Fishery Data Series No. 10-05

Control Efforts for Invasive Northern Pike on the Kenai Peninsula, 2005–2006

by

Robert L. Massengill

March 2010

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

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

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
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
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mid eye to fork	MEF
mid eye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
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	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
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.
minute (angular)	'
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
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 10-05

CONTROL EFFORTS FOR INVASIVE NORTHERN PIKE ON THE KENAI PENINSULA, 2005-2006

by
Robert L. Massengill
Alaska Department of Fish and Game, Division of Sport Fish, Soldotna

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

March 2010

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Robert L. Massengill,
Alaska Department of Fish and Game, Division of Sport Fish,
43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669-8367, USA

This document should be cited as:
Massengill, R. L. 2010. Control efforts for invasive northern pike on the Kenai Peninsula, 2005-2006. Alaska Department of Fish and Game, Fishery Data Series No. 10-05, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Invasive northern pike found in Southcentral Alaska, including the Kenai Peninsula, originated from illegal introductions and subsequent pioneering. Northern pike are native to many areas north of the Alaska Range. Invasive northern pike have the potential to severely impact native fish species, particularly salmonids and trout. This report summarizes efforts to reduce the population of northern pike in two Kenai Peninsula lakes and to inventory for the presence of northern pike in other local lakes. In 2005 and 2006, a total of 2,538 and 732 northern pike were removed, respectively, from two Kenai Peninsula area lakes. The Derks Lake northern pike catch per unit effort (CPUE) for gillnets was 0.067 in 2005 and 0.051 in 2006. The Sevena Lake northern pike CPUE was 0.241 in 2005 and 0.084 in 2006. *T*-tests comparing the mean CPUE between years for each lake showed the mean CPUE did not decrease significantly between 2004 and 2005 (Derks Lake [P =0.05] and Sevena Lake [P = 0.001]), 2005 and 2006 (Derks Lake [P = 0.10] and Sevena Lake [P = 0.03]), or 2004 and 2006 (Derks Lake [P = 0.03] and Sevena Lake [P = 0.00014]). Both lakes had higher proportions of smaller (juvenile) northern pike in 2006 compared to those taken in 2005. Nineteen other local lakes, suspected or believed to contain northern pike, were inventoried with gillnets in 2006 and northern pike were confirmed in six.

Key words: Kenai Peninsula, Derks Lake, Sevena Lake, northern pike, CPUE, invasive species.

INTRODUCTION

The Kenai Peninsula is one of the premier sport fishing areas in Alaska, receiving over 800,000 angler-days of effort in 2005; which is 33% of the total sport fishing effort in Alaska (Jennings et al. 2009). Most angling effort on the peninsula is directed at the Kenai River which is renowned worldwide for its large Chinook salmon *Oncorhynchus tshawytscha* and other popular fisheries for coho salmon *O. kisutch*, sockeye salmon *O. nerka*, rainbow trout *O. mykiss*, and Dolly Varden *Salvelinus malma*.

A growing threat to sport fisheries on the Kenai Peninsula is the (illegal) introduction and spread of northern pike *Esox lucius* into the lakes and streams of the area. These fish are indigenous north and west of the Alaska Range, but not on the Kenai Peninsula. This species was illegally introduced sometime during the 1970s into the Soldotna Creek drainage (Table 1, Figure 1) and were confirmed there by the Alaska Department of Fish and Game (ADF&G) in 1976[1]. Soldotna Creek is an open tributary of the Kenai River drainage. Northern pike spread from the initial introduction point, suspected to be Derks Lake, to the remainder of the Soldotna Creek drainage including East Mackey, West Mackey, Denise, Union, Sevena (Soldotna), and Tree lakes.

Northern pike are also present in Stormy Lake, a tributary to the Swanson River. Illegally introduced northern pike are also present in a series of landlocked lakes, located in the Tote Road area approximately 5 miles south of the city of Soldotna (Athons *Unpublished*[2]) The most recent locations where northern pike populations have been discovered are Arc Lake (confirmed in 2000) and Scout Lake (confirmed in 2005). Both of these discoveries were made by ADF&G stocked lakes personnel (P. Berkhahn, ADF&G fishery biologist, Soldotna, *personal communication*). Prior to the discovery of northern pike, both lakes were regularly stocked by ADF&G with salmon but stocking has since been discontinued. Lakes within the upper Moose River drainage that are open to the Kenai River are vulnerable to colonization by northern pike and there have been rare reports of northern pike being caught or observed there (Booth and Otis 1996; T. McKinley, ADF&G fishery biologist, Soldotna, *personal communication*).

---

[1] Northern Pike (Esox lucius L.) in the Soldotna Creek System. 1976. *Unpublished* report. Located at: ADF&G area office, Soldotna, AK; Division of Sport Fish, Research Biologist, *Soldotna Creek drainage* file.

[2] Athons. D. E.. *Unpublished*. October 19, 1983 memorandum to Soldotna office sport fish management biologist. Located at: ADF&G area office, Soldotna, AK; Division of Sport Fish, Management Biologist, *Totes Road Lakes* file. Subsequently referred to as (Athons, memorandum).

Northern pike prefer slow moving waters, vegetated habitat (Inskip 1982), and they rarely inhabit lake habitat away from the littoral zone. They are known to utilize similar habitat as some resident fish species and rearing/migrating salmonids (Rutz 1996). Rutz (1999) reported that stomach content analysis of Susitna River drainage northern pike revealed 80% of non-empty stomachs contained juvenile salmonids in an area where sticklebacks were also abundant. Prior to the introduction of northern pike, the lakes of Soldotna Creek drainage supported rainbow trout, Dolly Varden, and rearing salmon (primarily coho salmon). McKinley (*In prep*) found that many lakes in the Soldotna Creek drainage lost their salmonid populations after northern pike became established. The introduction of northern pike into local lakes threatens the same species that sustain the area's large sport fisheries, and also the overall balance of the ecosystem.

A survey conducted by ADF&G through a grant from the U.S. Fish and Wildlife Service (FWS), Cook Inlet Coastal Program found northern pike in seven of eight major lakes in the Soldotna Creek drainage (McKinley *In prep.*). A northern pike reduction program, conducted by ADF&G through a grant from the FishAmerica foundation in 2003, removed 1,535 northern pike from East and West Mackey lakes in the Soldotna Creek drainage via intensive gillnetting (Begich and McKinley 2005). In 2004 gillnet operations were continued at East and West Mackey lakes and expanded to include Derks and Sevena lakes in the Soldotna Creek drainage (McKinley *In prep.*). Since 2005, only Derks and Sevena lakes have been targeted for control efforts.

The goals of this project were to: (1) reduce the northern pike population and the migration of adult northern pike from Derks and Sevena lakes to Soldotna Creek to provide an opportunity for native species to rebound and reduce the likelihood of northern pike pioneering elsewhere, (2) collect lake water quality, stream flow, and lake volumetric data useful for planning future northern pike control strategies, and (3) inventory additional water bodies for the presence or absence of northern pike.

Objectives for 2005 and 2006 were to:

OBJECTIVES AND TASKS

2005 OBJECTIVES

1. Remove northern pike from Derks and Sevena lakes by harvesting them with gillnets.
2. Collect fork length[3] (FL) information for within and across year's comparisons of size distributions of the harvest.

2006 OBJECTIVES

1. Remove northern pike from Derks and Sevena lakes by harvesting them with gillnets.
2. Collect fork length (FL) information for within and across year's comparisons of size distributions of the harvest.
3. Test the hypothesis that the mean catch per unit effort ($\overline{CPUE}$) of gillnets set in Derks and Sevena lakes in 2006 is equal to or less than the $\overline{CPUE}$ of gillnets set in these lakes

[3] *Fork length* is the distance from the tip of the snout or lower jaw (whichever projects farther) to the tip of the middle rays of the tail fin (Morrow 1980).

during 2004 through 2005, such that a decrease of 0.04 in $\overline{CPUE}$ can be detected with at least 80% power and probability of a type I error equal to 0.05.

4 Map the bathymetry of at least 50% of Kenai Peninsula lakes with known northern pike populations where no bathymetric maps exist or for those with bathymetric maps that are outdated.

5. Use gillnets to document the presence or absence of northern pike in suspect lakes. Lakes to be sampled with gillnets include: Spirit Lake (also known as Elephant Lake), several unnamed lakes/ponds within 1.5 miles of East and West Mackey lakes, several unnamed lakes/ponds within 1.5 miles of the Tote Road Area lakes, and perhaps other lakes that are reported to contain northern pike

6. Collect water quality data periodically from all Kenai Peninsula lakes with known northern pike populations. Data to collect include: temperature, turbidity, dissolved oxygen, and pH, including stream discharge measurements of most tributaries in Soldotna Creek drainage.

