Colville River Fall Fishery Monitoring, 2006

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Cover Photograph: Harvested Arctic cisco being removed from a gillnet in the Nigliq delta, 2006.

EXECUTIVE SUMMARY

The goals of the 2006 Colville River fall fishery monitoring project were to estimate Arctic cisco catch rates for tracking abundance trends, to compare Arctic cisco biological data to other studies in the region, and to qualitatively predict future fishery performance.

The 2006 fishery began around October 14, although there were reports of fishery effort before this date. Fishery monitoring occurred from October 19 to November 11; 24 fishers set 57 gillnets during the 2006 fall fishery.

The 2006 Arctic cisco catch per unit of effort in the Nigliq Delta and the Nigliq Channel were the highest ever recorded in the fall fishery. The 1998 to 2000 Arctic cisco year classes were well represented in the 2006 fishery, with age-7 fish from the 1999 year class comprising most of the catch.

Young-of-the-year recruitment data, length and age data from the fishery, and length and age data from Prudhoe Bay and Oooguruk fyke net studies suggest that fall fishery harvest will decline in 2007, will be poor in 2008 and 2009, and may improve slightly in 2010 as the moderate 2005 year class begins to recruit to the fishery. Continued fishery harvest improvements could occur in 2011 as the 2006 year class recruits to the fishery and the 2005 year class remains available for harvest. Summer fyke net studies in the region will be useful for tracking growth of the 2005 and 2006 year classes and for identifying whether these year classes will recruit to the fishery.

We recommend that the fishery logbook program that was introduced in 2005 be terminated. Direct fisher interviews typically produce more timely and standardized data.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

Oil exploration and development in the coastal zone of the Alaskan Beaufort Sea has prompted a number of scientific studies designed to assess the effect of industry activities on regional fishery resources. Of particular interest is the Arctic cisco (qaaqtaq, *Coregonus autumnalis*). Arctic cisco is one of the most abundant species found in coastal waters of the North Slope and is the principal target of the Nuiqsut subsistence fishery and the former Colville River commercial fishery operated by the Helmericks family. These fisheries are conducted during the fall (October and November) using gillnets that are set under the ice of the Colville River (Plate 1). Because of their importance to regional fisheries, the Arctic cisco is considered to be one of the key indicator species for assessing the effects of Arctic oil development on regional resources (U.S. Army Corps of Engineers 1980, 1984).

A considerable body of information has been compiled on the Beaufort Sea Arctic cisco population over the past three decades. Fish monitoring studies have been conducted in the Prudhoe Bay area virtually ever summer since the late 1970s (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Biosonics 1984; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a, 1994b, 1999a, 1999b; Reub et al. 1991; Griffiths et al. 1995, 1996, 1997; Fechhelm et al. 2002, 2003, 2004, 2005). There have also been a series of annual studies of the Colville River commercial and subsistence fisheries that have paralleled the Prudhoe Bay studies. These include Moulton et al. (1986b, 1992, 1993, 2006), Moulton and Field (1988, 1991, 1994), Moulton (1994, 1995, 1997, 2001, 2003), and Moulton and Seavey (2004, 2005).

Many researchers have demonstrated that Arctic cisco in Alaska originate from Canada's Mackenzie River and that young fish are carried westward into Alaska by wind-driven coastal currents (Gallaway et al. 1983, Fechhelm and Fissel 1988, Bickham et al. 1989, Moulton 1989, Schmidt et al. 1989, Fechhelm and Griffiths 1990, Morales et al. 1993, Underwood et al. 1995, Colonell and Gallaway 1997, Moulton 2001). Meteorological conditions (winds) appear to be the main determinant of the strength of Arctic cisco year classes in Alaska and, in turn, Colville River fisheries. Climatic changes may be having a pronounced impact on this dispersal process and on the Colville River fisheries that depend upon them (Fechhelm et al. 2004). Further, a number of studies conducted in the Colville River have also shown that local hydrographic conditions in fall can alter the distribution of Arctic cisco locally thereby affecting the success of the fishery (Moulton et al. 1992; Moulton and Field 1994; Moulton 1994, 1995, 2001).

The Mackenzie River in Canada and the Colville River in Alaska are the two largest Beaufort Sea drainages and both systems provide overwintering habitat for large numbers of fish species, including Arctic cisco (Craig and Mann 1974; Craig 1984, 1989). The Sagavanirktok River is the third largest North Slope drainage; however, the amount of overwintering area in the river and delta is limited by the shallowness of the river's main channels and delta (Adams and Cannon 1987, Schmidt et al. 1989). Schmidt et al. (1989) reported that the Colville River had about 220 km of main channel deepwater habitat that

could be suitable for overwintering. By comparison, they estimated that the Sagavanirktok River had about 1.3 km of main channel deepwater habitat. None of the streams and rivers between the Sagavanirktok and Mackenzie rivers provides useful areas of overwintering habitat for Arctic cisco (Craig 1984). Fechhelm et al. (2005) hypothesized that it is this paucity of overwintering habitat that places young-of-the-year Arctic cisco at risk. Most of the fish unable to reach the overwintering haven of the Colville River (and possibly the marginal habitat provided by the Sagavanirktok River) before freeze-up likely perish. Young-of-the-year Arctic cisco appear to be unable to overwinter in marine coastal waters. Some consider winter mortality associated with the absence of adequate habitat to be one of the major factors limiting North Slope diadromous and freshwater fish populations, particularly for young fish (Craig 1989).

The annual success of young-of-the-year Arctic cisco recruitment to Alaskan overwintering areas affects the subsequent strength of that year class in the central Alaska population. In 23 years of summer fish monitoring programs at Prudhoe Bay, there has never been a year class that has strongly recruited into Alaska as 1-year-olds following a poor recruitment of young-of-the-year (Fechhelm et al. 2005). In fact, no year class that has failed to recruit to Alaska in their year of hatching has ever exhibited a strong presence in the central Alaskan population (Fechhelm et al. 2005).

During the fall, Arctic cisco move into Colville River channels as salinity increases following ice formation (Moulton and Field 1988, Moulton 1994). Periodic west winds move high salinity water upriver and with it the fish (Moulton and Seavey 2004). In years when salinity does not increase, such as 1988 and 1999, fishery yields are lower than expected (Moulton and Seavey 2005). The affinity of Arctic cisco to inhabit saline water during winter is also consistent with historical overwintering surveys (see Table 1 listing by Schmidt et al. 1989).

The Colville River fishery monitoring project began in 1985 in response to a request by the North Slope Borough for information to assess Colville River fisheries that may be affected by oil development in the region. In 1985, the study assessed both the summer and fall fisheries and investigated fish use of the Colville River delta (Fawcett et al. 1986, Moulton et al. 1986b). From 1986 to 2004, the project focused on assessing fishing patterns, total catch, and catch rates of the Arctic cisco fall fishery (Moulton and Field 1988, 1991, 1994; Moulton et al. 1992, 1993; Moulton 1994, 1995, 1997, 2001, 2003; Moulton and Seavey 2004, 2005). Additional information regarding the fall subsistence fishery in the eastern Colville River delta have been presented by George and Kovalsky (1986) and George and Nageak (1986). In 2005, fall fishery monitoring occurred during about half of the fishery and focused on assessing catch rates and fishing patterns (Moulton et al. 2006). The 2006 fall fishery monitoring was similar to the 2005 study.

OBJECTIVES

The goals of the 2006 Colville River fall fishery monitoring project were to estimate Arctic cisco catch rates and to qualitatively forecast subsequent fishery harvest of Arctic cisco. Specific objectives of the 2006 fishery monitoring study were to:

1) Monitor the Arctic cisco harvest during approximately half of the fishery using catch logbooks maintained by fishery participants, as well as through direct interviews with fishery participants;
2) Record effort and location of all subsistence nets;
3) Document subsistence fishery harvest;
4) Collect biological data from harvested Arctic cisco, such as age, length, and weight;
5) Measure water salinity in primary fishing areas;
6) Compare the 2006 fishery statistics to previously collected Arctic cisco data in the region.

METHODS

Fishery Effort and Harvest

Most fall subsistence fishery effort for Arctic cisco occurs in the Nigliq Channel of the Colville River, from the village of Nuiqsut downstream to the delta (Figure 1). Some subsistence fishery effort also occurs in the Kupigruak Channel in the eastern Colville River delta region. Fishery monitoring in 2006 was concentrated in four traditional fishing areas: the upper Nigliq Channel near Nuiqsut, the Uyagagviq area, the Nanuq area, and the Nigliq delta (Figure 2). Limited fishery information was also recorded for some fishing effort in the Kupigruak Channel.

Before the fishery began, field logbooks were provided to eight fishers who had regularly participated in past fall fisheries and were expected to fish in 2006. Fishers were asked to record the net location, set duration, net length, mesh size, and the number of fish caught by species. Because some of the initial eight fishers chose not to fish in 2006, field logbooks were also distributed to six additional fishers. Also, daily interviews were conducted with other fishers to collect effort and harvest data.

The start and end date and time was used to determine fishing effort for each net that was used to record harvest. Because multiple net lengths and set durations were used for harvesting fish, effort (net days) was standardized to 18 m net length and 24 h set duration. Catch per unit of effort (CPUE) estimates were calculated with these adjusted effort data. Also, multiple mesh sizes were used in the fishery; the most commonly used mesh size is 7.6 cm stretched mesh. Presentation of fishery data within this report specifies if the analysis includes all mesh sizes or the 7.6 cm mesh size data only.

Length, Weight, and Age of the Catch

During fisher interviews, the fork length (mm) was measured for a subset of the

harvested Arctic and least cisco (Plate 2). The daily number of fish measured for length varied depending on fish availability.

About 10 Arctic cisco were purchased daily from fishers and sacrificed for otolith extraction (Plate 3); fork length (mm) and weight (g) were also recorded. Weight was measured with an Acculab Vicon digital balance. Most fish were harvested in 7.6 cm stretched mesh gillnets, however, some were also harvested in 6.4 cm and 8.9 cm mesh. Otoliths were stored dry in individual sample vials for future laboratory analysis. Otoliths were prepared using the break and burn technique (Christensen 1964, Chilton and Beamish 1982). Otoliths were cracked through the center of the structure along the transverse axis using a sharp scalpel. The cut edge of each half of the otolith was placed next to an alcohol candle flame until the edge became discolored. The otolith halves were placed in a small putty cap with the burnt edge up and submerged in mineral oil, then viewed under a dissecting microscope with variable power from 7X to 30X. Dark annuli (rings) on the otolith represent reduced winter growth while the light colored sections correspond to the summer growth period. Otoliths typically have a spot birthmark at the center of the otolith; the birthmark is followed by summer and winter growth marks when the fish was age 0. Fish age was determined by counting the annuli after this first year.

Environmental Monitoring

Water salinity was measured every other day at four sampling locations corresponding to the major fishing areas (Figure 2); salinity was measured in parts per thousand (ppt) using a Yellow Springs Industries (YSI) Model YSI85 water meter. At each location, salinity was recorded at the surface and at 0.5 m increments along the water depth profile.

RESULTS

Fishery Effort and Harvest

The fishery began around October 14 (Table 1); temperatures were unseasonably warm in early October and the river was slow to freeze. Fishery monitoring began on October 19 and continued through November 11, 2006. A total of 24 fishers set 57 gillnets during the 2006 fall fishery (Table 2). The number of nets was an increase from 2005 and maintained the slight increasing trend of the number of nets over time (Figure 3), although this relationship is not significant ($p=0.66$). 55 of the 57 nets were set in the Nigliq Channel; the remaining 2 nets were set in the Kupigruak Channel.

