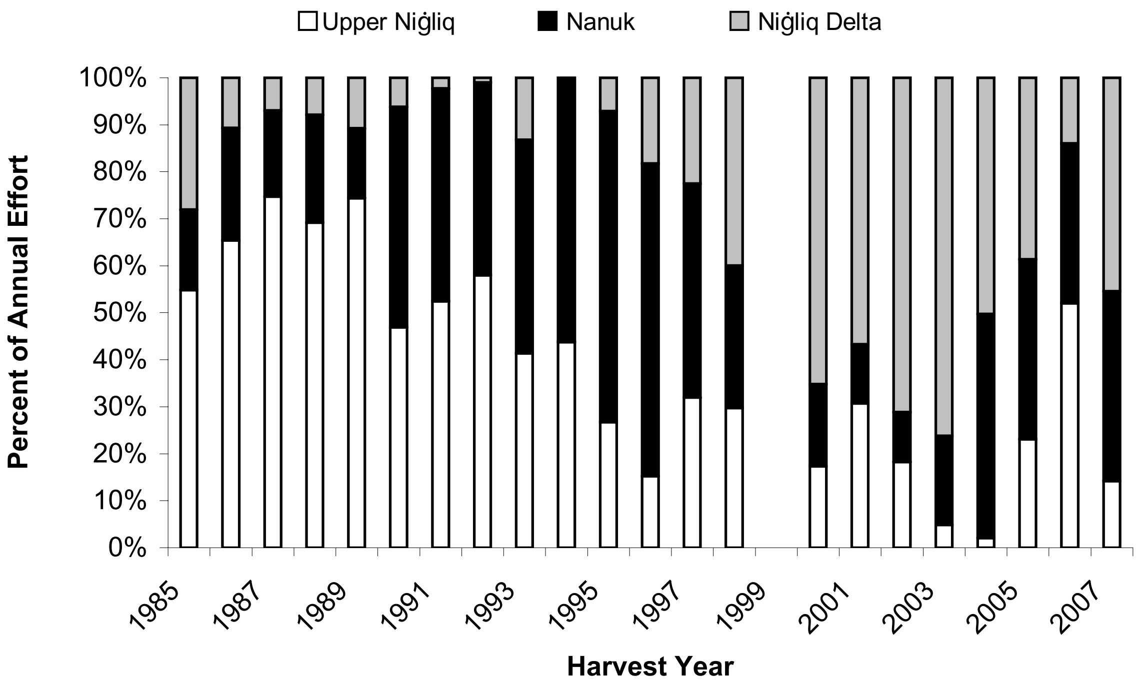

Figure 4. Percent of annual fishing effort attributed to each major fishing area in the Niġliq channel. Includes all net lengths and mesh sizes. The Uyagagviq effort was included in the Upper Niġliq effort (See Figure 2).

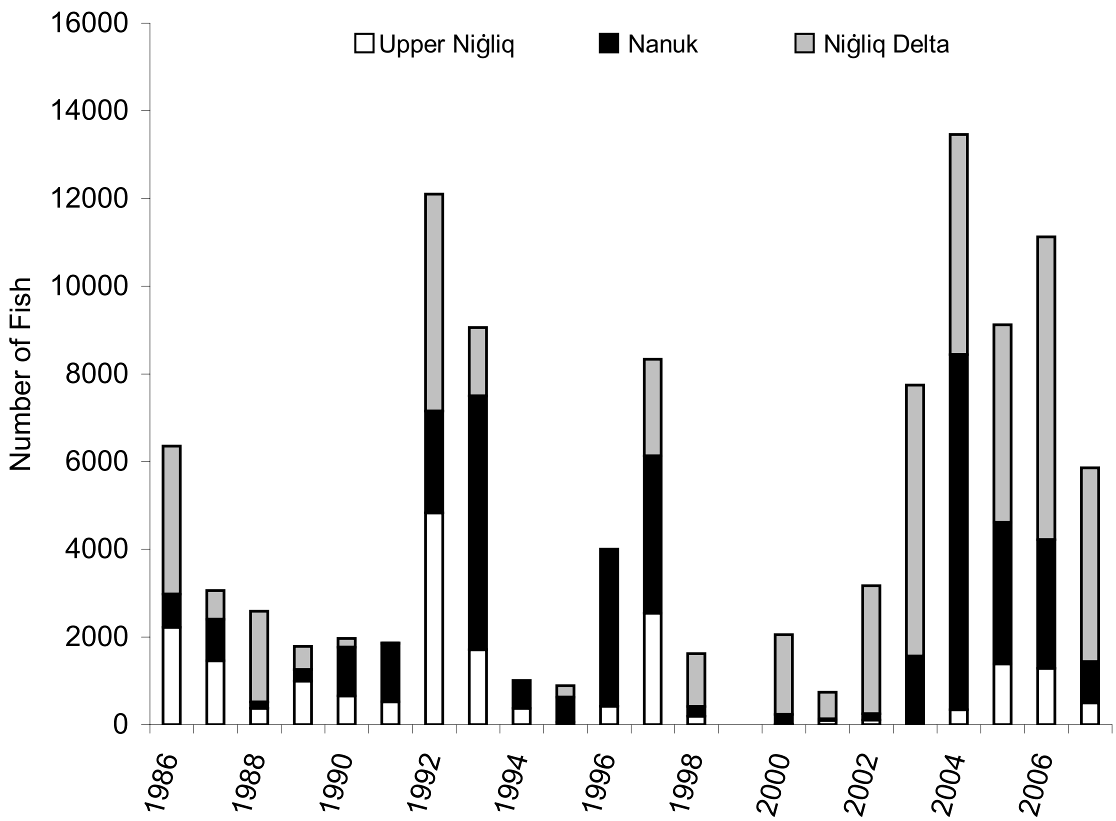

Figure 5. Observed number of Arctic cisco harvested in 7.6 cm (standardized to 18 m length) gillnets in the Niġliq channel from 1986–2007. The 2005–2007 data are not directly comparable to historical data because the fishery was not monitored for the entire fishing period.

Table 3. Arctic cisco catch, effort, and CPUE for each fishing area in the Niġliq channel, 1986–2007. Catch and effort data are for 7.6 cm mesh gillnets, standardized to 18 m length.

Harvest Year	Upper Niġliq Observed Catch (# of fish)	Upper Niġliq Effort (net days)	Upper Niġliq CPUE (fish/net day)	Nanuk Catch (# of fish)	Nanuk Effort (net days)	Nanuk CPUE (fish/net day)	Niġliq Delta Catch (# of fish)	Niġliq Delta Effort (net days)	Niġliq Delta CPUE (fish/net day)	Total Niġliq Channel Catch (# of fish)	Total Niġliq Channel Effort (net days)	Total Niġliq Channel CPUE (fish/net day)
1986	2,218	115.7	19.2	752	25.1	29.9	3,379	51.3	65.8	6,349	192.2	33.0
1987	1,451	131.7	11.0	948	32.6	29.1	661	31.3	21.1	3,060	195.7	15.6
1988	366	56.9	6.4	146	18.0	8.1	2,078	37.3	55.7	2,590	112.3	23.1
1989	993	90.8	10.9	258	14.3	18.0	535	21.7	24.7	1,786	126.8	14.1
1990	650	147.1	4.4	1,114	148.5	7.5	202	27.6	7.3	1,966	323.1	6.1
1991	522	143.0	3.7	1,327	326.9	4.1	16	8.0	2.0	1,865	477.9	3.9
1992[a]	4,825	316.2	15.3	2,322	130.4	17.8	4,956	96.2	51.5	12,103	542.8	22.3
1993[a]	1,709	106.2	16.1	5,783	158.3	36.5	1,568	57.7	27.2	9,060	322.2	28.1
1994	366	99.0	3.7	642	190.2	3.4	0	0.0	--	1,008	289.2	3.5
1995[a]	56	50.3	1.1	568	178.3	3.2	267	12.0	22.3	891	240.7	3.7
1996	413	36.0	11.5	3,591	193.3	18.6	0	0.0	--	4,004	229.3	17.5
1997	2,539	119.0	21.3	3,586	128.8	27.8	2,207	53.3	41.4	8,332	301.2	27.7
1998	189	92.3	2.0	218	83.7	2.6	1,214	155.3	7.8	1,621	331.3	4.9
1999	—	—	—	—	—	No Data	—	—	—	—	—	—
2000	8	8.0	1.0	217	62.0	3.5	1,826	190.4	9.6	2,051	260.4	7.9
2001	92	62.0	1.5	36	22.7	1.6	611	208.8	2.9	739	293.4	2.5
2002	103	115.7	0.9	137	36.7	3.7	2,925	460.9	6.3	3,165	613.2	5.2
2003	62	11.7	5.3	1,495	104.0	14.4	6,187	455.7	13.6	7,744	571.3	13.6
2004	338	22.0	15.4	8,102	270.9	29.9	5,021	199.7	25.1	13,461	492.6	27.3
2005	1,387	90.0	15.4	3,222	169.5	19.0	4,512	177.0	25.5	9,121	436.5	20.9
2006[a]	1,281	105.0	12	2,930	83.3	35	6,913	81.3	85	11,124	269.7	41
2007[a]	498	63.0	8	935	109.2	9	4,422	200.2	22	5,855	372.5	16
Total[b]	20,066	1,982	10	38,329	2,487	15	49,500	2,526	20	107,895	6,994	15

[a] Upper Niġliq catch and effort values include fish and net data from the Uyagagviq area (Area 630).
[b] Denotes average CPUE from 1986–2007.