7. Quantify northern pike spawning and rearing habitat in Soldotna Creek drainage.

Tasks

Collect size (FL) information from all northern pike harvested with gillnets. Evaluate differences in mean FL between years within lakes. Examine whether cumulative FL distributions change between years within lakes.

METHODS

STUDY DESIGN AND DATA COLLECTION

Control Netting

Sinking monofilament gillnets, manufactured by Christiansen's Nets[4], each 120 ft long, 6 in deep, with six 20 ft wide panels of variable mesh net (one each of sequentially attached ½ in, 5/8 in, ¾ in, 1 in, $1^1/_2$ in, and 2 in stretched mesh) with a ½ in diameter lead line were set to capture and remove northern pike.

Gillnets were set in littoral areas by a two-person crew operating from a skiff powered by an outboard motor. Nets were typically tethered to a fencepost onshore. An owl decoy was placed on top of the fencepost to discourage predation by birds. The small mesh end of the variable mesh gillnet was set inshore and the rest of the net was fed off the bow of the boat by one crew member as the other backed the boat away from shore in reverse. When the net was fully extended the outer end of the net was dropped. A two pound halibut weight attached to the lead line anchored it in place. A small buoy or cork was tied to the float line to mark the offshore end of the net and help the crew locate it upon their return.

Gillnetting effort varied during 2005 and 2006 between lakes and years due to weather and time constraints. However, whenever possible, an effort was made to fish each lake with a similar number of sets (one set = one gillnet fished for approximately 24 hours) each season. Most often this resulted in 48 sets per lake per week for at least several weeks each season.

[4] Product name is included for complete description of process, and does not constitute a product endorsement.

Gillnetting was conducted annually in the spring and fall. The general weekly fishing schedule was: set all gillnets on Monday, check all gillnets once daily from Tuesday through Thursday, and check and pull all gillnets from the water on Friday. No gillnets were fished on Saturday or Sunday.

Spring gillnetting was scheduled to begin immediately after ice-out in Derks and Sevena lakes. Fall gillnetting was to begin around the last week of September. We standardized the time of year to deploy gillnets to coincide with life history phases, such as post-spawning, so that netting results could be compared between years.

All captured northern pike were harvested. Each fish was placed in a tote in the netting boat and later measured for FL to the nearest millimeter. Time of each net set and check was recorded to the nearest minute and the number of northern pike harvested from each net was recorded. Harvested fish were taken to the Kenai Peninsula Food Bank in Soldotna for distribution to local families or used for educational purposes.

Water Quality/Streamflow/Mapping

In 2006, we collected monthly lake water quality data for 12 consecutive months at select lakes in the Soldotna Creek drainage and at two landlocked lakes near Soldotna. We also collected monthly stream discharge (ft^3/s) and water quality data for select streams in the Soldotna Creek drainage. Water quality parameters to be measured included: temperature (^oC), dissolved oxygen (mg/L), pH, and specific conductivity (mS/cm). We also planned to map suitable northern pike spawning habitat as described by Inskip (1982) and lake bathymetry in 2006 and 2007. Because the data collection needed to achieve these objectives is still ongoing, details for the study design and data collection will appear in a future report.

Northern Pike Inventory

Additional lakes were fished in 2006 with the same type of gillnets used for control efforts. The lakes targeted for inventory were those suspected of being highly vulnerable to northern pike infestation due to proximity to existing northern pike waters or those rumored to have had northern pike catches.

All fish captured for the northern pike inventory study were treated identically to those captured for the control netting portion of this study. Each fish was measured for FL to the nearest millimeter. The time of each net set and check was recorded to the nearest minute and the number of all fish harvested from each net was recorded. All harvested fish were taken to the Kenai Peninsula Food Bank for distribution to local families or used for educational purposes.

Lakes identified with suspected populations of northern pike that are scheduled to be inventoried include: Spirit Lake (also known as Elephant Lake) located approximately 6 miles north of downtown Soldotna, several unnamed lakes/ponds within 1.5 miles of East and West Mackey lakes, several unnamed lakes/ponds within 1.5 miles of the Tote Road Area lakes, and other lakes that had northern pike catches reported in season.

DATA ANALYSIS

Length Compositions

Mean fork length of sampled northern pike was estimated for each lake. Mean fork length estimates were calculated as the arithmetic mean of all fish fork lengths. Variances were

calculated with the squared deviations from the mean (standard variance formula). Standard errors of the mean (SE) were calculated as the square root of the variance divided by the square root of the sample size.

Mann–Whitney–Wilcoxon tests (MWW-test) were used to evaluate differences in mean fork length between years within Derks and Sevena lakes. Kolmogorov–Smirnov tests (KS-test) were also used to examine whether cumulative fork length distributions changed between years within lakes. All tests were conducted at the 0.05 level of significance.

Length distribution data were evaluated by two methods. The first incorporated the relative stock density (RSD) similar to that described by Gabelhouse (1984). RSD length categories were defined as follows: "juvenile," < 350 mm; "stock," 350 to 529 mm; "quality," 530 to 709 mm; "preferred," 710 to 859 mm; and "memorable," >860 mm. Secondly, length distribution data were partitioned into sixteen 50-mm length classes beginning at 50 mm that ended at 899 mm. The proportion of northern pike of each length class category *k*, in the catch from lake *L* was calculated as:

$$p_{Lk} = \frac{n_{Lk}}{n_L}, \tag{1}$$

where:

n_{Lk} = the total number of northern pike of length class category *k* from lake *L*

n_L = the number of northern pike caught in lake *L*.

The variance of the proportion was estimated as:

$$\hat{Var}(\hat{p}_{Lk}) = \frac{\hat{p}_{Lk}(1-\hat{p}_{Lk})}{n_L - 1}. \tag{2}$$

Catch per unit effort

Catch per unit effort (CPUE) of northern pike was calculated for each lake as:

$$CPUE = \frac{c}{e}, \tag{3}$$

where:

c = number of northern pike caught in a lake after fishing gillnets,

e = hours gillnets fished in a lake.

The mean CPUE for each lake over the sampling period was estimated as a ratio (Thompson 2002):

$$\overline{CPUE} = \sum_{i=1}^{n} c_i \Big/ \sum_{i=1}^{n} e_i, \tag{4}$$

where:

c_i = number of northern pike captured during week *i*,

e_i = hours nets soaked during week *i*,

with variance:

$$\hat{V}(\overline{CPUE}) = \frac{\sum_{i=1}^{n}\left(c_i - \overline{CPUE} \times e_i\right)^2}{\bar{e}^2 n(n-1)}, \quad (5)$$

where:

$$\bar{e} = \sum_{i=1}^{n} \frac{e_i}{n},$$

and

n = number of weeks nets soaked during the sampling period.

Two-sample *t*-tests were used to evaluate if the estimated weekly mean catch per unit effort ($\overline{CPUE}$) of gillnets set both in 2005 and 2006 had decreased since that of 2004 in each lake. A Bonferroni correction factor (0.05^3=0.000125) was used to adjust the level of significance for all tests performed. This method was chosen because the number of weeks of catch data from Derks and Sevena lakes was not equal among years. This method also ensures the most conservative criterion for rejecting the null hypothesis of a test that is part of a set of pairwise differences.

RESULTS

LENGTH ANALYSIS

In 2005, gillnet sampling commenced shortly after spring ice-out on May 11 at Derks Lake and continued intermittently through June 3. From May 4 through June 3, gillnets were set at Sevena Lake. During fall, gillnets were fished at Derks Lake from September 26 through October 20, and Sevena Lake from September 27 through October 20. In 2006, gillnet sampling began at ice-out on Derks Lake on May 11 and continued through June 2. At Sevena Lake, gillnets were fished from May 8 through May 26. During fall, Derks Lake was sampled with gillnets from September 26 through October 13, and Sevena Lake was sampled from September 25 through September 29.

Gillnetting operations in 2005 harvested 2,538 northern pike with fork lengths ranging from 122 to 754 mm (Table 2). Four hundred ninety-two of these were removed from Derks Lake (spring mean length 252 mm, SE = 7 mm; fall mean length 267 mm, SE = 6 mm), while 2,046 were harvested at Sevena Lake (spring mean length 453 mm, SE = 8 mm; fall mean length 279 mm, SE = 1 mm).

In 2006, netting operations harvested 732 northern pike that ranged in fork length from 115 to 530 mm (Table 2). Three hundred and fifty of these were removed from Derks Lake (spring mean length 224 mm, SE = 7 mm; fall mean length 306, SE = 3 mm), while 382 were removed

from Sevena Lake (spring mean length 262 mm, SE = 2 mm; fall mean length 399 mm, SE = 6 mm). As in 2004 (Begich *In prep.*), the size distribution of the spring northern pike population in both lakes shifted towards smaller fish and few northern pike remained in either lake that would be considered of quality size based on relative stock density (RSD) described by Gabelhouse (1984) (Table 3).

