ASSESSING THE IMPACT OF HARVEST ON KINGNAIT FJORD ARCTIC CHAR IN THE CUMBERLAND SOUND AREA OF BAFFIN ISLAND

Context

In 2006, the Nunavut Wildlife Management Board (NWMB) identified their intent to begin the process of setting Total Allowable Harvest (TAH) levels and Basic Needs Levels (BNLs) for stocks in the Nunavut Settlement Area (NSA). Fisheries and Aquaculture Management (FAM) in the Eastern Arctic Area office received a request for advice from the NWMB to support their setting of TAH levels for Cumberland Sound Arctic Char stocks. FAM identified priority stocks in the area, including Kingnait Fjord, for advice on total allowable harvest levels in their request submitted to DFO Science in December 2006. In April 2009, the NWMB announced they would be conducting a Public Hearing on June 2, 2009 to consider the level of TAH, the Basic Needs Level and the Surplus for the Arctic Char fishery in Kingnait Fjord. FAM then notified Science of the need for updated information and advice for Kingnait Fjord Arctic Char.

The Arctic Fisheries Scientific Advisory Committee reviewed data and developed advice for the Kingnait Fjord Arctic Char fishery in 1994/1995 (Cosens *et al.* 1998) in response to concerns expressed by DFO and the Pangnirtung Hunters and Trappers Association (HTA) regarding the level of harvest of the Kingnait Fjord Arctic Char stocks. In 2000, the HTA requested that the NWMB close Kingnait Fjord to commercial fishing as the population seemed to be in decline. The NWMB decided to close the waters to commercial fishing for at least five years and encouraged the community to minimize their subsistence fishing to aid recovery of the stocks. In 2002, and again in 2003, the HTA requested that Kingnait Fjord be reopened to commercial fishing. DFO Science provided advice following each request. Based on analysis of the samples collected in 2003, and applying the precautionary approach, DFO Science indicated that a total harvest (from all sources) of 2000 kg (4409 lb) would pose a low level of risk to the population. DFO Science also indicated that collection of biological data should be required. An annual exploratory licence with a 2000 kg (4409 lb) quota has been issued for this fishery since summer 2005/2006.

All biological data available for Kingnait Fjord Arctic Char were considered for this assessment, including how these data may support a decision on TAH. Given this information and advice is needed prior to June 2, 2009, and since the NWMB is the final advisory body for this request, it was determined that a Science Special Response Process would be used.

Background

Kingnait Fjord is identified as commercial fishing water on Schedule V of the Northwest Territories Fishery Regulations (Region VI, Baffin-High Arctic, 24.) with a quota 4500 kg (9921 lb) (round weight) for searun Arctic Char using nets with 139 mm (5.5 in) mesh. In the past, most harvest occurred in winter in one of several lakes in the river system at the head of the fjord where anadromous Arctic Char over-winter and spawn (Figure 1). Kagitugulu Lake (66°23'N 64°19'W) was the principle location where most fishing occurred during the Nunavut Wildlife Harvest Study

(Priest and Usher 2004). In the last four years, some portion of the commercial fishery has occurred in the summer. Fishing may target a mixed summer stock when carried out in the fjord however there are no data with which to test this possibility.

Analysis

Commercial harvest fishery data for Kingnait Fjord are summarized in Table 1. The data from DFO are reported in kg round weight by fiscal year (April 1 to March 31) and it is not possible to break these data down by calendar year. Subsistence harvest information (Table 2) includes harvest from the Nunavut Wildlife Harvest Study that was reported as the number of fish caught and then converted to wet weight using a conversion factor of 2.0 kg (4.4 lb) based on the average fish size from Kingnait Fjord sampling. The Harvest Study year ran from June 1 to May 31 but for comparison purposes, the Harvest Study data are summarized by Harvest Study year and DFO fiscal year (Table 2). There have been reports that at times the subsistence harvest from this stock has been as high as, or higher than, the commercial harvest and several years of very high harvest are reported in the Harvest Study. The community has expressed concerns in the past that the Harvest Study may overestimate the number of fish harvested for subsistence purposes and may include some portion of the commercial harvest. A good record of the subsistence harvest and the total yearly harvest (subsistence and commercial) from the stock is not available.

In 2000, the HTA requested that the NWMB close Kingnait Fjord to commercial fishing as the number of larger fish in the population seemed to be in decline. Unfortunately, there are no further details available about why the community wanted the fishery closed and no data for the stock during the periods leading up to and immediately following the closure.

