FALL 2019 SUBSISTENCE FISHERY MONITORING ON THE COLVILLE RIVER

DATA REPORT

Caitlin Forster and John C. Seigle

Prepared for

CONOCOPHILLIPS ALASKA, INC.
Anchorage, Alaska

Prepared by

ABR, INC.—ENVIRONMENTAL RESEARCH & SERVICES
Anchorage, Alaska | Fairbanks , Alaska

COVER

ABR fisheries biologist Caitlin Forster on the Niġliq Delta holding a Saffron Cod, 2019.
Photograph by Nina Selvage, ABR.

FALL 2019 SUBSISTENCE FISHERY MONITORING ON THE COLVILLE RIVER

DATA REPORT

Prepared for

ConocoPhillips Alaska, Inc.

P.O. Box 100360

700 G Street, ATO # 1902

Anchorage, AK 99510-0360

Prepared by

Caitlin E. Forster

John C. Seigle

ABR, Inc.—Environmental Research & Services

P.O. Box 240268

Anchorage, AK 99524

and

P.O. Box 80410

Fairbanks, AK 99708

February 2021

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

ABR, Inc.—Environmental Research & Services (ABR) works with fishery stakeholders in Nuiqsut, Alaska, to monitor the Colville River subsistence fishery, which is conducted using gillnets each fall after freeze-up in the Niġliq Channel of the Colville River (Figures 1 and 2). The monitoring program began in 1985 when the North Slope Borough, in consultation with local fisherman and industry, requested information on the potential impacts to fish health from activities associated with exploration and development of oil and gas near Prudhoe Bay and in the Colville River delta (Moulton et al. 2010). Initial surveys in the Colville River delta sought only to obtain estimates of the total subsistence and commercial fishing effort and harvest during the fall under-ice fishery. Over the years, the objectives of the project have evolved to include quantifying temporal trends in fishing effort, harvest results, and assessments of the general health of the fishery. We also include input from fishers about their perception of the health of the fishery to determine monitoring goals. The monitoring effort is supported by Conoco Philips Alaska, Inc. (CPAI).

The monitoring program has traditionally focused on the fall harvest of Arctic Cisco (*Coregonus autumnalis*; a whitefish species known as "Qaaktaq" in Iñupiaq), which are a staple in the diet of Nuiqsut residents and are traded widely with other northern Alaska communities. The program also attempts to quantify harvest of other subsistence species captured in the Arctic Cisco fishery.

The objectives of the 34th year of the harvest monitoring program were to:

- continue working with fishery participants per agreements made in 2007 (Seigle et al. 2008) to monitor the harvest of Arctic Cisco and other species throughout the fall fishing season;
- record specific fishing effort data (number and type of nets fishing at any given time) throughout the fall fishing season;
- collect age, length, and weight information for a subsample of harvested fishes;
- measure water salinity, temperature, pH, and dissolved oxygen in primary fishing areas; and
- compare the 2019 results with data from previous years for this program and other historical data.

METHODS

FISHERY EFFORT AND HARVEST

Four traditional fishing areas host the majority of subsistence fishing in the Colville River delta (upstream to downstream): the Upper Niġliq area (adjacent to the town of Nuiqsut), the mid-channel Nanuk area, the Niġliq Delta area, and the Main Channel area (Figure 2). The ABR fishery monitoring team included 2 scientists; we did not employ a local guide in 2019. ABR fishery monitors conducted daily interviews of fishers for harvest events from 14 October to 20 November 2019 in Nuiqsut. Additional harvest updates were received via social media posts until 15 December 2019. Harvest reports obtained via social media following the field effort were included in the current analysis. However, one fisher continued to harvest in the Upper Niġliq through January 2020. While not included in the current analysis of harvest estimates due to reporting constraints, those additional harvest records are discussed separately in this report. For the purposes of this analysis, a harvest event occurred anytime a fisher checked their net. The event may have been recorded by harvest monitors on location at the time of a harvest, after the event in Nuiqsut, or at a later date via email, social media, or telephone. During interviews, we recorded net length, net mesh size, and start and end times for each harvest event.

Fishing nets can vary by length (range: 40–120 m in 2019) and mesh size (range: 5.1–12.7 cm in 2019). To calculate fishing effort (i.e., net-days), we adjusted the recorded net length and effort to a standardized net length of 18 m (60 ft) and a full-day (24-hour) set duration. For example, if an 80 ft net was used during a 24-hour period, fishing effort was calculated as 80 ft/60 ft × 1 day = 1.3 adjusted net-days. Catch per unit effort (CPUE), expressed as catch per net-day, was calculated using these adjusted estimates of effort.

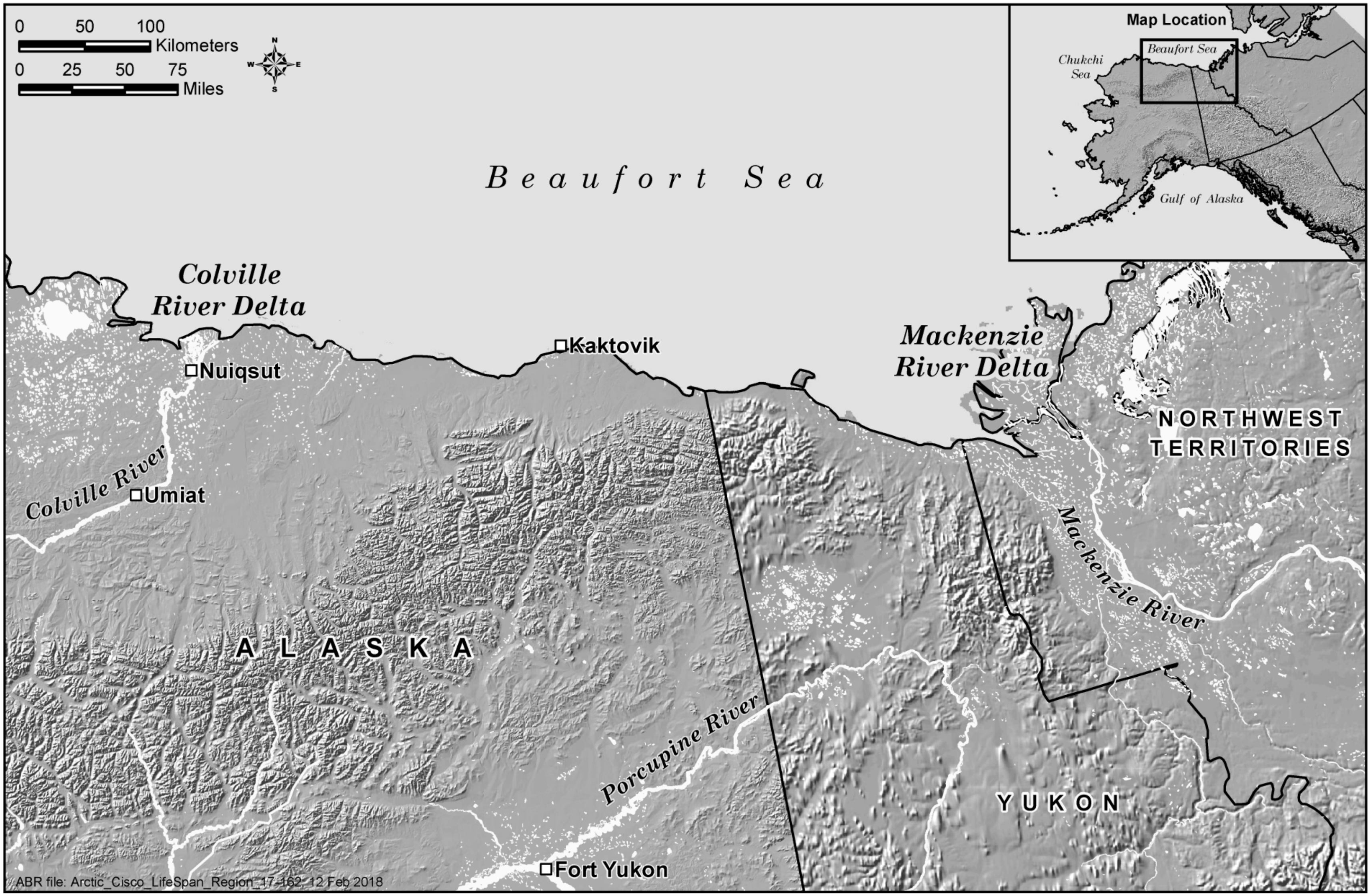

Figure 1. Waters important to the life history of Arctic Cisco in Canada and Alaska and the nearshore Beaufort Sea.

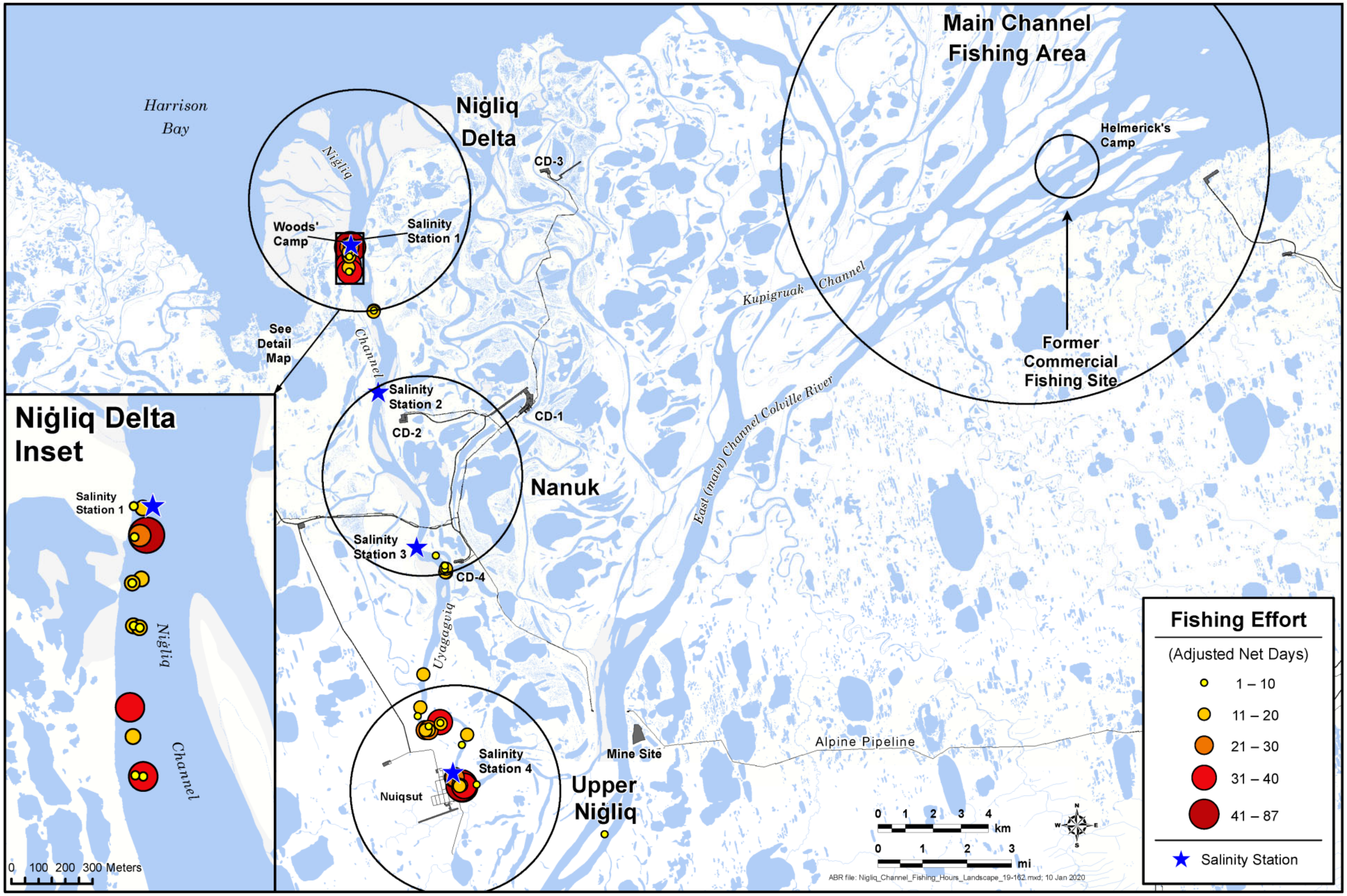

Figure 2. Water sampling stations and net sites in each of the 3 main subsistence fishing areas in the Niġliq Channel of the Colville River, Alaska, 2019.

In this report, we specify when data summaries include all mesh sizes combined and when they are limited to the most frequently used mesh size of 7.6 cm (3 in).

