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STOCK COMPOSITION OF NORTHERN PIKE IN MINTO FLATS DURING 1989[1]

By

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ABSTRACT

Stock assessment of northern pike in Minto Flats was investigated in 1989. A total of 470 northern pike *Esox lucius* were sampled in the spring with modified hoop traps and 374 were sampled in the fall with electrofishing. Abundance estimates of northern pike that overwinter in Areas I and III were not achieved due to insufficient numbers of fish captured. Length frequencies of fish sampled in Areas I And III appeared dissimilar. A greater percentage of fish from Area I were in the preferred and memorable categories of the Relative Stock Density index than fish from Area III. Estimation of sex was limited to 141 northern pike, of which 34 were females. Age 4 fish comprised the greatest proportion of samples from Area I, while fish of ages 5 and 6 comprised the greatest proportion of samples from Area III. Parameters of the von Bertalanffy growth model were estimated. Spring flooding and fall migratory timing may have accounted for the small numbers of northern pike sampled in 1989.

KEY WORDS: Northern pike, *Esox lucius*, Minto Flats Alaska, age composition, Relative Stock Density, length-at-age relationship, abundance, mark-recapture, electrofishing.

INTRODUCTION

Next to Arctic grayling *Thymallus arcticus*, northern pike *Esox lucius* are the most sought after indigenous sport fish species in interior Alaska (Holmes 1987). Between 75% and 90% of the annual harvest of northern pike in Alaska comes from interior Alaska with 65% from the Tanana River drainage (Figure 1). Minto Flats has supported the largest sport fishery for northern pike in Alaska in nine of the previous 12 years (Mills 1979-1989). From 1981-1984 the average sport harvest in Minto Flats was 2,279 northern pike. However, in 1985, a new sport fishery developed on a concentration of overwintering northern pike in the lower part of the Chatanika River. This fishery resulted in an increase in the sport harvest to an estimated 4,665 fish in 1985 and an estimated 4,903 northern pike in 1986. Angler reports and limited creel survey sampling (Holmes and Burkholder 1988) indicated that a large portion of the harvest from this new fishery was prespawning females.

In addition to sport harvests, there is a subsistence fishery on northern pike by the people of Minto Village. This subsistence harvest occurs primarily in the spring and fall with gill nets and hook and line. Estimated harvest of northern pike in the subsistence fishery has been reported as high as 3,003 in 1983 (Andrews 1988) and as low as 378 in 1988[1].

Concern that increasing sport harvests combined with subsistence harvests exceeded sustainable yield prompted the Department of Fish and Game to close the winter sport fishery for northern pike by emergency order in January 1987. In the spring of 1988 two new regulations went into effect. One regulation restricted the sport fishing season to 1 June through 14 October; the other regulation reduced the bag limit to five northern pike a day with one over 760 mm (30 inches). Along with the new regulations, the Department initiated a research program in 1987 to determine if present management practices are sufficient to maintain this important sport fishery.

This report summarizes research conducted in 1989 to estimate the abundance and population composition of northern pike in Minto Flats.

Study Area

Minto Flats is located approximately 50 km west of Fairbanks. It is a 200,000 ha area of marsh and lakes interconnected by numerous sloughs and four major rivers: the Chatanika, Goldstream, Tatalina and Tolovana rivers (Figure 2). The rivers are slow flowing and meandering, and the lakes are shallow and contain large areas of dense aquatic vegetation. Habitat for northern pike in Minto Flats consists of an estimated 6,000 ha (Holmes and Pearse 1987). Access to the area is by float equipped-aircraft, by road to Minto Village, or by road from Murphy Dome to the Chatanika River.

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[1] Neil Shishido Memorandum State of Alaska Department of Fish and Game 1/13/89. Subsistence Division, 565 University Ave. Fairbanks, AK.