There are limited data available on the Kingnait Fjord stock (i.e., age, length, round weight and catch-per-unit-effort) and what are available are difficult to compare for reasons related to differences in how the data were collected (i.e., net size and type, date of collection) (Table 3) and analyzed (i.e., ageing methods and different readers). Two net sizes, 127 mm and 139.7 mm (5 in and 5.5 in) mesh, were used in the fishery and in fishery independent sampling (Table 3). In 1993, fish were captured using hoop nets and gillnets (114 mm and 139.7 mm; 4.5 in and 5.5 in) (Table 3). Scientific multi-mesh nets (39 mm to 101.9 mm; 1.5 in to 4 in) were used to sample in summer 2006 and 2007 along with commercial nets (139.7 mm; 5.5 in) (Table 3). Fishery data from fish plant sampling in 2005 and 2006 came from a summer fishery in the fjord. These data may not be an accurate representation of the commercial harvest as they only reflect the fish sold to the plant and not necessarily all fish caught. Age data are available from 1983, 1991, 1997, 2003 and 2007 from the winter lake sampling (Table 3) and from 2006 and 2007 summer sampling in the fjord (Table 3). Following the recent aging of the 2006 and 2007 samples, a check was made of the 2003 samples and discrepancies were found so the 2003 samples were re-aged. Different methods were likely used to age the earlier samples, so they will also be re-aged to allow comparisons. No trend information is currently available for this stock.

Length frequency data provide some very basic information about the size of fish entering the fishery. However it is not possible to use lengths to say whether a stock is healthy as changes in length over time may reflect smaller fish entering the fishery or increased growth rate of younger fish in response to selective harvesting of older larger fish. The Kingnait Fjord Arctic Char length frequency data (Figures 2, 3 and 4) indicate a wide range in sizes of fish and included large individuals in all years when sampling occurred. The 2007 winter data (Figure 2) suggest a normal distribution of lengths, with the fishery targeting mature individuals.

Age structure of the population is generally more informative than length distribution. The 2007 data suggest a normal distribution of ages encompassing a wide range of ages in the harvest which is similar to the age distribution from 2003 (Figure 5A). The ages from the winter 2007 spawning stock sample range from 7 to 19 years and do not show a truncated age distribution which might be expected from over-fishing (Figure 5A). Estimates of mortality (Z^a) calculated from the 1983, 1991 and 2007 age data (Table 4) suggest that mortality levels were noticeably higher in 1991 than in 1983 and 2007. Prior to 1991, the commercial harvests increased steadily after 1985 and reached a peak in 1990 (Pike and Keast 1994). The estimate of mortality for 1991 may reflect those increasing harvests. In contrast, the 2007 sampling followed a seven-year period during which the commercial fishery was closed for five years and then followed by two years of lighter commercial fishing pressure, although subsistence harvest levels over this period are unknown. Age frequency distributions from summer sampling in the fjord in 2006 and 2007 (Figure 5B) are much different than winter sampling in the lakes . Multi-mesh gillnets used in the summer target a wider range of fish sizes and are not limited to the size of fish susceptible to the fishery. Differences between 2006 and 2007 may reflect the different month during which that sampling was undertaken.

The only estimate of population size available for Arctic Char in the lakes at the head of Kingnait Fjord dates back to 1993 (Cosens *et al.* 1998). The population estimate was generated by a mark-recapture study which suffered from non-random mixing of tagged fish which can increase uncertainty in the estimate. As a result, the study concluded that the stock size of char over 450 mm (17.7 in) fork length was between 27 381 and 48 046 fish.

Johnson (1980) undertook an experimental approach to determine exploitation rates for Arctic Char populations in the Canadian Arctic. Following a number of years of study of the Nauyak Lake anadromous Arctic Char population, a harvest rate of 11% of the standing stock was found to be excessive and resulted in population decline (Johnson 1980). Based on what is known about Arctic Char populations from this and other studies conducted across the Canadian Arctic, it appears that a harvest of 10% of the harvestable stock likely poses a high risk of causing population decline while 5% poses a moderate risk. Given uncertainty with current levels of total harvest, limited information to assess population characteristics under various harvest scenarios and an old population estimate, it is recommended that a precautionary approach be considered for management of this population at this time, using a 5% exploitation rate based on the 1993 population estimate. This level of exploitation would permit a harvest of 2700 kg (5952 lb), 3750 kg (8267 lb) or 4800 kg (10 582 lb) depending on whether the minimum, median or maximum population estimates for 1993, respectively, are used (Table 5).

A more current population estimate and accurate records of total harvest levels are needed to refine the exploitation rate for the Kingnait Fjord Arctic Char population. An experimental approach to examine the effects of different exploitation rates could be employed for waterbodies in the area.

