ANNUAL PROGRESS REPORT

Abundance and Distribution of Walleye, Northern Squawfish and Smallmouth Bass in John Day Reservoir, 1984

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ABSTRACT

Walleye, northern squawfish and smallmouth bass abundances were estimated in John Day Reservoir using a modified Schnabel multiple mark and recapture estimator. Sampling was conducted from March 25 to August 31 using gill nets, trap nets, boat electrofishing, angling and an angler survey. A total of 858 walleye, 4,552 northern squawfish, and 1,599 smallmouth bass were collected. Discrete populations were defined according to observed movements of recaptured and radiotagged fish. Abundance estimates were corrected for angler harvest, size selectivity of gear, tag loss and recruitment due to growth during sampling. In addition, the likelihood of biases resulting from differential mortality of marked fish was examined.

Abundances in John Day pool of walleye and northern squawfish with fork lengths greater than 250 mm were estimated at 15,832 and 80,486. Abundances of smallmouth bass with fork lengths greater than 200 mm were estimated to be 2,596 in lower John Day pool and 1,791 in upper John Day pool. Walleye and northern squawfish moved throughout the pool, whereas movements by smallmouth bass were more localized. Angler harvests of walleye and smallmouth bass in upper John Day pool from April through August were estimated at 309 and 584 fish. Angler harvest of northern squawfish was negligible. Most walleye collected were age 5. The most abundant age groups of northern squawfish and smallmouth bass were 10 and 2.

INTRODUCTION

The goal of this study is to determine the distribution, abundance and rates of growth and mortality of walleye (Stizostedion vitreum vitreum), northern squawfish (Ptychocheilus oregonensis) and smallmouth bass (Micropterus dolomieui) in John Day Reservoir. This research is part of a cooperative effort with the U. S. Fish and Wildlife Service (USFWS) to estimate the extent of predation on juvenile salmonids. This report summarizes work conducted in 1984, the third year of the study. Further background information and a description of the study area can be found in our 1982 (Willis et al. 1985) and 1983 (Nigro et al. 1985) annual reports.

Objectives in 1984 were:

1. Describe and correct for biases associated with techniques for sampling walleye, northern squawfish and smallmouth bass.

2. Describe movements and distribution of walleye, northern squawfish and smallmouth bass.

3. Estimate abundance of walleye, northern squawfish and smallmouth bass.

   a. Adjust abundance estimates for recruitment because of growth during the time recoveries were being made.

   b. Adjust abundance estimates for harvest of marked and unmarked fish by anglers.

4. Determine age composition of walleye, northern squawfish, and smallmouth bass.

5. Complete a literature review to identify various approaches to modeling the dynamics of walleye, northern squawfish and smallmouth bass populations and the extent of their predation on juvenile salmonids.

A brief narrative describing the scope of the predation and population dynamics model and a bibliography of modeling approaches can be found in Appendix F.

METHODS AND MATERIALS

Field Sampling

Capture and Handling

Sampling was conducted from March 25 to August 31 (Appendix A, Table A.1) to mark and recapture walleye, northern squawfish and smallmouth bass;

describe changes in their relative abundance during sampling; and evaluate size selectivity of capture gear. Sampling stations located in John Day forebay (159), Irrigon-Paterson (163-151) and McNary tailrace (161) remained unchanged from 1983 (Nigro et al. 1985) (Figure 1). Sampling in John Day tailrace (141) and Miller Island (131) was discontinued and effort in Arlington (156) was increased to more thoroughly sample John Day pool. Equal effort was expended in all four sampling areas.

Horizontal gill nets, trap nets, electrofishing and angling were used (Appendix A, Table A.2) as in 1983. Horizontal gill nets, similar to those used in 1983 but with larger mesh (alternating panels of 6.4.cm and 7.6.cm bar mesh) were also used in Irrigon-Paterson and McNary tailrace to sample larger walleye. Vertical gill nets were used to sample deep, open water stations. Vertical gill nets were 30.5-m deep x 3.0-m wide and had either 3.2,cm, 4.4.cm or 5.1-cm bar monofilament nylon mesh (2.7 kg tensile strength). Nets were set in groups of three; one of each mesh size. As in 1983, USFWS provided us with their catch, tagging, recapture and effort data (see Gray et al. 1985 for gear specifications).

Processing of captured fish was unchanged from 1983, except that in 1984 a clipped left pelvic fin rather than a hole punched in the left opercle was used to recognize fish which had lost their tags.

Radio Telemetry

Movements of 20 radiotagged walleye released in McNary tailrace (Appendix B, Table B.1) and 20 radiotagged northern squawfish released in McNary tailrace and John Day forebay (Appendix B, Table 8.2) were monitored to help define the areas over which abundance estimates apply. Radio transmitters were surgically implanted in walleye weighing a minimum of 1,950 g and northern squawfish weighing a minimum of 1,200 g, as described by Nigro et a1.(1985), except that fish were released immediately after recovery from the anesthesia.

Transmitters implanted in walleye weighed 35.5 g in air, measured 8.5.cm long by 2.0.cm in diameter, had an expected life of 300 days and transmitted at frequencies ranging from 49.61 to 49.99 MHz. Transmitters implanted in northern squawfish weighed 28.0 g in air, measured 6.5.cm long by 2.0.cm in diameter, had an expected life of 150 days and transmitted at frequencies ranging from 48.18 to 49.38 MHz.

Radiotagged fish were located from airplane, boat and shore. Two flights covering the John Day pool were made each week from April through August. A third observation was made each week from boat or shore. Flights were conducted as in 1983 except that directional loop antennae were used on the airplane instead of omnidirectional antennae so that locations of radiotagged fish could be determined using peak and null signals. A boat mounted yagi antenna on a 4-m telescoping mast was used to increase the distance of signal reception when tracking by boat. Once in close proximity to a fish, a

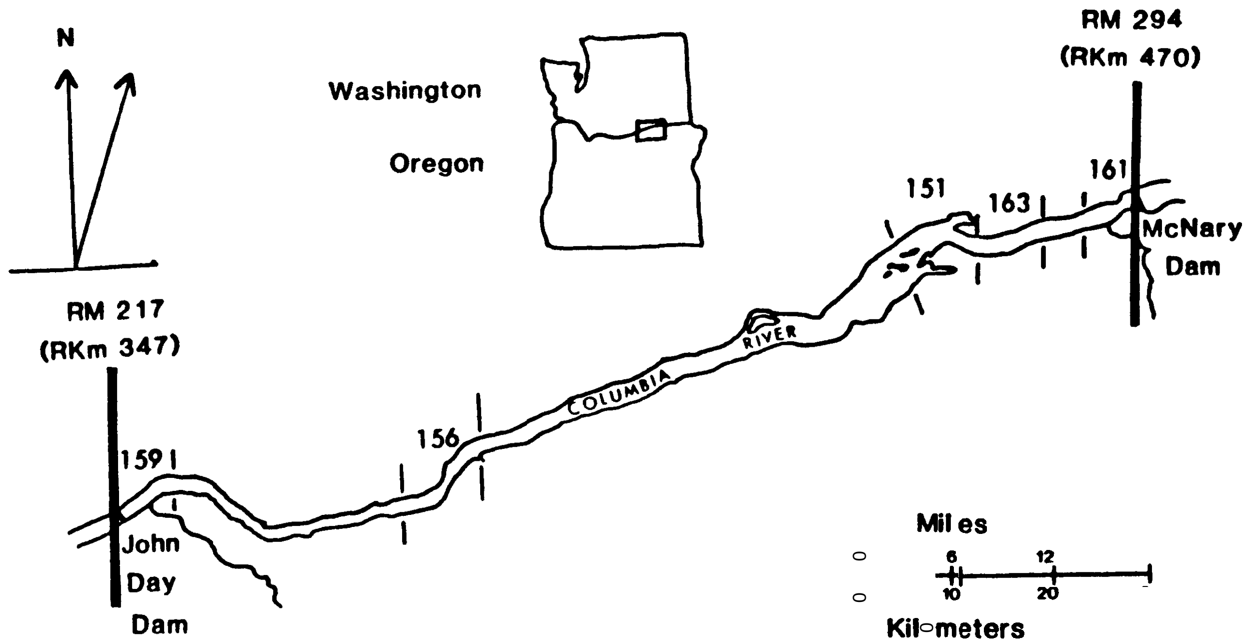

Figure 1. Locations of sampling stations in John Day Reservoir, 1984.

hand-held directional loop antenna was used to pinpoint fish location. Shoreline tracking was conducted with a hand-held directional loop antenna as in 1983.

Angler Survey

Anglers were surveyed from March 25 to August 31 between McNary Dam and Paterson (approximately 27 km downriver) to estimate harvest and recover marked walleye, northern squawfish and smallmouth bass. Anglers fishing in the river channel were counted concurrently from the Oregon and Washington shores on all weekend days and holidays (Appendix C, Table C.1). Weekly counts were also made on two randomly selected weekdays; alternately from each shore. Anglers fishing in Plymouth and Paterson sloughs were counted only from the Washington shore. Anglers were counted at 3-hour intervals (Appendix C, Table C.2); starting time was randomly selected as either 0700 or 0800. Each count was completed in 1/2 to 2 hours, but was considered instantaneous. Anglers were interviewed between angler counts as in 1983 for information on species sought, effort and catch (Appendix C, Table C.3).

Laboratory Analysis

Subsamples of scales collected from walleye, northern squawfish and smallmouth bass from March through June were aged to determine population age structure. Scale samples were sorted by 25-mm fish length intervals. For each species and population, ten samples per interval were randomly selected and independently read by two persons using standard techniques (Jearld 1983).

Data Analysis

Catch Characteristics

Size selectivity of gear for walleye, northern squawfish and smallmouth bass was evaluated to determine whether length-frequency distributions of fish in catches were the same as those of their populations. Catches within John Day forebay, Arlington, Irrigon-Paterson, McNary tailrace and McNary tailrace boat-restricted zone were pooled for all stations and length-frequency distributions were compared between gear as in 1983. Tests for size specific differences in vulnerability to capture by all gears combined were also made as in 1983.

Movements and Distribution

Areas and time periods for which populations of walleye, northern squawfish and smallmouth bass were considered discrete were defined by plotting locations by date where recaptured fish were marked and recaptured and where radiotagged walleye and northern squawfish were observed.

Population Abundance

Population abundances of walleye, northern squawfish and smallmouth bass were estimated using a multiple mark and recapture method (Nigro et al. 1985). As in 1983 the sampling season was divided into consecutive 2-week periods. Catches within a period were pooled and treated as a single catch. Recaptured fish were treated as such only when recaptured in a period subsequent to that in which released, and estimates are of abundance at the beginning of the census. Abundance estimates for walleye and northern squawfish were made for the entire John Day pool while separate estimates of smallmouth bass abundance were made for the lower (John Day forebay and Arlington) and upper (Irrigon-Paterson and McNary tailrace) pool according to observed patterns of movement. Adjustments for vulnerability, recruitment due to growth during sampling and known removals follow approaches used in 1983.

Tests of the assumption that marked and unmarked fish suffer the same mortality were made by comparing the. survival of marked and unmarked fish captured during sampling (Nigro et al. 1985). The extent of tag loss was determined by comparing the numbers of recaptures with and without tags. Marked fish recaptured without tags were apportioned between periods according to ratios observed among marked fish recaptured with tags to avoid underestimating numbers of recaptures.

Age Composition

Age composition of a population was estimated by multiplying the number of fish in a 25-mm length interval by the proportion of fish of each age in a subsample from that length interval (Ketchen 1950).

RESULTS

Wall eye

Catch Characteristics

Differences among gear were apparent in numbers and length-frequency distributions of walleye sampled. About 82% of walleye sampled were caught by gillnetting, trapnetting and electrofishing (Table 1). The remainder of walleye sampled were caught with the USFWS trawl or were examined during angler interviews. Only one walleye was caught in John Day forebay and 30 walleye were caught in Arlington. Differences in walleye length-frequency distributions between gear were statistically significant ($p<0.05$) in McNary tailrace (Figure 2) but not Irrigon-Paterson (Figure 3).

Size specific differences in vulnerability of walleye to capture by all gears combined were observed in John Day pool. The ratio of recaptures to marks at large for walleye with fork lengths less than or equal to 475 mm was statistically ($p<0.05$) different ($X2=9.0, df=1, p<0.01$) from that of walleye with fork lengths greater than 475 mm (Figure 4).

Table 1. Total catch (and catch per hour) of walleye (<250 mm) by gear and location, March-August 1984. Dashes indicate no effort.

	Location					
Gear	All	John Day forebay	Arlington	Irrigon-Paterson	McNary tailrace	McNary tailrace BRZ[a]
Bottom gill nets	262 (0.32)	0	15 (0.07)	87 (0.42)	160 (0.81)	0
Trap net	109 (0.01)	0	4 (d)	49 (0.02)	56 (0.02)	--
Trap net lead	5 (d)	1 (d)	2 (d)	0	2 (d)	--
ODFW[b] electrofisher	62 (0.62)	0	1 (0.07)	16 (0.48)	45 (1.32)	0
USFWS[c] electrofisher	121 (0.41)	0	7 (0.08)	26 (0.35)	83 (1.84)	5 (0.50)
Angling	0	0	--	--	--	0
Surface gill net	0	--	--	--	--	0
USFWS gill net	146 (0.28)	0	1 (0.02)	80 (0.31)	61 (0.33)	4 (0.14)
Vertical gill net	0	0	0	--	--	--
USFWS trawl	72 (4.11)	--	--	--	72 (4.11)	--
Angler survey	81	--	--	66	15	0
Total	858	1	30	324	494	9

[a]Boat-restricted zone.
[b]Oregon Department of Fish and Wildlife.
[c]U.S. Fish and Wildlife Service.
[d]Catch per hour <0.005.

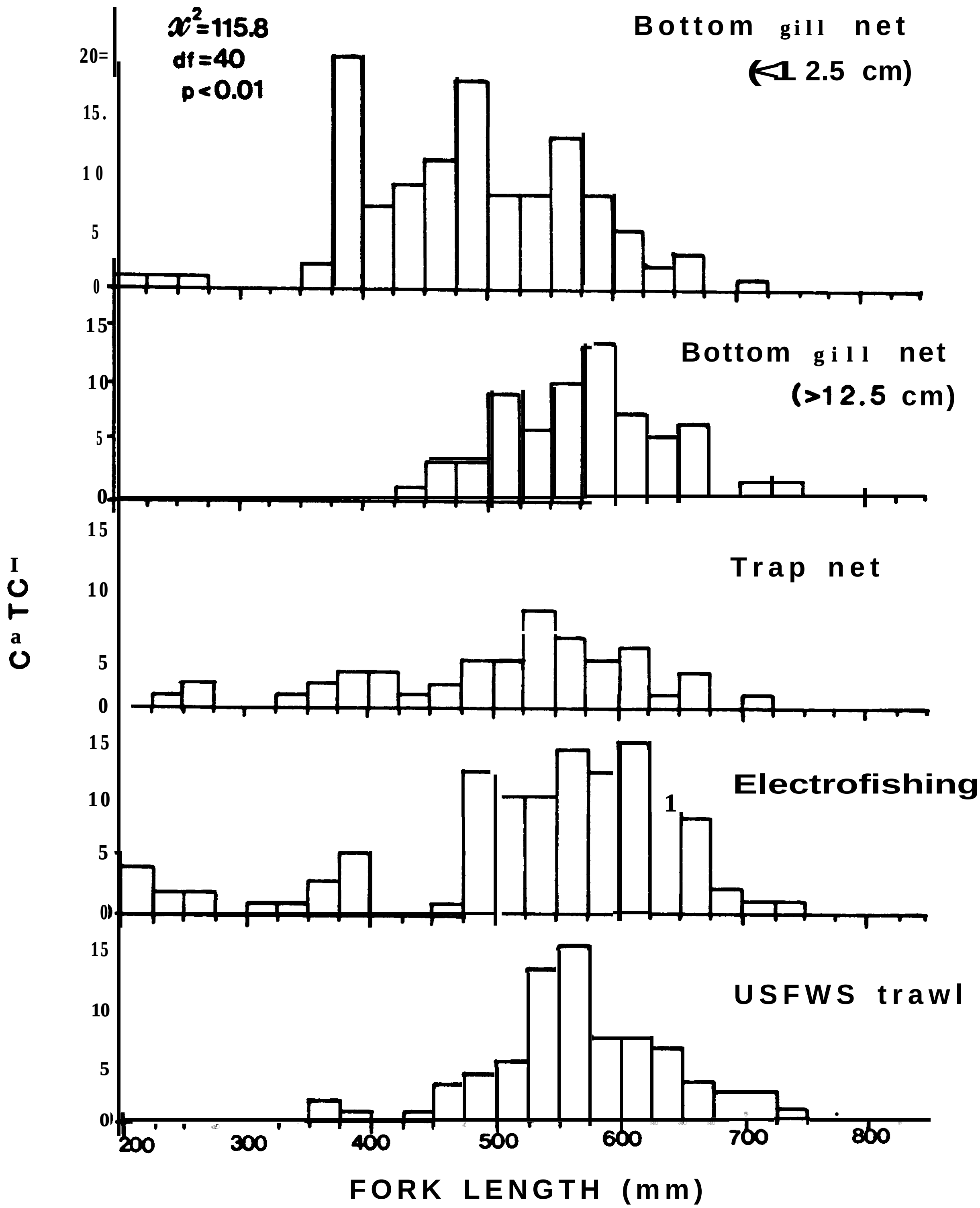

Figure 2. Length-frequency distributions of walleye collected in McNary tail-race, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) and minimum (>12.5 cm) mesh sizes of bottom gill nets are in parentheses.

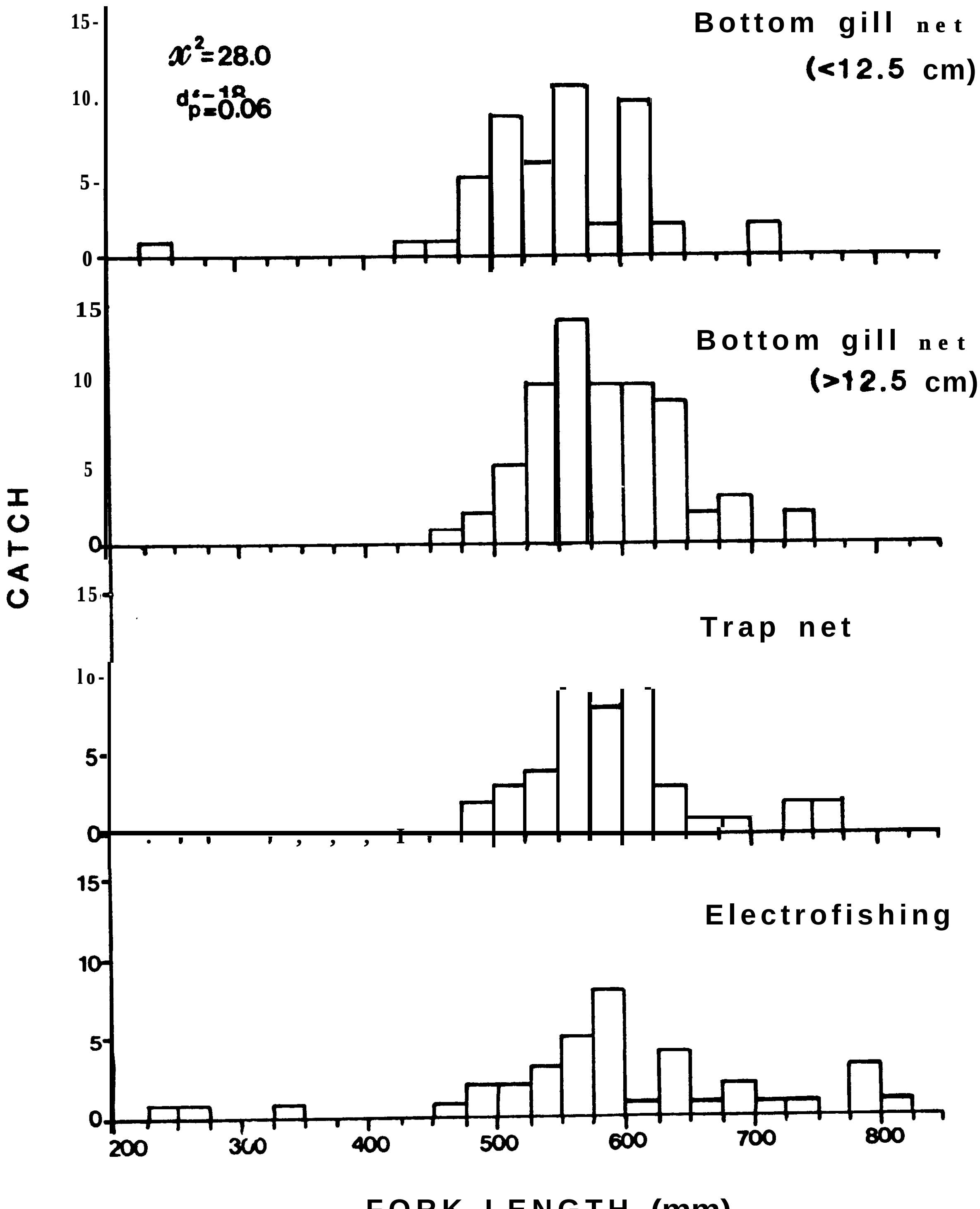

Figure 3. Length-frequency distributions of walleye collected in Irrigon-Paterson, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) and minimum (>12.5 cm) mesh sizes of bottom gill nets are in parentheses.

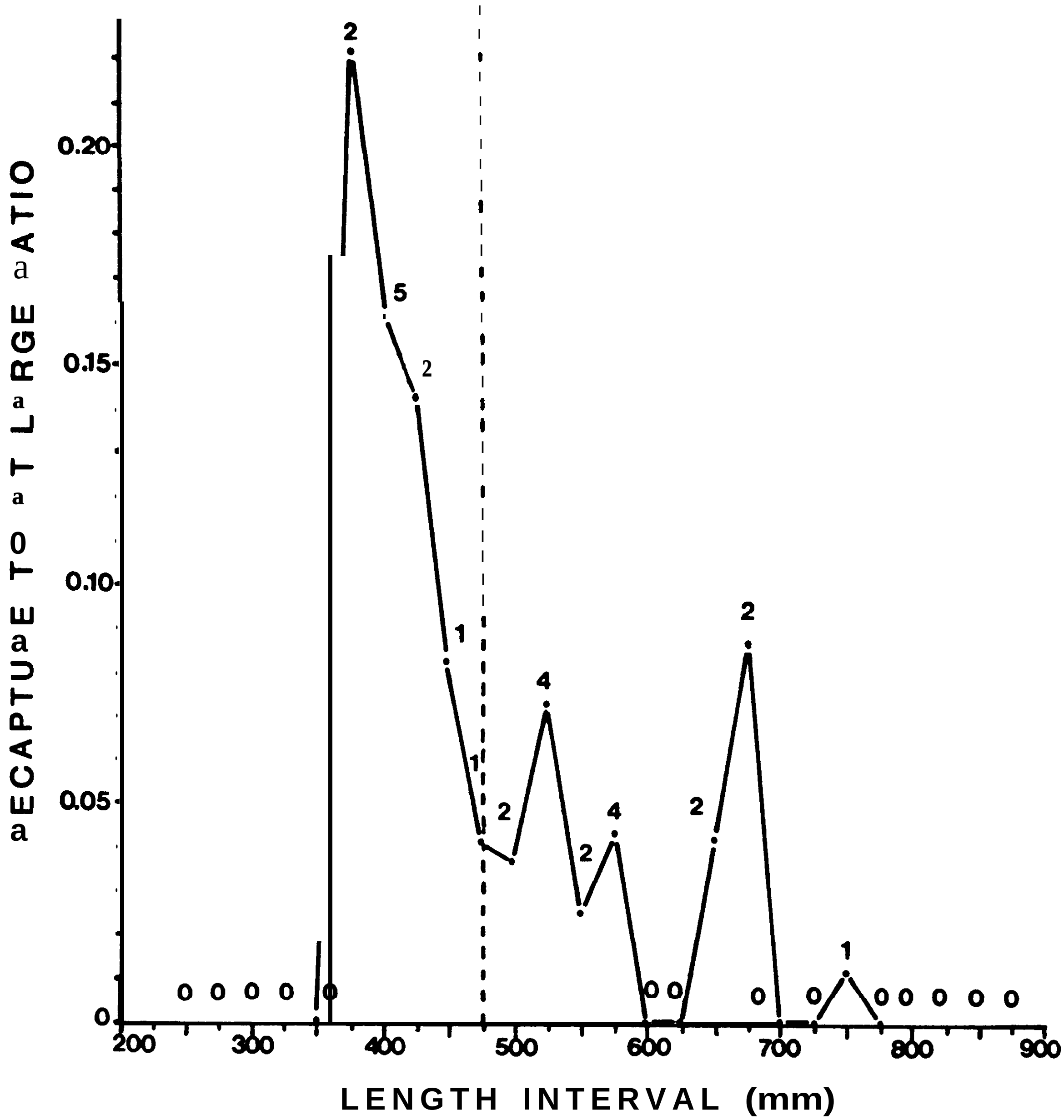

Figure 4. Ratios of recaptures to marks at large (vulnerability) for walleye in John Day pool by length interval, March-August 1984. Total recaptures within a length interval is above each point. Dashed line indicates length at which recruitment to the gear is considered complete.