During harvest interviews, we asked at least some of the following questions:

- How many nets are you fishing?
- Who else checks your nets?
- How long have your nets been actively fishing (helps define total season effort)?
- What are your net dimensions?
- How many Arctic Cisco and other fish species did you harvest in each net?
- How frequently do you check your nets?
- Where is your net and has it been moved recently (i.e., within the past week)?

Reported harvest numbers from these interviews were used in CPUE analysis only if the fisher also knew the number of days that each net fished and the number of fish caught in nets of each mesh size.

LENGTH, WEIGHT, AND AGE OF CATCH

During harvest events, fish were removed from nets, tallied by species, and a sub-sample was measured for fork length (to the nearest mm; Seigle et al. 2016 and 2017). The total number of fish measured during a harvest event depended on several factors including a fisher's availability, the total number of fish caught in the net, and the number of other active fishers in the area. When several fishers were harvesting simultaneously in the same area, we attempted to obtain a sub-sample of measurements from every fisher.

When possible, we paid a participation honorarium to fishers who were willing to share information on their harvest activities and donated a sub-sample of fish from their harvest for age, length, and weight analyses (~10 fish/day at $10/fish). Honoraria were also offered to fishers who otherwise provided detailed information about their fishing efforts (and the efforts of other fishers) and harvests outside of normal daily encounters with the monitoring team. Most samples were donated from 7.6-cm mesh nets as this is the most common mesh size used in the fishery, although fish from other known mesh sizes were accepted. The fish were kept frozen and transported to Anchorage where we measured them for fork length (mm) and weight (g) using a top-loading electronic scale and extracted otoliths for ageing.

Otoliths (i.e., sagittae, or earbones) were extracted and cleaned with tap water and stored in 96-well pipette trays for ageing. We prepared 1 otolith from each fish using the break-and-burn technique (Chilton and Beamish 1982). The otolith preparations were examined under a dissecting microscope at 25× magnification using reflected light. Alternating bands of dark and light on the otolith correspond to winter and summer growth, respectively, and together represent one year's growth. 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. All annuli outside this region were then counted to determine the age of the fish (Seigle et al. 2016).

WATER QUALITY

We measured water salinity and temperature approximately every other day after the start of on-ice activities at water quality stations corresponding to areas of concentrated fishing effort (Figure 2). We removed surface ice and lowered the probe-end of a YSI Professional Plus meter into the water. Salinity was measured in parts per thousand (ppt) and was recorded at the surface and at 0.5-m depth increments to the river bottom. The monitoring team also measured temperature (°C), dissolved oxygen (mg/L and % saturation), conductivity (µS/cm), pH, and turbidity at a depth of 3 m.

RESULTS AND DISCUSSION

FISHERY EFFORT AND HARVEST

In 2019, the onset of ice formation on the Niġliq Channel of the Colville River was the week of 13 October, and coincided with the arrival of ABR scientists in Nuiqsut on 14 October. Ice thickness increased to 13 cm (5 in) over the course of 2–3 days, a thickness considered safe for river travel. The first nets were not deployed until 19 October in the Upper Niġliq fishing area, 10 days later than the long-term average start date of 9 October (Table 1, Figure 2). The late start was a likely due to a lack of snow on the river which makes travel over ice with snowmobiles a challenge, particularly for liquid-cooled machines which require snow or ice-chips to be driven up into the track and liquid exchanger areas during operation to keep coolant levels at satisfactory operating conditions. Another factor in the late start was the timing of safe ice conditions relative to the timing of the Alaska Federation of Natives conference in Fairbanks, Alaska (17–19 October) which was attended by many fishers.

A major warming event following initial freeze-up occurred from 28 October until 3 November and resulted in melted ice, substantial river overflow, and ultimately, unsafe ice conditions. Following this warming event, several fishers reset their nets in the Upper Niġliq on 3 November, but many fishers in the Nanuk and Niġliq Delta fishing region did not reset their nets until 5 November or later. The late onset of initial fishing activity coupled with this warming event resulted in a short period of fishing effort monitoring in the second half of the season (4–20 November). At the time of the monitoring team's departure from Nuiqsut, 13 nets (9 fishers) were still active. However, we determined from conversations with fishers via phone and social media that all but one net was pulled by 28 November. The last net continues to fish as of 18 February 2020. For harvest assessment purposes, we set 15 December as the final date of the 2019 harvest season. Additional reported harvests from the last remaining net will be discussed separately. The survey team conducted 213 interviews during the period from 19 October to 15 December, 81 fewer than the 294 interviews conducted in 2018 (Table 2).

A total of 25 households deployed 42 nets on the Niġliq and Main channels of the Colville River (Table 2). A total of 62 net-sets (61 in the Niġliq Channel and 1 in the Main Channel) were completed with these 42 nets (Table 2, Figure 3, Appendix A). We received a report of an additional

Table 1. Estimated onset of the fall subsistence fishery for Arctic Cisco in the Niġliq Channel of the Colville River, Alaska, 1985–2019.

Year	Start Date	Five-year average of start date
1985	2 October	–
1986	3 October	–
1987	8 October	–
1988	14 October	–
1989	22 October	9 October
1990	6 October	10 October
1991	12 October	12 October
1992	26 September	10 October
1993	3 October	7 October
1994	3 October	4 October
1995	16 October	6 October
1996	28 September	3 October
1997	13 October	6 October
1998	28 September	5 October
1999	--	6 October
2000	3 October	3 October
2001	6 October	5 October
2002	14 October	5 October
2003	16 October	9 October
2004	9 October	9 October
2005	7 October	10 October
2006	14 October	12 October
2007	4 October	10 October
2008	4 October	7 October
2009	6 October	7 October
2010	5 October	6 October
2011	13 October	6 October
2012	21 October	9 October
2013	9 October	10 October
2014	16 October	12 October
2015	6 October	13 October
2016	15 October	13 October
2017	15 October	12 October
2018	11 October	12 October
2019	19 October	13 October
Average	9 October	

Table 2. Summary statistics for fall fishing effort in the Colville River delta, Alaska, 2019. Values in parentheses are the total number sets for those nets.

Fall fishing effort	Summary of 2018 Effort	Summary of 2019 Effort
Number of recorded harvest events	294	213
Number of Households	32	25
Number of mesh nets		
5.1 cm (2.0 in)	0	0
6.4 cm (2.5 in)	3(4)	1(2)
7.0 cm (2.75 in)	4(4)	0
7.6 cm (3.0 in)	26(36)	34(49)
8.3 cm (3.25 in)	2(3)	3(6)
8.9 cm (3.5 in)	6(6)	3(4)
10.2 cm (4.0 in)	0	0
11.4 cm (4.5 in)	0	1(1)
12.7 cm (5.0 in)	2(2)	0
Number of Nets in Niġliq Channel	46	41
Total Number of Nets	47	42
Average Nets/Household	1.47	1.68
Net sets		
Upper Niġliq	23	24
Nanuk	11	11
Niġliq Delta	18	26
Main Channel	3	1
Total number of sets	55	62
Adjusted net days/mesh nets		
5.1 cm mesh nets	–	–
6.4 cm mesh nets	121.7	28.3
7.0 cm mesh nets	56.8	–
7.6 cm mesh nets	570.3	762.0
8.3 cm mesh nets	28.2	53.3
8.9 cm mesh nets	83.8	68.3
10.2 cm mesh nets	–	–
11.4 cm mesh nets	–	6.7
12.7 cm mesh nets	4	–
Adjusted net days by Upper Niġliq	390.7	452.7
Adjusted net days by Nanuk	119.8	85.3
Adjusted net days by Niġliq Delta	338.0	379.3
Adjusted net days by Main Channel	16.3	1.3
Total adjusted net days	864.8	918.6

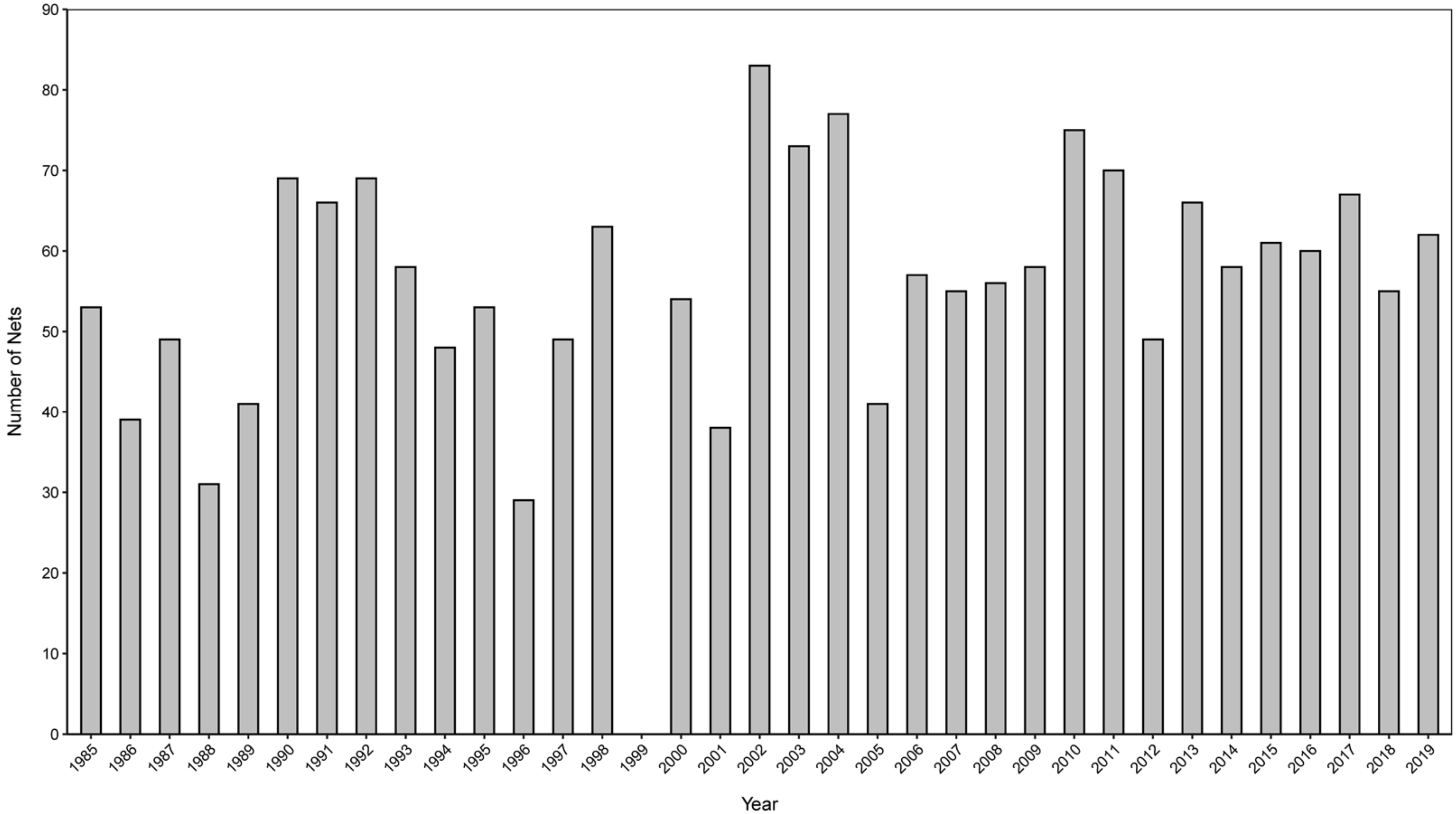

Figure 3. Number of nets deployed annually in the fall subsistence fishery for Arctic Cisco, Colville River, Alaska, 1985–2019.

net-set in the Main Channel, but neither the set nor harvest results could be confirmed. The 2019 total effort represented a reduction from 2018 in which 32 households deployed 47 nets, but only 55 net-sets, 7 fewer net-sets than were recorded in 2019. The increase in net-sets can be attributed to the warming event, which resulted in fishers pulling and then re-setting their nets due to marginal ice conditions for fear of losing nets or getting them stuck in the ice once rotten ice refreezes with the nets still in place.

We estimated 917.3 net-days of fishing effort in the Niġliq Channel and 1.3 net-days of fishing in the Main Channel for a total of 918.6 net-days of effort in 2019 (Table 2, Appendix A). Despite fewer days of active fishing, total fishing effort was 53.8 net-days higher than in 2018 (Table 2). Five mesh sizes were deployed in 2019, but as in previous years, the most frequently used mesh size was 7.6 cm (762.0 adjusted net-days). This was followed by 8.9-cm mesh nets (68.3 net-days), 8.3-cm mesh nets (53.3 net-days), 6.4-cm mesh nets (28.3 net-days), and 11.4-cm mesh nets (6.7 net-days). In the Niġliq Channel, most of the fishing effort took place in the Upper Niġliq (452.7 adjusted net-days, 49.4%), followed by the Niġliq Delta (379.3 net-days, 41.3%) and the Nanuk fishing areas (85.3 net-days, 9.3%) (Table 2, Figure 4).