Conclusions

The total harvest (commercial and subsistence combined) and estimate of population size are important in determining the sustainable harvest level of a stock. With a management goal of long term sustainability under continued harvest, the exploitation rate for a stock should not be so high as to cause population decline. Based on what is known about other Arctic Char populations across the Canadian Arctic, it seems that removal of 10% of the harvestable stock poses a high risk of population decline while 5% poses a moderate risk. Given uncertainty with current levels of total harvest, limited information to assess population characteristics under various harvest scenarios and an old population estimate, a precautionary approach should be taken when establishing harvest rates. An exploitation rate of 5% of the 1993 population estimate should be considered. This level of exploitation would permit a harvest of 2700 (5952 lb), 3750 (8267 lb) or 4800 kg (10 582 lb) depending on whether the minimum, median or maximum population estimates for 1993, respectively, are used.

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Appendices

Table 1. Summary of harvest data available for Kingnait Fjord Arctic Char. All are commercial harvests unless identified as Exploratory/Experiment (E). Fisheries Management and Harvest Information System (FMHIS) is a DFO database. All harvests are presented by DFO fiscal year (April 1 – March 31) except for 1982 and 1983 which are presented by calendar year.

Year	Harvest Months or Season	Quota in kg (lb)	Harvest in kg round wt (lb)	Source
1982		4500 (9921)	4500 (9921)	Yaremchuk *et al.* 1989
1983		4500 (9921)	4545 (10 020)	
1984/1985	10, 12	4500 (9921)	1346 (2967)	
1985/1986	11	4500 (9921)	4280 (9436)	FMHIS
1986/1987	4, 5, 8, 9	4500 (9921)	5600 (12 346)	Yaremchuk *et al.* 1989
1987/1988	4, 10		3656 (8060)	FMHIS
1988/1989	1, 4, 6	4500 (9921)	6018 (13 267)	DFO 1991 and FMHIS
1989/1990	1, 3	4500 (9921)	7603 (16 762)	DFO 1992a and FMHIS
1990/1991	Winter	1000 (2205)	1000 (2205)	DFO 1992b and FMHIS
1991/1992	Winter	4500 (9921)	4545 (10 020)	DFO 1993, Cosens *et al.* 1993 and FMHIS
1992/1993	Winter	4500 (9921)	4955 (10 924)	DFO 1994, Cosens *et al.* 1993 and FMHIS
1993/1994	Winter	4500 (9921)	6247 (13 772)	DFO 1995 and FMHIS
1994/1995	Winter	4500 (9921)	5598 (12 341)	DFO 1996 and FMHIS
1995/1996	Winter	4500 (9921)	7184 (15 838)	DFO 1997
1996/1997	Winter	1000 (2205)	334 (736)	DFO 1999
1997/1998	Winter	4500 (9921)	3509 (7736)	FMHIS
1998/1999	1, 2, 3	4500 (9921)	4130 (9105)	FMHIS
1999/2000	1, 2	4500 (9921)	4799 (10 580)	FMHIS
2000/2001		Closed		
2001/2002		Closed		
2002/2003		Closed		
2003/2004		Closed		
2004/2005		Closed		
2005/2006	Summer	2000 (4409)E	1919 (4231)	FMHIS
2006/2007	Summer	2000 (4409)E	1617 (3565)	FMHIS
2007/2008	Winter	2000 (4409)E	1258 (2773)	FMHIS
2008/2009	Summer & Winter	2000 (4409)E	3129 (6898)	FMHIS

Table 2. Summary of subsistence harvests reported for Kingnait Fjord Arctic Char. Harvests are presented by DFO fiscal year (April 1 – March 31) and the Nunavut Wildlife Harvest Study (Priest and Usher 2004) data are also presented by Harvest Study year (June 1 – May 31). A conversion factor of 2.0 kg (4.4 lb) (the average size of fish sampled from Kingnait Fjord in 1991 and 1997 combined) was used to convert the number of fish to round weight.

Year	Harvest Months	Number of fish	Estimated Weight in kg (lb)
From Cosens *et al.* 1998			
1993/1994			3956 (8721)
Nunavut Wildlife Harvest Study			
Harvest Study Year			
01/06/1996-31/05/1997	8,1,2	805	1610 (3549)
01/06/1997-31/05/1998	6,1,2,3,4,5	5270	10 540 (23 237)
01/06/1998-31/05/1999[1]	1,2,3,5	4115	8230 (18 144)
01/06/1999-31/05/2000	1,2,3,4	1525	3050 (6724)
01/06/2000-31/05/2001	1,5	370	740 (1631)
Total		12085	24170 (53 286)
DFO Year			
01/04/1996-31/03/1997	8,1,2	805	1610 (3549)
01/04/1997-31/03/1998	6,1,2,3	4940	9880 (21 782)
01/04/1998-31/03/1999[1]	4,5,1,2,3	3845	7690 (16 954)
01/04/1999-31/03/2000	5,1,2,3	2035	4070 (8973)
01/04/2000-31/03/2001	4,1	150	300 (661)
01/04/2001-31/03/2002	5	310	620 (1367)
Total		12085	24170 (53 286)

[1]one record (400 fish/800 kg (3527 lb)) included in this total had the correct waterbody name but the wrong coordinates.