A total of 1072 net days of effort occurred in 2006; this total effort includes all mesh sizes with the net length standardized to 18 m (Table 2). Most effort in 2006 occurred in the upper Nigliq area (Figure 4). Conversely, most of the harvested Arctic cisco came from the Nigliq Delta, based on the total catch and CPUE for the 7.6 cm mesh (Table 3 and Figure 5). The 2006 Arctic cisco CPUE of 41 fish/net day in the Nigliq Channel was the highest ever recorded for the fishery (Figure 6), based largely on the high CPUE in the Nigliq Delta (Table 3). The daily average CPUE increased as the fishery progressed; daily average CPUE in 2006 was high compared to most other years (Figure 7).

For least cisco, the majority of fishing effort was recorded in the upper Nigliq area, while the Nigliq Delta accounted for most of the harvest (Table 4). Arctic cisco and least cisco comprised most of the fishery catch; no other species were significantly represented in the catch (Table 5).

Length, Weight, and Age of the Catch

A total of 4,351 Arctic cisco were measured for fork length. Lengths ranged from 272 mm to 411 mm; about 50% of the Arctic cisco ranged from 320 mm to 340 mm in length (Figure 8). Arctic cisco length frequency differed among mesh sizes (Figure 9). The length and weight of Arctic cisco were highly correlated (Figure 10). 580 least cisco were measured for fork length; lengths ranged from 175 mm to 371 mm (Figure 8).

The 2006 Arctic cisco catch was composed of about 60% age 7, 20% age 6, and 15% age 8; age-5 and age-9 Arctic cisco each accounted for a small percent of the catch. These values remained consistent regardless of whether fish were captured in all meshes combined or were caught in 7.6 cm mesh only (Figure 11). There is a general increasing trend in Arctic cisco length at age, although there is considerable overlap in lengths for each successive age group (Figure 12).

Environmental Monitoring

Water salinity in the Nigliq Channel decreased with distance from the Beaufort Sea (Figure 13). Over time, salinity in each area increased slightly (Figure 13). Water salinity also increased with depth (Figure 14).

DISCUSSION

The 2006 Nigliq Channel and Nigliq Delta CPUE was the highest ever recorded in the fall subsistence fishery (Table 3 and Figure 6). There was a strong presence of the 1999 year class in the fishery as demonstrated by the high proportion of age-7 Arctic cisco in the catch (Figure 15). The 1999 year class has the second highest total CPUE of any year class in the Nuiqsut fall fishery (Figure 16). The presence of the 1999 year class in the fishery should diminish next year as remaining fish mature and return to the MacKenzie River.

Age-6 (2000 year class) and age-8 (1998 year class) Arctic cisco were also well represented in the 2006 fishery (Figure 15). The 2006 age-8 Arctic cisco CPUE was the highest ever recorded for this age class (Figure 15). Young-of-the-year recruitment data were not available for the 2000 year class (Figure 17) and the 2000 year class was not very well represented as age 4 or age 5 in the 2004 and 2005 fisheries (Figure 15). However, the occurrence of age-6 fish in the 2006 fishery suggests that Arctic cisco recruitment to the Alaska population in 2000 was good. In general, year classes with a strong presence of age-6 fish also had a strong age-7 component in the fishery the following year (Figure 15). Thus, the majority of fish available for the 2007 fishery will

likely be age-7 fish remaining from the 2000 year class and perhaps a small component of age-8 fish from the strong 1999 year class.

Recruitment of young-of-the-year Arctic cisco to the Alaska population has been weak for the 2001 through 2004 year classes (Figure 17), suggesting that few Arctic cisco of harvestable size will recruit to the fishery from 2007 to 2009. The presence of age-5 fish from the 2001 year class in the 2006 fishery likely resulted from the small recruitment in 2001 (Fechhelm et al. 2002); the low CPUE of age-1 Arctic cisco during 2002 Prudhoe Bay studies supports the premise of a weak 2001 year class (Fechhelm et al. 2003). The moderate young-of-the-year recruitment in 2005 should begin recruiting to the fishery about 2010 at age 5. Young-of-the-year Arctic cisco recruited to the Alaska population in 2006, however, there is some uncertainty in the strength of the 2006 age class. One young-of-the-year Arctic cisco was captured on the last day of sampling (August 28) at Prudhoe Bay (personal communication, Robert Fechhelm, LGL Ecological Research Associates, Texas). In most years, young-of-the-year Arctic cisco recruitment is detected at Prudhoe Bay by mid to late August (recorded range from July 27 to September 13). Fyke net sampling near the Colville River delta for the Oooguruk Development Project also captured young-of-the-year Arctic cisco in 2006; the first recruit was captured on September 1 and young-of-the-year Arctic cisco were present until sampling ended on September 21. The Oooguruk fyke net CPUE (fish/net/day) was 7, suggesting that the 2006 Arctic cisco recruitment to the Alaska population was modest (Figure 17; personal communication, Benjamin Williams, LGL Alaska Research Associates, Anchorage).

The majority (83%) of Arctic cisco captured in 7.6 cm mesh during the 2006 fall fishery ranged from 310 to 350 mm (Figure 18). Summer fyke net studies at Prudhoe Bay and Oooguruk indicated that there was a sizable group of fish in this length range available for harvest in 2006 (Figure 18). Also, length frequency data from Prudhoe Bay and Oooguruk suggest that there are few fish in smaller size classes that will be available for harvest in the next few years (Figure 18).

Water salinities throughout much of the Nigliq Channel were near 20 ppt. Arctic cisco are known to migrate into Colville River channels as the ice forms and salinity increases (Moulton and Field 1988, Moulton 1994). The 2006 water salinities were conducive to Arctic cisco moving into the Colville River and being available for harvest during the fall fishery.

Fishery harvest data were collected from 313 unique gillnet sets during the 3 weeks of fishery monitoring. Of these, 84% were derived from direct interviews with fishers and 16% resulted from the logbook program that originated in 2005. The direct interview method for obtaining fishery information typically produced more uniform data while data collected through the logbook program commonly required some type of clarification or adjustment. Further, the logbook data were often difficult to obtain on a timely basis. We recommend that future fishery monitoring efforts focus on obtaining data through direct fisher interviews rather than the logbook program.

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TABLES

Table 1. Estimated onset of fishing in the Colville River fall subsistence fishery, 1985 to 2006.

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
Average	7-Oct

Table 2. Total effort recorded for the 2006 fall fishery, including all fishers, mesh sizes, net lengths, and fishing areas.

Fisher Code	Fishing Area	Net	Net Code	Net Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net Days	Adjusted[a] Net Days
1	610	A	06001A	18.3	7.6	10/14/06	10/27/06	13	13.0
1	610	B	06001B	24.4	6.4	10/14/06	11/15/06	32	42.7
1	610	C	06001C	24.4	7.6	10/14/06	11/15/06	32	42.7
1	610	D	06001D	30.5	6.4	10/25/06	10/26/06	1	1.7
4	610	A	06004A	18.3	7.6	10/15/06	11/20/06	36	36.0
4	610	B	06004B	18.3	6.4	10/15/06	10/31/06	16	16.0
4	610	C	06004C	18.3	7.6	10/15/06	11/20/06	36	36.0
4	650	D	06004D	18.3	7.6	10/30/06	11/20/06	21	21.0
4	650	E	06004E	18.3	6.4	10/30/06	11/20/06	21	21.0
7	630	A	06007A	30.5	7.6	10/19/06	10/29/06	10	16.7
7	630	B	06007B	24.4	7	10/18/06	10/27/06	9	12.0
7	630	C	06007C	24.4	7	10/18/06	10/27/06	9	12.0
7	650	D	06007D	30.5	7.6	11/1/06	11/15/06	14	23.3
20	100	A	06020A	18.3	7.6	11/2/06	11/5/06	3	3.0
20	100	B	06020B	30.5	8.9	11/2/06	11/5/06	3	5.0
24	610	A	06024A	24.4	7.6	10/22/06	11/10/06	19	25.3
25	610	A	06025A	30.5	7.6	10/18/06	10/24/06	6	10.0
25	610	B	06025B	24.4	8.9	10/19/06	11/3/06	15	20.0
25	650	C	06025C	30.5	7.6	10/24/06	11/3/06	10	16.7
25	650	D	06025D	18.3	8.9	10/26/06	11/6/06	11	11.0
25	650	E	06025E	24.4	8.9	11/3/06	11/6/06	3	4.0
32	630	A	06032A	24.4	7.6	10/21/06	11/10/06	20	26.7
32	630	B	06032B	24.4	7.6	10/21/06	11/10/06	20	26.7
33	670	A	06033A	24.4	7.6	10/29/06	11/4/06	6	8.0
33	670	B	06033B	24.4	7.6	10/29/06	11/4/06	6	8.0
36	610	A	06036A	24.4	8.9	10/29/06	11/15/06	17	22.7
37	670	A	06037A	24.4	7.6	10/29/06	11/20/06	22	29.3
43	650	A	06043A	24.4	8.9	11/1/06	11/20/06	19	25.3
43	610	B	06043B	24.4	8.9	11/10/06	11/20/06	10	13.3
51	670	A	06051A	30.5	8.9	10/29/06	11/4/06	6	10.0
51	670	B	06051B	18.3	8.9	10/29/06	11/20/06	22	22.0
54	650	A	06054A	24.4	7.6	10/25/06	11/15/06	21	28.0
54	650	B	06054B	18.3	8.9	10/26/06	11/15/06	20	20.0
57	650	A	06057A	24.4	7.6	10/23/06	11/20/06	28	37.3
57	650	B	06057B	24.4	6.4	10/25/06	11/20/06	26	34.7
63	670	A	06063A	24.4	7.6	10/25/06	11/2/06	8	10.7
63	670	B	06063B	24.4	7.6	10/27/06	11/7/06	11	14.7

Table 2 (cont.) Total effort recorded for the 2006 fall fishery, including all fishers, mesh sizes, net lengths, and fishing areas.

Fisher Code	Fishing Area	Net	Net Code	Net Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net Days	Adjusted[a] Net Days
66	610	A	06066A	24.4	8.9	10/21/06	11/11/06	21	28.0
66	610	B	06066B	24.4	7.6	10/21/06	11/11/06	21	28.0
66	610	C	06066C	18.3	6.4	10/21/06	10/31/06	10	10.0
66	610	D	06066D	24.4	8.9	10/29/06	11/11/06	13	17.3
66	610	E	06066E	18.3	6.4	11/3/06	11/15/06	12	12.0
69	650	A	06069A	24.4	8.9	10/25/06	11/5/06	11	14.7
69	670	B	06069B	24.4	7.6	10/28/06	11/20/06	23	30.7
70	670	A	06070A	30.5	7.6	10/28/06	11/3/06	6	10.0
72	630	A	06072A	30.5	8.9	10/21/06	10/30/06	9	15.0
72	650	B	06072B	24.4	7.6	10/24/06	11/20/06	27	36.0
72	650	C	06072C	24.4	7.6	10/26/06	11/20/06	25	33.3
72	650	D	06072D	30.5	8.9	10/30/06	11/11/06	12	20.0
73	610	A	06073A	24.4	7.6	10/22/06	10/31/06	9	12.0
74	670	A	06074A	30.5	7.6	10/29/06	11/2/06	4	6.7
79	610	A	06079A	18.3	7.6	10/15/06	10/30/06	15	15.0
79	650	B	06079B	24.4	7.6	10/25/06	11/2/06	8	10.7
88	610	A	06088A	24.4	7	11/5/06	11/15/06	10	13.3
88	610	B	06088B	24.4	unknown	11/6/06	11/15/06	9	12.0
89	610	A	06089A	18.3	6.4	10/15/06	10/31/06	16	16.0
89	630	B	06089B	18.3	6.4	10/31/06	11/5/06	5	5.0
							Total Adjusted Net Days		1072.0

[a]Net days were standardized to a net length of 18 m.

Table 3. Arctic cisco catch, effort, and CPUE for each fishing area in the Nigliq Channel, 1986-2006. Catch and effort data are for 7.6 cm mesh gillnets, standardized to 18 m length.