Movements and Distribution

Marked walleye moved between McNary tailrace and Irrigon-Paterson (Table 2 and Figure 5). Two marked walleye were recaptured by anglers between McNary tailrace and Irrigon-Paterson. No marked walleye were recovered outside John Day pool.

Distances traveled by radiotagged walleye in upper John Day pool ranged from 5 to 80 km during our sampling season. Movements of 2 or 3 kilometers per day were frequent and 20-km movements over 3-day periods were common (Figure 6). Nineteen of 20 walleye monitored from April through August entered at least one sampling station. Twelve radiotagged walleye entered sampling stations in McNary tailrace and Irrigon-Paterson.

Population Abundance

Walleye abundance in John Day pool was estimated as 15,832 fish. Walleye with fork lengths less than or equal to 475 mm comprised only 5% of the estimated abundance (Table 3).

Anglers harvested an estimated 309 walleye from John Day pool above Paterson between April 8 and August 31 (Table 4). Estimated harvest of marked walleye was 25% greater than observed harvest. Anglers seldom took walleye with fork lengths less than 500 mm (Figure 7).

Survival of unmarked and marked walleye captured during field sampling was not significantly ($p<0.05$) different ($\chi^2=0.5, df=2, p=0.47$). Two of 29 walleye recaptured during sampling had lost their tags.

Age Composition

Ages of walleye in samples ranged from 1 to 12 years but the majority were age 5 (Figure 8).

Northern Squawfish

Catch Characteristics

Gears contributed unequally to the catch of northern squawfish and different gears caught fish of different lengths. Small-meshed (<12.5 cm) bottom gill nets, electrofishing and trap nets contributed 31%, 29% and 27% of the northern squawfish sampled. Eight percent of the samples were caught by angling (Table 5). Statistically significant ($p<0.05$) differences between gears were observed among length-frequency distributions of northern squawfish caught in John Day forebay (Figure 9), Arlington (Figure 10), Irrigon-Paterson (Figure 11), McNary tailrace (Figure 12) and McNary tailrace boat-restricted zone (Figure 13).

Table 2. Numbers of marked walleye released and recaptured by location, March-August 1984.

Location Released	Number Released	Location Recaptured A	B	C	D	E	F
A. John Day forebay	0	0	--	--	--	--	--
B. Arlington	27	--	0	--	--	--	--
C. Irrigon-Paterson	218	--	--	3	--	--	1
D. McNary tailrace	397	--	--	4	30	--	1
E. McNary tailrace BRZ[a]	8	--	--	--	--	0	--
F. Other	1	--	--	--	--	--	0

[a]Boat-restricted zone.

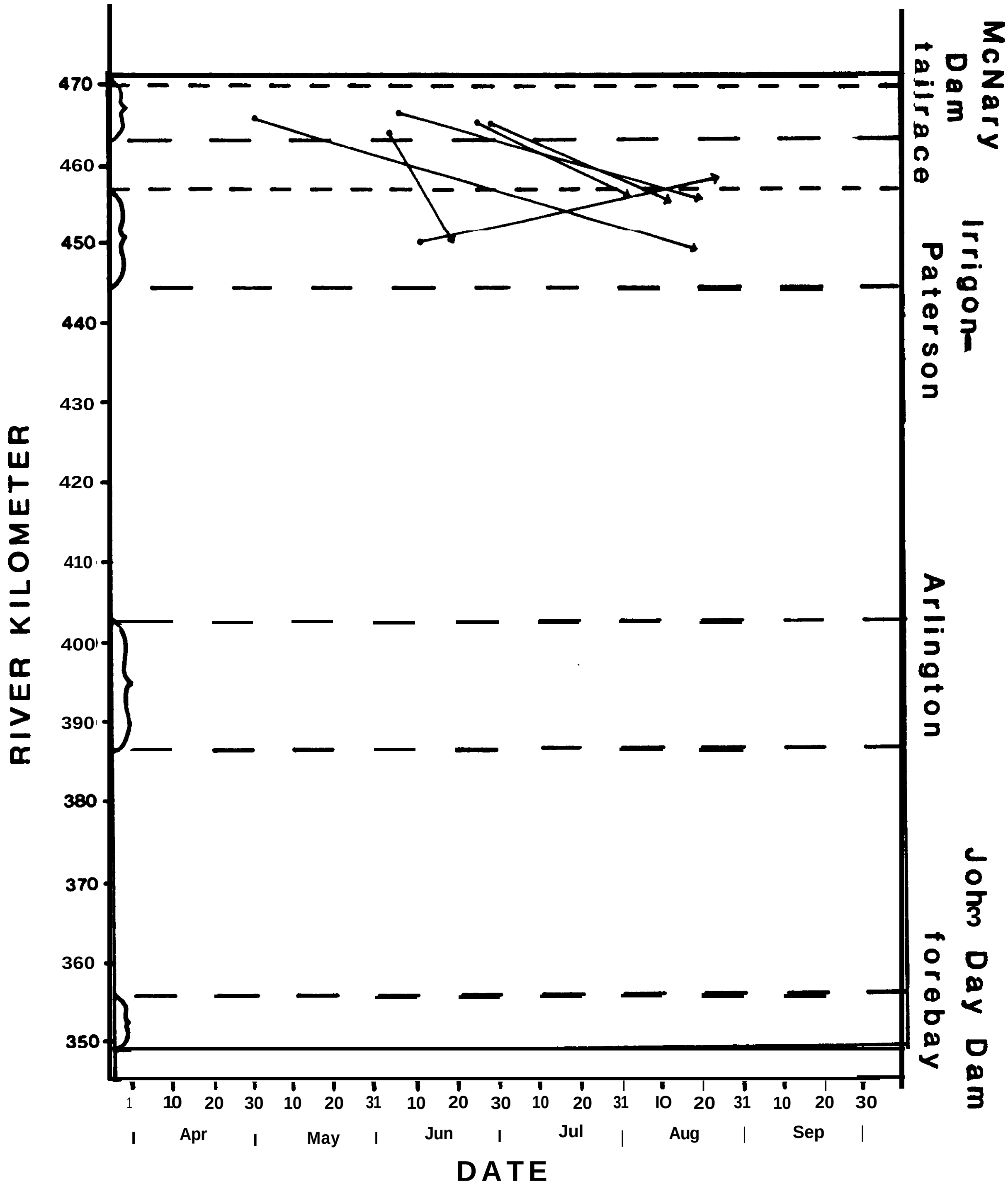

Figure 5. Locations and dates of releases and recoveries of marked walleye recaptured in stations other than where marked, 1984. Areas sampled are indicated by brackets.

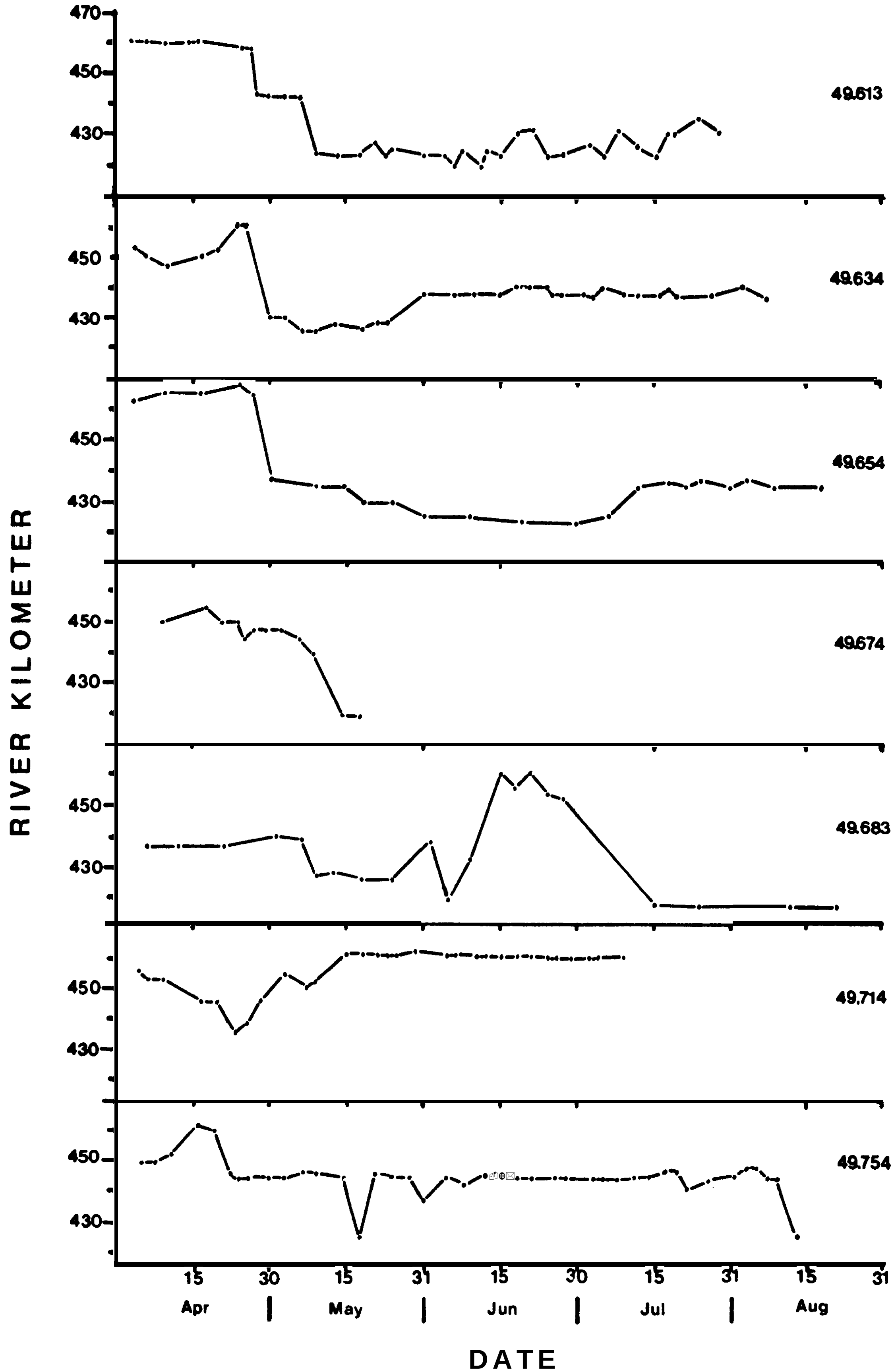

Figure 6. Movements of 19 radiotagged walleye released in McNary tailrace, 1984. Transmitter frequency (MHz) is noted for each fish.

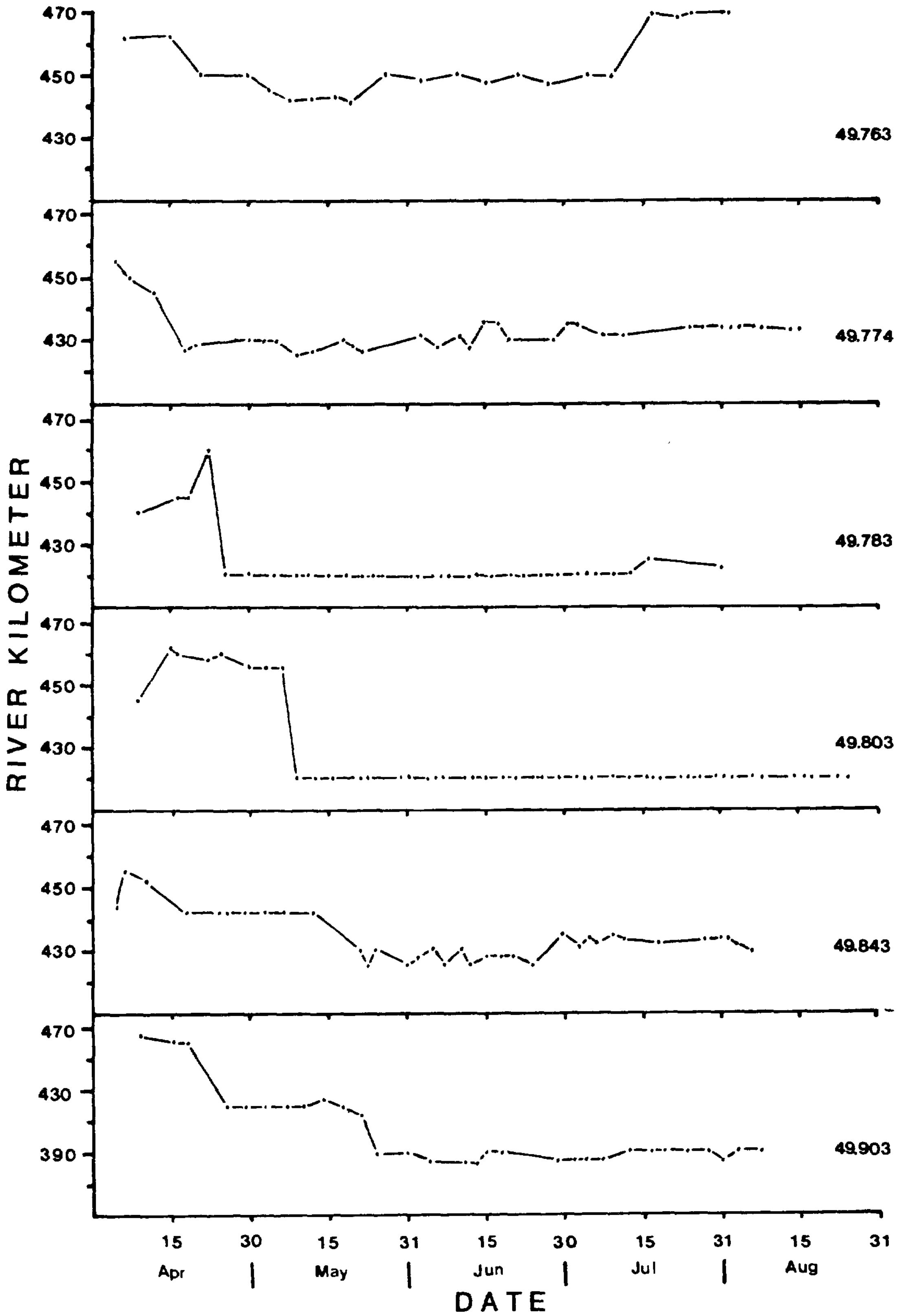

Figure 6. (Continued).

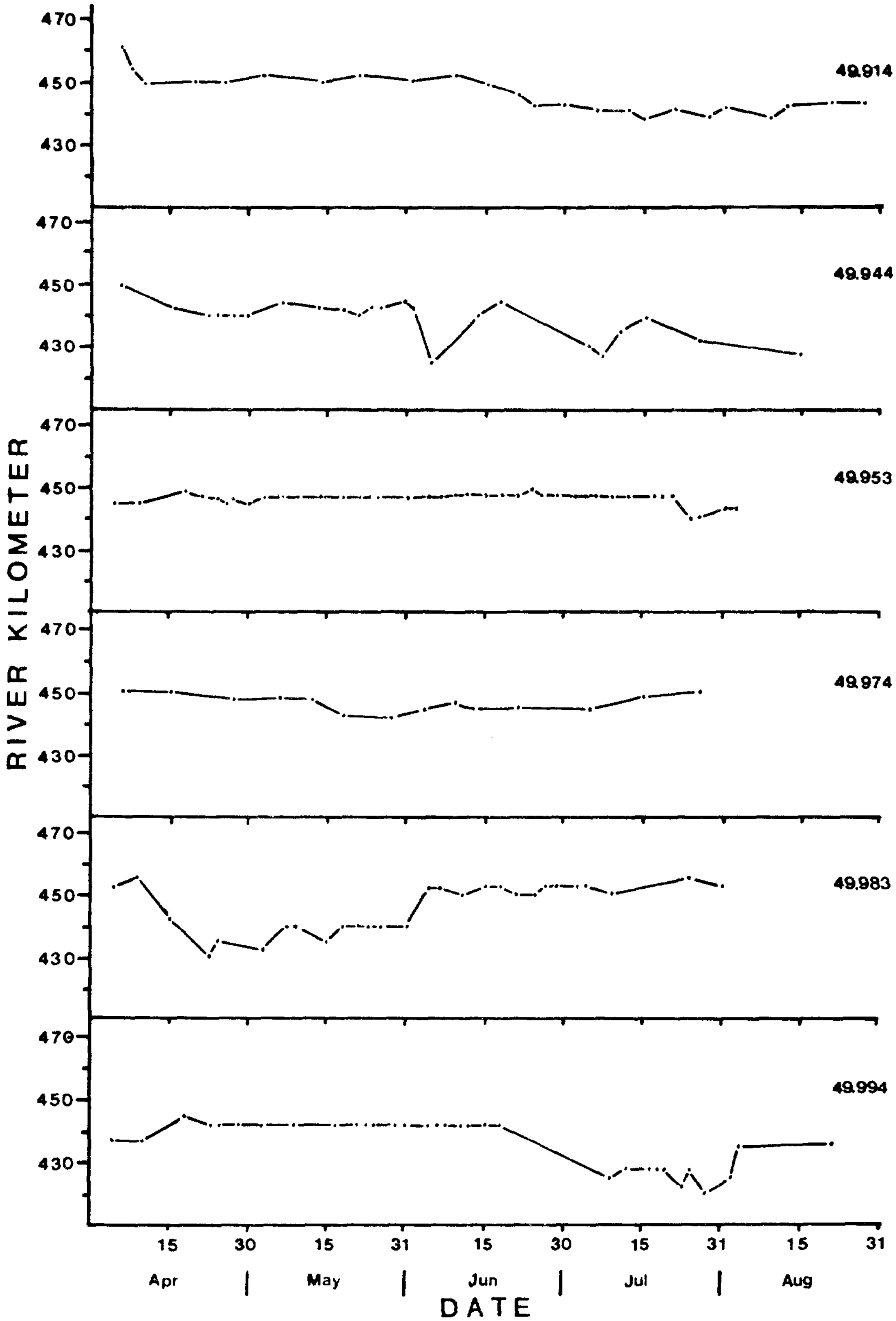

Figure 6. (Continued).

Table 3. Estimated abundance of walleye in John Day Reservoir based on multiple mark and recapture survey and Overton's (1965) estimator, April 8-August 31, 1984.

Length Interval (mm)	Estimate	95% Confidence Limits	
		Lower	Upper
250-475	744	396	1,474
>475	15,088	7,767	31,203

Table 4. Estimated and observed numbers[a] of unmarked and marked walleye harvested by anglers in upper John Day pool, April 8-August 31, 1984.

Status	Period 8	9	10	11	12	13	14	15	16	17	Sum
Unmarked											
Estimated	19	16	11	4	4	0	13	55	37	125	284
Observed	6	3	2	1	1	0	4	9	10	38	74
Marked											
Estimated	3	6	0	0	0	0	3	6	0	7	25
Observed	1	1	0	1	1	0	3	3	4	6	20

[a]Includes fish >250 mm fork length from April 8-June 30 and fish ≥300 mm fork length from JuTy l-August 25.

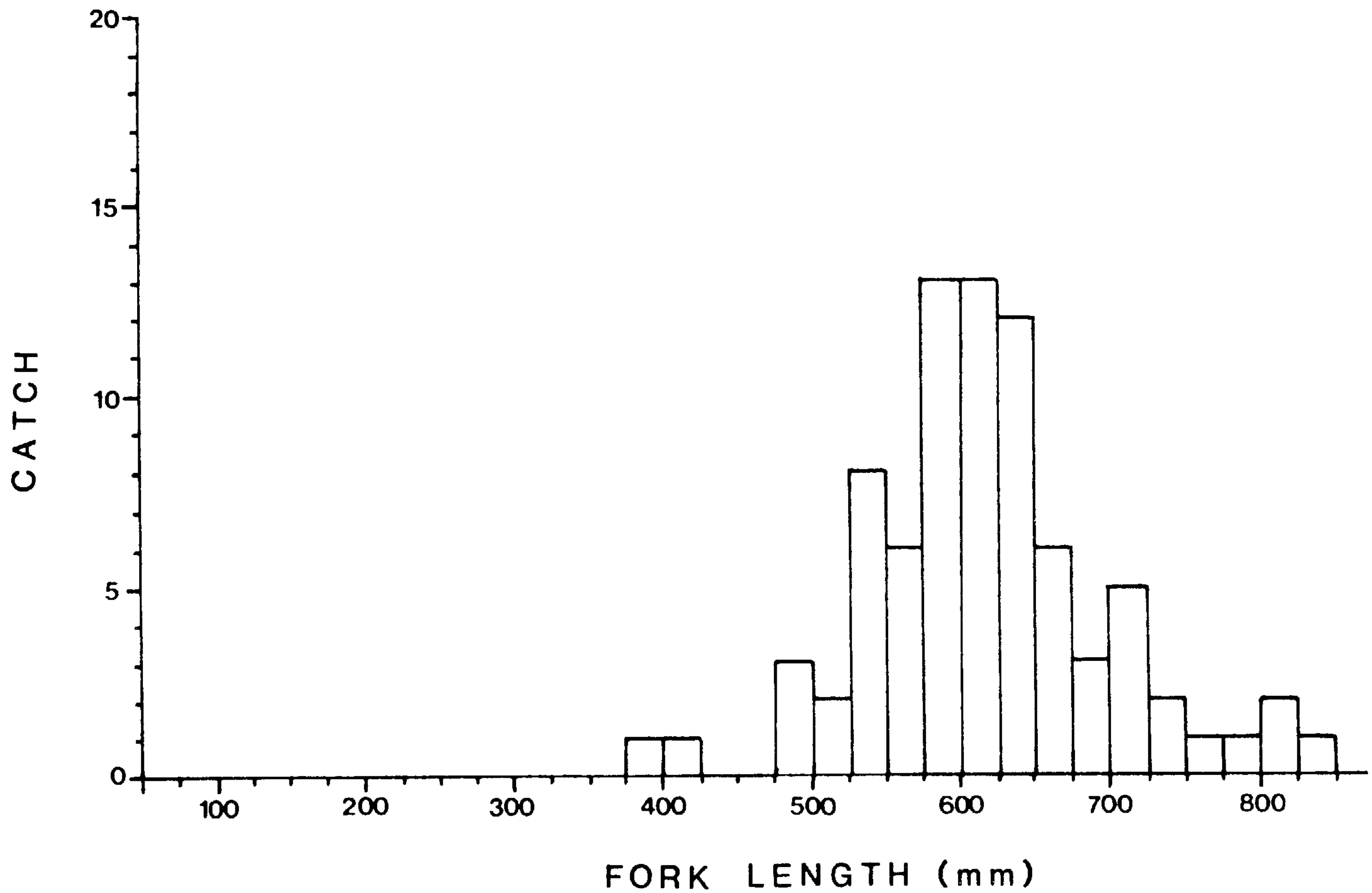

Figure 7. Length-frequency distribution of walleye harvested by anglers in McNary tailrace, April 8-August 31, 1984.

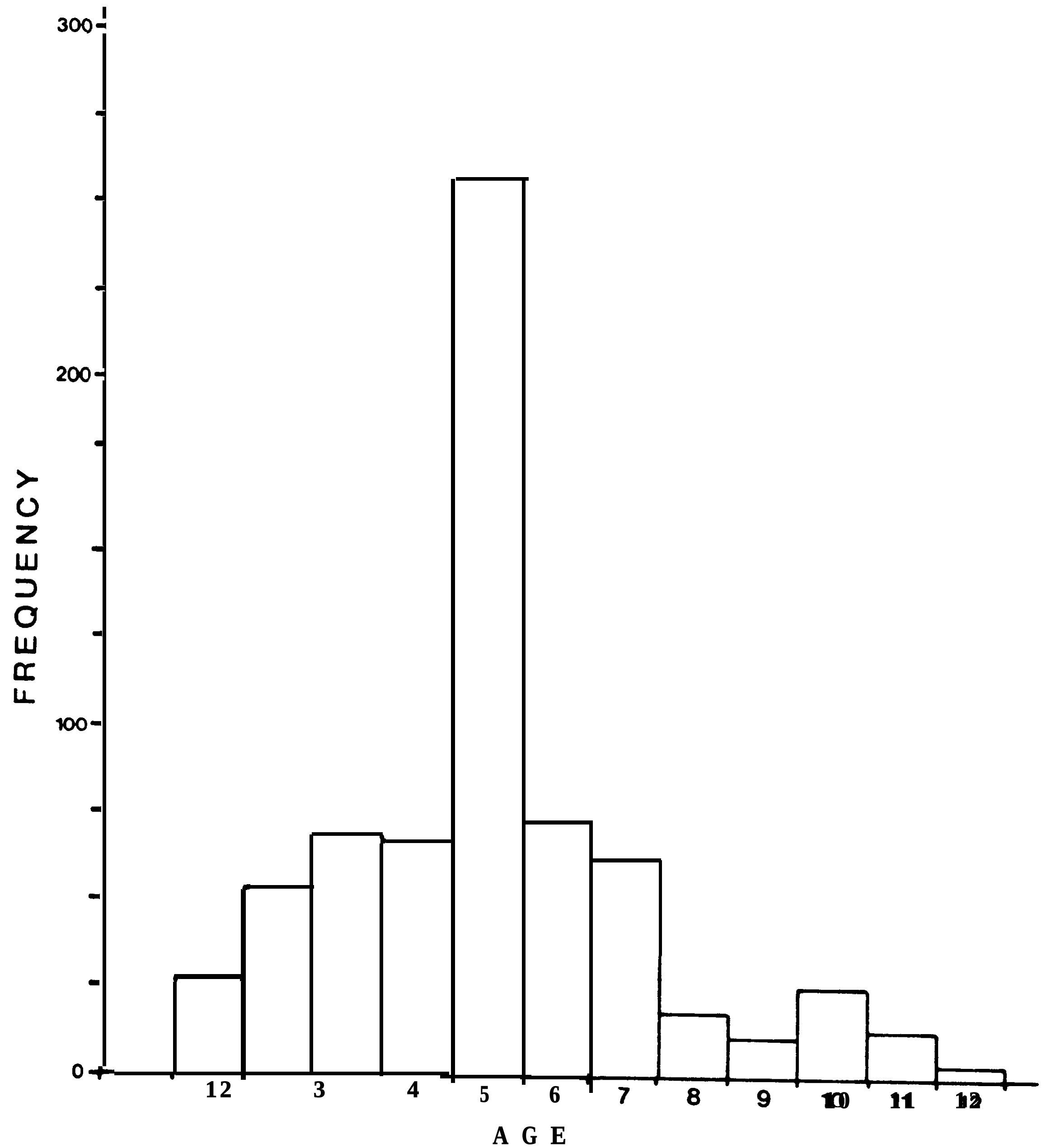

Figure 8. Estimated age-frequency distribution of Walleye catch in John Day pool, March-June 1984.

