COMMERCIAL FISHERIES INVESTIGATIONS

PROJECT COMPLETION REPORT

Project No. 2-225-R: Northern Pike Investigations

Period Covered: 1 April, 1974-30 September, 1977

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RESEARCH SEGMENT

STATE: Iowa NAME: Northern Pike Investigations

PROJECT NO.: 2-225-R

SEGMENT NOS.: 1-3

Period Covered: 1 April, 1974 through 30 September, 1977

ABSTRACT: Analyses of northern pike populations vital statistics in Pools 9, 10, 13 and 14 of the Mississippi River from 1974-1977 indicated that life history characteristics were not significantly different from one location to another, but there was a significant difference in the numerical population size between pools with the upper pools containing higher populations. Suitability of northern pike as a commercial food-fish was evaluated. Weight-length relationships, condition factors, and age and growth statistics were determined from 1,601 northern pike. Fecundity data from 58 fish collected in Pools 9, 13 and 18 could be predicted through multiple regression ayalysis. Eighty-six percent of the variation in fecundity was explained by body size. Numerical population estimates were based on tag returns from 1,618 marked fish. Population size diminished downstream. Annual survival estimates, based on age distribution, were 22% and 33% for males and females, respectively. Fishing mortality was less than 1%. Movement was determined through recapture of marked fish. Sixty-four percent moved upstream, 21% moved downstream, while 15% were captured near the release site. Response to a questionnaire indicated upstream commercial fishermen with large operations favored returning northern pike to the commercial fishery. Tests for chemical contaminants Dieldrin, DDE, Heptachlor Epoxide, Chlordane, Mercury, and PCB in northern pike flesh showed concentrations less than FDA tolerance levels. Weight change resulting from various food processing procedures indicated small fish did not lose as much in processing as large fish. Dressed weight expressed as a percent of whole weight was 72%. Smoked weight was 37% and fillet weight was 47% of whole weight. Recommendations for increasing utilization of surplus northern pike stocks by commercial harvest are presented.

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STUDY OBJECTIVE

To determine vital statistics including abundance, age structure, size distribution, growth, mortality, fecundity, and seasonal movement, along with marketing and harvest potential of northern pike in four pools of the upper Mississippi River bordering Iowa.

INTRODUCTION

Large populations of northern pike, *Esox lucius* (Linnaeus), are known to exist in the Mississippi River bordering Iowa, particularly in the more northern navigation pools. The Iowa Conservation Commission captured 2,000-3,000 northern pike each spring in Pool 9 near Lansing, Iowa, for artificial propagation. Surveys and fish distribution records by Cleary, Nord, and others in annual reports of the Upper Mississippi River Conservation Committee (UMRCC) indicated northern pike are indigenous to all pools of the Mississippi River north of Caruthersville, Missouri. Relative abundance diminished in a downstream direction and abundant populations were rare south of Clinton, Iowa.

Northern pike were commercially harvested from Iowa waters until 1959. Pressure from organized public groups along with a desire by the UMRCC for uniform regulations resulted in closure of the fishery. Spring trap net catches in Pool 9 recorded at the Lansing Fish Hatchery, showed no apparent difference in catch per unit effort (C/E) when 1955-1959 and 1964-1970 data were compared. Cleary, in a 1958 Iowa Conservation Commission administrative report noted no discernable difference in length-frequency distribution or age structure of northern pike populations sampled in Pools 7 and 9. Pool 7 is located between Minnesota and Wisconsin and was not subjected to commercial food-fish exploitation. Current sport fishing surveys indicate few northern pike are caught by anglers. Presumably, a large segment of northern pike population mortality is attributable to natural causes.

A three year investigation of northern pike populations in four Mississippi River pools was initiated on 1 April, 1974 in cooperation with the National Marine Fisheries Service and the Iowa Conservation Commission under authority of PL:88-309.

DESCRIPTION OF STUDY AREA

The Mississippi River is comprised of an intricate network of diverse aquatic habitats, ranging from interconnected river lakes and ponds to the swift navigation channel and extensive pool and tailwater area adjacent to locks and dams. The locks and dams were not intended for flood control, but they have created more stable water levels and increased siltation of many backwater areas.

Prior to construction of dams which created a 2.74 m (9 ft) deep navigation channel, a 1.8 m (6 ft) channel project was accomplished by the construction of hundreds of rock and brush "wing dams" designed to direct current into the main channel. Major side channel exits from the main channel were blocked by rock and brush "closing dams". These diversion structures were later submerged by impounded waters of the navigation dams.

The present impounded river contains several distinctly different fish habitats. The UMRCC adopted a uniform classification system (Appendix A) separating aquatic habits into seven categories: tailwaters, main channel, main channel border, side channel, slough, and lake and pond. Aquatic habitat in the 502.5 km (312.3 mi) segment of river bordering Iowa (Figure 1) includes 41,454 ha (102,433 ac) particularly suited to northern pike. Forty-two percent of this available habitat lies within Pools 9, 10 and 11.

METHODS AND PROCEDURES

Northern pike were captured with single-lead modified fyke nets. Twenty-three to thirty nets with .91 x 1.82 m (3 x 6 ft) frames, 9.12-18.24 m (30-60 ft) leads, and .8 m (2.6 ft) diameter hoops with 3.8 cm (1.25 in) mesh (bar measure) were set perpendicular to shore in each of the study pools. Distance from shore to the trap varied so as to place the net in .6-1.5 m (2-5 ft) of water.

Fish were captured soon after ice-out, when water temperatures were 4.4°-11.1°C (40°-52°F), because netting success was highest during the spawning season. Additional netting during mid-summer and autumn was conducted to determine catch per effort (C/E).

Fish were held on board a boat in a 246 L (65 gal) wooden aerated live tank until 40-50 fish were collected. Tricaine methanosulphate was administered as an anesthetic to reduce stress. Fish were weighed to the nearest .01 kg and measured for total body length in millimeters (mm). Scale samples were collected from an area 4-6 scale rows beneath the anterior portion of the dorsal fin. Sex and maturity were determined by stripping eggs and external examination of the genital pore (Casselman, 1974a; Demachenko, 1963).

The annual goal was to mark 100 fish with tags in Pools 10, 13 and 14. An additional goal to mark 600 fish by excision of various fin combinations (Table 1) and 900 fish by tagging was set for Pool 9.

Tags were serially numbered Floy anchor tags. International orange, Number FD67, tags were inserted at the distal end of the dorsal fin in 1974. Care was taken to anchor the T-bar behind the interneural rays at a posterior angle of 50°-70° to retard loss. The shank length of FD67 tags, 1.27 cm (.5 in), made placement on large fish difficult. In 1975 and 1976 yellow FD68 tags were used. These had a shank length of 3.18 cm (1.25 in) and were readily attached to all sizes of fish captured.

Return of tag information by anglers was voluntary. Tags were affixed with the identification "IA CONS COMM". Posters stating the study purpose and requesting tag information were placed in 77 bait shops, sporting goods stores