Table 3. Summary of Kingnait Fjord Arctic Char sampling.

Year	Number of Fish Sampled	Date or Time of Year	Sample Type	Gear Type (mesh size)	Type of Data Collected
1983	70	January 1983	Test netting	39-139 mm (1.5 - 5.5 in) mesh gillnet	Length, weight, age, gender
1990/1991	100	February, March 1991	Commercial Monitoring	127 mm (5 in) mesh gillnet	length, weight, age, gender
1993/1994	986	August 1993	Mark-Recapture Study[1]	hoopnets and gillnets: 139.7 mm (5.5 in) and 114 mm (4.5 in)	length, tag number
1996/1997	100	March 1997	Fishery Independent Sampling	127 mm (5 in) mesh gillnet	length, weight, age
2002/2003	197	March 2003	Fishery Independent Sampling	139.7 mm (5.5 in) gillnet	length, weight, age, gender
2005/2006	858	July 2005	Plant sampling		length
2006/2007	98	August 2006	Scientific Sampling and Fishery Independent Sampling	gill nets: 39-101.9 mm (1.5-4 in) and 139.7 mm (5.5 in)	length, weight, age, gender, maturity, gonad weight
2006/2007	462	Summer 2006	Plant sampling		length
2007/2008	200	March 2007	Fishery Independent Sampling	139.7 mm (5.5 in) gillnet	length, weight, age, gender
2007/2008	230	July 2007	Scientific Sampling and Fishery Independent Sampling	gill nets: 39-101.9 mm (1.5-4 in) and 139.7 mm (5.5 in)	length, weight, age, gender, maturity, gonad weight

[1]From 1993-1998 there were 363 recaptures of tagged fish with date and tag numbers recorded

Table 4. Mean fork length and age of Arctic Char captured in gillnets in Kingnait Fjord. Mortality estimates (Z^a) were calculated based on the age data. Data for 1983 and 1991 from Pike and Keast (1994) and data for 2007 from Tallman (unpublished data).

Year	Mean Length in mm (in)	Mean Age (y)[1]	Z^a
1983	522 (20.5 in)	11.7	0.28
1991	542 (21.3 in)	10.8	0.53
2007	559 (22.0 in)	11.5	0.20

[1]age determination methods differed between years

Table 5. The 1993 population estimates (Cosens *et al.* 1998, Pike and Keast 1994) and associated amounts of harvest permitted under 5% and 10% exploitation rates. Arrows indicate increasing level of risk to the population.

	→			
	Minimum	Median	Maximum	
Number of Fish	27 000	37 500	48 000	
Weight of Fish (kg)[1] (Weight of Fish (lb))	54 000 (119 050)	75 000 (165 347)	96 000 (211 644)	
				↓
5% exploitation	2700 kg (5952 lb)	3750 kg (8267 lb)	4800 kg (10 582 lb)	
10% exploitation	5400 kg (11 905 lb)	7500 kg (16 535 lb)	9600 kg (21 164 lb)	

[1]using average fish size of 2.0 kg (4.4 lb)