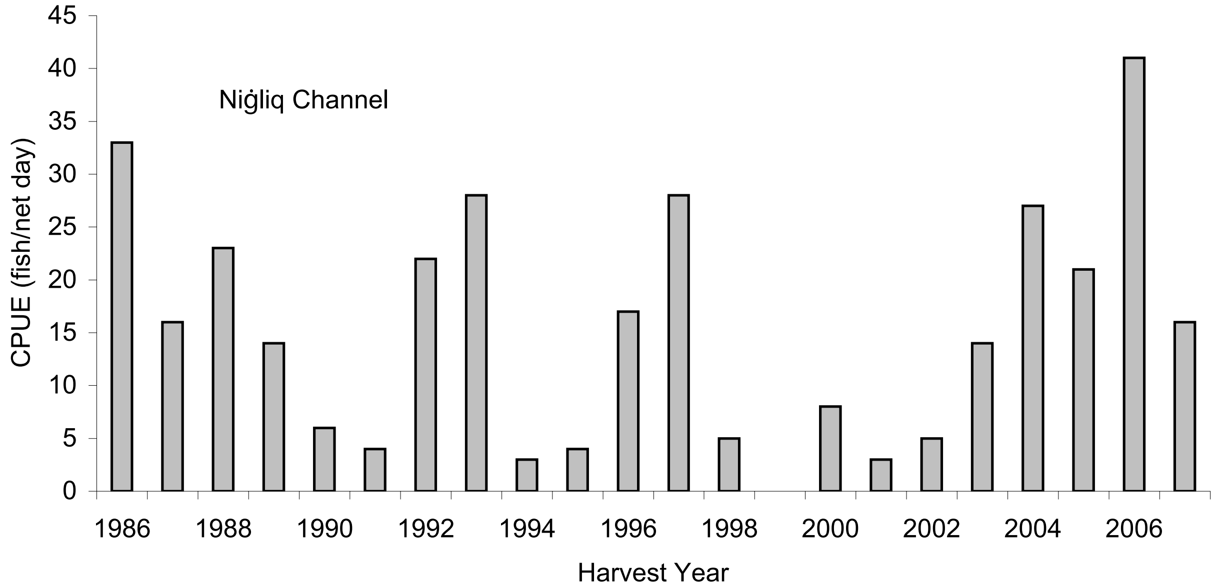

Figure 6. Arctic cisco CPUE in the Niġliq channel for 7.6 cm mesh gillnets standardized to 18 m length, 1986–2007.

ranged in age from 4 to 9 years (n = 135). Of these samples, 31% were age-6 fish, 27% were age-7, 19%, were age-5, 11% were age-8, 9% were age-4, and 2% were age-9 (Figure 11). Because different mesh-size nets catch different age classes (i.e., sizes of fish) differentially, we also examined harvest for different mesh sizes. In 7.6 cm mesh size nets (n = 39), age-7 fish comprised 36% of the catch followed by age-6 fish at 28%. Fish of age-4, 5 and 8 also comprised significant portions of the catch at 13%, 18% and 5%, respectively (Figure 11). Arctic cisco generally recruit to the fishery at age-4 when they reach lengths sufficient for capture in 6.4 and 7.6 cm mesh size nets. As fish continue to grow, they are caught in higher proportions. In 2007, there was a general trend towards increasing length with age that appears to top out at around 7 years of age (Figure 12).

Ageing a subsample of the harvest caught in 7.6 cm mesh nets allowed us to determine the relative percentages of each year class. These percentages were applied to the CPUE total (16 fish per adjusted net day; Table 3) to back-calculate the relative age structure and daily CPUE for the 2007 harvest. From these analyses, we determined that age-7 fish were the dominate age class represented in 7.6 cm gill nets in 2007. Harvest of age-8 fish was substantially reduced compared to 2006 (Daigneault and Reiser 2007). As expected for 7.6 cm nets, the CPUE increased from age-4 to age-6 (Figure 13). The 1999 year class (age-8 fish) should disappear from the fishery in 2008. The cumulative total CPUE for the 1999 year class was one of the highest in 21 years of monitoring. The 2000 and 2001 year classes are well represented but, again, the CPUE for younger fish was lower (Figure 14).

SALINITY MEASUREMENTS

Arctic cisco are commonly associated with salinities in the range of 15 to 25 ppt (parts per thousand) (Moulton 1994). West winds in the Colville Delta raise water levels on the Niġliq channel and bring saline waters upstream, which attracts increased numbers of Arctic cisco farther up the channel (Moulton and Seavey 2004). Salinity decreased from the downstream delta location (Hydro Station 1) to the upstream location in Nuiqsut (Hydro Station 4). However, the salinity at 3 m depth was within the appropriate range for Arctic cisco at the first three water monitoring stations (Figures 2 and 15). Salinities in the Upper Niġliq region, where CPUE and total harvest levels were lowest, remained below 15 ppt throughout the 2007 harvest season. Uyagagviq station (Figure 2) displayed a near doubling in salinity between 22

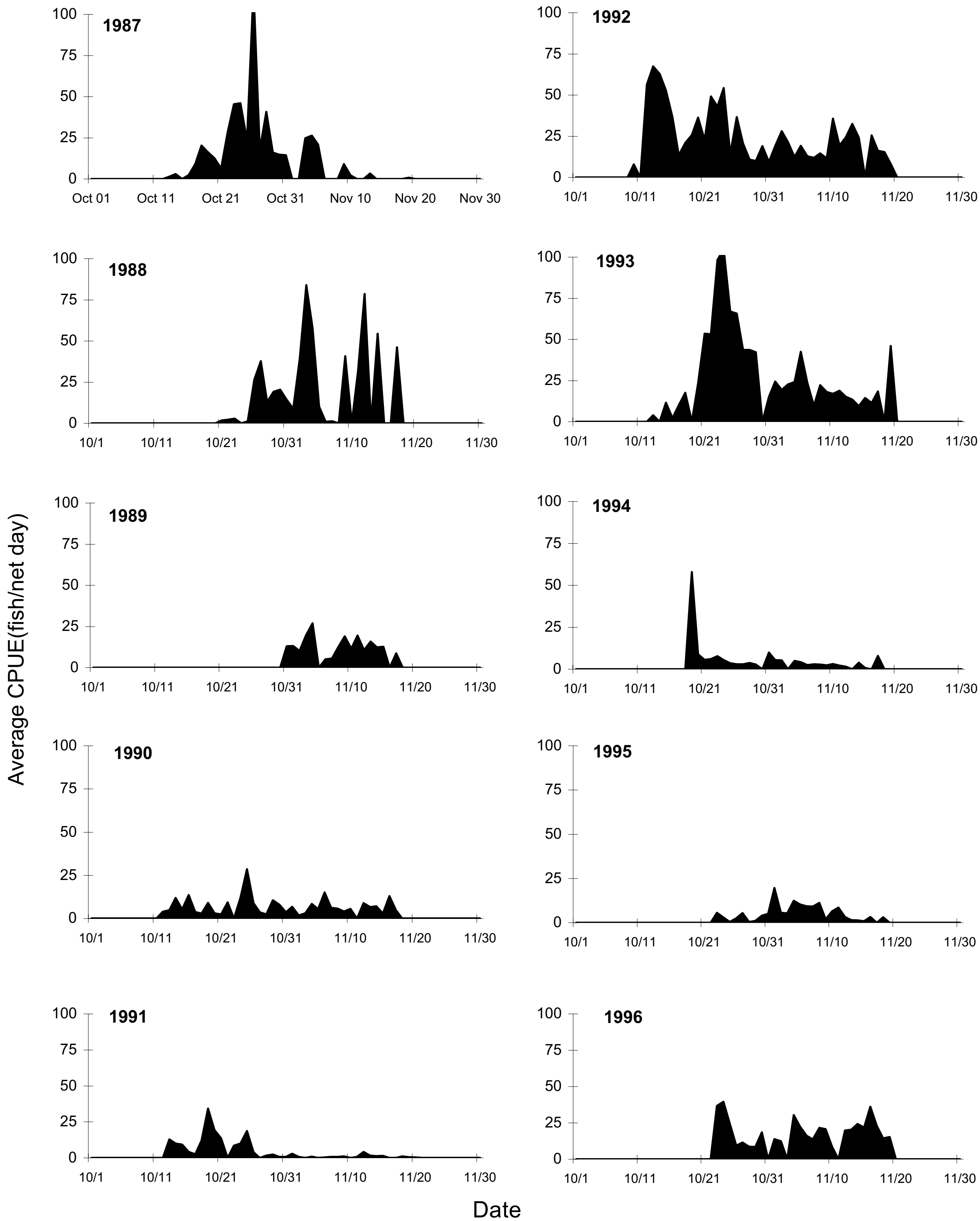

Figure 7a. Average daily Arctic cisco CPUE in the Niġliq channel for 7.6 cm mesh gill nets standardized to 18 m length, 1987–1996.

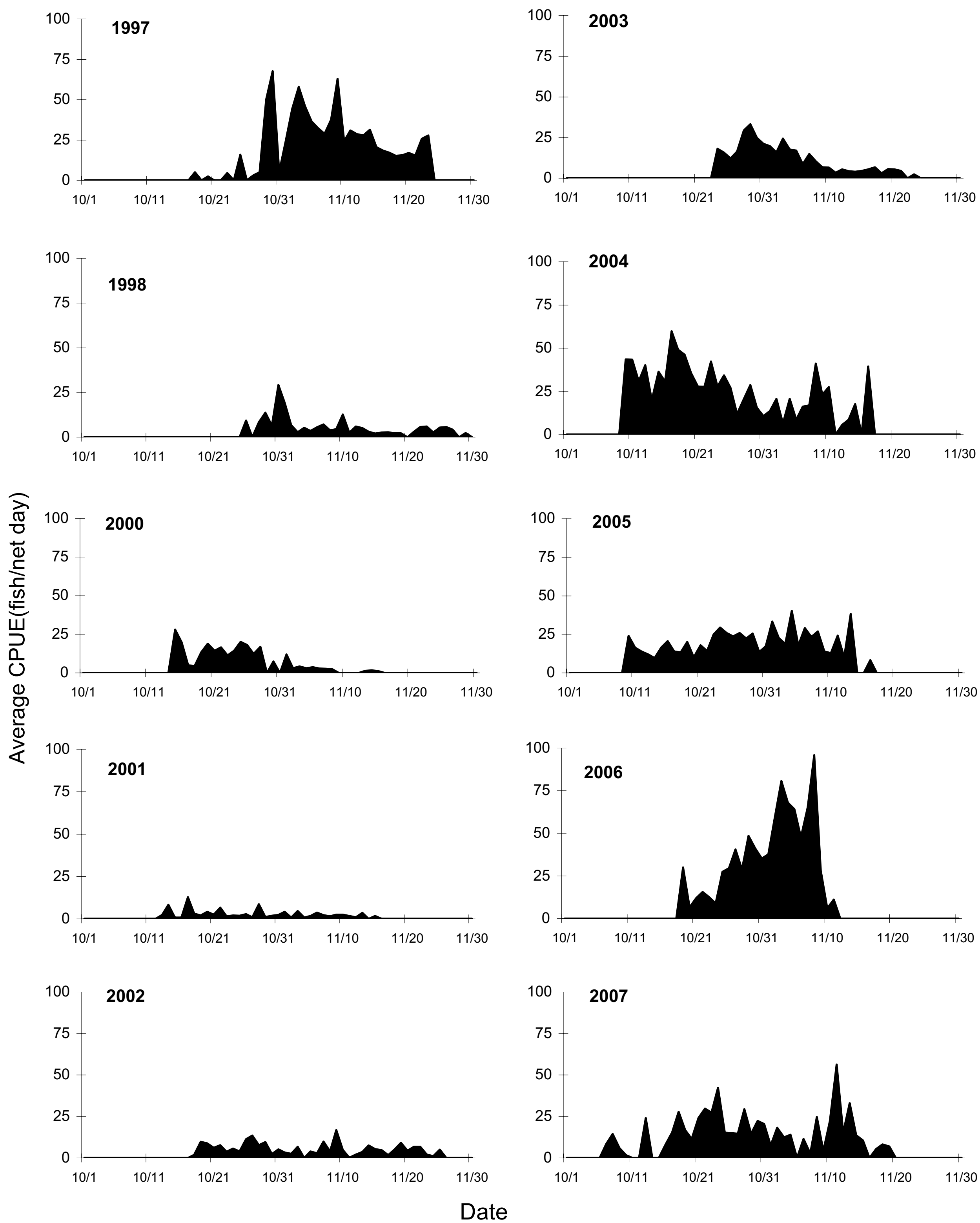

Figure 7b. Average daily Arctic cisco CPUE in the Niġliq channel for 7.6 cm mesh gill nets standardized to 18 m length, 1997–2007.