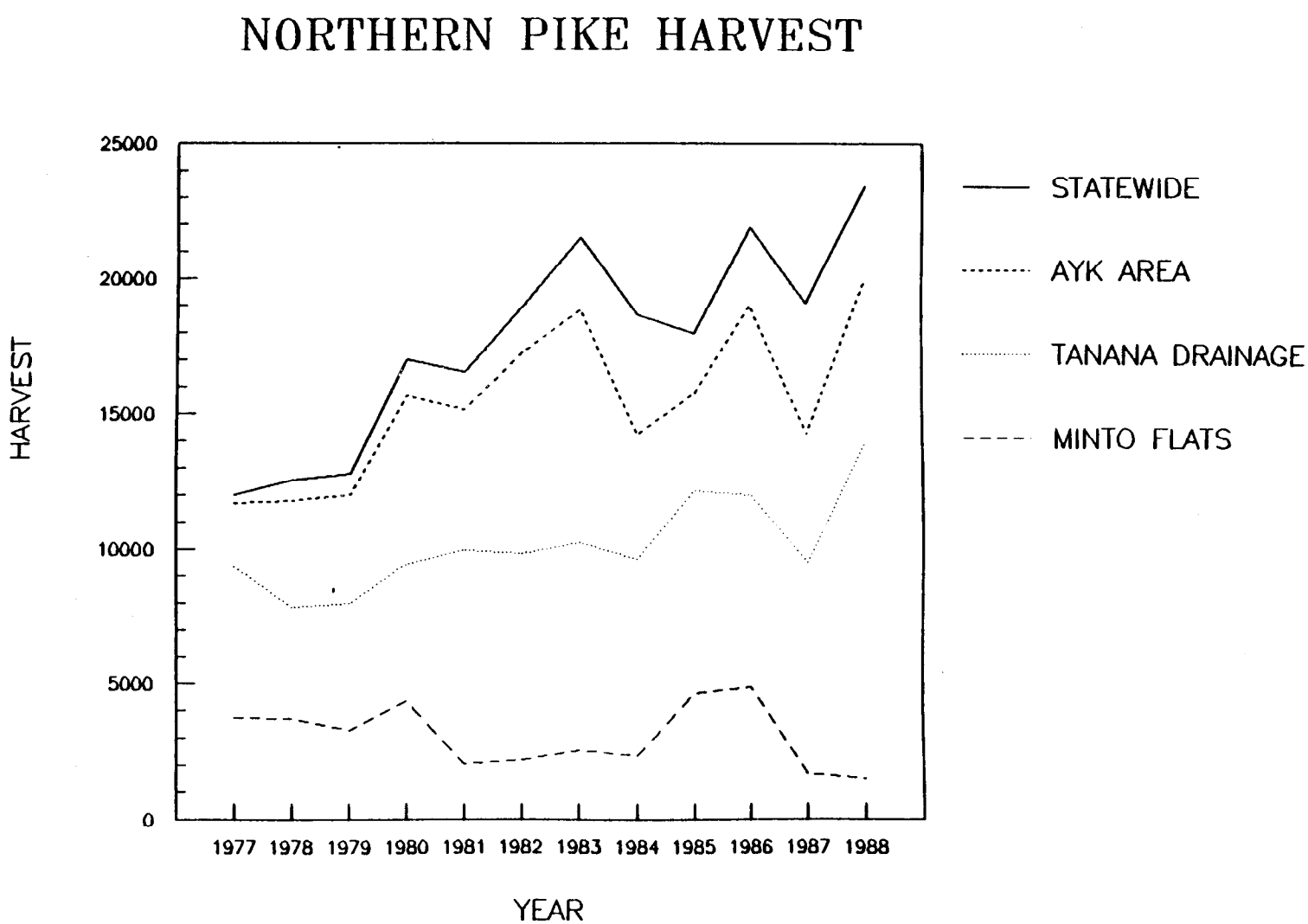

Figure 1. Estimated sport harvest of northern pike in Alaska, the Arctic-Yukon-Kuskokwim Area (AYK), the Tanana drainage, and Minto Flats, 1977-1988 (Mills 1979-1989).

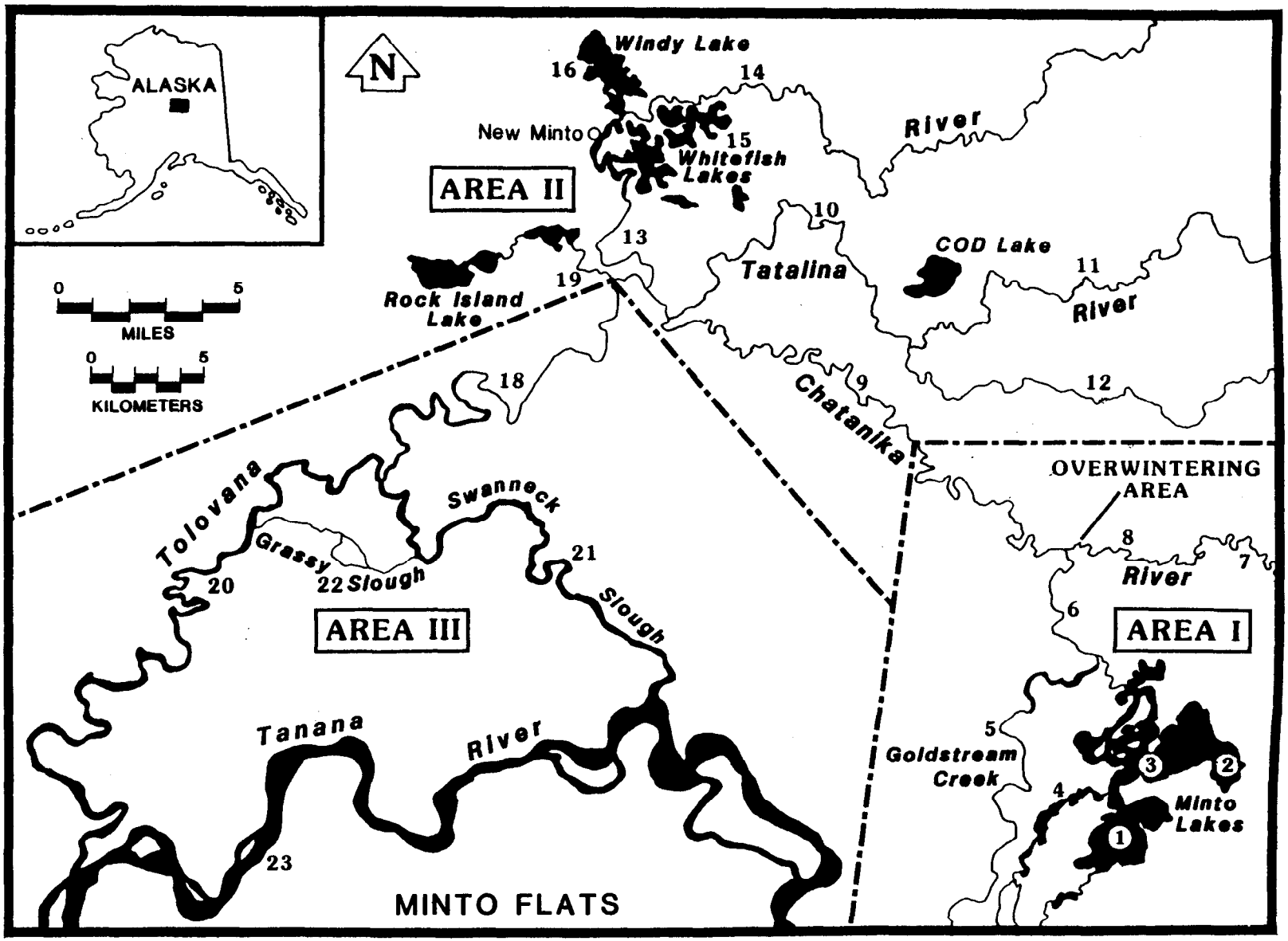

Figure 2. Minto Flats drainage and major sampling Areas.