From direct interviews, we recorded a total harvest of 6,254 Arctic Cisco in 7.6-cm mesh nets in the Niġliq Channel in 2019, which is a substantial decrease in the recorded harvest of 17,449 fish in 2018 (Tables 3 and 4, Figure 5). An additional 2 fish were recorded in the Main Channel. However, as in previous years, it is likely that a small number of additional days of harvests went unreported during the same time frame in which this harvest was reported. Therefore, with any discussion of Main Channel harvest assessment, it should be noted that fishing effort was lower in 2019, but reporting on the results of those efforts also was incomplete.

A total of 7,416 Arctic Cisco were harvested from nets of a known mesh size and known fishing duration (Table 3) and were used to calculate the Arctic Cisco CPUE by mesh size. In 2019, the total average estimated CPUE for 7.6-cm nets in the Niġliq Channel was 19.5 fish per net-day, which is considerably less than in 2018 (57.3 fish per net-day) but consistent with the long-term average CPUE in the Niġliq Channel (Table 4). Harvest rates by river section were highest in the Nanuk area (34.6 fish per net-day), followed by the Niġliq Delta (27.5 fish per net-day), and lowest in the Upper Niġliq (12.2 fish per net-day) (Tables 3 and 4). Additionally, the single interview conducted for harvests from 7.6-cm mesh nets in the Main Channel resulted in an estimated CPUE of 1.5 fish per net-day (Table 3). As stated above, we do not feel that this interview was reflective of the Main Channel fishing results overall. However, considering weather conditions, patchy fishing effort, and low reporting for Main Channel effort and harvests, the results indicate that the Main Channel did not contribute significantly to overall harvests of Arctic Cisco in 2019.

The long-term average estimated CPUE for 7.6-cm nets in the Niġliq Channel is 19.5 fish per net-day (95% CI = 15.0–24.0 fish per net-day) (Table 4, Figure 6). The long-term average CPUE for 7.6-cm mesh nets, by Niġliq Channel section, is 9.0 fish per net-day (95% CI = 6.8–11.3 fish per net-day) in the Upper Niġliq, 16.9 fish per net-day (95% CI = 13.1–20.7 fish per net-day) in the Nanuk area, and 30.1 fish per net-day (95% CI = 21.9–38.4 fish per net-day) in the Niġliq Delta (Table 4, Figure 6).

Overall, observed CPUE in 2019 for all mesh sizes ranged from 8.0 fish per net-day in 8.9-cm (3.5-in) mesh in the Upper Niġliq area, to 38.8 fish per net-day in 8.3-cm (3.25-in) mesh nets in the Nanuk area (Table 3). We used these CPUE estimates to calculate a total estimated harvest of 17,544 fish (Table 5). This is 37% of the 2018 estimated harvest of 48,056 Arctic Cisco. However, 2018 was also the second highest harvest estimate (excluding commercial harvest) since the inception of the harvest monitoring program in 1985 (average = 32,774 fish, 95% CI = 27,903 – 37,645 fish; Appendix B). Although the 2019 harvest estimate is the second lowest since ABR began monitoring the fishery in 2007 (the lowest was 17,222 fish in 2008), it is the only 11th lowest subsistence harvest estimate since the inception of the harvest monitoring program in 1985 (Appendix B).

A total of 8 species were recorded during the 2019 fall fishery, 1 fewer than the 9 species recorded in 2018 (Table 6). If we include all fish

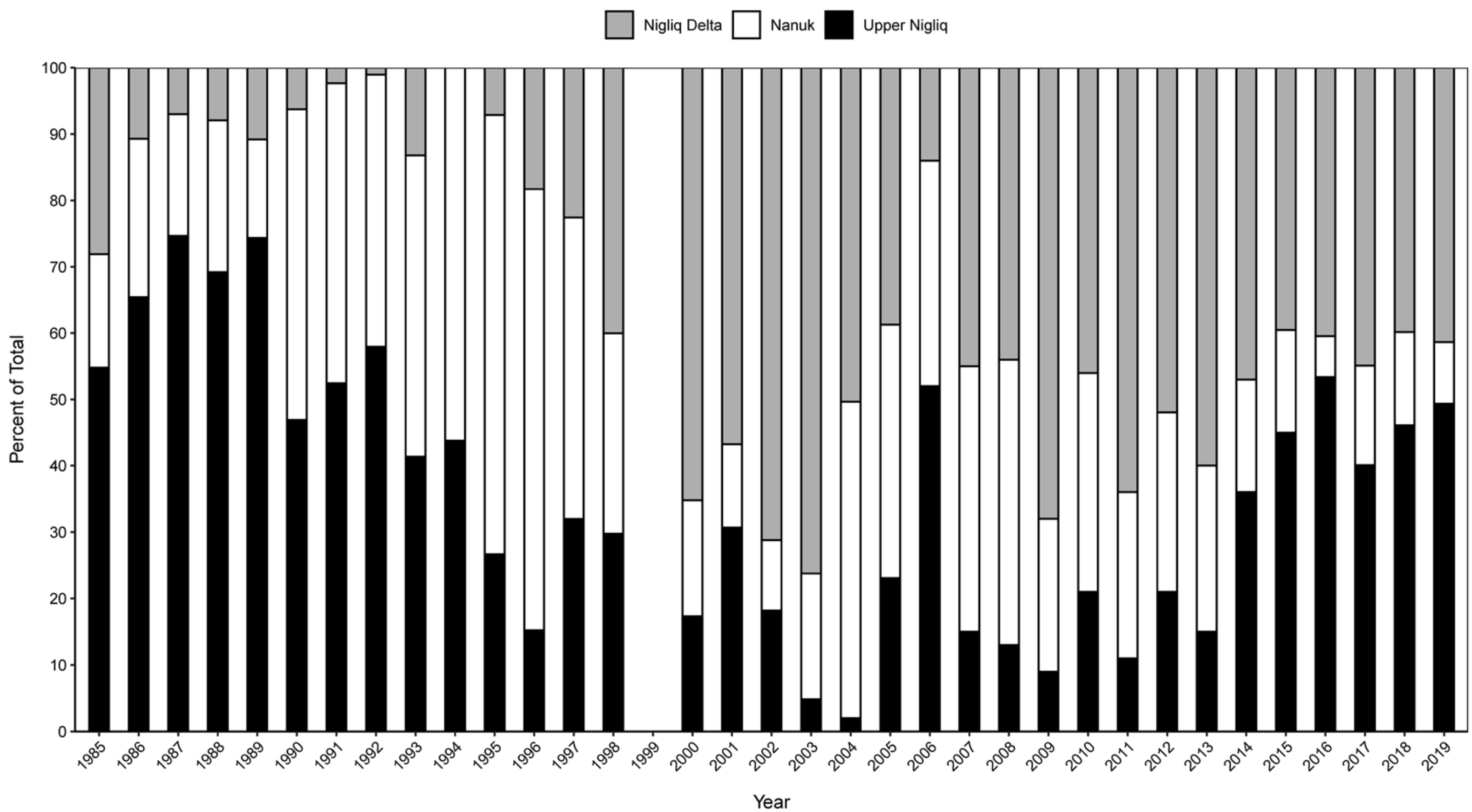

Figure 4. Percent of annual fishing effort in each of 3 Niġliq Channel fishing areas, Colville River, Alaska, 1985–2019.

Table 3. Observed catch of Arctic Cisco (number of fish), effort (adjusted net-days), and catch per unit effort (CPUE; fish/net-day) for each fishing area in 3 Niġliq Channel fishing areas and in the Main Channel fishing area by mesh size, Colville River, Alaska, 2019. Nets are standardized to 18 m length.

	Mesh size (cm)				
Location	6.4	7	7.6	8.3	8.9
Upper Niġliq Area					
Number of Interviews	–	–	90	–	14
Catch (# of fish)	–	–	2,225	–	221
Effort (net-days)	–	–	182.3	–	27.7
CPUE (fish/net-day)	–	–	12.2	–	8.0
Nanuk Area					
Number of Interviews	–	–	24	13	–
Catch (# of fish)	–	–	1,059	569	–
Effort (net-days)	–	–	30.6	14.7	–
CPUE (fish/net-day)	–	–	34.7	38.8	–
Niġliq Delta Area					
Number of Interviews	3	–	52	9	–
Catch (# of fish)	124	–	2,970	246	–
Effort (net-days)	5.0	–	108.0	15.0	–
CPUE (fish/net-day)	24.8	–	27.5	16.4	–
Total Niġliq Channel					
Number of Interviews	3	–	166	22	14
Catch (# of fish)	124	–	6,254	815	221
Effort (net-days)	5.0	–	320.9	29.7	27.7
CPUE (fish/net-day)	24.8	–	19.5	27.4	8.0
Main Channel Area					
Number of Interviews	–	–	1	–	–
Catch (# of fish)	–	–	2	–	–
Effort (net-days)	–	–	1.3	–	–
CPUE (fish/net-day)	–	–	1.5	–	–
Total Niġliq Channel and Main Channel					
Number of Interviews	3	–	167	22	14
Catch (# of fish)	124	–	6,256	815	221
Effort (net-days)	5.0	–	322.2	29.7	27.7
CPUE (fish/net-day)	24.8	–	19.4	27.4	8.0

Table 4. Observed catch of Arctic Cisco (number of fish), effort (adjusted net-days), and catch per unit effort (CPUE; fish/net-day) for each fishing area in the Niġliq Channel, Colville River, Alaska, 1986–2019. Catch and effort data are for 7.6 cm mesh gillnets standardized to 18 m length.

	Upper Niġliq			Nanuk			Niġliq Delta			Total Niġliq Channel		
Year	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE
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	12.0	2,930	83.3	35.0	6,913	81.3	85.0	11,124	269.7	41.3

Table 4. Continued.

	Upper Niġliq			Nanuk			Niġliq Delta			Total Niġliq Channel		
Year	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE	Observed Catch	Effort	CPUE
2007[a]	498	63.0	7.9	935	109.2	8.6	4,422	200.2	22.1	5,855	372.5	15.7
2008[a]	156	44.0	3.5	1,665	203.3	8.2	2,662	198.3	13.4	4,483	445.6	10.1
2009[a]	0	0.0	0.0	1,027	88.3	11.6	4,258	196.3	21.7	5,285	284.6	18.6
2010[a]	91	34.7	2.6	270	98.0	2.8	1,866	193.0	9.7	2,227	326.0	6.8
2011[a]	212	27.3	7.8	1,064	56.3	18.9	13,395	320.7	41.8	14,671	404.3	36.3
2012[a]	86	24	3.6	1,313	48.3	27.2	5,413	173.7	31.2	6,812	246.0	27.7
2013[a]	335	48.0	7.0	589	39.3	15.0	4,536	327.0	13.9	5,460	414.3	13.2
2014[a]	1,211	123.7	9.8	2,588	98.8	26.2	10,193	370.0	27.5	13,992	592.5	23.6
2015[a]	2,403	105.3	22.8	605	32.7	18.5	10,053	169.8	59.2	13,061	307.8	42.4
2016[a]	2,392	203.3	11.8	180	9.0	20.0	5,140	195.2	26.3	7,712	407.5	18.9
2017[a]	1,310	119.3	11.0	757	37.8	20.0	7,896	161.3	49.0	9,963	318.4	31.3
2018[a]	2,563	126.5	20.3	1,168	35.4	33.0	13,718	142.5	96.3	17,449	304.4	57.3
2019[a]	2,225	182.3	12.2	1,059	30.6	34.6	2,970	108.0	27.5	6,254	320.9	19.5
Total[b]	1,002	92	9.0	1,534	99	16.9	3,988	154.0	30.1	6,523.2	344.4	19.5

[a] Upper Niġliq catch and effort values include fish and net data from the Uyagagviq area (Area 630).

[b] Denotes average CPUE from 1986–2019.