Table 4. Species composition of the subsistence harvest from the Colville River fall fishery, expressed as a percent of the sampled catch, 1985–2007. Table includes all fish caught every net, regardless of mesh size.

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007
Arctic cisco	69.5	95.9	71.8	90.6	66.2	39.6	62.8	89.2	85.4	39.6	34.7	81.9	74.8	39.6	79.4	35.6	49.8	66.3	74.7	81.3	86.6	71.7
Bering Cisco	(a)	(a)	(a)	(a)	(a)	21.8	1.2	0.1	0.02	0.1	0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.06	0.0	0.0	0
Least cisco	14.8	3.8	18.7	8.3	23.7	30.2	30.0	6.0	11.1	44.6	35.0	4.8	22.9	50.8	14.0	29.6	30.6	22.3	24.2	14.8	12.0	22.3
Broad whitefish	15.1	0.3	5.5	0.6	7.0	5.3	1.0	0.2	0.3	2.2	7.6	0.1	1.3	0.4	0.2	5.5	1.6	0.2	0.03	0.20	0.4	0.4
Humpback whitefish	0.5	0.03	3.8	0.5	3.1	2.9	3.8	0.1	0.4	13.2	22.3	0.4	0.9	8.9	6.0	27.8	17.5	9.4	0.85	3.5	0.9	5.5
Arctic grayling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Rainbow smelt	0.2	0.03	0.01	0.0	0.03	0.2	1.0	0.0	0.04	0.3	0.2	0.1	0.0	0.0	0.3	0.1	0.2	0.9	0.08	0.15	0.0	0
Round whitefish	0.0	0.01	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Dolly Varden char	0.0	0.0	0.03	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Northern Pike	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0
Saffron cod	0.0	0.0	0.03	0.0	0.03	0.03	0.04	0.0	0.01	0.0	0.0	0.02	0.0	0.0	0.03	0.0	0.1	0.6	0.04	0.01	0.0	0.1
Burbot	0.0	0.0	0.06	0.1	0.03	0.01	0.09	0.0	0.0	0.0	0.1	0.02	0.0	0.0	0.0	1.3	0.2	0.1	0.03	0.0	0.0	0
Arctic flounder	0.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Fourhorn sculpin	(b)	(b)	(b)	(b)	(b)	(b)	(b)	4.4	2.7	(b)	(b)	12.5	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Total Observed:	2,705	8,952	6,826	2,948	2,946	7,911	7,576	24,305	17,155	3,792	7,155	5,730	19,758	6,481	3,871	3,515	8,445	16,654	20,705	13,957	17,344	14,686

(a) = included with Arctic cisco prior to 1990
(b) = always present but not counted

Table 5. Least cisco catch, effort, and CPUE for each fishing area in the Niġliq channel, 1986–2007. Catch and effort data are for 7.6 cm mesh gillnets, standardized to 18 m length.

Harvest Year	Upper Niġliq Observed Catch (# of fish)	Upper Niġliq Effort (net days)	Upper Niġliq CPUE (fish/net day)	Nanuk Catch (# of fish)	Nanuk Effort (net days)	Nanuk CPUE (fish/net day)	Niġliq Delta Catch (# of fish)	Niġliq Delta Effort (net days)	Niġliq Delta CPUE (fish/net day)	Total Niġliq Channel Catch (# of fish)	Total Niġliq Channel Effort (net days)	Total Niġliq Channel CPUE (fish/net day)
1986	146	115.7	1.3	16	25.1	0.6	24	51.3	0.5	186	192.2	1.0
1987	730	131.7	5.5	63	32.6	1.9	12	31.3	0.4	805	195.7	4.1
1988	93	56.9	1.6	12	18.0	0.7	105	37.3	2.8	210	112.3	1.9
1989	332	90.8	3.7	16	14.3	1.1	10	21.7	0.5	358	126.8	2.8
1990	711	147.1	4.8	416	148.5	2.8	179	27.6	6.5	1,306	323.1	4.0
1991	50	143.0	0.3	272	326.9	0.8	0	8.0	0.0	322	477.9	0.7
1992[a]	261	316.2	0.8	88	130.4	0.7	151	96.2	1.6	500	542.8	0.9
1993[a]	181	106.2	1.7	498	158.3	3.1	96	57.7	1.7	775	322.2	2.4
1994	330	99.0	3.3	711	190.2	3.7	0	0.0	--	1,041	289.2	3.6
1995[a]	238	50.3	4.7	494	178.3	2.8	94	12.0	7.8	826	240.7	3.4
1996	14	36.0	0.4	195	193.3	1.0	0	0.0	--	209	229.3	0.9
1997	1,370	119.0	11.5	1,575	128.8	12.2	203	53.3	3.8	3,148	301.2	10.5
1998	544	92.3	5.9	577	83.7	6.9	935	155.3	6.0	2,056	331.3	6.2
1999	0	0.0	--	0	0.0	--	0	0.0	--	0	0.0	--
2000	11	8.0	1.4	97	62.0	1.6	330	190.4	1.7	438	260.4	1.7
2001	129	62.0	2.1	222	22.7	9.8	491	208.8	2.4	842	293.4	2.9
2002	176	115.7	1.5	165	36.7	4.5	1,033	460.9	2.2	1,374	613.2	2.2
2003	25	11.7	2.1	459	104.0	4.4	1,038	455.7	2.3	1,522	571.3	2.7
2004	167	22.0	7.6	2,493	270.9	9.2	1,483	199.7	7.4	4,143	492.6	8.4
2005	405	90.0	4.5	710	140.3	5.1	700	177.0	4.0	1,815	407.3	4.5
2006[a]	274	92.7	3.0	261	67.3	4.0	414	65.0	6.0	949	225.0	4.0
2007[a]	939	63.0	15.0	559	109.4	5.0	1,085	188.7	6.0	2,583	361.2	7.0
Total[b]	7,126	1,969	4	9,899	2,442	4	8,383	2,498	3	25,408	6,909	4

[a] Upper Niġliq catch and effort values include fish and net data from the Uyagagviq area (Area 630).
[b] Denotes average CPUE from 1986–2007.

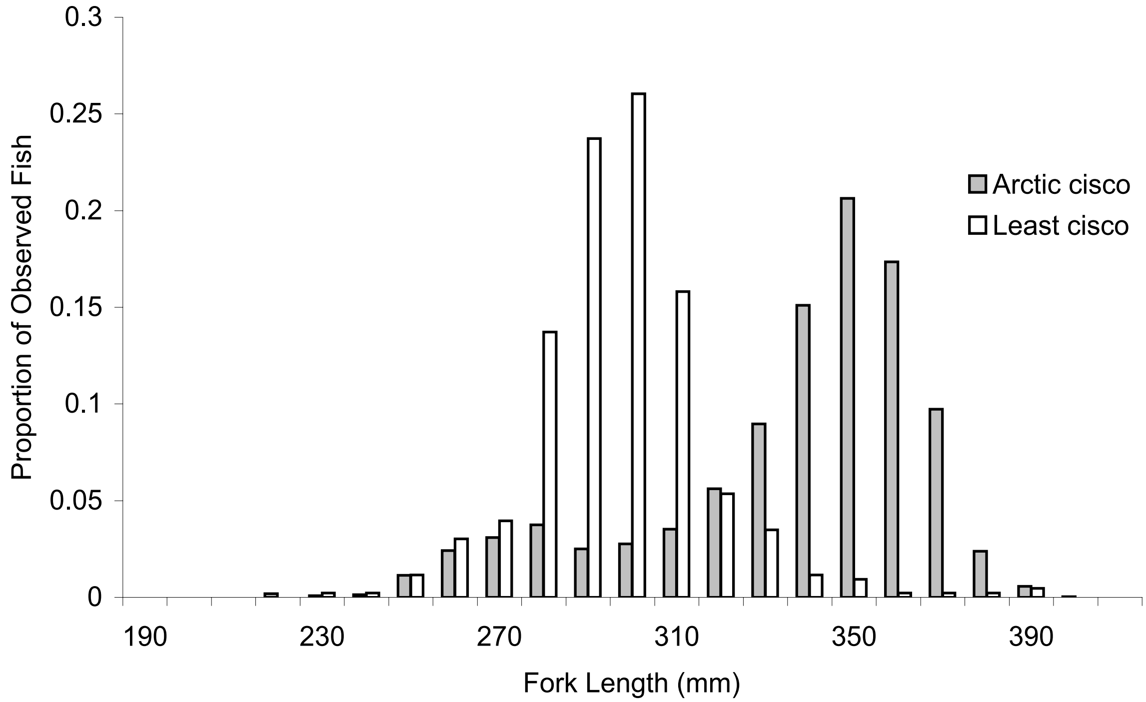

Figure 8. Observed length frequency of Arctic cisco (ARCS) and least cisco (LSCS) captured in nets of all mesh sizes in the Niġliq channel fall fishery, 2007.

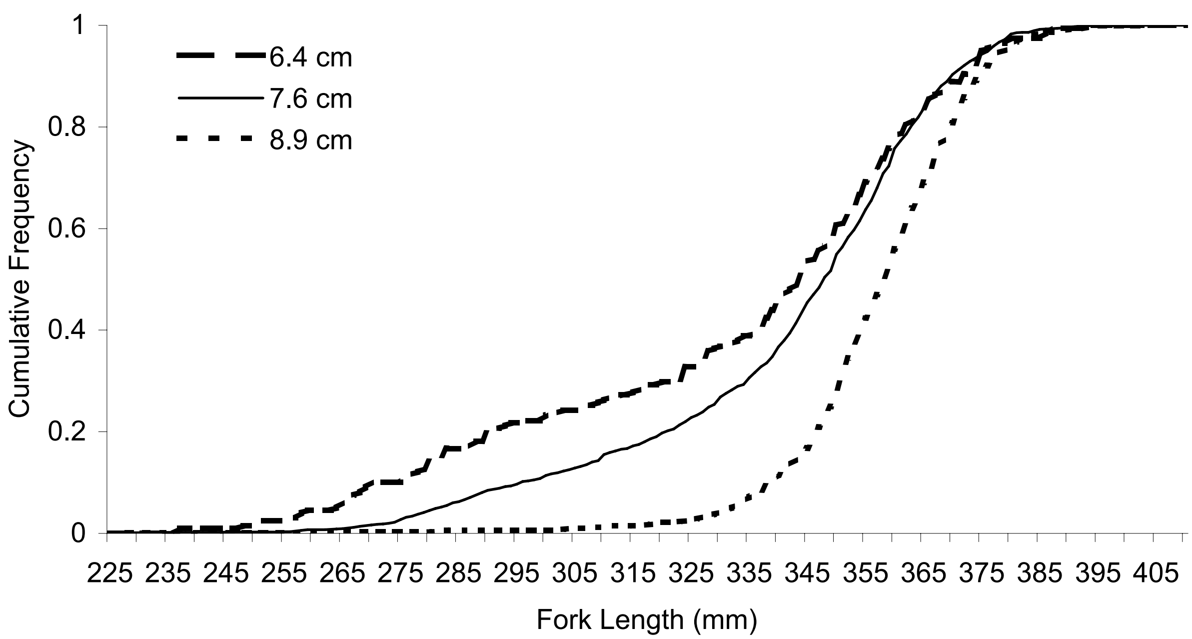

Figure 9. Cumulative length frequency of Arctic cisco harvested in different gillnet mesh sizes in the Niġliq channel fall fishery, 2007.