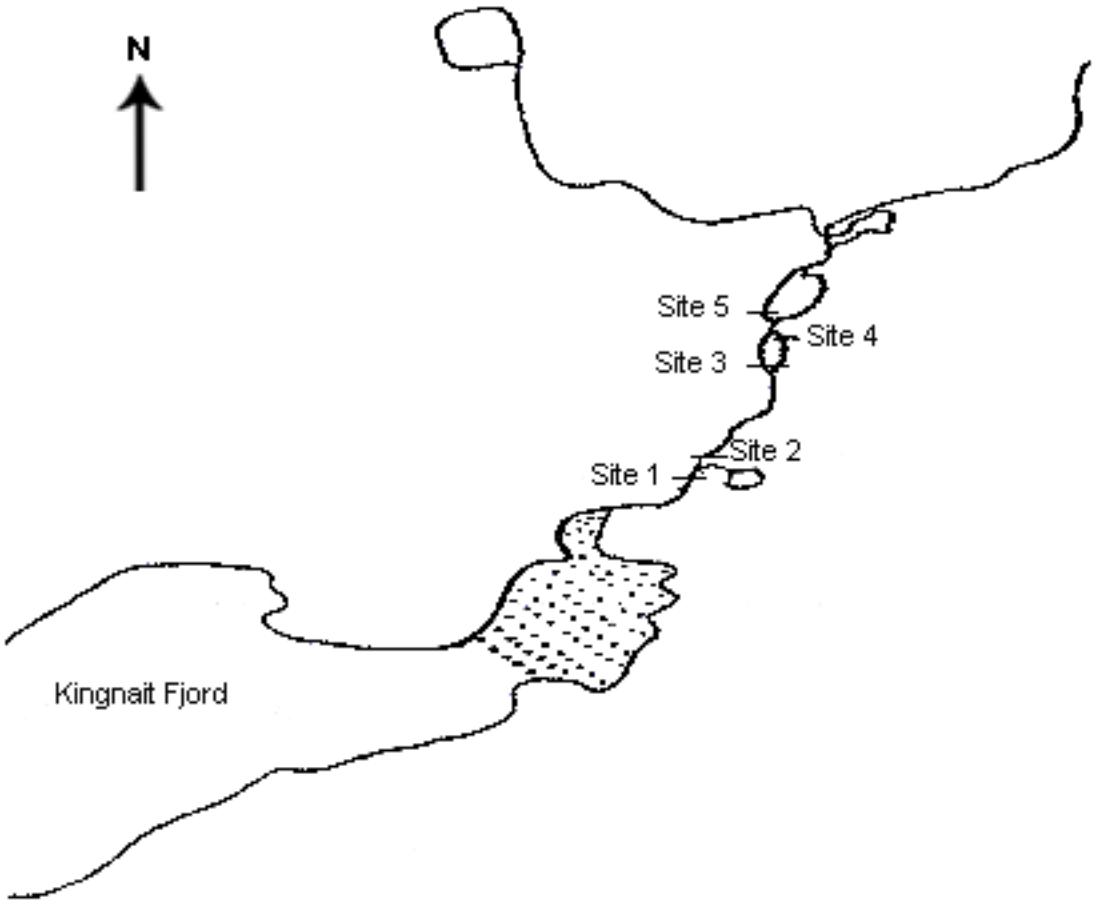

Figure 1. Arctic Char over-winter and spawn in one of several lakes in the river system at the head of Kingnait Fjord (from Pike and Keast 1994). Kagitugulu Lake (site 5) was the principle location where most fishing occurred in the Nunavut Wildlife Harvest Study.