Study Objectives

Research goals of this project are the stock assessment of northern pike in Minto Flats, and investigations on the life history of populations for management of the sport fishery.

Based on previous research (Burkholder 1989) the objectives for the 1989 field season were to estimate:

1. the abundance of northern pike that overwinter in Area I (Figure 2);
2. the abundance of northern pike that overwinter in Area III (Figure 2);
3. the age and sex composition of northern pike in Areas I and III; and,
4. the parameters of the age-length relationships for northern pike in Areas I and III.

METHODS

There were two discrete sampling events (8 May to 14 June and 18 September to 6 October) during 1989. Sampling gear included: hoop traps with leads and wings, gill nets and pulsed D.C. boat-mounted electrofishing systems. The electrofishing system (with the exception of the electrodes) was described by Clark (1985, 1989). Spherical electrodes[2] were used. Description of pulse width, duty cycle, voltage and amperage used in sampling are in Appendix A1.

Northern pike were captured, and measured to the nearest 1 mm of fork length (FL). Because sex determination using external characteristics was unreliable (Casselman 1974), sex was recorded only for northern pike extruding sexual products. The right pectoral fin was clipped on each fish over 299 mm in length and each fish was tagged with a Floy FD-68 internal anchor tag. The capture location of each fish was recorded as one of 23 subareas of Minto Flats (Table 1).

A scale sample was removed from each fish for estimating age. Scales were taken from the preferred zone adjacent to but not on the lateral line above the pelvic fins as described by Williams (1955). Previous analysis (Peckham and Bernard 1987) indicated ages read from scales, sagittal otoliths, and cleithra were similar. Scales were stored in coin envelopes and were later removed for cleaning and mounting on gum cards. Gum cards were used to make impressions on 20 mil acetate using a Carver press at 137,895 kPa (20,000 psi) heated to 93^{0}C for 30 s. Annuli were counted along their dorsal radius using a Micron 770 Microfiche reader. Scales, cleithra, and vertebrae were taken from northern pike killed during sampling.

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[2] Ichthyo Technologies, Post Office Box 96 Flagstaff, Arizona 86002, USA

Table 1. Sampling areas in Minto Flats.

Area	Section	Location
I	1	Upper Minto Lake
I	2	Big Minto Lake
I	3	Lake Channels to Goldstream
I	4	Rotten Slough
I	5	Goldstream (above Lake Channels)
I	6	Goldstream (below Lake Channels)
I	7	Chatanika (above Murphy Dome Road)
I	8	Chatanika (Murphy Dome Road to Goldstream)
I	9	Chatanika (Goldstream to Rock Island Slough
II	10	Tatalina (Chatanika to Forks)
II	11	Tatalina (Above Forks)
II	12	Washington Creek
II	13	Tolovana (Rock Island Slough to Minto Village)
II	14	Tolovana (above Minto Village)
II	15	Whitefish Lakes
II	16	Lakes North Of Minto
II	17	Lakes Northwest of Minto
III	18	Tolovana (Rock Island Slough to Swanneck)
III	19	Rock Island Slough
III	20	Tolovana (Swanneck Slough to Tanana)
III	21	Swanneck Slough
III	22	Grassy Slough
III	23	Tanana River

Abundance

Seasonal migration of northern pike occurs between areas in Minto Flats. The sampling design assumed that northern pike would be marked in Areas I and III before they moved into Area II in the spring and that they would be recaptured in Areas I and III after they have left Area II in the fall. Based on population estimates preformed in 1988, sample sizes to reach objective criteria for the mark-recapture experiment were 1,050 and 850 fish for Areas I and III, respectively, during the spring; and 850 and 750 fish for Areas I and III, respectively, during the fall.

The modified Peterson mark-recapture estimator (Chapman 1951) was intended to be used to estimate population abundance of northern pike larger than 299 mm FL in Area I and in Area III of Minto Flats. Population abundance and the approximate variance of this estimator are calculated with the following formulas (Seber 1982):

$$\hat{N} = \frac{(C+1)(M+1)}{(R+1)} - 1; \qquad (1)$$

and,

$$\hat{V}[N] = \frac{(M+1)\ (C+1)\ (M-R)\ (C-R)}{(R+1)^2(R+2)}; \qquad (2)$$

where:

M = the number marked during the first period;

C = the number captured during the second period; and,

R = the number captured during the second period with marks from the first period.

Conditions for the accurate use of the Petersen mark-recapture estimator include (Seber 1982):

1. a closed population (no change in the number of fish in the population during the experiment);

2. all northern pike have the same probability of capture in the marking sample or in the recapture sample, or marked and unmarked northern pike mix completely between marking and recapture events;

3. marking of northern pike does not affect their probability of capture in the recapture sample;

4. northern pike do not lose their marks between marking and recapture events; and,

5. all marked northern pike are reported when recovered in the recapture sample.