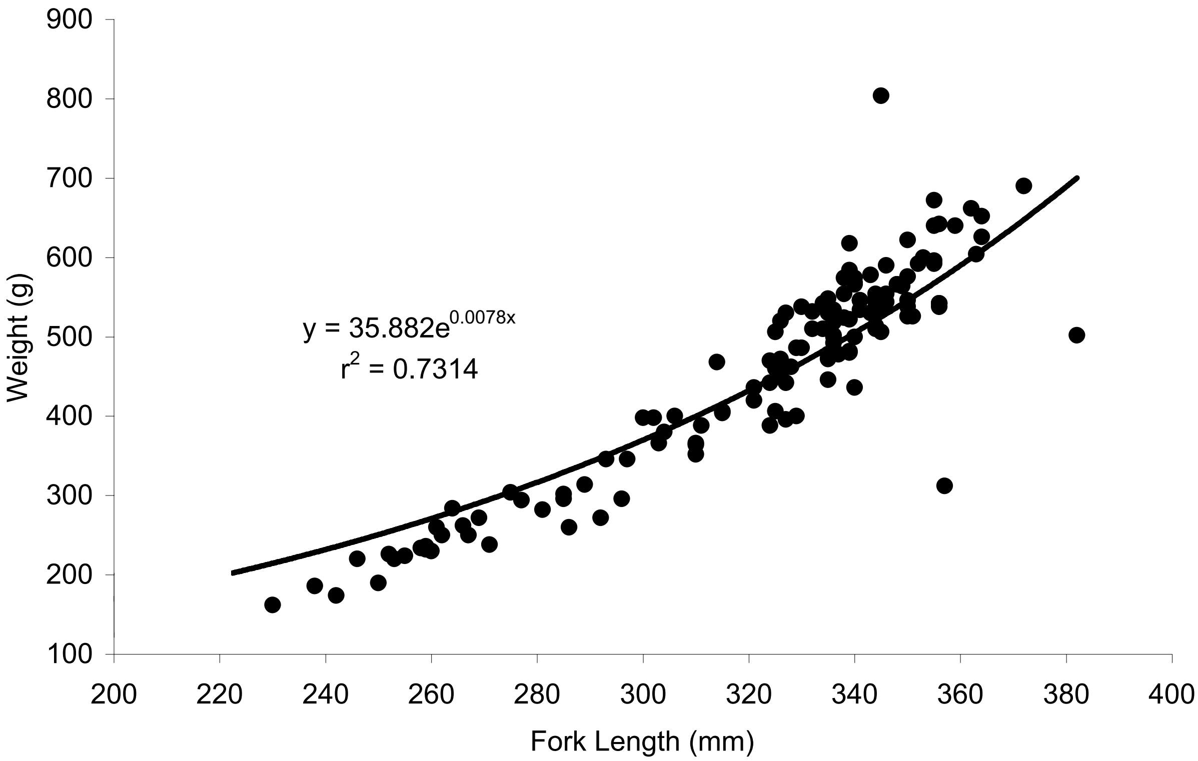

Figure 10. Arctic cisco length and weight relationship in the Niġliq channel fall fishery, 2007. Includes fish captured in gillnets of all mesh sizes (n = 135).

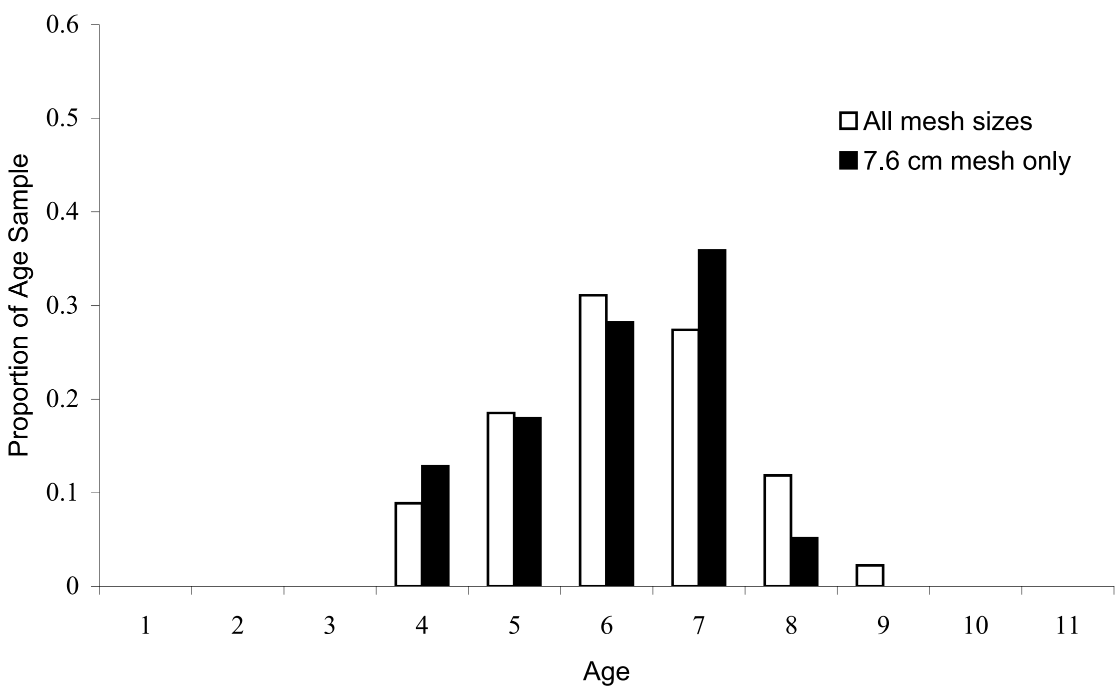

Figure 11. Age composition of Arctic cisco harvested in the Niġliq channel fall fishery, 2007. Results are displayed for all mesh sizes combined (n = 135) and for 7.6 cm mesh nets only (n = 39).

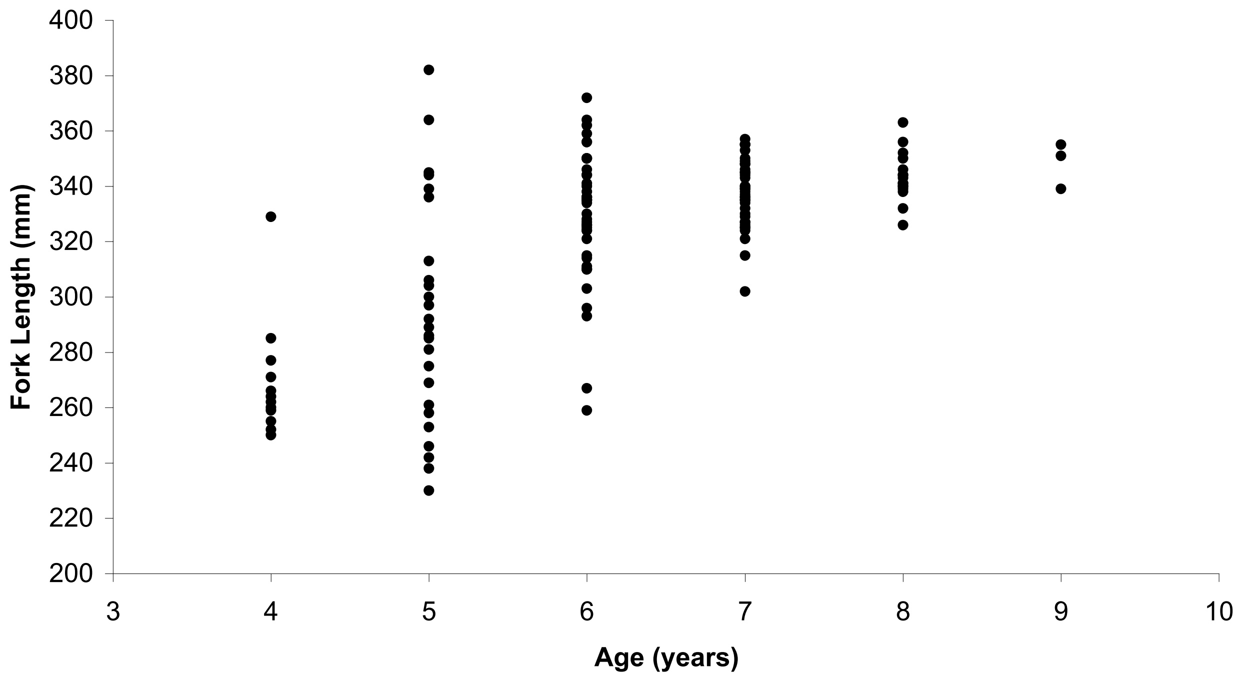

Figure 12. Age-specific length (mm) distribution of Arctic cisco harvested in the Niġliq channel, 2007. Includes fish captured in gillnets of all mesh sizes (n = 135).

and 24 October (Figure 15). This corresponds to the time of highest daily CPUE in the Niġliq channel (Figure 7). Salinity normally reaches 15 ppt by early November (Moulton and Seavey 2004). Salinity levels reached this mark by early November in the three downstream locations within about the first meter of water depth (Figure 16).

DISCUSSION

Monitoring of the fishery in 2007 commenced on 20 October, which coincidentally was the average start date of harvesting among all fishers during the 2007 season. An early freeze-up in 2007 allowed some fishers to start early (4 October), so some fishing effort was missed by the monitoring team. This did not appear to be a big problem, however, because snow cover on the river was light and travel was very arduous and hard on the snow machines, which reduced fishing effort in the early weeks of the fishery. Overall, we conducted over 350 individual interviews (logbook and oral interviews combined) with fishers at 55 different nets over 30 days of monitoring, and we think this provided a reasonable sample of the 2007 harvest.

The 2007 fishery was marked by the continued importance of the 2000 year class (Figure 13). As expected, the 1999 year class played a diminished role in the fishery, (Daigneault and Reiser 2007). The bulk of the remaining 1999 year class likely exited the Colville delta, having reached maturity and embarked upon a spawning migration to the Mackenzie River system in Canada (Gallaway et al. 1983). CPUE has traditionally been determined for the most prevalent mesh size (7.6 cm). Indeed, 7.6 cm mesh nets composed 36 of the 55 nets monitored (Table 2) and, therefore, provided a good measure for comparison among years of CPUE. Factoring in nets of different sizes along with 7.6 cm mesh nets implies that the 2001 and 2002 year classes also were harvested in moderate numbers (Figures 9–12).