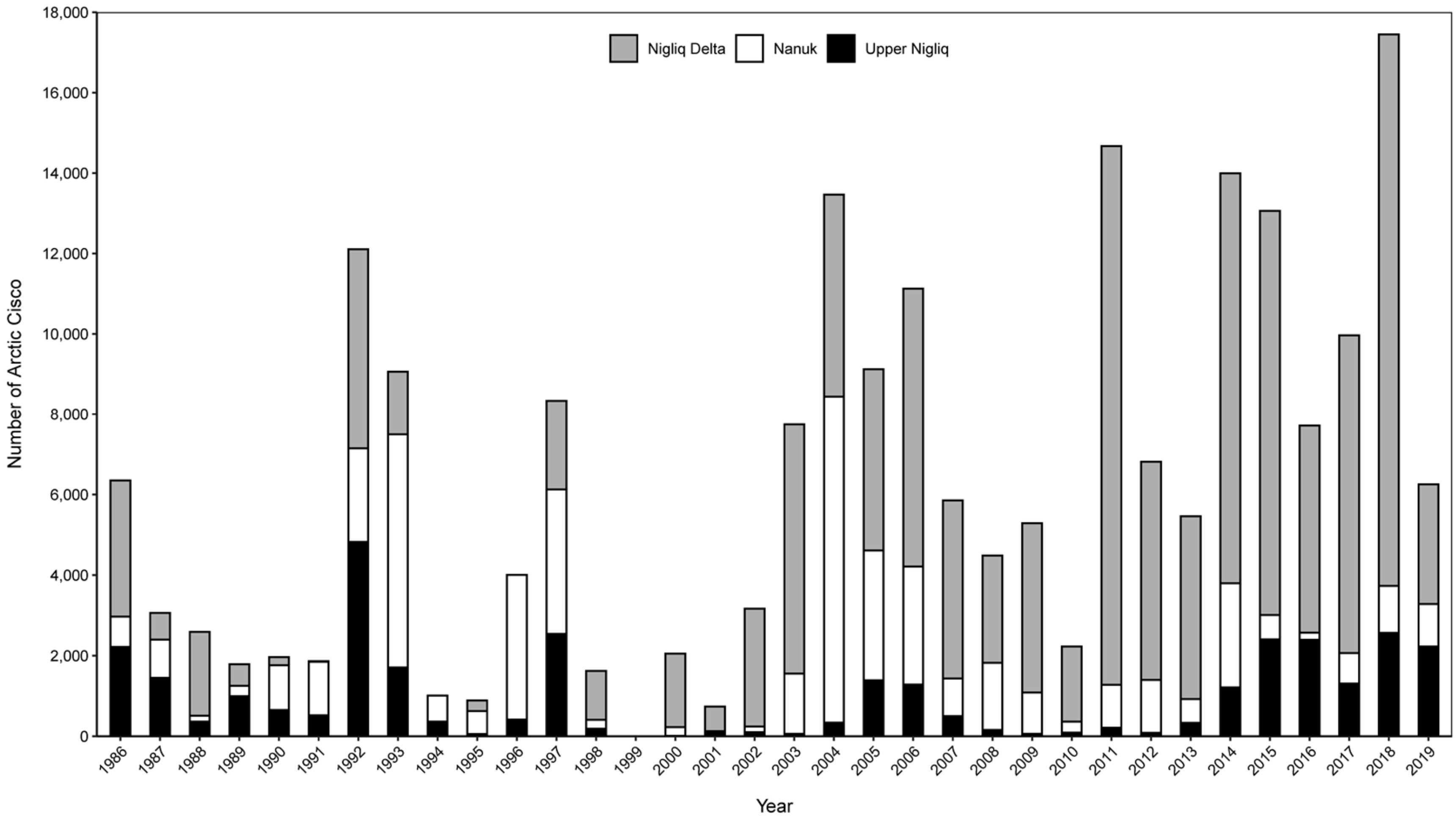

Figure 5. The observed number of Arctic Cisco harvested in 7.6-cm mesh nets in each of 3 Niġliq Channel fishing areas, 1986–2019.

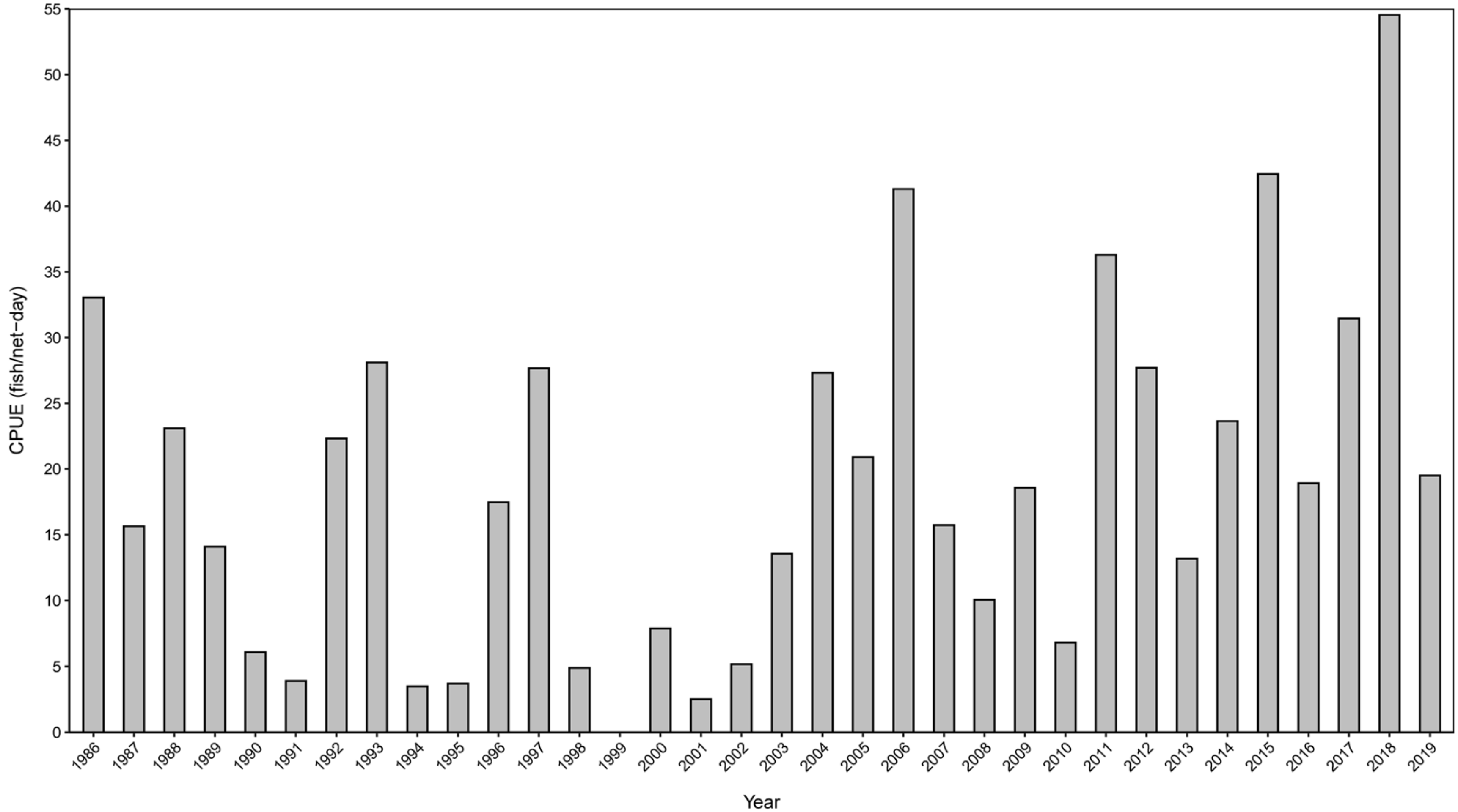

Figure 6. Catch per unit effort of Arctic Cisco in 7.6-cm mesh gill nets, Niġliq Channel, Colville River, Alaska, 1986–2019.

Table 5. The estimates of total harvest of Arctic Cisco in the Niġliq Channel and Main Channel fishing areas. Estimates are based on calculated effort and estimated CPUE for each river section by mesh size, Colville River, Alaska, 2019.

Mesh Size (cm)	Niġliq Channel net-days	CPUE (fish/net day)	Estimated Niġliq Channel Harvest	Main Channel Area net-days	CPUE (fish/net day)	Estimated Main Channel Harvest	Total Estimated Harvest
5.1	–	–	–	–	–	–	–
6.4	28.3	24.8	702	–	–	–	702
7.0	–	–	–	–	–	–	–
7.6	760.7	19.5	14,834	1.3	1.5	2	14,836
8.3	53.3	27.4	1,460	–	–	–	1,460
8.9	68.3	8.0	546	–	–	–	546
10.2	–	–	–	–	–	–	–
11.4	6.7	0	0	–	–	–	0
12.7	–	–	–	–	–	–	–
		Total	17,542			2	17,544

reported to us but that could not be associated with a specific mesh size or known fishing effort, a total of 10,399 fish were recorded during interviews in 2019. Arctic Cisco were the numerically dominant species caught (7,687 fish, 73.9% of harvest), which is normal for the annual fall under-ice gillnet fishery, followed by Least Cisco (1,362 fish, 13.1% of harvest), Fourhorn Sculpin (940 fish, 9.0% of harvest), Humpback Whitefish (222 fish, 2.1% of harvest), Broad Whitefish (103 fish, 1.0% of harvest), Rainbow Smelt (37 fish, 0.4% of harvest), Saffron Cod (27 fish, 0.3% of harvest), and Burbot (21 fish, 0.2% of harvest).

Although the number of Least Cisco harvested in 2019 (1,362 fish) was less than in 2018 (1,748 fish), that total represented a greater proportion of total fish harvest (13.1% in 2019 vs 5.7% in 2018). Least Cisco is an important bycatch species taken in the Arctic Cisco fishery. In the previous 6 years (a period of higher than average Arctic Cisco harvests), average Least Cisco harvest had been 4.5% of overall species composition in the fishery. However, the long-term average contribution of Least Cisco to the fall fishery harvest is ~18%. The increase in 2019 may signal a return to historical catch proportions, i.e., a higher percentage of Least Cisco taken by fishers in the coming years.

Starting with the 2010 year class, the fishery has caught few age-5 fish in the harvest annually. The reason for this is unclear but could be related to behavior of age-5 fish (e.g., occupying unfished sections of the river), or recruitment strength of young-of-the-year (YOY) Arctic Cisco to the Alaskan Beaufort Sea coastline from the Mackenzie River system spawning grounds. Ongoing nearshore summer fyke net surveys at Prudhoe Bay suggest that recruitment strength of YOY Arctic Cisco since 2012 has been low compared the 2007–2011 period (Green et al. 2019). There is a strong relationship between recruitment strength of YOY Arctic Cisco to Prudhoe Bay during summer months and subsequent recruitment to the under-ice fishery in the Niġliq Channel 5–7 years later (Seigle et al. *in review*). Thus, we expect to see lower than average harvests of Arctic Cisco over the next several years. This may result in higher numbers of Least Cisco due to decreased competition for resources from Arctic Cisco, or at least an increase in the proportion of Least Cisco in the fishery.

Page intentionally left blank.

Table 6. Species composition of the observed harvest from the fall subsistence fishery for Arctic Cisco expressed as a percent of the sampled catch, Colville River, Alaska, 1985–2019. Table includes all fish caught in every net, regardless of mesh size and location.