Due to the long hiatus between sampling events of the mark-recapture experiments, both mortality and recruitment likely occurred between sampling events. The Peterson estimator is appropriate if either mortality or recruitment (but not both) occurs between events. Therefore, recruitment into the size range of the estimated population through growth was to be culled from the fall sample using a non-parametric procedure described by Robson and Flick (1965). Because sampling gear might be selective for larger or smaller northern pike, chi-square analysis of marked and recaptured fish by length category was used to test for equal probabilities of capture for northern pike of all sizes. With rejection of the null hypothesis, abundance was estimated for each size group and the estimates summed as recommended by Ricker (1975).

Length, Sex, and Age Composition

The lengths of northern pike were grouped into categories according to those defined by Gabelhouse (1984) for estimate of Relative Stock Density. These categories were: "stock" size, 300 to 599 mm (FL); "quality" size, 525 to 654 mm; "preferred" size, 655 to 859 mm; "memorable" size, 860 to 1,079 mm; and "trophy" size, 1,080 mm and longer.

The proportions of the populations in each sex, age and size category were estimated with the following equations (Cochran 1977):

$$\hat{p}_j = \frac{n_j}{n}; \text{ and,} \tag{3}$$

and,

$$V[\hat{p}_j] = \frac{\hat{p}_j(1-\hat{p}_j)}{n - 1}; \tag{4}$$

where:

n_j = the number in the sample from group j;

n = the sample size; and,

p_j = the estimated fraction of the population that is made up of group j.

If size selectivity in sampling gear was detected, the proportion of the populations corresponding to each sex, age, and size category was to be estimated with equation (5) and the approximate variance was to be calculated with equation (6) (from the delta method, Seber 1982):

$$\hat{p}_j = \frac{\Sigma \hat{p}_{ij} \hat{N}_i}{\hat{N}} ; \text{ and,} \tag{5}$$

$$V[\hat{p}_j] \approx \Sigma V[\hat{p}_{ij}] \left(\frac{\hat{N}_i}{\hat{N}} \right)^2 + \frac{\Sigma V[\hat{N}_i] (\hat{p}_{ij} - \hat{p}_j)^2}{\hat{N}^2} \tag{6}$$

where:

p_{ij} = the estimated fraction of the population that is made up of group j in strata i; and,

N_i = the estimated population abundance in strata i.

Length-at-Age

Growth characteristics were estimated with length-at-age data using the von Bertalanffy growth model (Ricker 1975). Parameters were fitted by nonlinear regression with the Marquardt compromise (Marquardt 1963). The range of parameter values chosen for iteration by the model were a: 400 to 1,200 by 200; b: 0 to 0.4 by 0.1; and c: -2.0 to 2.0 by 0.5. Spring sampling data for 1987-1989 were combined, sexes were combined, and age classes that contained more than 50 individuals were randomly subsampled for this analysis.

RESULTS

Abundance

The number of northern pike captured was insufficient to estimate abundance in areas I and III of Minto Flats in 1989. During the spring sampling event, 66 and 404 northern pike > 299 mm (FL) were captured in Area I and Area III, respectively. During the fall sampling event, 320 and 54 northern pike > 299 mm were captured in Area I and Area III, respectively. Ten northern pike > 299 mm were captured in Area II during the fall sampling event. Only one marked northern pike from the spring sampling event was recovered in the fall (marked in Area III and recaptured in Area III).

Length Composition

Length frequencies of fish sampled in Areas I and III dissimilar (Figures 3 and 4). Mean lengths for fish sampled in Area I in the spring (525 mm, SE = 162) significantly differed ($p < 0.05$) for fish sampled in Area I in the fall (628 mm, SE = 138). Mean lengths for fish captured in Area III in the spring (553 mm, SE = 121) significantly differed ($p = 0.01$) for fish captured in Area III in the fall (496 mm, SE = 129). A greater percentage of fish from Area I