Table 5. Total catch (and catch per hour) of northern squawfish (≥250 mm) by gear and location, March-August 1984. Dashes indicate no effort.

	Location					
Gear	All	John Day forebay	Arlington	Irrigon-Paterson	McNary tailrace	McNary tailrace BRZ[a]
Bottom gill nets	1,417 (1.75)	427 (2.20)	197 (0.96)	254 (1.22)	537 (2.73)	2 (2.00)
Trap net	873 (0.09)	271 (0.11)	277 (0.13)	144 (0.06)	181 (0.08)	--
Trap net lead	362 (0.04)	142 (0.06)	61 (0.03)	85 (0.03)	74 (0.03)	--
ODFW[b] electrofisher	259 (2.60)	17 (1.18)	30 (2.02)	45 (1.35)	124 (3.65)	43 (14.10)
USFWS[c] electrofisher	1,055 (3.57)	265 (3.50)	209 (2.29)	87 (1.18)	97 (2.16)	397 (39.70)
Angling	364 (2.60)	2 (0.08)	--	--	--	362 (2.84)
Surface gill net	96 (5.42)	--	--	--	--	96 (5.73)
USFWS gill net	89 (0.17)	0	26 (0.49)	9 (0.03)	13 (0.07)	41 (1.39)
Vertical gill net	15 (0.01)	9 (0.01)	6 (0.01)	--	--	--
USFWS trawl	9 (0.51)	--	--	--	9 (0.51)	--
Angler survey	13	--	--	8	4	1
Total	4,552	1,133	806	632	1,039	942

[a]Boat-restricted zone.
[b]Oregon Department of Fish and Wildlife.
[c]U.S. Fish and Wildlife Service.
[d]Catch per hour <0.005.

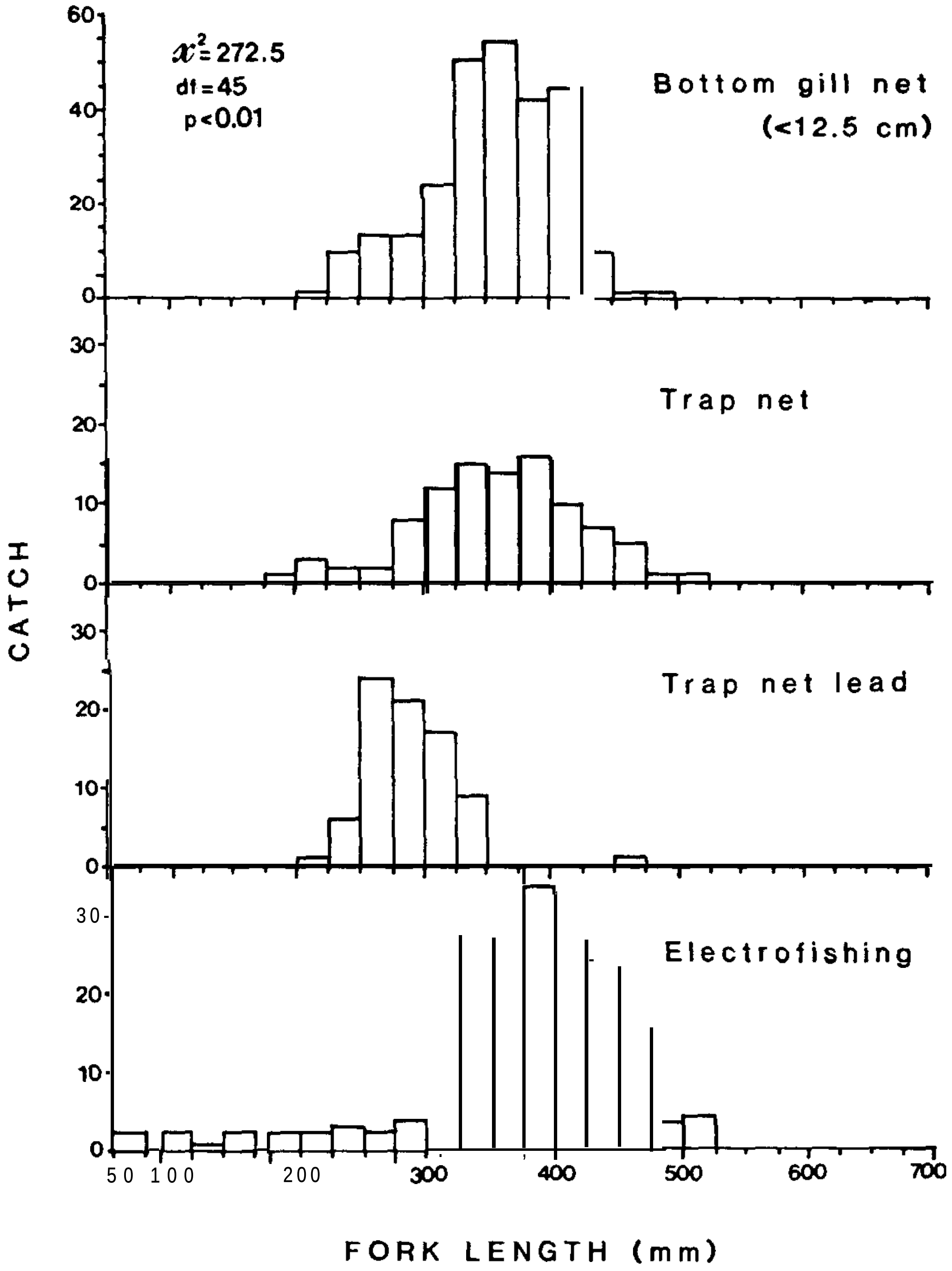

Figure 9. Length-frequency distributions of northern squawfish collected in John Day forebay, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

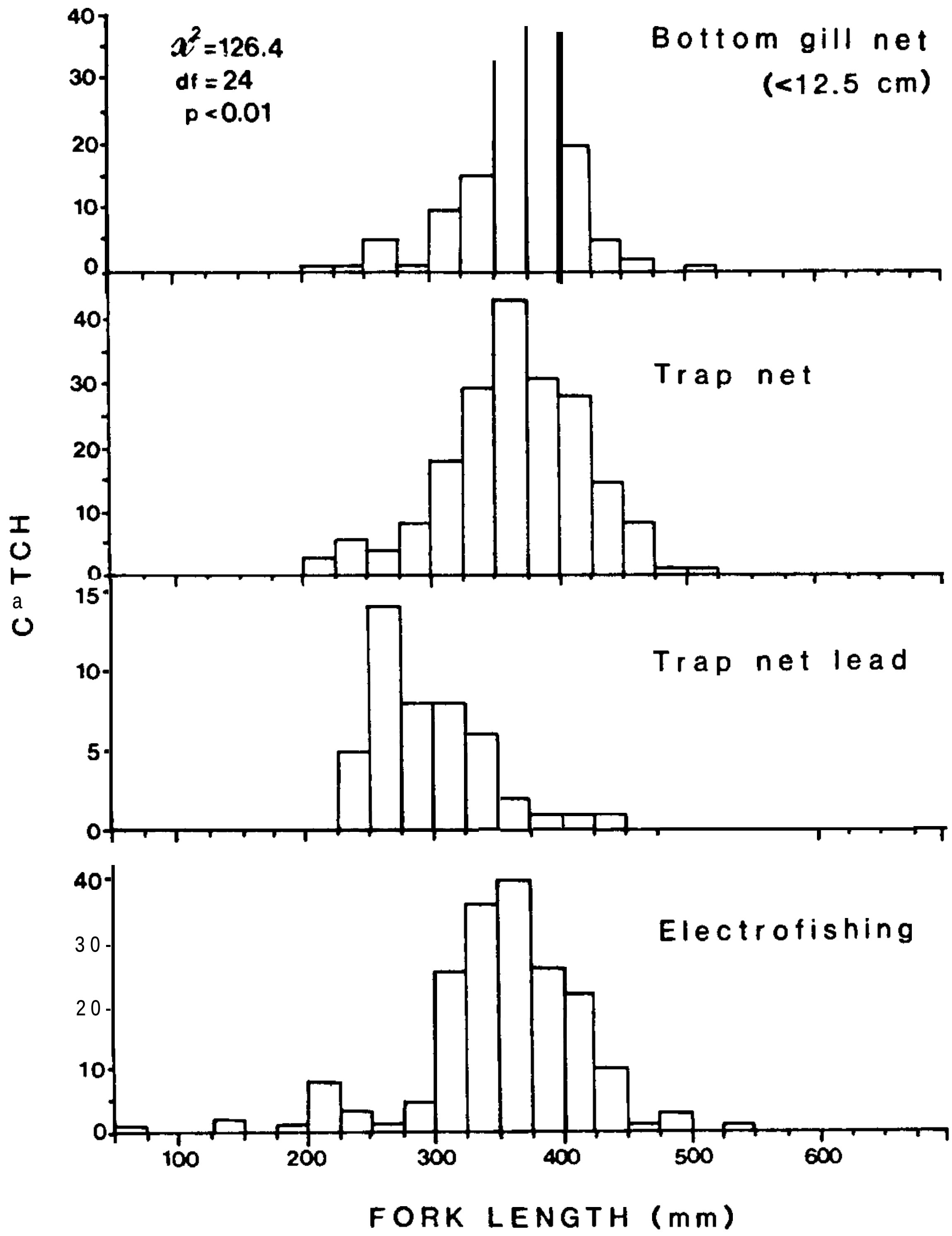

Figure 10. Length-frequency distributions of northern squawfish collected in Arlington, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

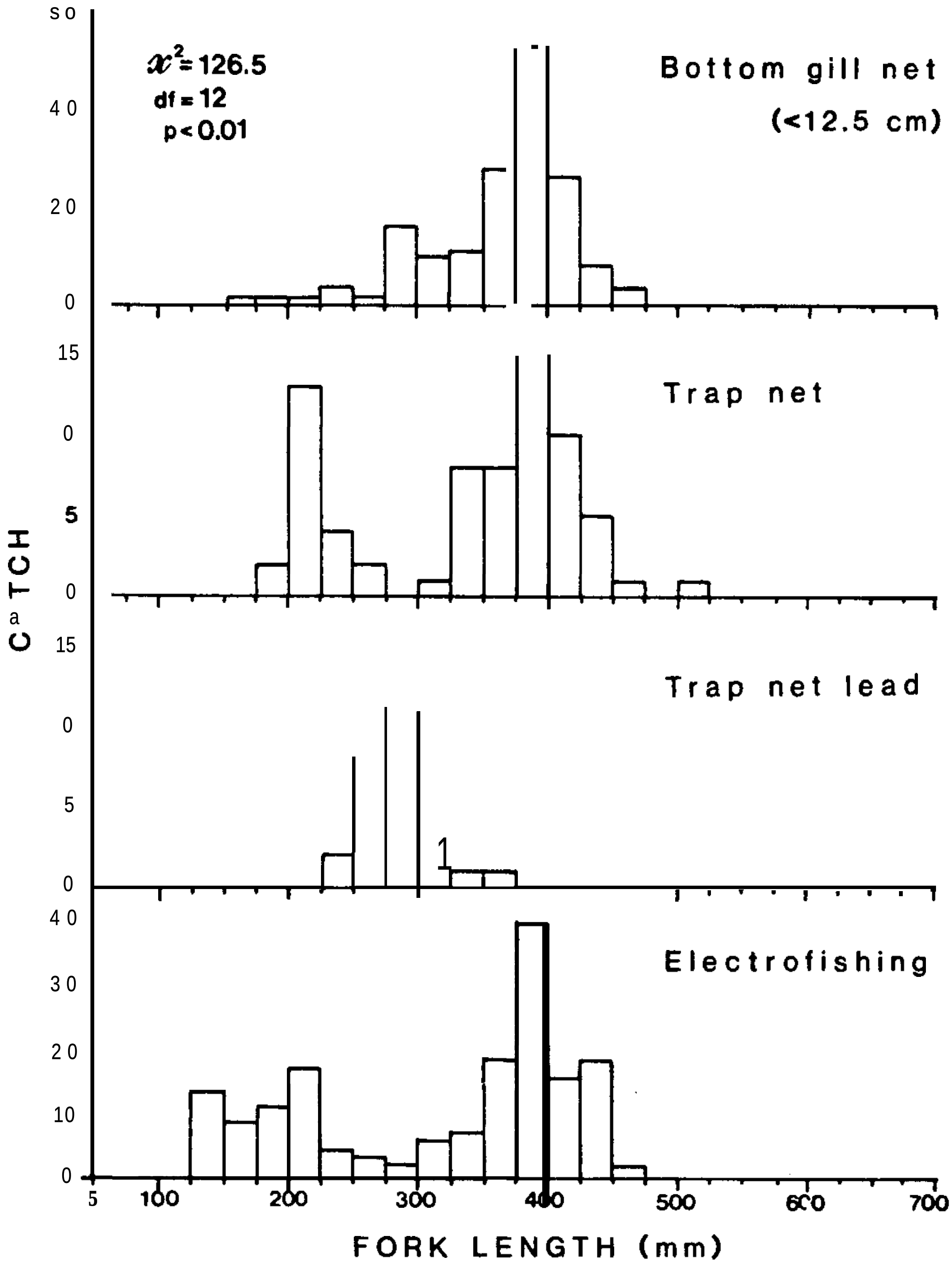

Figure 11. Length-frequency distributions of northern squawfish collected in Irrigon-Paterson, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

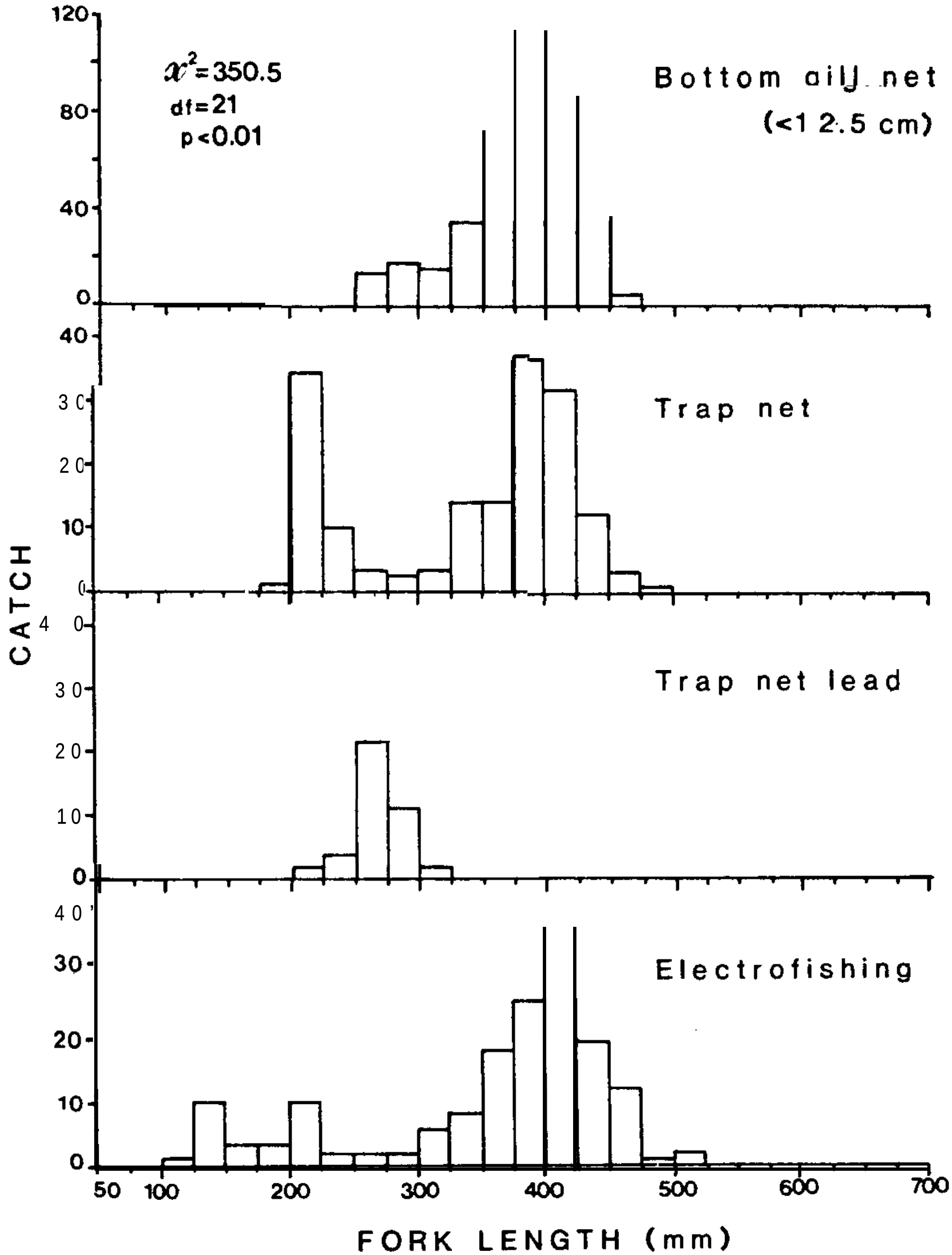

Figure 12. Length-frequency distributions of northern squawfish collected in McNary tailrace, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

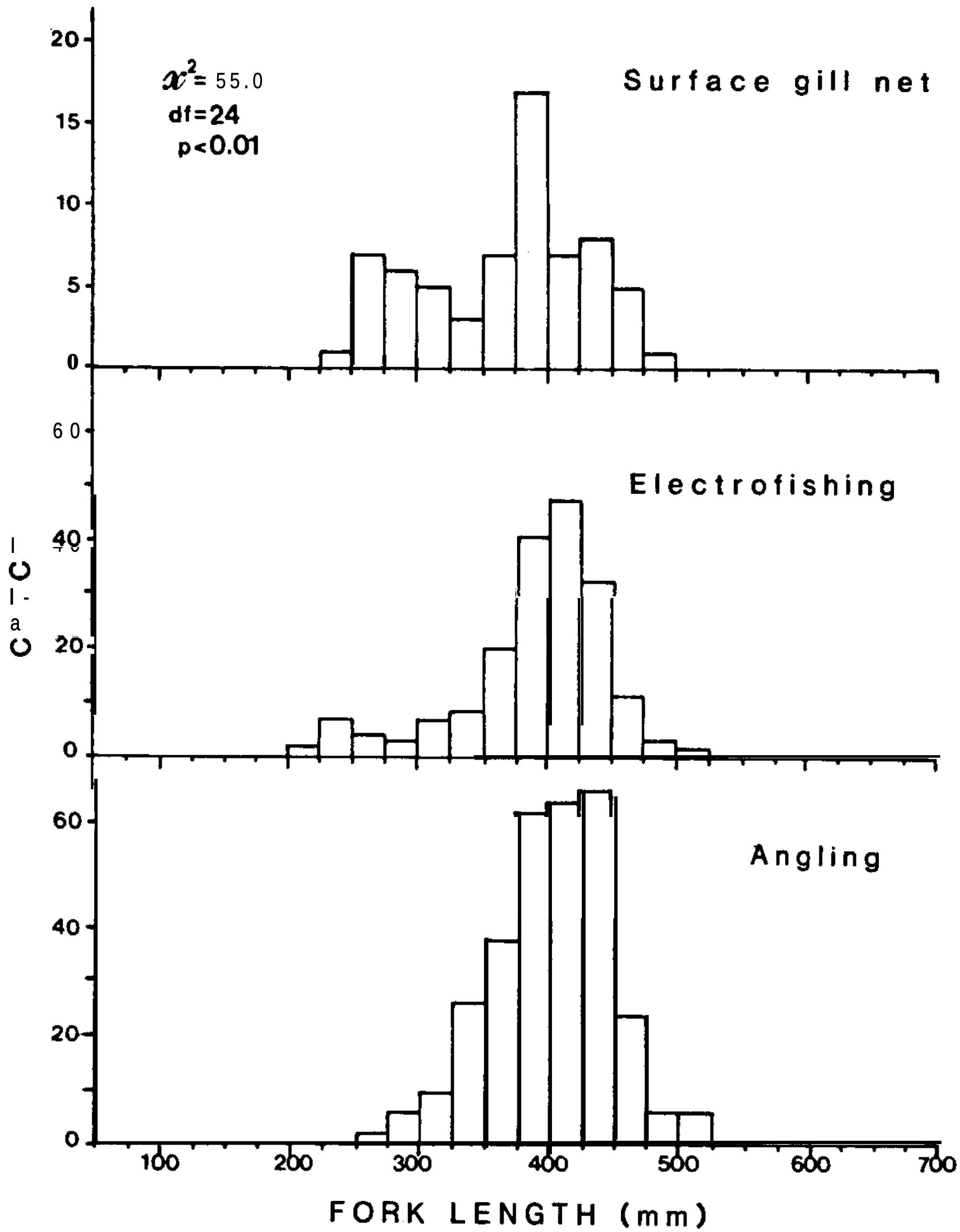

Figure 13. Length-frequency distributions of northern squawfish collected in McNary tailrace boat-restricted zone, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length.

Vulnerability to capture varied with size of northern squawfish. Size specific differences in the ratio of recaptures to marks at large were statistically significant ($p<0.05$) between northern squawfish less than or equal to 375 mm and greater than 375 mm ($X^2=7.7, df=1, p<0.01$) (Figure 14).

Movements and Distribution

Widespread movements of marked northern squawfish were observed in John Day Reservoir (Table 6, Figure 15). Fish marked in any sampling station appeared likely to be recaptured in any other station. Recapture in stations other than where marked often occurred within a week of release and down- and up-reservoir movements were observed throughout the sampling season.

Radintagged northern squawfish monitored from April through August also exhibited wide ranging movements. Eight of 10 northern squawfish released in John Day forebay traveled outside the forebay (Figure 16). One northern squawfish released in John Day forebay was located in Irrigon-Paterson, 97 km above John Day Dam. Three fish were located in the tailrace below John Day Dam but two later returned to the forebay. Six radiotagged northern squawfish from the forebay traveled intn the John Day River. Northern squawfish radiotagged and released in McNary tailrace were located up to 50 km downriver (Figure 17). Four of ten northern squawfish released in McNary tailrace were located in and downriver of Irrignn-Paterson.

Population Abundance

An estimated 80,486 northern squawfish were present in John Day pool (Table 7). Anglers harvested an estimated 269 northern squawfish from John Day pool above Paterson between April 8 and August 31 (Table 8). Estimated harvest of marked northern squawfish exceeded observed harvest by 43%. Anglers apparently took northern squawfish of all lengths (Figure 18).

Mortality of unmarked northern squawfish captured during field sampling was statistically ($p<0.05$) different ($X^2=5.6, df=1, p=0.02$) from that of marked northern squawfish, but unmarked fish were more likely to die than were marked fish. Thirteen of 110 northern squawfish recaptured during sampling had lost their tags.

Age Composition

Ages of northern squawfish in samples ranged from 2 to 14 years, but the most abundant age group was 10 years (Figure 19).

Smallmouth Bass

Catch Characteristics

Differences were observed among gears in the numbers and sizes of smallmouth bass sampled (Table 9). Approximately 81% of smallmouth bass sampled were caught by electrnfishing. Statistically significant ($p<0.05$) differences between gears were observed among length-frequency distributions of smallmouth bass collected in John Day forebay (Figure 20), Arlington (Figure 21) and Irrigon-Paterson (Figure 22). Only electrofishing sampled appreciable numbers of smallmouth bass with fork lengths of 200 mm or less.