Harvest Year	Upper Nigliq			Nanuq			Nigliq Delta			Total Nigliq Channel		
	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)
1986	2,218	115.7	19	752	25.1	30	3,379	51.3	66	6,349	192.1	33
1987	1,451	131.7	11	948	32.6	29	661	31.3	21	3,060	195.6	16
1988	366	56.9	6	146	18.0	8	2,078	37.3	56	2,590	112.2	23
1989	993	90.8	11	258	14.3	18	535	21.7	25	1,786	126.8	14
1990	650	147.1	4	1,114	148.5	8	202	27.6	7	1,966	323.2	6
1991	522	143.0	4	1,327	326.9	4	16	8.0	2	1,865	477.9	4
1992[a]	4,825	316.2	15	2,322	130.4	18	4,956	96.2	52	12,103	542.8	22
1993[b]	1,709	106.2	16	5,783	158.3	37	1,568	57.7	27	9,060	322.2	28
1994	366	99.0	4	642	190.2	3	0	0.0	-	1,008	289.2	3
1995[c]	56	50.3	1	568	178.3	3	267	12.0	22	891	240.6	4
1996	413	36.0	11	3,591	193.3	19	0	0.0	-	4,004	229.3	17
1997	2,539	119.0	21	3,586	128.8	28	2,207	53.3	41	8,332	301.1	28
1998	189	92.3	2	218	83.7	3	1,214	155.3	8	1,621	331.3	5
1999	No Data											
2000	8	8.0	1	217	62.0	4	1,826	190.4	10	2,051	260.4	8
2001	92	62.0	1	36	22.7	2	611	208.8	3	739	293.5	3
2002	103	115.7	1	137	36.7	4	2,925	460.9	6	3,165	613.3	5
2003	62	11.7	5	1,495	104.0	14	6,187	455.7	14	7,744	571.4	14
2004	338	22.0	15	8,102	270.9	30	5,021	199.7	25	13,461	492.6	27
2005	1,387	90.0	15	3,222	169.5	19	4,512	177.0	25	9,121	436.5	21
2006[d]	1,281	105.0	12	2,930	83.3	35	6,913	81.3	85	11,124	269.7	41
Totals	19,568	1,919	10	37,394	2,378	16	45,078	2,326	19	102,040	6,622	15

[a] Upper Nigliq catch and effort values include 1,721 fish and 102.3 net days from Uyagagviq (Area 630).

[b] Upper Nigliq catch and effort values include 1,373 fish and 71.8 net days from Uyagagviq (Area 630).

[c] Upper Nigliq catch and effort values include 45 fish and 33.3 net days from Uyagagviq (Area 630).

[d] Upper Nigliq catch and effort values include 873 fish and 55.7 net days from Uyagagviq (Area 630).

Table 4. Least cisco catch, effort, and CPUE for each fishing area in the Nigliq Channel, 1986-2006. Catch and effort data are for 7.6 cm mesh gillnets, standardized to 18 m length.

Harvest Year	Upper Nigliq			Nanuq			Nigliq Delta			Total Nigliq Channel		
	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)	Catch (# of fish)	Effort (net days)	CPUE (fish/net day)
1986	146	115.7	1	16	25.1	1	24	51.3	0	186	192.2	1
1987	730	131.7	6	63	32.6	2	12	31.3	0	805	195.7	4
1988	93	56.9	2	12	18.0	1	105	37.3	3	210	112.3	2
1989	332	90.8	4	16	14.3	1	10	21.7	0	358	126.8	3
1990	711	147.1	5	416	148.5	3	179	27.6	6	1,306	323.1	4
1991	50	143.0	0	272	326.9	1	0	8.0	0	322	477.9	1
1992	261	316.2	1	88	130.4	1	151	96.2	2	500	542.8	1
1993	181	106.2	2	498	158.3	3	96	57.7	2	775	322.2	2
1994	330	99.0	3	711	190.2	4	0	0.0	--	1,041	289.2	4
1995	238	50.3	5	494	178.3	3	94	12.0	8	826	240.7	3
1996	14	36.0	0	195	193.3	1	0	0.0	--	209	229.3	1
1997	1,370	119.0	12	1,575	128.8	12	203	53.3	4	3,148	301.2	10
1998	544	92.3	6	577	83.7	7	935	155.3	6	2,056	331.3	6
1999						No Data						
2000	11	8.0	1	97	62.0	2	330	190.4	2	438	260.4	2
2001	129	62.0	2	222	22.7	10	491	208.8	2	842	293.4	3
2002	176	115.7	2	165	36.7	5	1,033	460.9	2	1,374	613.2	2
2003	25	11.7	2	459	104.0	4	1,038	455.7	2	1,522	571.3	3
2004	167	22.0	8	2,493	270.9	9	1,483	199.7	7	4,143	492.6	8
2005	405	90.0	5	710	140.3	5	700	177.0	4	1,815	407.3	4
2006	274	92.7	3	261	67.3	4	414	65.0	6	949	225.0	4
Totals	6,187	1,906	3	9,340	2,332	4	7,298	2,309	3	22,825	6,548	3

Table 5. Species composition of the catch from the Colville River fall fishery, expressed as a percent of the sampled catch, 1985-2006.

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006
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
Bering Cisco	(a)	(a)	(a)	(a)	(a)	21.8	1.2	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1	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
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	0.0	0.2	0.4
Humpback whitefish	0.5	0.0	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	0.9	3.5	0.9
Round whitefish	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	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dolly Varden	0.0	0.0	0.0	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
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
Northern Pike	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
Burbot	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.3	0.2	0.1	0.0	0.0	0.1
Rainbow smelt	0.2	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0	0.3	0.2	0.1	0.0	0.0	0.3	0.1	0.2	0.9	0.1	0.2	0.0
Saffron cod	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	0.6	0.0	0.0	0.0
Arctic flounder	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
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)
Total Sampled Catch:	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

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

FIGURES

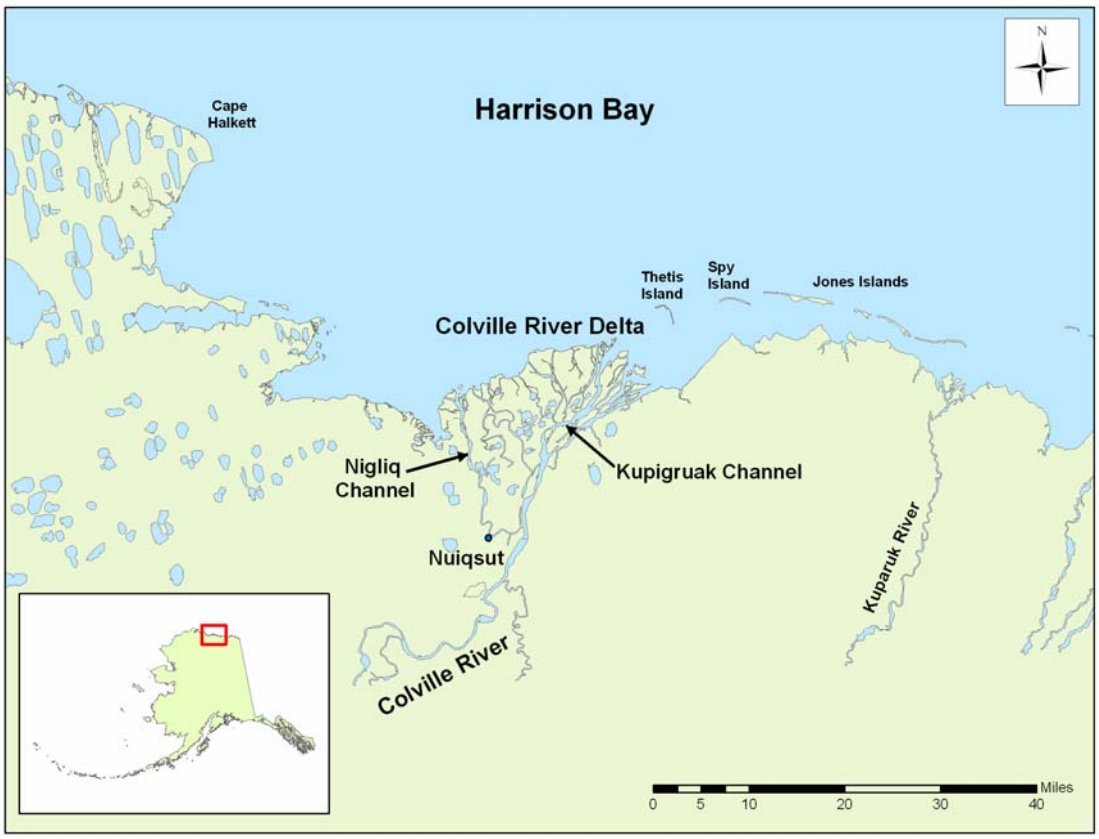

Figure 1. Overview of the Colville River delta area, noting the primary river channels targeted during the subsistence fishery.

Figure 2. Detailed view of the Colville River delta, depicting the Nigliq and Kupigruak channels and the water sampling and net sites during the 2006 fishery.

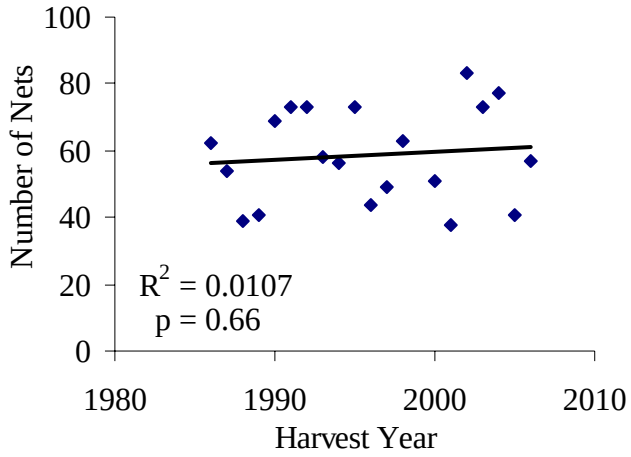

Figure 3. Annual number of gillnets used in the Colville River fall subsistence fishery, 1986 to 2006.