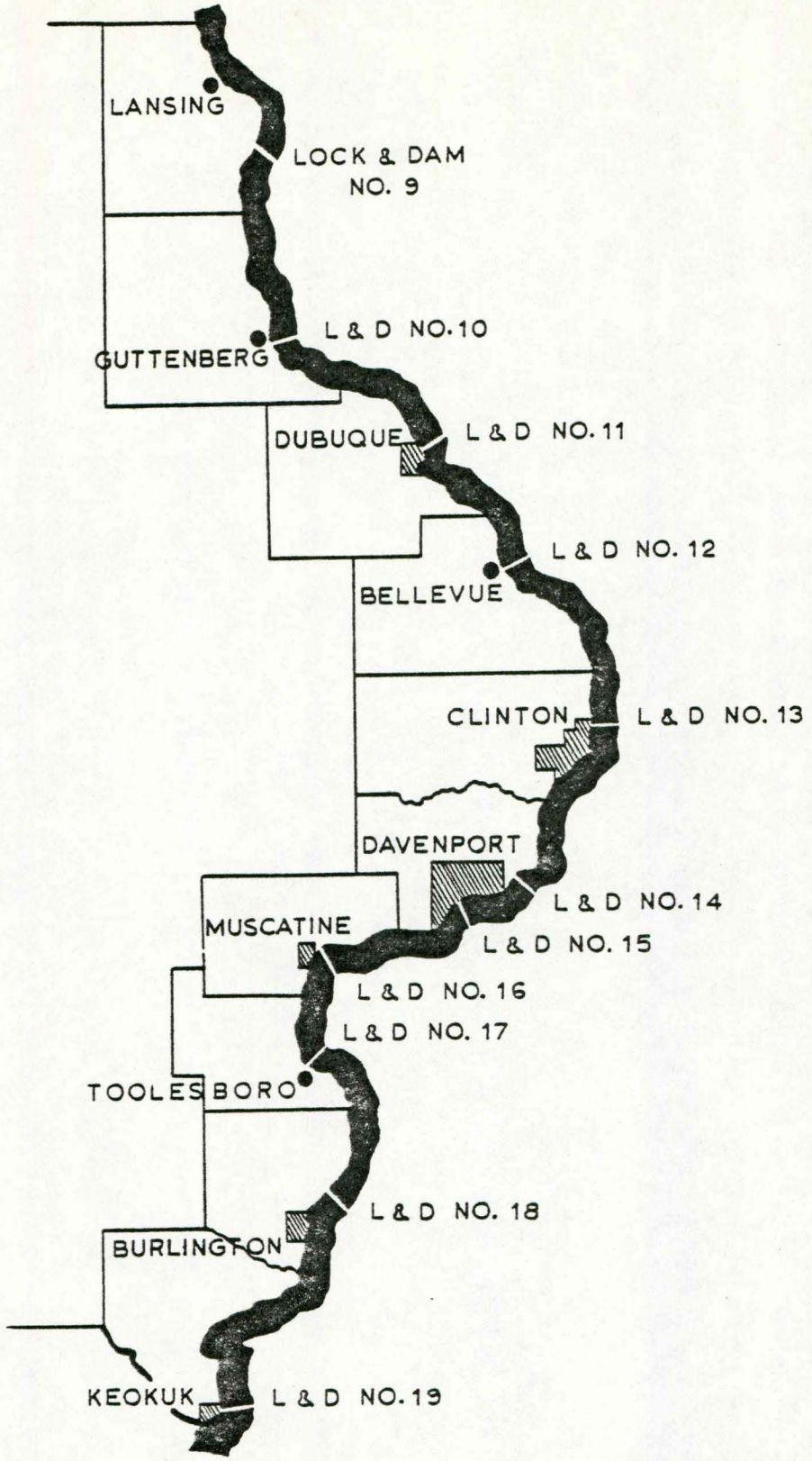

Figure 1. Location of Mississippi River pools sampled for northern pike.

Table 1. Number of northern pike marked and released in Pools 9, 10, 13 and 14.

	Pool	Type of mark		Number marked
		Fin removal	Tag implant	
1974	9	Left pelvic	Left side	304
		Right pelvic	None	303
	10	None	Left side	111
	13	None	Left side	111
	14	None	Left side	54
1975	9	Left pectoral	Left side	61
		Right pectoral	None	61
	10	None	Left side	137
	13	None	Left side	121
	14	None	Left side	100
1976	9	None	Right side	305
	10	None	Right side	105
	13	None	Right side	103
	14	None	Right side	106

and other locations near study areas frequented by sportsmen. Postage-paid postcards for reporting tag information were attached to each poster. Information requested included tag number, location caught, capture date, length and weight of fish. Space was also provided on the postcards for the angler's name and address in order that information could be returned to the cooperator. Posters were examined bimonthly during each study segment. Missing or damaged posters were replaced and needed postcards added.

Northern pike age and growth were determined by microprojection of plastic scale impressions and total body length and weight mreasurements collected and recorded during all three years of study. Accuracy was evaluated by comparing subsamples with clethria (Casselman, 1974b) collected from fish used in fecundity and weight loss analyses. Weight-length regression, body condition factors, body-scale regression and back calculation of body length at each year of life were calculated using an age and growth computer program (Mayhew, 1973).

Mortality and survival were estimated from age frequency distributions. Data for males and females were analyzed independently by location and year.

Numerical estimates of northern pike populations were made during 1975, 1976 and 1977 for all study pools. Population size was estimated from the Peterson equation

$$\hat{N} = \frac{MC}{R}$$

where

$\hat{N}$ = estimated number of fish in the population

M = number of fish marked and released

C = number of fish in the recapture sample

R = number of recaptured marked fish

Fecundity was estimated from selected females captured after tagging concluded in Pools 9, 13 and 14 during 1974, 1975 and 1976. Entire ovary volume was measured, a 15 ml sample preserved in 10% formalin, and the entire sample counted to determine numbers of ova.

A questionnaire (Appendix B) requesting information on expected benefits of a northern pike commercial fishery was mailed to 623 commercial fishermen. Responses were voluntary and no attempt was made to encourage additional responses after the initial return. Results were analyzed by pool in which the fishermen operated and by size of the business.

Northern pike were tested for chemical contamination from composite flesh samples of 18 fish in Pool 9 and 22 fish in Pool 14 collected during March, 1976. Fish from Pool 9 were captured 3.2-6.4 km (2-4 mi) upstream from Lansing, Iowa and fish from Pool 14 were captured 3.2-6.4 km (2-4 mi) downstream from Camanche, Iowa. Both sampling stations were located in Iowa waters. Three, 25-30 gm (.065-.076 lbs) samples of flesh were removed from each fillet near the midsection, anterior to the dorsal fin. Samples consisted of verticle bands of flesh. Disposable surgical gloves were worn during the sampling process. The three samples from each fish were pooled with other samples for replication. Pooled samples were prewashed with ether, double wrapped in aluminum foil, and frozen. Analyses were conducted by the Iowa State Hygienic Laboratory.

Weight changes resulting from various processing methods were determined from 47 fish. Individual fish were measured in millimeters and weighed to the nearetst .01 kilogram and marked by placing a No. 2 Monel Wing Band at the base of the dorsal fin. Fish were dressed by removing the head anterior to the clethria and eviserated. Scales and fins remained intact. A sample of 10 fish of various sizes was further processed by filleting. Those not processed for fillet weight were smoked.

Commercial harvest statistics for northern pike were obtained from fishermen interviews and UMRCC records.

LIFE HISTORY INVESTIGATIONS

The majority of studies concerned with northern pike in Europe and North America have been made in still-water habitats; comparatively few publications exist concerning northern pike in running waters (Mann, 1976; Paragamian, 1976; Hartley, 1947; and Carbine, 1948).

WEIGHT-LENGTH RELATIONSHIPS

Weight-length relationships were computed independently for each pool by sex for 1974, 1975 and 1976 by the transformed linear regression model:

$$\log_{10} W = a + b \log_{10} TL$$

where W is weight in grams and TL is total length in millimeters (Table 2). Negative intercept values in the body-scale regression resulted from a lack of small fish in the sample. A new regression coefficient for linear estimation was calculated by fitting the body-scale regression model centered to the origin (TL = 0, W = 0) (Figure 2). Regression coefficients were tested for linearity in a Student's t-test distribution. Unequal variances were assumed in the test.

Table 2. Regression coefficients, coefficients standard error, and correlation coefficients of weight-length relationships for northern pike by sex, year, and pool.

		Parameter	Pool 9	Pool 10	Pool 13	Pool 14
1974	Male	Intercept (a)	-4.64	-5.08	-5.09	-5.34
		Standard error (S_a)	.23	.15	.20	.55
		Slope (b)	2.80	2.97	2.96	3.05
		Standard error (S_b)	.09	.05	.07	.20
		Correlation coefficient (r)	.93	.99	.98	.95
	Female	Intercept (a)	-5.17	-4.79	-5.01	-5.12
		Standard error (S_a)	.19	.61	.39	.19
		Slope (b)	3.01	2.88	2.96	2.98
		Standard error (S_b)	.07	.22	.14	.07
		Correlation coefficient (r)	.97	.93	.96	.98
1975	Male	Intercept (a)	-5.47	-4.92	-5.85	-4.97
		Standard error (S_a)	.34	.14	.22	.37
		Slope (b)	3.09	2.90	3.11	2.92
		Standard error (S_b)	.12	.05	.08	.13
		Correlation coefficient (r)	.97	.99	.98	.95
	Female	Intercept (a)	-5.65	-4.61	-4.46	-4.92
		Standard error (S_a)	.28	.31	.39	.37
		Slope (b)	3.16	2.80	2.77	2.92
		Standard error (S_b)	.10	.11	.14	.13
		Correlation coefficient (r)	.99	.97	.94	.96
1976	Male	Intercept (a)	-4.86	-4.60	-3.79	-4.50
		Standard error (S_a)	.17	.50	.59	.30
		Slope (b)	2.88	2.79	2.50	2.75
		Standard error (S_b)	.06	.18	.21	.11
		Correlation coefficient (r)	.97	.89	.84	.97
	Female	Intercept (a)	-4.89	-4.74	-4.36	-4.86
		Standard error (S_a)	.14	.36	.33	.46
		Slope (b)	2.91	2.87	2.74	2.91
		Standard error (S_b)	.05	.13	.12	.16
		Correlation coefficient (r)	.97	.96	.96	.92