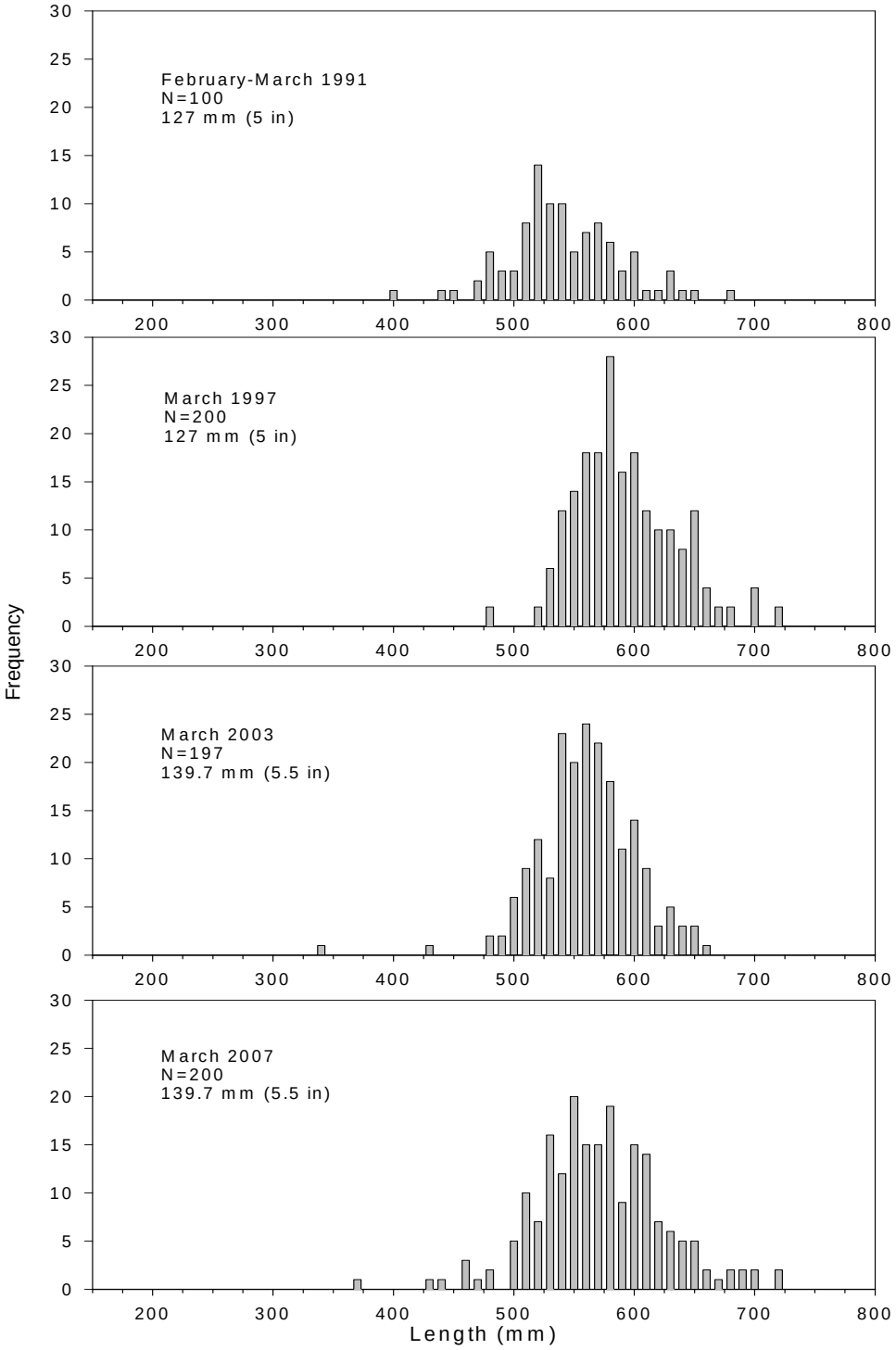

Figure 2. Length frequency data from 1991, 1997, 2003 and 2007 winter lake sampling. All sampling used commercial mesh gillnets but mesh sizes differed.