Year	Arctic Cisco	Bering Cisco	Least Cisco	Broad Whitefish	Humpback Whitefish	Arctic Grayling	Rainbow Smelt	Round Whitefish	Dolly Varden Char	Northern Pike	Saffron Cod	Burbot	Arctic Flounder	Fourhorn Sculpin	Sheefish	Total Observed
1985	69.5	(a)	14.8	15.1	0.5	0	0.2	0	0	0	0	0	0	(b)	0	2,705
1986	95.9	(a)	3.8	0.3	0.0	0	0.03	0.01	0	0	0	0	0	(b)	0	8,952
1987	71.8	(a)	18.7	5.5	3.8	0	0.01	0	0.03	0	0.03	0.06	0	(b)	0	6,826
1988	90.6	(a)	8.3	0.6	0.5	0	0	0	0	0	0	0.1	0	(b)	0	2,948
1989	66.2	(a)	23.7	7.0	3.1	0	0.03	0	0	0	0.03	0.03	0	(b)	0	2,946
1990	39.6	21.8	30.2	5.3	2.9	0	0.2	0	0.1	0	0.03	0.01	0	(b)	0	7,911
1991	62.8	1.2	30.0	1.0	3.8	0	1	0.03	0	0	0.04	0.09	0	(b)	0	7,576
1992	89.2	0.1	6.0	0.2	0.1	0	0	0	0	0	0	0	0	4.4	0	24,305
1993	85.4	0.02	11.1	0.3	0.4	0	0.04	0	0	0	0.01	0	0	2.7	0	17,155
1994	39.6	0.1	44.6	2.2	13.2	0	0.3	0	0	0	0	0	0	(b)	0	3,792
1995	34.7	0.2	35.0	7.6	22.3	0	0.2	0	0	0	0	0.1	0	(b)	0	7,155
1996	81.9	0	4.8	0.1	0.4	0	0.1	0	0	0	0.02	0.02	0.02	12.5	0	5,730
1997	74.8	0	22.9	1.3	0.9	0	0	0	0	0	0	0	0	(b)	0	19,758
1998	39.6	0	50.8	0.4	8.9	0	0	0.2	0	0	0	0	0	(b)	0	6,481
2000	79.4	0.1	14.0	0.2	6.0	0	0.3	0	0	0	0.03	0	0	(b)	0	3,871
2001	35.6	0.1	29.6	5.5	27.8	0	0.1	0	0	0	0	1.3	0	(b)	0	3,515
2002	49.8	0.1	30.6	1.6	17.5	0	0.2	0	0	0	0.1	0.2	0	(b)	0	8,445
2003	66.3	0.2	22.3	0.2	9.4	0	0.9	0	0	0	0.6	0.1	0	(b)	0	16,654
2004	74.7	0.06	24.2	0.0	0.9	0	0.08	0	0	0	0.04	0.03	0	(b)	0	20,705
2005	81.3	0	14.8	0.2	3.5	0	0.15	0	0	0	0.01	0	0	(b)	0	13,957
2006	86.6	0	12.0	0.4	0.9	0	0	0	0	0.1	0	0	0	(b)	0	17,344
2007	71.7	0	22.3	0.4	5.5	0	0	0	0	0	0.1	0	0	(b)	0	14,686
2008	84.1	0.2	14.7	0.0	0.1	0	0.7	0	0	0	0.1	0.01	0	(b)	0	9,199
2009	85.4	0.2	9.2	0.2	0.5	0	4.3	0	0	0	0.1	0.03	0	(b)	0	11,700
2010	60.7	0	34.4	0.4	3.0	0	1.3	0	0	0	0.2	0	0	(b)	0	18,505
2011	94.8	0	4.0	0.1	0.6	0	0.4	0	0	0	0.09	0	0	(b)	0	28,211
2012	77.8	0	19.8	0.6	0.9	0	0.4	0	0	1	0.5	0	0	(b)	0	17,172
2013	82.5	0	7.7	0.1	2.3	0	5.5	0	0	0	1.8	0	0	(b)	0	13,872
2014	95.4	0	2.1	0.4	0.6	<0.01	1.3	0	0	0	0.2	<0.01	0	(b)	0	19,217
2015	95.6	0	2.2	0.1	0.4	0	0.7	0	0	0	0.2	<0.01	0	(b)	<0.01	22,586
2016	91.8	0	3.4	0.1	0.4	0	2.4	0	0	0	1.9	0.01	0	(b)	0	13,782
2017	89.7	0	6.0	0.3	0.5	<0.01	1.2	<0.01	<0.01	0	0.2	0.10	0	(b)	<0.01	20,224
2018	85.6	0	5.7	0.1	0.5	0	0.4	0	<0.01	0	0.2	<0.01	0	7.5	0	30,569
2019	73.9	0	13.1	1.0	2.1	0	0.4	0	0	0	0.3	0.2	0	9	0	10,399

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

Page intentionally left blank.

POST-MONITORING SEASON FISHING EFFORT

One fisher continued to harvest after 15 December 2019 and is still fishing as of early February 2020. That fisher is within walking distance of Nuiqsut and has stated that he will continue fishing into March in an effort to document harvest composition in the Upper Niġliq. The fisher continues to check his net every 3–4 days, often posting the harvest results on social media. As of 9 February 2020, he had reported catching nearly 800 Arctic Cisco since 15 December 2019. This fisher reports catching Least Cisco and Humpback Whitefish in modest numbers as well, with at least 150 fish cumulative reported since 15 December 2019. These results indicate that Arctic Cisco are still moving in the Upper Niġliq throughout deep winter. Additionally, he as reported that Humpback Whitefish are "smaller" than those caught earlier in the fishing season.

LENGTH, WEIGHT, AND AGE OF CATCH

ABR measured a sub-sample of 538 Arctic Cisco and 134 Least Cisco from all mesh sizes in 2019. Arctic Cisco ranged in length from 280 mm to 395 mm with an average of 344.9 mm (95% CI = 343.5–346.3 mm) and a median of 346 mm (Figure 7). The middle 50% of fish ranged from 334 to 356 mm, which was similar to fish lengths measured in 2018 (329 mm–353 mm), and larger than in 2017 (315–336 mm), 2016 (312–339 mm), and 2015 (315–339 mm). Least Cisco ranged from 265 mm to 408 mm with an average of 326 mm (95% CI = 320.9–330.1 mm) and a median of 323 mm.

During the 2019 field surveys, we received 190 Arctic Cisco that were analyzed for age (via otoliths), length, and weight. These fish were caught in all parts of the river using 6.4-cm, 7.6-cm, 8.3-cm, and 8.9-cm mesh nets. Most (n = 138) of the otoliths sampled for Arctic Cisco came from 7.6-cm mesh nets. For Arctic Cisco, length and weight were strongly correlated (R^2 = 0.659, all mesh sizes) (Figure 8). For all net mesh sized combined, fish ranged in age from 5 to 8 years, with an age composition of 0.5%, age 5; 12.2%, age 6; 69.2%, age 7; and 18.1%, age 8. For only those Arctic Cisco caught in 7.6-cm-mesh, fish ranged in age from 5 to 8 years with an age composition of 0.7%, age 5; 14.5%, age 6; 66.7%, age 7; and 18.1%, age 8. As might be expected for fish not yet sexually mature, fork lengths generally increased as a function of age (Figure 9).

We estimated an age-specific CPUE by applying the percentages for age-composition of Arctic Cisco to the overall CPUE of 19.5 fish per adjusted net-day and by assuming that our sub-sample in 7.6-cm mesh nets was representative of age-composition throughout the river. We calculated an estimate of 0.2 age-5 fish per net day, 2.8 age-6 fish per net-day, 13.0 age-7 fish per net-day, and 3.5 fish age-8 fish per net-day (total = 19.5 fish per net-day; Table 4, Figure 10). The Arctic Cisco caught in 7.6-cm mesh nets in 2019 represented the 2011–2014 hatching year class (i.e., fish that are 5–8 years of age). We can reasonably assume that the 2010 year class no longer contributes to the Colville River fishery, as it is likely that most of these fish had already returned to spawn in the Mackenzie River system during summer 2019.

Based on our age readings for the 2019 survey samples, the estimated CPUE of 3.5 fish per net-day (7.6-cm mesh) has raised the overall contribution of the fish per net-day for the 2011 year class cohort to a total of ~51 fish per net-day since 2015 (representing age-5, age-6, age-7, and age-8 fish). We assume that 2019 is likely the last year that the 2011 year class will contribute meaningfully to harvests in the Colville River fall fishery because those fish will begin migrating back to spawning grounds in the Mackenzie River system during the summer and fall of 2020, never to return to Alaskan waters.

Similar to 2010, the 2011 year class was characterized by a near-absence of age-5 fish in the age samples collected in 2016 (Figure 11) (Seigle et al. 2017). The class reappeared in the subsequent 3 seasons, again suggesting that age-5 fish were either residing in un-fished portions of the river, or that the harvest monitoring team simply did not obtain any 2011 year class samples during the 2016 surveys.

The estimated cumulative total CPUE for the year classes after 2011 is currently 28.6 fish per net-day for 2012 (representing age-5, age-6, and age-7 fish), 3.7 fish per net-day for 2013 (age-5 and age-6 fish), and 0.1 fish per net-day for 2014 (age-5 fish) (Table 7).

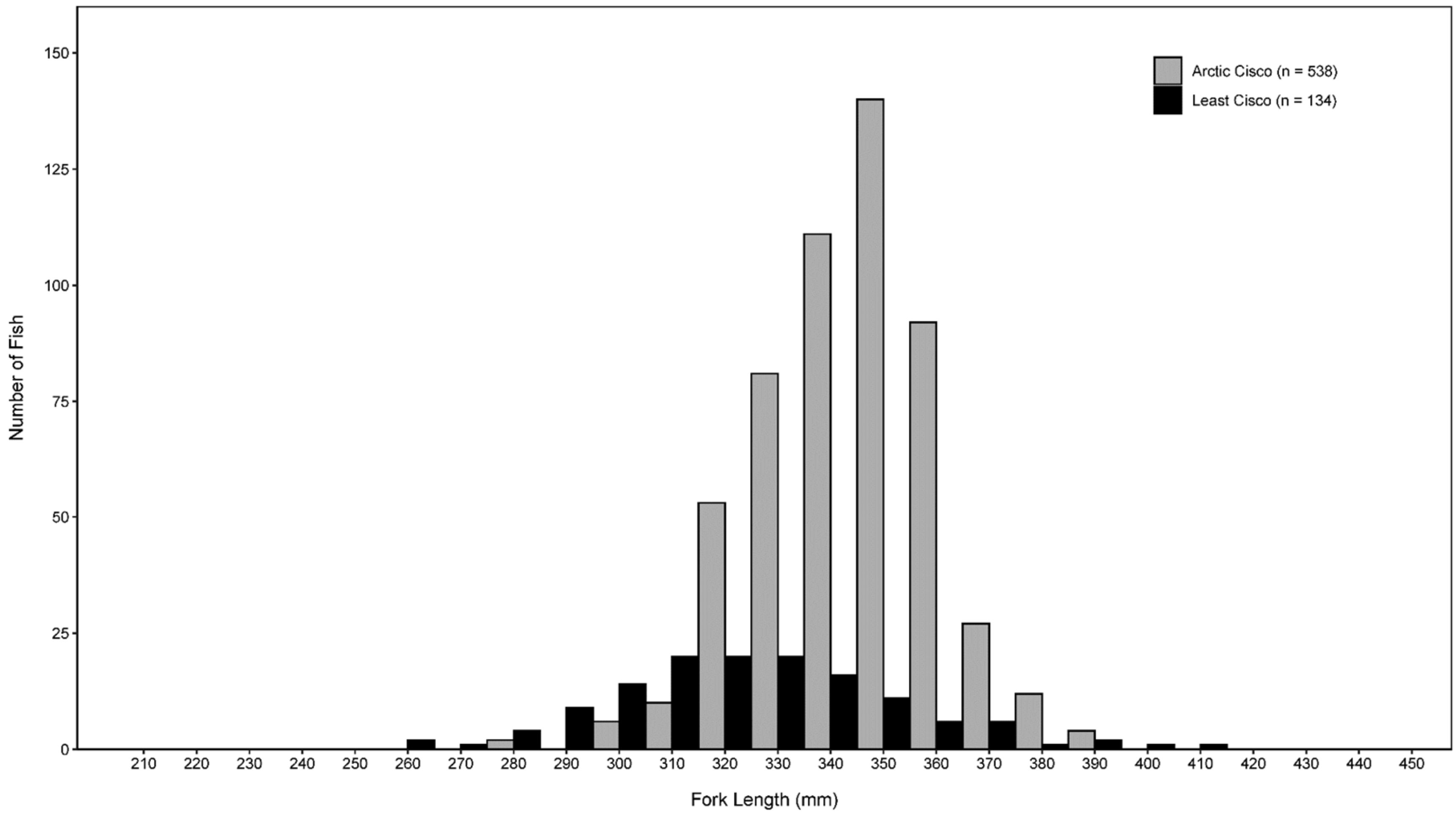

Figure 7. Length frequency of Arctic Cisco captured in all mesh sizes in the fall subsistence fishery, Niġliq Channel, Colville River, Alaska, 2019.