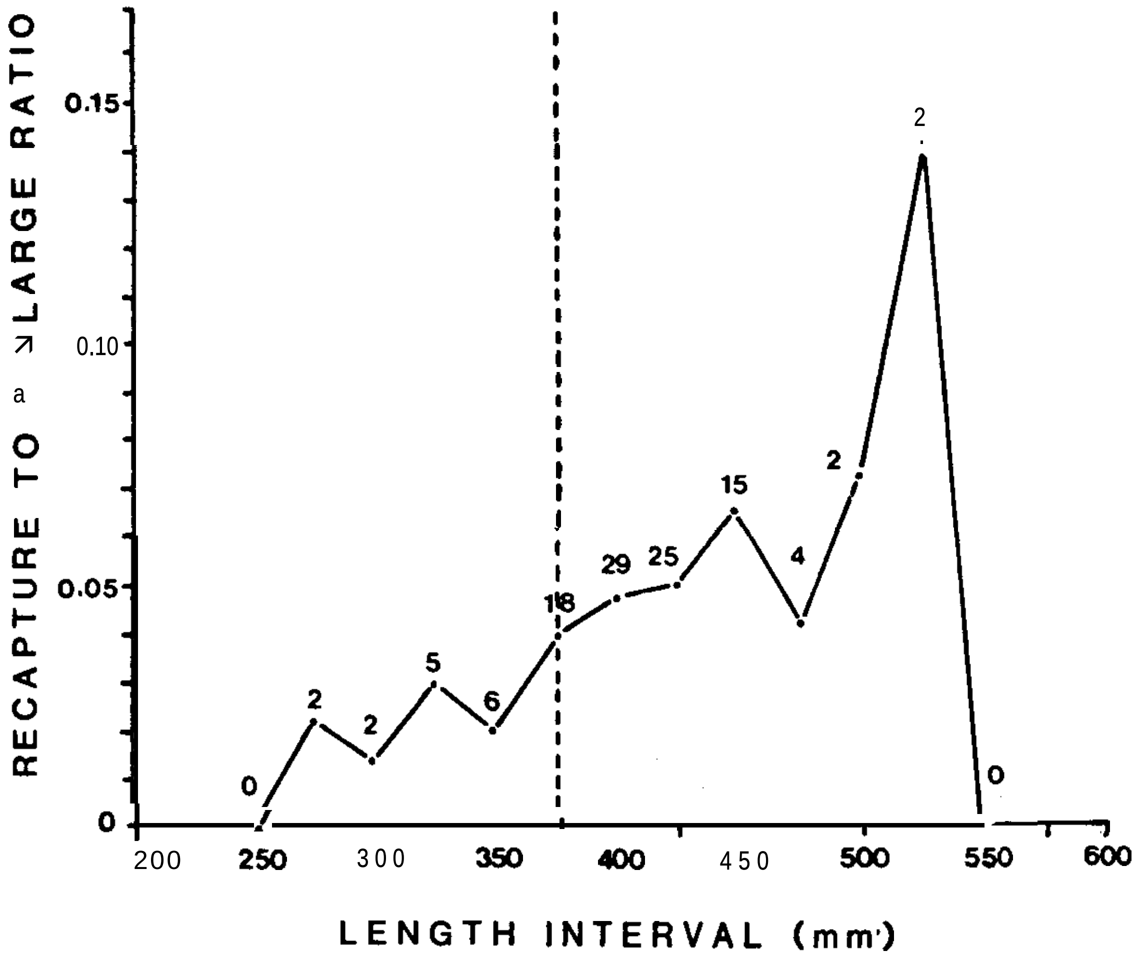

Figure 14. Ratios of recaptures to marks at large (vulnerability) for northern squawfish in John Day pool by length interval, March-August 1984. Total recaptures within a length interval is above each point. Dashed line indicates length at which recruitment to the gear is considered complete.

Table 6. Numbers of marked northern squawfish released and recaptured by by location, March-August 1984.

Location Released	Number Released	Location Recaptured A	B	C	D	E	F
A. John Day forebay	656	14	..	..	--	--	3
B. Arlington	445	1	18	--	1	3	1
C. Irrigon-Paterson	335	--	..	13	2	2	--
D. McNary tailrace	756	1	3	7	24	9	1
E. McNary tailrace BRZ[a]	357	..	1	1	5	2	--
F. Other	24	..	..	..	1	..	0

[a]Boat-restricted zone.

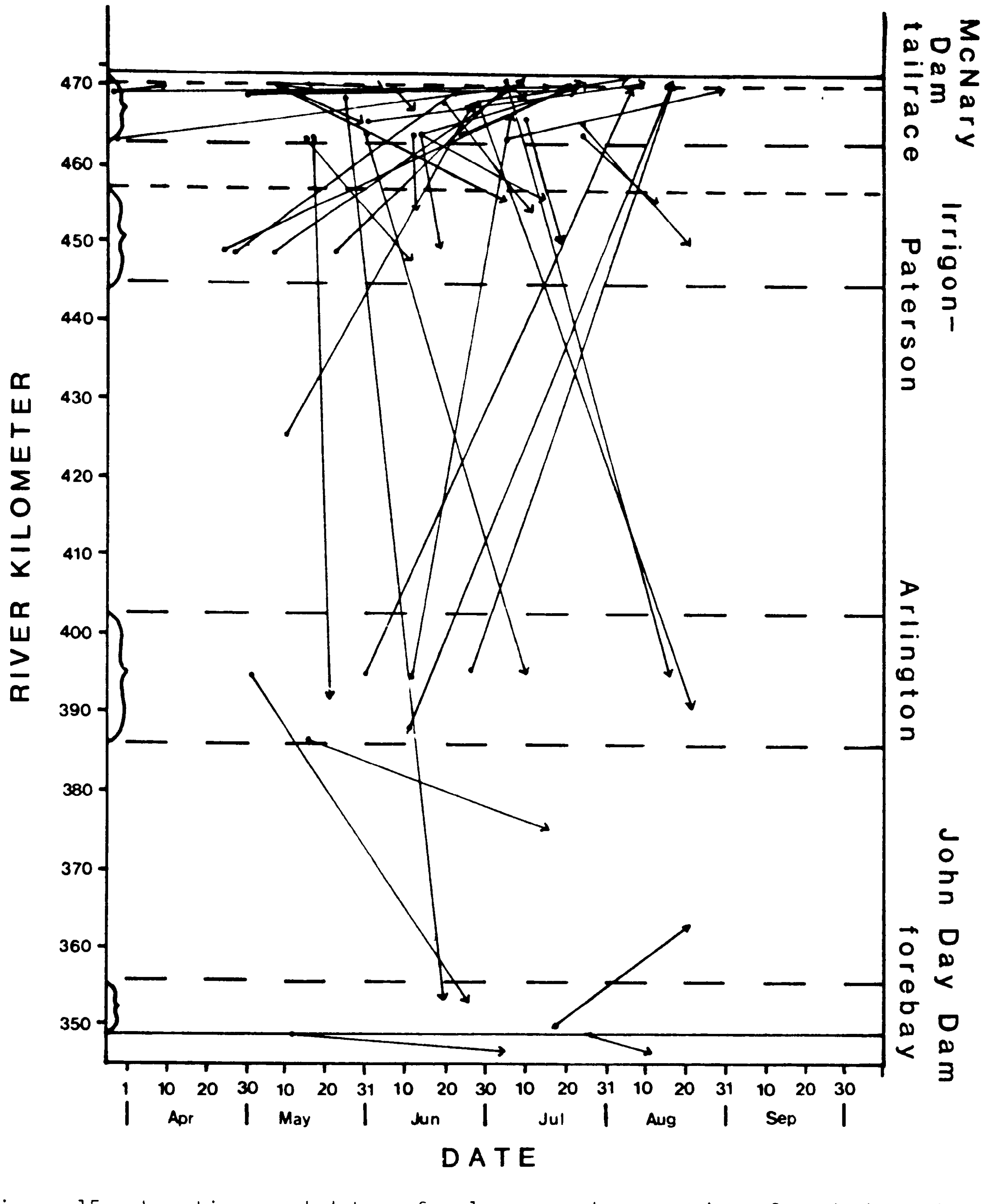

Figure 15. Locations and dates of releases and recoveries of marked northern squawfish recaptured in stations other than where marked, 1984. Areas sampled are indicated by brackets.

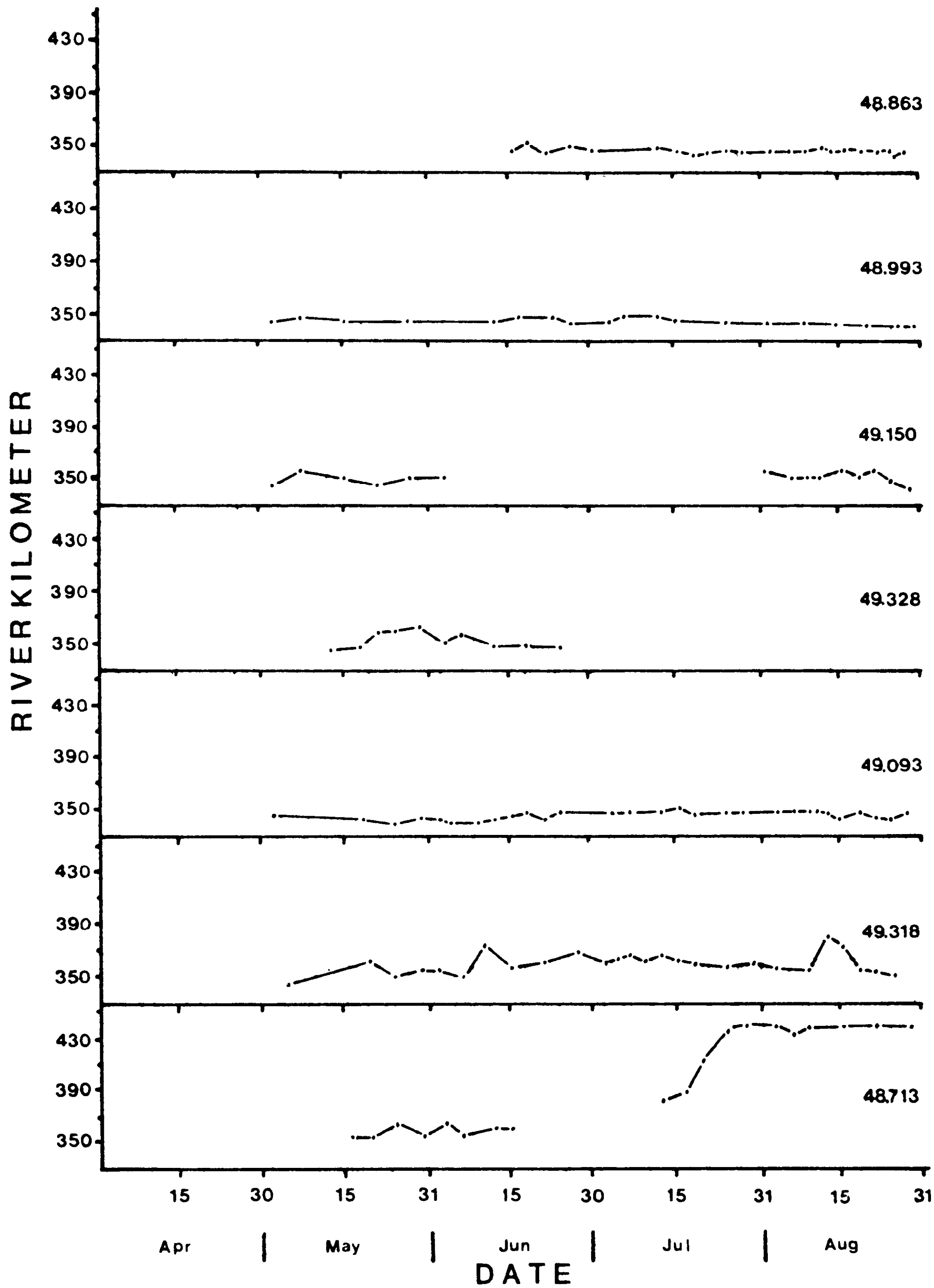

Figure 16. Movements of seven radiotagged northern squawfish released in John Day forebay, 1984. Transmitter frequency (MHz) is noted for each fish.

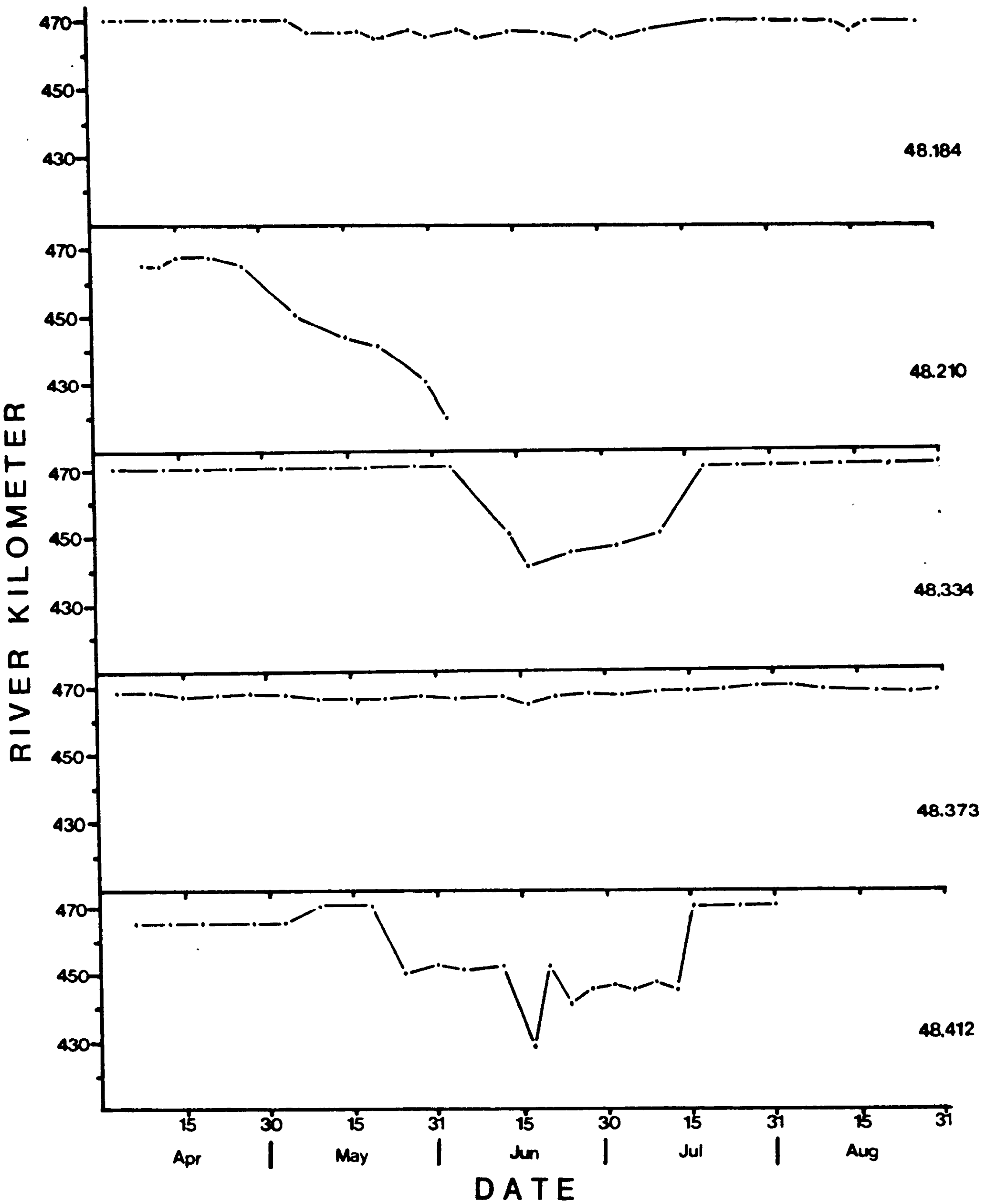

Figure 17. Movements of 10 radiotagged northern squawfish released in McNary tailrace, 1984. Transmitter frequency (MHz) is noted for each fish.

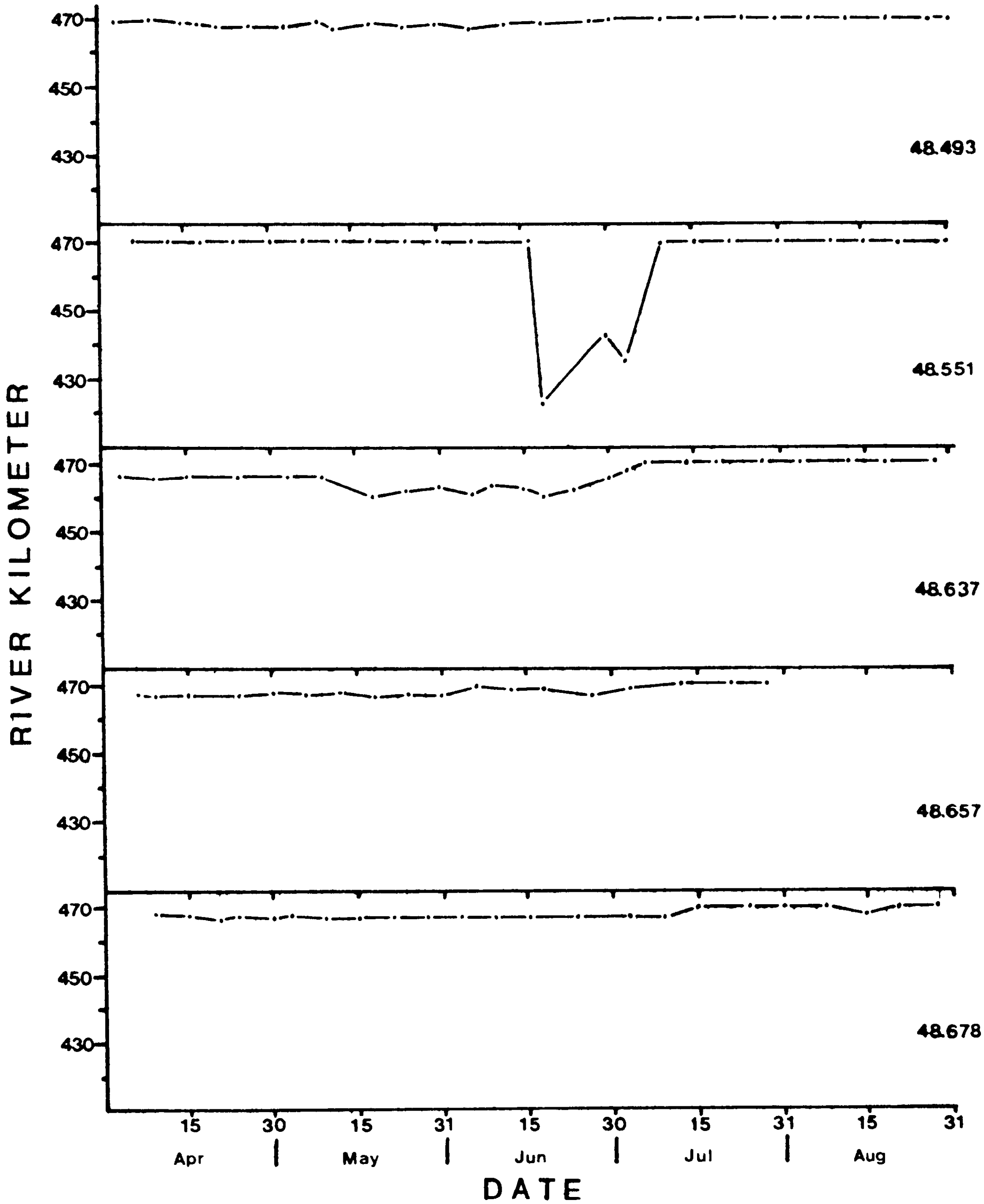

Figure 17. (Continued).

Table 7. Estimated abundance of northern squawfish in John Day Reservoir based on multiple mark and recapture survey and Overton's (1965) estimator, March 25-August 31, 1984.

Length Interval (mm)	Estimate	95% Confidence Limits	
		Lower	Upper
250-475	50,224	32,414	79,590
>375	30,262	23,723	39,996

Table 8. Estimated and observed numbers[a] of unmarked and marked northern squawfish harvested by anglers in upper John Day pool, March 15-August 31, 1984.

Status	Period											Sum
	7	8	9	10	11	12	13	14	15	16	17-	
Unmarked												
Estimated	8	0	65	0	28	0	73	34	8	19	4	239
Observed	1	0	15	0	7	1	13	3	2	6	1	49
Marked									5			
Estimated	0	0	0	0	0	0	25	0	5	0	0	30
Observed	0	0	0	1	0	1		5	6		21	21

[a]Includes fish >250 mm fork length.

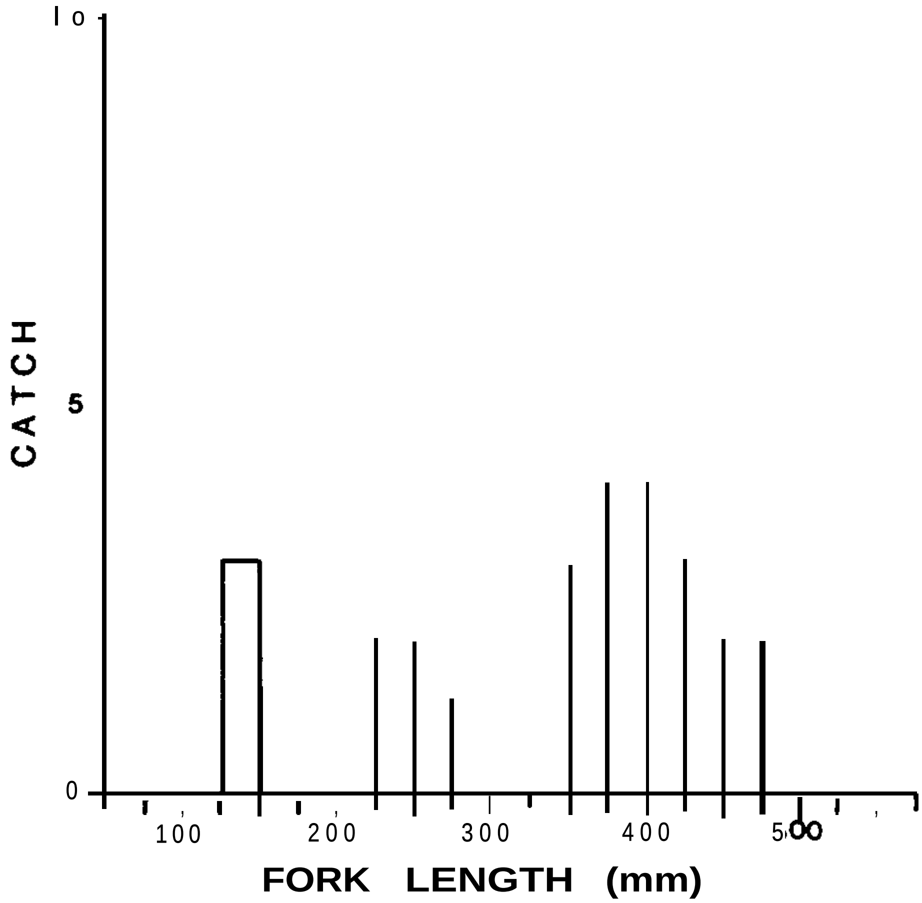

Figure 18. Length-frequency distribution of northern squawfish harvested by anglers in McNary tailrace, April 8-August 31, 1384.