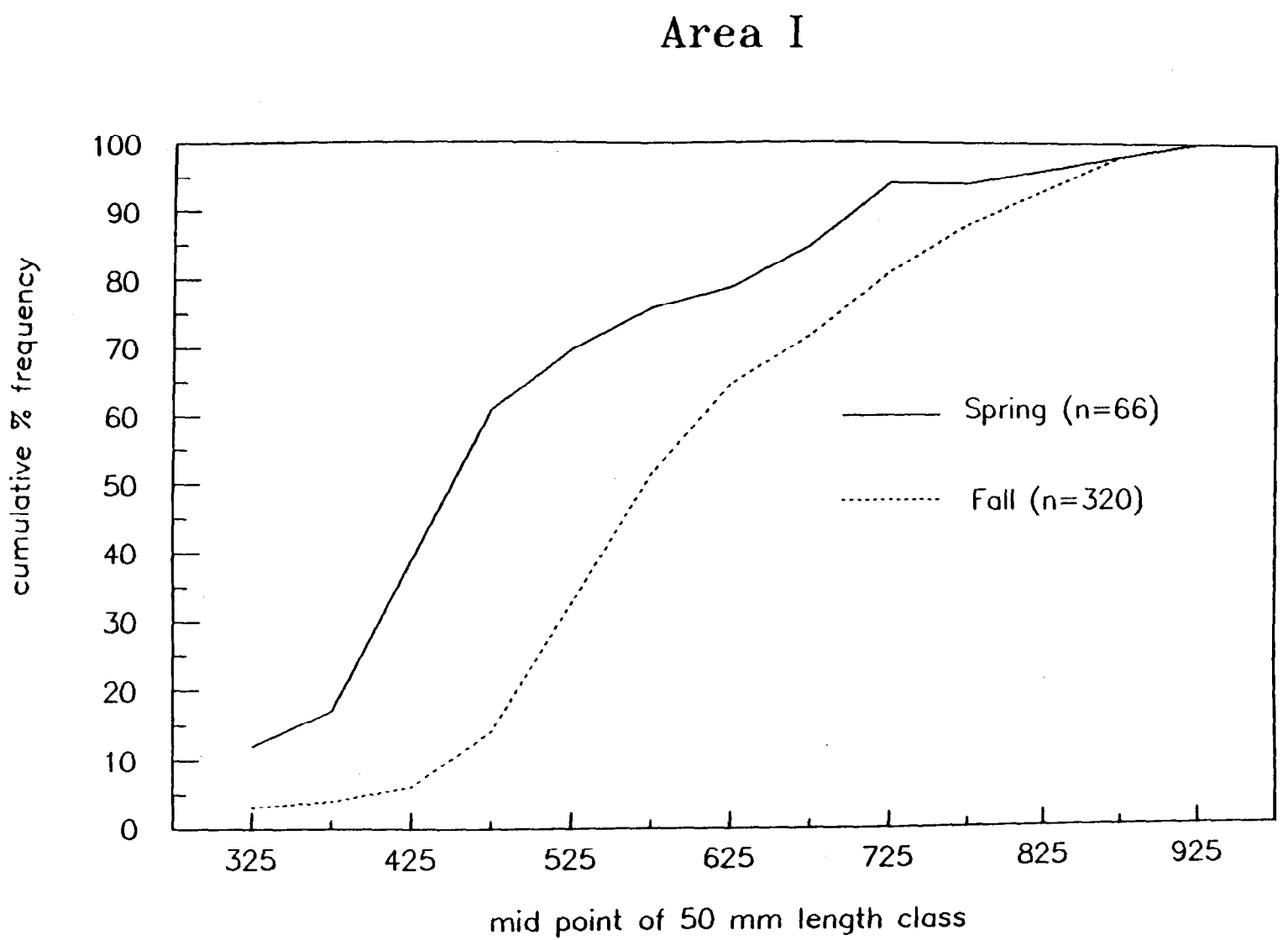

Figure 3. Cumulative length frequency (mm) of northern pike captured in Area I of Minto Flats in spring and fall 1989.

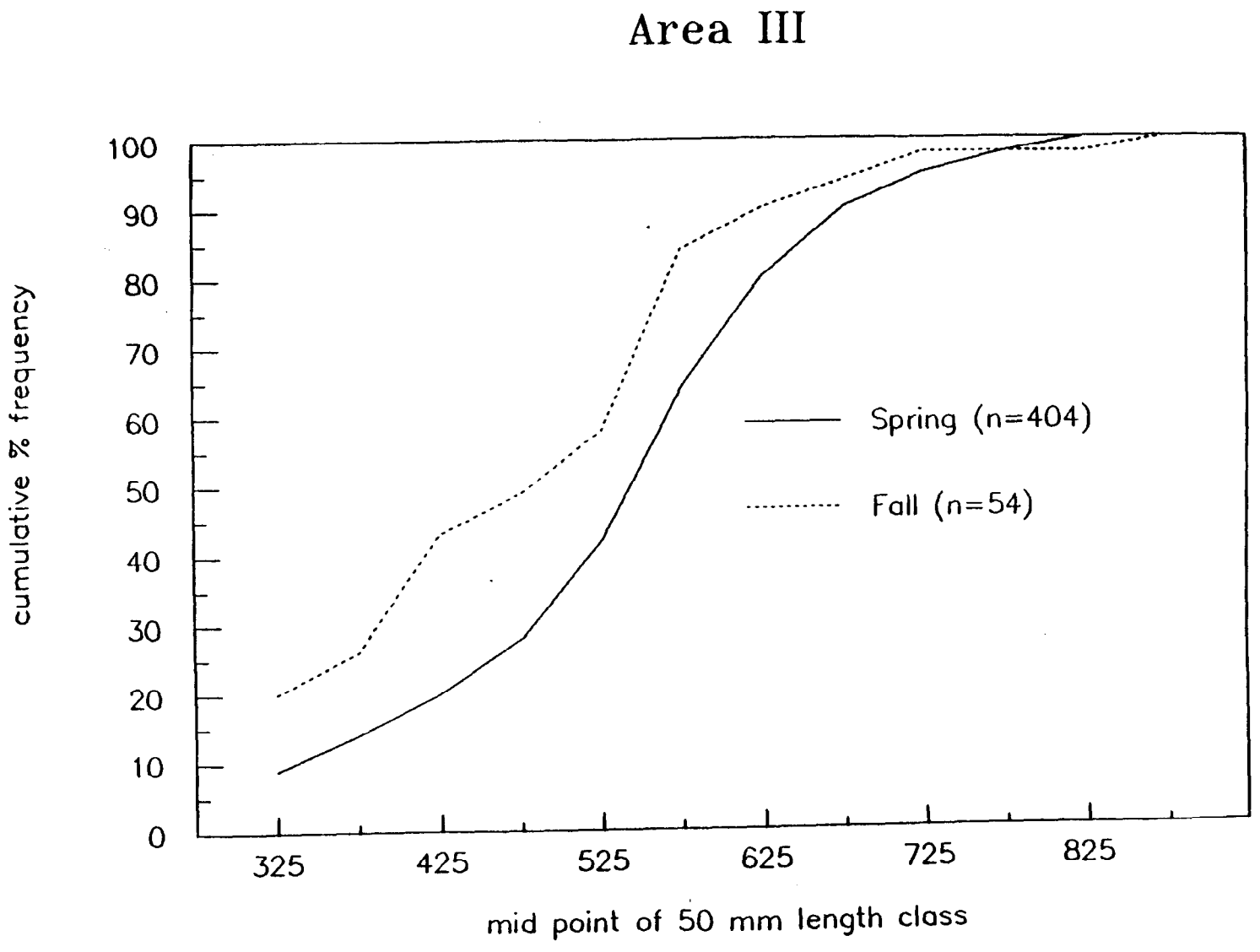

Figure 4. Cumulative length frequency (mm) of northern pike captured in Area III of Minto Flats spring and fall 1989.

