Fairbanks Fishery Resources Progress Report Number FY86-1

FISHERIES INVESTIGATIONS IN BEAUFORT LAGOON, ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA, 1985

David W. Wiswar
Robin L. West

Key Words: Arctic char, Arctic cisco, movements, distribution, Beaufort Lagoon, Arctic National Wildlife Refuge

Fairbanks Fishery Resources Station
U.S. Fish and Wildlife Service
101 12th Avenue, Box 20, Rm. 110
Fairbanks, Alaska 99701

9 May 1986

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Fisheries invesitgations in Beaufort Lagoon, Arctic National Wildlife Refuge, Alaska, 1985.

David W. Wiswar and Robin L. West. U.S. Fish and Wildlife Service, Fishery Resources, Fairbanks, Alaska.

Abstract: Arctic char (Salvelinus alpinus), Arctic cisco (Coregonus autumnalis), fourhorn sculpin (Myoxocephalus quadricornis) and Arctic flounder (Liopsetta glacialis) were the major fish species captured by fyke nets in Beaufort Lagoon, Alaska from July 7 to August 9, 1985.

Arctic char ranged from 68 to 817 mm fork length and exhibited a bi-modal length frequency distribution. Juvenile char in the 151-200 mm length group comprised 19% of those captured and measured. These were mostly age 3 year smolts. Adult char between 400 and 500 mm comprised 30% of those captured and measured. These lengths correspond to ages 6 to 9 years. Eighty percent of the Arctic char were captured at the inside barrier island station. Most of these were moving in a westerly direction. Two periods of char abundance were observed. The first occurred in early July; 92% of the char were $\geq$ 350 mm. The second peak occurred after July 30. Forty-five percent of these char were less than 350 mm fork length. In the 1985 sampling period 1,262 Arctic char were tagged with Floy anchor tags. Recapture information is presented.

Arctic cisco ranged from 90 to 493 mm in length. Most (72%) were in the length group 351 to 400 mm; which corresponds to ages 7-13 years. Ninety percent of the Arctic cisco were captured at the inside barrier island station and 70% of these fish were moving in a westerly direction. Peak movement of cisco in Beaufort Lagoon occurred in early and mid-July. Arctic cisco captured in Beaufort Lagoon were longer than those reported from the Prudhoe Bay area.

INTRODUCTION

Fisheries investigations were conducted in Beaufort Lagoon, Arctic National Wildlife Refuge (ANWR) to determine use by anadromous and marine species. The objectives were to determine relative abundance, distribution, movements, and age and growth characteristics of the major fish species. The 1985 study was conducted to supplement and assist the interpretation of data collected from the area during the 1984 field season (West and Wiswar 1985). The major fish species utilizing the lagoon include Arctic char (Salvelinus alpinus), Arctic cisco (Coregonus autumnalis), fourhorn sculpin (Myoxocephalus quadricornis), and Arctic flounder (Liopsetta glacialis).

These investigations are part of a series of fish and wildlife studies provided for by the Alaska National Interest Lands Conservation Act (ANILCA) in which a comprehensive and continuing inventory and assessment of the fish and wildlife resources of the coastal plain was mandated.

STUDY AREA

Beaufort Lagoon (69°52'N, 142°15'W) is located approximately 60 km southwest of Barter Island (Fig. 1). The lagoon borders the Arctic coastal plain and is separated from the Beaufort Sea by a long, narrow barrier island. The Aichilik and Egaksrak Rivers are major rivers flowing into the lagoon. Traditional names for smaller embayments within Beaufort Lagoon are Nuvagapak Lagoon on the west side of the Aichilik River delta and Egaksrak Lagoon on the east. All sampling was confined to Nuvagapak Lagoon.

The nearshore waters are influenced by a northwesterly longshore current and wind patterns associated with storms (Truett 1981). The entrances to Beaufort Lagoon are near Angun Point and the Aichilik River delta. Beaufort Lagoon is described as a limited exchange lagoon (Hachmeister and Vinelli 1984) where the flow of nearshore waters is restricted from entering the lagoon by the barrier islands.

Most of Beaufort Lagoon is covered with fast ice during the winter months. The open water season usually runs from late June until September or October. In June, snow melt runoff enters the lagoon from the rivers and accelerates breakup in the lagoon. Waters inside the lagoon tend to be warmer and less saline than offshore waters during the summer months due to the freshwater intrusions being retained within the lagoon by the barrier islands.

The width of Beaufort Lagoon varies from 0.3 km. to approximately 2.0 km. Water depths are up to 3.6 meters over an organic-mud substrate. The shoreline of the barrier island is comprised of sand and small-size gravel.

METHODS

Sampling was conducted from July 7 to August 9, 1985 at 3 of the locations (Fig. 2). The stations were also sampled during the 1984 investigation (West and Wiswar 1985) and included three habitat types: nearshore mainland (Sta. 2); mid-lagoon (Sta. 3); and inside barrier island (Sta. 4). At stations 2

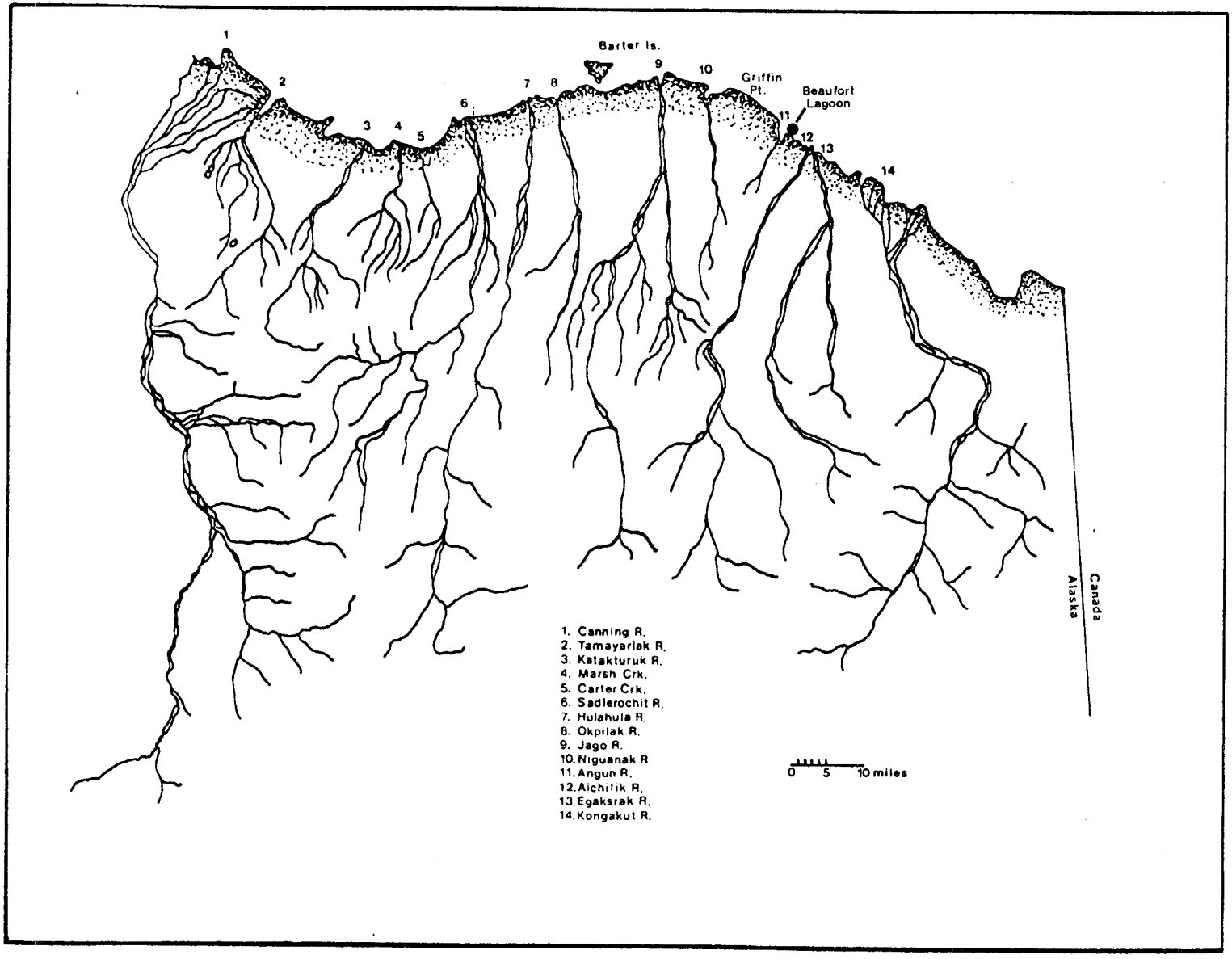

Figure 1. Major rivers on the north slope in the Arctic National Wildlife Refuge, Alaska.