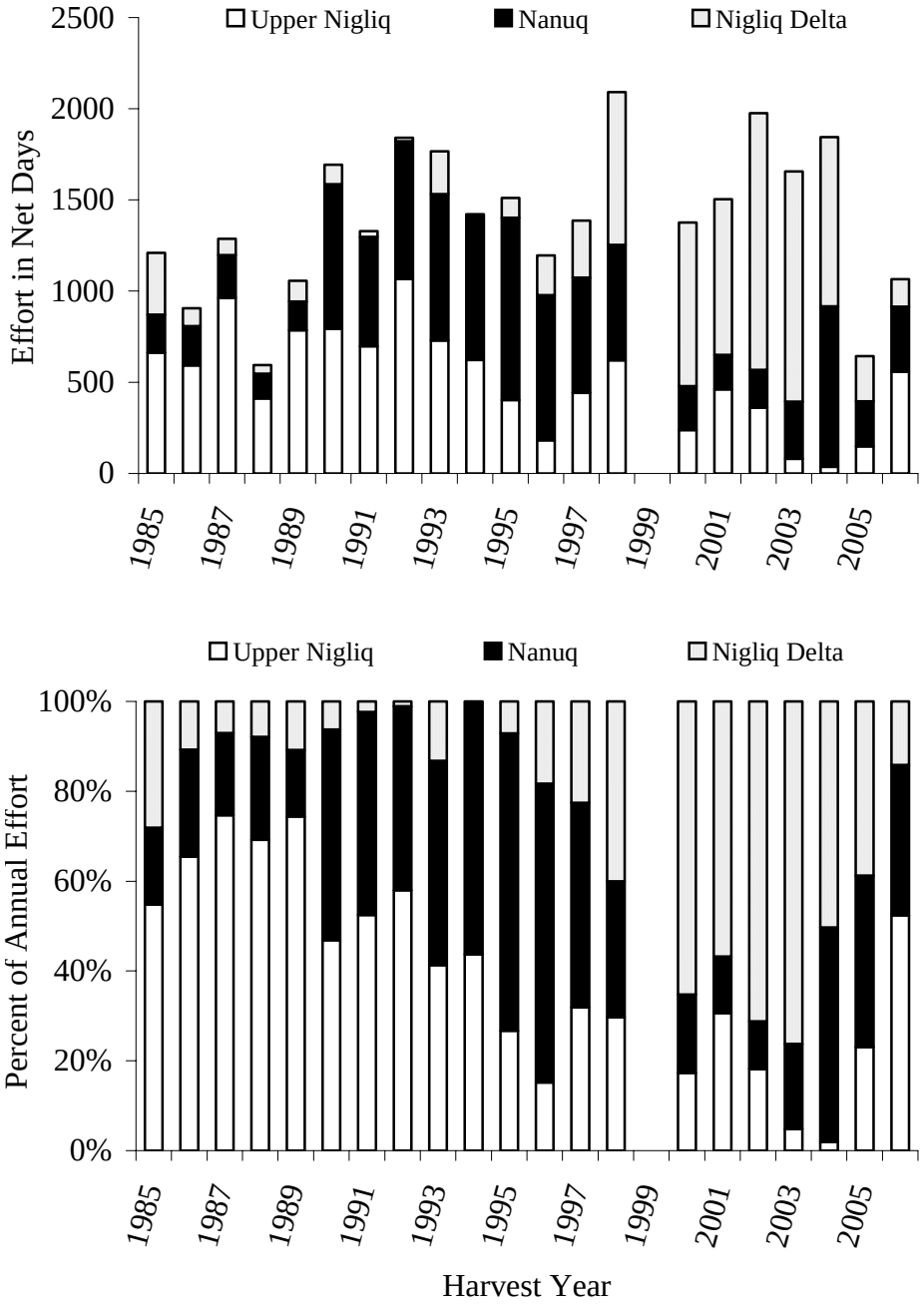

Figure 4. Annual fishing effort (net days) apportioned by major fishing area in the Nigliq Channel, 1986 to 2006. Data are standardized to 18 m net length and include all mesh sizes. 2005 and 2006 net days are not directly comparable to historical data; effort was adjusted to display the percent of annual fishing effort. Uyagagviq effort was included in the Upper Nigliq effort (see note in Table 3).

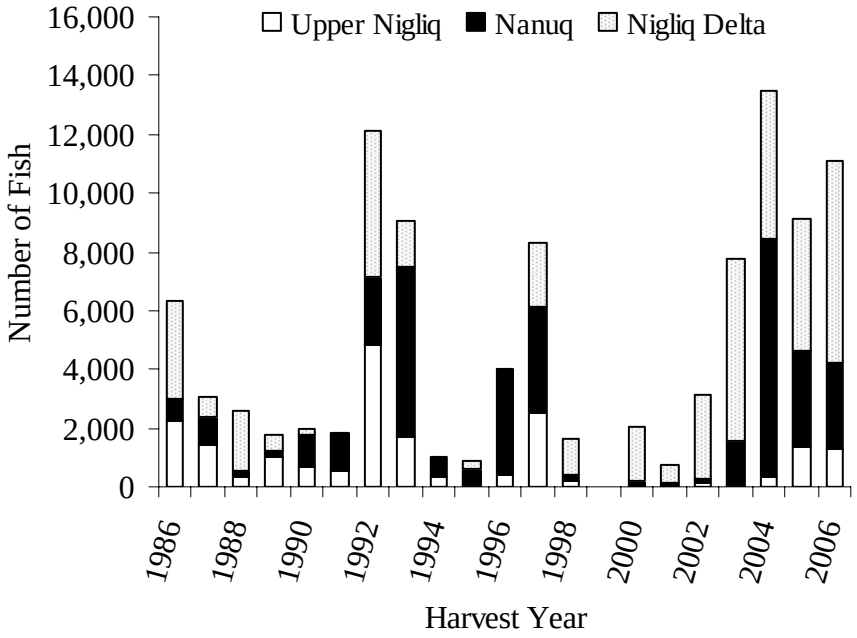

Figure 5. Number of Arctic cisco harvested in 7.6 cm mesh gillnets in Nigliq Channel fishing areas, 1986 to 2006. The 2005 and 2006 data are not directly comparable to historical data because the fishery was not monitored for the entire fishing period.

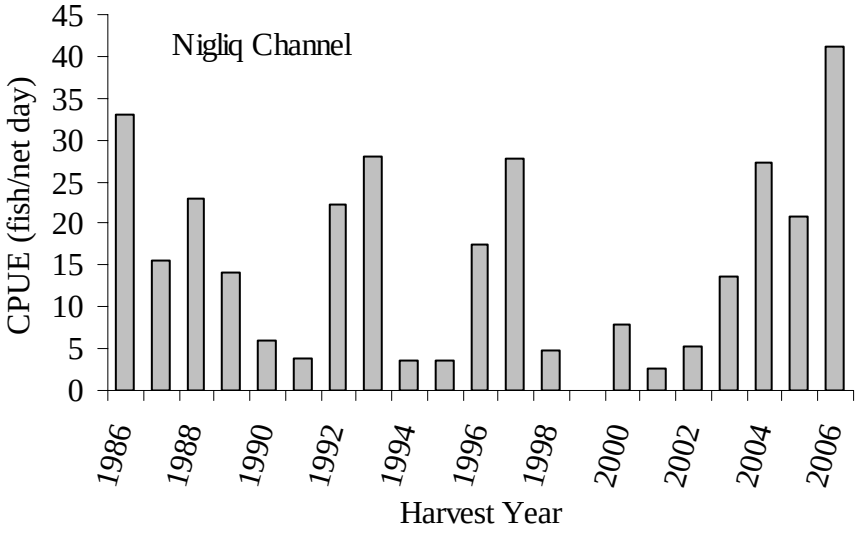

Figure 6. Arctic cisco CPUE in the Nigliq Channel for 7.6 cm mesh gillnets standardized to 18 m length, 1986-2006.

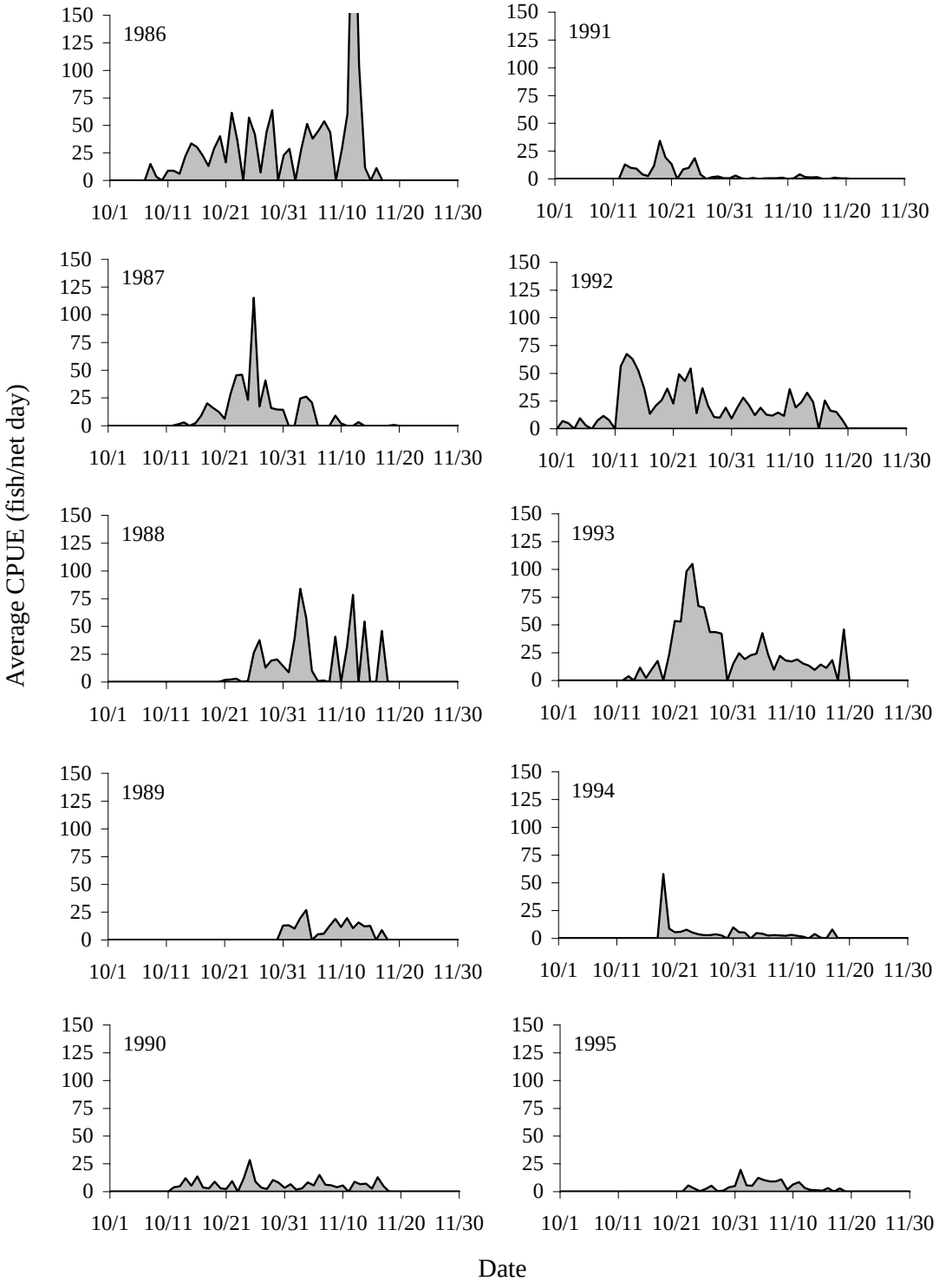

Figure 7. Average daily Arctic cisco CPUE in the Nigliq Channel for 7.6 cm mesh gillnets standardized to 18 m length, 1986-2006.