Table 2. Percentage of northern pike in Relative Stock Density categories for spring and fall samples in Area I.

		Spring			Fall		
Category	Gablehouse Minimum Length	Relative Stock Density[a]	SE	n	Relative Stock Density	SE	n
Stock	300 mm	63.64	5.97	42	21.87	2.31	70
Quality	525 mm	12.12	4.05	8	41.88	2.76	134
Preferred	655 mm	19.70	4.93	13	30.94	2.59	99
Memorable	860 mm	4.54	2.58	3	5.00	1.22	16
Trophy	1,080 mm				0.31	0.31	1
Totals		100.00		66	100.00		320

[a] Relative Stock Density expressed as a percentage: categories taken from Gabelhouse (1984).

Table 3. Percentage of northern pike in Relative Stock Density categories for spring and fall samples in Area III.

		Spring			Fall		
Category	Gablehouse Minimum Length	Relative Stock Density[a]	SE	n	Relative Stock Density	SE	n
Stock	300 mm	33.17	2.35	134	50.00	6.87	27
Quality	525 mm	48.27	2.49	195	40.74	6.75	22
Preferred	655 mm	18.06	1.92	73	9.26	3.98	5
Memorable	860 mm	0.50	0.35	2			
Trophy	1,080 mm						
Totals		100.00		404	100.00		54

[a] Relative Stock Density expressed as a percentage: categories taken from Gabelhouse (1984).

were in the preferred and memorable size categories than fish from Area III, for both spring and fall samples (Tables 2 and 3).

Sex was determined for 107 males and 34 females. Length frequency in samples of females in Area I was dissimilar to length frequencies in samples of males in Area I ($p < 0.05$) and males in Area III ($p < 0.05$); Figure 5). Length frequency in samples of males from Area I were not significantly different ($p = 0.99$) in samples of males from Area III. Females in Area III were not included due to known gear bias (about 35% were caught in trap leads).

Age Composition

Ages for northern pike > 299 mm ranged from age 1 to age 11 in Area I (Table 4) and from age 2 to age 10 in Area III (Table 5). Age 4 fish comprised the greatest proportion (43%) of samples from Area I in spring and fall (Table 4). Age 6 and age 5 fish comprised the greatest proportion (30% and 25%, respectively) of samples from Area III in the spring.

Length-at-Age

The asymptotic length (a) for northern pike captured in the spring of 1987-1989 was 941 mm (SE = 34 mm), the Brody growth coefficient (b) was 0.172 (SE = 0.19), and the theoretical age at length zero (c) was -0.652 (SE = 0.26) (Figure 6).

DISCUSSION

Spring flooding and timing of sampling during the fall may have contributed to small numbers of northern pike captured in Minto Flats in 1989. In the spring of 1989, high water and associated organic debris hampered the effectiveness of gill nets and modified hoop traps in capturing northern pike. Floating debris clogged, then destroyed, sampling gear. Flooding inundated sections 1 - 5 of Area I and created one expanse of water. Since northern pike were not restricted to defined channels or migration corridors, interception of northern pike by passive gear was greatly reduced. In the early 1970's Cheney (1972) also attributed low catch per unit effort for northern pike in Minto Flats during the spring to high water.

Northern pike migrate between sections of Minto Flats in fall, before dispersing to over-wintering sites. The migration was a discrete event and occurred just prior to freeze up in 1987 and 1988. Similar movement patterns have been reported for northern pike in the Chisana River drainage (Behrends and West 1987). During the migration, northern pike are concentrated, and it is at this time that electrofishing becomes an efficient method of capture. This resulted in a high rate of capture with electrofishing gear in 1987 and 1988 for specific sections of Minto Flats. However, in 1989 the fish were not concentrated and electrofishing gear was not effective in the capture of northern pike. It is hypothesized that northern pike dispersed to overwintering sites prior to the fall sampling event thus decreasing the rate of capture. Electrofishing in Minto Flats as well as the Dall River has not been an effective capture method on dispersed populations (Arvey and Burkholder in press).