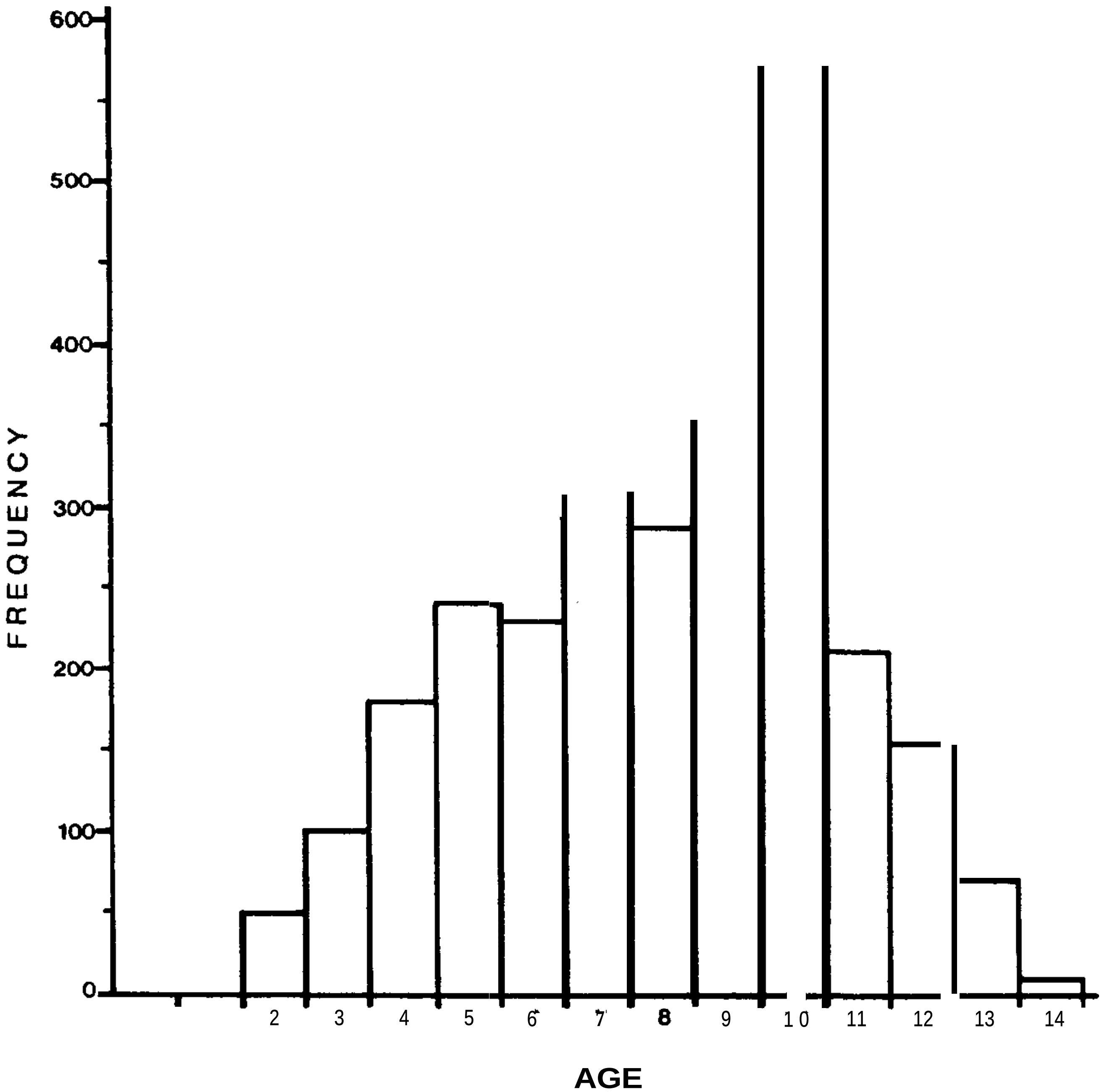

Figure 19. Estimated age-frequency distribution of northern squawfish catch in John Day pool, March-June 1984.

Table 9. Total catch (and catch per hour) of smallmouth bass (>250 mm) by gear and location, March-August 1984. Dashes indicate no effort.

	Location					
Gear	All	John Day forebay	Arlington	Irrigon-Paterson	McNary tailrace	McNary tailrace BRZ[a]
Bottom gill nets	107 (0.13)	31 (0.16)	29 (0.14)	34 (0.16)	13 (0.07)	0
Trap net	73 (0.01)	23 (0.01)	35 (0.02)	7 (d)	8 (d)	--
Trap net Lead	11 (d)	2 (d)	2 (d)	3 (d)	4 (d)	--
ODFW[b] electrofisher	417 (4.19)	143 (9.90)	117 (7.88)	149 (4.45)	8 (0.24)	1 (0.33)
USFWS[c] electrofisher	877 (2.96)	302 (3.99)	334 (3.66)	212 (2.87)	19 (0.42)	10 (1.00)
Angling	0	0	--	--		0
Surface gill net	0	--	--	--	--	0
USFWS gill net	55 (0.10)	0	6 (0.11)	43 (0.17)	6 (0.03)	0
Vertical gill net	0	0	0	--	--	--
USFWS trawl	5 (0.28)	--	--	--	5 (0.28)	--
Angler survey	54	--	--	39	15	0
Total	1,599	501	523	496	78	11

[a]Boat-restricted zone.
[b]Oregon Department of Fish and Wildlife.
[c]U.S. Fish and Wildlife Service.
[d]Catch per hour <0.005,

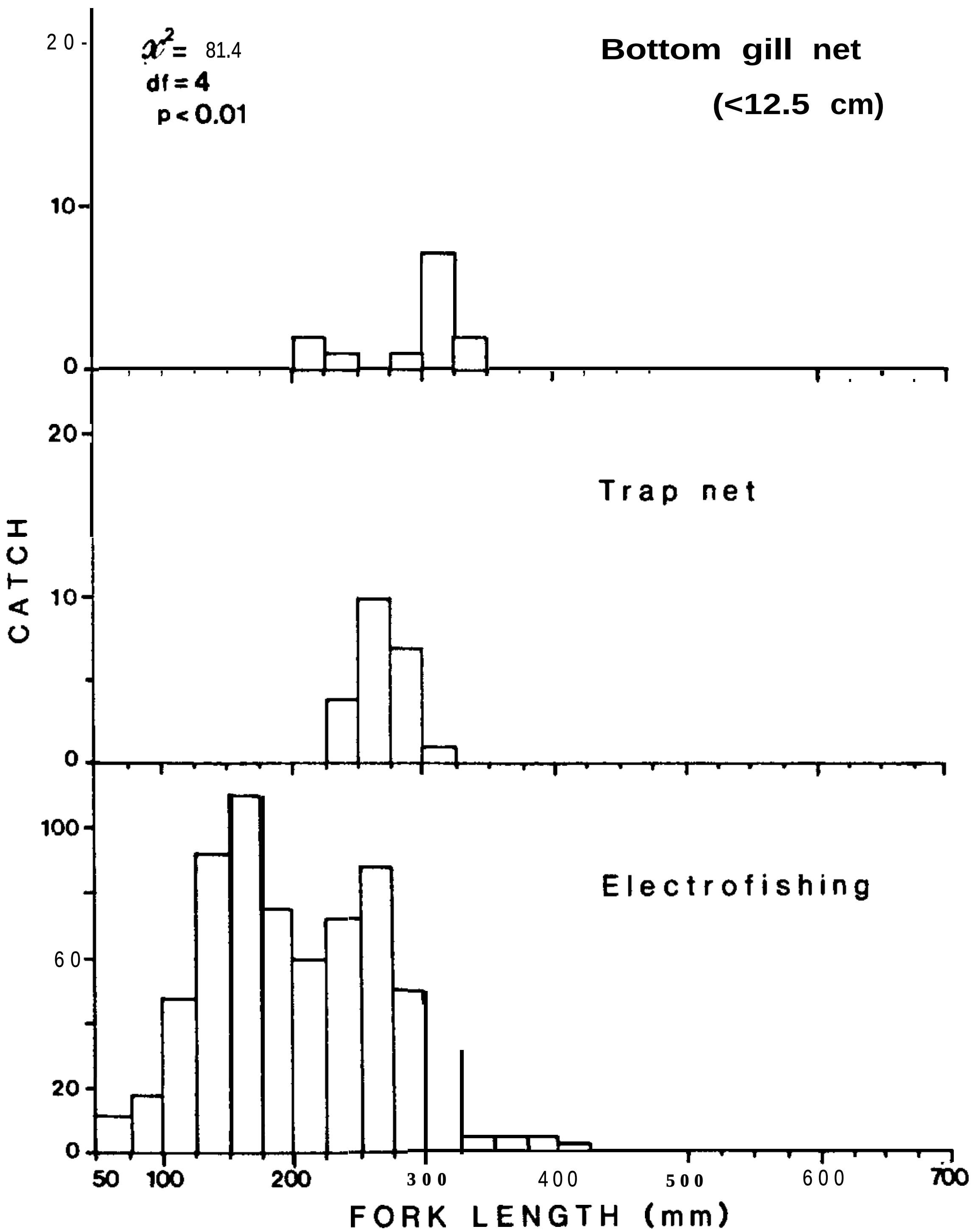

Figure 20. Length-frequency distributions of smallmouth bass collected in John Day forebay, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

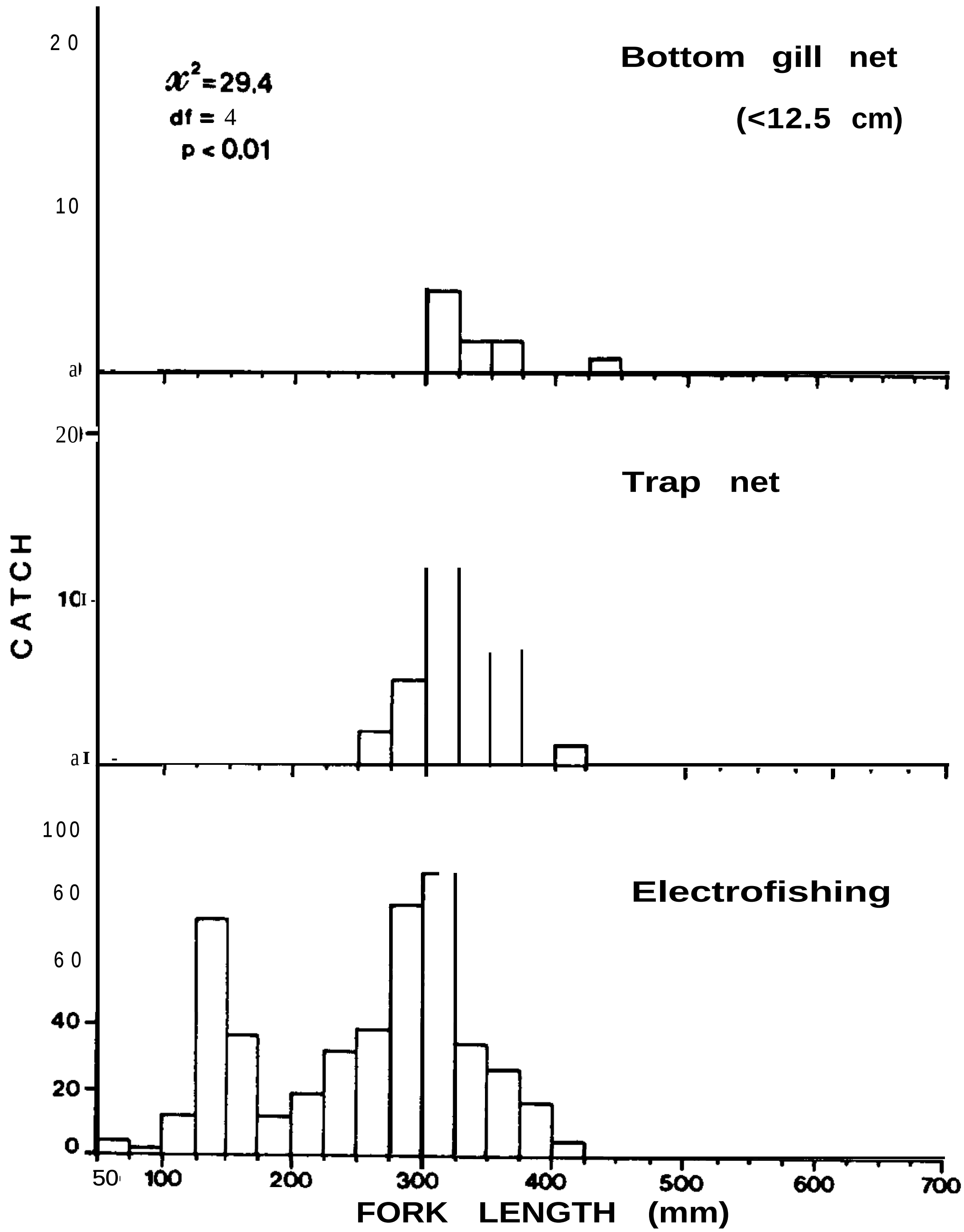

Figure 21. Length-frequency distributions of smallmouth bass collected in Arlington, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

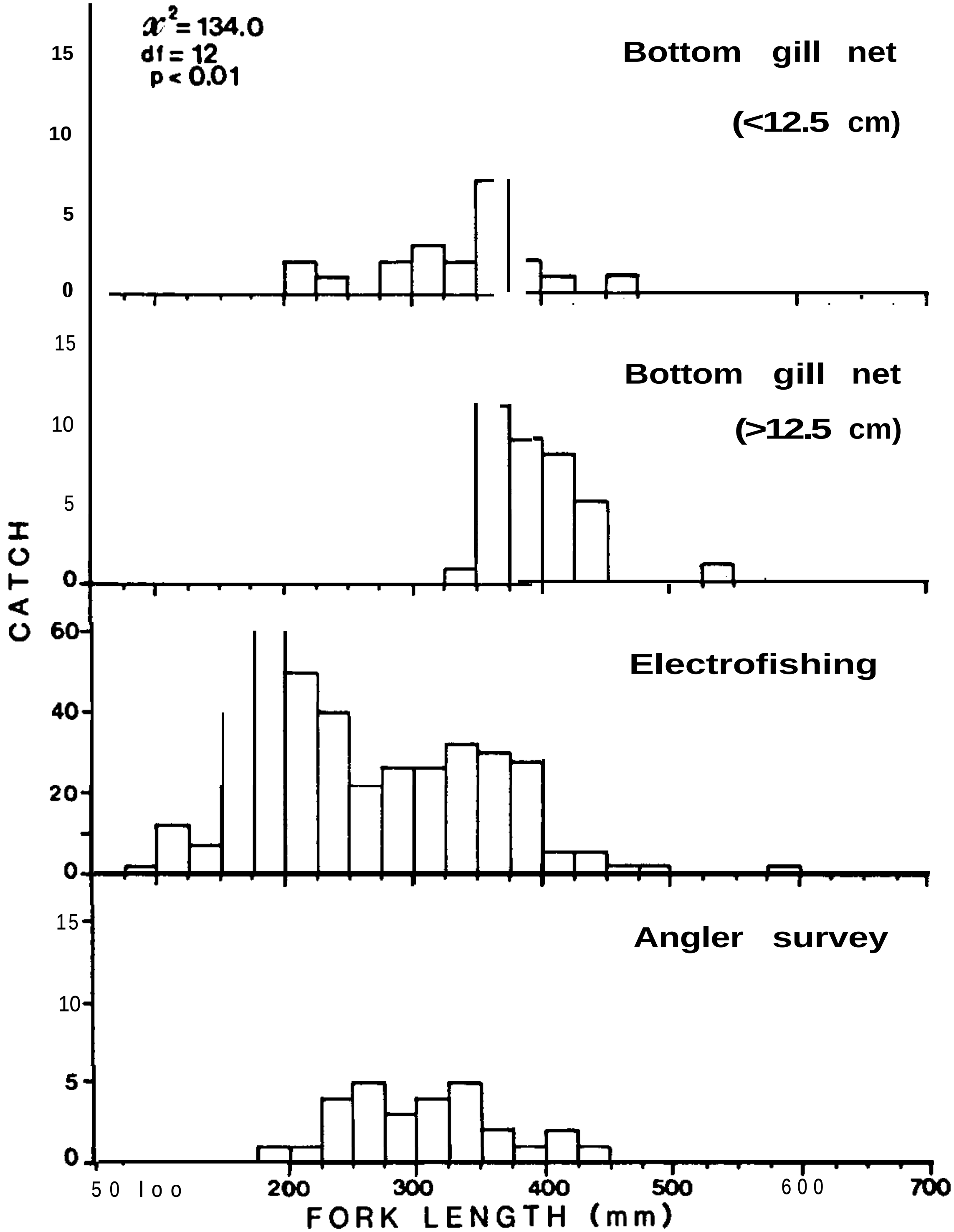

Figure 22. Length-frequency distributions of smallmouth bass collected in Irrigon-Paterson, March-June 1984. Chi-square values with degrees of freedom and observed probabilities are included for tests of independence between gear and length. Maximum (<12.5 cm) and minimum (>12.5 cm) mesh sizes of bottom gill nets are in parentheses.

Vulnerability of smallmouth bass of taggable size to capture did not appear related to size in either lower or upper John Day pool (Fiqure 23).

Movements and Distribution

Limited movements of marked smallmouth hass were observed ('Table 10 and Figure 24). Marked fish moved between Arlington and John Day forebay. Three smallmouth bass marked in Irrignn-Paterson were recaptured hy anglers between Irrigon-Paterson and McNary tailrace. No movements of marked smallmouth hass were observed hetween upper and lower reservnir stations.

Population Abundance

Estimates of smallmouth bass abundance in John Day Reservoir totaled 4,387 fish (Table 11). Anqler harvest above Paterson totaled 584 fish between April 8 and August 31 (Table 12). Estimated removals of marked smallmouth bass were 19% greater than observed removals. Most smallmouth bass harvested had fork lengths greater than 200 mm (Figure 25).

Survival of unmarked smallmouth bass captured during field sampling was not significantly ($p<0.05$) different ($X2=0.1, df=1, p=0.74$) from that of marked smallmouth bass. Seven of 212 recaptured smallmouth bass had lost their tags.

Age Composition

Ages of smallmouth bass in samples ranged from 1 to 11 years, hut the most abundant age group in the upper and lower pool was 2 years (Figures 26 and 27).

DISCUSSION

Vertical gill nets did not capture large numbers of predators in offshore habitats. Use was restricted to lower reservoir stations during summer after high spring flows declined. Consistent catches of northern squawfish by vertical gill nets in pelagic areas of Arlington and John Day forebay in August did indicate northern squawfish were present in those areas.

Sampling at Arlington rather than John Day tailrace enabled us to estimate the abundance of northern squawfish reservoir-wide and confirmed that walleye were predominantly distributed in the upper one-third of the reservnir. Because smallmouth bass were not observed to move hetween lower and upper pool stations, it is unknown what portion of the smallmouth bass population between Arlington and Irrignn-Paterson is included in abundance estimates. Sampling between Arlinqtnn and Irrignn-Paterson will be done in 1985 to determine whether marked fish move into that area.

The difference between 1983 and 1984 estimates of walleye abundance in John Day Reservoir was not statistically ($p<0.05$) significant ($z=1.73, p=0.08$) according to a test for differences between Schnabel population estimates (Chapman and Overton 1966). The difference between 1983 and 1984 estimates of smallmouth bass abundance in upper John Day pool was statistically ($p<0.05$) significant ($z=2.86, p<0.01$). This difference could indicate declining

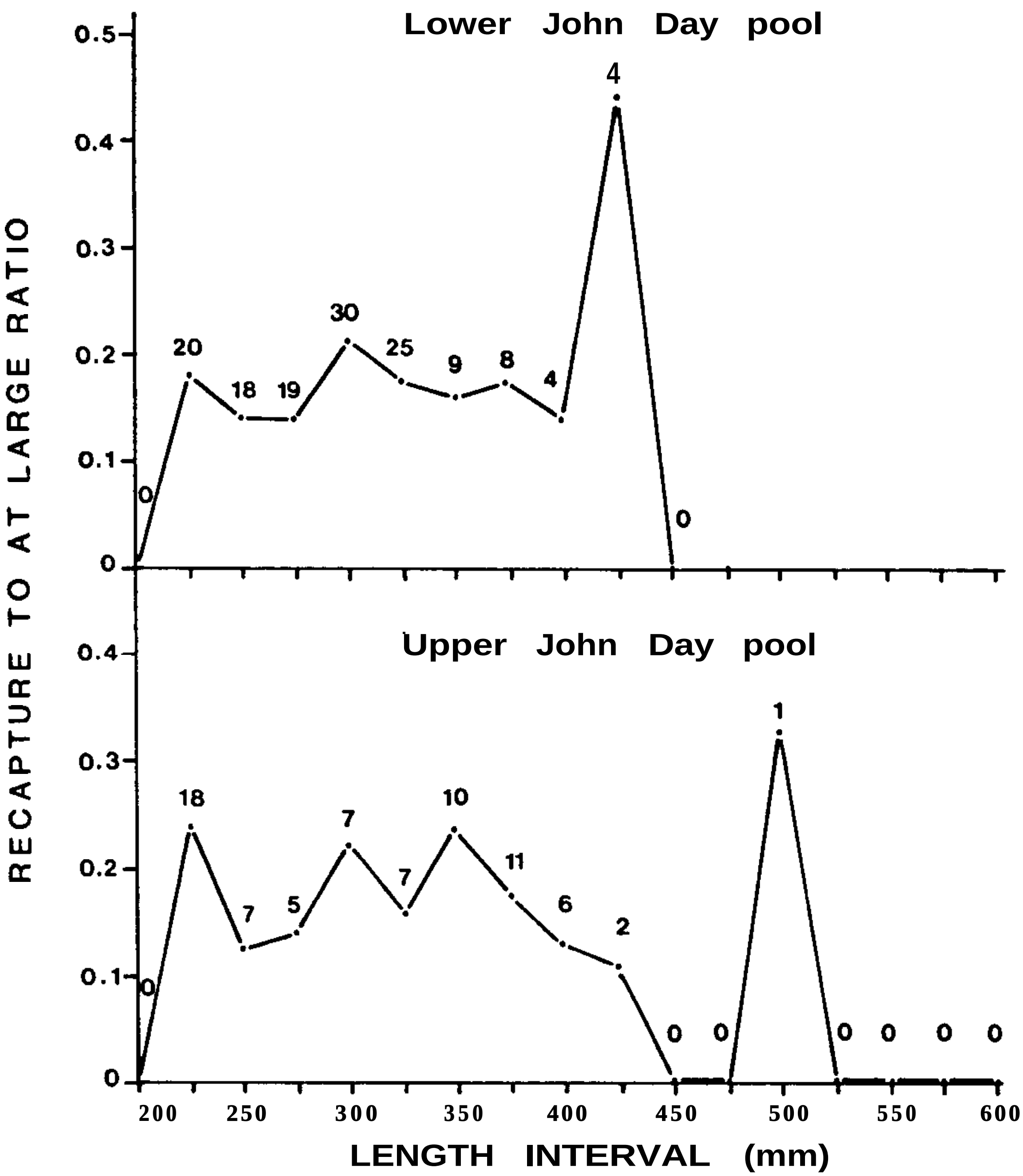

Figure 23. Ratios of recaptures to marks at large (vulnerability) for smallmouth bass by length interval, March-August 1984. Total recapture within a length interval is above each point.

Table 10. Numbers of marked smallmouth bass released and recaptured by location, March-August 1984.

Location Released	Number Released	Location Recaptured					
		A	B	C	D	E	F
A. John Day forebay	409	76	1	--	--	--	7
B. Arlington	386	2	103	--	--	--	5
C. Irrigon-Paterson	365	--	--	89	--	--	3
D. McNary tailrace	56	--	--	--	6	--	--
E. McNary tailrace BRZ[a]	11	--	--	--	3	0	--
F. Other	0	--	--	--	--	--	--

[a]Boat-restricted zone.

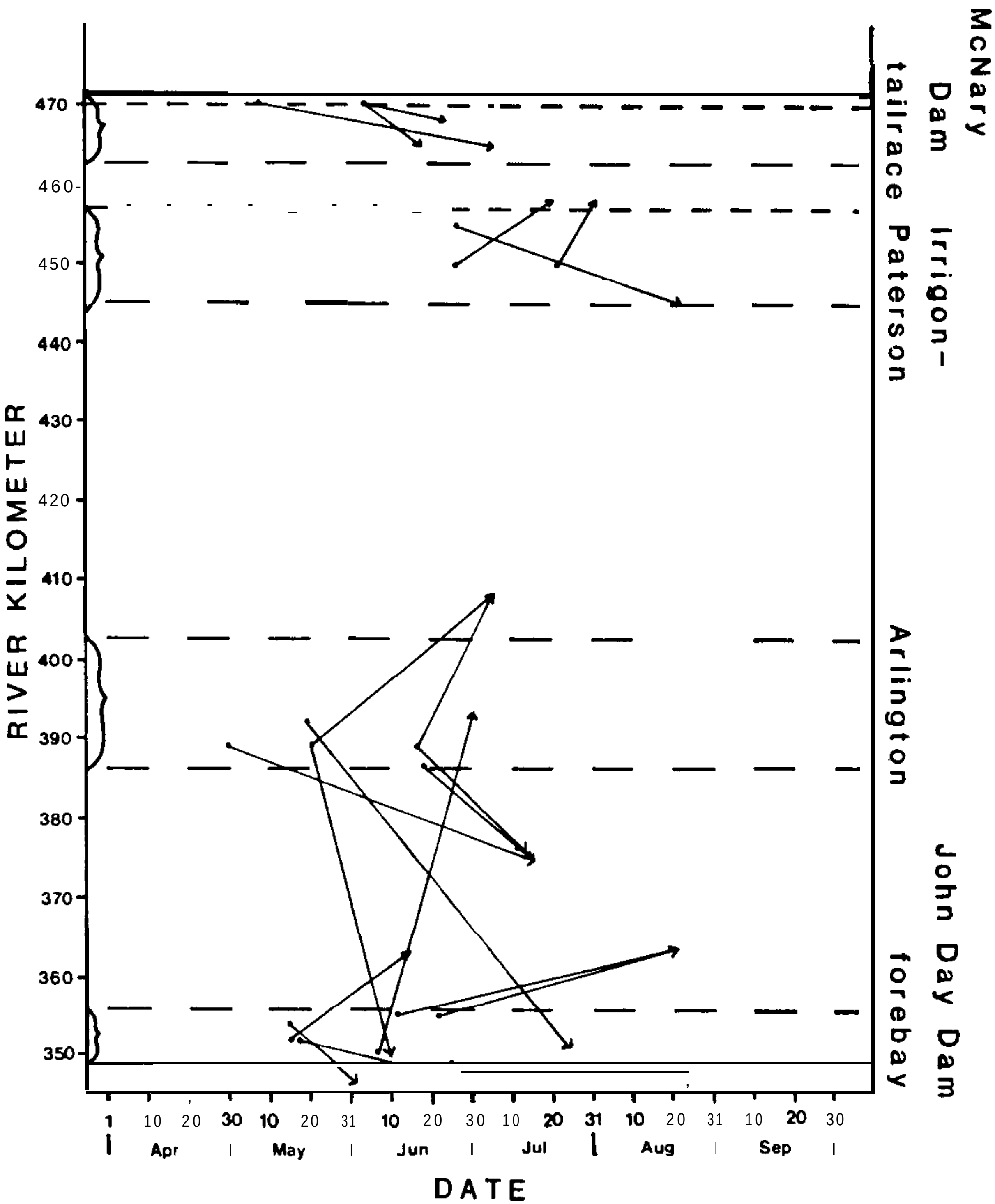

Figure 24. Locations and dates of releases and recoveries of marked smallmouth bass recaptured in stations other than where marked, 1984. Areas sampled are indicated by brackets.