Although, the lack of good snow conditions on the river was an issue for many fishers early in the harvest season, the total number of fishers participating in the fishery was similar to past years (Figure 3). However, daily harvest rates relative to effort did not approach 2006 levels for the Niġliq channel (Figure 7; also see Figure 7 in Daigneault

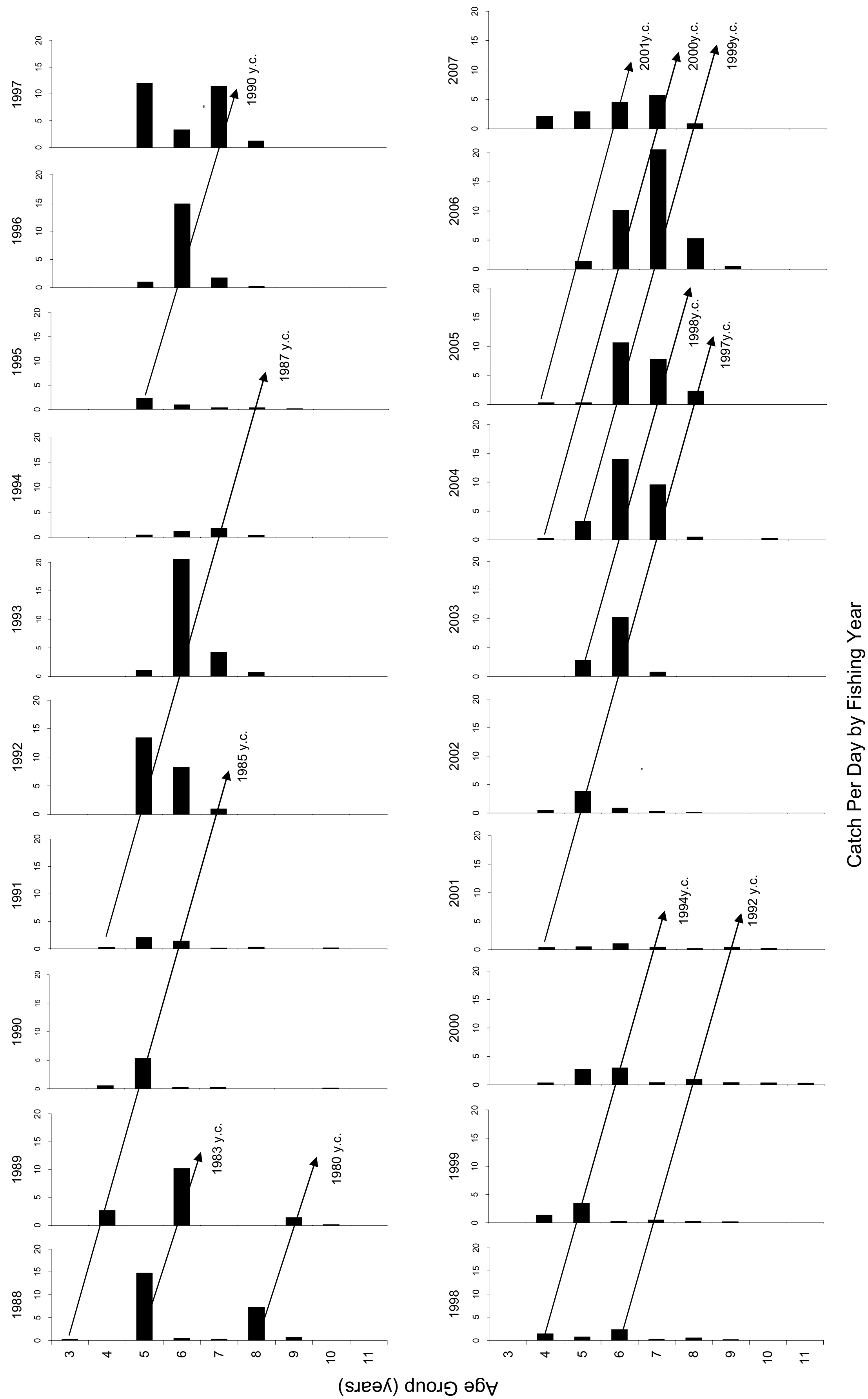

Figure 13. Age-specific Arctic cisco CPUE in the Nigliq channel subsistence fishery by year, 1988–2007. Includes fish caught in 7.6 cm mesh gillnets, standardized to 18 m length. Arrows demonstrate the progression of select year classes through the fishery over time.

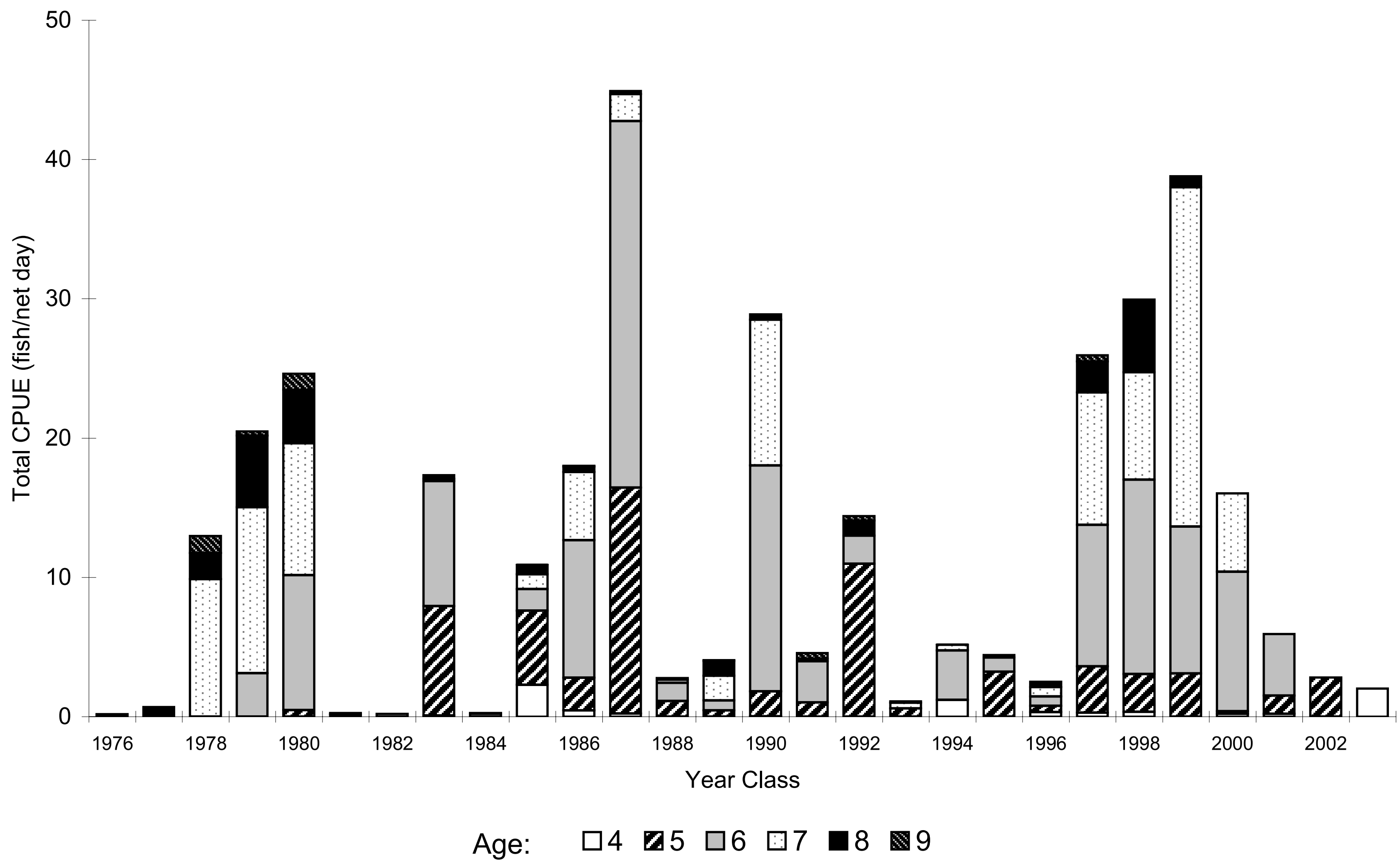

Figure 14. Total cumulative CPUE for Arctic cisco in the Niġliq channel by year class. Includes fish caught in 7.6 cm mesh gillnets, standardized to 18 m length. Age specific CPUE data from harvest years 1984–2007 were assigned to their appropriate year class (e.g., age-7 fish harvested in 2007 were assigned to the 2000 year class).

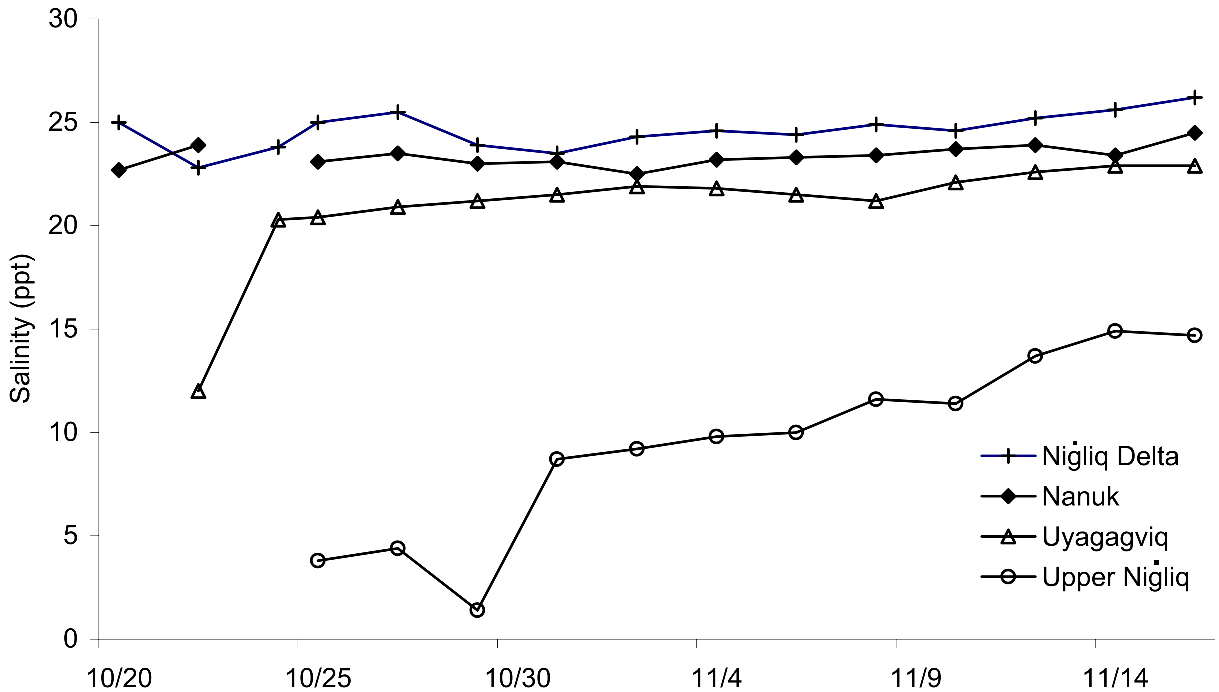

Figure 15. Salinity (parts per thousand) measured 3 m below the water surface at hydro stations located in major fishing areas in the Niġliq channel, 2007 (See Figure 2).

and Reiser 2007) during the periods of intense fishing. Nonetheless, the total monitored 2007 harvest of Arctic cisco in 7.6 cm mesh nets (5,855 fish) was the 8th best total since monitoring began in the mid-1980s (Table 3). Furthermore, discussions with subsistence fishers revealed a general satisfaction with the 2007 harvest.