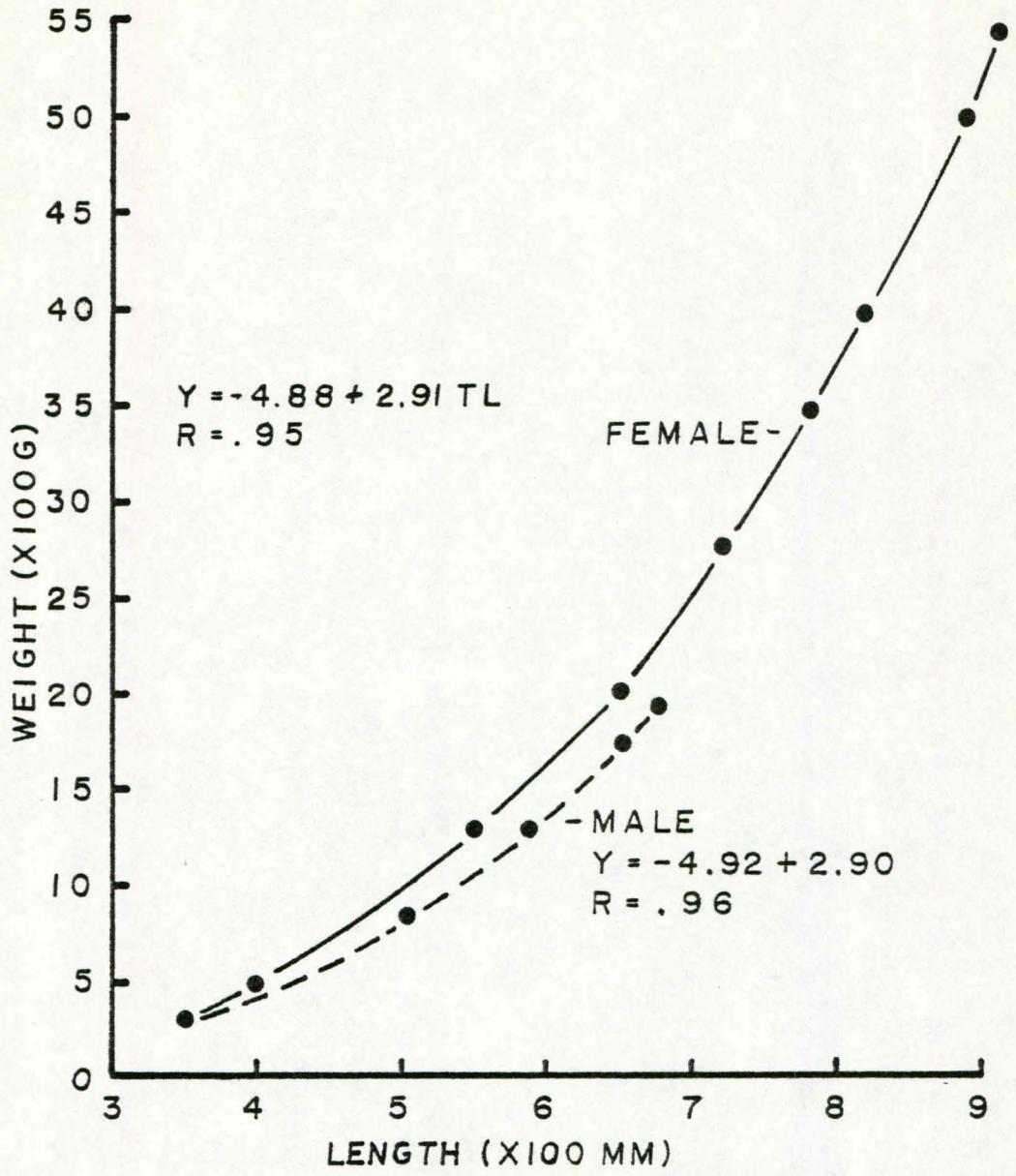

Figure 2. Weight-length regression for male and female northern pike.

Testing revealed no significant differences between location or year at the 95% confidence level. Significant differences occurred between sexes. Coefficients were pooled within sexes by year and pool. Weight-length relationships for each sex were best described by the equations

$$\log_{10}W = -4.92 + 2.90 \log_{10}TL \quad \text{male}$$
$$\log_{10}W = -4.88 + 2.91 \log_{10}TL \quad \text{female}$$

Standard deviations of the pooled slope values were ± .15 and ± .12 for males and females, respectively. Correlation coefficients for the pooled regressions were .96 for male and .95 for female northern pike.

COEFFICIENT OF CONDITION

Body condition was determined from the equation

$$K = \frac{W(10^5)}{TL^3}$$

where K was body condition factor, W was weight in grams and TL was total body length in millimeters. Condition coefficients (K) were calculated from means of fish in 25 mm (.984 in) class intervals for each pool, each year and by sex.

Mean K-factors and sample size are shown in Table 3. Two hundred seventy-six comparisons were possible. The various groups were tested at the .05 level of probability in a Student's t-distribution where variance between groups was assumed unequal. Mean K-factors within pools and within sexes were compared with grand average means within sexes. No significant differences occurred. Mean body condition (K) for male northern pike ranged from .63 at Pool 9 in 1975 to .68 at Pool 10 in 1976, while mean body condition (K) of female northern pike ranged from .63 at Pool 9 in 1975 to .80 at Pool 10 in 1974.

AGE AND GROWTH

Estimations of total length at each annulus (Table 4) were pooled by sex for collection years and location. Average lengths of 352, 503, 587, 650, and 676 mm (13.8, 19.8, 23.1, 25.6, and 26.6 in) for age 1 through 5 males were calcaulated. Average length at each annulus for females was 397, 553, 647, 722, 782, 818, 911 and 884 mm (15.6, 21.8, 25.5, 28.4, 30.8, 32.2, 35.9 and 34.8 in) for the first 8 years of life. The decline in TL at age 8 was based on only one fish from collection year 1976. Grand average growth increments (Figures 3 and 4) were 352, 152, 83, 56 and 43 mm (13.8, 6.0, 3.3, 2.2 and 1.7 in) for males age 1 through 5 and 397, 159, 95, 70, 54, 40, 39 and 28 mm (15.6, 6.2, 3.7, 2.8, 2.1, 1.6, 1.5 and 1.1 in) for females age 1 through 8.

FECUNDITY

Fecundity data were collected from fish in Pools 9, 13 and 14 during 1974, 1975 and 1976. Fifty-eight fish ranging in size from 381 mm (15 in) and 3.7 kg (8.2 lbs) to 845 mm (33.3 in) and 4.54 kg (10 lbs) were examined. Total estimated ova ranged from 4,046 to 139,547 (Table 5). Mean egg production was 29,294 ova/kg of fish with a standard deviation of ± 2,337.

Table 3. Mean condition factors by sex, year, and pool. Grand mean with pools and years combined, by sex.

	Pool	Year		Mean condition factor (K)	Sample size
Male	9	1974		.66	174
		1975		.63	36
		1976		.67	124
			Mean	.65	334
	10	1974		.67	82
		1975		.65	95
		1976		.68	61
			Mean	.66	238
	13	1974		.63	60
		1975		.66	62
		1976		.65	60
			Mean	.64	182
	14	1974		.61	26
		1975		.64	52
		1976		.65	46
			Mean	.63	124
			Grand Mean	.65	
Female	9	1974		.73	127
		1975		.63	24
		1976		.74	179
			Mean	.72	330
	10	1974		.80	29
		1975		.67	42
		1976		.79	43
			Mean	.74	114
	13	1974		.76	46
		1975		.77	59
		1976		.78	42
			Mean	.76	147
	14	1974		.68	27
		1975		.73	48
		1976		.78	58
			Mean	.73	133
			Grand Mean	.74	

Table 4. Estimated body length at each annulus for northern pike in four pools of the Mississippi River.

		Pool	Sample size	Estimated TL at each annulus							
				1	2	3	4	5	6	7	8
Male	1974	9	173	358	493	585	668				
		10	82	345	496	589	649				
		13	60	347	500	577	617	623			
		14	26	354	501	594	684				
Female	1974	9	127	393	539	646	735	809	857		
		10	29	383	548	628	692	736			
		13	46	375	553	672	739	792			
		14	27	387	551	647	726	792	843	934	
Male	1975	9	36	356	500	582	661				
		10	95	329	476	558	641	702			
		13	62	345	498	594	646	752			
		14	52	346	507	611	666	723			
Female	1975	9	24	410	558	662	757	870			
		10	42	390	550	649	740	811	866		
		13	59	388	557	647	719	774	802		
		14	48	386	540	632	711	766	818		
Male	1976	9	124	381	516	590	648	715			
		10	61	331	508	597	656	686			
		13	60	379	533	591	635	658			
		14	46	351	503	576	626	661			
Female	1976	9	179	417	549	632	704	770	822	888	884
		10	43	410	569	652	731	776	803		
		13	42	415	555	647	705	755	768		
		14	58	407	572	651	706	740	712		
Male	Grand $\bar{X}$ est. TL			352	503	587	650	676			
	Grand $\bar{X}$ increments			352	152	83	56	43			
	Sum of increments			352	504	587	643	686			
Female	Grand $\bar{X}$ est. TL			397	553	647	722	782	818	911	884
	Grand $\bar{X}$ increments			397	159	95	70	54	40	39	28
	Sum of increments			397	556	651	721	775	815	854	882