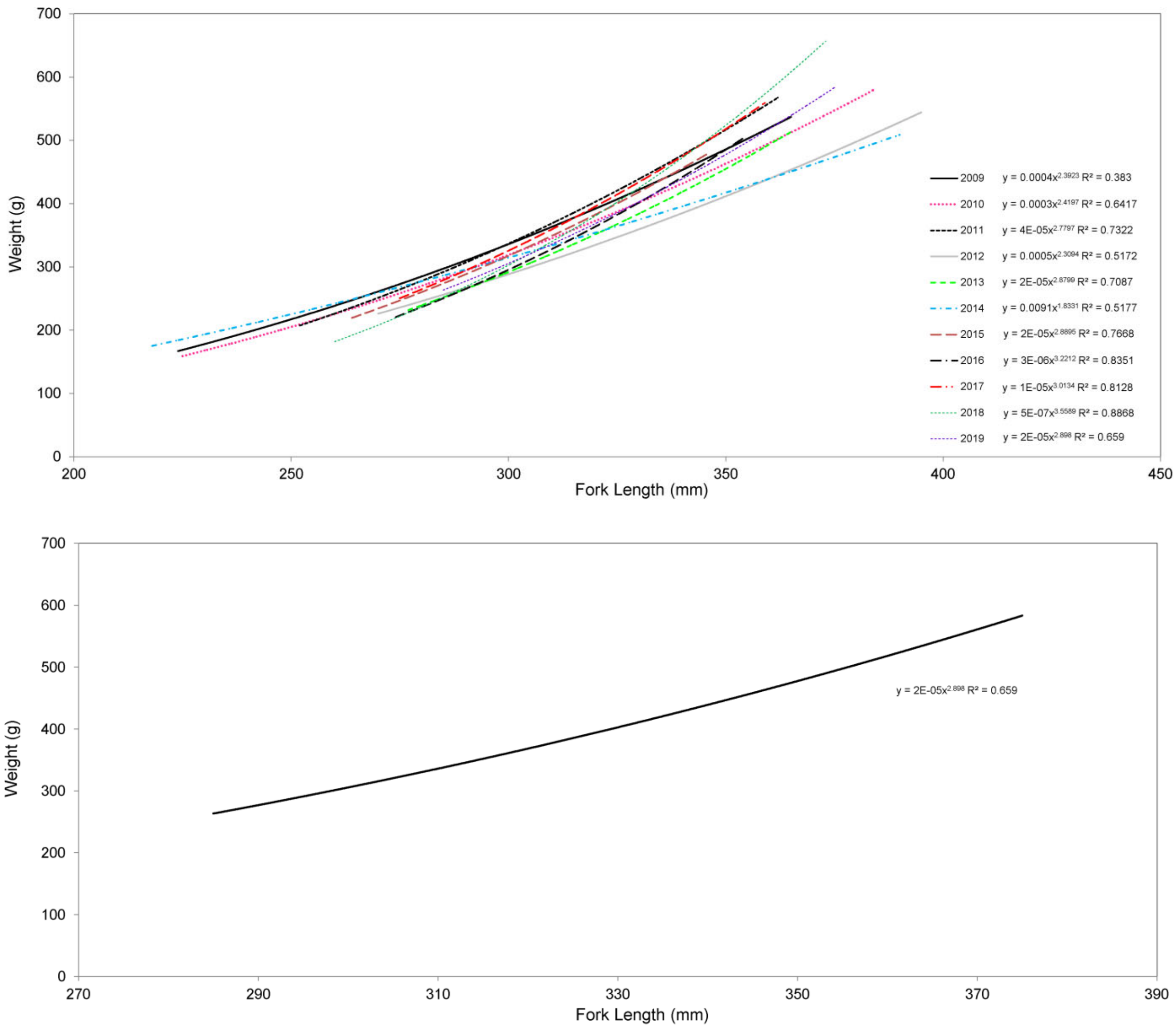

Figure 8. Length-weight regression for Arctic Cisco captured in 7.6-cm mesh nets in the fall subsistence fishery, Niġliq Channel, Colville River, Alaska, 2009–2019.

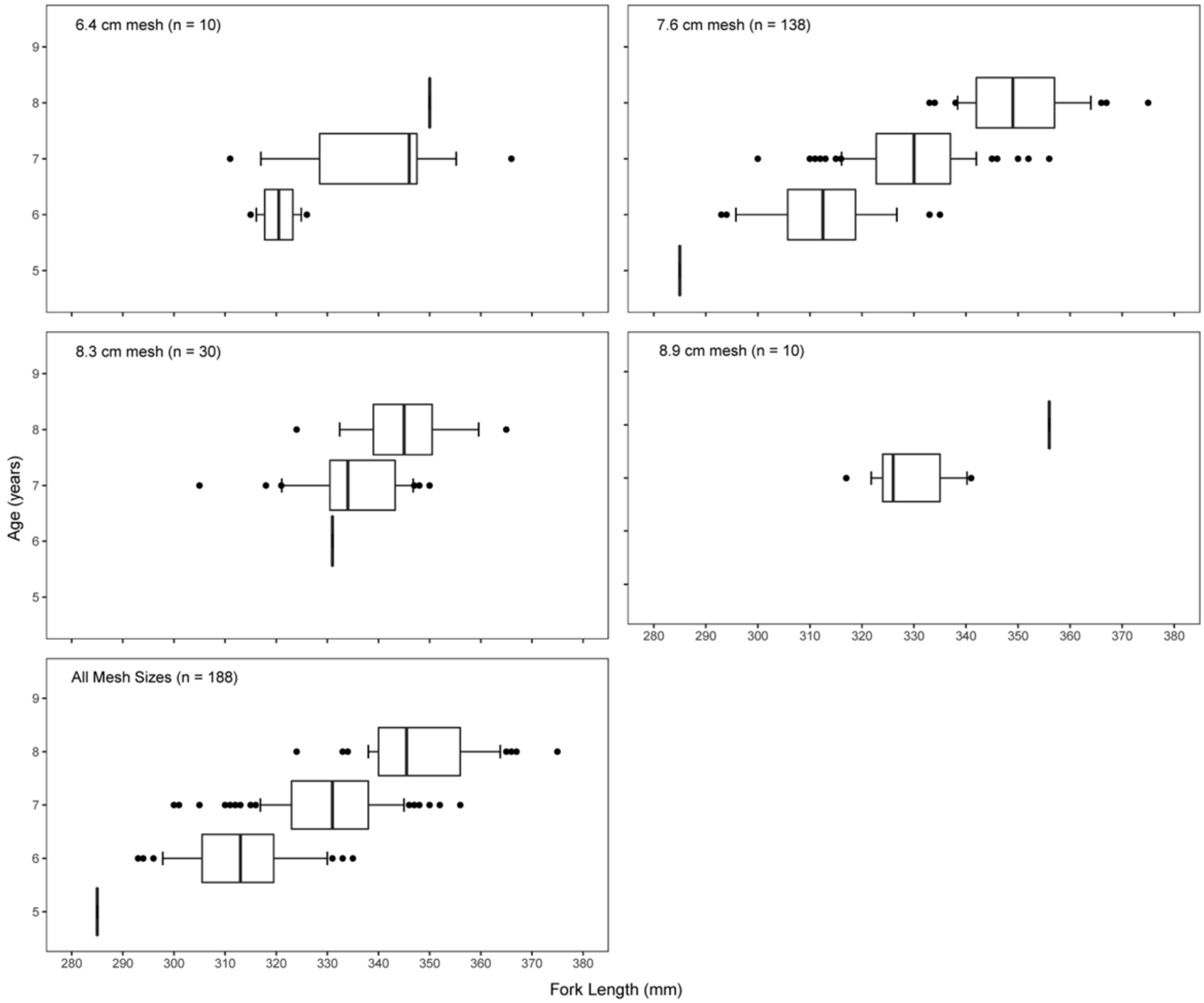

Figure 9. Age-specific length distribution by mesh size of Arctic Cisco harvested in the fall subsistence fishery, Niġliq Channel, Colville River, Alaska, 2019.

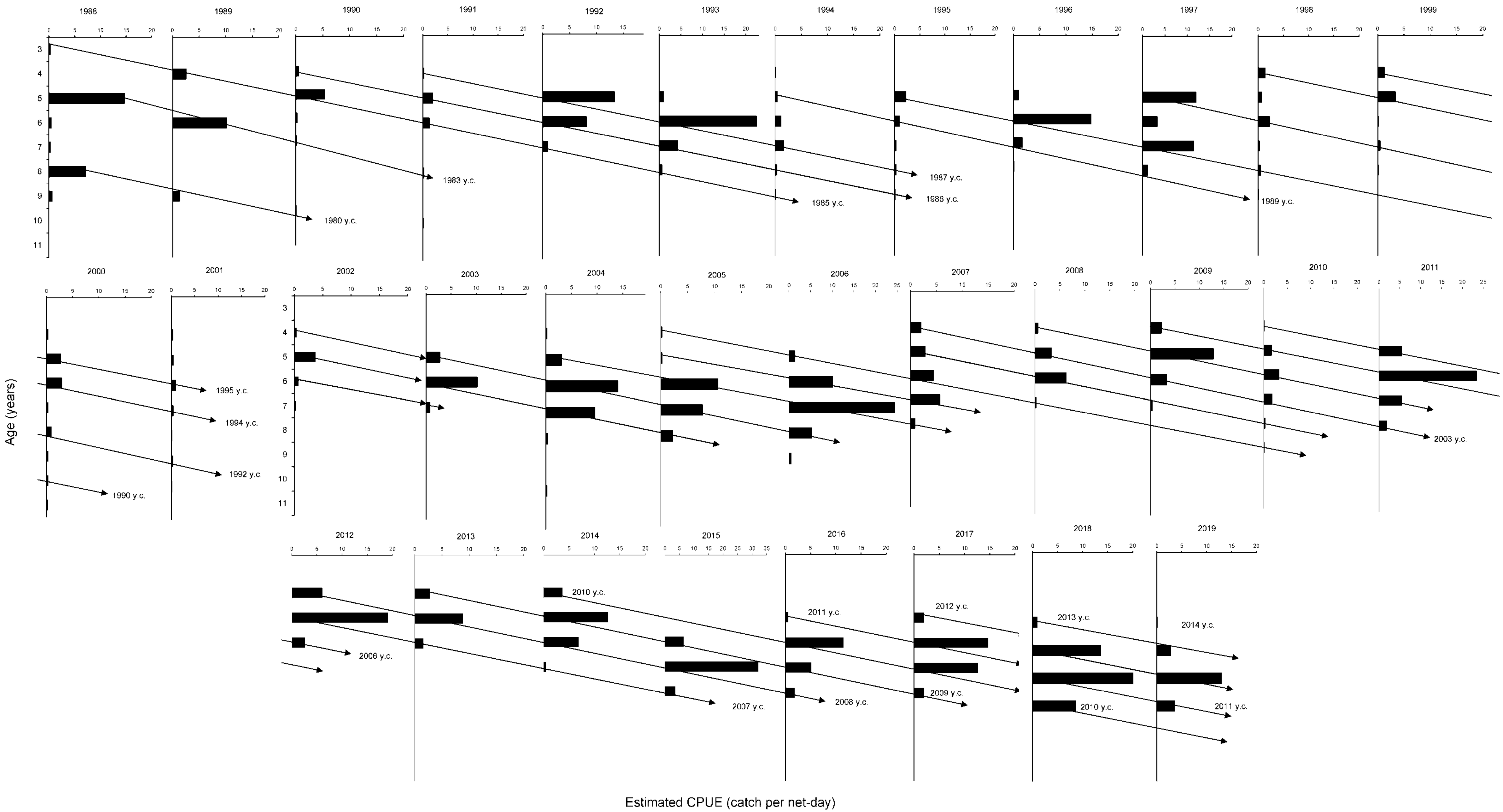

Figure 10. Catch per unit effort (CPUE) of Arctic Cisco by age class in the fall subsistence fishery, Niġliq Channel, 1988–2019. Arrows demonstrate the progression of select year classes through the fishery. Only fish harvested in 7.6-cm mesh gill nets are included and counts are standardized to 18-m net length, as described in text.
.

Page intentionally left blank.