Two different tests (MWW-test, *t*-test) were conducted to detect if the estimated mean fork length of northern pike decreased in each lake from 2005 to 2006. Results for Derks Lake indicated mean fork length did not decrease from 2005 to 2006 (MWW-test statistic = 69524.4, $P = 1.00$). Results for Sevena Lake (MWW-test statistic = 511425.5, $P < 0.01$) indicated mean length did decrease from 2005 to 2006. *T*-tests rendered the same conclusions as the MWW-tests.

The cumulative length distributions of northern pike sampled from Derks Lake (KS-test, $D = 0.260$, $P < 0.001$) and Sevena Lake (KS-test, $D = 0.251$, $P < 0.001$) were significantly different between 2005 and 2006 (Figures 2 and 3). The 2006 harvest from Sevena Lake had larger proportions of smaller northern pike (length <350mm) than 2004 and 2005 (Figure 4). Derks Lake also had a larger proportion of smaller northern pike (length <350mm) in 2006 harvest than 2004 and 2005 (Figure 5).

Differences in the RSD were evident for northern pike sampled between years from Derks and Sevena lakes (Table 3). For instance, in 2006 the percentage of juvenile fish sampled from both lakes increased whereas the percentage of all other size categories decreased when compared to 2005. This increasing proportion of smaller northern pike being captured is consistent with results observed between the years 2003 and 2004 in both lakes (Begich *In prep*).

CPUE ANALYSIS

The highest weekly northern pike CPUEs observed in Derks Lake each year during 2004-2006 were 0.296, 0.084, and 0.137, respectively; the estimated mean CPUEs for those years were 0.128 (SE = 0.013), 0.067 (SE = 0.003), and 0.051 (SE = 0.000), respectively (Table 4). The highest weekly northern pike CPUEs for Sevena Lake during 2004-2006 were 0.576, 0.543, and 0.173, respectively; estimated mean CPUEs for those years were 0.517, 0.241, and 0.084, respectively (Table 4).

Two-sample *t*-tests were used to detect whether the mean northern pike CPUE decreased between years for Derks and Sevena lakes. Results for Derks Lake *t*-tests comparing mean CPUEs for 2004 and 2005 ($t = 1.86$, df = 7, $P = 0.052$) and for 2005 and 2006 ($t = 0.91$, df = 9, $P = 0.19$) indicated that mean CPUEs did not decrease significantly over these two 1-year durations (Tables 5 and 6). Results for Sevena Lake *t*-tests comparing mean CPUEs for 2004 and 2005 ($t = 4.06$, df = 9, $P = 0.001$) and for 2005 and 2006 ($t = 2.10$, df = 11, $P = 0.03$) indicated that mean CPUE did not decrease significantly over these two 1-year durations (Tables 5 and 6). A *t*-test comparing mean CPUEs for 2004 and 2006 at Derks lake ($t = 2.151$, df = 10, $P = 0.03$) indicated that mean CPUE did not decrease significantly over a 2-year duration. Another *t*-test comparing mean CPUEs for 2004 and 2006 at Sevena Lake ($t = 11.10$, df = 4, $P = 0.00014$) indicated that mean CPUE did not decrease significantly over a 2-year duration (Table 7).

Bycatch

Unlike 2005, the 2006 Sevena Lake gillnet bycatch of native fish species such as rainbow trout, Dolly Varden, and juvenile coho salmon was a major concern (Table 8). The incidental catch of coho salmon and Dolly Varden increased so much in the fall of 2006 that gillnetting was suspended early. Very few native fish species were captured incidentally in Derks Lake in 2005 or 2006; however, several juvenile coho salmon were captured in 2006. No coho salmon juveniles were captured in Derks Lake in 2005.

NORTHERN PIKE INVENTORY

In spring 2006, a total of 19 lakes were fished with variable mesh gillnets to determine the presence or absence of northern pike. Eighteen of those lakes (all are without official lake names and referred to as the Tote Road Area lakes) are located about 5 miles south of Soldotna. Previous to the 2006 inventory effort, ADF&G had assumed that five interconnected Tote Road Area lakes near Stubblefield Road contained northern pike. Northern pike were believed to exist in those lakes because of local reports and ADF&G test netting results from two of those lakes in fall 1983 (Athons, *memorandum*) and sport angling efforts in one lake during spring 2001 (T. McKinley, ADF&G fishery biologist, Soldotna, *personal communication*). A comprehensive inventory to confirm the exact lakes in the area containing northern pike had not previously been conducted. During June 2006, each of the 18 lakes in the Tote Road area were fished with one or two variable mesh gillnets and northern pike were caught in six of these lakes (Figure 6). Five of the six lakes were the original five lakes previously believed to have northern pike. The sixth lake (called Leisure Lake by locals) is the westernmost lake in Figure 6. A local landowner also reported seeing northern pike during the springtime in an intermittent flowage that drains westward from the Stubblefield Road area.

In spring of 2006, the Soldotna ADF&G office received a report of northern pike in an unspecified lake northeast of the Captain Cook State Recreational Area (9 miles north of Nikiski) in a location known as the Grey Cliff area). An attempt to contact the person who submitted this report to get more details about the lake was unsuccessful. However, on June 5 ADF&G personnel drove up to the Grey Cliff area to try to locate the lake that was reported to contain northern pike. Salmo Lake fit the reported description best, so a single gillnet was set in this lake and allowed to fish for 2 days. Four rainbow trout and zero northern pike were caught.

Spirit Lake (also known as Elephant Lake) and Sports Lake were both fished with variable mesh gillnets in 2006 by ADF&G personnel (P. Berkhahn, ADF&G fishery biologist, Soldotna, *personal communication*). Although ADF&G received reports of northern pike being caught in both of these lakes, no northern pike were captured.

No new lakes in the Soldotna Creek drainage were inventoried during 2006 due to time constraints.

WATER QUALITY/STREAMFLOW/MAPPING

Lake water quality and streamflow data were collected monthly in 2006 from select locations within Soldotna Creek drainage and from two landlocked lakes near Soldotna. When completed, these data will be compiled and summarized in a future report to assess the feasibility of other northern pike control strategies.

The mapping of suitable northern pike habitat in select water bodies on Kenai Peninsula was attempted in the summer of 2006 but was halted due to time constraints, technical difficulties, and the realization that the GPS equipment available did not provide the desired level of accuracy.

To date, an investigation into the feasibility of collecting bathymetric data electronically is ongoing and has been delegated to ADF&G regional staff to research and develop a protocol for bathymetric mapping within Region II[5].

DISCUSSION

Kenai Peninsula northern pike control efforts in 2005 and 2006 continued to evolve from the first control efforts in 2002. Annual mean northern pike CPUEs (from gillnetting efforts) were analyzed to determine if gillnetting can reduce northern pike abundance. Two-sample *t*-tests using a Bonferroni correction factor indicated that no significant decrease was detected in any lake during 2004-2006. However, the result of the *t*-test comparing mean CPUEs for 2004 and 2006 at Sevena Lake (p-value of 0.00014 was in close proximity to a 0.000125 level of significance) allows one to conclude that some evidence exists suggesting a 2-year decrease in mean CPUE at Sevena Lake.

Surveys to assess northern pike populations are often conducted with gillnets (Diana 1983; Neumann and Willis 1995; Pierce et al. 1994; Rutz 1996). In general, findings from gillnet surveys of northern pike show that catch per unit effort or mean catch per effort is positively correlated with abundance (Neuman and Willis 1995; Paukert and Willis 2003; Pierce and Tomcko 2003).

In the 3 years that Sevena and Derks lakes have been gillnetted (2004-2006), a significant reduction in the northern pike population greater than 300 mm FL appears to have occurred in at least Sevena Lake. This conclusion is based on two assumptions. The first is the intuitive notion that catch rates reflect fish densities. Secondly, gillnets fished comparable stages of the northern pike life cycle between years (e.g. the spring post-spawn period and the fall period in both Sevena and Derks lakes), thus allowing a relative comparison of catch rates.

Based on the length frequency data for each lake (Figures 4 and 5), it appears that northern pike are fully recruited to the gillnet gear at approximately 300 mm FL. The influence of gear on the length of northern pike captured is a common observation in similar studies; however, several studies also point out that gear selectivity is negligible for northern pike > 300 mm FL (Roach 1997, 1998 a-b; Rutz 1999).

We have also learned that in an open system where northern pike are targeted for reduction, the population can quickly rebound. During fall 2006, the Derks Lake northern pike mean CPUE increased after displaying 2 consecutive years of decrease; this increase coincided with a high water event from exceptionally heavy August and September rainfall and increased efforts by local beavers to raise the height of an existing dam near the Derks Lake outlet. We believe that northern pike may have migrated into Derks Lake (from East Mackey Lake) when the water level rose and provided easy access between these two lakes. A beaver dam at the Derks Lake outflow appeared to be a nearly complete barrier for fish movement between Derks Lake and

[5] Also known as ADF&G, Division of Sport Fish, Southcentral Region.