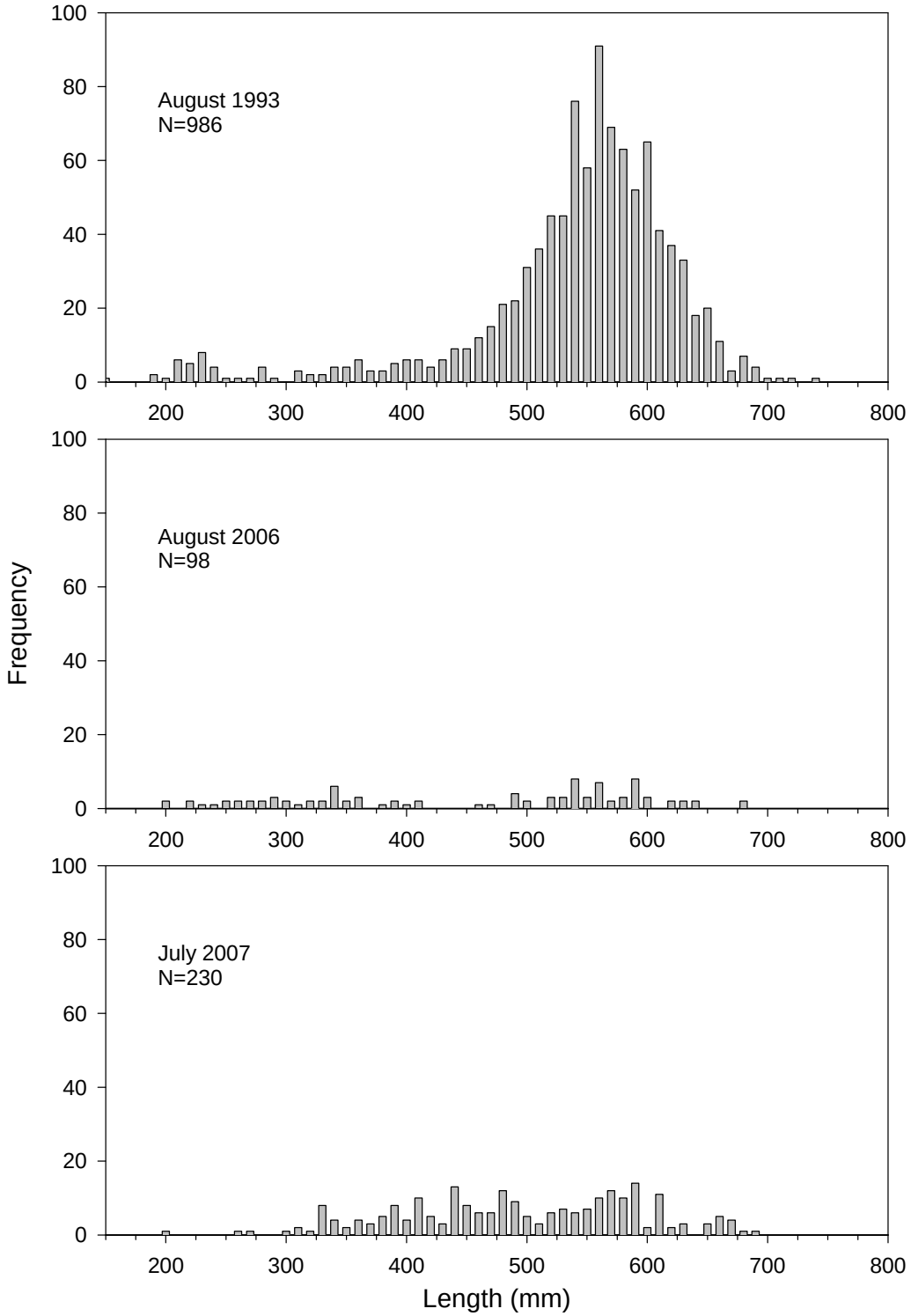

Figure 3. Length frequency data from summer sampling in 1993, 2006 and 2007. Sampling in 1993 used gillnets (114 and 139.7mm; 4.5 in and 5.5 in) and hoopnets to capture fish for a mark-recapture study. In 2006 and 2007 fish were caught with multi-mesh gillnets (39-101.9 mm; 1.5 – 4 in) and 139.7 mm (5.5 in) commercial nets.

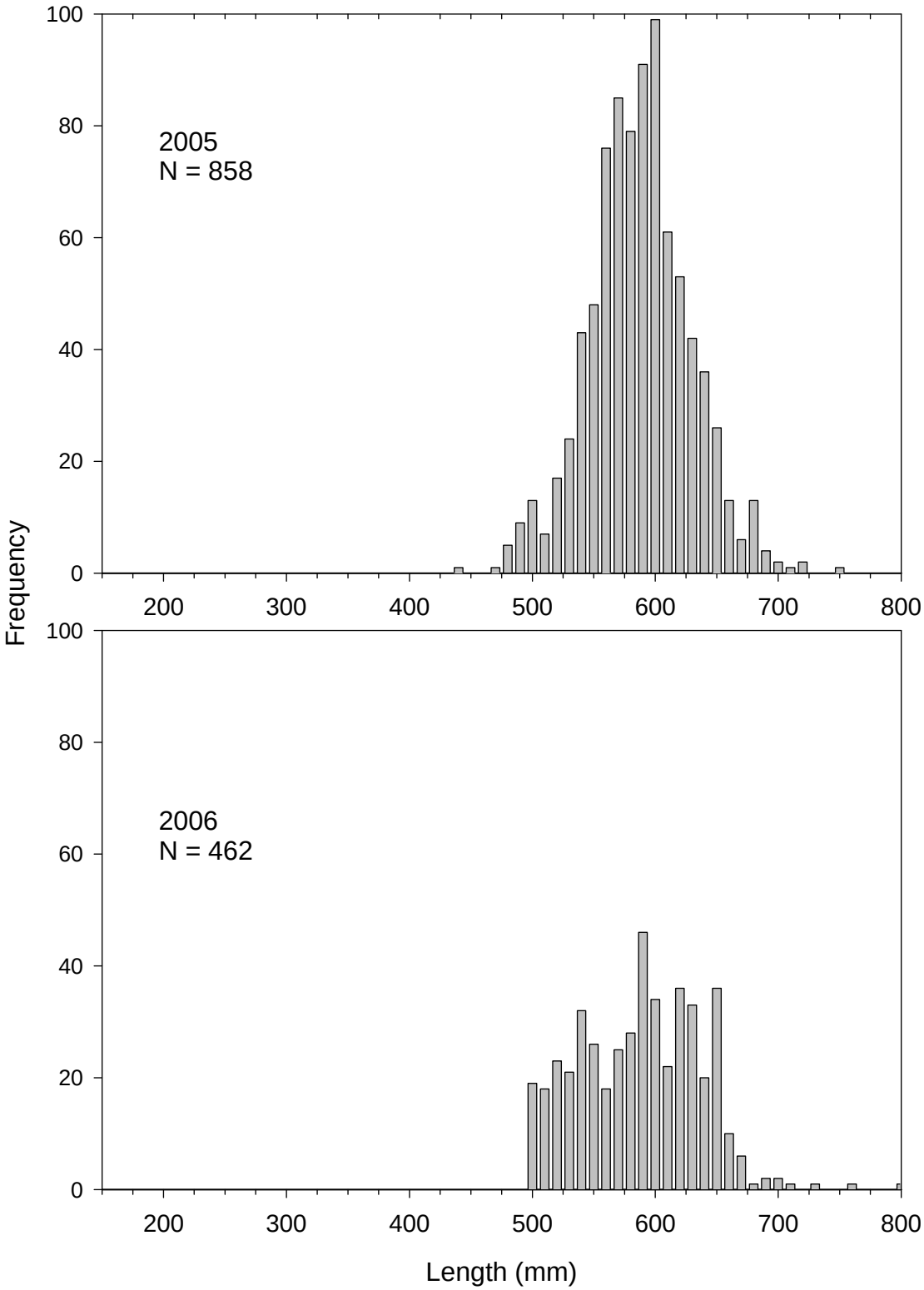

Figure 4. Length frequency data from summer Plant Sampling in 2005 and 2006.