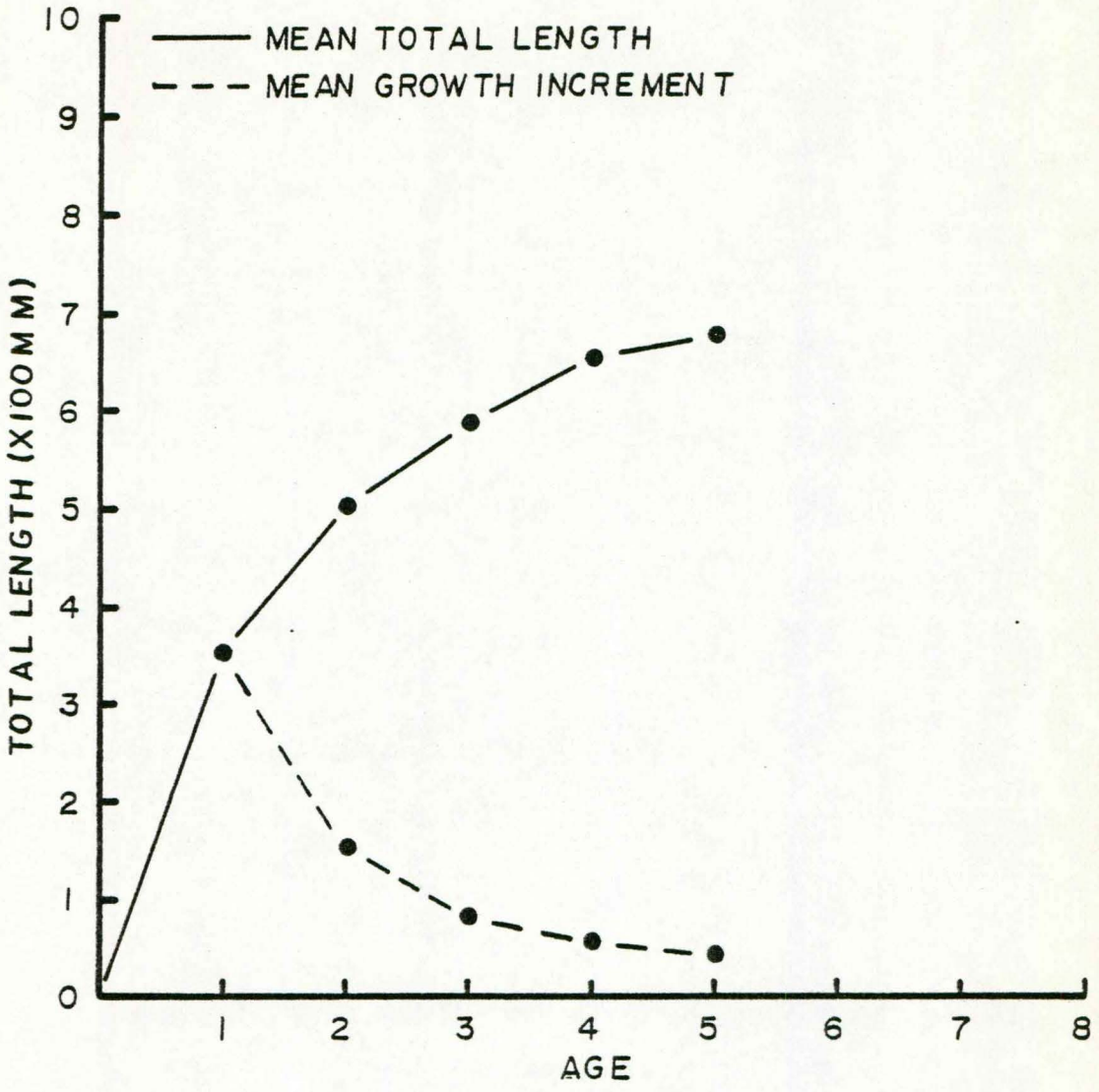

Figure 3. Estimate growth in body length for male northern pike collected during 1974-1976 in Pools 9, 10, 13 and 14 of the Mississippi River.

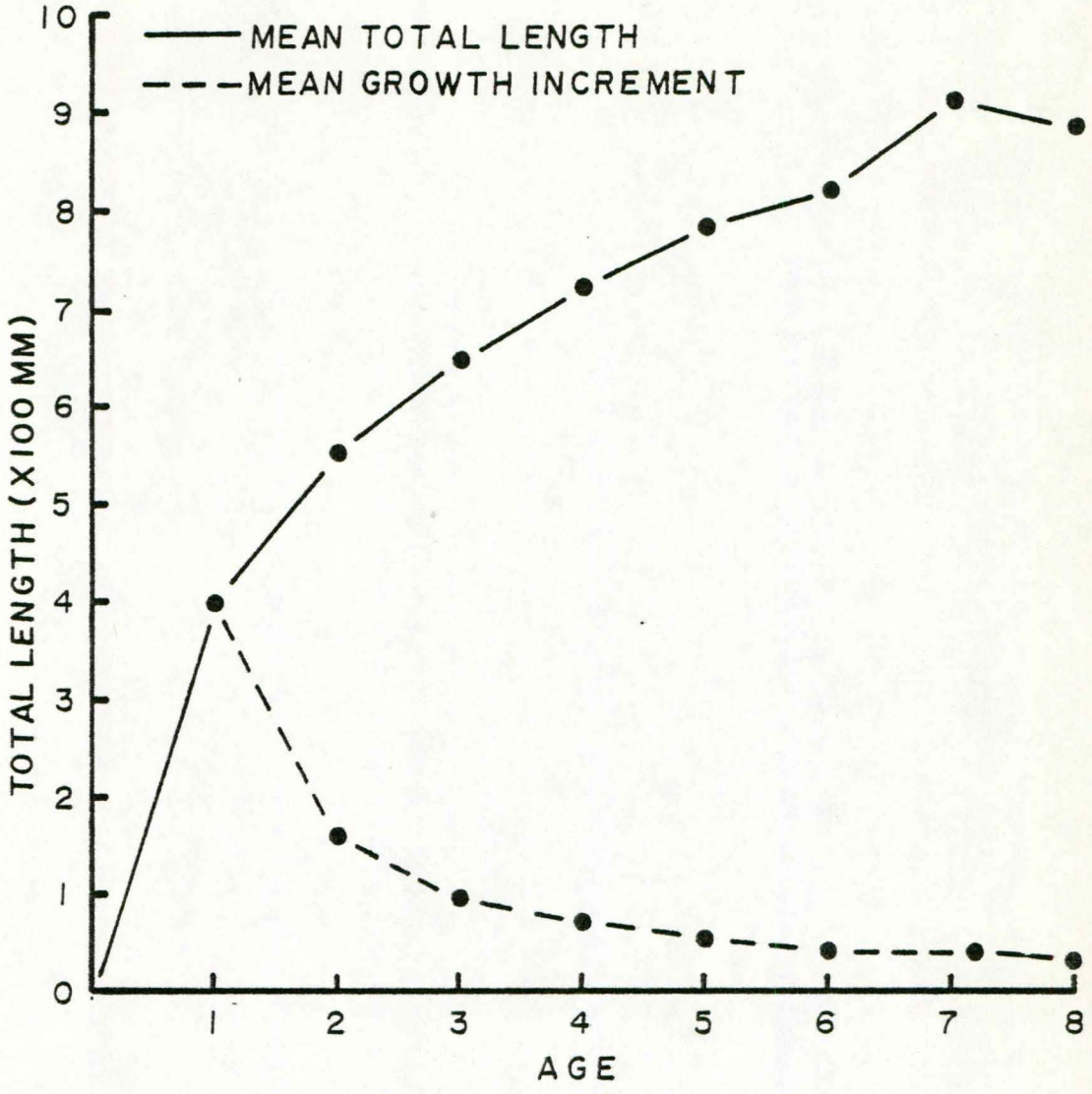

Figure 4. Estimated growth in body length for female northern pike collected during 1974-1976 in Pools 9, 10, 13 and 14 of the Mississippi River.

Table 5. Mean egg volume and number from northern pike during 1974-76.

Class interval (mm)	Sample size	Mean length (mm)	Mean weight (g)	Mean volume of eggs (ml)	Mean number of eggs	Standard deviation
376-400	5	388	394	43	9,257	3,479
401-425	4	411	436	70	14,388	2,544
426-450						
451-475	3	459	650	115	21,226	4,295
476-500	2	486	880	175	32,025	7,106
501-525	1	503	880	126	31,752	---[a]
526-550	3	541	980	226	41,457	2,447
551-575	2	568	1,165	233	31,943	2,790
576-600	6	589	1,433	322	51,127	5,621
601-625	2	621	1,730	343	61,137	1,056
626-650	2	635	1,840	333	48,888	17,233
651-675	4	662	1,965	439	69,857	20,670
676-700	5	686	2,130	370	59,259	13,323
701-725	6	712	2,580	459	66,873	18,939
726-750	1	729	2,950	650	87,750	---[a]
751-775	4	761	3,267	680	97,817	22,509
776-800	4	786	3,425	551	100,243	18,762
801-825	1	806	3,410	570	78,660	---[a]
826-850	3	842	4,400	827	123,186	19,748

[a]Standard deviation was not computed.

Linear regression equations for total length and weight on ova were formulated in the simple functions (Figures 5 and 6)

$$Y = a + b\ TL$$

$$Y = a + b\ Wgt$$

where Y = total ova, TL = total body length in mm, and Wgt = total body weight in kg. Regression coefficients were as follows: Ova (Y) = -80,473.4 + 221.7 TL and Ova (Y) = 5,510 + 27.01 Wgt. Eighty percent of the variation in ova were explained by length and 85% explained by weight.

Multiple linear regression of TL and Wgt on ova using the model

$$Y = a + b_1\ TL + b_2\ Wgt$$

was: Ova (Y) = -10,216.09 + 39.03 TL + 22.57 Wgt. Eighty-six percent of the variation in ova was explained by the independent variables.