Soldotna Creek; the dam was approximately 5 feet high and the spillover was diffuse and obstacle-filled.

Recruitment of more catchable size fish, following a summer of rapid growth, may also have contributed to the Derks Lake northern pike mean CPUE increase during fall 2006. However, mean CPUE did not increase between the Derks Lake spring and fall netting efforts in 2005. In addition, the mean length of northern pike caught from Derks Lake in fall 2006 (306 mm) was more similar to the mean length of fish captured in 2004 (323 mm) than in fall 2005 (267 mm). The increased abundance and greater percentage of larger fish observed in fall 2006 in Derks Lake, similar to 2004 observations, suggests that immigration might be responsible for this increase in length.

No increase was detected in the fall 2006 Sevena Lake northern pike mean CPUE (compared to fall 2005), but mean length did increase substantially. Fall 2006 netting efforts in Sevena Lake were aborted after 4 days due to the increased catch of native fish. The Sevena Lake fall sample of northern pike (38 fish) was small; however, an abundance of prey species and low competition likely provided optimal conditions for growth. Immigration of northern pike and native fish species into Sevena Lake is likely because there are no barriers between the lake and the rest of the drainage.

The 2006 Sevena Lake mean northern pike CPUE (0.0842) is a six-fold decrease from the 2004 CPUE (0.5169). Another encouraging observation was the increase of the native fish species bycatch. Compared to 2005, Sevena Lake catches of juvenile coho salmon and Dolly Varden increased over 24-fold and the rainbow trout catch increased by 4-fold, and this occurred with only 53% of the 2005 netting effort. These results show the ability of native fish populations to rebound quickly when invasive northern pike numbers are reduced.

The management objective for the Kenai Peninsula northern pike fishery is to maximize harvest opportunity to reduce the abundance of invasive northern pike. Consequently, there is no bag or possession limit for northern pike in waters of Kenai Peninsula. Sport fishing methods and means have been liberalized in many Area lakes with northern pike, to allow five lines to be fished while ice fishing. Local interest does exist for a northern pike fishery and harvest estimates display a recent increasing trend. From 2000 through 2005, an estimated average of 860 northern pike was harvested (Table 9) from the Kenai Peninsula. This average harvest represents a significant increase from the 1981-1999 average of 123 northern pike.

How control efforts are perceived by the contingent of serious local northern pike sport anglers is unknown. Some local lakes which were fished with control gillnets to remove northern pike have been reported to provide poor sportfishing opportunities 2 years after netting ceased. How long this effect remains is unknown and it may be worthwhile to inventory these lakes, such as East and West Mackey lakes, to document if the northern pike mean CPUE and length has recovered to pre-control levels or if other native fish species are recolonizing.

RECOMMENDATIONS

Because Sevena Lake and Derks Lakes connect directly with Soldotna Creek, control efforts in these lakes should reduce the likelihood that adult northern pike will emigrate into Soldotna Creek and the Kenai River. Three other lakes (Union Lake, West Mackey Lake and East Mackey Lake) with northern pike populations would be closed to Soldotna Creek if not for their connection to it through Derks Lake. Prior to our control efforts, Sevena Lake was the most

prolific lake for northern pike sportfishing in the area and a likely producer of northern pike that have spread to other locations in the Soldotna Creek drainage. Therefore, continuing control efforts in both of these lakes is warranted as a short-term solution to reduce the threat of northern pike entering the Kenai River.

Recent efforts to collect water quality and stream flow data to help assess other control options (e.g.,. Rotenone, control structures, etc.) is a positive step. The intent is to ultimately implement an action plan to permanently control, or possibly eradicate, northern pike that threaten the Kenai River drainage. Reports of northern pike pioneering areas like the Moose River drainage (a tributary to Kenai River) have surfaced over the years. Efforts to verify the presence of northern pike in the Moose River drainage have failed in the past (Palmer and Tobin 1996; T. McKinley, ADF&G, fishery biologist, Soldotna, *personal communication*) although a northern pike was documented at a U.S. Fish and Wildlife Service (FWS) operated weir near river mile 7 of Moose River in the mid-1980s (J. Dean, FWS biologist, Kenai, *personal communication*). New reports have surfaced of northern pike being sport-caught in Swanson River, a drainage linked to Stormy Lake which has a confirmed population of northern pike. A net barrier was constructed at the outlet of Stormy Lake to reduce fish movement, but it does not stop all fish movement.

We recommend that future northern pike inventory work be expanded to include Moose River drainage and Swanson River to determine if northern pike are present or absent in these areas.

A device that shows promise as an inventory tool for northern pike is the quatrefoil light trap (Floyd et al. 1984). Quatrefoil light traps have been shown to be effective at catching juvenile and larval northern pike (Pierce et al. 2006; Zigler and Dewey 1995). A benefit to catching larval northern pike is that they indicate reproduction is occurring nearby (as opposed to the capture of an occasional strayed adult northern pike). Unlike gillnets, light traps would eliminate the concern of catching waterfowl and adult native fish species. This author recommends field testing light traps in 2007 to see if they work as a northern pike assessment tool. Because gillnetting efforts in Derks and Sevena lakes will continue next year, we recommend that the light traps be tested there. Testing quatrefoil light trap performance against variables such as ambient light conditions, color of emitted light, trap and trap-opening size, could provide insight into whether they will work well as an inventory tool.

ACKNOWLEDGEMENTS

I would like to thank the following Fish and Game employees: Tim McKinley, Jerry Strait, Ramona Baker, and Kristine Dunker. Thanks also to volunteers Clyde Mullican at Sevena Lake, the Freindshuh family for granting us access to Derks Lake, Dave and April Williams at West Mackey, and Earl and Alvin Pierce at East Mackey Lake. This investigation was partially funded by the U.S. Fish and Wildlife Service Aquatic Nuisance Species Program, Grant number 701813G254.

REFERENCES CITED

Begich, R. B. *In prep.* Control and removal of invasive northern pike on the Kenai Peninsula, 2004. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Begich, R. N., and T. R. McKinley. 2005. Restoration of salmonid habitat by control and removals of invasive northern pike, Kenai Peninsula, 2003. Alaska Department of Fish and Game, Special Publication No. 05-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp05-07.pdf

Booth, J. A., and E. O. Otis. 1996. Fishery investigations of the Moose River, Kenai National Wildlife Refuge, Alaska, 1985 and 1986. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 38, Kenai, Alaska.

Diana, J. S. 1983. Growth, maturation, and production of northern pike in three Michigan Lakes. Transactions of the American Fisheries Society 112:338-346.

Floyd, K. B., W. H. Courtenay, and R. D. Hoyt. 1984. A new larval fish light trap: the quatrefoil trap. Progressive Fish Culturist 46:216-219.

Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-32.pdf

Howe, A. L., G. Fidler, and M. J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds95-24.pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-29(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-25(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001c. Revised Edition. Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-41 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-41(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001d. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series No. 01-08, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-08.pdf

Inskip, P. D. 1982. Habitat suitability index models: northern pike. U.S. Department of Interior, Fish and Wildlife Service FWS/OBS-82/10.17

Jennings, G. B., K. Sundet, and A. E. Bingham. 2007. Participation, catch, and harvest in Alaska sport fisheries during 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-40.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. 2009. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2005. Alaska Department of Fish and Game, Fishery Data Series No. 09-47, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/FDS09-47.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2004. Participation, catch, and harvest in Alaska sport fisheries during 2001. Alaska Department of Fish and Game, Fishery Data Series No. 04-11, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-11.pdf

REFERENCES CITED (Continued)

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-34.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-44.pdf

McKinley, T. R. *In prep.* Survey of northern pike in lakes of the Soldotna Creek drainage, 2002. Alaska Department of Fish and Game, Special Publication, Anchorage.

Mills, M. J. 1982. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-1982, Project F-9-14, 23 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-14(23)SW-I-A.pdf

Mills, M. J. 1983. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15, 24 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-15(24)SW-I-A.pdf

Mills, M. J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1983-1984, Project F-9-16, 25 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-16(25)SW-I-A.pdf

Mills, M. J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1984-1985, Project F-9-17, 26 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-17(26)SW-I-A.pdf

Mills, M. J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1985-1986, Project F-10-1, 27 (RT-2), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-10-1(27)RT-2.pdf

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-002.pdf

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-052.pdf

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-122.pdf

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-44.pdf

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-58.pdf

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-40.pdf

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-42.pdf

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-28.pdf

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage.

REFERENCES CITED (Continued)

Neumann, R. M., and D. W. Willis. 1995. Seasonal variation in gill-net sample indexes for northern pike collected from a glacial prairie lake. North American Journal of Fisheries Management 15:838-844.

Palmer, D. E., and J. H. Tobin. 1996. Status of northern pike population in the Moose River watershed, Kenai National Wildlife Refuge, Alaska, 1996. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series 96-7, Kenai.