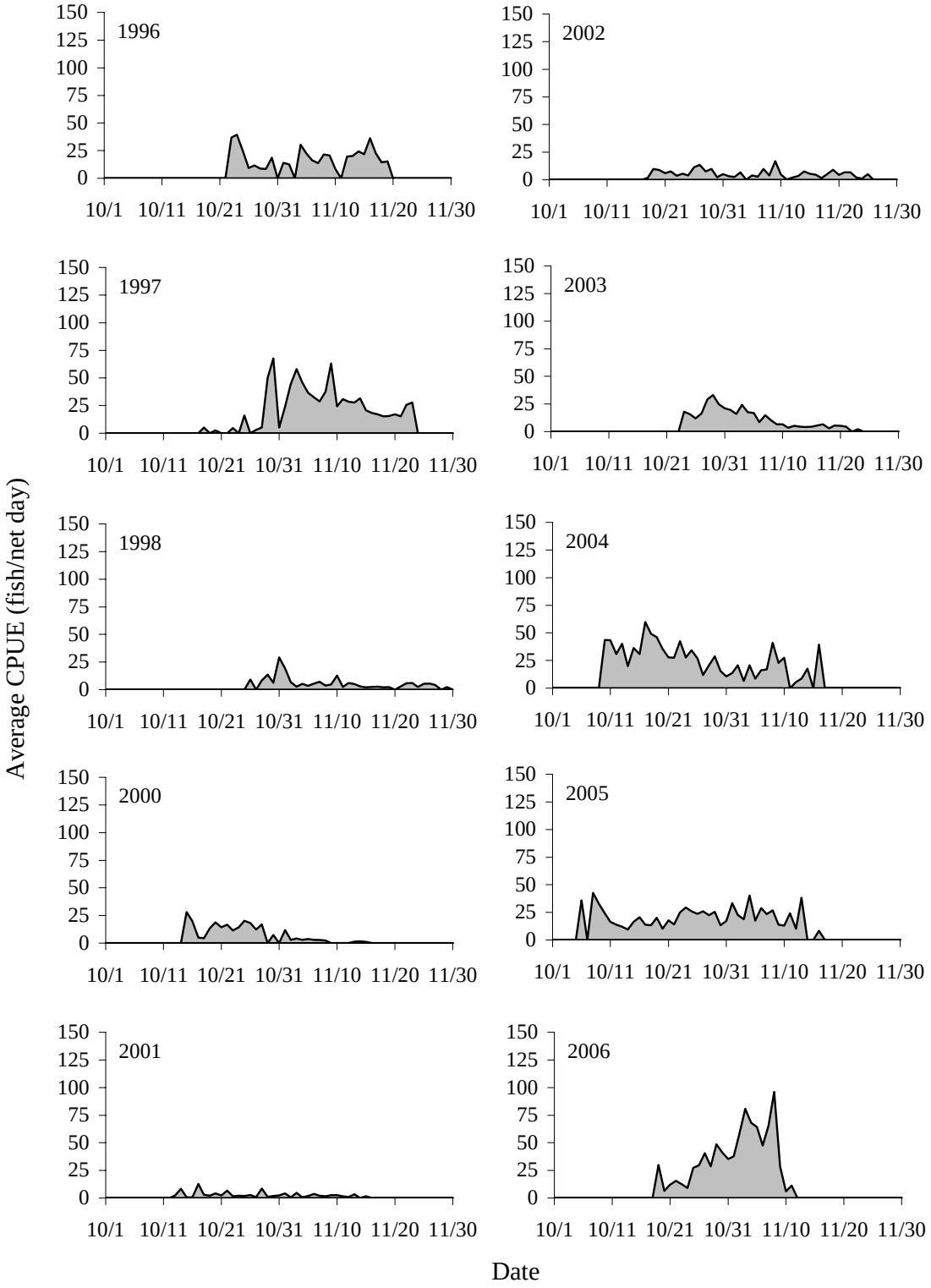

Figure 7 (cont.). Average daily Arctic cisco CPUE in the Nigliq Channel for 7.6 cm mesh gillnets standardized to 18 m length, 1986-2006.

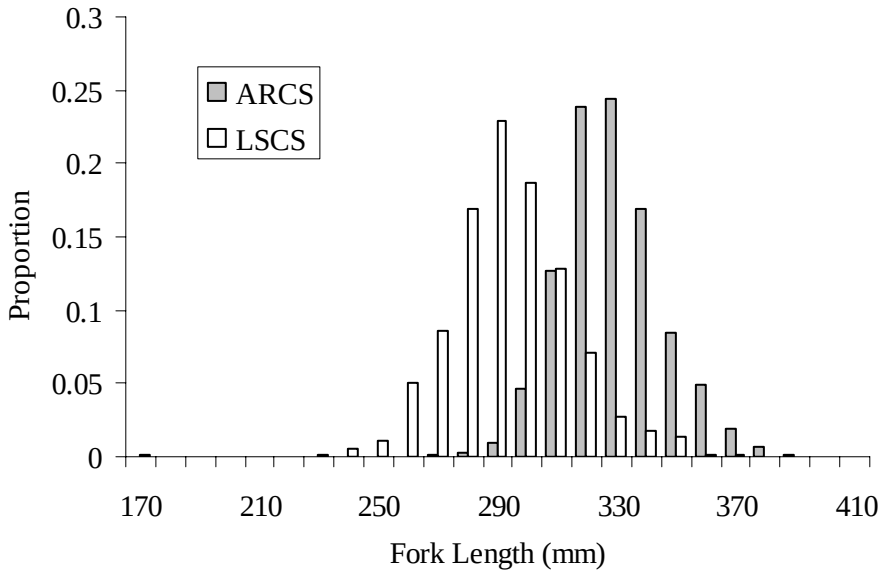

Figure 8. Length frequency of Arctic and least cisco captured in all mesh sizes in 2006. Lengths are grouped in 10mm increments.

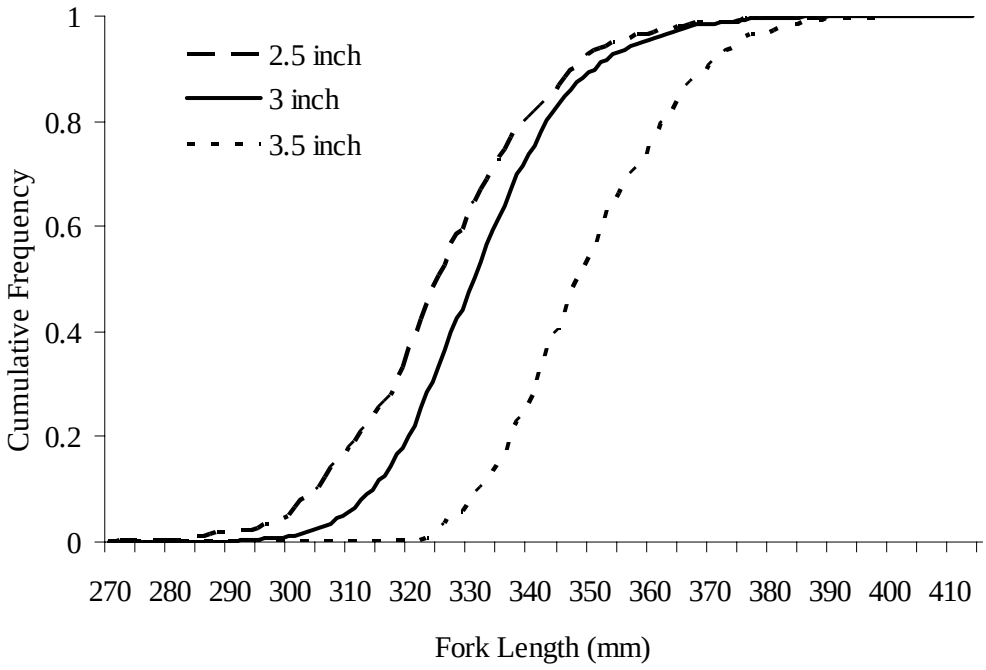

Figure 9. Cumulative length frequency of Arctic cisco harvested in different gillnet mesh sizes, 2006.

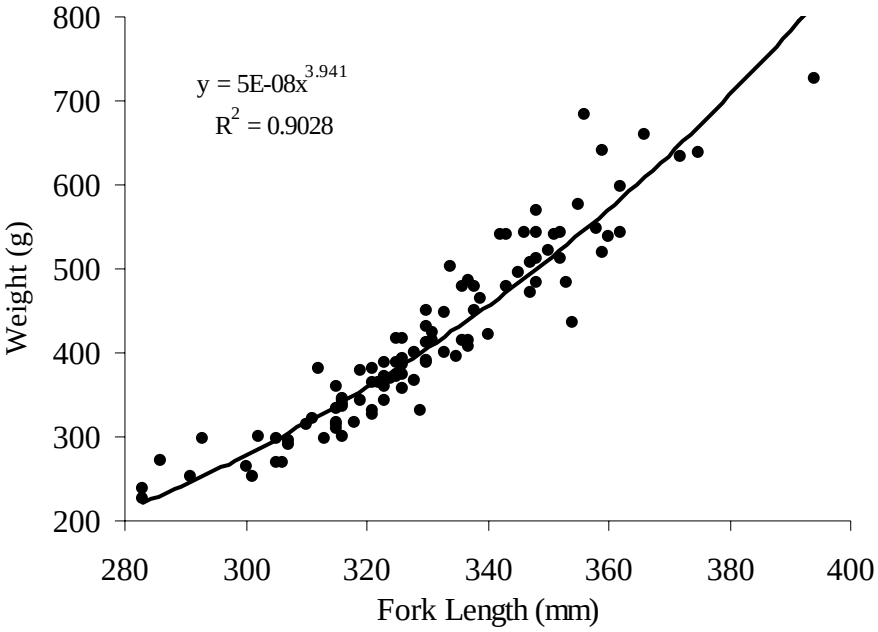

Figure 10. Arctic cisco length weight relationship in 2006. Includes fish captured in all mesh sizes.

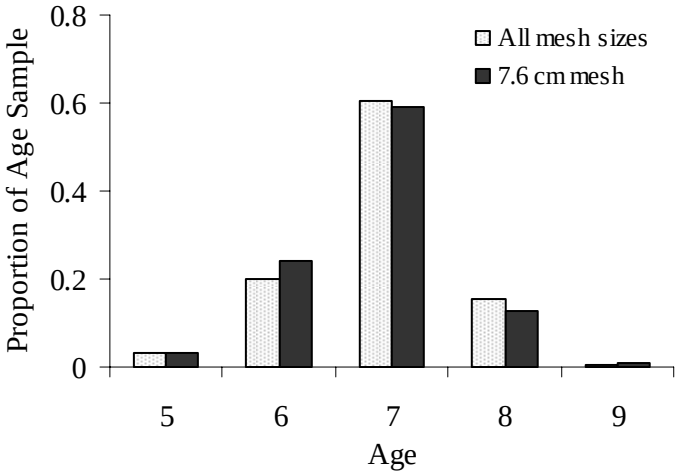

Figure 11. Age composition of Arctic cisco harvested in 2006, displayed separately for all mesh sizes and for the 7.6 cm mesh only.

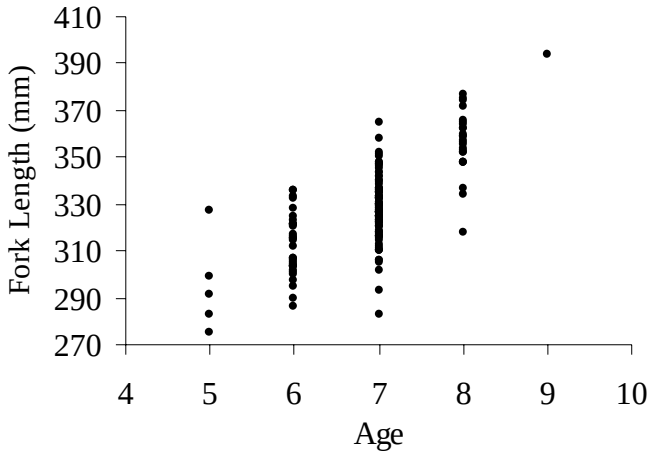

Figure 12. Age-specific length distribution of Arctic cisco harvested in 2006. Includes fish captured in all mesh sizes.