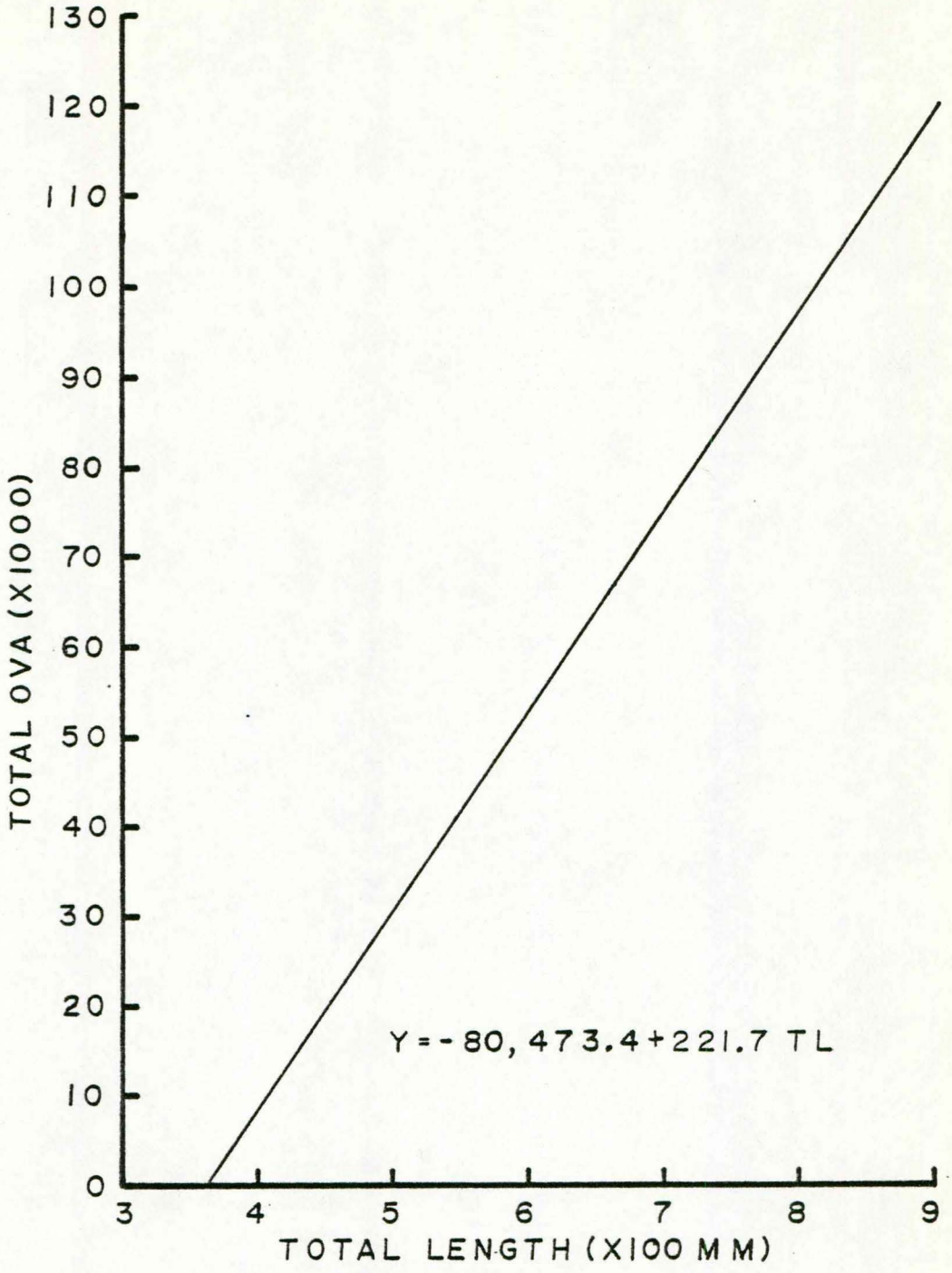

Figure 5. Linear regression of ova on total length for northern pike collected from Pools 9, 13 and 14 of the Mississippi River during 1974-1976.

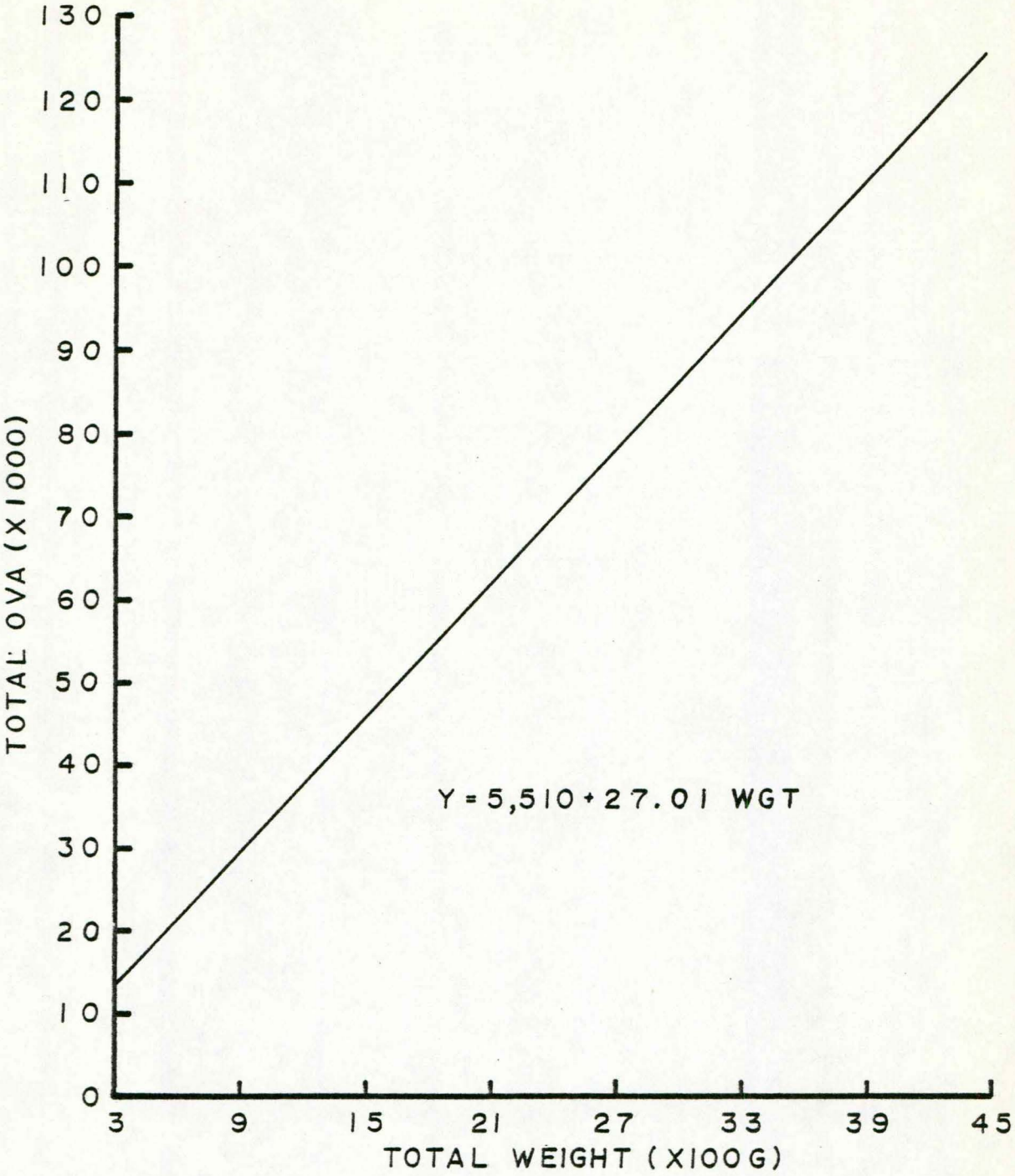

Figure 6. Linear regression of ova on body weight for northern pike collected from Pools 9, 13 and 14 of the Mississippi River during 1974-1976.

ESTIMATED SIZE OF FISH POPULATIONS

Marking goals were achieved in all pools except Pool 14 in 1974 and Pool 9 in 1975. Tagging was initiated in Pool 9 during the first year and proceeded in a downstream direction. Spawning activity had diminished in Pool 14 before netting effort was applied and fish were no longer as vulnerable. In 1975, netting began in Pool 14 and proceeded upstream. Although the spawning season was not over in Pool 9 when the netting crew arrived, flooding made netting unproductive.

The annual tag loss rate was estimated from the ratio of tag retentions among recovered fish which were both tagged and fin-clipped at the time of release (Robson, 1966). One fish was recaptured which had lost the plastic sheath of the Floy tag, however the shank remained attached. Tag loss was estimated as < 1%. Handling mortality was estimated from the ratio of recaptured fish which had left as opposed to right pelvic fins (pectoral fins were used in 1975) removed. Handling mortality was considered negligable.

Numerical population estimates were made in Pools 9, 10, 13 and 14 during 1975, 1976 and 1977 (Table 6). The Petersen estimator, as previously defined, was used. Sampling was done with replacement. The validity of the estimator rests on the assumptions as defined by Ricker (1975). All of these assumptions were satisfied except the assumption that there will have been no additions to the population.