Paukert, C. P., and D. W. Willis. 2003. Population characteristics and ecological role of northern pike in shallow natural lakes in Nebraska. North American Journal of Fisheries Management 23:313-322.

Pierce, R. B., S. Shroyer, B. Pittman, D. E. Logson, and T. D. Kolander. 2006. Catchability of larval and juvenile northern pike in quatrefoil light traps. North American Journal of Fisheries Management 26:908-915.

Pierce, R. B., and C. M. Tomcko. 2003. Variation in gill-net and angling catchability with changing density of northern pike in a small Minnesota Lake. Transactions of the American Fisheries Society 132:771-779.

Pierce, R. B., C. M. Tomcko, and T. D. Kolander. 1994. Indirect and direct estimates of gill-net selectivity for northern pike. North American Journal of Fisheries Management 14:170-177.

Roach, S. M. 1997. Abundance and composition of the northern pike population in Minto Lakes, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-17.pdf

Roach, S. M. 1998a. Abundance and composition of the northern pike population in Harding Lake, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-14.pdf

Roach, S. M. 1998b. Abundance and composition of the northern pike populations in Minto Lakes, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-12, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-12.pdf

Rutz, D. S. 1996. Seasonal movements, age and size statistics, and food habits of upper Cook Inlet northern pike during 1994 and 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-29, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-29.pdf

Rutz, D. S. 1999. Movements, food availability and stomach contents of northern pike in selected Susitna River drainages, 1996-1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-5, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-05.pdf

Thompson, S. K. 2002. Sampling, 2nd edition. John Wiley and Sons, New York.

Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 03-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-05.pdf

Zigler, S. J., and M. R. Dewey. 1995. Phototaxis of larval and juvenile northern pike. North American Journal of Fisheries Management 15:651-653.

TABLES

Table 1.–The current status of northern pike in Kenai Peninsula waters.

Location			Northern pike status		
Description	Lake	Code (see Figure 1)	Presence confirmed	Reported but not confirmed	Lakes of concern [a]
Soldotna Creek drainage		[b]	X		
	Derks Lake	1	X		
	Sevena Lake	2	X		
	Cicsca Lake	5			X
	East Mackey Lake	14	X		
	West Mackey Lake	15	X		
	Union Lake	16	X		
	Denise Lake	17	X		
	Tree Lake	18	X		
Soldotna area					
	Tote Road Area lakes (6)	19	X		
	Arc Lake	20	X		
	Scout Lake	21	X		
	Spirit Lake	23		X	
	Sports Lake	[c]		X	
Moose River drainage		[d]	X		
	Watson Lake	4		X	
	Silver Lake	6			X
	Mosquito Lake	7			X
	Camp Island Lake	8			X
	Grebe Lake	9			X
	Rock Lake	10			X
	Swan Lake	11			X
	Loon Lake	12			X
	Moosehorn Lake	13			X
	Egumen Lake	22		X	
	Peterson Lake	[e]			X
Swanson River drainage	Stormy Lake	3	X		
Nikiski area	Cabin Lake	[f]		X	

Note: "X"= this category is applicable.

[a] Northern pike have not been confirmed or reported in these lakes yet, but due to their close proximity or connection to waters where northern pike have been found, they are susceptible to future colonization by northern pike.

[b] Soldotna Creek drainage is labeled and circled on Figure 1.

[c] Sports Lake (not shown on Figure 1) is located about 0.5 miles southwest of West Mackey Lake.

[d] Moose River is labeled on Figure 1.

[e] Peterson Lake (not shown on Figure 1) is located about 0.5 miles east of Egumen Lake and these lakes are connected by a stream.

[f] Cabin Lake is a landlocked lake located about 4 miles north of Nikiski.

Table 2.–Fork length of northern pike harvested from selected lakes on Kenai Peninsula, 2005 and 2006.

Year	Location	Season	Harvest (no. of fish)	Fork length (mm)				
				Minimum	Median	Maximum	Mean	SE
2005	Derks Lake	Spring	180	165	235	503	252	7
	Derks Lake	Fall	312	122	287	443	267	6
		Subtotal	492					
	Sevena Lake	Spring	643	154	462	754	453	8
	Sevena Lake	Fall	1,403	177	275	656	279	1
		Subtotal	2,046					
		Total	2,538					
2006	Derks Lake	Spring	74	145	206	462	224	7
	Derks Lake	Fall	276	142	311	530	306	3
		Subtotal	350					
	Sevena Lake	Spring	344	115	271	386	262	2
	Sevena Lake	Fall	38	340	395	480	399	6
		Subtotal	382					
		Total	732					

Note: "Harvest" = fish kept; "fork length" = is the distance from the tip of the snout or lower jaw (whichever projects farther) to the tip of the middle rays of the tail fin (Morrow 1980); “SE” = standard error of the mean.

Table 3.–Relative stock density estimates and standard errors for northern pike harvested from Derks and Sevena lakes, 2005 and 2006.

	Relative stock density (RSD) [a]		Derks Lake			Sevena Lake		
Year	Category	Minimum length (mm)	Harvest (no. of fish) [b]	RDS estimate	SE	Harvest (no. of fish)	RDS estimate	SE
2005	Juvenile	< 350	410	0.833	0.017	1,385	0.677	0.010
	Stock	350	82	0.167	0.017	620	0.303	0.010
	Quality	530	ND	ND	ND	40	0.020	0.003
	Preferred	710	ND	ND	ND	1	0.000	0.000
	Memorable	860	ND	ND	ND	ND	ND	ND
	Total		492	1.000		2,046	1.000	
2006	Juvenile	< 350	315	0.905	0.016	345	0.903	0.015
	Stock	350	32	0.092	0.016	37	0.097	0.015
	Quality	530	1	0.003	0.003	ND	ND	ND
	Preferred	710	ND	ND	ND	ND	ND	ND
	Memorable	860	ND	ND	ND	ND	ND	ND
	Total		348	1.000		382	1.000	

Note: "SE" = the standard error of the mean; "ND" = no data.

[a] Source: as described in Gabelhouse (1984)

[b] All but two of the 350 northern pike captured in Derks Lake in 2006 were measured.

Table 4.–Summary of northern pike sampling effort and harvest for Derks and Sevena lakes, 2004-2006.

Year	Location	Sampling period: Range of dates (mm/dd-mm/dd)	Sampling period: Season [a]	Number of sets [b]	Effort (hrs. fished)	Harvest (no. of fish)	Estimated mean CPUE [c]	Standard error of the mean (SE)
2004 [d]	Derks Lake	05/10 - 05/14	Spring	36	850.75	94	0.110	
		05/24 - 05/28	Spring	48	1,093.88	71	0.065	
		05/31 - 06/04	Spring	36	832.16	246	0.296	
		06/7 - 06/11	Spring	36	842.54	111	0.132	
		06/14 - 06/18	Spring	12	276.73	38	0.137	
		09/20 - 09/24	Summer/Fall	36	835.96	109	0.130	
		10/18 - 10/22	Fall	48	1,109.00	81	0.073	
		Total		252	5,841.02	750	0.128	0.013
	Sevena Lake	06/28 - 07/02	Summer	15	286.25	138	0.482	
		07/05 - 07/09	Summer	9	211.92	122	0.576	
		07/12 - 07/16	Summer	12	287.91	153	0.531	
		10/11 - 10/15	Fall	10	218.49	111	0.508	
		10/18 - 10/22	Fall	15	338.05	170	0.503	
		Total		61	1,342.62	694	0.517	0.007
2005	Derks Lake	05/08 - 05/14	Spring	24	242.00	ND [e]	-	
		05/15 - 05/21	Spring	36	562.75	43	0.076	
		05/22 - 05/28	Spring	48	1,185.00	100	0.084	
		05/29 - 06/04	Spring	48	1,030.75	37	0.036	
		09/25 - 10/01	Fall	48	1,171.97	93	0.079	
		10/02 - 10/08	Fall	48	1,175.97	85	0.072	
		10/09 - 10/15	Fall	48	1,163.23	97	0.083	
		10/16 - 10/21	Fall	36	856.63	37	0.043	
		Total		336	7,388.30	492	0.067	0.003
	Sevena Lake	05/01 - 05/07	Spring	24	589.25	320	0.543	
		05/08 - 05/14	Spring	36	869.25	242	0.278	
		05/15 - 05/21	Spring	48	1,126.25	54	0.048	
		05/22 - 05/28	Spring	48	1,138.00	16	0.014	
		05/29 - 06/04	Spring	36	865.25	11	0.013	
		09/25 - 10/01	Fall	36	810.18	379	0.468	
		10/02 - 10/08	Fall	48	1,112.77	446	0.401	
		10/09 - 10/15	Fall	48	1,143.78	445	0.389	
		10/16 - 10/21	Fall	36	849.23	133	0.157	
		Total		360	8,503.97	2,046	0.241	0.024
2006	Derks Lake	05/07 - 05/13	Spring	12	280.42	13	0.046	
		05/14 - 05/20	Spring	48	1,144.10	23	0.020	
		05/21 - 05/27	Spring	48	1,165.37	24	0.021	
		05/28 - 06/03	Spring	36	850.70	14	0.016	
		09/24 - 09/30	Fall	48	1,188.82	163	0.137	
		10/01 - 10 /07	Fall	48	1,141.88	56	0.049	
		10/08 - 10/14	Fall	48	1,128.35	57	0.051	
		Total		288	6,899.63	350	0.051	0.000
	Sevena Lake	05/07 - 05/13	Spring	48	1,158.88	201	0.173	
		05/14 - 05/20	Spring	48	1,123.82	102	0.091	
		05/21 - 05/27	Spring	48	1,150.60	41	0.036	
		05/28 - 06/03	Spring	0	ND	ND	-	
		09/24 - 09/30	Fall	48	1,105.15	38	0.034	
		10/01 - 10 /07 [f]	Fall	0	ND	ND	-	
		10/08 - 10/14 [f]	Fall	0	ND	ND	-	
		Total		192	4,538.45	382	0.084	0.019

Note: "-" = value can't be computed due to limitations of the data; "ND" = no data.