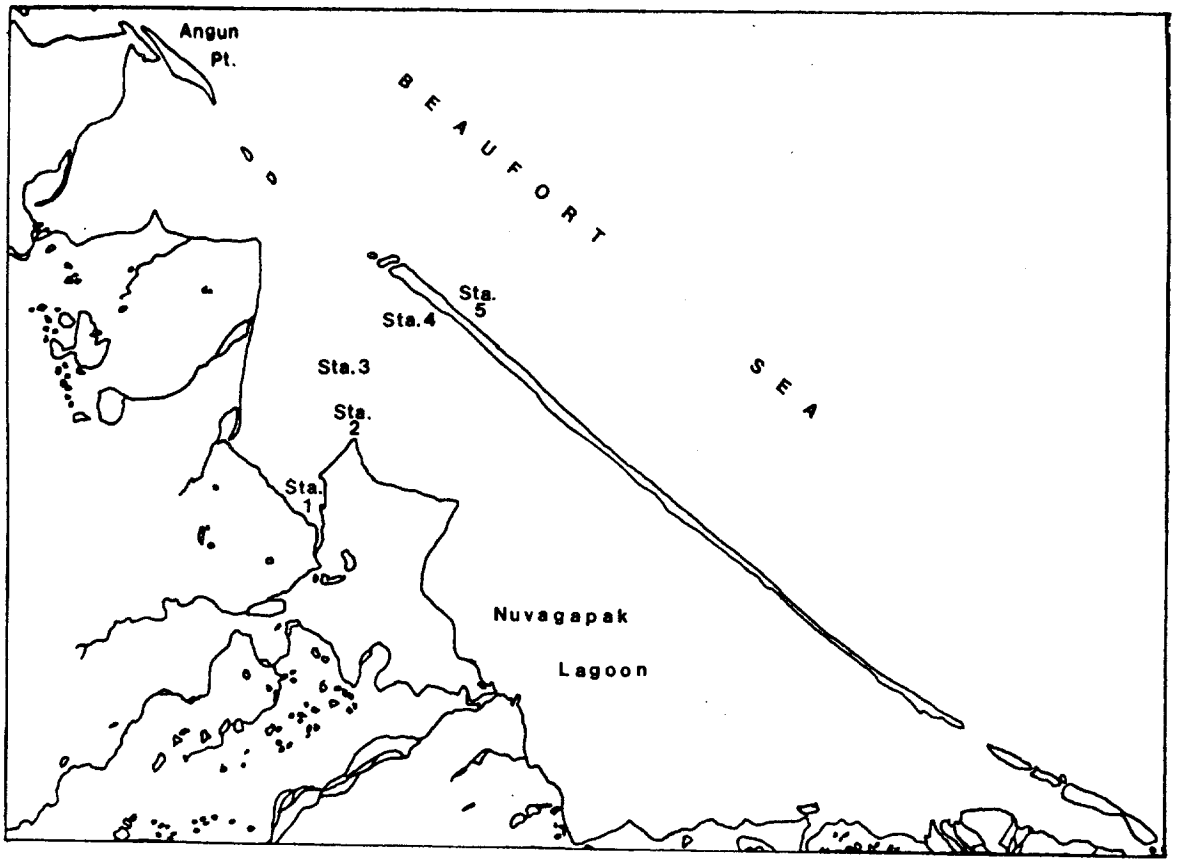

Figure 2. Sampling stations, Beaufort Lagoon, Alaska, 1985. Stations 2 and 4 were fyke net stations operated July 7 to August 9; station 3 was an experimental gillnet site fished July 22 - 29, 1985.

and 4, dual trap, directional fyke nets with 61 m (200 ft.) leads and 15.25 m (50ft.) wings were employed. The leads extended perpendicularly from shore and the traps set in water less than 1.2 m (4 ft.) deep. A 38.1 x 1.8 m (125 ft. X 6 ft.) monofilament experimental gill net with five panels of 12.7, 25.4, 38.1, 50.8, and 63.5 mm (0.5, 1.0, 1.5, 2.0 and 2.5 inch) bar mesh was used at Station 3. The net was weighted and set near the bottom of the 3.6 m deep water column. The gill net station was operated from July 22-29 only.

Access to Beaufort Lagoon was by chartered fixed-wing aircraft from Barter Island. A Mark III Zodiak inflatable raft with a 15 hp outboard motor was used to set and check nets. Nets were checked once daily except during extremely poor weather conditions.

Fork lengths of fish were measured to the nearest millimeter. Weights of fish were estimated to the nearest gram using Pesola spring scales with ranges of 0-250 g, 0-500 g and 0-2000 g. A coefficient of condition (K) was calculated using the equation:

$$K = \frac{\text{weight (g)} \times 10^5}{\text{length (mm)} \times 10^3}$$

Numbered Floy FD-67 anchor tags were implanted in Arctic char and Arctic cisco to aid in determining fish movements.

Arctic char ages were determined from otoliths. Otoliths were cleaned in a solution of Photo-flo and read under reflected light or ground on 400 grit sandpaper and read under transmitted light with a Bauch and Lomb dissecting scope at 3-7 power. Arctic cisco scales were mounted on gummed cards and pressed against acetate with a hydraulic press to form impressions. Impressions were magnified (40 and 70x) with a Bell and Howell microfiche reader to identify annuli. Arctic cisco otoliths were broken, burned and coated with cedar wood oil. Annuli were counted under 10-70x magnificaton with a Bausch and Lomb dissecting microscope.

Water temperature was measured with a standard centigrade stick thermometer. Salinity was measured with a YSI model 33 T-S-C meter.

RESULTS and DISCUSSION

Nine species of fish were caught in Beaufort Lagoon (Table 1). Four species were anadromous: Arctic char, Arctic cisco, least cisco and rainbow smelt. The four marine species found were fourhorn sculpin, Arctic flounder, saffron cod and an unidentified species of eelpout. Arctic grayling was the only freshwater species caught.

Arctic char were the most numerous fish caught, comprising 43% of the total catch and 83% of the anadromous species caught. Fourhorn sculpin ranked second in the catch (37%) and comprised 77% of the marine species caught. These were followed by Arctic flounder and Arctic cisco at 10% and 8% of the total catch, respectively. Arctic char and fourhorn sculpin were also the most numerous fish caught in Beaufort Lagoon in 1984 (West and Wiswar 1985).

Table 1. Summary of fish species and numbers caught, Beaufort Lagoon, July and August 1985.

Species	Station 2 Fyke Net	Station 3 Gill Net	Station 4 Fyke Net	Total
Arctic char (Salvelinus alpinus)	433	1	1727	2161
Arctic cisco (Coregonus autumnalis	41	26	341	408
Fourhorn sculpin (Myoxocephalus quadricornis)	1487	4	365	1856
Arctic flounder (Liopsetta glacialis)	453	0	68	521
Least cisco (Coregonus sardinella)	18	0	2	20
Saffron cod (Eleginus gracialis)	25	0	4	29
Eelpout (Lycodes sp.)	0	0	7	7
Rainbow smelt (Osmerus mordax)	0	0	1	1
Arctic grayling (Thymallus arcticus)	1	0	7	8
	2458	31	2522	5011

Griffiths (1983) reported that Arctic char and Arctic cisco comprised only 7 and 8 % of the total fish caught in Beaufort Lagoon in 1982. Fourhorn sculpin and Arctic flounder were the most numerous fish species caught in Beaufort Lagoon that year representing 57 and 27 percent, respectively, of the total number. This study was conducted only from July 25 to August 5, 1982 and sampling stations differed from the 1984 and 1985 studies.

Arctic char

Eighty percent of the Arctic char captured in Beaufort Lagoon were taken at the inside barrier island fyke net station (Sta. 4) (Fig. 2). Arctic char moving in a westerly direction at this station accounted for 68% of the total catch. Arctic char moving easterly at the nearshore mainland fyke net station (Sta. 2) had the second highest capture rate with 15% of the total char caught. Only 1 char was captured at the mid-lagoon station (Sta. 3) after 167.5 hrs. of gill net fishing.