This estimator may be negatively biased (estimating a number < $\hat{N}$) if any product of M and C is < $3\hat{N}$ (Ricker, 1975; Robson, 1968). Numerical estimates of northern pike populations inhabiting Pools 13 and 14 during 1975 and Pool 14, during 1976 and 1977 were not biased. Bias of $\hat{N}$ for Pools 9, 10 and 13 was calculated from the equation

$$\text{bias of } \hat{N} = 100\, e^{-(MC/N)} \text{ percent}$$

where e^x extrapolates as the antilogarithm of x and other symbols are as previously defined. $\hat{N}$ was underestimated by approximately 13-37% in the 5 cases for which bias could be ascertained. The standard error of $\hat{N}$, designated by S.E.($\hat{N}$), was estimated from the usual function

$$S.E.(\hat{N}) = \hat{N}\sqrt{\frac{(\hat{N} - M)(\hat{N} - C)}{MC(\hat{N} - 1)}}$$

where symbols are as previously defined. Standard error, where calculable, ranged from ± 107 to ± 98,201. Population estimates ranged from 469 to 98,515. Confidence intervals at the 95% level are presented in Table 6. Numerical estimates consistantly indicated smaller populations in downstream pools in all years. Relative density, as indicated by numbers of recaptured fish, also suggests lower population densities in downstream pools.

SURVIVAL AND FISHING MORTALITY

Northern pike survival estimates in Pools 9, 10, 13 and 14 were calculated from the pooled age distribution (Table 7) observed over 3 years. Data were pooled to reduce bias resulting from unequal recruitment between years. Variance decreased because of increased sample size. Estimates were calculated by two procedures (Table 8). Initial analysis was by Heincke's method

Table 6. Numerical population estimate of northern pike in Pools 9, 10, 13 and 14 of the Mississippi River during 1975, 1976 and 1977.

	Pool	Marked fish at large	Recapture sample size	Marked fish recaptured	Numerical estimate[a]	Negative bias in percent
1975	9	304	61	0	NC[b]	NC
	10	111	137	0	NC	NC
	13	111	130	9	1,603	NS[c]
	14	54	113	13	469	NS
1976	9	61	307	2	9,363	13
	10	137	107	2	7,329	13
	13	121	107	4	3,237	13
	14	100	111	5	2,220	NS
1977	9	305	323	1	98,515	36
	10	105	235	0	NC	NC
	13	103	109	2	5,613	13
	14	106	119	17	742	NS

[a]The estimate is made at time t and is interpreted for t - 1; i.e., a 1975 estimate represents 1974 population size.

[b]Not computed.

[c]Not significantly biased.

Table 7. Age distribution of northern pike in Pools 9, 10, 13 and 14 of the Mississippi River.

	Pool	Sample size	Age							
			I	II	III	IV	V	VI	VII	VIII
Male	9	333	34	183	96	15	5			
	10	238	4	49	135	47	3			
	13	182	1	42	100	31	8			
	14	124	1	31	70	19	3			
Mean			13	76	100	28	5			
Female	9	330	20	107	93	69	32	6	2	1
	10	114		12	29	44	22	7		
	13	147		6	49	68	18	6		
	14	133	1	22	54	39	13	3	1	
Mean			10	59	56	55	21	6	2	1

Table 8. Survival estimates for male and female northern pike in Pools 9, 10, 13 and 14 of the Mississippi River.

	Pool	Heincke survival estimate	Chapman-Robson survival estimate	Variance of Chapman-Robson estimate	Standard error of Chapman-Robson estimate
Male	9	.17	.18	.0010	.03
	10	.06	.06	.0010	.03
	13	.28	.25	.0010	.03
	14	.24	.22	.0015	.04
	Mean	.25	.22	.0010	.03
Female	9	.37	.33	.0013	.04
	10	.24	.20	.0047	.07
	13	.26	.25	.0015	.04
	14	.30	.29	.0027	.05
	Mean	.35	.34	.0017	.04

$$\hat{S} = \frac{\Sigma N - N_0}{\Sigma N}$$

where $\hat{S}$ is the estimate of survival, N_1, N_2, N_3, etc. are successive numbers of fish in the age distribution, N_0 is the age of full recruitment or vulnerability to gear, and ΣN is the sum of these. This estimate is appropriate for northern pike since difficulty in age assignment increased with age and it was not necessary to know the number of fish in each age group older than that coded as N_0.

Survival estimated by this method ranged from .06-.28 for males and from .24-.37 for females. Overall means for males and females were .25 and .35, respectively.

A second estimate, following the method of Chapman and Robson as described by Everhart (1975)

$$S = \frac{T}{N + T - 1}$$

where, $\hat{S}$ is the survival estimate and the ages are coded so that the frequency of the youngest age in the sample is set at zero following the notation; $N_0 - 0$, $N_1 = 1$, etc. T equals the sum of the coded age multiplied by its frequency, and ΣN equals $N_0 + N_1 + N_2 \cdots N_{x\Sigma}$. The Chapman-Robson estimator takes into account the probability of changing mortality with increasing age. Estimations of N_0 are increasingly accurate if both types of estimators are used.

The age of full recruitment and vulnerability to the fishery was tested through a Chi-square comparison of Chapman-Robson and Heincke estimates. The equation

$$X^2 = \frac{(\text{Chapman, Robson est.} - \text{Heincke est.})^2}{T(T-1)(\Sigma N - 1)/\Sigma N(\Sigma N + T - 1)^2(\Sigma N + T - 2)}$$

where, all symbols are as previously defined, was used. N_0 was equal to age 3 and age 4 for males and females, respectively.

The estimated variance of the Chapman-Robson estimator was calculated by the following methods

$$\hat{V}(\hat{S}) = \frac{\hat{S}(1-\hat{S})^2}{\Sigma N}$$ large samples (Pools 9 and 10 - males) (Pool 9 - females)

and

$$\hat{V}(\hat{S}) = \hat{S}(\hat{S} - \frac{T-1}{\Sigma N + T - 2})^2$$ small samples

where all symbols are as previously defined. Standard error was computed by the usual procedure and is presented in Table 8.

Survival estimated by this method ranged from .05 to .25 for males and from .20 to .33 for females. Mean estimates of survival for the composite samples were .22 and .34 for males and females, respectively.

Fishing mortality, as determined by anglers tag returns is minimal and perhaps negligable compared to total mortality. Of the 1,618 fish tagged and released, only 22 (1.4%) are known to have been captured. Voluntary response may be 20-30% (Mitzner, personal communication).

MOVEMENT

Movement was determined from the capture of previously marked fish (Table 9). Estimates from angler caught fish indicated 64% of the marked fish moved upstream, 21% moved downstream, while 15% were captured near the release site. Mean distance moved was 7.4 km (4.6 mi) with a standard deviation of ± 12.5 km (± 7.8 mi).

Estimates based on experimentally caught fish were 32% moved upstream, 13% moved downstream and 55% were captured near the released site. Mean distance moved was 1.3 km (.8 mi) with a standard deviation of ± 2.6 km (1.6 mi).

Mean time at large for angler captured fish varied consistantly by location (Appendix C).

Table 9. Movement[a] of northern pike as determined from tagged fish.

Pool	Source of tag return	Sample size	Movement expressed as percent of sample size			Mean distance		Standard deviation	
			Upstream	Downstream	Static	km	(mi)	km	(mi)
9	Angler	6	83	0	17	9.2	(5.7)	± 10.3	(6.4)
	Experimental	4	25	50	25	1.9	(1.2)	± 2.1	(1.3)
10	Angler	4	25	50	25	(0)	(0)	± 2.6	(1.6)
	Experimental	7	29	29	42	1.0	(0.6)	± .8	(0.5)
13	Angler	6	67	17	17	5.3	(3.3)	± 7.2	(4.5)
	Experimental	17	35	12	53	2.4	(1.5)	± 4.2	(2.6)
14	Angler	6	83	17	0	14.0	(8.7)	± 2.1	(13.1)
	Experimental	45	31	0	69	1.0	(0.6)	± 1.8	(1.1)
Combined	Angler	22	64	21	15	7.4	(4.6)	± 12.6	(7.8)
	Experimental	73	32	13	55	1.3	(0.8)	± 2.6	(1.6)

[a]This does not preclude the possibility that fish may have moved both upstream and downstream during the period in which they were at large. Values presented represent point of release in relation to point of capture.

COMMERCIAL FISHERY ASPECTS

HISTORY OF COMMERCIAL HARVEST

Northern pike was commercially harvested in all states bordering the upper Mississippi River in the late 1800's. Harvest records (Table 10) show a total harvest of 51,528 kg (113,600 lbs) valued at $5,750 in 1894 and 30,754 kg (67,800 lbs) valued at $2,600 in 1899. Harvest after 1922 was permitted only by Iowa. Maximum reported harvest in Iowa was 21,772 kg (48,000 lbs). The smallest catch was 5,897 kg (13,000 lbs) in 1957. Commercial harvest was statuatorally terminated in 1959.

Value per kilogram remained at 49-51¢ (22-23¢/lbs) during most years. Total value ranged from $3,000-$11,000 with an average of $5,940.