[a] Seasons: Spring (Mar 21-Jun 20), Summer (Jun 21-Sep 22), Fall (Sep 23-Dec 21).

[b] One set equals one gillnet fished for approximately a 24-hour period.

[c] CPUE = catch per unit effort = northern pike catch per hour of netting effort.

[d] Source: 2004 data (Begich *In prep*)

[e] Catch data were lost for eleven nets each fishing at the same time for approximately one calendar day each.

[f] Fall gillnetting discontinued earlier because of increased incidental catches of juvenile coho salmon and Dolly Varden.

Table 5.–*T*-test statistics comparing mean CPUE between years for gillnetted northern pike at Derks and Sevena lakes, 2004 and 2005.

Lake/year	Total effort (hours)	Total catch (no. of fish)	Mean CPUE	Number of weekly netting periods	*T*-test statistic (*t*)	Degrees of freedom (df)	Critical values	*P*-value (*P*)	Outcome [a]
Derks Lake									
2004	5841.0	750	0.1284	7					
2005	7146.3	492	0.0688	7 [b]					
Test results					1.8640	7	1.895	0.052	Fail to reject H^o
Sevena Lake									
2004	1342.6	694	0.5169	5					
2005	8504.0	2,046	0.2406	9					
Test results					4.0570	9	1.833	0.0014	Fail to reject H^o

Note: *T*-test criteria included an alpha level of 0.05 using a one-tailed test.

[a] Ho: Mean CPUE2004 - Mean CPUE2005 = 0; HA: Mean CPUE2004 - Mean CPUE2005 > 0

[b] The first week of eight weekly fishing periods was disregarded because an unknown number of northern pike were caught.

Table 6.–*T*-test statistics comparing mean CPUE between years for gillnetted northern pike at Derks and Sevena lakes, 2005 and 2006.

Lake/year	Total effort (hours)	Total catch (no. of fish)	Mean CPUE	Number of weekly netting periods	*T*-test statistic (*t*)	Degrees of freedom (df)	Critical values	*P*-value (*P*)	Outcome [a]
Derks Lake									
2005	7146.3	492	0.0688	7 [b]					
2006	6899.6	350	0.0507	7					
Test results					0.9109	9	1.86	0.19	Fail to reject H^o
Sevena Lake									
2005	8504.0	2,046	0.2406	9					
2006	4538.5	382	0.0842	4					
Test results					2.1004	11	1.78	0.03	Fail to reject H^o

Note: *T*-test criteria included an alpha level of 0.05 using a one-tailed test.

[a] Ho: Mean CPUE2005 - Mean CPUE2006 = 0; HA: Mean CPUE2005 - Mean CPUE2006 > 0

[b] The first week of eight weekly fishing periods was disregarded because an unknown number of northern pike were caught.

Table 7.–*T*-test statistics comparing mean CPUE between years for gillnetted northern pike at Derks and Sevena lakes, 2004 and 2006.

Lake/year	Total effort (hours)	Total catch (no. of fish)	Mean CPUE	Number of weekly netting periods	*T*-test statistic (*t*)	Degrees of freedom (df)	Critical values	*P*-value (*P*)	Outcome [a]
Derks Lake									
2004	5841.0	750	0.1284	7					
2006	6899.6	350	0.0507	7					
Test results					2.1508	10	1.812	0.03	Fail to reject H^o
Sevena Lake									
2004	1342.6	694	0.5169	5					
2006	4538.5	382	0.0842	4					
Test results					11.9972	4	2.132	< .00014	Fail to reject H^o

Note: *T*-test criteria included an alpha level of 0.05 using a one-tailed test.

[a] Ho: Mean CPUE2004 - Mean CPUE2006 = 0; HA: Mean CPUE2004 - Mean CPUE2006 > 0

Table 8.–Bycatch of other fish species in northern pike control project gillnets, Derks and Sevena lakes, 2005 and 2006.

		Bycatch (no. of fish)			
Location	Year	Rainbow trout	Dolly Varden	Coho salmon (juvenile)	Sculpin [a]
Derks Lake	2005	3	0	0	0
	2006	1	0	3	0
	% change	-67%	-	-	-
Sevena Lake	2005	6	35	93	0
	2006 [b]	33	902	2,331	4
	% change	450%	2477%	2406%	-

Note: "bycatch" = incidental harvest; "-" = value can't be computed due to limitations of the data.

[a] Family *Cottidae* - genus and species unknown.

[b] Northern pike control project gillnetting discontinued 1 week earlier than originally scheduled due to increased incidental catches of other fish species.

Table 9.–Kenai Peninsula northern pike harvest estimates, 1981-2005.

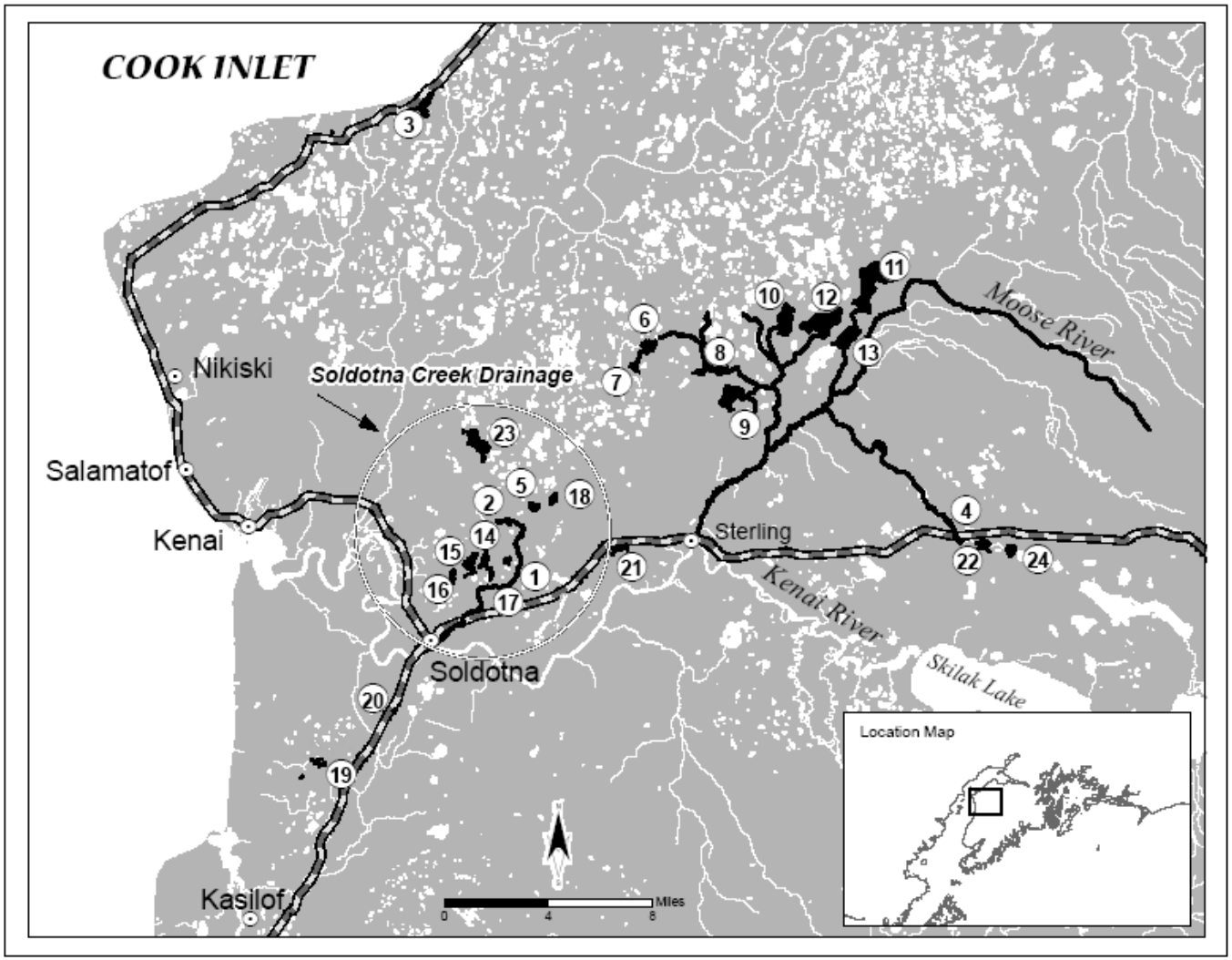
Year	Estimated harvest (number of fish)		
	Kenai Peninsula Lakes	Kenai River	Total
1981	32	ND [a]	32
1982	105	ND [a]	105
1983	294	ND [a]	294
1984	187	ND [a]	187
1985	52	69	121
1986	0	0	0
1987	0	12	12
1988	36	0	36
1989	49	18	67
1990	30	10	40
1991	86	0	86
1992	239	0	239
1993	216	26	242
1994	36	0	36
1995	219	29	248
1996	32	92	124
1997	21	7	28
1998	114	0	114
1999	329	0	329
2000	153	6	159
2001	1,288	0	1,288
2002	368	12	380
2003	641	58	699
2004	2,353	58	2,411
2005	212	12	224
1981-2005 Mean	284	19	300
2000-2005 Mean	836	24	860

