Fishery Data Series No. 02-14

Stock Assessment of Northern Pike in Lake Aleknagik, 1998-1999

by

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Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

In 1998 and 1999, we performed a capture-recapture experiment to determine abundance of northern pike *Esox lucius* in Lake Aleknagik, located in Southwest Alaska. Radiotelemetry was used to determine that the northern pike population in the lake was closed from July 1998 through July 1999, and thus that abundance and length composition of northern pike in the lake could be reliably estimated by the experiment. Estimated abundance was 11,580 (SE = 800) northern pike ≥300 mm fork length in 1998. However, abundance was probably slightly more because northern pike were not recaptured in one of the sampling locations. The mean length of northern pike was 485 mm (SE = 0.05; n = 1,249) in 1998, which was similar to the 1999 mean length of 489 mm (SE = 0.08; n = 1,102).

Key Words: northern pike, *Esox lucius*, Lake Aleknagik, length composition, population abundance, radiotelemetry.

INTRODUCTION

Northern pike *Esox lucius* are an important subsistence species in Southwest Alaska and have become increasingly popular with sport anglers. The Wood River Lake system (Figure 1), located in Wood-Tikchik State Park, supports one of the most highly exploited northern pike populations in Southwest Alaska (Minard et. al 1998). Average annual sport harvest of northern pike in this system was 241 fish from 1990 to 1999 (Mills 1991-1994; Howe et al. 1995 and 1996, 2001a-d; Table 1). Total subsistence harvest of northern pike in the Wood River Lake system is unknown but probably far exceeds the sport harvest.

Information about northern pike of the Wood River Lakes is limited. Chihuly (1976) estimated size composition of northern pike but did not estimate abundance. Limited sampling conducted in 1997 suggested that the size composition might have declined since Chihuly's study. The goal of our study was to conduct a stock assessment of northern pike in Lake Aleknagik. To accomplish this, information was needed on abundance and size composition of northern pike. This information will be used to develop a management plan for Lake Aleknagik and other nearby lakes.

Research objectives for this study were to:

1. Investigate the feasibility of estimating abundance by determining if there was geographic closure of the northern pike population in Lake Aleknagik from 1998 through 1999;
2. If there was closure, estimate the abundance of northern pike in Lake Aleknagik in 1998; and
3. Estimate age and length compositions of northern pike ≥300 mm in Lake Aleknagik in 1998 and 1999.

METHODS

NORTHERN PIKE SAMPLING

Lake Aleknagik was divided into four sampling locations (Figure 2) to help ensure uniform distribution of effort. A combination of angling, hoop traps, and variable mesh gillnets was used to capture northern pike immediately following ice-out in 1998 and 1999. Gillnets were set parallel to shore when fish were in shallow vegetation. Northern pike were actively moved into the nets by wading and splashing. At other times, gillnets were arranged perpendicular to shore and fish were allowed to move without disturbance. Perpendicular gillnet sets were