In 1984 the inside barrier island fyke net station accounted for 88% of the Arctic char captured utilizing the same location and methods (West and Wiswar 1985). The majority of those char (98%) were captured during July 24-30. The mid-lagoon station (Sta. 3) was fished for 44.5 hours during July 25-27, 1984 and 89.5 hours during August 20-24, 1984 capturing only one Arctic char.

A total of 1,262 Arctic char were tagged in Beaufort Lagoon in 1985; of those 29 (2.3%) were recaptured within the lagoon during the summer sampling period. In addition one char tagged in Beaufort Lagoon in 1984 was recaptured, two char tagged at Fish Hole #2 on the Hulahula River in 1983, and two char tagged by LGL near the Sagavanirktok River delta in 1982. Arctic char tagged at Beaufort Lagoon in 1985 were also recaptured by subsistence fishermen at Griffin Point (n=2) (Fig. 1) and Bernard Spit at Barter Island (n=3). A char tagged in Beaufort Lagoon in August 1984 was also recaptured off Bernard Spit in July 1985.

Based on recapture information use of the lagoon by char ranged from 1 to 33 days. This is assuming that those fish did not leave the lagoon between the time of tagging and recapture. The mean time was 6.7 days between initial tagging and recapture. Eight fish (28%) were recaptured 10 to 33 days after being tagged.

Twenty-one char tagged moving westerly at the inside barrier island station (Sta. 4) were recaptured within the lagoon. Of these, 13 (62%) were recaptured at the initial tagging site, 6 (29%) were recaptured while moving easterly at the same station, and 2 were recaptured at the nearshore mainland station (Sta. 2) 4 and 5 days later. One char tagged at Station 1 in 1984 was recaptured in 1985 at Station 2. The two stations are only 0.3 km apart.

Daily catch-per-unit-effort (CPUE) of Arctic char was highly variable over the sampling period. The mean CPUE for 3 day time periods at Station 4 was taken and plotted (Fig. 3). In general it appears that the peak movement occurred in early July and after July 30. The earlier peak was dominated by adult char with 92% of the catch being over 350 mm in length. The second peak was strongly influenced by immmature char, especially first year smolts. Forty-five percent of the catch during the second peak (July 30-Aug 1) were 350 mm in length or less. Twenty-two percent of the total were between 151 and 200 mm. Similar trends were also observed during the 1984 sampling at Beaufort Lagoon.

A storm on July 27 from the northwest blew the Sta. 4 trap down sometime early that day. It was not reset until the evening of July 29. Also, the Sta. 2 trap was not considered operating for a 33 hr. period for the same reason. There was no apparent correlation between char CPUE and salinity or water temperature.

The length of Arctic char captured in Beaufort Lagoon ranged from 68-817 mm and exhibited a bi-modal distribution. Juvenile char between 151-200 mm in length comprised approximately 19% of those captured and measured; adult Arctic char between 400-500 mm comprised 30% (Fig. 4).

Fish ages determined from otoliths ranged from 2 to over 15 years. The age-specific length, weight, condition and sex ratio is presented in Table 2. Juvenile Arctic char in the length class 151-200 mm correspond to 3 year old fish. Those char measuring between 401-500 mm correspond to year classes 6-9. Although there were no 6 year old char aged in the 1985 sample, they were included in this length group in 1984 (West and Wiswar 1985).

The largest annual increment in length, 149 mm, was between the ages 4 and 5. This may not characterize the population as a whole as the sample size was low.

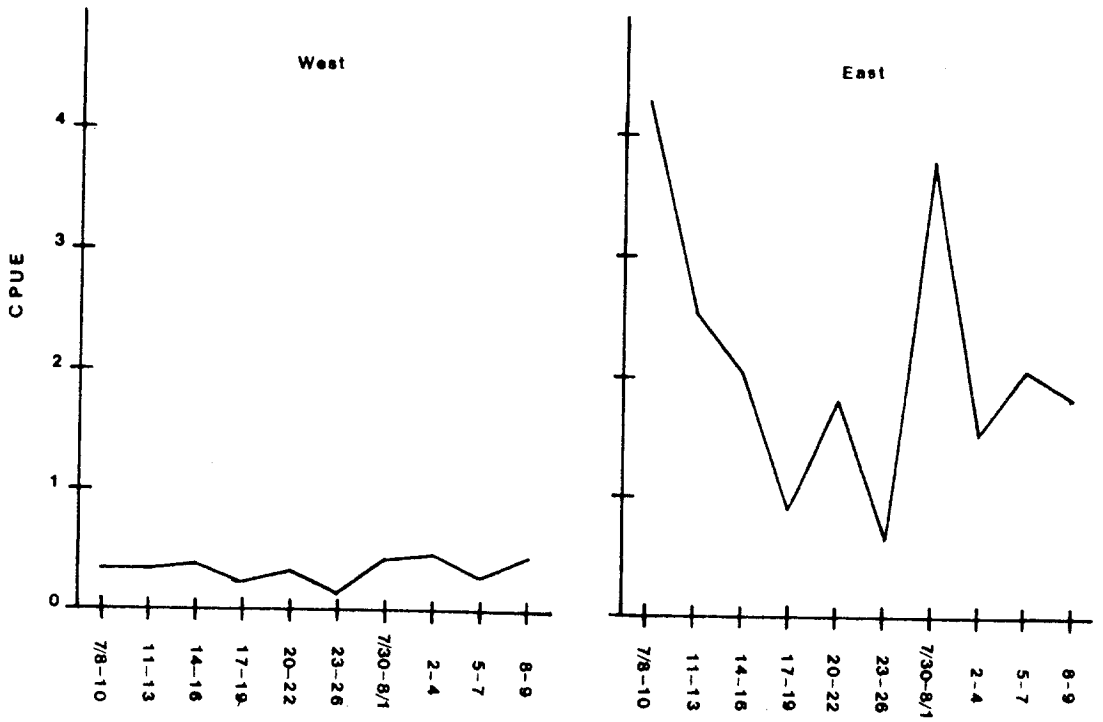

Figure 3. Catch rate of Arctic char at the inside barrier island fyke net station (Sta. 4), Beaufort Lagoon, Alaska, July and August 1985. CPUE = average number of fish caught per hour. West facing trap catches fish moving east, and vis-a-vis.

Table 2. Age-specific length, weight, and condition for Arctic char, Beaufort Lagoon, Alaska, July and August 1985. Age determined from otoliths.

Age	n	Fork Length (mm) Mean	Range	S.D.	Weight (g) Mean	Range	S.D.	Condition Factor K
2	3	110.2	103-117	7.1	10.8	7.8-12.8	2.6	0.77
3	5	189	156-211	20.2	52.2	28.1-71.8	17.2	0.79
4	1	221	---	---	89.5	---	---	0.83
5	3	370	366-373	3.6	354.6	343.5-373.6	16.7	0.70
6	-	---	---	---	---	---	---	----
7	3	475.3	469-481	6.0	706.3	563-854	145.5	0.66
8	1	506	---	---	1163	---	---	0.90
9	2	498	458-538	56.6	1049	880-1218	239.0	0.85
10	4	596.3	567-622	24.6	1882	1628-2238	294.7	0.88
11	3	578	549-610	30.6	1672.7	1318-2063	373.	0.86
12	-	---	---	---	---	---	---	----
13	-	---	---	---	---	---	---	----
14	-	---	---	---	---	---	---	----
15	1	817	---	---	4820	---	---	0.88
	26							