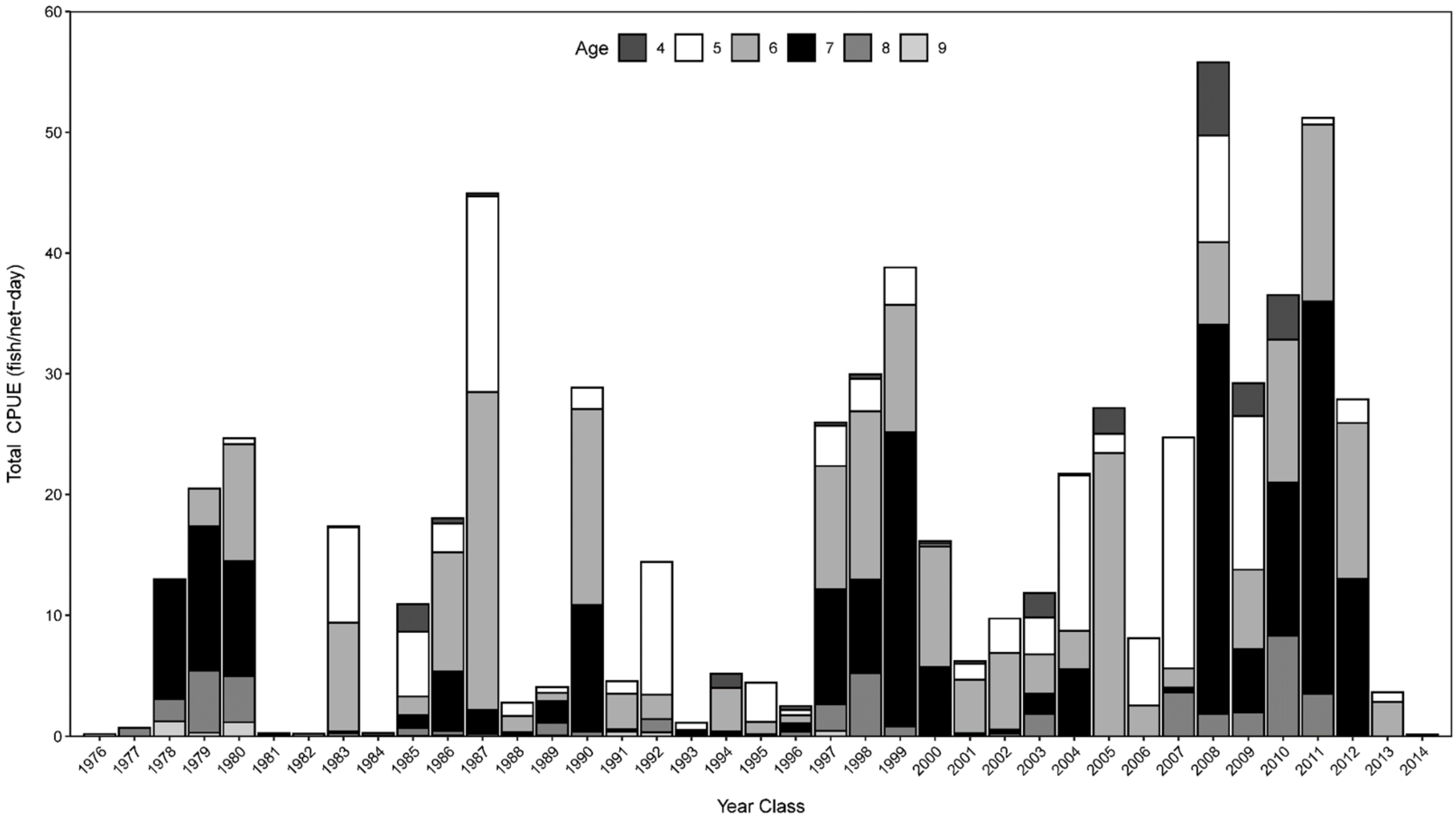

Figure 11. Cumulative catch per unit effort of Arctic Cisco by year class in the fall subsistence fishery, Niġliq Channel, Colville River, 1976–2014.

Table 7. Cumulative catch per unit effort (CPUE) of Arctic Cisco in 7.6-cm mesh gill nets by year class in the fall subsistence fishery, Niġliq Channel, Colville River (1981–present).

Year Class	CPUE
1981	0.4
1982	0.2
1983	17.3
1984	0.3
1985	10.9
1986	18.0
1987	44.9
1988	2.8
1989	4.3
1990	29.2
1991	4.7
1992	14.4
1993	1.1
1994	5.4
1995	4.4
1996	2.5
1997	25.9
1998	29.9
1999	38.8
2000	16.1
2001	6.2
2002	9.7
2003	11.8
2004	21.7
2005	27.2
2006	8.1
2007	24.7
2008	55.7
2009	29.1
2010	36.6
2011[a]	52.8
2012[a]	28.6
2013[a]	3.7
2014[a]	0.1

[a] Calculation assumes that the 2011–2014 year classes are still contributing to cumulative CPUE.

WATER QUALITY

Salinity and temperature monitoring began on 22 October 2019 at station 4. The remaining 3 stations (3, 2, and 1 from upstream to downstream) were established on 24 October. The warming event, beginning 28 October, prevented the ABR survey team from collecting water quality data due to unsafe travel conditions on the Niġliq Channel. Collection of water quality data resumed at the most upstream station (station 4) on 2 November. By 6 November, all water quality stations were safely accessible, and ABR visited each one until 17 November. Salinity at the downstream locations (Niġliq Delta) registered above 15 ppt by 26 October (at 3-m depth). Salinity never surpassed 11 ppt during the survey season at the most upstream station near Nuiqsut in the Upper Niġliq (Figures 2 and 12). Salinity at 3-m depth peaked at 24.7 ppt on 13 November (Station 1), at 22.3 ppt on 15 November (Station 2), at 20.3 ppt on 6 November (Station 3), and 10.8 ppt on 17 November (Station 4).

For comparison, salinity at 3-m depth in the Niġliq Delta area peaked at 22.5 ppt in 2018, peaked at 19 ppt in 2017, and peaked at 25.1 ppt in 2016 (Seigle et al. 2019, 2018, 2017). The Upper Niġliq area (Station 4) near Nuiqsut reached a maximum of 11.9 ppt in 2018, 3.3 ppt in 2017, and 11.3 ppt in 2016. One fisher discovered large numbers of marine amphipods feeding on dead Arctic Cisco in the Niġliq Channel, which we have not previously been reported that far upstream. However, amphipods are not uncommon in brackish waters of the outer delta. Ideal salinity conditions for Arctic Cisco (>15 ppt) were generally present at the 3 downstream stations (Stations 3, 2, and 1; Figures 2 and 12). Favorable salinity conditions for Arctic Cisco at the downstream locations may contribute to higher CPUE at the downstream Nanuk (CPUE = 34.6 fish per net-day) and Niġliq Delta (CPUE = 27.5 fish per net-day) fishing areas when compared to the upstream Upper Niġliq fishing area (CPUE = 12.2 fish per net-day) (Figure 2, Table 4).

Water temperatures were generally higher upstream near Nuiqsut and lower at downstream stations in the delta (Figure 12). There were two dates (25, 26 October), where downstream temperatures (Station 3) exceeded upstream

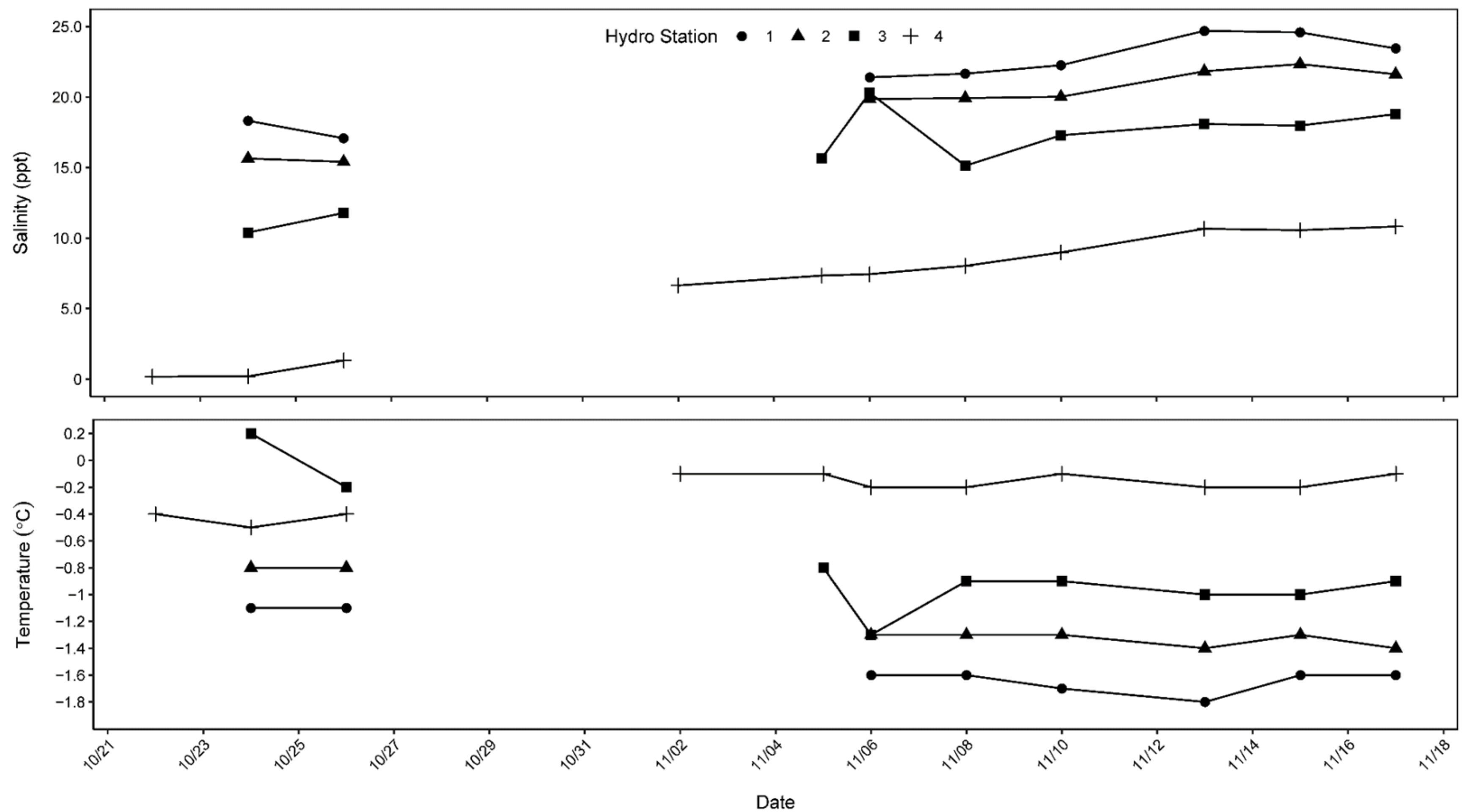

Figure 12. Salinity and temperature measured at 3.0-m depth from 4 water stations on the Niġliq Channel, Colville River, Alaska, 22 October to 17 November 2019.

temperatures (Station 4) by ~0.7 and 0.2 °C, respectively. This corresponds roughly to the period of unusual warmup that caused many fishers to remove their nets for approximately 1 week. Otherwise, the relationship of temperatures among stations was consistent throughout the season.

SUMMARY

Results for the 2019 under-ice fall gillnet fishery in the Nuiqsut area were characterized by unusual environmental conditions. The start date of the 2019 season was one of the latest recorded since harvest monitoring began in the mid-1980s, and an ice melt event at the end of October interrupted typical fishing activity. Despite these limitations, participation in the fishery was still strong, with a higher fishing effort than in 2018. The average CPUE of 19.5 Arctic Cisco per net-day in 7.6-cm mesh nets in the Niġliq Channel was much lower than the 57.3 Arctic Cisco per net-day documented in the previous year. However, 2019 CPUE is consistent with the historical average CPUE for this fishery, and is the fourth lowest value in the last decade of harvest monitoring.

Anecdotal information on continuing harvest results posted by a single fisher on social media from 15 December 2019 to early February 2020 indicate that successful Arctic Cisco harvests continue well into deep winter in the Niġliq Channel. Additionally, this fisher has provided the survey team with useful anecdotal information on harvests of other species including Least Cisco and Humpback Whitefish during the coldest months when fishing typically ceases in the Niġliq Channel.

The overall observed harvest of all species caught in 2019 was lower when compared to 2018, although Least Cisco represented a higher proportion of the overall catch than in recent years. Age and length structure of Arctic Cisco collected in 2019 indicate that larger fish, associated with age-6 (2013 year class), age-7 (2012 year class), and age-8 (2011 year class), dominated harvest results. As in recent years, the age-5 year class was essentially absent, raising the question as to whether they will reappear in 2020.

Given the unusual environmental conditions on the Niġliq Channel in 2019, the survey team recorded fewer harvest results than normal, although effort was higher than in 2018. It is possible that the late start of the fishery and more than a week of suspended effort in late October resulted in a missed opportunity to increase harvest yields to above average levels. While it is tempting to attribute the average results of the 2019 fishing season to environmental conditions surrounding fishing activities, it should be noted that in 2018, we projected a decline in the number of Arctic Cisco in the Colville River Fall Fishery in the near future based on lower reported YOY recruitment to the area around Prudhoe Bay in recent summer surveys (Seigle et al. 2019). Thus, lower adult harvest rates in the Niġliq Channel were not entirely unexpected. With similarly low recruitment of YOY to Prudhoe Bay waters in summer 2019, we may continue to see lower adult recruitment to the fall under-ice fishery through at least 2024.

LITERATURE CITED

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. 102 pp.

Green, D. G., J. Priest, K. P. Gatt, and T. M. Sutton. 2019. Beaufort Sea Nearshore Fish Monitoring Study: 2018 Annual Report. Unpublished report for Hilcorp LLC, Anchorage, AK, by University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Department of Fisheries, Fairbanks, AK. 85 pp.

Hauck, K. 1980. Alaska Department of Fish and Game, Fish Pathology Laboratory Report Accession Number 1981-0094. Unpublished manuscript. Available at Alaska Department of Fish and Game, Fish Pathology Laboratory, Anchorage, AK.