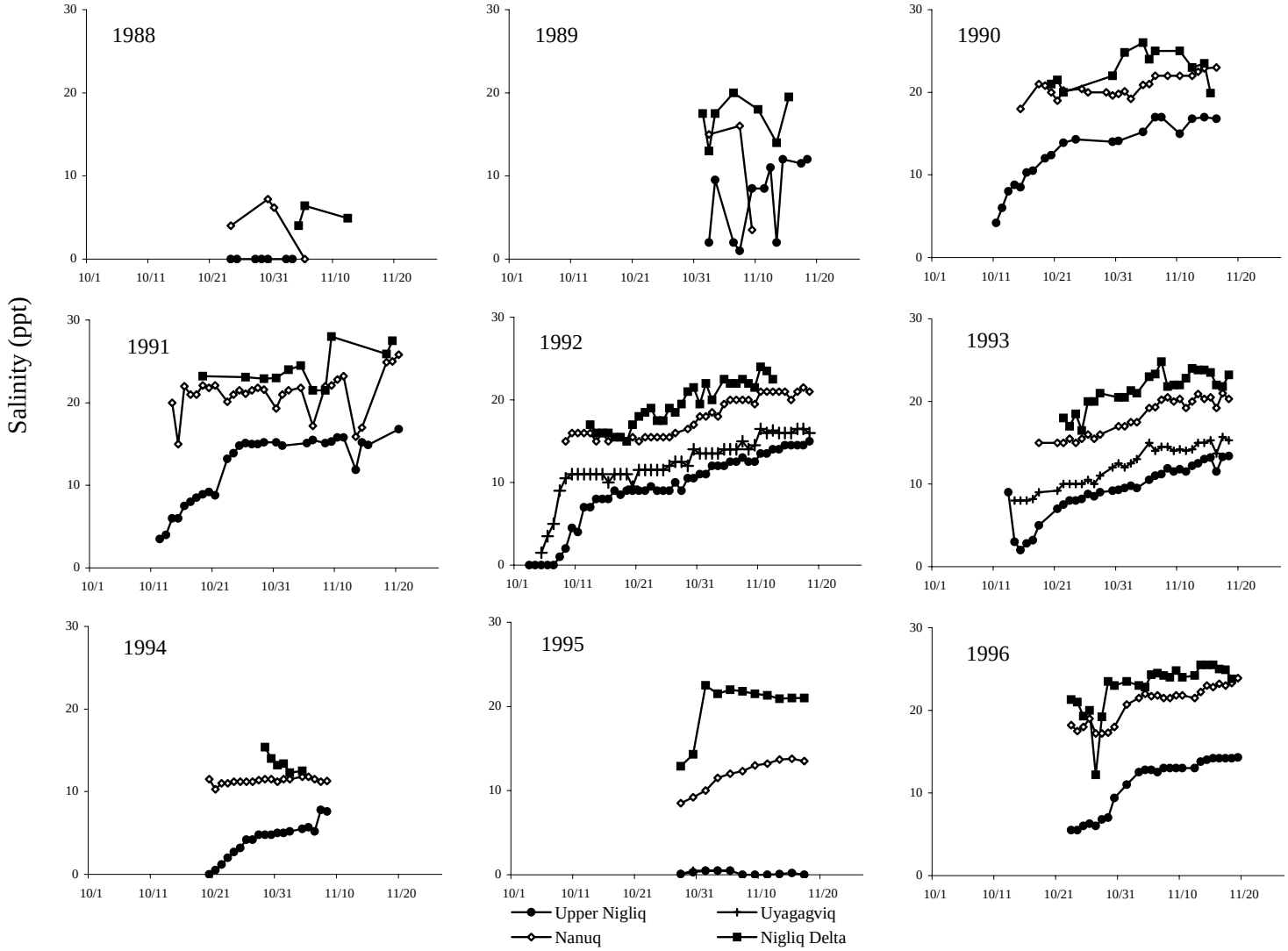

Figure 13. Water salinity (parts per thousand) measured 3 m below the water surface in Nigliq Channel fishing areas, 1988-2006.

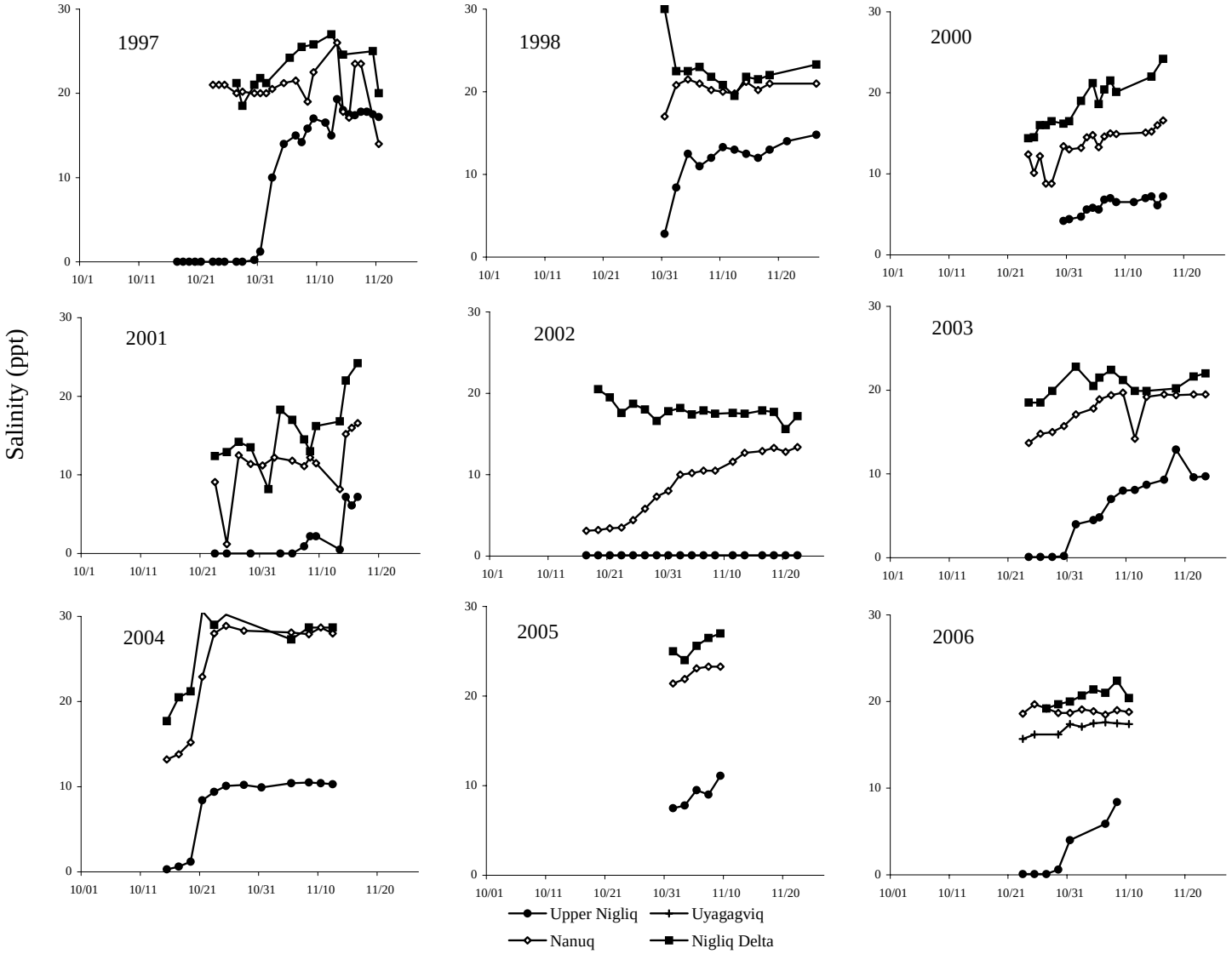

Figure 13 (cont.). Water salinity (parts per thousand) measured 3 m below the water surface in Nigliq Channel fishing areas, 1988-2006.

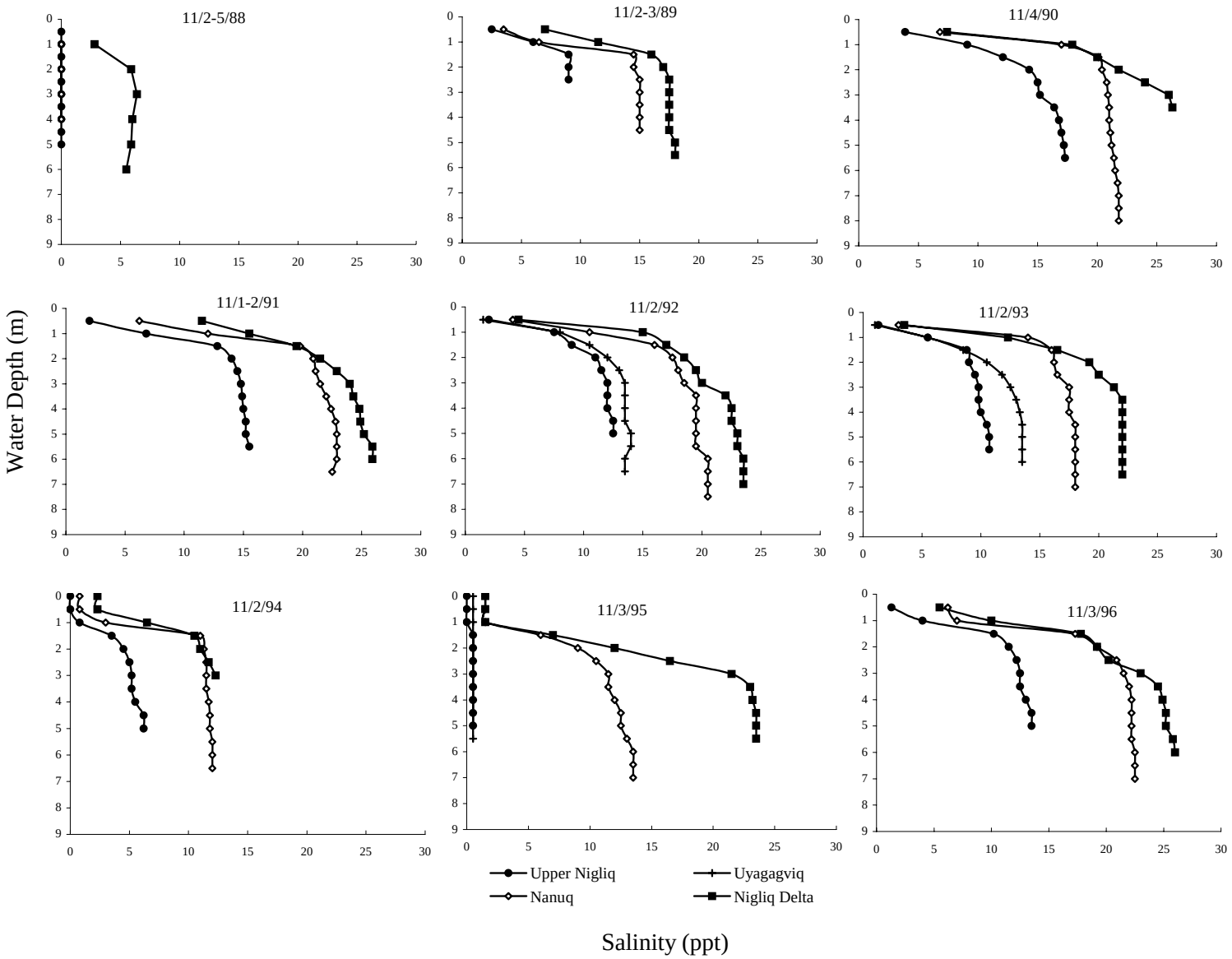

Figure 14. Early November water salinity depth profile in Nigliq Channel fishing areas, 1988-2006.