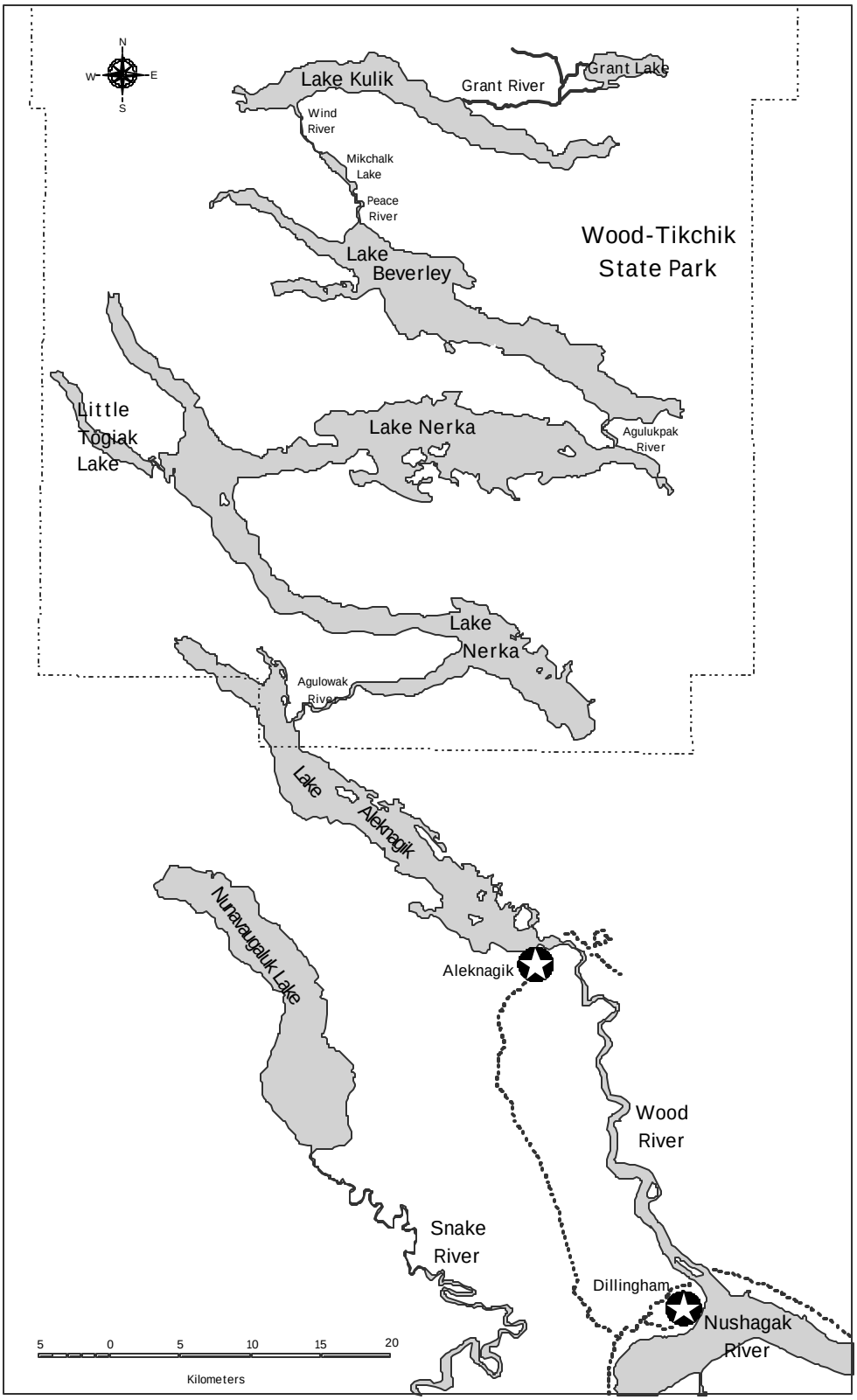

Figure 1.-Map of Wood River Lakes system.

Table 1.-Sport harvest of northern pike from the Wood River Lakes system, 1990-1999.

Year	Harvest
1990	99
1991	503
1992	333
1993	139
1994	126
1995	373
1996	258
1997	351
1998	54
1999	173
Average	241

checked a minimum of once every hour, and hoop traps were checked daily.

All captured fish were measured for fork length (FL) to the nearest millimeter. Healthy northern pike ≥ 300 mm FL were tagged with an individually numbered Floy T-bar anchor tag inserted in the basal rays of the dorsal fin on the left side. Tagged fish were also finclipped in 1998 to evaluate tag loss.

ABUNDANCE

A multiple-year capture-recapture experiment based on two sampling events was used to estimate abundance of northern pike. An important assumption of the multiple-year capture-recapture experiment was that every animal in the population had the same probability of being caught each year (Seber 1982).

Assumptions for this design (Seber 1982) were:

1. The population was closed;
2. Fish had the same probability of being marked, or fish had the same probability of capture in the second event, or marked and unmarked fish mixed between events;
3. Capture of fish in the first event did not affect the probability of recapture;
4. Fish did not lose marks before the second event; and
5. Recaptures in the second event were reported.

We assumed that marked and unmarked fish were equally vulnerable to mortality (Seber 1982). All captured fish were examined for tags and finclips to assess potential problems of tag loss. To improve chances of equal probability of capture, effort was distributed equally among all locations and gear types. Sampling occurred over a long period, approximately 45 days, to minimize problems of marked fish not mixing with unmarked fish. Samples collected in 1999 were utilized as the second event of the mark-recapture experiment.

RADIOTELEMETRY

To test assumption 1 in Lake Aleknagik, radiotelemetry was used to track movements of northern pike during 1998 and 1999. In June and July of 1998, 60 mature northern pike were implanted with Advanced Telemetry Systems[1] high frequency radio transmitters following procedures described by Hart and Summerfelt (1975). Movements were periodically monitored by aerial and boat surveys and continuously by fixed stations at the inlet and outlet of the lake. A Global Positioning System (GPS) was used to record latitude and longitude and verify visual locations of fish.