Note: "harvest" = fish kept; "ND" = no data.

Source: Alaska Statewide Harvest Survey (SWHS) reports (Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006 a-b, 2007, 2009; Mills 1982-1994; Walker et al. 2003;

[a] No Kenai River northern pike harvest reported by the SWHS prior to 1985 (Mills 1986).

FIGURES



Location codes: (1) Derks Lake, (2) Sevena Lake, (3) Stormy Lake, (4) Watson Lake (5) Cisca Lake, (6) Silver Lake, (7) Mosquito Lake, (8) Camp Island Lake, (9) Grebe Lake, (10) Rock Lake, (11) Swan Lake, (12) Loon Lake, (13) Moosehorn Lake, (14) East Mackey Lake, (15) West Mackey Lake, (16) Union Lake, (17) Denise Lake, (18) Tree Lake, (19) Tote Road Area lakes [6], (20) Arc Lake, (21) Scout Lake, (22) Egumen Lakes, (23) Spirit Lake, and (24) Peterson Lake.

Figure 1.–Locations of Kenai Peninsula lakes that have or may have populations of northern pike.

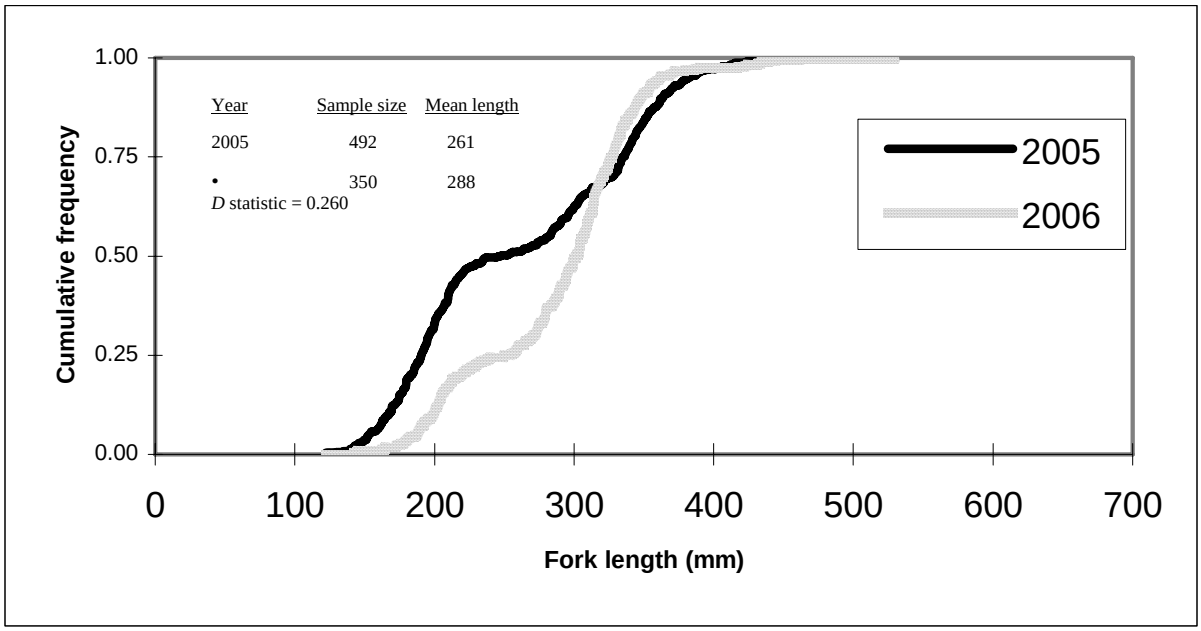


Figure 2.–KS-test comparing northern pike length samples from Derks Lake, 2005 and 2006.

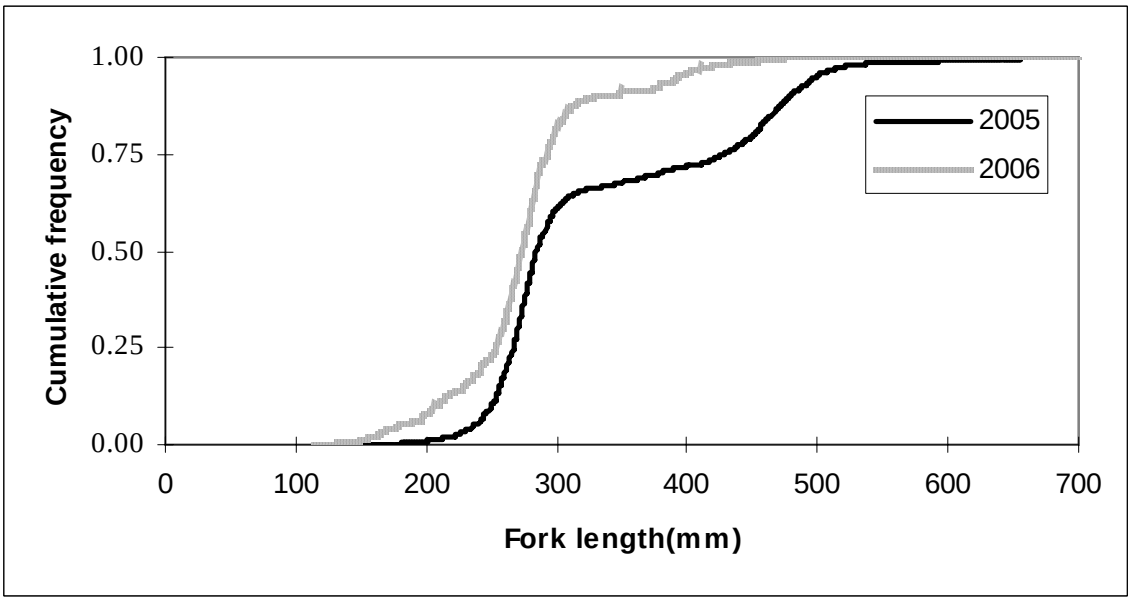


Figure 3.–KS-test comparing northern pike length samples from Sevena Lake, 2005 and 2006.