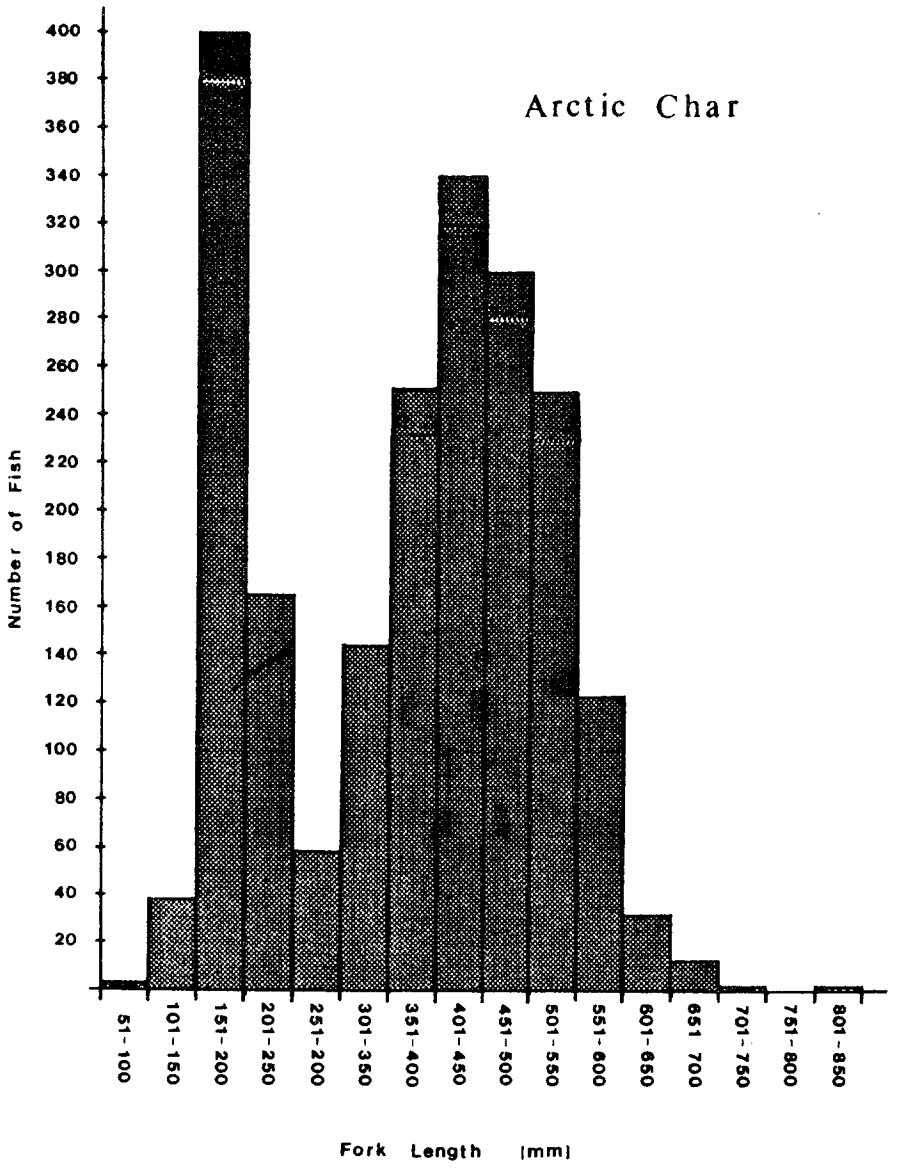

Figure 4. Length frequencies of 2,122 Arctic char captured with fyke nets, Beaufort Lagoon, Alaska, July and August 1985.

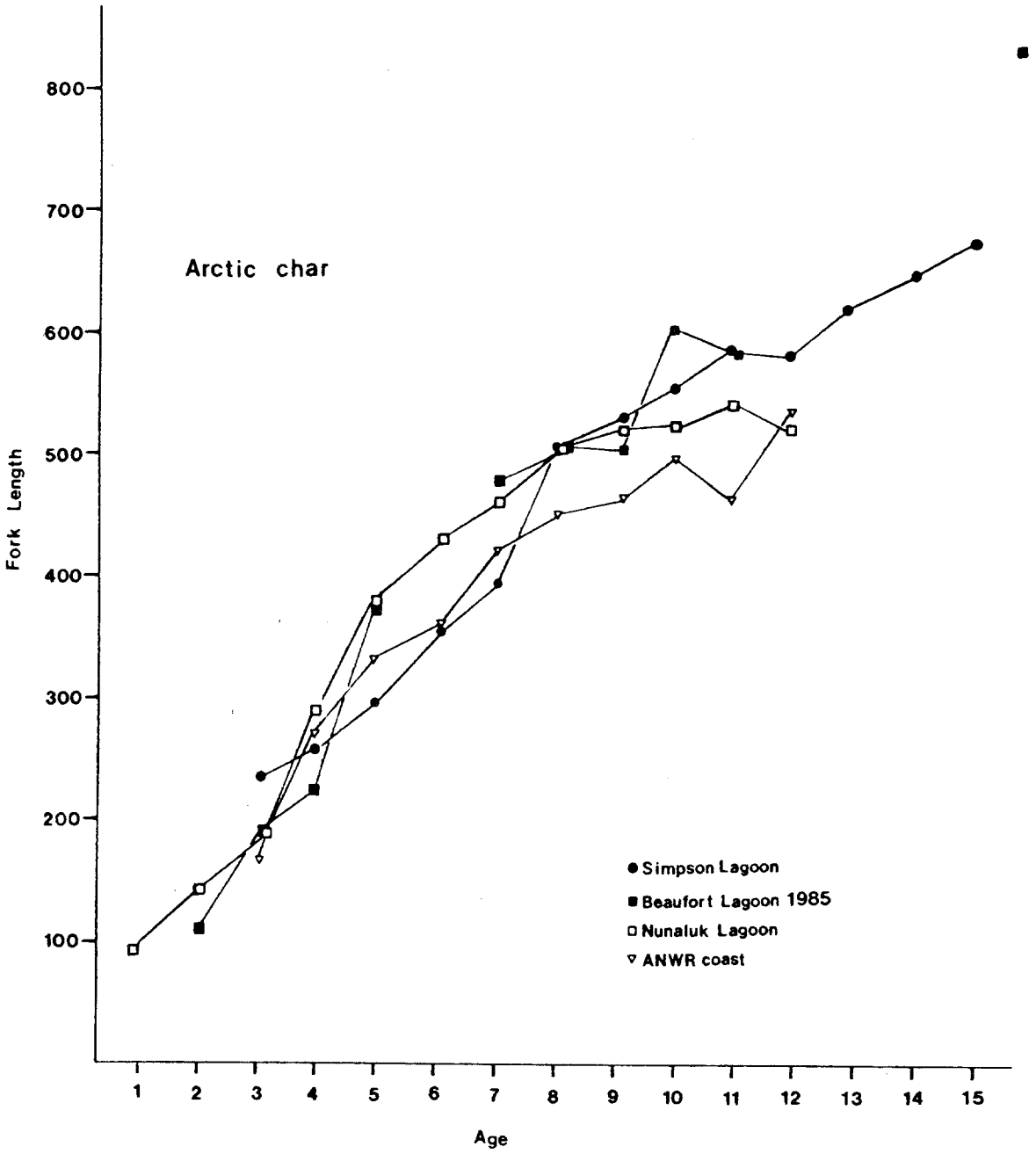

Figure 5. Comparison of age-specific length for Arctic char from coastal areas of the Beaufort Sea. Beaufort Lagoon data from this report; Simpson Lagoon - Craig and Haldorson 1981; Nunaluk Lagoon - Griffiths et al. 1975; ANWR coast - Roguski and Komarek 1972.

The dominant length groups and corresponding age classes were similar in Beaufort Lagoon in 1984 and 1985. In other studies across the Beaufort Sea coastline (Yoshihara 1973, Griffiths et al. 1975, Griffiths et al. 1977) the dominant length classes were also in the 400-500 mm range; however, in Simpson Lagoon, Craig and Haldorson (1981) found Arctic char over 500 mm to dominate the gill net captures of adult char. The overall age-specific lengths of char from Beaufort Lagoon fall within the range reported for ANWR coastal lagoons (Roguski and Komarek 1972), the Sagavanirktok River delta (Yoshihara 1972), Nunaluk Lagoon, Y.T. (Griffiths et al. 1975) and Simpson Lagoon (Craig and Haldorson 1981) (Fig. 5).

Arctic cisco

Ninety percent of the Arctic cisco captured by fyke net in Beaufort Lagoon were from the inside barrier island station (Sta. 4). The east facing trap captured 70% of the total and the west facing trap collected 20% indicating primarily a westerly movement in that area of the lagoon. Although the catch from Station 2 was low by comparison, 95% of the juvenile Arctic cisco (n=18) were collected here. In 1984, the fyke net results where comparable with this years results (West and Wiswar 1985). Station 4 accounted for 85% of the Arctic cisco with the east facing trap capturing about 80% of the total.

At the mid-lagoon gill net station (Sta. 3) 26 Arctic cisco were taken during a 167.5 hour effort (mean CPUE=0.15). The mid-lagoon station was fished from July 22-29, 1985. The catch results from the gill net station at mid-lagoon were higher in July 1984 with a mean CPUE of 0.70 Arctic cisco per hour between July 25 and 27.

A total of 320 Arctic cisco were tagged in Beaufort Lagoon in 1985. No recaptures were made within the lagoon. One recapture was reported from the lower reaches of the Colville River in mid-October 1985 (Larry Moulton, pers. comm. 1985).