Table 11. Estimated abundance of smallmouth bass based on multiple mark and recapture survey and Overton's (1965) estimator, March 25-August 31, 1984.

Location	Length Interval (mm)	Estimate	95% Confidence Limits	
			Lower	Upper
Lower John Day pool	>199	2,596	2,180	3,140
Upper John Day pool	>199	1,791	1,392	2,394

Table 12. Estimated and observed numbers[a] of unmarked and marked smallmouth bass harvested by anglers in upper John Day pool, April 8-August 31, 1984.

Status	Period 8	9	10	11	12	13	14	15	16	17	Sum
Unmarked											
Estimated	0	0	11	203	146	59	100	13	9	0	541
Observed	0	0	3	13	14	9	4	4	4	0	51
Marked											
Estimated	0	0	0	31	0	0	0	4	3	4	42
Observed	0	0	4	4	5	5	4	6	6	2	36

[a]Includes fish >200 mm fork length from April 8-June 30 and fish ≥250 mm fork length from July 1-August 25.

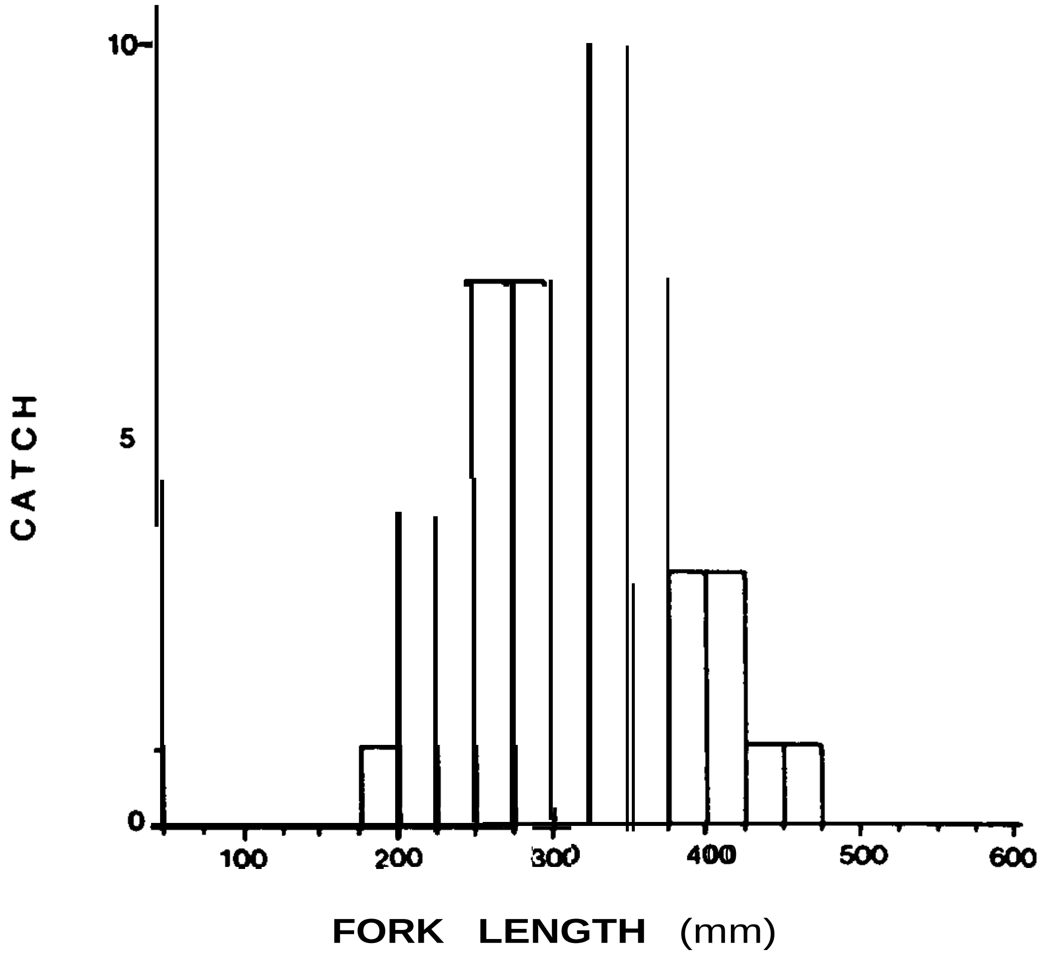

Figure 25. Length-frequency distribution of smallmouth bass harvested by anglers in McNary tailrace, April 8-August 31, 1984.

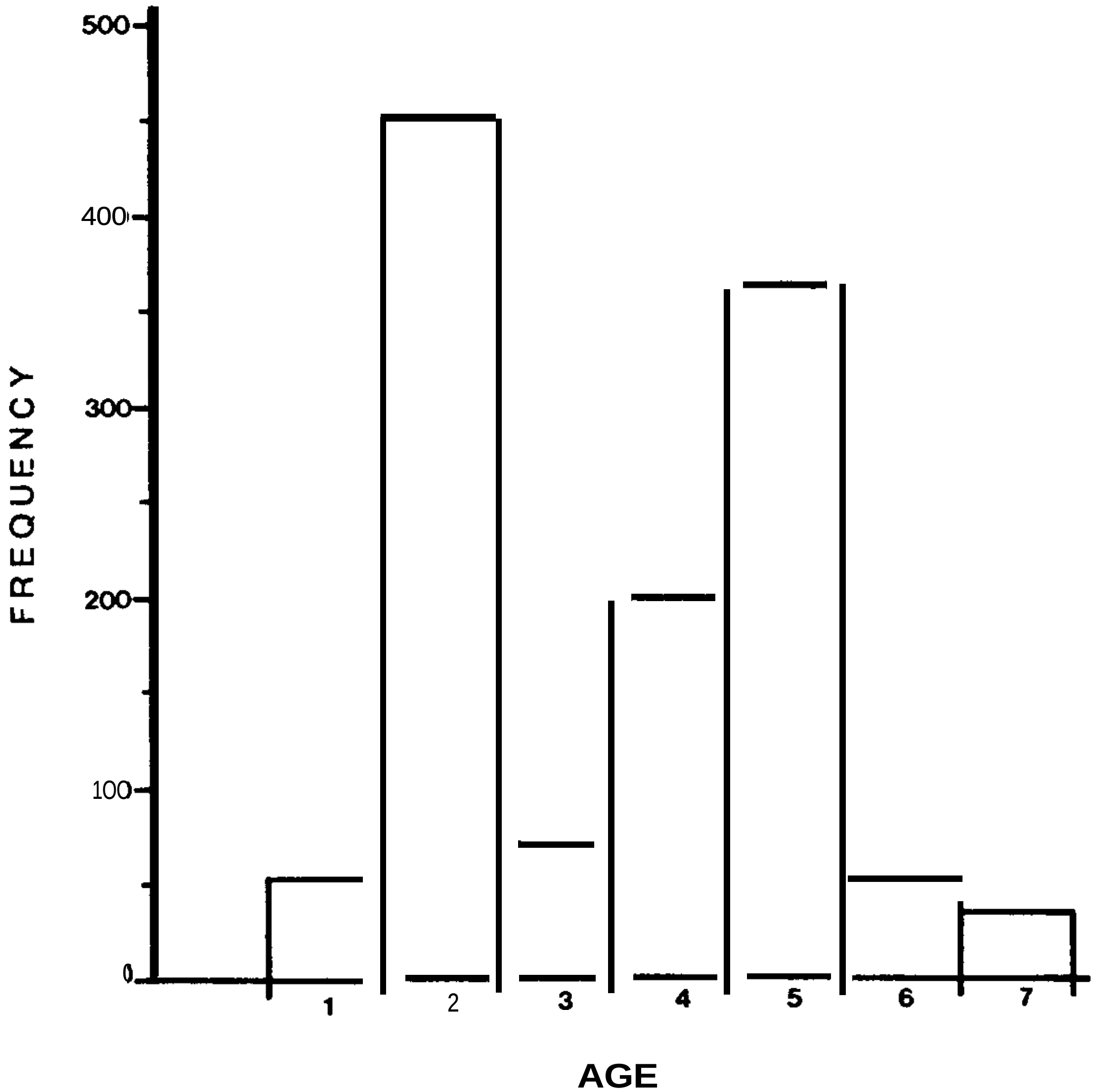

Figure 26. Estimated age-frequency distribution of smallmouth bass catch in lower John Day pool, March-June 1984.

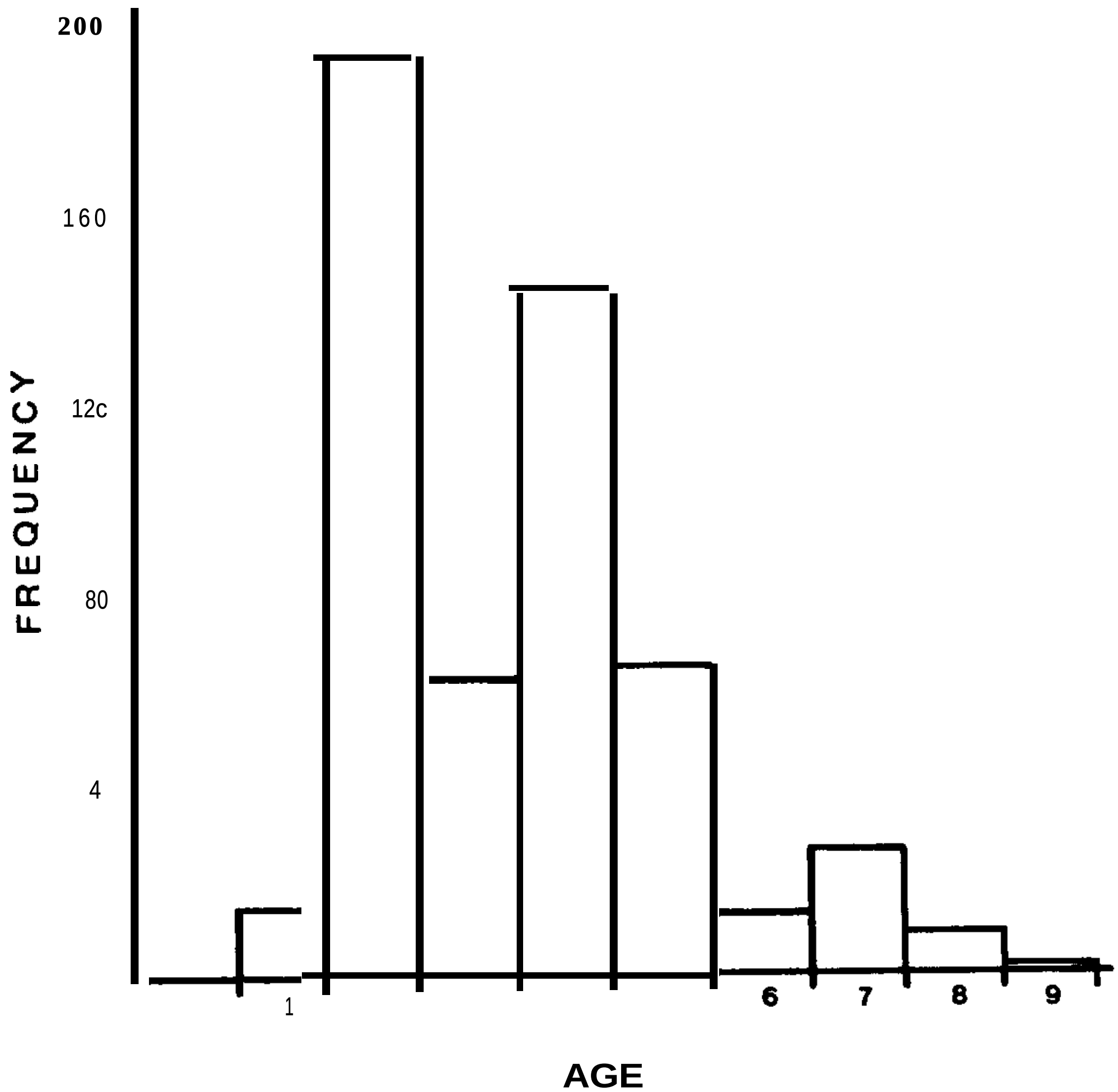

Figure 27. Estimated age-frequency distribution of smallmouth bass catch in upper John Day pool, March-June 1984.

abundance or could be a result of more intensive sampling of a localized population at Irriqon-Paterson in 1984. Abundance estimates of northern squawfish populations made in 1984 were not comparable with estimates from previous years because of differences in areas over which abundance estimates applied.

Walleye reproduction in John Day Reservoir or recruitment of juvenile walleye from upriver reservoirs appears to have been limited since 1979 when Brege (1981) noted uncharacteristically large numbers of young-of-the-year passing John Day Dam. Most walleye caught in 1984 were 5 years old. This 1979 year class also comprised the majority of walleye caught in John Day Reservoir by us in 1982 and 1983 and hy Maule (1982) in 1980 (Figure 28).

A large number of tags from smallmouth bass marked in John Day forebay were returned by mail from anglers fishing in John Day River. As a result an angler survey will be conducted in John Day forebay and John Day River in 1985. Smaller diameter spaghetti taqs will also be used in 1985 to address the increasing tag loss problem observed in 1984.

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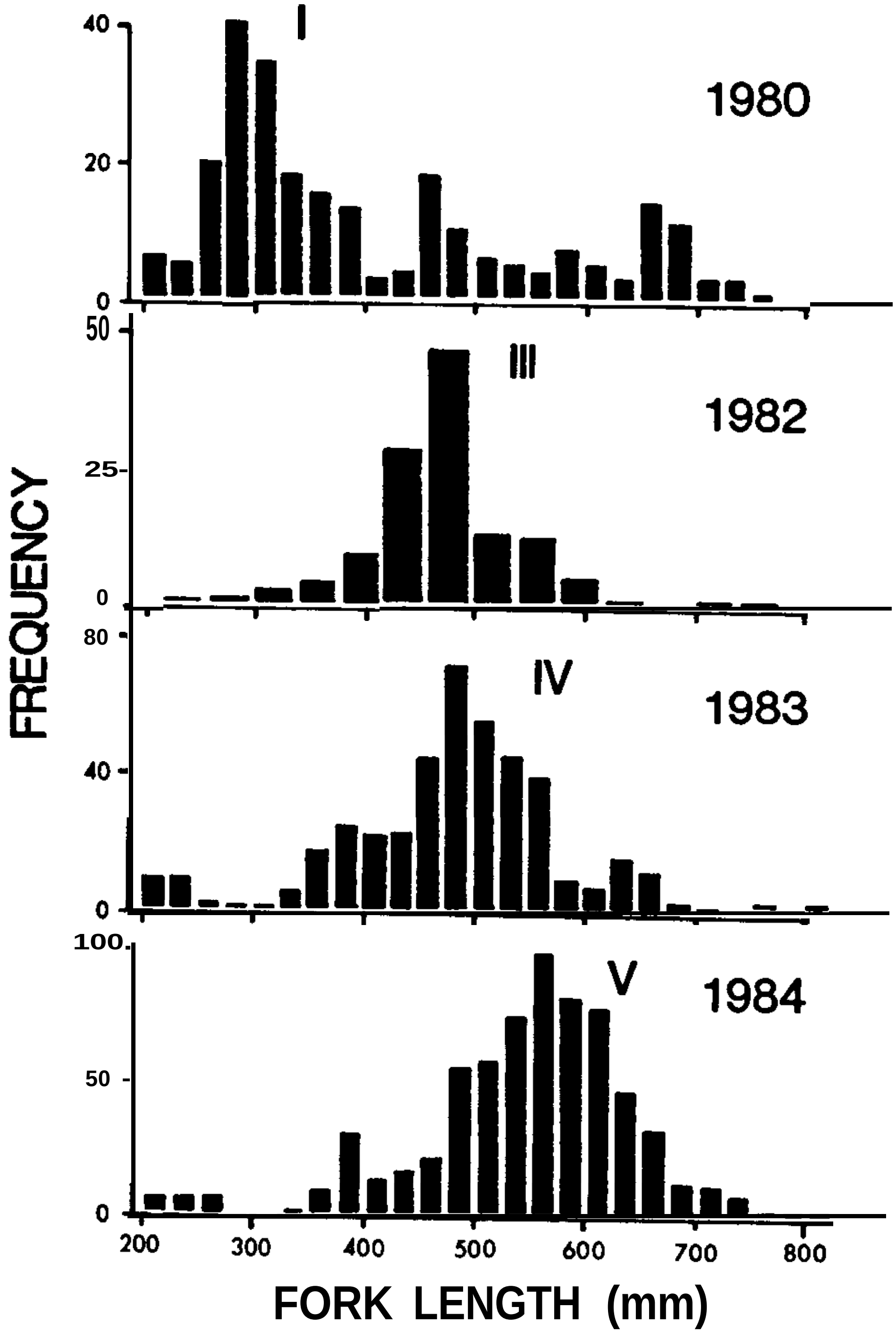

Figure 28. Length-frequency distributions of walleye collected in John Day Reservoir, 1980-84, from Maule (1982), Willis et al. (1985) and Nigro et al. (1905).

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APPENDIX A

Sampling Periods, Sampling Effort and Catch Per Unit Effort

Table A.1. Dates corresponding to sampling periods, March-August 1984.

Sampling Period	Beginning Date	Ending Date
7	Mar 25	Apr 7
8	Apr 8	Apr 21
9	Apr 22	May 5
10	May 6	May 19
11	May 20	Jun 2
12	Jun 3	Jun 16
13	Jun 17	Jun 30
14	Jul 1	Jul 14
15	Jul 15	Jul 28
16	Jul 29	Aug 18
17	Aug 19	Sep 1

Table A.2 Distribution of sampling effort (in hours) by location, gear and period, March-August 1984.

Location/Gear	Period 7	8	9	10	11	12	13	14	15	16	17	Sum
John Day forebay												
Bottom gill net	2	13	23	13	21	23	19	12	24	24	18	192
USFWS[a] gill net	0	0	0	0	0	0	0	0	0	1	0	1
Vertical gill net	0	0	1	205	206	0	0	0	0	211	0	623
Trap net	0	261	193	208	211	209	202	250	352	284	332	2,502
Trap net lead	0	284	194	206	212	210	203	253	285	289	286	2,422
ODFW[b] electrofisher	0	1	0	5	0	6	0	0	0	3	0	15
USFWS electrofisher	0	0	9	6	14	0	19	4	6	0	18	76
Angling	0	7	4	2	5	4	0	0	4	0	0	26
Arlington												
Bottom gill net	0	15	23	22	14	27	24	14	24	14	27	204
USFWS gill net	0	0	15	1	12	0	0	0	0	0	25	53
Vertical gill net	0	0	207	220	70	0	0	0	0	202	0	699
Trap net	0	139	262	218	234	214	204	211	254	211	160	2,107
Trap net lead	0	139	281	220	234	213	204	220	276	213	211	2,211
ODFW electrofisher	0	1	0	5	0	3	0	0	0	7	0	16
USFWS electrofisher	0	0	9	0	22	0	26	4	4	0	26	91
Irrigon-Paterson												
Bottom gill net	8	13	28	19	21	22	21	18	20	20	19	209
USFWS gill net	0	71	0	73	0	57	0	0	0	60	0	261
Trap net	0	360	0	283	217	290	273	215	281	284	280	2,483
Trap net lead	0	260	0	284	220	292	276	216	283	285	281	2,497
ODFW electrofisher	0	0	4	0	5	0	6	6	5	0	7	33
USFWS electrofisher	0	16	0	19	0	17	0	0	0	22	0	74
McNary tailrace												
Bottom gill net	8	0	25	20	20	21	26	24	19	16	17	196
USFWS gill net	0	57	0	53	0	32	0	0	0	43	0	185
Trap net	134	0	286	209	237	209	279	213	257	211	210	2,245
Trap net lead	134	0	289	213	216	210	282	214	258	212	211	2,239
ODFW electrofisher	2	0	5	0	5	0	6	5	6	0	5	34
USFWS electrofisher	0	8	0	14	0	10	0	0	0	13	0	45
USFWS trawl	0	5	0	6	0	6	0	0	0	1	0	18
McNary tailrace BRZ[c]												
Bottom gill net	0	0	0	0	0	0	0	0	0	1	1	2
Surface gill net	0	0	0	2	0	2	0	0	3	5	5	17
USFWS gill net	0	5	0	6	0	5	0	0	0	15	0	31
ODFW electrofisher	0	0	0	0	0	0	0	0	1	0	2	3
USFWS electrofisher	0	2	0	3	0	2	0	0	0	3	0	10
Angling	7	5	4	8	1	8	8	8	20	23	35	127
All												
Bottom gill net	18	41	99	74	76	93	90	68	87	75	82	803
Surface gill net	0	0	0	2	0	2	0	0	3	5	5	17
USFWS gill net	0	133	15	133	12	94	0	0	0	119	25	531
Vertical gill net	0	0	208	425	276	0	0	0	0	413	0	1,322
Trap net	134	760	741	918	899	922	958	889	1,144	990	982	9,337
Trap net lead	134	783	764	923	882	925	965	903	1,102	999	989	9,369
ODFW electrofisher	2	2	9	10	10	9	12	11	12	10	14	101
USFWS electrofisher	0	26	18	42	36	29	45	8	10	38	44	296
Angling	7	12	8	10	6	12	8	8	24	23	35	153
USFWS trawl	0	5	0	6	0	6	0	0	0	1	0	18

[a]U.S. Fish and Wildlife Service.
[b]Oregon Department of Fish and Wildlife.
[c]Boat-restricted zone.