Compared with the total commercial fishery, northern pike contributed 1.4% of the value in Iowa and 1% of the total weight harvested. Upstream pools consistantly produced more northern pike than downstream pools. Pools 9, 10, and 11 produced 58.5%, 27.4%, and 10.3% of the catch, respectively. Northern pike were not reported from some pools during 1954-1959. In Pools 9, 10, and 11 northern pike contributed 2.1%, 4.1% and 1.9% of the total fishery, respectively.

Interviews with commercial fishermen indicated that low harvest in downstream pools increased reporting error. Not enough fish were harvested to produce a market. As a result, northern pike were frequently weighed with other species, usually carp, and sold at the same price, making separate records impractical.

Entrapment devices were the most effective gear, accounting for 89.9% of the catch. Seines, entanglement gear and set lines followed with 7.9%, 1.0% and 0.2% of the catch, respectively.

Although records do not specify monthly harvest, fishermen interviews indicated most of the harvest occurred in March and April during spawning. A secondary peak in harvest occurred in autumn (September and October) with the remainder of the catch scattered throughout the summer. Few were taken under ice cover.

Fishing records kept by a commercial fisherman who has fished Pool 9 since the late 1930's indicated similar trends for catch and value. Most of his commercial northern pike catch was taken in modified fyke nets. Catch records showed an average annual northern pike harvest of about 1,134 kg (2,500 lbs). Approximately 50% of this catch occurred in April, while nearly 10% was caught in March, May, September, October, and November. Spring values was as much as 30% higher than autumn values. Values increased as sufficient supply became available to establish a market.

MARKET DEMAND

Market demand was surveyed by questionnaires, along with telephone and personal interviews of fishermen and wholesale fish markets. A questionnaire (Appendix B) requesting information on expected benefits of a northern pike commercial fishery was mailed to 623 commercial fishermen. Voluntary responses

Table 10. Selected commercial harvest statistics of northern pike from the upper Mississippi River between 1894-1959.

	Illinois		Iowa		Minnesota		Missouri		Wisconsin	
	Pounds (kg)	Value	Pounds (kg)	Value	Pounds (kg)	Value	Pounds (kg)	Value	Pounds (kg)	Value
1894	9,865 (4,475)	$505	18,445 (8,367)	$ 820	35,395 (16,055	$1,626	1,895 (860)	$170	48,008 (21,776)	$2,631
1899	5,475 (2,483)	309	25,042 (11,350)	1,000	23,725 (10,761)	840			13,535 (6,139)	447
1922			20,100 (9,117)	1,850						
1931			4,700 (2,132)	470						
1950			7,100 (3,221)	1,061						
1954			46,600 (21,137)	5,592						
1955			9,800 (4,445)	1,176						
1956			24,600 (11,158)	2,952						
1958			16,300 (7,394)	3,743						
1959			20,800 (9,435)	4,765						

were obtained from 302. Results were analyzed by pool in which the fishermen operated and business size. Size of fishing operation was determined by estimated mean annual harvest and was catagorized as < 454, 454-4,536 and > 4,536 kg (< 1,000, 1,000-10,000 and > 10,000 lbs). In general, responses (Tables 11 and 12) were evenly distributed among pools. The proportion of large operators decreased progressively downstream (Appendix D). Sixteen percent reported > 4,536 kg (>10,000 lbs), 20% reported 454-4,536 kg (1,000-10,000 lbs) and 56% reported < 454 kg (< 1,000 lbs).

Forty percent indicated northern pike were present in sufficient quantities in their locality for commercial harvest. Response varied from 17% to 86%, with more fishermen upstream than downstream providing an affirmative response. This trend was expected as population density diminishes downstream. Responses also varied with size of fishing operation; a greater percentage of large operators answered yes. Responses of fishermen indicating they would fish for northern pike if placed on the commercial list followed a similar trend with 43% answering affirmative. The more upstream and larger operators stated northern pike would increase their income by a significant amount, but only 28% of the overall number held this opinion.

Most fishermen expected sales to be local rather than distant. This opinion was especially prevalent among downstream fishermen and small operators.

Fishermen were asked if they had fished for northern pike when they were on the commercial list prior to 1959. Twelve percent answered in the affirmative. Response to this question was biased by longevity of the fishing operation. As a result more large, well established operators had more experience than small operators. More upstream fishermen had fished for northern pike than downstream fishermen.

Condition of fish at time of sale (i.e., whole, dressed, drawn, etc.) was not specified on the questionnaire and response to expected value per pound varied widely. There was no significant difference in response between pools, but there was a difference by size of operator. The greater portion of fishermen annually landing over 4,536 kg (10,000 lbs) expected only 24-55¢/kg (11-25¢/lbs). A high percentage of those landing 454-4,536 kg (1,000-10,000 lbs) expected 57¢-$1.10/kg (26-50¢/lbs) while a large portion of those landing < 454 kg (< 1,000 lbs) expected $1.12-$2.20/kg (51¢/$1.00/lbs).

Local market operator opinions were as varied as fishermen's. Most local wholesalers and market personnel indicated there was little demand locally prior to the 1959 closing and that they usually shipped whole northern pike to Chicago, Illinois markets. Some local buisness was anticipated to develop in the areas of smoked, fresh whole and filleted products.

Three large Chicago, Illinois wholesale buyers were interviewed by telephone. All handle Canadian northern pike but indicated demand was light. One buyer indicated northern pike were presently of marginal value and resulted in little or no profit because of spoilage problems caused mainly by shipping delays. This buyer expressed special interest in an Iowa northern pike fishery, pointing out that Mississippi River fish are received within two days of capture compared to four days for Canadian fish. Thus, he reasoned, a better market could be established with a fresher product. Prices paid to shippers were 40-44¢/kg (18-20¢/lbs) whole and 77-99¢/kg (35-45¢/lbs) dressed (headed and drawn). Volumes handled ranged from 91-136 kg (200-300 lbs) to 680-907 kg (1,500-2,000 lbs) per week.

Table 11. Percent affirmative responses to questions posed to commercial fishermen pertaining to northern pike with responses grouped according to pool in which the fishermen operated.

Question	Pool											Combined pool
	9	10	11	12	13	14	15	16	17	18	19	
Do you think northern pike are present in sufficient numbers in your area to harvest commercially?	86	68	48	50	47	41	27	24	32	17	21	40
Would you fish for northern pike if they could be legally taken commercially?	71	56	48	46	29	48	54	32	32	33	28	43
Do you feel they would increase your income by a worthwhile amount?	58	50	41	33	17	33	17	7	18	29	7	28
Did you fish for northern pike before 1959 when the season was open?	28	12	18	25	10	15	8	10	5	2	3	12
Would you expect to market your northern pike locally or by shipping to Chicago? (answer in % local).	79	30	62	13	82	85	89	91	83	96	92	72

Table 12. Percent affirmative responses to questions posed to commercial fishermen pertaining to northern pike with responses grouped according to size of fishing business.

Question	Size of fishing business expressed as average annual harvest		
	< 454 kg (< 1,000 lbs)	454- 4,536 kg (1,000-10,000 lbs)	> 4,536 kg (> 10,000 lbs)
Do you think northern pike are present in sufficient numbers in your area to harvest commercially?	26	51	71
Would you fish for northern pike if they could be legally taken commercially?	31	53	71
Do you feel they would increase your income by a worthwhile amount?	13	36	61
Did you fish for northern pike before 1959 when the season was open?	4	12	39
Would you expect to market your northern pike locally or by shipping to Chicago? (answer in % local).	87	68	50

WEIGHT LOSS IN PROCESSING

Data were collected on the incremental weight loss associated with various processing methods from 47 fish. This represented an adequate sample for statistical analysis to determine differences in weight change by fish size. Fish size ranged up to 1,010 mm (40 in) and 6.70 kg (14.8 lbs).

Small fish did not lose as much weight when dressed as did large fish. Dressed weight decreased 79.7% to near 70% for fish .5-2.0 kg (1.1-4.4 lbs) and remained at 70% for larger fish. Dressed weight was 72% of whole weight for the entire sample. Smoked weight was 37% and fillet weight was 47.4% of whole weight.

CHEMICAL CONTAMINATION OF NORTHERN PIKE FLESH

A literature search conducted during 1974 indicated the presence of various contaminants in some food-fish species in the upper Mississippi River which would affect the value of northern pike as a commercial product. Generally, these investigations have been of a broad "spot check" nature for the purpose of locating problem areas. Results have indicated contamination has exceeded Food and Drug Administration (FDA) recommended tolerance limits in only a few instances. Morris and Johnson (1970a and 1970b) found some bottom feeders exceeding safe levels for Dieldrin in the downstream portion of the river. High concentrations of Polychlorinated Biphenols (PCB's) have resulted in the banning of commercial fishing for some species in the St. Paul-Minneapolis, Minnesota area.

Records of analyses of northern pike were sparse. The species was included in tests for chlorinated hydrocarbons (Kleinert, 1968; Degurse, 1972) and Mercury (Kleinert, 1972). These studies included fish from the Mississippi River bordering Wisconsin. Though concentrations were well within acceptable limits, number of northern pike tested were not sufficient to be conclusive.

Tests were conducted to determine chlorinated hydrocarbon pesticides, Atrazine, PCB's and Mercury. Analyses for phenols were not attempted due to a lack of an acceptable method.