The general satisfaction of fishers probably was related to the total CPUE for the Niġliq channel, which was the 9th best in 21 years of monitoring. Furthermore, the Niġliq Delta area CPUE of 22 fish per day was slightly above the all-time average. Conversely, CPUE levels were below average for both the Upper Niġliq and the Nanuk areas. While CPUE was comparatively low in the Nanuk area, 40% of effort was still focused there. Effort decreased markedly from 2006 to 2007 in the Upper Niġliq area because the majority of effort moved to the Niġliq Delta. This likely occurred because the higher harvest rates there were communicated to other fishers. Although the trip from Nuiqsut to the delta is time-consuming and costly in terms of fuel, fishers apparently will redistribute their efforts to the delta if catch rates diminish close to town (Figure 4).

By the third week in October, fishers were harvesting high numbers of Arctic cisco in the Niġliq Delta (Table 3). The peaks in daily harvest that occurred on 24 October and 12 November (Figure 7) were associated with slight increases of salinity around the same time (Figure 15). These increases in salinity normally are associated with increases in west winds that bring saline waters farther upstream (Moulton and Field 1988, Moulton 1994). Indeed, interviews with fishers during these time periods indicated that west winds were prevalent.

Arctic cisco harvests are predicted to diminish in the next 3 years based on low numbers of young-of-the-year in summer fyke net surveys near Prudhoe Bay in previous years (Figure 17). However, the presence of moderate numbers of smaller fish caught in 6.4 cm mesh nets by subsistence fishers in 2007 (Figure 9), as well as reasonable proportions of 2000 and 2001 age classes in the Niġliq channel harvest in 2007

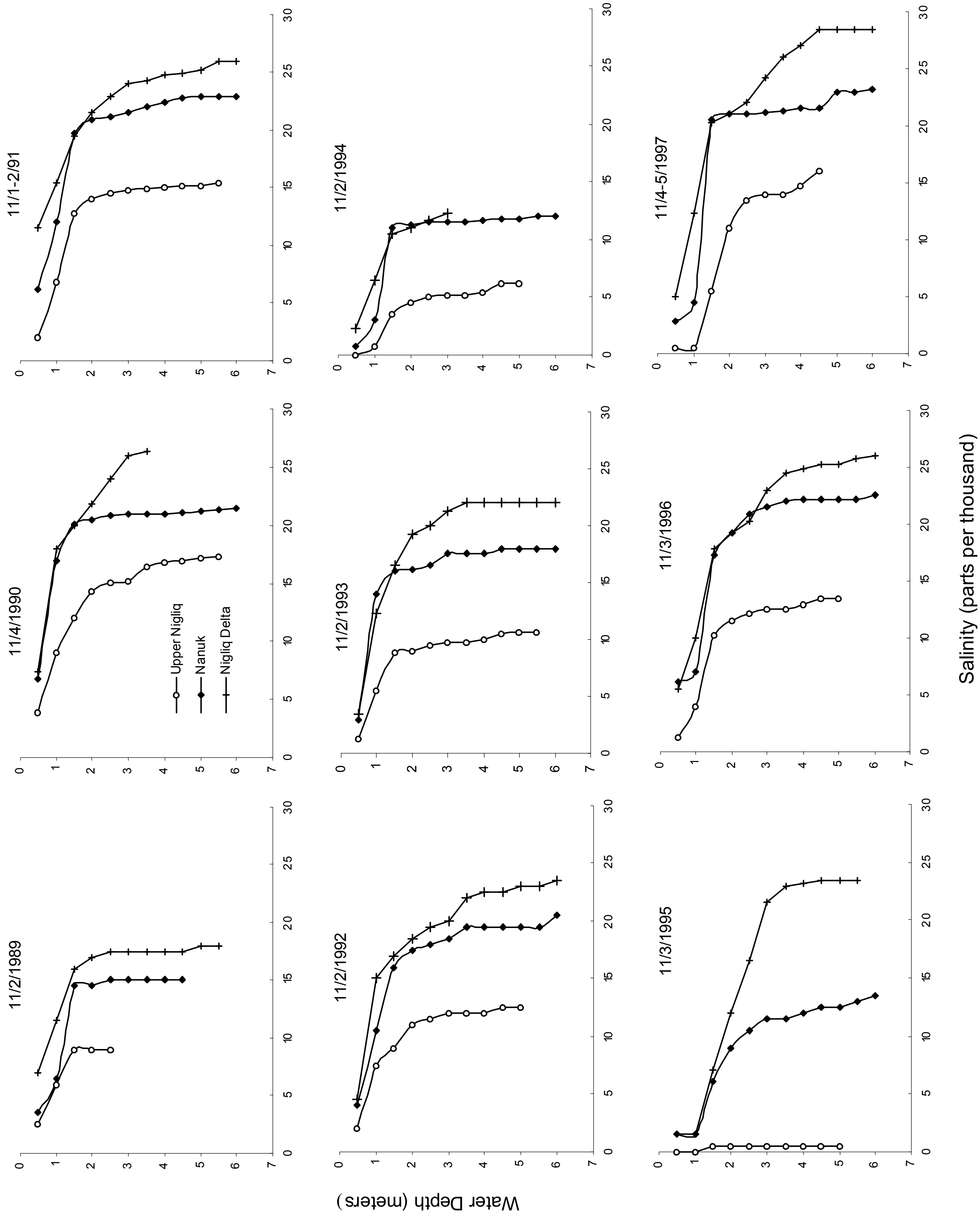

Figure 16a. Early November water salinity depth profiles in Nigliq channel fishing areas, 1989–1997.

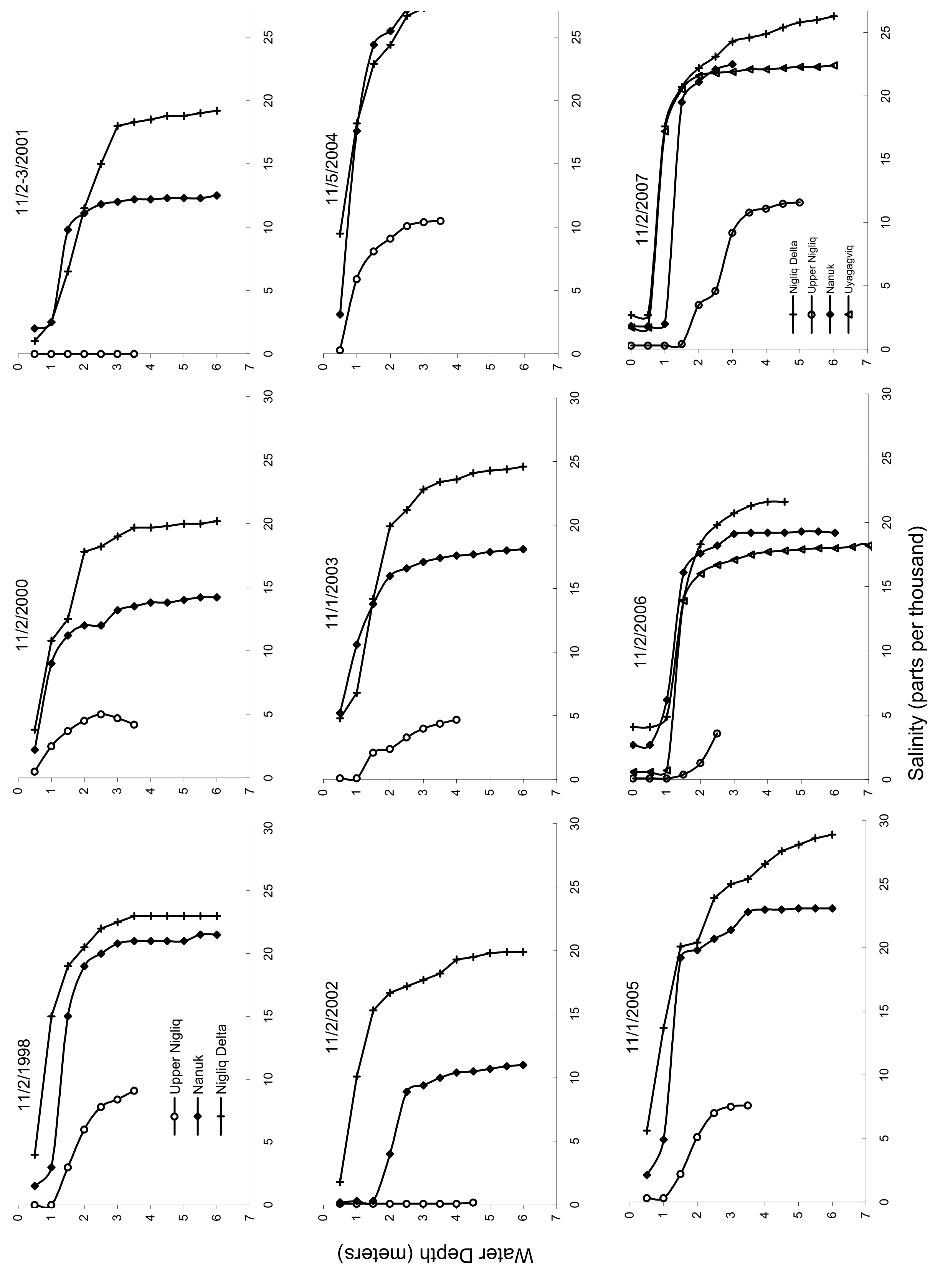

Figure 16b. Early November water salinity depth profiles in Nigliq channel fishing areas, 1998–2007.