[1] Product names used in this report are included for scientific completeness but do not constitute product endorsement.

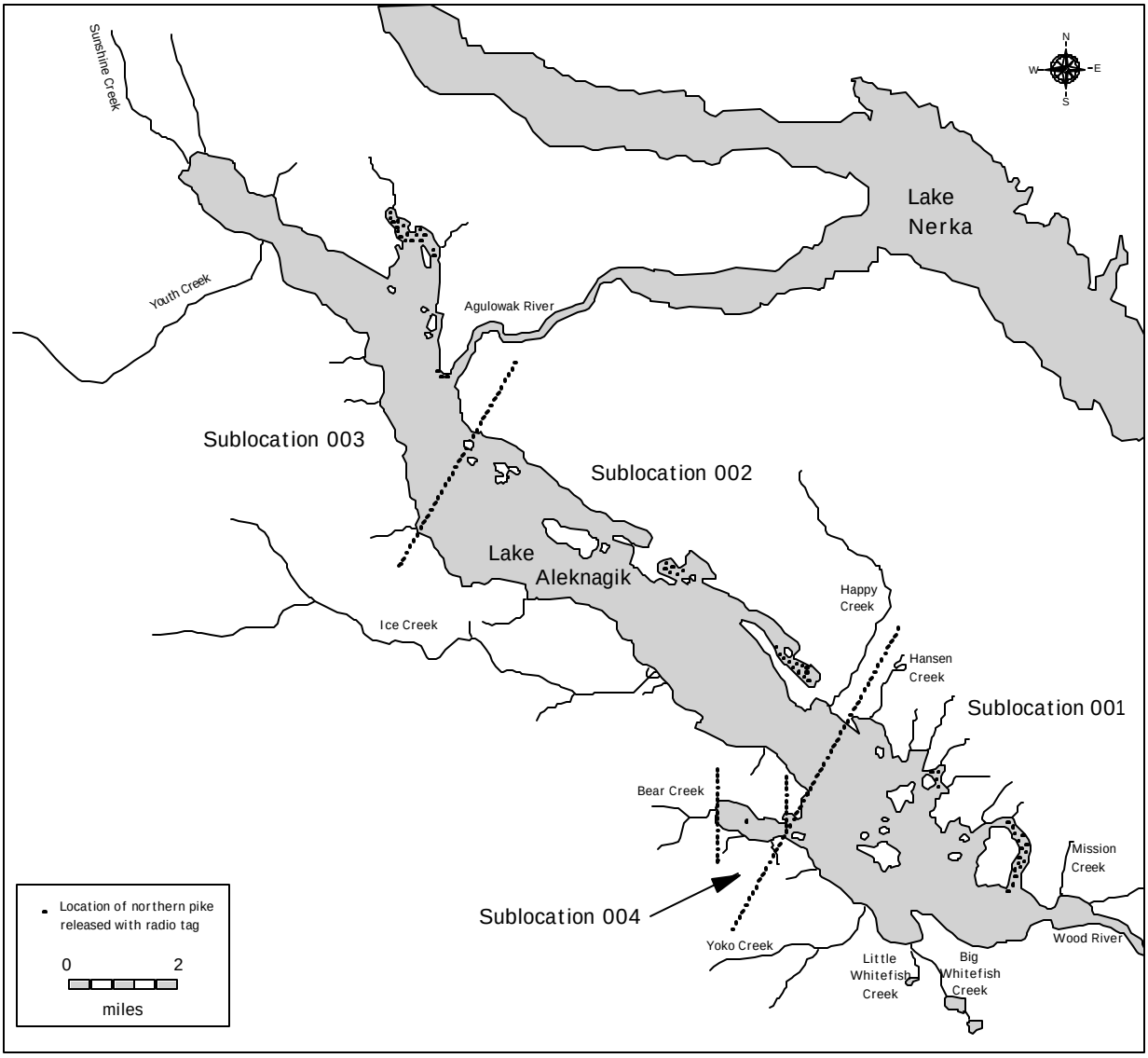

Figure 2.-Lake Aleknagik sampling areas.

DATA ANALYSIS

Tests for consistency of the Petersen estimate (Seber 1982, page 438) were used to check for incomplete mixing and differences in recapture rates and marking rates between locations (assumption 2). An analysis of growth recruitment between 1998 and 1999 followed procedures of Robson and Flick as outlined in Seber 1982 (pages 74-81).