Moulton, L. L., B. Seavey, and J. Pausanna. 2010. History of an under-ice fishery for Arctic Cisco and Least Cisco in the Colville River, Alaska. Arctic 63: 381–390.

Seigle, J. C., S. M. Murphy, and S. R. Braund. 2008. Fall 2007 fishery monitoring on the Colville River. Report by ABR, Inc., Anchorage, AK, for ConocoPhillips Alaska, Inc., Anchorage, AK. 33 pp.

Seigle, J. C., L. Gutierrez, J. R Rose, J. E. Welch, A. Prichard, and J. P. Pausanna. 2016. Fall 2015 subsistence fishery monitoring on the Colville River. Report by ABR, Inc., Anchorage, AK, for ConoccoPhillips Alaska, Inc., Anchorage, AK. 57 pp.

Seigle, J. C., L. V. Ellis, J. E. Welch, A. Hovis, and J. P. Parrett. 2017. Fall 2016 Subsistence fishery monitoring on the Colville River. Report by ABR, Inc., Anchorage, AK, for ConoccoPhillips Alaska, Inc., Anchorage, AK. 36 pp.

Seigle, J.C., J.E. Welch, and J.P.Parret. 2018. Fall 2017 subsistence fishery monitoring on the Colville River. Report by ABR, Inc., Anchorage, AK, for ConoccoPhillips Alaska, Inc., Anchorage, AK. 37 pp.

Seigle, J.C., J.E. Welch, and J.P.Parret. 2019. Fall 2018 subsistence fishery monitoring on the Colville River. Report by ABR, Inc., Anchorage, AK, for ConoccoPhillips Alaska, Inc., Anchorage, AK. 38 pp.

Seigle, J.C., A.K. Prichard, and A.E. Gall. *In review*. Factors influencing harvest rates of Arctic cisco during the annual Colville River delta under-ice subsistence fishery. Polar Biology.

Sformo, T. L., B. Adams, J. C. Seigle, J. A. Ferguson, M. K. Purcell, R. Stimmelmayr, J. H. Welch, L. M. Ellis, J. C. Leppi, and J. C. George. 2017. Observations and first reports of saprolegniosis in Aanaakłiq, broad whitefish (*Coregonus nasus*), from the Colville River near Nuiqsut, Alaska. Polar Science 14: 78–82.

Van den Berg, A. H., D. Mclaggan, J. Dieguez-Uribeondo, and P. van West. 2013. The impact of the water moulds *Saprolegnia diclina* and *Saprolegnia parasitica* on natural ecosystems and the aquaculture industry. Fungal Biology Reviews 27: 33–42.

Van West, P. 2006. *Saprolegnia parasitica*, an oomycete pathogen with a fishy appetite: new challenges for an old problem. Mycologist 20: 99–104.

Appendix A. Total fishing effort (adjusted net-days) recorded for the fall subsistence fishery for Arctic Cisco in 3 Niġliq Channel fishing areas and in the Main Channel fishing area, Colville River, Alaska, 2019.

Fisher Code	Fishing Area	Net	Net Code	Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net-days	Adjusted Net-days
21	Upper Niġliq	A	16 21A 1	100	3	10/23/2019	10/25/2019	2	3.3
31	Upper Niġliq	A	16 31A 1	80	3	10/19/2019	11/1/2019	13	17.3
31	Upper Niġliq	B	16 31B 1	60	3	10/19/2019	10/25/2019	6	6.0
31	Upper Niġliq	B	16 31B 2	60	3	10/25/2019	11/1/2019	7	7.0
42	Upper Niġliq	A	16 42A 1	60	3	10/19/2019	10/30/2019	11	11.0
55	Upper Niġliq	A	16 55A 1	100	3	10/21/2019	11/9/2019	19	31.7
56	Upper Niġliq	A	16 56A 1	80	3	10/19/2019	10/29/2019	10	13.3
56	Upper Niġliq	B	16 56B 1	80	3	11/2/2019	11/16/2019	14	18.7
65	Upper Niġliq	A	16 65A 1	60	3	11/3/2019	11/27/2019	24	24.0
65	Upper Niġliq	B	16 65B 1	60	3	11/3/2019	11/27/2019	24	24.0
70	Niġliq Delta	A	16 70A 1	100	3	10/23/2019	10/28/2019	5	8.3
70	Niġliq Delta	A	16 70A 2	100	3	11/5/2019	11/15/2019	10	16.7
72	Niġliq Delta	A	16 72A 1	60	3	10/25/2019	11/3/2019	9	9.0
72	Niġliq Delta	A	16 72A 2	60	3	11/9/2019	11/14/2019	5	5.0
72	Niġliq Delta	B	16 72B 1	80	3	10/26/2019	11/14/2019	19	25.3
72	Niġliq Delta	C	16 72C 1	100	3	10/26/2019	11/27/2019	32	53.3
74	Niġliq Delta	A	16 74A 1	100	3	10/24/2019	10/27/2019	3	5.0
74	Niġliq Delta	A	16 74A 2	100	3	11/5/2019	11/9/2019	4	6.7
74	Niġliq Delta	A	16 74A 3	100	3	11/18/2019	11/27/2019	9	15.0
74	Niġliq Delta	B	16 74B 1	100	3	10/24/2019	10/27/2019	3	5.0
74	Niġliq Delta	B	16 74B 2	100	3	11/5/2019	11/9/2019	4	6.7
74	Niġliq Delta	B	16 74B 3	100	3	11/18/2019	11/27/2019	9	15.0
77	Upper Niġliq	A	16 77A 1	60	3	10/19/2019	12/15/2019	57	57.0
77	Upper Niġliq	B	16 77B 1	60	3	10/23/2019	12/15/2019	53	53.0

Appendix A. Continued.

Fisher Code	Fishing Area	Net	Net Code	Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net-days	Adjusted Net-days
82	Niġliq Delta	A	16 82A 1	100	3	10/24/2019	10/30/2019	6	10.0
82	Niġliq Delta	A	16 82A 2	100	3	11/3/2019	11/7/2019	4	6.7
82	Niġliq Delta	A	16 82A 3	100	3	11/7/2019	11/27/2019	20	33.3
82	Niġliq Delta	B	16 82B 1	80	3	10/24/2019	10/30/2019	6	8.0
82	Niġliq Delta	B	16 82B 2	80	3	11/3/2019	11/27/2019	24	32.0
87	Niġliq Delta	A	16 87A 1	80	3	10/24/2019	10/30/2019	6	8.0
87	Niġliq Delta	A	16 87A 2	80	3	11/12/2019	11/27/2019	15	20.0
87	Niġliq Delta	B	16 87B 1	100	3	10/24/2019	10/30/2019	6	10.0
87	Niġliq Delta	C	16 87C 1	80	3	11/18/2019	11/27/2019	9	12.0
91	Upper Niġliq	A	16 91A 1	80	3	10/20/2019	10/28/2019	8	10.7
91	Upper Niġliq	A	16 91A 2	80	3	11/1/2019	11/17/2019	16	21.3
91	Niġliq Delta	B	16 91B 1	100	3.25	11/6/2019	11/17/2019	11	18.3
93	Upper Niġliq	A	16 93A 1	90	3.5	10/19/2019	10/27/2019	8	12.0
93	Upper Niġliq	A	16 93A 2	90	3.5	11/1/2019	11/15/2019	14	21.0
93	Nanuq	B	16 93B 1	60	3.25	10/22/2019	10/27/2019	5	5.0
93	Nanuq	B	16 93B 2	60	3.25	11/1/2019	11/2/2019	1	1.0
93	Nanuq	B	16 93B 3	60	3.25	11/2/2019	11/5/2019	3	3.0
93	Nanuq	B	16 93B 4	60	3.25	11/5/2019	11/11/2019	6	6.0
95	Upper Niġliq	A	16 95A 1	60	3	10/19/2019	10/30/2019	11	11.0
101	Upper Niġliq	A	16 101A 1	40	3.5	10/29/2019	11/27/2019	29	19.3
102	Upper Niġliq	A	16 102A 1	100	4.5	10/19/2019	10/23/2019	4	6.7
107	Upper Niġliq	A	16 107A 1	60	3	10/19/2019	10/24/2019	5	5.0
107	Nanuq	A	16 107A 2	60	3	10/24/2019	10/27/2019	3	3.0
107	Nanuq	A	16 107A 3	60	3	11/1/2019	11/5/2019	4	4.0

Appendix A. Continued.

Fisher Code	Fishing Area	Net	Net Code	Length (m)	Stretched Mesh (cm)	Start Date	End Date	Net-days	Adjusted Net-days
107	Nanuq	A	16 107A 4	60	3	11/5/2019	11/11/2019	6	6.0
108	Upper Niġliq	A	16 108A 1	60	3	11/17/2019	11/27/2019	10	10.0
110	Niġliq Delta	A	16 32A 1	100	2.5	10/26/2019	11/3/2019	8	13.3
110	Niġliq Delta	A	16 32A 2	100	2.5	11/5/2019	11/14/2019	9	15.0
118	Upper Niġliq	A	16 118A 1	100	3	10/19/2019	10/27/2019	8	13.3
118	Upper Niġliq	B	16 118B 1	120	3	10/19/2019	11/8/2019	20	40.0
119	Main Channel	A	16 119A 1	80	3	10/25/2019	10/26/2019	1	1.3
120	Upper Niġliq	A	16 120A 1	80	3.5	10/27/2019	11/8/2019	12	16.0
213	Nanuq	A	16 213A 1	80	3	11/3/2019	11/17/2019	14	18.7
213	Nanuq	B	16 213B 1	80	3.25	11/2/2019	11/17/2019	15	20.0
214	Niġliq Delta	A	16 214A 1	100	3	11/5/2019	11/14/2019	9	15.0
214	Niġliq Delta	B	16 214B 1	100	3	11/10/2019	11/14/2019	4	6.7
214	Nanuq	C	16 214C 1	60	3	11/10/2019	11/17/2019	7	7.0
214	Nanuq	D	16 214D 1	100	3	11/10/2019	11/17/2019	7	11.7
Total									918.6

Appendix B. Estimated harvest of Arctic Cisco from the Colville River delta commercial and subsistence fisheries, 1967–2019.

Year	Estimated commercial harvest[a]	Estimated subsistence harvest	Estimated total harvest
1967	21,904		21,904
1968	41,948		41,948
1969	19,593		19,593
1970	22,685		22,685
1971	41,312		41,312
1972	37,101		37,101
1973	71,575		71,575
1974	44,937		44,937
1975	30,953		30,953
1976	31,659		31,659
1977	31,796		31,796
1978	18,058		18,058
1979	9,268		9,268
1980	14,753		14,753
1981	38,176		38,176
1982	15,975		15,975
1983	18,162		18,162
1984	27,686		27,686
1985[b]	23,678	46,681	70,359
1986[b]	29,595	33,253	62,848
1987[b]	27,948	20,847	48,795
1988[b]	10,470	6,098	16,568
1989[b]	24,802	12,892	37,694
1990[b]	21,772	11,224	32,996
1991[b]	23,731	8,269	32,000
1992[b]	22,754	45,401	68,155
1993[b]	31,310	46,994	78,304
1994[b]	8,958	10,956	19,914
1995[b]	14,311	8,573	22,884
1996[b]	21,817	41,205	63,022
1997[b]	16,990	33,274	50,264
1998[b]	8,752	13,559	22,311
1999[b]	8,872	–	8,872
2000[b]	2,619	9,956	12,575
2001[b]	1,924	3,935	5,859
2002[b]	3,935	7,533	11,468
2003[b]	–	23,369	23,369
2004[b]	–	40,605	40,605
2005[b, c]	–	–	–

Appendix B. Continued.

Year	Estimated commercial harvest[a]	Estimated subsistence harvest	Estimated total harvest
2006[c, d]	–	–	–
2007[e]	–	42,226	42,226
2008[e]	–	17,222	17,222
2009[e]	–	22,792	22,792
2010[e]	–	23,837	23,837
2011[e]	–	43,276	43,276
2012[e]	–	22,728	22,728
2013[e]	–	22,240	22,240
2014[e]	–	33,240	33,240
2015[e]	–	52,107	52,107
2016[e]	–	26,577	26,577
2017[e]	–	33,247	33,247
2018[e]	–	48,056	48,056
2019[e]	–	17,544	17,544
Average	23,425	25,929	32,774

[a] Commercial harvest numbers provided by J. Helmericks, 1967–2002. No commercial harvest after 2002.
[b] MJM monitoring.
[c] No harvest estimates calculated.
[d] LGL monitoring.
[e] ABR monitoring.