Daily CPUE of Arctic cisco was variable. Using the data from Station 4 fyke net, peak movements appeared to be between early and mid-July (Fig. 6). Similar to the data shown for Arctic char at the east trap of Sta. 4, a second peak occurred after July 30. In 1984, the highest CPUE for Arctic cisco at this site occurred on July 28.

At the nearshore mainland station (Sta. 2), Arctic cisco were captured moving in a westerly direction on only 2 (6%) of the 32 days the trap was fishing and moving in an easterly direction on 10 days (31%).

The length of Arctic cisco captured in Beaufort Lagoon ranged from 90-493 mm. Seventy-two percent of the Arctic cisco measured (n=378) were in the 351-400 mm size class (Fig. 7). Juvenile cisco, those less than 170 mm, comprised only 5% of the sample. Arctic cisco from 170 to 325 mm were not caught.

Arctic cisco ages, determined from otoliths (n=52), ranged from 7 to 13 years and correspond to fork length measurements from 345 to 430 mm. Age-specific length data are presented in Table 3. The ages corresponding to the predominant length classes are 8, 9 and 10 (Fig. 7). Within these age classes, females comprised about 47% of the sample. Age estimates derived

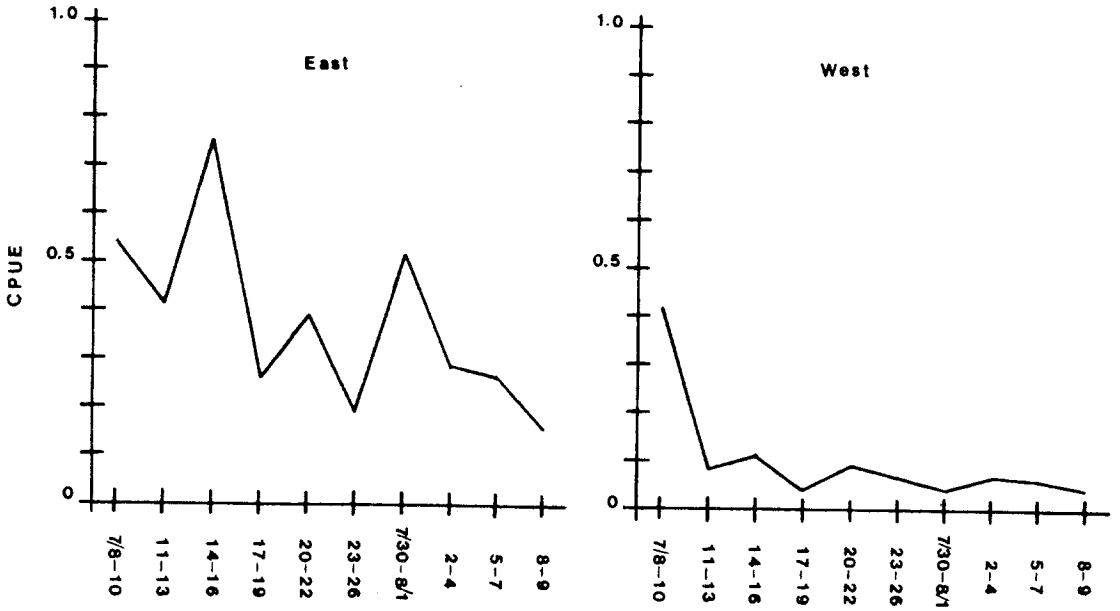

Figure 6. Catch rate of Arctic cisco at the inside barrier island fyke net station (Sta. 4), Beaufort Lagoon, Alaska, July and August 1985. CPUE = average number of Arctic cisco caught per hour. East facing trap captures fish moving in a westerly direction, and vis-a-vis.

from otoliths were compared with age estimates from scales. Otolith age estimates were an average of 1.7 years older than those estimates from scales (Corley 1985). Arctic cisco age information presented by West and Wiswar (1985) are based on scale readings. Otoliths from these samples (n=84) were later read and the results also demonstrated an average 1.7 year higher age estimate with otoliths compared to scales (Table 4).

The largest annual increment in length, 21.9 mm, was between ages 7 and 8. The growth increment between ages 9 and 10 showed a decrease rather than an increase probably because of slow growth and an inadequate sample size.

The predominant length group for Arctic cisco captured during 1984 ranged from 351-400 mm. These fish corresponded to age classes 7, 8 and 9 years.

Arctic cisco from Beaufort Lagoon collected in 1984 and 1985 were longer than those captured in Simpson Lagoon and the Colville River delta (Craig and Haldorson 1981), between Harrison Bay and Brownlow Point (Bendock 1979) and those from the Sagavanirktok River delta (Griffiths et al. 1983). For age classes 7 through 10, Beaufort Lagoon Arctic cisco were 14-32 mm longer than those from Simpson Lagoon in 1977 (Fig. 8).

Table 3. Age-specific length, weight, condition and sex ratio for Arctic cisco, Beaufort Lagoon, Alaska, July and August 1985. Ages determined from otoliths.

Age	n	Fork Length (mm) Mean	Range	S.D.	Weight (g) Mean	Range	S.D.	Condition Factor $\bar{K}$	Sex Ratio % Females
7	9	362.6	345-380	12.5	543.2	431-680	81.4	1.15	44
8	13	384.5	365-411	13.8	551.5	437-710	86.0	0.97	46
9	13	391.0	371-426	15.6	635.2	434-850	133.9	1.02	53
10	7	386.9	368-411	14.8	582.9	487-700	85.2	1.00	42
11	1	400.0	---	---	619.0	---	---	0.97	0
12	7	418.1	406-446	13.2	722.3	600-851	77.1	0.99	57
13	2	417.0	404-430	18.4	717.0	697-737	28.3	0.99	50
	52								

Table 4. Age-specific length, weight, condition and sex ratio for Arctic cisco, Beaufort Lagoon, Alaska, summer 1984. Ages determined from otoliths.

Age	n	Fork Length (mm) Mean	Range	S.D.	Mean Weight (grams) Mean	Range	S.D.	Condition Factor ($\bar{K}$)	Sex Ratio % Females
6	2	330.5	294-367	51.6	438.5	282-595	221.3	1.16	0
7	31	371.2	331-408	14.5	603.7	425-775	91.7	1.17	39
8	23	381.1	329-411	15.8	645.0	464-895	106.8	1.16	70
9	12	400.1	369-420	21.6	718.6	460-1120	168.2	1.11	67
10	10	404.4	364-438	25.1	739.5	530-995	168.0	1.11	60
11	4	412.0	401-432	13.8	850.0	690-1050	150.8	1.21	100
12	1	481.0	---	---	655.0	---	---	0.59	100
13	1	429.0	---	---	870.0	---	---	1.10	100
	84								