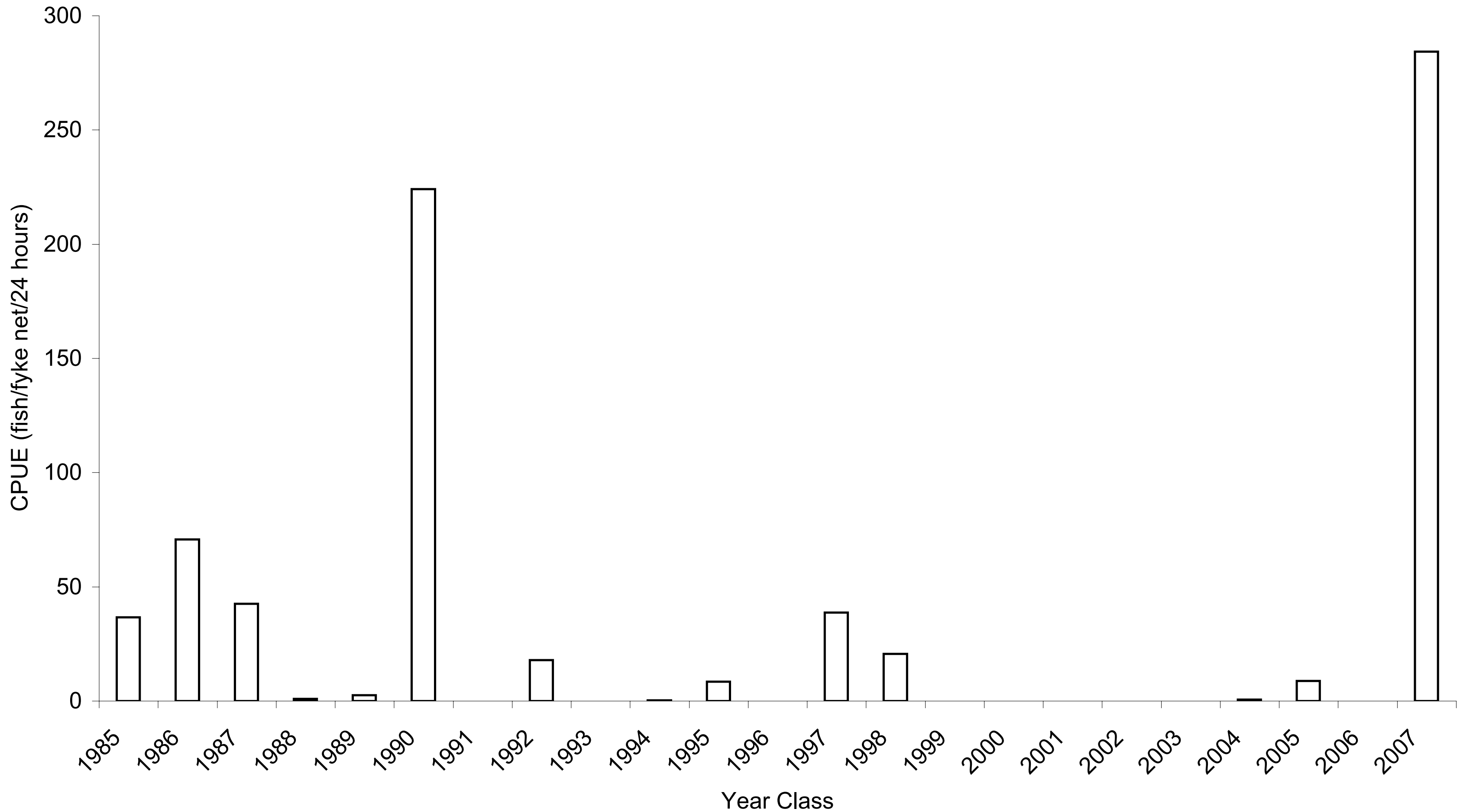

Figure 17. CPUE of young-of-the-year Arctic cisco in Prudhoe Bay (1985–2007) fyke nets (Source: Robert Fechhelm, LGL Ecological Research Associates, Texas, pers. comm. 2008).

(Figures 11–13), suggest that harvest levels could remain at moderate levels over the next 2–3 years. Furthermore, a particularly high count of young-of-the-year in Prudhoe Bay in 2007 suggests that increased harvest levels could occur starting in 2011 (Figure 17). Of course any predictions of future harvests must take into account the importance of unpredictable variables such as wind, salinity, and natural mortality of subadult age classes in any given year (Moulton and Seavey 2004).

The creation of a stakeholder and monitoring plan for Arctic cisco (Appendix A) proved to be a positive step for the monitoring team, and hopefully for the residents of Nuiqsut and other stakeholders. Clearly defining the responsibilities of the monitoring team and the fishers helped facilitate a successful monitoring program in 2007. The logbooks that were distributed to select fishers over the last three years have produced variable results. Although few fishers were interested in maintaining daily logbooks to record their harvest, the ones who were willing provided invaluable assistance in assessing the Niġliq channel harvest of Arctic cisco. Hence, we think the combination of methods that we used in 2007 can work in the long term.

LITERATURE CITED

ABR, Inc.—Environmental Research & Services (ABR, Inc.); Sigma Plus, Statistical Consulting Services; Stephen R. Braund & Associates; and Kuukpik Subsistence Oversight Panel, Inc. 2007. Variation in Abundance of Arctic Cisco in the Colville River: Analysis of Existing Data and Local Knowledge, Volumes I and II. Prepared for the U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, Anchorage, AK. Technical Report No. MMS 2007-042. Contract No. 1435-01-04-CT-34979.

Bickham, J.W., S.M. Carr, B.G. Hanks, D.W. Burton, and B.J. Gallaway. 1989. Genetic analysis of population variation in the Arctic cisco (*Coregonus autumnalis*) using electrophoretic, flow cytometric, and mitochondrial DNA restriction analysis. Biol. Pap. Univ. Alaska No. 24:112–122.

Bond, W.A., and R.N. Erickson 1985. Life history studies of anadromous coregonid fishes in two freshwater lake systems on the Tuktoyaktuk Peninsula, Northwest Territories. Can. Tech. Rept. Fish. Aquat. Sci. 1336:1–61.

Bond, W.A., and R.N. Erickson. 1997. Coastal migrations of Arctic cisco in the Eastern Beaufort Sea. Pages 155–164 *in* J. Reynolds, editor. Fish ecology in Arctic North America. American Fisheries Society Symposium 19, Bethesda, Maryland.

Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Canadian Special Publication of Fisheries and Aquatic Sciences 60.

Craig, P.C. 1984. Fish use of coastal waters of the Alaskan Beaufort Sea: A review. Trans. Amer. Fish Soc. 113:265–282.

Craig, P.C., and L. Halderson. 1981. Beaufort Sea barrier island-lagoon ecological process studies: Final report, Simpson Lagoon. Part 4. Fish. Pages 384–678 *in* Environ. Assess. Alaskan Cont. Shelf. OCS Final Rep. Princ. Invest., MMS/NOAA, OCSEAP, Anchorage, Alaska Vol. 7.

Daigneault, M.J., and C. Reiser. 2007. Colville River fall fishery monitoring, 2006. Report by LGL Alaska Research Associates, Inc., for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

Fechhelm, R.G., and D.B. Fissel. 1988. Wind-aided recruitment of Canadian Arctic cisco (*Coregonus autumnalis*) into Alaskan waters. Can. J. Fish. Aquat. Sci. 47:2164–2171.

Gallaway, B.J., R.G. and Fechhelm. 2000. Anadromous and amphidromous fishes *in* The Natural History of an Arctic Oil Field. Joe C. Truett and Stephen R. Johnson editors. Academic Press, New York, 422 pp.

Gallaway, B.J., W.B. Griffiths, P.C. Craig, W.J. Gazey, and J.W. Helmericks. 1983. An assessment of the Colville River delta stock of Arctic cisco (*Coregonus autumnalis*)—migrants from Canada? Fairbanks: Biol. Pap. Univ. Alaska No 21:4–23.

MBC Applied Environmental Sciences. 2004. Proceedings of a Workshop on the Variability of Arctic cisco (*Qaaktaq*) in the Colville River. November 18–20, Nuiqsut, AK. OCS Study, MMS 2004-033. Anchorage, AK: USDOI, MMS, Alaska OCS Region, 60 pp. plus appendices.

Moulton, L.L. 1989. Recruitment of Arctic cisco (*Coregonus autumnalis*) into the Colville Delta, Alaska *in* 1985. Biol. Pap. Univ. Alaska No. 24:107–111.

Moulton, L.L. 1994. The 1993 Endicott Development Fish Monitoring Program. Vol. II: The 1993 Colville River Fishery. Report by MJM Research, Bainbridge Island, WA, for BP Exploration (Alaska) Inc. and North Slope Borough. 60 pp. + app.

Moulton, L.L., and L.J. Field. 1988. Assessment of the Colville River fall fishery 1985–1987. Report by Environmental Sciences and Engineering, Inc. for ARCO Alaska, Inc., North Slope Borough, and the City of Nuiqsut. 42 pp.

Moulton, L.L., L.J. Field, and S. Brotherton. 1986. Assessment of the Colville River fishery in 1985. Colville River Fish Study, Ch. 3. Prepared by Entrix, Inc., for ARCO Alaska, Inc., the North Slope Borough, and the City of Nuiqsut. 86 pp.

Moulton, L.L., and B.T. Seavey. 2004. Harvest estimate and associated information for the 2003 Colville River fall Fishery. Report by MJM Research for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

Moulton, L.L., B.T. Seavey, and J. Pausanna. 2006. Harvest rates for the 2005 Colville River fall fishery. Report by MJM Research for ConocoPhillips Alaska, Inc., Anchorage, Alaska.

Appendix A. Stakeholder engagement and monitoring plan for the fall subsistence fishery monitoring on the Colville River.

FALL SUBSISTENCE FISHERY MONITORING ON THE COLVILLE RIVER

STAKEHOLDER ENGAGEMENT AND MONITORING PLAN

Prepared for

ConocoPhillips Alaska Inc.
and
The Kuukpik Subsistence Oversight Panel, Inc.

by
ABR, Inc.—Environmental Research & Services
and
Stephen R. Braund & Assoc.

November 2007

BACKGROUND

The fall subsistence fishery conducted in the Colville River by the residents of Nuiqsut, Alaska has been monitored annually since 1985 (no data were collected in 1999) by contractors (MJM Research [1985–2005] and LGL Alaska Research Associates [2006]) representing ConocoPhillips Alaska, Inc. (CPAI) and its predecessors (see Daigneault and Reiser 2007 and Moulton et al. 2006). The focus of the monitoring program has been on Arctic cisco (*qaaktaq; Coregonus autumnalis*), which is a staple in the diet of Nuiqsut residents. The impetus for the monitoring program primarily has been concern that oil and gas exploration and development in the nearshore marine environment and, more recently, on the Colville delta could adversely affect these anadromous fish. The main goals of the monitoring program have been to obtain estimates of the total fishing effort and catch and to predict future harvest. These goals have been accomplished by a variety of methods, including direct interviews with fishers and log books that were distributed to select fishers.

Prior to implementing a monitoring program in 2007, CPAI deemed it necessary to 1) reaffirm that there was support for the monitoring program among the primary stakeholders, which include Nuiqsut fishers, the Kuukpik Subsistence Oversight Panel, Inc. (KSOPI), the North Slope Borough [NSB] Department of Wildlife Management, and CPAI, and 2) to gain consensus on how the monitoring program should be implemented. These issues were addressed at community meetings held in Nuiqsut on 17 September and 15 October 2007, both of which were attended by ~25 residents. The monitoring team (i.e., ABR, Inc. and SRB&A) also held meetings with the *Qaaktaq* Panel (see below) on 15 and 16 October 2007. The main outcome of these meetings was that there was strong support to continue the monitoring program. The monitoring team also was able to develop a general consensus with the panel on the details of the monitoring program, and the points of consensus were presented and discussed at the 15 October 2007 community meeting.