Length class proportions for fish ≥ 300 mm FL were estimated by:

$$\hat{p}_k = \frac{x_k}{n}, \text{ and} \quad (1)$$

$$\hat{V}[\hat{p}_k] = \frac{\hat{p}_k(1-\hat{p}_k)}{n-1}; \quad (2)$$

where:

$\hat{p}_k$ = the proportion of fish in length class or age k;

x_k = the number of sampled fish that were in length class or age k; and

n = the number of fish that were measured for length or for which ages were determined.

Data files and computer programs used to produce this report are listed in Appendix A1.

RESULTS

RADIOTELEMETRY AND POPULATION ABUNDANCE

In June and July of 1998, 60 mature northern pike were implanted with radio transmitters (Figure 2). Tracking of northern pike (Table 2) indicated that early in the year (ice-out; May 12) when water temperatures were 1°-5°C, fish were located in moderately deep water (1-1.5 m) approximately 8-10 m offshore. Fish then moved closer to shore as water temperatures rose to about 6°C, and by May 31 fish were in nearshore areas spawning in brush and submerged vegetation. As spawning was completed from June 5–June 20 and water temperatures rose to above 8°C, fish began to move slightly farther offshore into 1-3 m of water but still remained in the bays in which they had spawned. Very little movement occurred for the remainder of June, July, and August, and no movement between sublocations or out of the lake was recorded during this period.

Fish began moving into the main lake to a depth of 3-5 m in mid-September when water levels and temperatures began to drop to below 8°C. Movements into the main lake continued during October when northern pike appeared to be moving to overwintering areas. During October, two fish also moved between sublocations (from 001 to 004 and from 002 to 001) indicating that mixing occurred between sublocations. Fish remained in the main lake in 3-5 m of water, and no significant movements were detected from November 1998 through April 1999. No movement was detected out of the lake by the fixed stations at the inlet and outlet of the lake. Therefore, we assumed the population within the lake was closed. Of the four sublocations where fish marked with Floy tags were released, sublocation 004 only had five tags released and there were no recaptures among 54 fish examined there in 1999. Thus, sublocation 004 was deleted from the analysis. For the remaining sublocations, 1,314 fish were marked and released in 1998. Among 1,097 fish examined for the second event in 1999, 989 fish

Table 2.-Numbers of radio-implanted northern pike released, number alive, and mortalities located, by date of tracking.

Date (m/d/yr)	Cumulative number of tags released	Number alive located	Number mortalities located
7/5/1998	40	33	1
7/20/1998	44	30	0
7/30/1998	52	41	1
8/6/1998	56	40	1
8/16/1998	59	49	2
8/25/1998	60	57	1
9/13-14/1998 [a]	60	12	1
9/24/1998	60	26	7
10/2/1998	60	42	6
10/21/1998	60	23	7
10/30/1998 [a]	60	0	1
11/10/1998	60	23	6
2/16/1999	60	18	10
3/23/1999	60	43	1
5/7/1999	60	29	13
5/17/1999	60	46	12
5/25/1999	60	37	8
6/3/1999	60	33	8
6/11/1999	60	29	9
6/17-18/99	60	36	9
6/22/1999	60	30	9
7/5/1999	60	31	12
7/16/1999	60	33	12
7/29/1999	60	24	4

[a] Survey incomplete and/or poor tracking conditions.

were unmarked and 108 were recaptured with marks.

Break points for testing for effects of recruitment were 323, 329, 350, 400, 418, 432, 459, 466, 480, and 490 mm. Non-parametric tests for growth recruitment indicated that fish in length classes ≥400 mm were not affected by growth recruitment. A contingency table comparing frequencies of marked and unmarked fish in the second event among sublocations 001, 002, and 003 indicated that marking rates were equal at 0.12 among the three sublocations (P = 0.71); therefore geographic stratification was not necessary.

The Robson-Flick abundance estimate for sublocations 001, 002, and 003 during 1998 was 11,580 (SE = 800, CV = 7%) northern pike. Total abundance was probably more because sublocation 004 was not included in the analysis. This estimate depended on the assumption that the length distribution of fish tagged in 1998 was representative of the population.