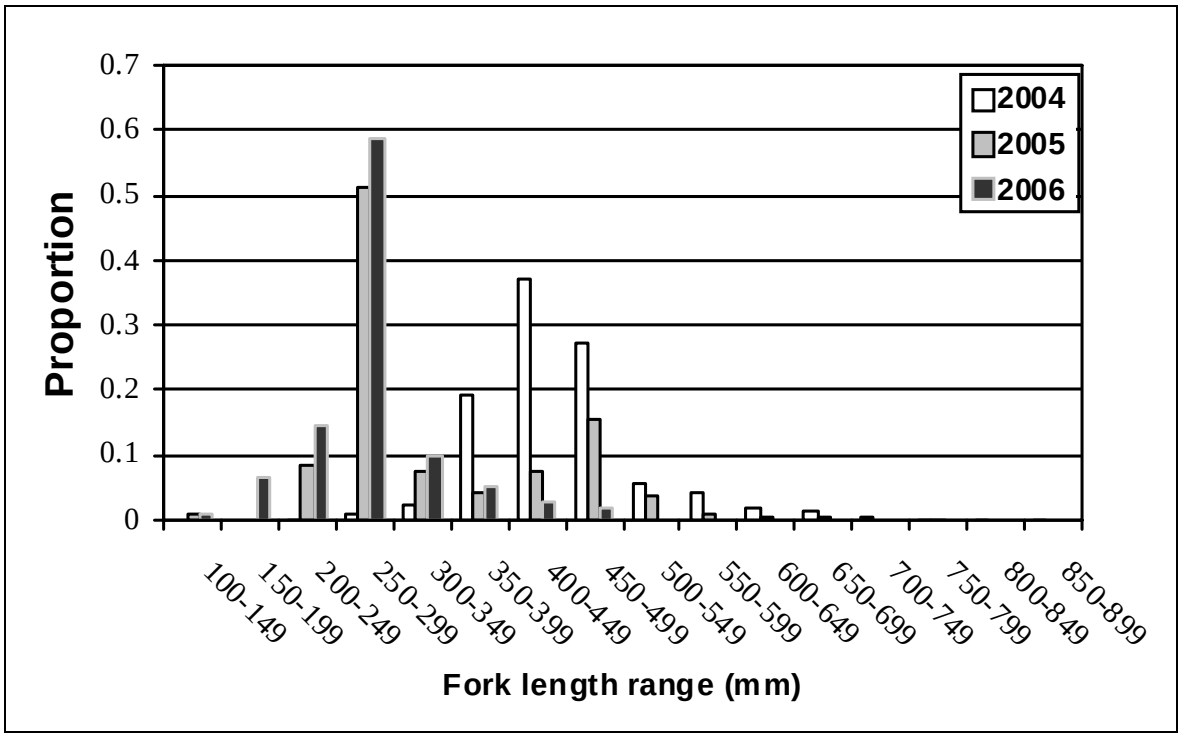


Figure 4.–Fork length range distributions for northern pike harvested from Sevena Lake, 2004–2006.

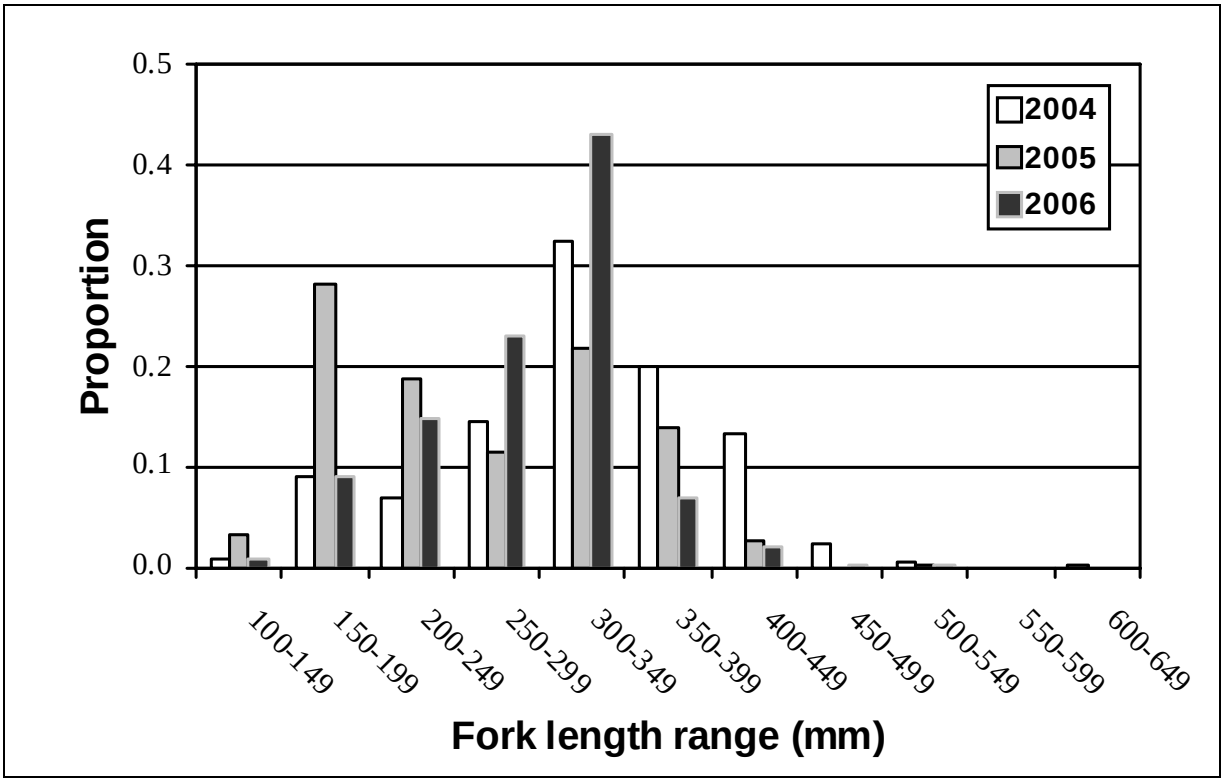


Figure 5.–Fork length range distributions for northern pike harvested from Derks Lake, 2004-2006.

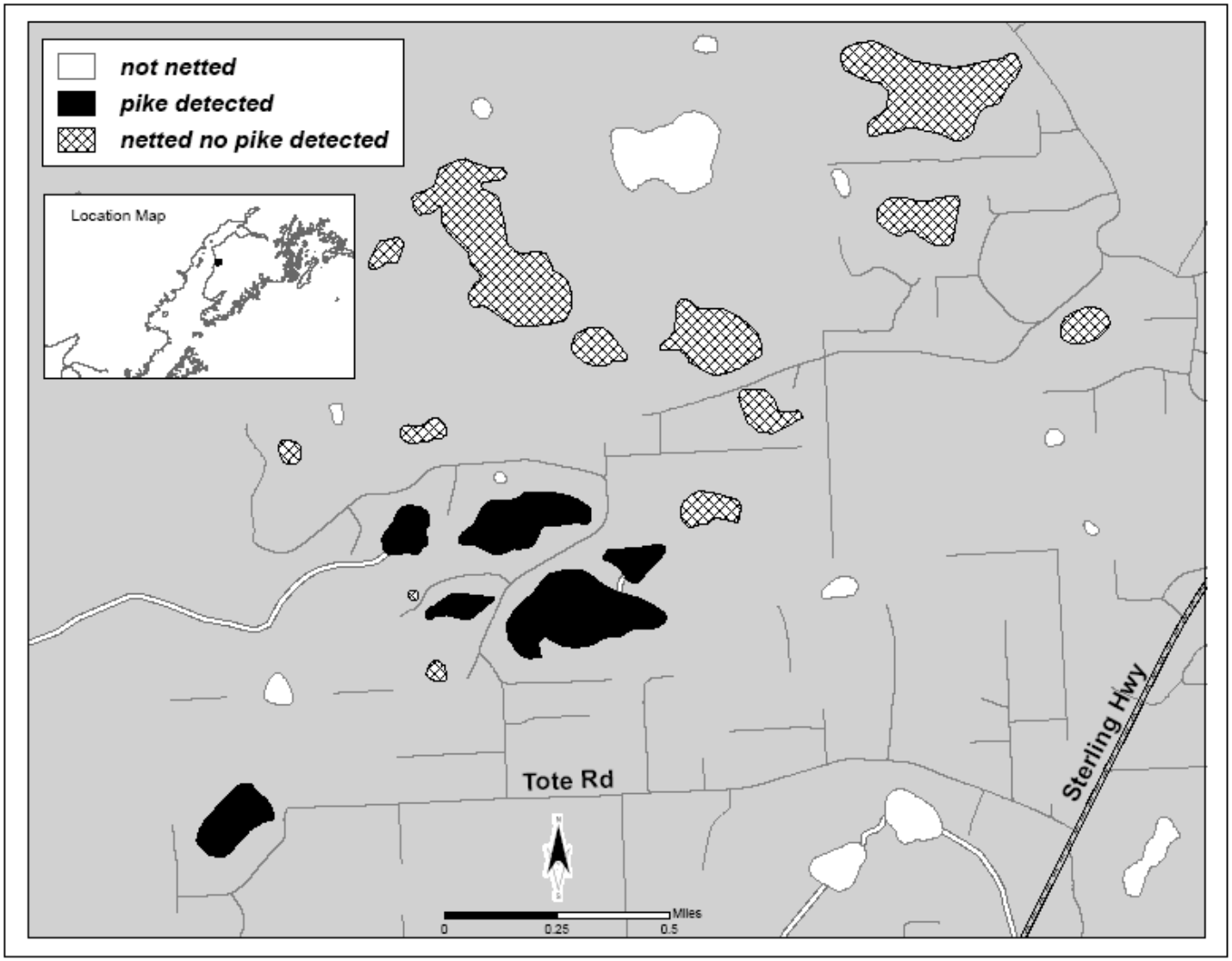


Figure 6.–Tote Road Area lakes where the presence (solid black) or absence (crosshatching) of northern pike was confirmed by gillnetting in 2006.