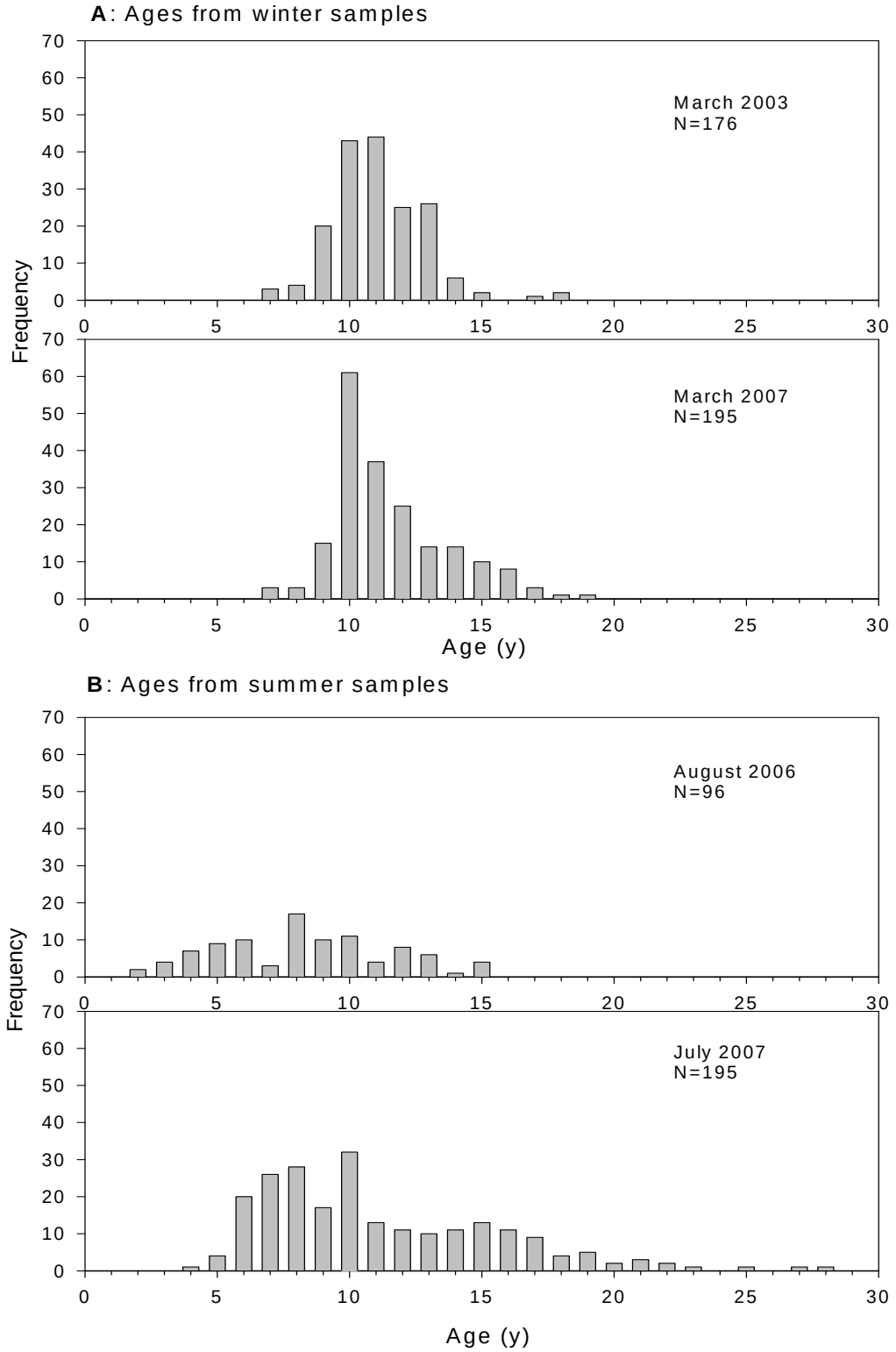

Figure 5. Age frequency data for winter lake samples (A) and summer fjord samples (B).In summer 2006 and 2007 fish were caught with multi-mesh gillnets (39-101.9 mm; 1.5 -4 in) and 139.7 mm (5.5 in) commercial nets. Winter sampling only used 139.7 mm (5.5 in) commercial nets.

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