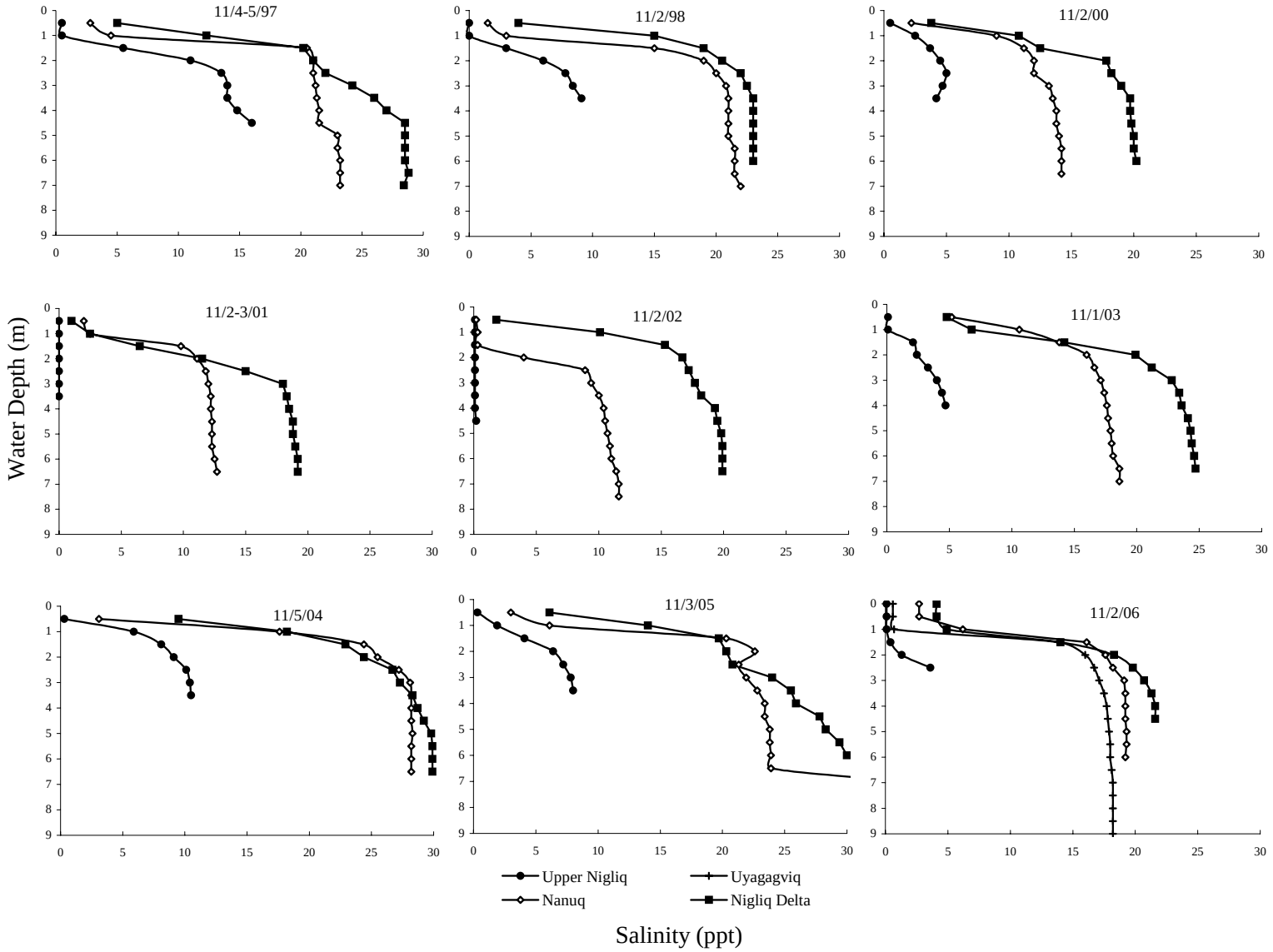

Figure 14 (cont.). Early November water salinity depth profile in Nigliq Channel fishing areas, 1988-2006.

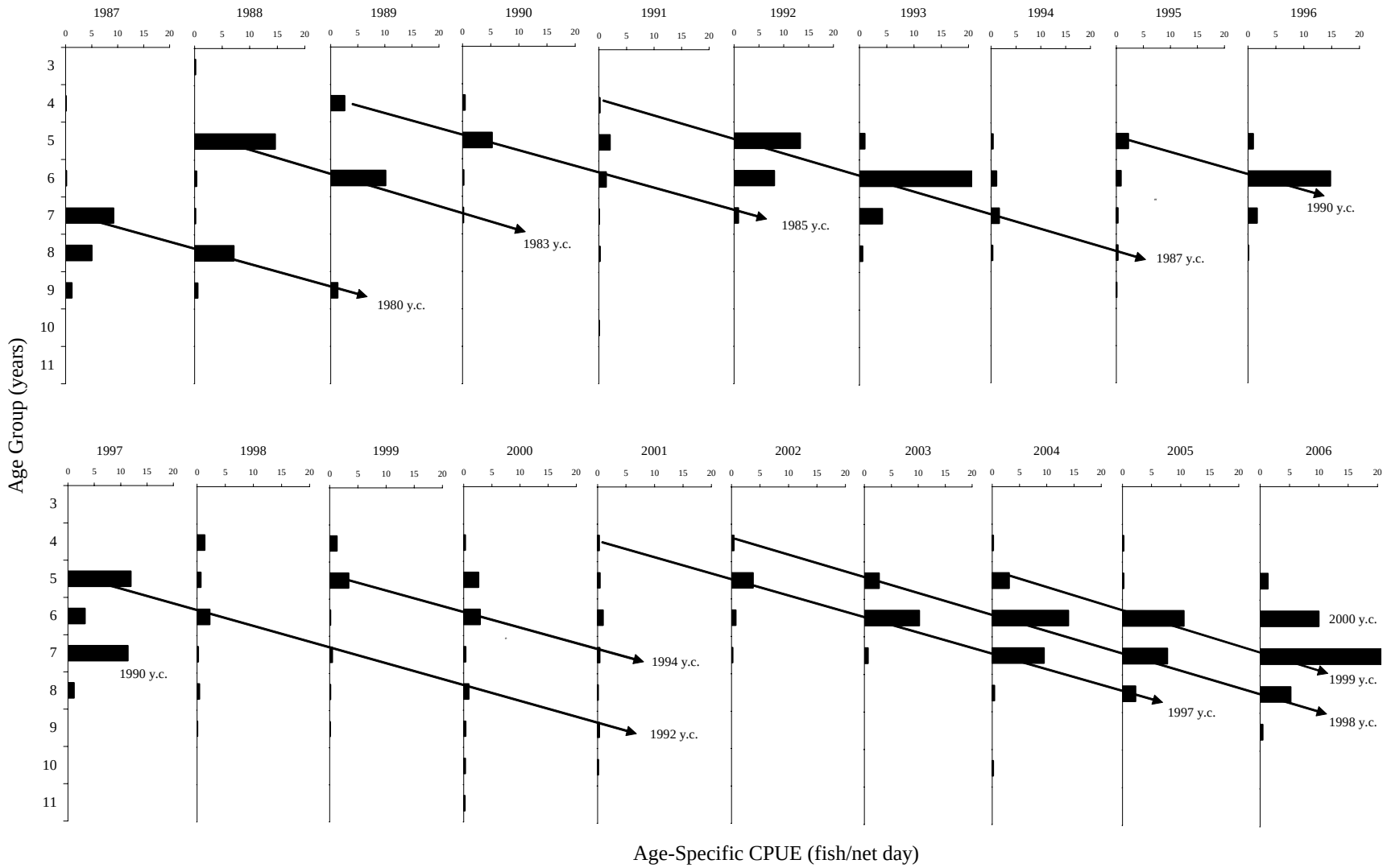

Figure 15. Age-specific Arctic cisco CPUE in the Nigliq Channel subsistence fishery by fishing year, 1987 to 2006 (includes fish caught in 7.6 cm mesh gillnets, standardized to 18 m length). Arrows demonstrate the progression of select year classes through the fishery.

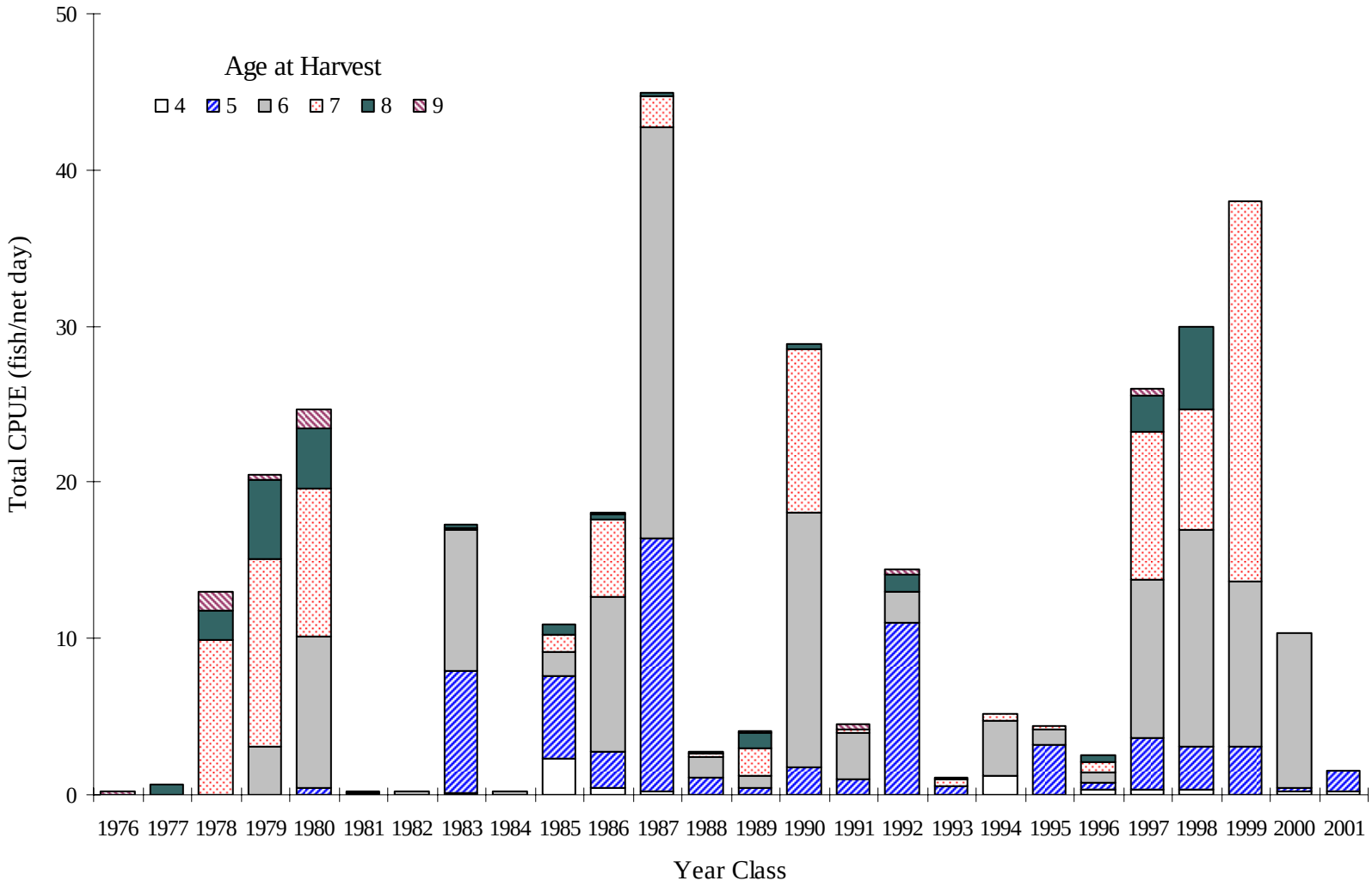

Figure 16. Total CPUE (7.6 cm mesh only) for each Arctic cisco year class. Age-specific CPUE data from harvest years 1984 to 2006 were assigned to the appropriate year class (e.g., age-7 Arctic cisco harvested in 2006 were assigned to the 1999 year class).