Test results (Table 13) indicated substantial differences between sampling stations, however, all were well below FDA tolerance levels for the paramters tested. Pesticide concentrations were quite low. PCB's were well below the acceptable limits. Atrazine was not detected.

These samples are consistent with others tested from the Mississippi River in the past, showing higher levels of pesticides in Pool 14 samples. This indicates significant inflow from sources between Pools 9 and 14. PCB's showed the opposite effect, strongly suggesting that the major sources of PCB's in the Mississippi River are upstream from both sampling sites.

ACCOMPLISHMENTS, NEEDS AND RECOMMENDATIONS

Intensive investigations into the biology of northern pike in four pools of the upper Mississippi River from 1974-76 showed that life history characteristics were not significantly different from one location to another, but that there was a significant difference in numerical population size. The latter fact is

Table 13. Concentrations of chemical contaminants in composite northern pike flesh samples from two Mississippi River locations.

Pool	Replicate	Dieldrin (ppb)	DDE (ppb)	Heptachlor epoxide (ppb)	Chlordane (ppb)	PCB[a] (ppm)	Mercury (ppm)
9	1	2	1	-	-	.22	.12
	2	2	2	-	-	.16	.27
	3	2	1	-	-	.29	.19
	Mean	2.0	1.3	-	-	.22	.19
14	1	14	6	3	7	.11	.17
	2	15	7	3	8	.10	.16
	3	12	4	2	6	.10	.17
	Mean	13.7	5.7	2.7	7.0	.10	.17

[a]Parts per million as Arochlor 1254.

supported by established trends in estimated numerical population size and by relative abundance indexes. Mean survival estimates were 22% and 34% for males and for females. Fishing mortality is estimated to be less than 2%, natural mortality is therefore estimated to be 75% for male northern pike and 64% for female northern pike. Thus, there exists a potential for greatly increased harvest of northern pike without any significant adverse affects upon the population density.

The upper Mississippi River is a tremendously important sport fishery resource. People living in Iowa counties bordering the river spent over 2 million days pursuing this recreational activity. Thirty-seven percent of the fishing in the 15 counties in northeast Iowa is done on the Mississippi River (Central Research Corp., 1976). Northern pike is the preferred sport fish of 6% of the fishermen in northeast Iowa; however, only 1% of the fish caught are northern pike.

Northern pike had been successively commercially harvested from Pools 9 and 10 prior to 1959. There is not a discernable difference in relative abundance estimates established prior to 1959 with those currently established. Life history characteristics of commercially exploited northern pike populations are similar to those same characteristics of unexploited populations (Helms, 1975). Historically, northern pike contributed < 2% to the value of the total Iowa commercial fishery; however, they are a desirable commercial product and they could increase commercial fishermen income, especially those fishermen operating in Pools 9 and 10.

More efficient utilization of the resource could be attained and a step towards achieving optimum sustainable yield taken, by initiating the following recommendations.

1. Decrease natural mortality by making more efficient use of renewable resource by opening Pools 9 and 10 to commercial fishing. Evaluate this fishery three years after initiation by comparing age structure, growth and survival rates with those presently established.

   Opening northern pike to commercial exploitation requires legislative action. A bill should be proposed which would allow the Conservation Commission to add or delete species from the list of permissive catch, as defined in Section 109.111 of the Iowa Conservation Laws. The basis for this action would be Section 109.39. This action is biologically sound and desirable from a management viewpoint, however, present political realities dictate a different approach. Commission approval to proceed with a legislative proposal to return northern pike to the list of permissive catch should be requested. Once approval is granted, the next step would be to present the proposal, its background and the benefits expected to special interest groups and the general public. Minnesota and Wisconsin are the bordering states affected and they would be contacted through the UMRCC. Resolution of potential conflicts with bordering states is necessary for proper enforcement of regulations. Following legislative approval and after the commercial fishery is established, a two year investigation of the effects of the commercial fishery on northern pike populations should be initiated. The extent of this investigation has been previously defined.

There are large northern pike populations in Pools 9 and 10. A significant portion of the biomass is surplus stock in that natural mortality is 65% to 75%, sport fishing mortality is minimal and total mortality is 66% to 78%. Commercial exploitation has not adversely affected past or present northern pike stocks. Commercial fishermen will fish for northern pike when they are returned to the commercial list and there is a demand, both local and distant, for Mississippi River northern pike. There is no current problem with chemical contamination of northern pike flesh. Northern pike will not constitute a large portion of the total commercial fishery, either in weight or in value, but they will add $5,000 to $15,000 in income to commercial fishermen operating in Pools 9 and 10.

2. Increase survival by stabilizing water levels. Year class abundance is directly affected by rapid temperature change which could be dampened through reduction in water level fluctuation (Franklin, 1963). In northern pike populations the time from hatching until termination of the alevin stage is critical to establishment of year class abundance and therefore, mortality may be diminished if a more stable environment is provided.

   It may be possible to stablize water levels through cooperative water level manipulation plans established by the Iowa Conservation Commission, member states in the UMRCC, U.S. Fish and Wildlife Service and the Army Corps of Engineers. Proposals are now being drafted by personnel in the Fisheries Management Branch which would accomplish this goal.

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APPENDIX A

UMRCC Habitat Classification Categories

Tailwaters

Includes areas immediately below the dams which are affected by the passage of waters through gates of the dam and out of the locks. These areas change in size according to water stage, and the arbitrary lower boundary for fishery purposes has been set at a distance of 0.80 km (0.50 m) below the dams.

Main Channel

Includes only the portion of the river through which large commercial craft can operate. It is defined by combinations of contraction devices (wing dams), river banks, islands, and buoys and other markers. It has a minimum depth of 2.74 m (9 ft) and a minimum width of 121.6 m (400 ft).

Main Channel Border

The zone between the 2.74 m (9 ft) channel and the main river bank, islands, or submerged definitions of the old main river channel. It includes all areas in which wing dams occur along the main channel.

Side Channels

Includes all departures from the main channel border in which there is current during normal river stage.

River Lakes and Ponds

This classification along with slough replaces the old term "back waters". River lakes and ponds in general are open expanses of water with little or no current. Several types of lakes occur along the Mississippi. These are: lakes of formation due to the fluviatile dams, lakes of mature flood plains and lakes due to behavior of higher organisms. Ponds differ from lakes only by size.

Sloughs

This category includes all of the remaining aquatic habitat found in the river. Sloughs often border on the "lake or pond" category on the one side and on the "side channel" category on the other. They have no current at normal water stage, muck bottoms, and an abundance of submerged and emergent aquatic vegetation.

APPENDIX B

NORTHERN PIKE COMMERCIAL FISHING QUESTIONNAIRE

1. In which pool(s) do you fish? _____

2. How many pounds of fish do you catch in average year?

   ( ) Under 1,000 lbs
   ( ) 1,000 to 10,000 lbs
   ( ) Over 10,000 lbs

3. Do you think northern pike are present in sufficient numbers in your are to harvest? ( ) Yes ( ) No

4. Would you fish for northern pike if they could be legally taken commercially? ( ) Yes ( ) No

5. How would you market them? ( ) Yes ( ) No

6. What price per pound would you expect to receive? _____

7. Do you feel they would increase your income by a worthwhile amount? ( ) Yes ( ) No

8. Did you fish for northern pike before 1959 when the season was open? ( ) Yes ( ) No

9. Do you have or know of any personal oogs or records dating back to the 1950's (or earlier) which would contain information on harvest or values of northern pike? ( ) Yes ( ) No

10. Mark one of the following:

   ( ) I want northern pike returned to commercial list.

   ( ) I don't want northern pike returned to commercial list.

   ( ) I don't care if it is returned to the commercial list or not.

COMMENTS:

APPENIX C

Number of tagged fish recovered, period of capture and mean time at large, by pool and year, of angler caught northern pike in the Mississippi River.

				Period of recapture								
				1974		1975		1976		1977		
	Pool	Number marked	Number recovered	1 Jan-30 June	1 July-31 Dec	1 Jan-30 June	1 July-31 Dec	1 Jan-30 June	1 July-31 Dec	1 Jan-30 June		Mean time at large
1974	9	304	4	3		1						149
	10	111	1				1					548
	13	111	4		1	2		1				456
	14	54	2			1	1					342
	Combined	580	11	3	1	4	2	1				332
1975	9	61	1			1						30
	10	137	3			1	2					120
	13	121	2			2						81
	14	100	2			2						58
	Combined	419	8			6	2					83.5
1976	9	305	1					1				16
	10	105										
	13	103										
	14	106	2					1		1		205
	Combined	619	3					2		1		142

APPENDIX D

Questionnaire response[a] in each pool grouped according to size of fishing business

Pool	Sample size	Size of fishing business			
		> 10,000 lbs (> 4,536 kg)	1,000-10,000 lbs (454- 4,536 kg)	< 1,000 lbs (< 454 kg)	Not indicated
9	35	37	49	14	-
10	34	21	26	50	3
11	23	13	26	61	-
12	14	29	21	43	7
13	39	15	23	62	-
14	21	19	14	57	10
15	13	-	23	69	8
16	20	5	20	70	5
17	22	14	23	54	9
18	51	12	25	63	-
19	30	6	17	77	-

[a]Response expressed as percent of sample size.