This "Stakeholder Engagement and Monitoring Plan" was prepared for distribution to all stakeholders and is intended to document how the fishery monitoring program will be implemented in 2007.

STAKEHOLDER ENGAGEMENT

The goal of the Stakeholder Engagement Plan is to clearly articulate how the monitoring team and the Nuiqsut fishers and their support institutions (KSOPI and NSB) will work together to successfully implement a monitoring program for the Colville fall fishery. Specifically, the plan will address 1) how effective communication and good relations among all stakeholders will be maintained and 2) how community concurrence with the objectives and methods associated with the monitoring program will be achieved. This plan is based on our understanding of what has worked successfully in the past and on feedback obtained at public meetings held in Nuiqsut on 17 September and 15 October 2007 where these issues were reviewed and discussed and with meetings held with the *Qaaktaq* Panel (see below) on 15 and 16 October 2007.

The monitoring team will strive for a greater level of community involvement in the fall fishery monitoring program by enhancing communication among fishers, monitors, and other stakeholders before, during, and after the fishing season. Specifically, the monitoring team will 1) engage the community as a whole through public meetings in Nuiqsut, 2) use KSOPI as a resource for coordinating the logistics of the monitoring team and for representing the subsistence community, 3) engage a group of local experts (*Qaaktaq* Panel) familiar with the fall fishery, and 4) continue to hire local fishers to assist in the field data collection.

A previous study on Arctic cisco for the Minerals Management Service (ABR, Inc., et al. 2007) established a Panel of Experts, which was a group of 10 Nuiqsut residents who were selected by the community to work with the scientists. The role of the panel in the MMS study was to enhance the scientific understanding of Arctic cisco biology and population dynamics by providing local and traditional knowledge and by reviewing and assessing scientific data and conclusions. The panel spent three years (2005–2007) working with scientists, and there was strong agreement among the scientists, panel members, and MMS that this was a successful collaboration and means of integrating scientific and local knowledge. The monitoring team sought to build on this success and invited the panel to participate in this study and perform similar functions. At panel meetings on 15 and 16 October 2007, the panel accepted the invitation, renamed the panel the "*Qaaktaq* Panel," and decided that the panel would be comprised of the following individuals:

1. Joeb Woods
2. Marjorie Ahnupkana
3. Gordon Brown—KSOPI Board
4. Dora Nukapigak
5. Robert Lampe, Sr.
6. Gordon Matumeak
7. Eli Nukapigak—KSOPI Board
8. James Taalak—Cultural Coordinator for City of Nuiqsut
9. Billy Oyagak
10. Lydia Sovalik
11. Dwayne Hopson

NOTE: Eli Nukapigak, Billy Oyagak, Lydia Sovalik, Dwayne Hopson, and James Taalak are new nominees to the panel, and not all have accepted thus far.

In addition to keeping the monitoring program focused on the needs of the community and facilitating communications between stakeholders, the panel also will help resolve any conflicts or issues that arise from the monitoring program. Fishers will be instructed to register any complaints regarding the monitoring program with KSOPI at first opportunity. Because the monitoring team will be coordinating with the KSOPI office on a regular basis, these complaints will be responded to quickly. The monitoring team leader will first attempt to deal directly with the person issuing the complaint. If the issue can not be resolved in this manner, the issue will be brought to the panel for mediation. If that mediation is unsuccessful, a formal complaint will be drafted and forwarded to all stakeholders (CPAI, KSOPI, NSB) for future resolution.

MONITORING

For the 2007 monitoring program, the monitoring team will use methods that are similar and compatible with previous years so that the data are comparable among years. Hence, this Monitoring Plan is based on our understanding of what has worked successfully in the past and on feedback obtained from stakeholders.

Prior to 2005, interviews with fishers who were actively fishing were the main method for collecting harvest data. In 2005 and 2006, log books were added to the program, whereby a subset of fishers were responsible for documenting their own harvest. The monitoring team will use both interviews with fishers and logbooks as the methods of data collection in 2007.

The monitoring team will establish a "day station" on the Niġliq Channel where monitors will make themselves available in the field on a regular schedule. The station would be strategically positioned and would be a place where fishers could come and talk to monitors. We also are attempting to implement a process where fishers report to the KSOPI office or directly to monitors the times they intend to be out fishing. With this information in hand, the monitors will be able to efficiently visit specific fishing camps to collect data.

The monitoring team will be comprised of four individuals, two of which would be ABR biologists and two would be local community members who will be employed by ABR. The community members will help with field logistics, equipment, translation, data acquisition, and as a liaison for the monitors and fishers. Each day, the monitors will check in at the KSOPI office to determine who is planning to fish that day. They then will proceed on separate snow machines to the day station or to specified fish camps. Interviews will be conducted during periods of active fishing whenever possible. If the monitors are not able to interview the fisher while fishing, they will seek to interview the fisher as soon as possible. The monitors will help fishers pull their nets and process fish when those fishers are being interviewed; however, monitors will not tend nets for fishers who are absent or not being interviewed. There will be no compensation of fishers associated with these interviews.

The traditional goal of harvest monitoring of Arctic cisco in the Colville River has been to measure fishing effort and catch rates over the course of the season in order to make predictions about total harvest. This is difficult because it requires complete records of harvest from each fisher. The logistics of collecting this information is hampered by a number factors including, but not limited to:

–Not all nets are checked at predictable, regular intervals

–Multiple households are often responsible for checking the same net(s)

–Fishers with day jobs often check their nets on an irregular basis

–The majority of fishers on the Niġliq channel check nets from 1–5 pm. Hence, there are too many fishers fishing simulataniously to allow harvest interviews with each fisher, each day.

Thus, the monitoring team will focus on a group of primary fishers spread out over the ~14 miles of the Niġliq channel from Nuiqsut to the mouth of the channel. The *Qaaktak* Panel was interviewed to determine the names of these prospective fishers. The list is composed of fishers who set nets in three distinct areas of the river. With this list in hand, the monitoring team will seek to get daily reports on effort and catch from primary fishers on a daily basis. When the monitoring team are unable to actually attend the nets during harvest, we will attempt to interview those fishers in town.

Other fishers not listed by the panel will still be interviewed when possible, and the placement/removal of nets will be monitored daily. Efforts will be taken to meet with all net owners at some point in the season in order to interview them on their fishing statistics for the season. Information on harvest from primary fishers in distinct regions of the river, together with information on the total number of nets and harvest dates and catch totals for other fishers will allow us to make an estimate of total catch.

Data collected during daily interviews with fishers include:

–Net length and mesh size deployed

–Fishing time

–Number of fish caught

–A sub-sample of fish will be measured for length

Other interview questions asked over the fishing season include:

–What dates each net was first set?

–What are the dimensions of your net(s)?

–How often do you check your net(s)?

–Who else, besides you, checks these net(s)?

–About what time are they usually checked?

–Have you moved your nets from a different location?

Monitoring will focus on the Niġliq Channel, but occasional trips to other fishing locations will be undertaken if significant fishing effort is occurring elsewhere.

The monitors also will distribute logbooks to fishers who are willing to work mostly autonomously on monitoring their catch. The monitors will work closely with these fishers, particularly at the onset of the fishing season, so that filling out the required data forms is as easy as possible. Fishers will not be compensated for maintaining logbooks, although drawings for prizes will conducted for those fishers who turn in logbooks.

The monitors will purchase a sample of fish for age, length, weight, genetic, and potential tissue analysis. These fish will be preserved for further analysis. Fishers also have been asked to turn in any fish that show abnormalities. These fish will be preserved for future analysis by the NSB scientists.

Salinity measurements will be collected at areas associated with high density of net deployment. In the past there have been 3–4 water sampling stations for these measurements along the channel. The stations have normally been spread out among the Niġliq, Nanuk and Upper Niġliq areas of the channel. Salinity monitoring will occur on an every other day basis.

MEETINGS

Communication between the monitors and the fishers and among all stakeholders is a key component of the Monitoring and Stakeholder Engagement Plan. The monitoring team has scheduled two meetings each year in Nuiqsut, one before (held on 15–16 October 2007) and one after the fishing season. The next meeting will be held in late-winter/spring after the annual report is complete. In future years, the meeting before the fishing season will be held in late summer/early fall. For each meeting, the monitoring team will schedule a meeting with the community in the evening and have more detailed meetings with the *Qaaktaq* Panel on the afternoon preceding and the morning following the community meeting. The monitoring team will pay the *Qaaktaq* Panel an honorarium of $200 per person for attending both the afternoon meeting on the first day and the morning meeting on the second day. If a panel member only attends one of those meetings, the pay would be $100.

The main purpose of the 2007 late summer/fall meeting was to discuss with the panel and the community the overall support for continuing to monitor, all aspects of implementing the upcoming monitoring program, and to review in detail what is expected of the fishers, who provide data, and the monitors, who collect data. Meetings with the *Qaaktaq* Panel will include a review of those topics and also will be more focused on biological and harvest issues. Panel meetings also will provide a forum for exchange of scientific and local knowledge. In the afternoon meeting, the monitoring team will work with the Panel to discuss issues and draft resolutions for consideration by the community at the evening meeting.

The late winter/spring meetings will focus on dissemination of results of the previous fall's monitoring program and a discussion of the health of the fishery with the community. In addition to making the technical report available to interested participants, the scientific team will prepare a nontechnical presentation of the results of the monitoring program and what is known about future harvest estimates. These meetings also will be an opportunity to review what aspects of the monitoring program worked well and what could be improved. The monitoring program in previous years primarily focused on collecting field data and writing technical reports for CPAI. These reports were written for technical audiences, and they generally received limited distribution in Nuiqsut. In the spirit of enhanced community involvement, the study team will provide additional communication with the community after the monitoring season as described above.

Representatives from CPAI, the NSB, and KSOPI board of directors will be invited to participate in the evening community meetings. The community has expressed that they would like a forum to discuss results of and ideas for enhancements to the monitoring program, and having all of the stakeholders present at these meetings would be important. There will be no compensation for participants at the community meetings, although door prizes will be provided.

KSOPI will be asked to help coordinate all of these meetings and to participate both as facilitators and representatives of the subsistence community at the evening community meetings. The study team will pay KSOPI or other village institutions for any facility rental costs.

LITERATURE CITED

ABR, Inc.–Environmental Research & Services (ABR, Inc.); Sigma Plus, Statistical Consulting Services; Stephen R. Braund & Associates; and Kuukpik Subsistence Oversight Panel, Inc. 2007. Variation in the Abundance of Arctic Cisco in the Colville River: Analysis of Existing Data. OCS Study, MMS 2007-042.

Daigneault, M. J. and C. Reiser. 2007. Colville River fall fishery monitoring, 2006. Unpublished report prepared for ConocoPhillips Alaska Inc. by LGL Alaska Research Associates.

Moulton, L.L., B. T. Seavey, and J. Pausanna. 2006. Harvest Rates for the 2005 Colville River Fall Fishery. Unpublished report prepared for ConocoPhillips Alaska Inc. by MJM Research.