LENGTH COMPOSITION

In 1998, fork length of captured northern pike in Lake Aleknagik ranged from 310-736 mm, with a mean of 485 mm (SE = 0.05; n = 1,249; Table 3, Figure 3). In 1999, northern pike ranged from 300-936 mm, with a mean of 490 mm (SE = 0.08; n = 1,102; Table 4, Figure 3). Northern pike that were 400-599 mm in length comprised approximately 88% of the population in 1998 and 73% in 1999.

DISCUSSION

This is the first study of northern pike in Lake Aleknagik since Chihuly (1976). Although the study objectives were different from the previous study, two of our findings are comparable with those of Chihuly. The proportion of large (>800 mm FL) northern pike in Lake Aleknagik was low during our study and the previous study. Chihuly (1976) found only two northern pike >800 mm total length in a sample of more than 2,000 fish, and only three northern pike were >800 mm FL in our 1998-1999 sample of 2,351 fish. Our observations of northern pike habitat associations in Lake Aleknagik are also similar to those of Chihuly (1976). Movements of northern pike were typical of those documented in other studies as northern pike were consistently located in warm, shallow bays containing dense stands of

Table 3.-Length composition (mm FL) of northern pike ≥300 mm in Lake Aleknagik, 1998.

Length Class	Number of Fish	Proportion	SE
300-324	2	0.0016	0.0011
325-349	9	0.0072	0.0024
350-374	25	0.0200	0.0040
375-399	64	0.0512	0.0062
400-424	124	0.0993	0.0085
425-449	170	0.1361	0.0097
450-474	200	0.1601	0.0104
475-499	170	0.1361	0.0097
500-524	175	0.1401	0.0098
525-549	105	0.0841	0.0079
550-574	82	0.0657	0.0070
575-599	69	0.0552	0.0065
600-624	27	0.0216	0.0041
625-649	11	0.0088	0.0026
650-674	5	0.0040	0.0018
675-699	5	0.0040	0.0018
700-724	3	0.0024	0.0014
725-749	3	0.0024	0.0014
750-774	0	0.0000	
775-799	0	0.0000	
800-824	0	0.0000	
825-849	0	0.0000	
850-874	0	0.0000	
875-899	0	0.0000	
900-924	0	0.0000	
925-950	0	0.0000	
Total	1,249	1.0000	