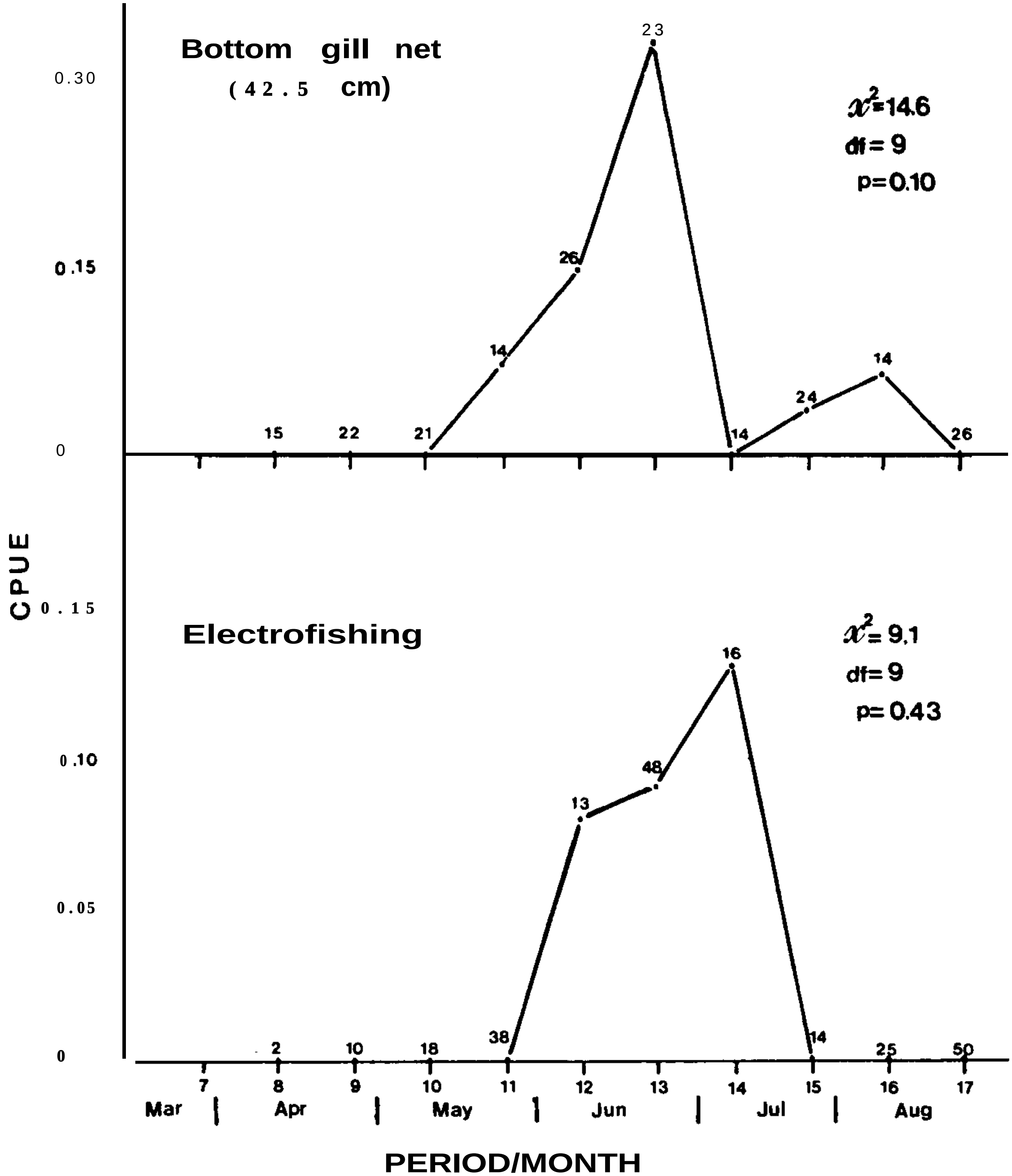

Figure A.1. Catch per unit effort (CPUE) of walleye by gear in Arlington, 1984. Units of effort are net hour (bottom gill net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

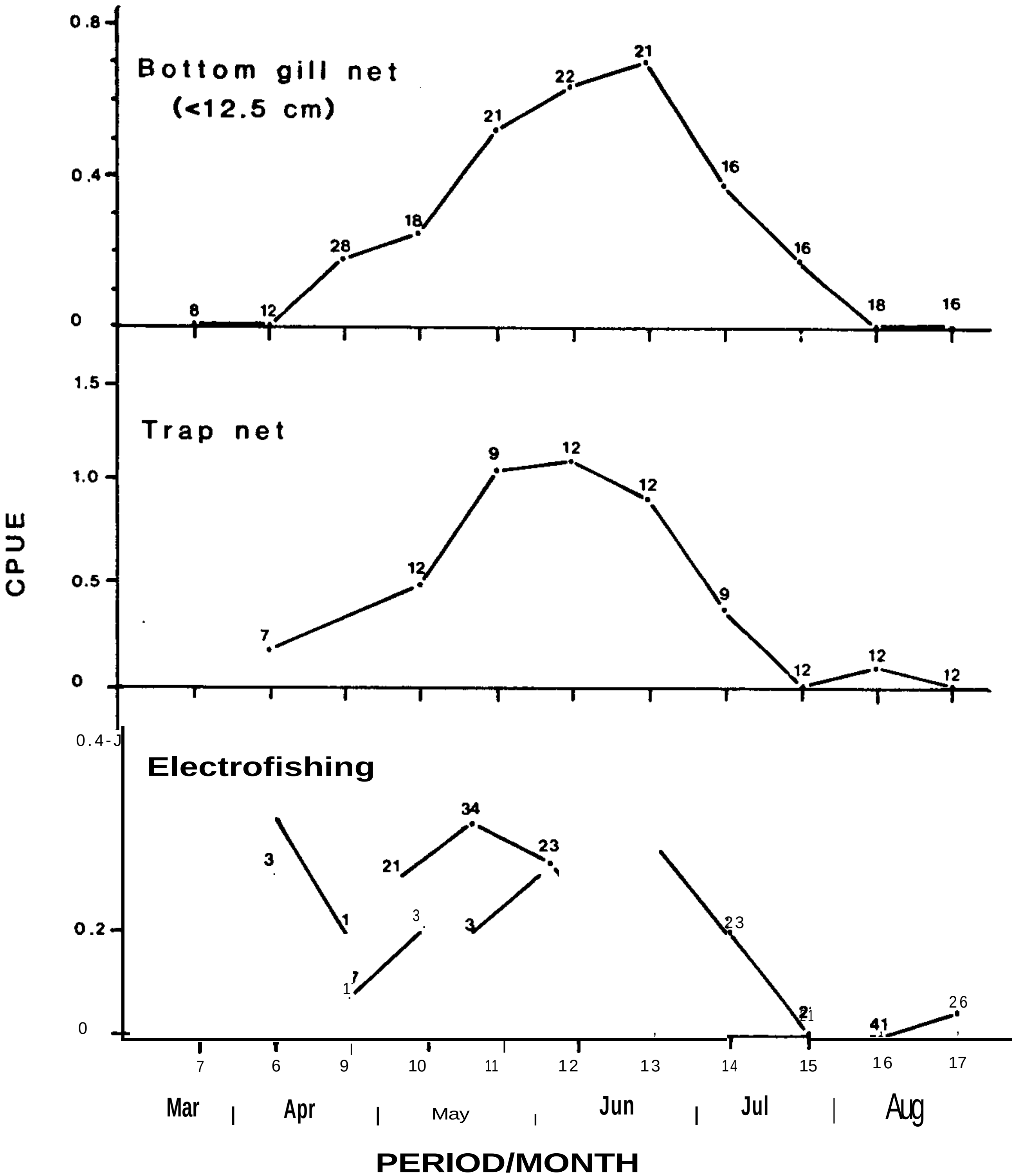

Figure A.2. Catch per unit effort (CPUE) of walleye by gear in Irrigon-Paterson, 1984. Units of effort are net hour (bottom gill net), net day (trap net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

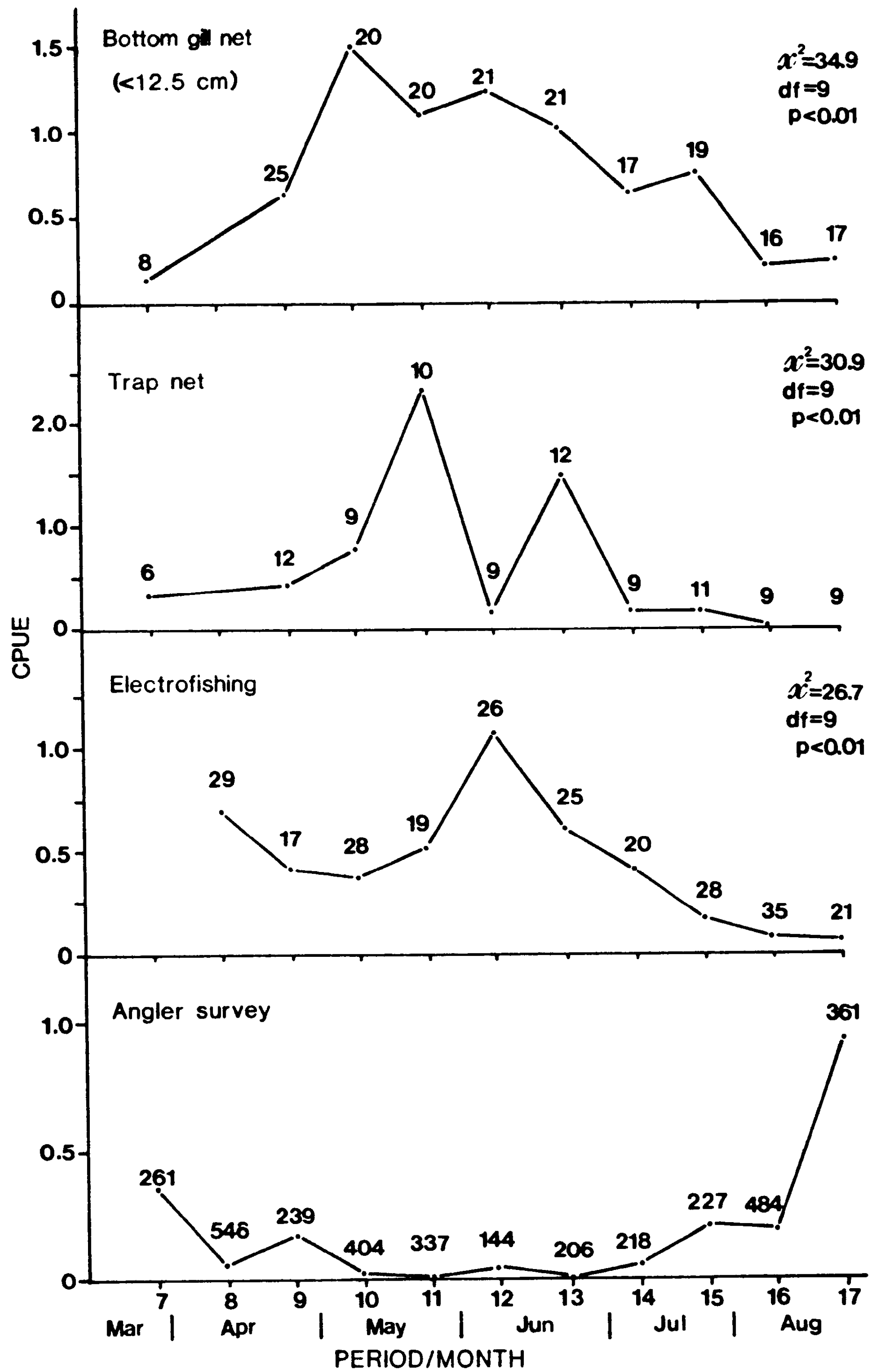

Figure A.3. Catch per unit effort (CPUE) of walleye by gear in McNary tailrace, 1984. Units of effort are net hour (bottom gill net), net day (trap net), 900 second current-on time (electrofishing) and angler hour (angler survey). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

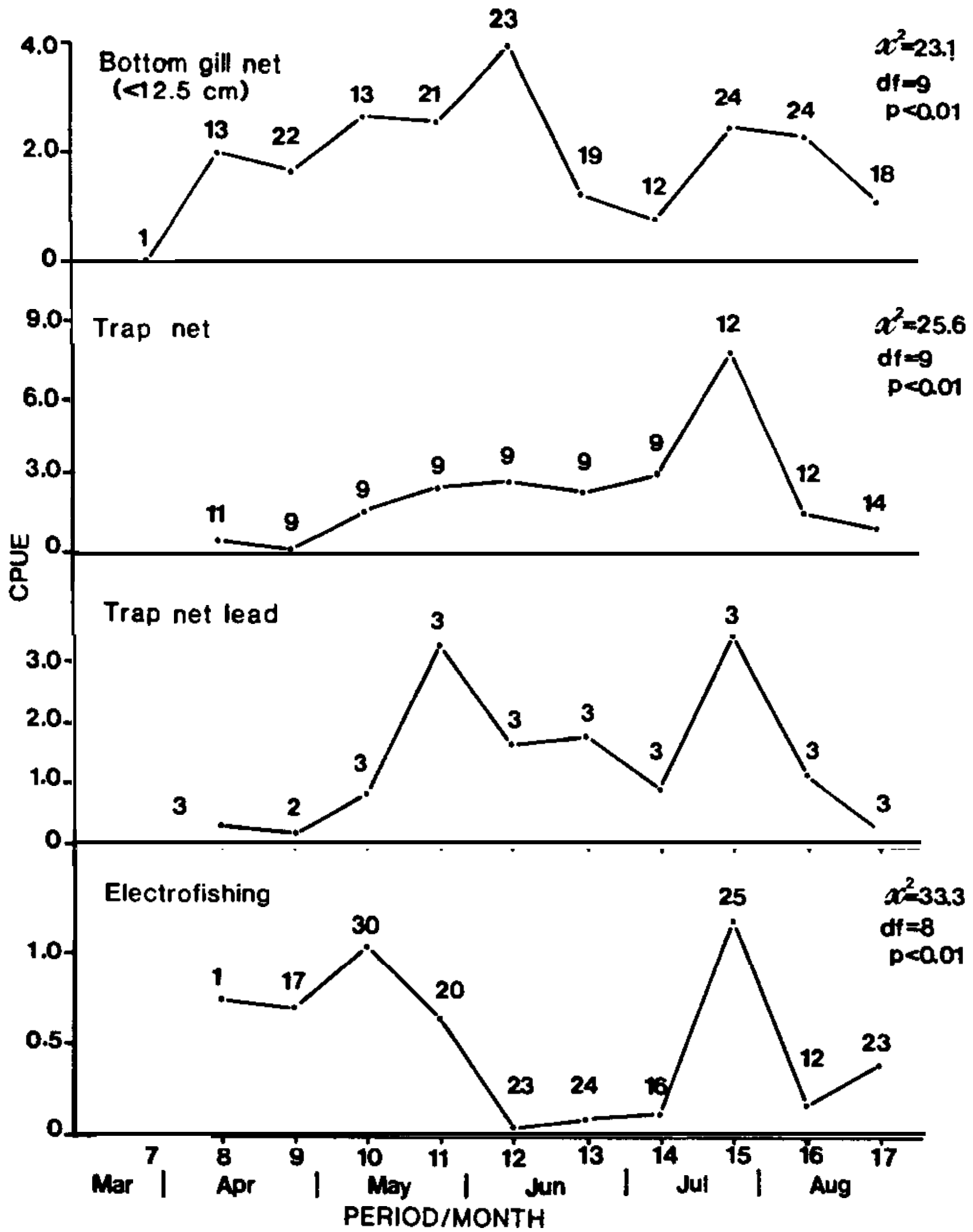

Figure A.4. Catch per unit effort (CPUE) of northern squawfish by gear in John Day forebay, 1984. Units of effort are net hour (bottom gill net), net day (trap net and trap net lead) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods where appropriate. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

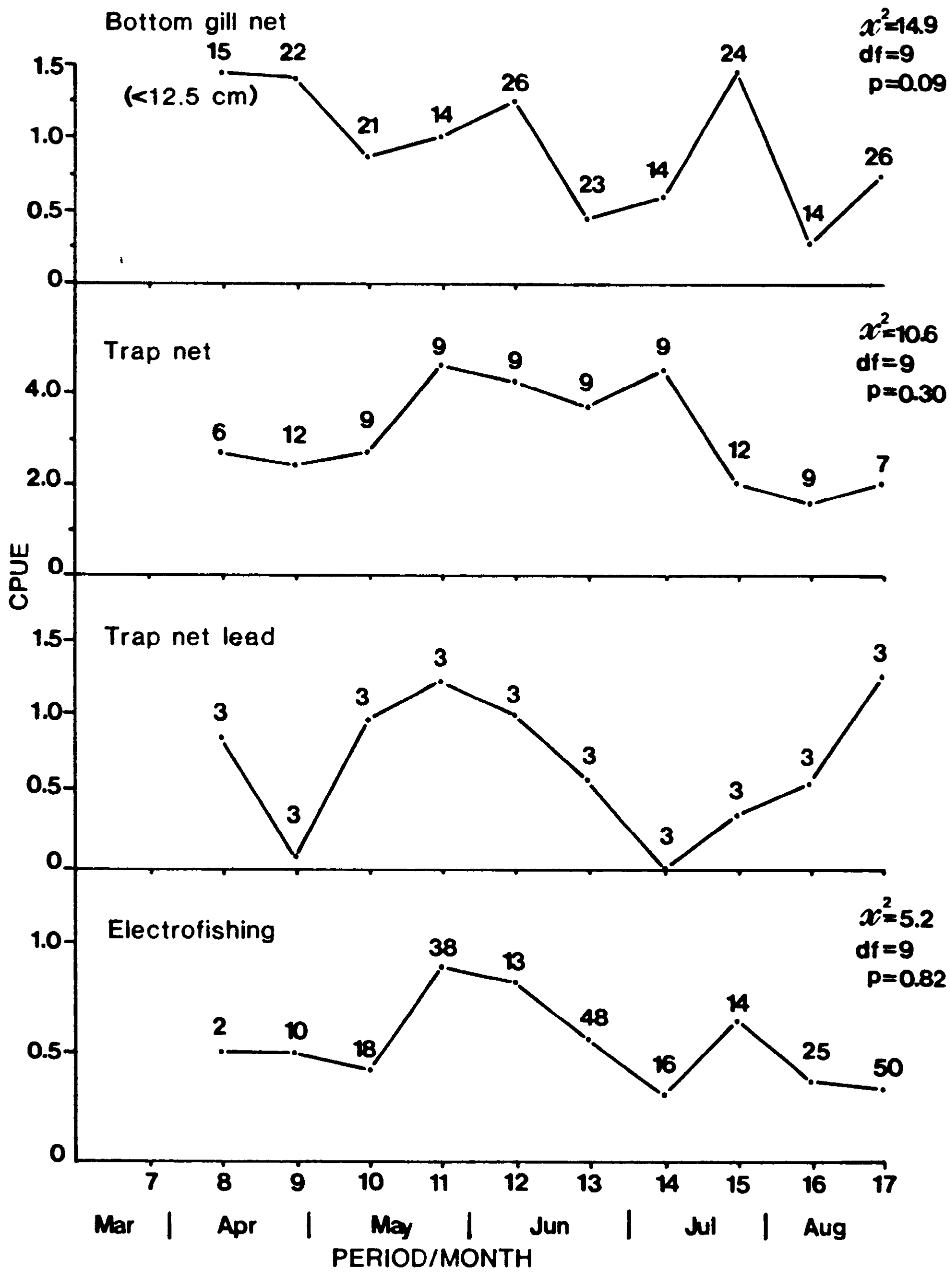

Figure A.5. Catch per unit effort (CPUE) of northern squawfish by gear in Arlington, 1984. Units of effort are net hour (bottom gill net), net day (trap net and trap net lead) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods where appropriate. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

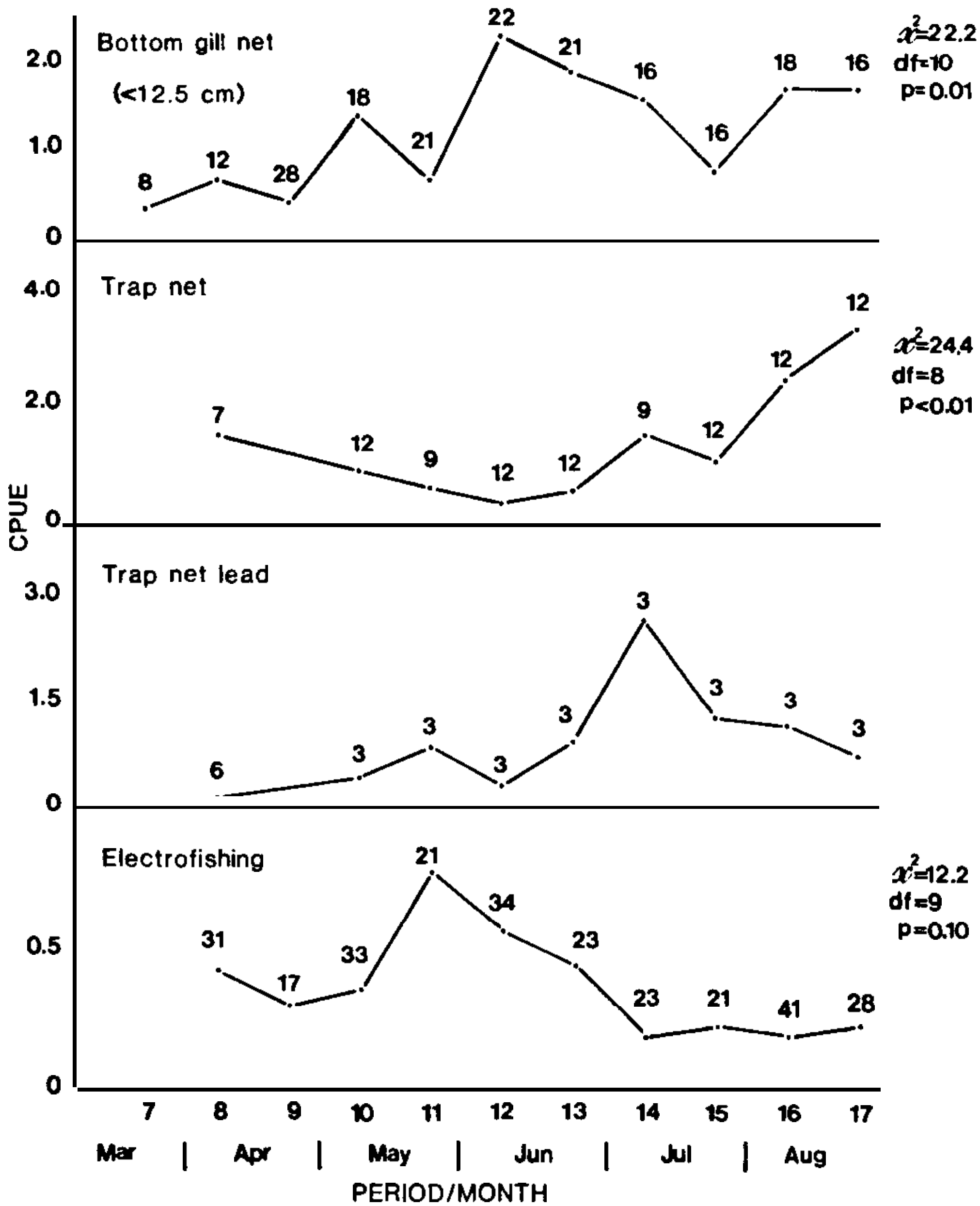

Figure A.6. Catch per unit effort (CPUE) of northern squawfish by gear in Irrigon-Paterson. 1984. Units of effort are net hour (bottom gill net), net day (trap net and trap net lead) and 900 second current-on time (electrofishing. Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods where appropriate. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

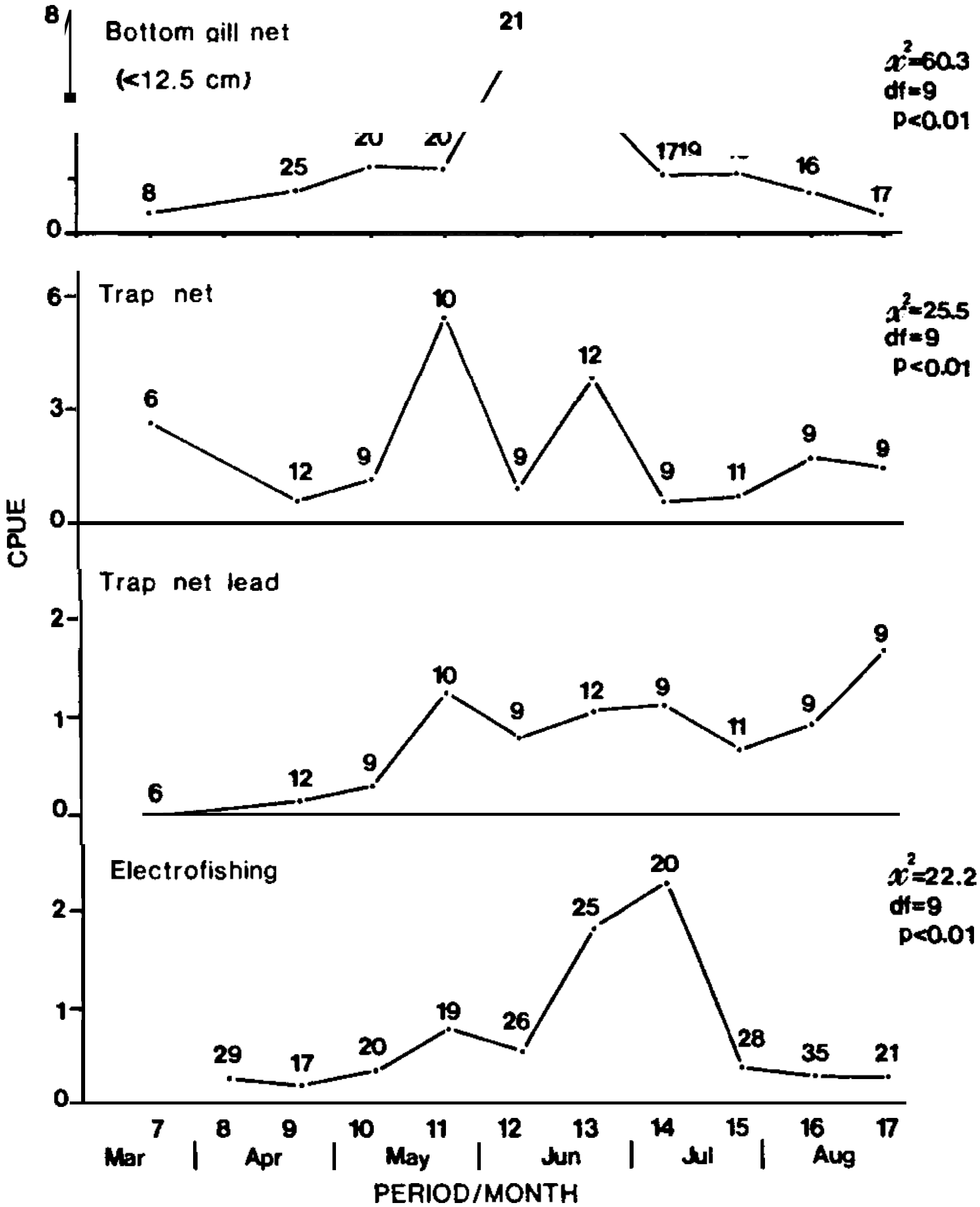

Figure A.7. Catch per unit effort (CPUE) of northern squawfish by gear in McNary tailrace, 1984. Units of effort are net hour (bottom gill net), net day (trap net and trap net lead) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods where appropriate. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