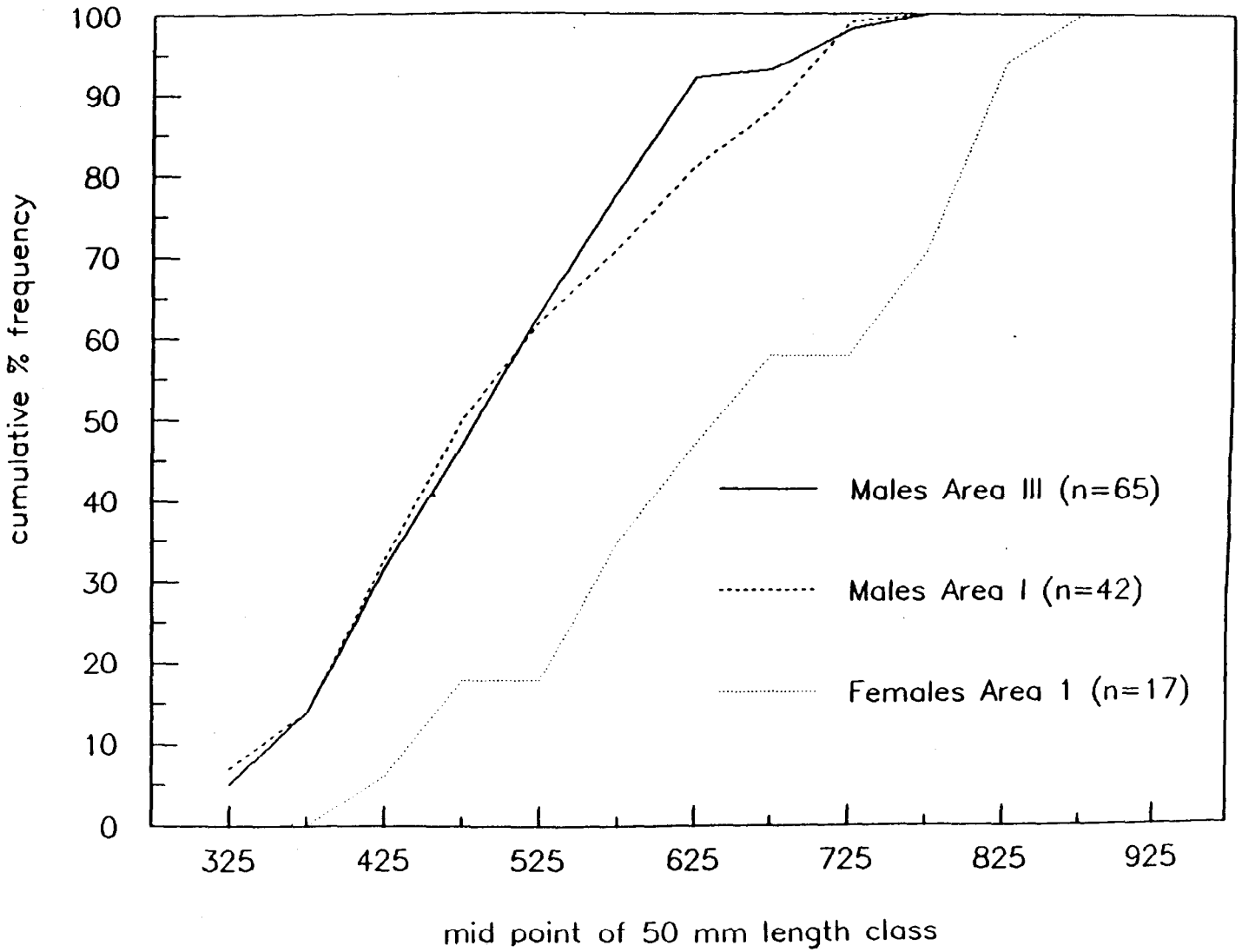

Figure 5. Cumulative length frequency (mm) of male and female northern pike captured in Area I and Area III in Minto Flats 1989.

Table 4. Age composition of northern pike >299 mm for spring and fall samples taken in Area I of Minto Flats.

	Spring			Fall		
Age Class	Sample Size	Sample Proportion	SE	Sample Size	Sample Proportion	SE
1				4	0.01	0.01
2	1	0.02	0.02	4	0.01	0.01
3	6	0.10	0.04	19	0.07	0.02
4	25	0.43	0.07	59	0.21	0.02
5	6	0.10	0.04	50	0.18	0.02
6	7	0.12	0.04	54	0.19	0.02
7	7	0.12	0.04	39	0.14	0.02
8	4	0.07	0.03	33	0.12	0.01
9	2	0.04	0.02	13	0.04	0.01
10				5	0.02	0.01
11				1	< 0.01	< 0.01
Totals	58	1.00		281	1.00	

Table 5. Age composition of northern pike >299 mm for spring and fall samples taken in Area III of Minto Flats.

	Spring			Fall		
Age Class	Sample Size	Sample Proportion	SE	Sample Size	Sample Proportion	SE
1						
2	15	0.04	0.01	11	0.23	0.06
3	24	0.07	0.01	9	0.19	0.06
4	34	0.10	0.01	6	0.13	0.05
5	87	0.25	0.02	13	0.28	0.07
6	104	0.30	0.02	5	0.11	0.05
7	55	0.16	0.02	2	0.04	0.03
8	22	0.06	0.01			
9	1	< 0.01	< 0.01	1	0.02	0.02
10	1	< 0.01	< 0.01			
11						
Totals	343	1.00		47	1.00	