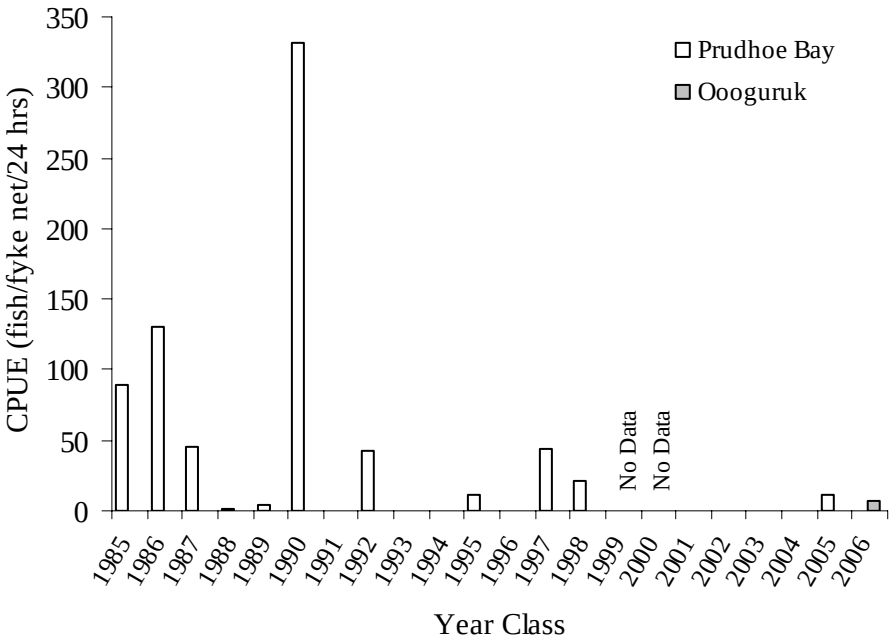

Figure 17. CPUE of young-of-the-year Arctic cisco in Prudhoe Bay (1985-2006) and Oooguruk (2006 only) fyke nets (Source: Robert Fechhelm, LGL Ecological Research Associates, Texas, and Benjamin Williams, LGL Alaska Research Associates, Inc., Anchorage). Because of differences between these projects, the CPUE data may not be directly comparable.

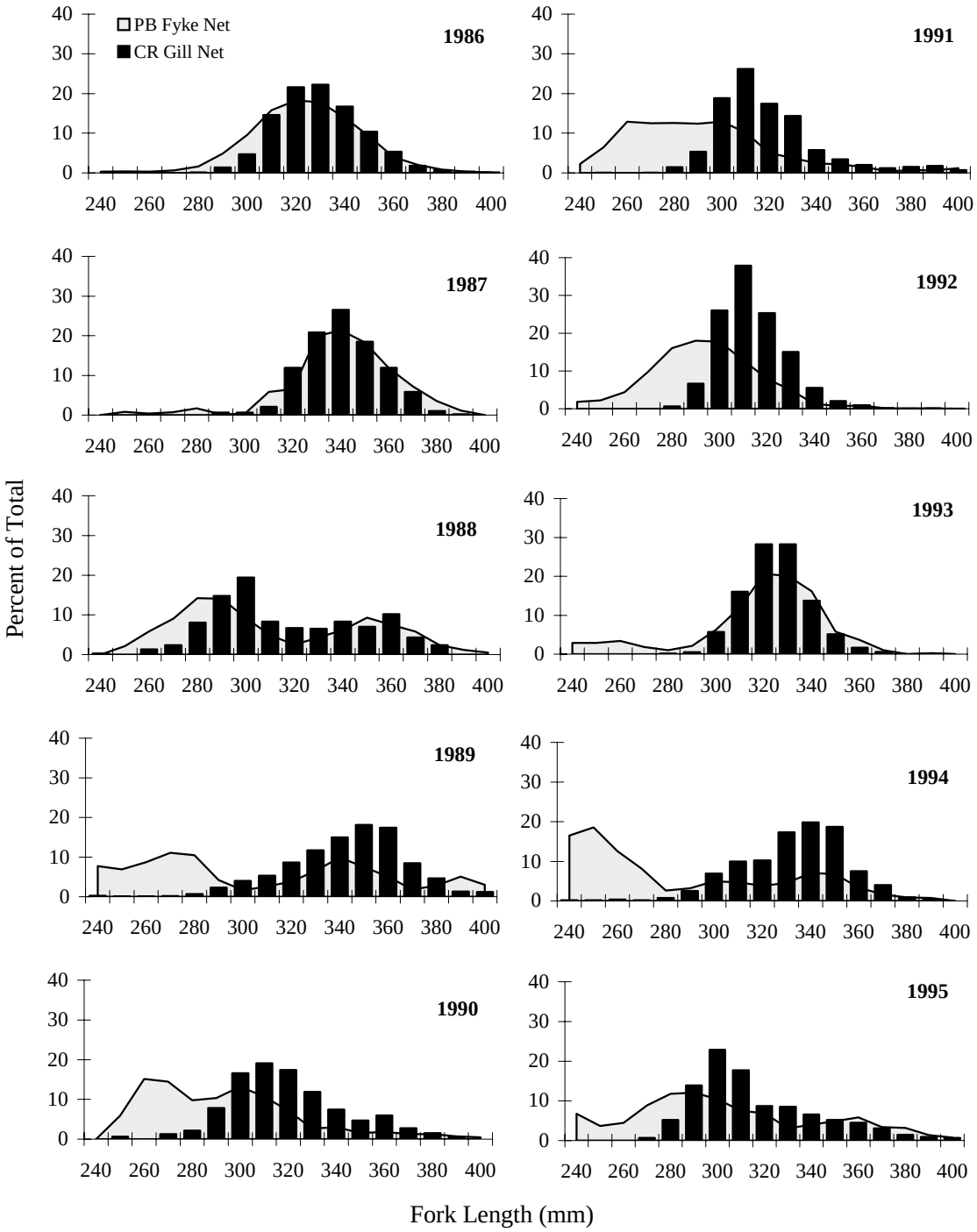

Figure 18. Length frequency of Arctic cisco captured after August 14 during summer fyke net sampling at Prudhoe Bay (1986-2006) and Oooguruk (2006 only) compared to Arctic cisco length frequency of fish caught in 7.6 cm mesh gillnets in the Colville River fall subsistence fishery.

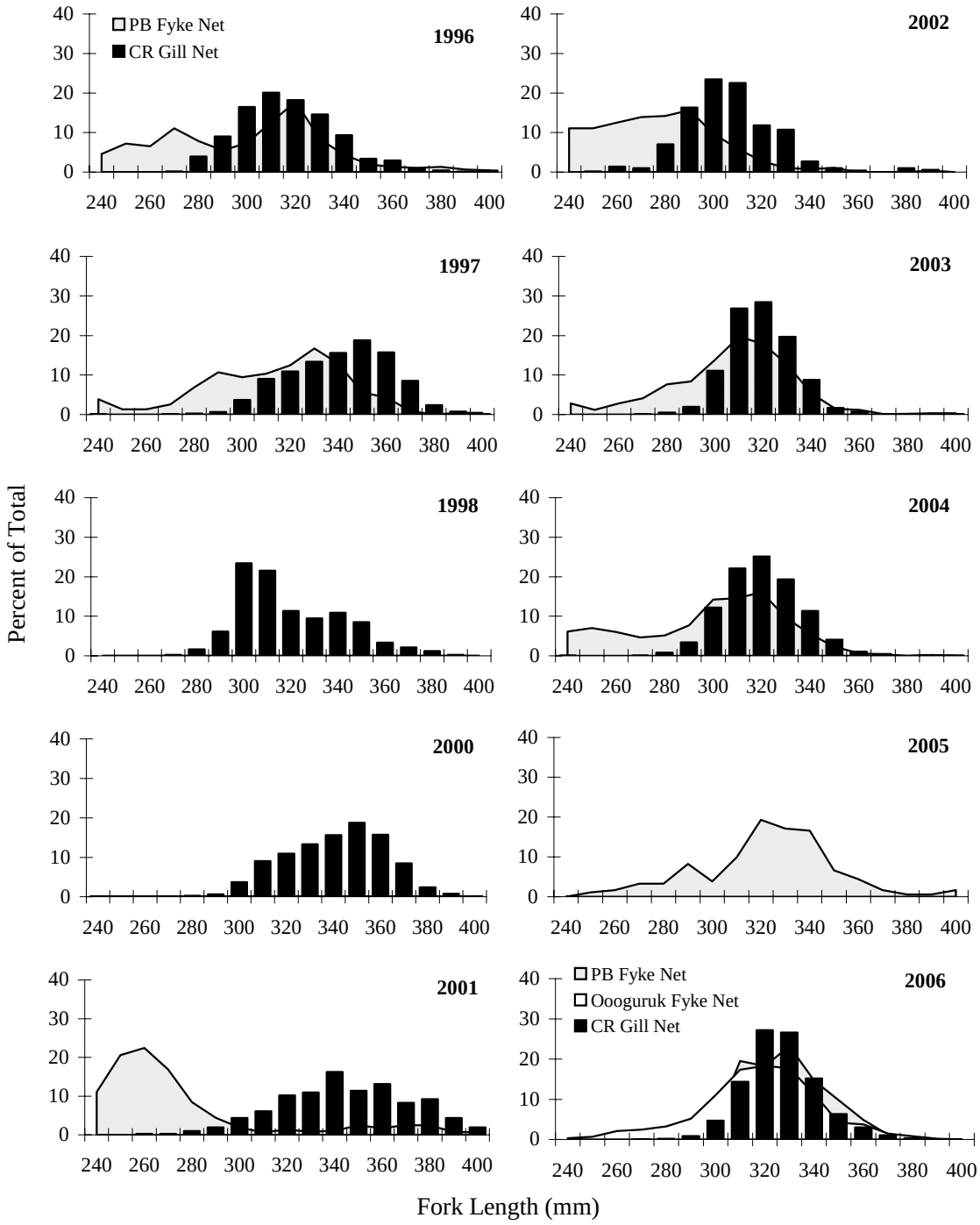

Figure 18 (cont.). Length frequency of Arctic cisco captured after August 14 during summer fyke net sampling at Prudhoe Bay (1986-2006) and Oooguruk (2006 only) compared to Arctic cisco length frequency of fish caught in 7.6 cm mesh gillnets in the Colville River fall subsistence fishery.

PLATES

Plate 1. Gillnet with Arctic cisco; net was recently retrieved from under the ice.

Plate 2. Measuring length of harvested Arctic cisco.

Plate 3. Removing Arctic cisco otolith for aging; view underneath gill plates.

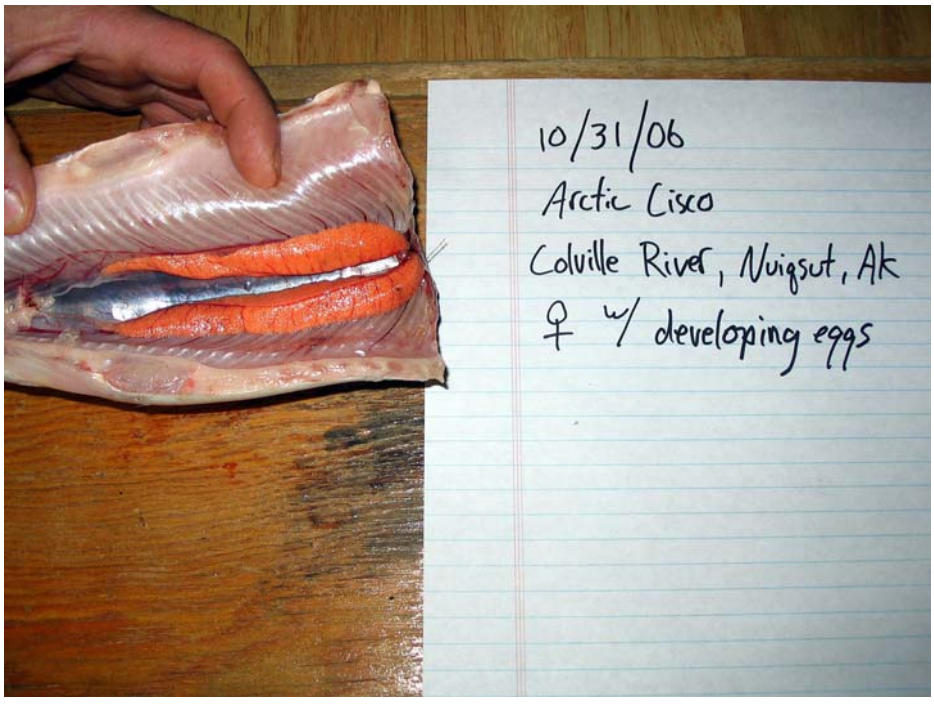

Plate 4. Large female Arctic cisco with developing eggs; otolith was previously extracted from this fish.