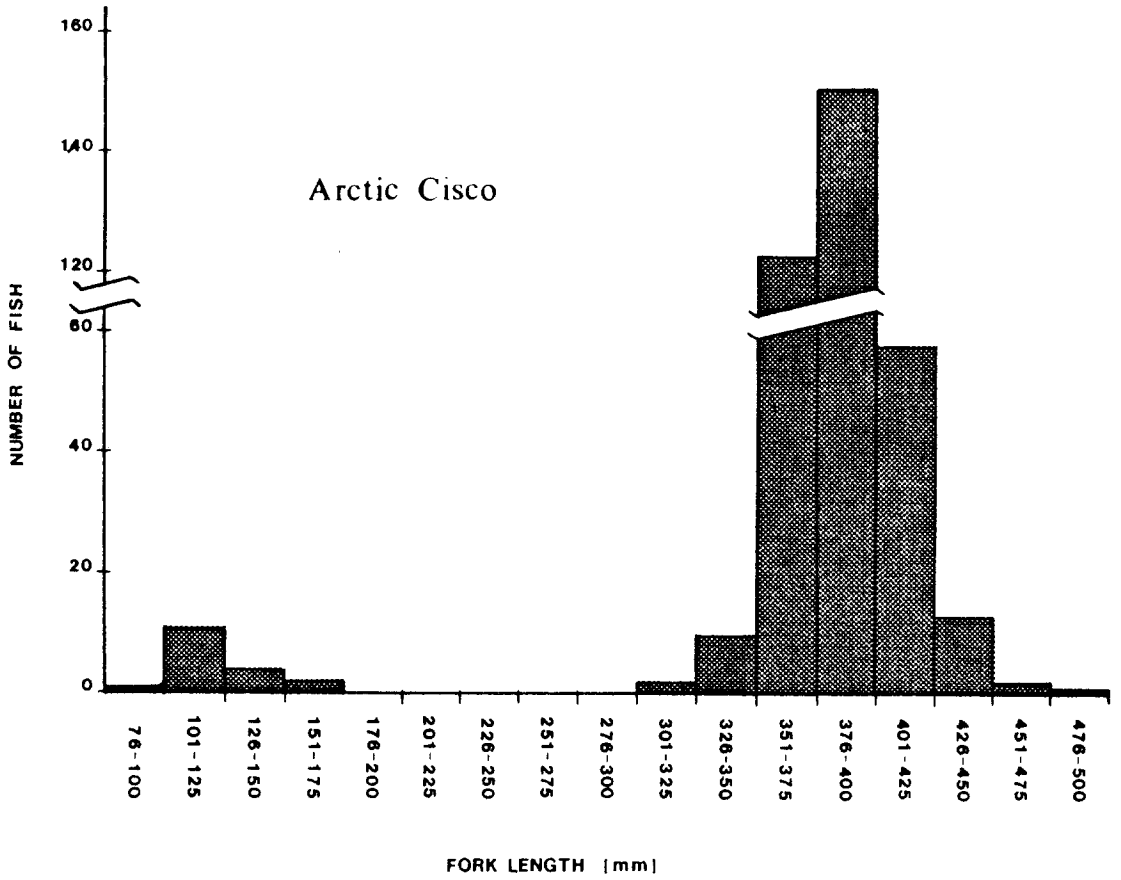

Figure 7. Length frequencies of 378 Arctic cisco captured in Beaufort Lagoon, Alaska, July and August 1985.

Fourhorn sculpin

Eighty percent of the fourhorn sculpin captured in Beaufort Lagoon were from the nearshore mainland station (Sta. 2). Differences between the counts of westerly and easterly moving sculpins were not as pronounced as those for anadromous species. Sculpins moving in a westerly direction at Station 2 accounted for about 50% of the total catch and those moving easterly 30%. At Station 4 the differences between westerly and easterly movements were slight, 9 and 11%, respectively. The catch from the mid-lagoon gill net station was only 4 sculpin. In 1984, Station 2 accounted for 67% of the sculpin caught by fyke net (West and Wiswar 1985).

The CPUE for fourhorn sculpin at Station 2 was variable on a day-to-day basis. The CPUE for approximate 3 day periods is shown in Figure 9. A period of peak movement was evident in early July, a second occurred after July 28, and a third peak was recorded around August 8 and 9. At Station 4, catch rates were low and fairly even up to about August 5 where an increase was seen followed by a decline.

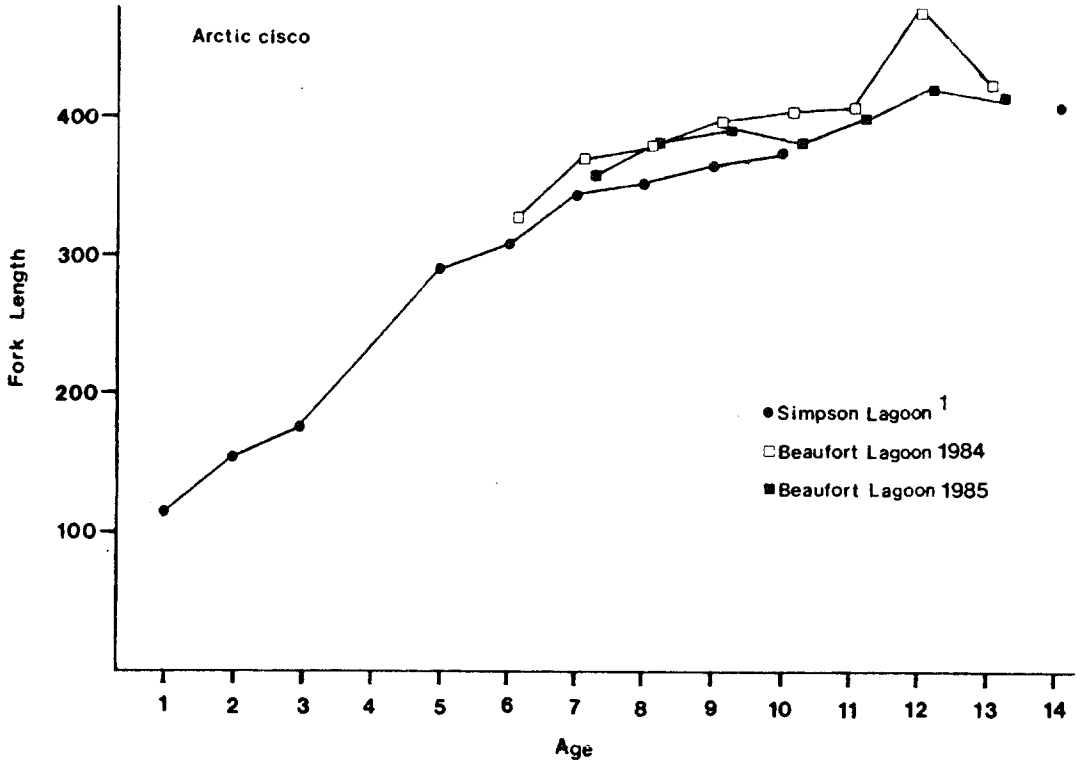

Figure 8. Comparison of age-specific length for Arctic cisco, Alaskan Beaufort Sea coast. 1 = Craig and Haldorson 1981.

The length of fourhorn sculpin observed in Beaufort Lagoon ranged from 16-285 mm. For those fish captured by fyke nets the range was 38-285 mm. By this capture method the dominant length group was 51-75 mm (Fig. 10). On July 24, 1985 young-of-the-year fourhorn sculpin measuring 16-19 mm were observed over a sandy substrate near Station 4.

Sculpin ages estimated from otoliths ranged from 3 to 8 years (Table 5). Lengths from those sculpins aged ranged from 118-267 mm. For those fish age 4 and over, females comprised about 65%. The female ratio of the older sculpins was also high in the 1984 sample.

From the age-specific length data collected in 1984 (West and Wiswar 1985) the 51-75 mm length group, dominating the 1985 catch, was probably comprised of fish primarily 1 and 2 years old. The largest annual growth increment observed for sculpins in 1985 was between ages 4 and 5. Fourhorn sculpin from Beaufort Lagoon in 1985 averaged about 20 mm longer than those from the same age classes in Simpson Lagoon, 1977 (Craig and Haldorson 1981), 35 mm longer than those from Kaktovik, Alaska (Griffith et al. 1977) and almost 80 mm longer than those from Nunaluk Lagoon, Yukon Territory (Griffith et al. 1975) (Fig. 11).

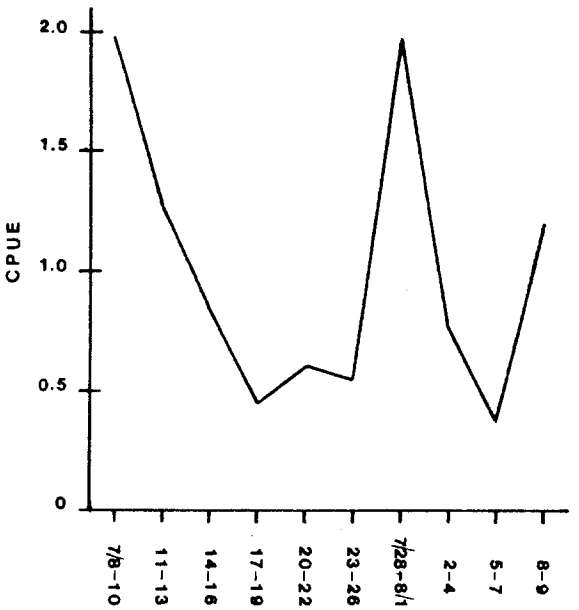

Figure 9. Catch rate of fourhorn sculpin at the nearshore mainland station (Sta. 2) Beaufort Lagoon, Alaska, July and August 1985. CPUE = average number of fourhorn sculpin caught per hour.