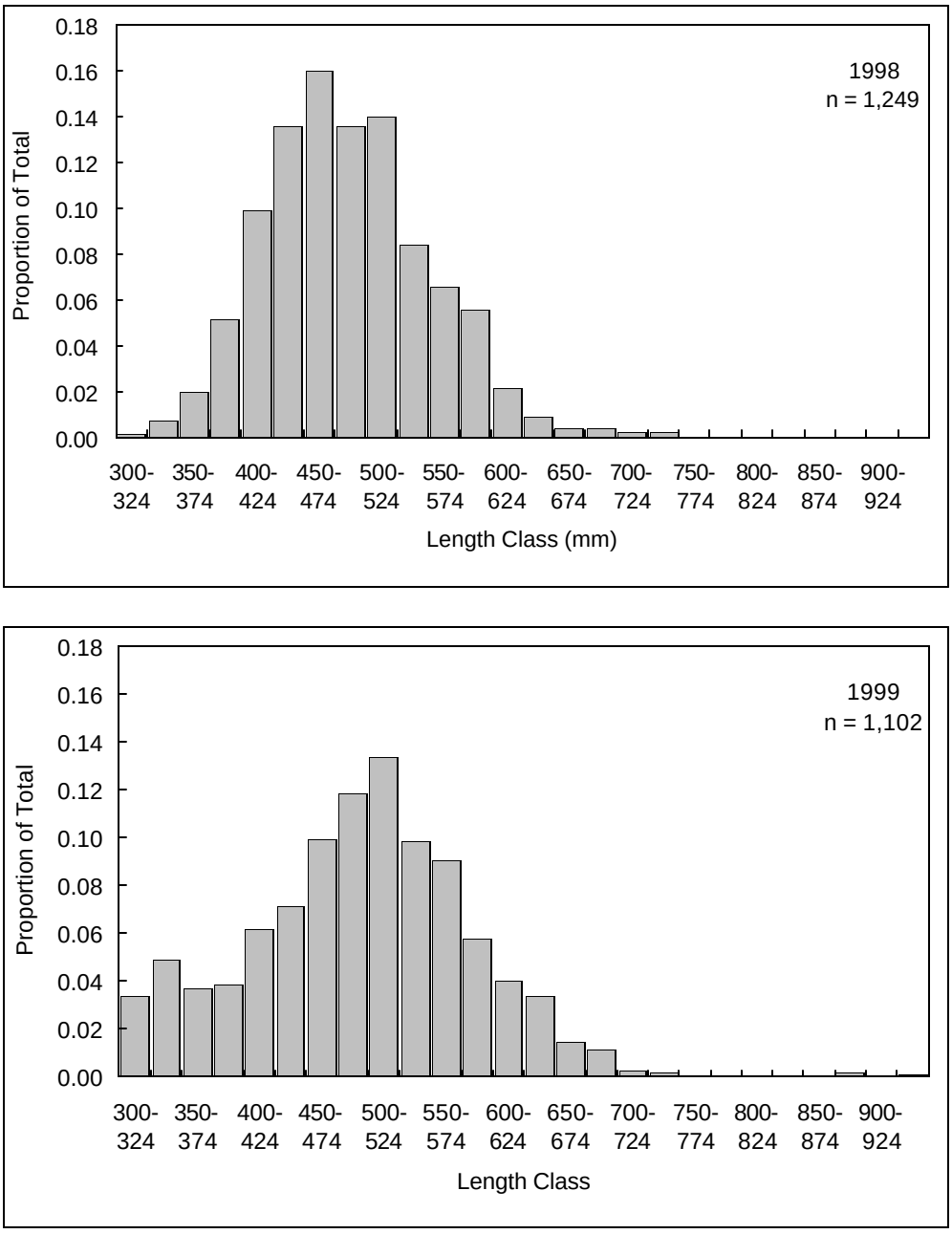

Figure 3.-Length frequency distribution of northern pike ≥300 mm FL in Lake Aleknagik during 1998 and 1999.

aquatic vegetation (Chihuly 1976). This type of habitat comprises less than 5% of the total surface area in Lake Aleknagik (Chihuly 1976). Significant movements occurred only during spring as northern pike moved to spawning and feeding areas and during fall as they moved offshore to overwintering areas.

Because this was the first estimate of northern pike abundance in the Wood River Lakes system comparative data are limited to interior Alaska.

Roach (1997) estimated an abundance of 1,780 northern pike ≥300 mm FL in Harding Lake, an oligotrophic lake located near Fairbanks, Alaska. Estimated abundance of northern pike ≥300 mm FL in Lake Aleknagik was 11,580 fish. However, the relative density of northern pike in Lake Aleknagik was 1.39 fish/ha which was similar to the 1.78 fish/ha estimated for Harding Lake (Roach 1997).

Table 4.-Length composition (mm FL) of northern pike ≥300 mm in Lake Aleknagik, 1999.

Length Class	Number of Fish	Proportion	SE
300-324	37	0.0336	0.0054
325-349	54	0.0490	0.0065
350-374	41	0.0372	0.0057
375-399	43	0.0390	0.0058
400-424	68	0.0617	0.0073
425-449	79	0.0717	0.0078
450-474	110	0.0998	0.0090
475-499	131	0.1189	0.0098
500-524	148	0.1343	0.0103
525-549	109	0.0989	0.0090
550-574	100	0.0907	0.0087
575-599	64	0.0581	0.0070
600-624	44	0.0399	0.0059
625-649	37	0.0336	0.0054
650-674	16	0.0145	0.0036
675-699	13	0.0118	0.0032
700-724	3	0.0027	0.0016
725-749	2	0.0018	0.0013
750-774	0	0.0000	
775-799	0	0.0000	
800-824	0	0.0000	
825-849	0	0.0000	
850-874	0	0.0000	
875-899	2	0.0018	0.0013
900-924	0	0.0000	
925-950	1	0.0009	0.0010
Total	1,102	1.0000	

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APPENDIX A. COMPUTER FILES AND SOFTWARE

Appendix A1.-Computer files from 1998 and 1999 and software used to produce this report.

Data files:	Description
T-000401b011998.dta	1998 Aleknagik Lake northern pike AWL data.
T-000401b011999.dta	1999 Aleknagik Lake northern pike AWL data.

Analysis programs:	Description
KS2M.EXE	A program developed by ADF&G Sport Fish Division, Research and Technical Services staff for conducting Kolmogorov-Smirnov two-sample tests.
ADK2.EXE	A program developed by ADF&G Sport Fish Division, Research and Technical Services staff for conducting Anderson-Darling K-Sample tests.
BBX.SAS	A SAS program that uses biological data (AWL files) to produce tables of mean length and weight by sex and age group.