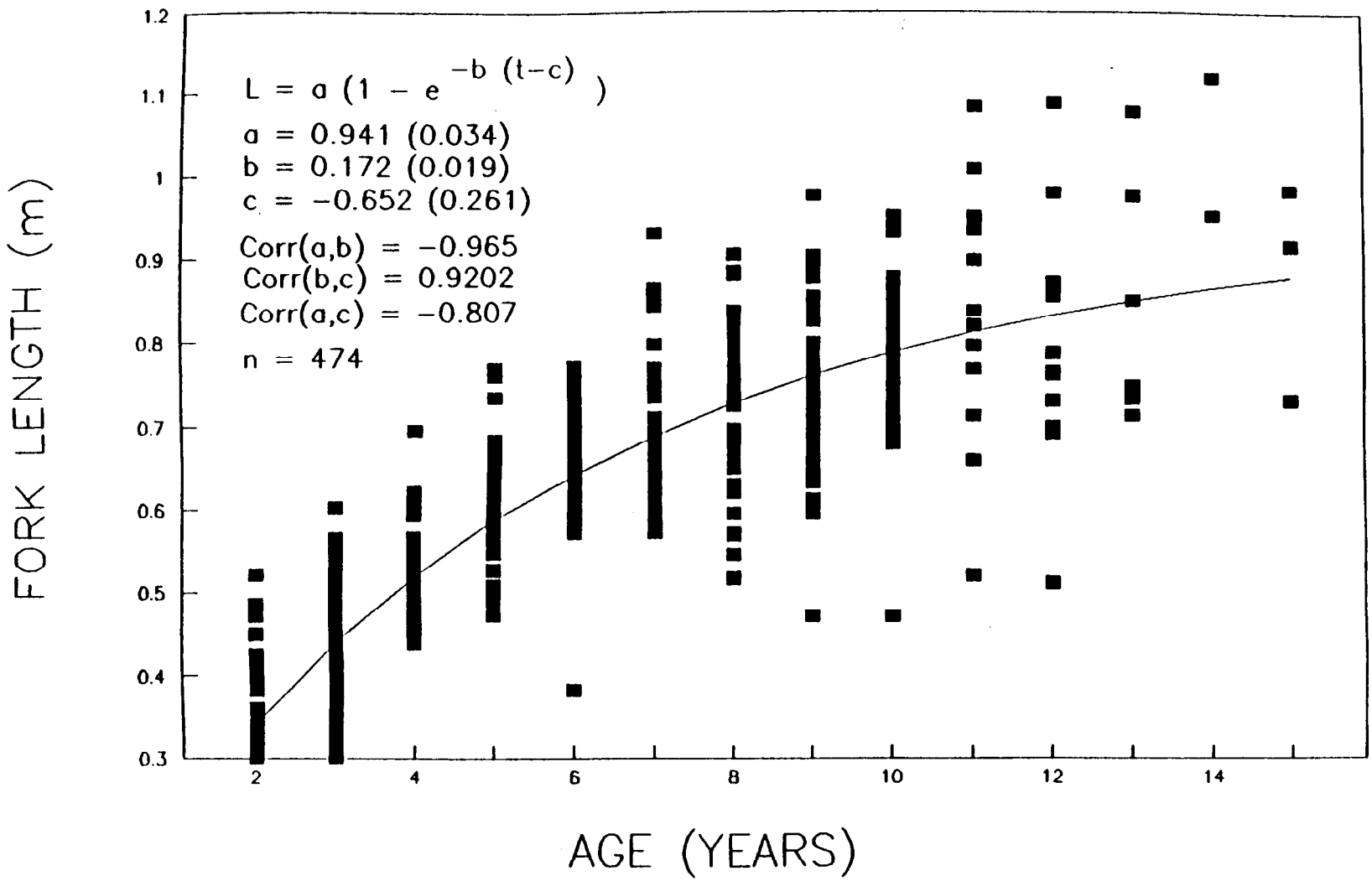

Figure 6. Length-at-age relationship for northern pike in Minto Flats.

The electrical fields for dropper and spherical electrodes were mapped and the associated power densities were calculated to determine if the spherical electrode was responsible for the unsuccessful electrofishing. Power densities were found to be higher for the spherical electrode (0.2 m to 4.0 m) than for the dropper electrode (Appendix B1), indicating the spherical electrode was not responsible for the unsuccessful electrofishing. Under better conditions (low water in the spring and correct timing of sampling in the fall) and/or by using different gear, the 1989 objectives probably could have been achieved in Minto Flats.

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APPENDIX A

Appendix A1. Water conductivity and VVP settings for sections electrofished in Minto Flats in 1989[a].

Section	Conductivity (μmhos at 25^0 C)	Volts	Amps
3	170	250	2.5
5	270	250	2.5
6	220	250	2.5
8	150	250	<1.0
10	220	220	2.5
13	240	220	2.5
18	210	220	2.5
20	260	220	2.5

[a] Duty cycle = 50%, and pulse rate = 20.

APPENDIX B

Appendix B1. Electrical fields for dropper and spherical anodes[a].

Distance (m)	Dropper Anode[b] Voltage Gradient (V/cm)	Dropper Anode[b] Power Density ($\mu W/cm^3$)	Spherical Anode[c] Voltage Gradient (V/cm)	Spherical Anode[c] Power Density ($\mu W/cm^3$)
0.00	4.93	3,403	2.64	976
0.00	5.51	4,250	2.53	876
0.00	5.20	3,786	2.78	1082
0.05	2.93	1,177	4.54	2886
0.05	3.22	1,452	3.26	1488
0.05	3.37	1,590	2.58	932
0.20	1.20	202	2.26	715
0.20	1.18	195	2.04	583
0.40	0.76	81	1.44	290
0.40	0.74	77	1.36	259
0.60	0.51	36	0.96	129
0.60	0.49	34	0.95	126
0.80	0.40	22	0.83	96
0.80	0.39	21	0.83	96
1.00	0.39	21	0.72	73
1.00	0.37	19	0.73	75
1.20	0.34	16	0.67	63
1.20	0.34	16	0.66	61
1.40	0.31	13	0.58	47
1.40	0.31	13	0.62	54
1.60	0.29	12	0.54	41
1.60	0.30	12	0.55	42
1.80	0.28	11	0.52	38
1.80	0.29	12	0.53	39
2.00	0.26	9	0.43	26
2.00	0.27	10	0.44	27
3.00	0.31	12	0.34	16
3.00	0.31	12	0.34	16
4.00	0.22	7	0.29	12
4.00	0.21	6	0.28	11

[a] Conductivity = 140 μmhos at 25^0 C.
[b] VVP: 430 V, 2.25 A.
[c] VVP: 430 V, 2.0 A.