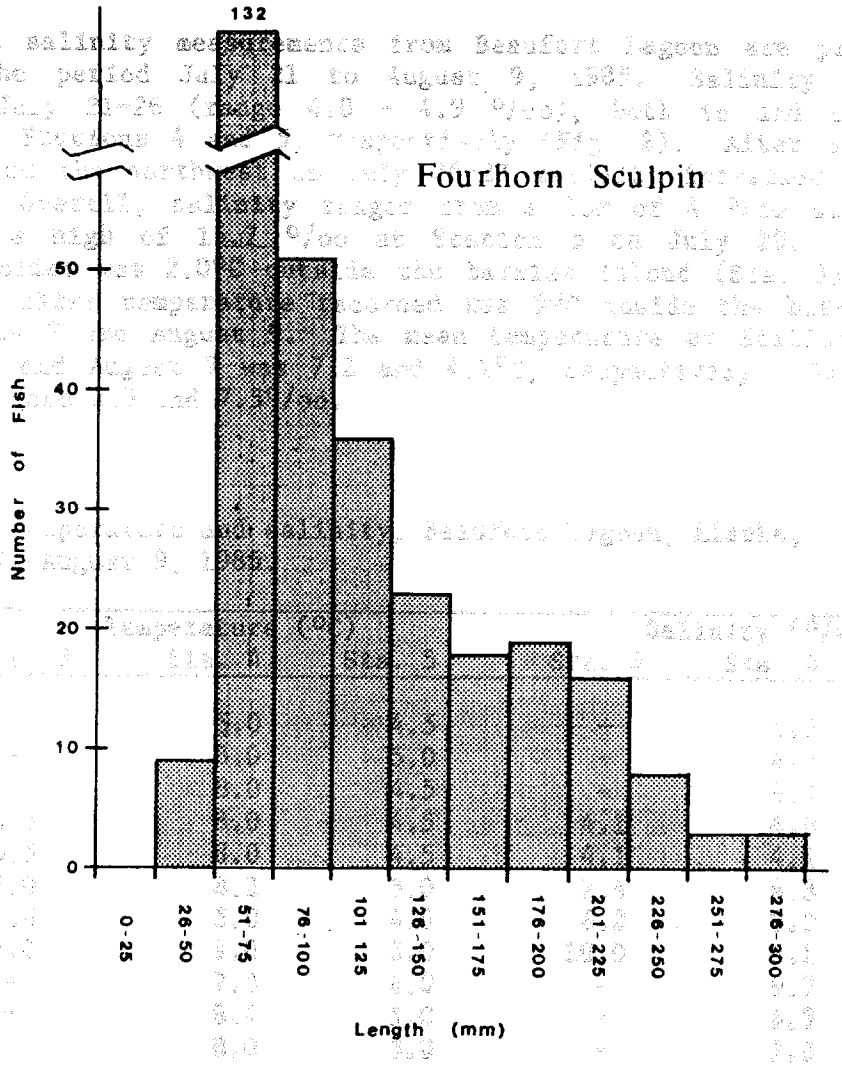

Figure 10. Length frequencies of 318 fourhorn sculpins captured by fyke nets in Beaufort Lagoon, Alaska, July and August 1985.

Table 5. Age-specific length and weight information for fourhorn sculpin, Beaufort Lagoon, Alaska, July and August 1985. Ages determined from otoliths.

Age	n	Fork Length (mm Mean	Range	S.D.	Weight (g) Mean	Range	S.D.
3	4	139.6	118-155	14.2	23.1	13.8-39.9	12.4
4	8	185.6	163-207	13.6	61.2	34.5-91.8	17.4
5	3	210.7	208-213	2.5	95.5	91.2-99.8	4.3
6	3	226.7	224-231	3.8	119.7	100.8-139.5	19.4
7	6	249.3	242-264	8.5	165.3	147.5-181.6	12.2
8	1	267.0	---	---	168.0	---	---
	25						

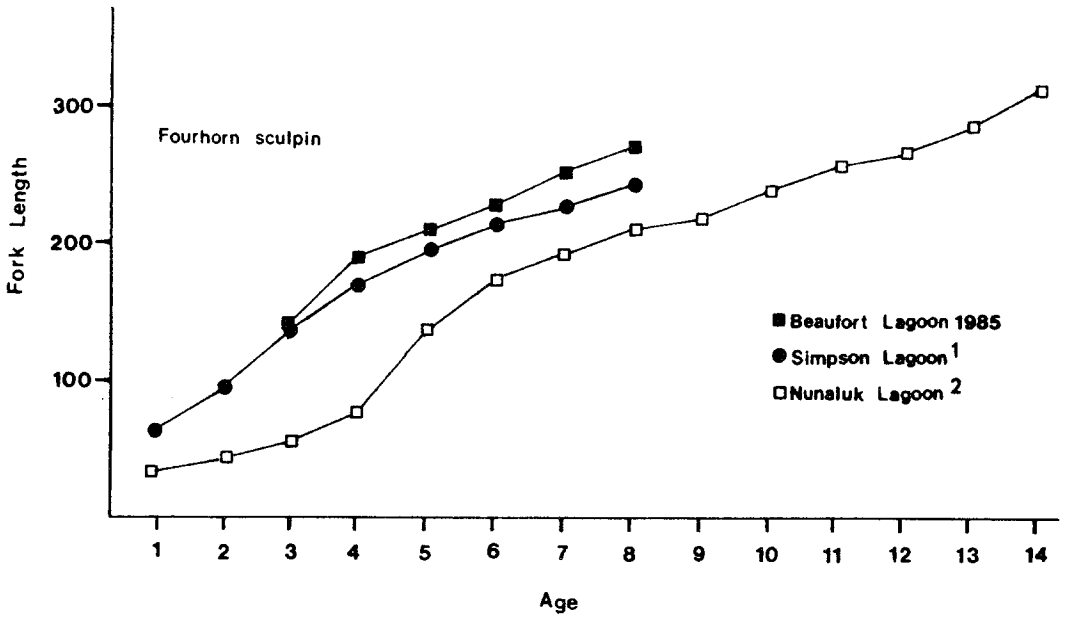

Figure 11. Comparison of age-specific length of fourhorn sculpins, Beaufort Sea coast. 1 = Craig and Haldorson 1981. 2 = Griffiths et al. 1975.

Water temperature and salinity

Temperature and salinity measurements from Beaufort Lagoon are presented in Table 6 for the period July 21 to August 9, 1985. Salinity was fairly constant from July 21-26 (range 4.0 - 4.9 °/oo), both in and outside the barrier island, Stations 4 and 5, respectively (Fig. 2). After a period of strong winds from the northwest on July 26-27 salinity increased and became more variable. Overall, salinity ranged from a low of 4 °/oo at Station 4 on July 25 to a high of 15.7 °/oo at Station 5 on July 29. The lowest temperature recorded was 2.0°C outside the barrier island (Sta. 5) on August 5. The highest water temperature recorded was 9°C inside the barrier island (Sta. 4) on July 2 and August 9. The mean temperature at Stations 4 and 5 between July 21 and August 9 was 7.2 and 4.2°C, respectively. Corresponding mean salinities were 6.5 and 7.5°/oo.

Table 6. Water temperature and salinity, Beaufort Lagoon, Alaska, July 21-August 9, 1985.

Sampling Date	Temperature (°C)			Salinity (°/oo)		
	Sta. 3	Sta. 4	Sta. 5	Sta. 3	Sta. 4	Sta. 5
7/21/85	-	5.0	4.5	-	4.5	4.6
7/22	-	8.0	5.0	-	4.2	4.6
7/23	-	8.0	4.5	-	4.1	4.3
7/24	8.5	8.0	4.5	4.1	4.0	4.3
7/25	8.5	8.0	4.5	4.1	4.1	4.5
7/26	7.0	8.2	3.0	7.4	4.3	4.9
7/27	9.0	5.0	4.0	6.2	8.9	11.1
7/28	7.0	9.0	3.0	10.0	5.1	15.7
7/29	-	7.0	6.0	-	9.7	11.3
7/30	-	8.4	5.0	-	6.3	10.6
7/31		8.0	3.0	-	7.0	6.5
8/1	-	8.5	4.0	-	6.2	7.0
8/2	-	8.5	4.0	-	6.4	7.1
8/3	-	-	-	-	6.9	6.5
8/4	-	4.5	4.0	-	8.2	8.2
8/5	-	4.5	2.0	-	7.5	7.0
8/6	-	5.5	3.0	-	8.4	6.8
8/7	-	6.5	4.5	-	8.0	7.7
8/8	-	7.0	5.0	-	7.9	8.2
8/9	-	9.0	8.0	-	9.0	9.0

CONCLUSION

Arctic char and Arctic cisco were captured primarily along the lagoon side of the barrier island of Beaufort Lagoon in 1984 and 1985. The utilization of this habitat type by these species has also been reported in Simpson Lagoon (Craig and Haldorson 1981).

Utilization of the mid-lagoon by Arctic char is considered to be low based on captures at Station 3. A comparison of CPUE for this station with the inside barrier island or nearshore mainland is difficult due to different capture techniques (variable mesh gill net vs. fyke net); however, a comparison with Station 1 in 1984 (a gill net located near the mainland shoreline) demonstrates a higher CPUE at that station. Overall, only 2 char were caught in 1984 and 1985 with a combined effort of 301.5 hours fishing at the mid-lagoon (Sta. 3) sample site. Arctic cisco showed higher use of the mid-lagoon area than Arctic char for both years based on CPUE of gill net captures. Arctic cisco showed a preference towards the mid-lagoon over the nearshore station (Sta. 1) in July 1984. In 1984, CPUE for Arctic cisco was higher at all stations in July than in August.

The small number of tagged Arctic char recaptured at Beaufort Lagoon makes conclusions about their movement speculative. Two char recaptured at Beaufort Lagoon in 1985 were originally tagged near the Sagavanirktok River delta in 1983. These fish may be from that river system, or could have been Canning River or Hulahula River fish. Tagged Arctic char from the Canning and Huluhula Rivers have been recovered form the Prudhoe Bay area. As no Arctic char tagged in the Canning River [554 Arctic char tagged in summer 1981 and 1982 (Smith and Glesne 1983)] have been recaptured east of that drainage it appears more likely that these were Hulahula River char. Based on recaptures in Beaufort Lagoon and tag returns from the subsistence fishery at Barter Island it is suspected that Arctic char utilizing Beaufort Lagoon are comprised primarily of char from the Hulahula River and rivers east of the lagoon.

The high incidence of Arctic char captured in the east facing trap of the fyke net stationed at the lagoon side of the barrier island (Sta. 4) indicates a strong westerly movement. Many of the fish may exit the lagoon between the west end of the island and Angun Point. Two char tagged on the same day at the same station at Beaufort Lagoon were recaptured at Bernard Spit off Barter Island a day apart suggesting that some schooling may occure. Arctic char moving in small schools of 10-20 fish have been reported by Griffiths et al. (1975) off Nunaluk Spit, Y.T.

Arctic char movements within the lagoon may consist of a counter-clockwise pattern close to the barrier island shoreline. The fish captured moving in a westerly direction at Station 4 inside the barrier island were the fish that comprised the greater number of recaptures. Most of these recaptures (62%) occurred at this same station (Sta. 4) one to 33 days later ($\bar{x}$ = 10.3 days) and 29% were recaptured at this station while moving east. Most recaptures at Station 4 West occurred within 2 days of initial capture. This may indicate that char once reaching the west end of the lagoon start moving east with little time milling at any one site. The furthest easterly movement may include a great distance along the barrier islands, or Arctic char may spend more time milling at the east end of the lagoon before continuing west again.

Arctic cisco appear to be widely dispersed within the lagoon, utilizing mid-lagoon areas as well as the nearshore areas; whereas, Arctic char were found to be concentrated in areas close to the barrier island or mainland shores. The period of peak movement through Beaufort Lagoon for Arctic cisco occured during the month of July. These Arctic cisco are probably stocks from the Mackenzie River, N.W.T. (Gallaway et al. 1983). The occurrence of larger size classes of Arctic cisco along the ANWR coastline (Roguski and Komarek 1972; West and Wiswar 1985; and this report) compared to the western Beaufort Sea may indicate that there is some stock separation during the summer along the coast and possibly these stocks overwinter in different locations as well. Of the 52 adult Arctic cisco examined in Beaufort Lagoon in 1985, none were going to spawn in the upcoming fall.

No tagged Arctic cisco were recaptured within the lagoon or reported by the subsistence fishery at Barter Island; however, one cisco was recaptured in the Colville River delta. There is still a large gap in the existing information on Arctic cisco distribution between Beaufort Lagoon and Prudhoe Bay. Even with the extensive sampling effort in Prudoe Bay since the early 1980's, the larger size cisco have not been reported there with the frequency they have along the ANWR coastline. Distribution throughout the year of all age classes of the potentially different Arctic cisco stocks should receive a high priority for future regional fisheries studies.

ACKNOWLEDGEMENTS

The authors wish to thank the following people who assisted in the field gathering data: Tonya M. Stevens, Michael Phillips, C. Ann Swartz and Patricia Rost. Thanks also go to David Daum and Susan Mang for typing the manuscript and Reed Glesne and Gerry Gray for reviewing and editing the report.

LITERATURE CITED

Bendock, T. 1979. Beaufort Sea estuarine fishery study. Final report. Pages 670-729 in Environ. assess. Alaskan cont. shelf. BLM/NOAA, OCSEAP. Vol. 4.

Corley, S.D. 1985. Age estimates from scales and otoliths of Arctic cisco collected in Beaufort Lagoon, Alaska, in 1985. U.S. Fish and Wildl. Serv., Nat. Fish. Res. Center, Seattle, Washington. unpublished report.

Craig, P.C. and L. Haldorson. 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. BLM/NOAA, OCSEAP. Vol. 7.

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 - migrants from Canada? Bio. Pap. Univ. Alaska. No. 21. Fairbanks, Alaska. pp 4-23.

Griffiths, W.B. 1983. Fish investigations in Angun and Beaufort Lagoons, Eastern Beaufort Sea, Alaska. Pages 176-222 in report by LGL for Min. Mgmt. Serv., BLM/NOAA, OCSEAP.

Griffiths, W., P. Craig, G. Walder and G. Mann. 1975. Fisheries investigations in a coastal region of the Beaufort Sea (Nunaluk Lagoon, Y.T.). Chap. 2, pages 1-219 in P.C. Craig, ed. Fisheries investigations in a coastal region of the Beaufort Sea. Can. Arctic Gas Study Ltd. Bio. Rep. Ser. 34

Griffiths, W.B., J. DenBeste and P. Craig. 1977. Fisheries investigations in a coastal region of the Beaufort Sea (Kaktovik Lagoon, Barter Island, Alaska). Chap. 2, pages 1-190 in P.J. McCart, ed. Fisheries investigations along the North Slope from Prudhoe Bay, Alaska to the MacKenzie delta, NWT. Can. Arctic Gas Study Ltd. Bio. Rep. Ser. 40.

Griffiths, W.B., D.R. Schmidt, R.G. Fechhelm, B.J. Gallaway, R.E. Dillinger, W.J. Gazey, W.H. Neill, and J.S. Baker. 1983. In B.J. Gallaway and R.P. Britch, eds. Environmental summer studies (1982) for Endicott Development. Fish ecology. Vol. III. Rep. by LGL Alaska Research Associates and Northern Technical Services for Sohio Alaska Petroleum Co. Anchorage, Alsaka. 323 pp.

Hachmeister, L.E., and J.B. Vinelli. 1984. Physical Oceanography. In J.C. Truett (ed.), Environmental characterization and biological use of lagoons in the eastern Beaufort Sea, p 501-579. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 24:129-579.

Roguski, E.A. and E. Komarek, Jr. 1972. Monitoring and evaluation of Arctic waters with emphasis on the North Slope drainages. Alaska Dep. Fish and Game. Fed. Aid Fish. Restor. Prog. Rep., Proj. F-9-3, Job G-III-A. 22 pp.

Smith, M.W. and R.S. Glesne. 1983. Aquatic studies on the Arctic National Wildlife Refuge, 1981 and 1982. Pages 291-364 in G.W. Garner and P.E. Reynolds, eds. 1982 update report baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildl. Serv., Anchorage, Ak. 379 pp.

Truett, J. 1981. Beaufort Sea barrier island-lagoon ecological process studies. Final report, Simpson Lagoon. Part 2. Physical processes. Pages 52-108 in Environ. assess. Alaskan cont. shelf. BLM/NOAA, OCSEAP. Vol. 7.

West R.L. and D.W. Wiswar. 1985. Fishery investigations on the Arctic National Wildlife Refuge, 1984. Pages 729-777 in G.W. Garner and P.E. Reynolds, eds. 1984 update report baseline study of the fish, wildlife, and their habitats. Vol. II. U.S. Fish and Wildl. Serv., Anchorage, Ak. 777 pp.

Yoshihara, H.T. 1972. Monitoring and evaluation of Arctic waters with emphasis on North Slope drainages. Alaska Dep. Fish and Game. Fed. Aid Fish. Restor. Prog. Rep., Proj F-9-4, Job G-III-A. 44 pp.

Yoshihara, H.T. 1973. Monitoring and evaluation of Arctic waters with emphasis on North Slope drainages. Alaska Dep. Fish and Game. Fed. Aid Fish. Restor. Prog. Rep., Proj. F-9-5, Job G-III-A. 83 pp.