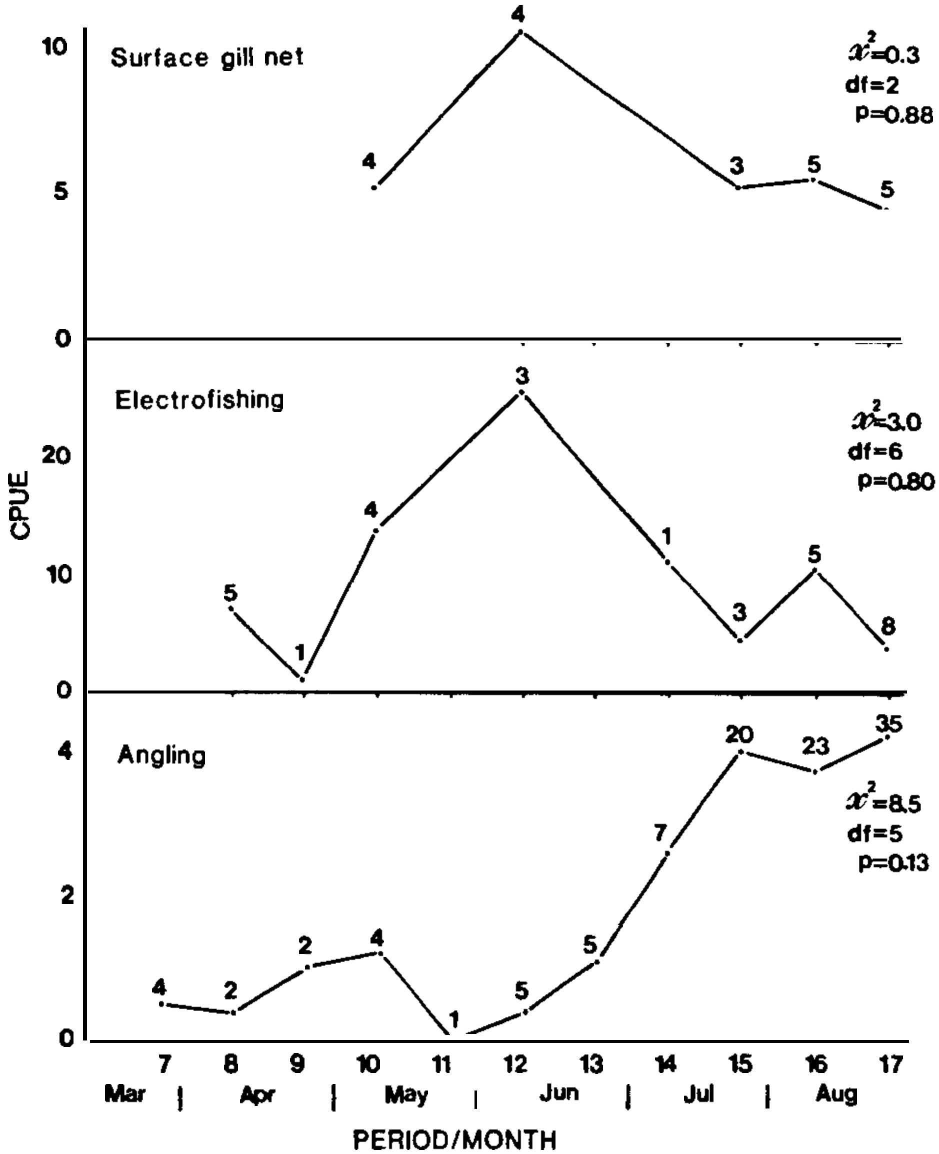

Figure A.8. Catch per unit effort (CPUE) of northern squawfish by gear in McNary tailrace boat-restricted zone, 1984. Units of effort are net hour (surface gill net), 900 second current-on time (electrofishing) and angler hour (angling). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods.

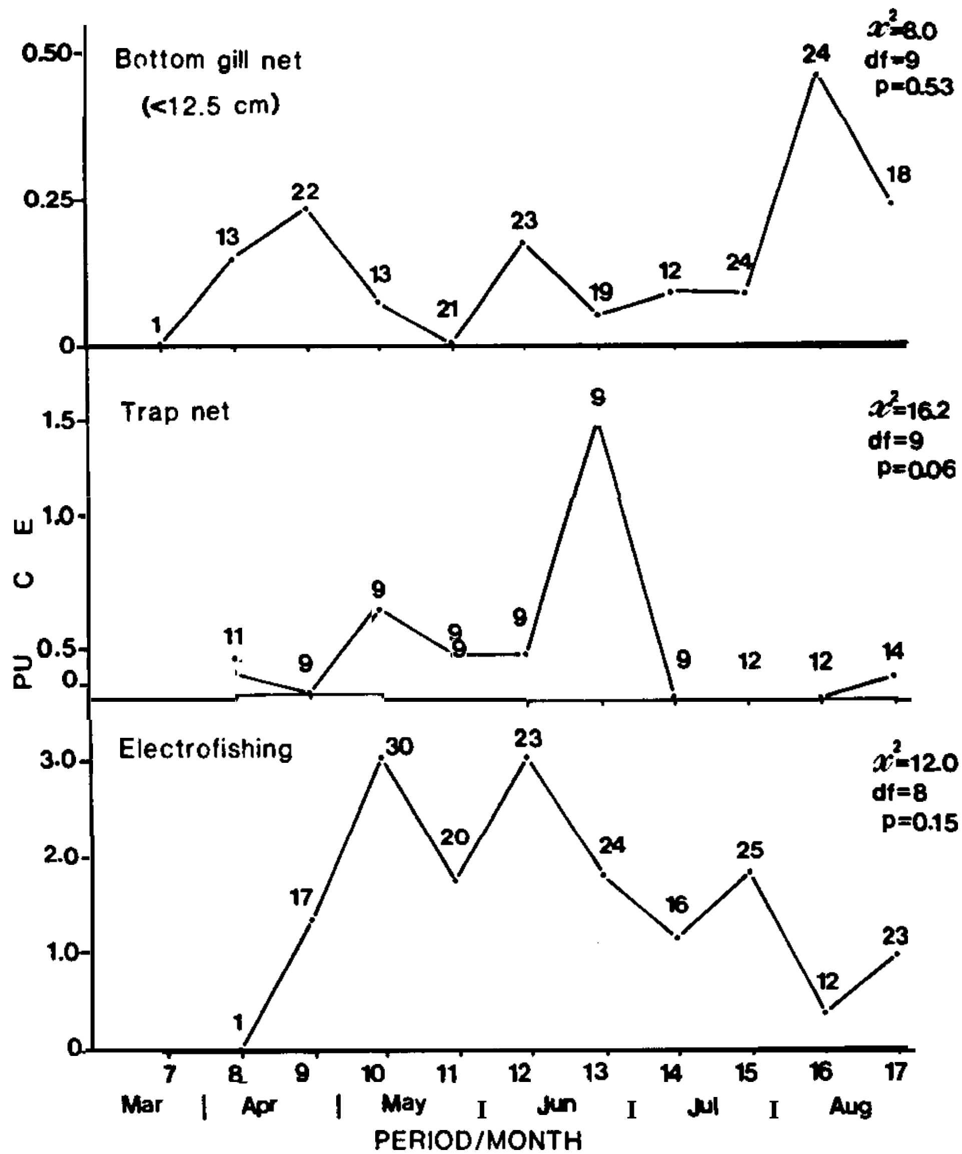

Figure A.9. Catch per unit effort (CPUE) of smallmouth bass by gear in John Day forebay, 1984. Units of effort are net hour (bottom gill net), net day (trap net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods. Maximum ('12.5 cm) mesh size of bottom gill nets is in parentheses.

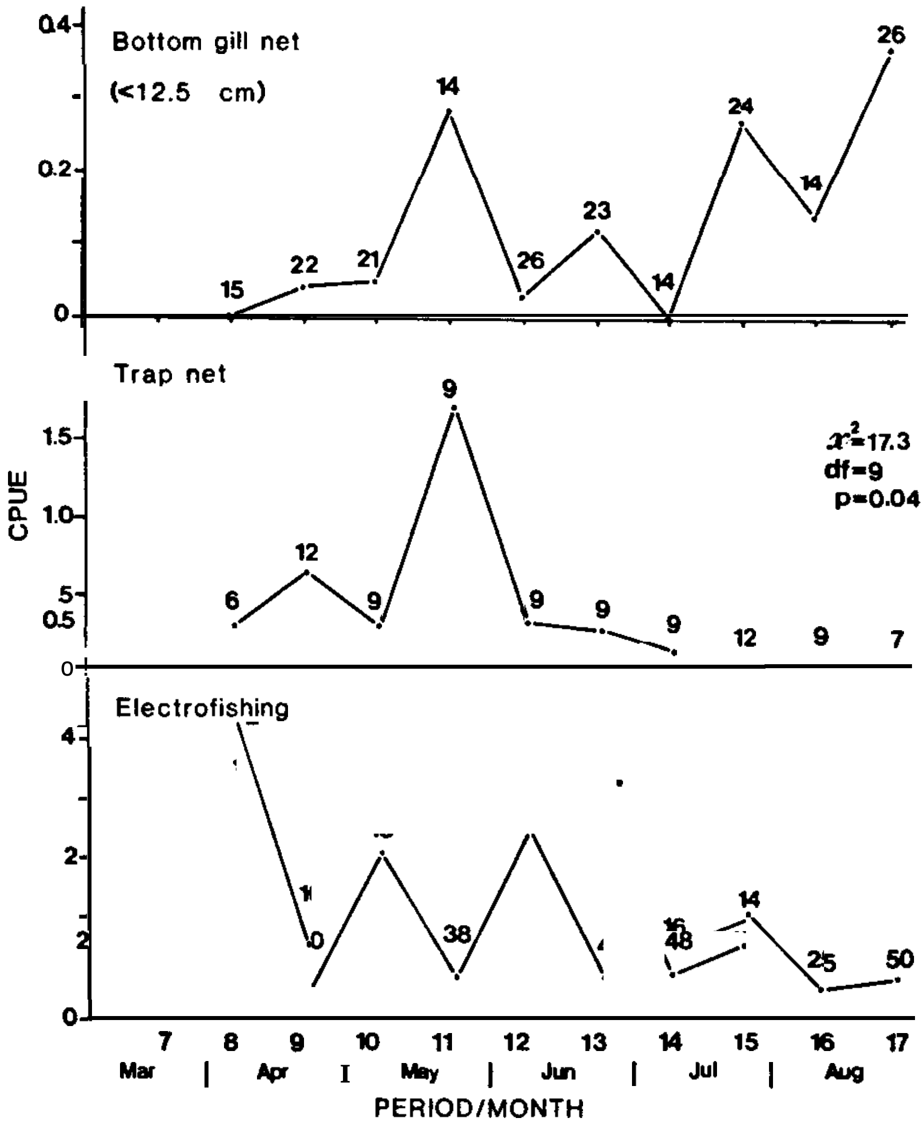

Figure A.10. Catch per unit effort (CPUE) of smallmouth bass by gear in Arlington, 1984. Units of effort are net hour (bottom gill net), net day (trap net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods except where precluded by lack of variation between samples. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

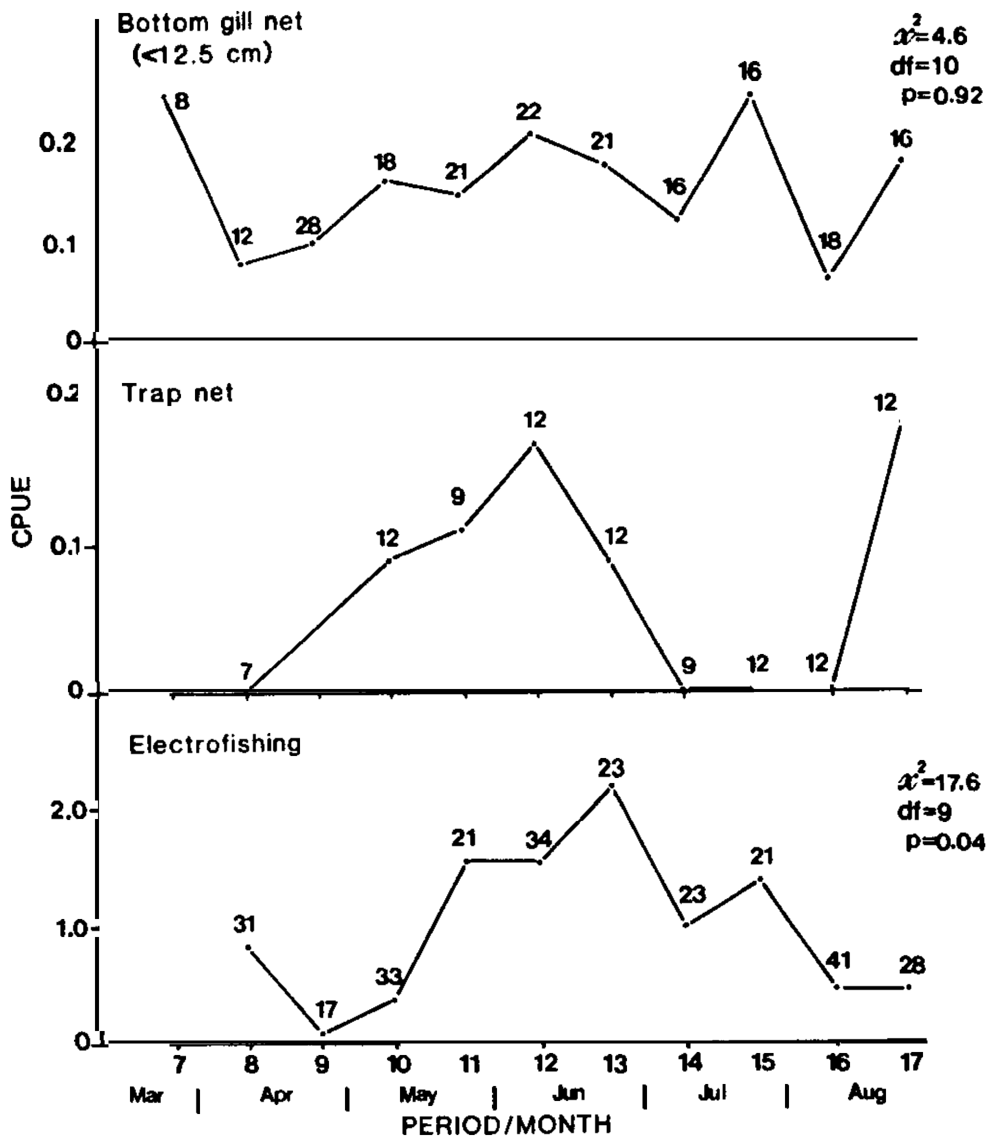

Figure A.11. Catch per unit effort (CPUE) of smallmouth bass by gear in Irrigon-Paterson, 1984. Units of effort are net hour (bottom gill net), net day (trap net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods except where precluded by lack of variation between samples. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

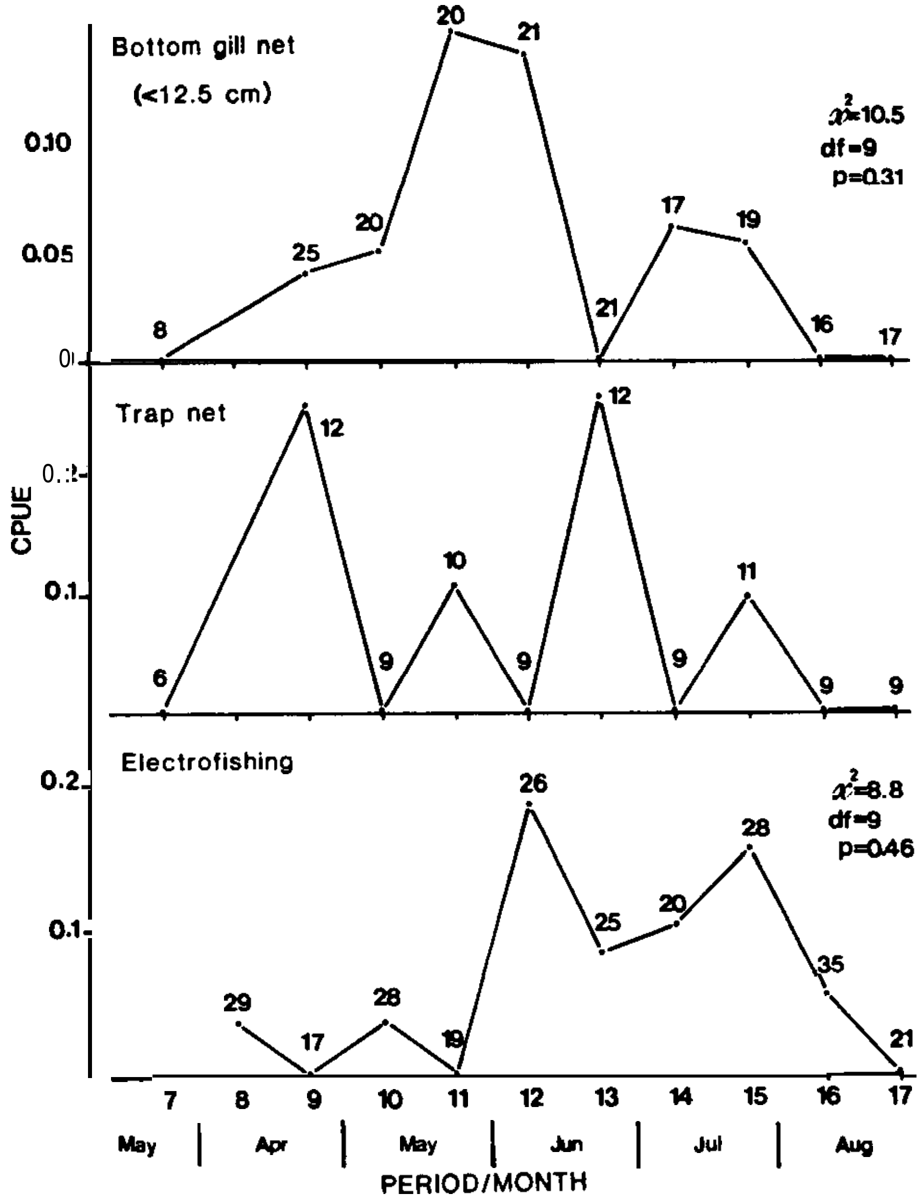

Figure A.12. Catch per unit effort (CPUE) of smallmouth bass by gear in McNary tailrace, 1984. Units of effort are net hour (bottom gill net), net day (trap net) and 900 second current-on time (electrofishing). Total effort within a period is above each point. Chi-square values with degrees of freedom and observed probabilities by gear are included for tests for differences between periods except where precluded by lack of variation between samples. Maximum (<12.5 cm) mesh size of bottom gill nets is in parentheses.

APPENDIX B

Movements of Radiotagged Walleye and Northern Squawfish

Methods

Movements of radiotagged walleye and northern squawfish were used to delineate areas where fish were considered discretely distributed during sampling (see Methods and Materials). However, observations of radiotagged fish were also used to examine correlations between seasonal changes in flows and habitat utilization by walleye and northern squawfish in John Day pool. Chi-square analyses based on two-way continqency tables (FKEQ procedure, SAS Institute, Inc. 1982) were used to determine whether utilization of embayments or the main river channel by walleye and northern squawfish was independent of discharge at McNary Dam (Snedecor and Cochran 1967). An area was classified as an embayment if it was not in the main flow of the river. Tributaries and backwater areas (sloughs) comprised the majority of embayments within the study area. Locations of radiotagged fish were grouped into four periods corresponding to when discharge at McNary Dam was constant (December 1, 1983-March 13, 1984 and July 17-August 31), increasing (March 14-June 13) and decreasing (June 14-July 16) (Figure B.1).

Results

Walleye

Nineteen radiotagged walleye were located 895 times from December 1903 through August 1984. There was a significant ($p<0.05$) relationship (X^2=121.7, df=3, $p<0.01$) between habitats utilized by walleye and discharge at McNary Dam. Prior to mid-July, 12 of 19 radiotagged walleye were located in embayments, primarily in Paterson Slough (Figure B.2) and near Crow Butte (Figure B.3). In mid-July, when discharge declined and flows were constant, some walleye that were utilizing embayments moved into the main river channel (Figure B.4). By early August, all walleye whose transmitters had not yet failed were located in the main river channel.

Northern Squawfish

Nine radiotagged northern squawfish released in McNary tailrace and seven released in John Day forebay were located 426 and 246 times. There was a significant ($p<0.05$) relationship between habitats utilized and discharge at McNary Dam for northern squawfish released in McNary tailrace (X2=60.1, df=2, $p<0.01$), but not for northern squawfish released in John Day forebay (X2=5.9, df=2, p=0.05). Plymouth Slough and embayments along the Oregon shore less than 2.5 km below McNary Dam (Figure 0.5) were primary areas used in McNary tailrace. In John Day forebay, radiotagged northern squawfish were located in the main river channel or in the John Day River (Figure 8.6). In mid-July radiotagged northern squawfish in McNary (Figure 6.7) and John Day (Figure 8.8) tailraces moved upriver to and remained in the vicinity of the dams.

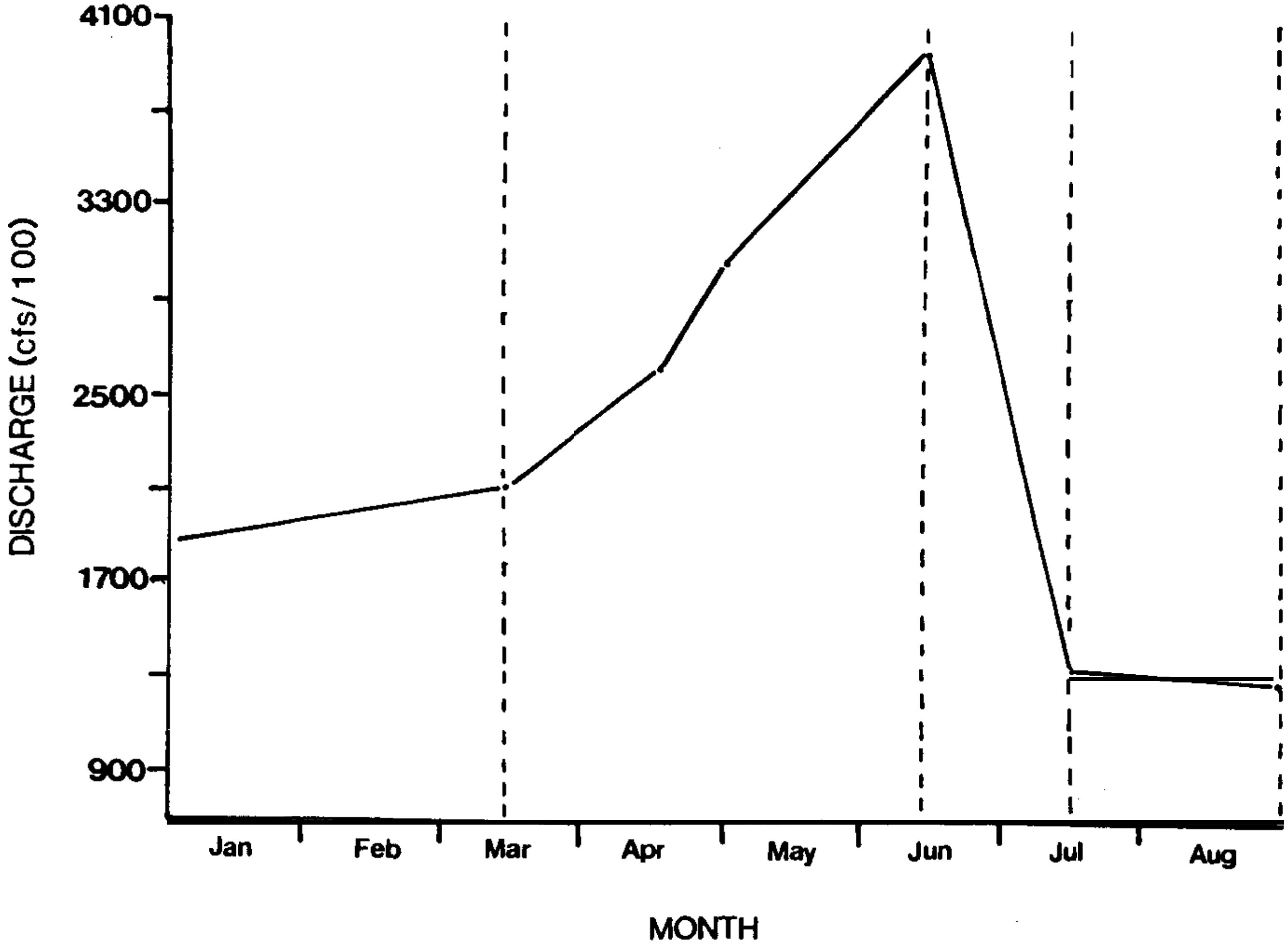

Figure B.1. Discharge at McNary Dam from January through August, 1984 (Water Budget Center, 1984). Vertical lines delineate four periods in which locations of radiotagged fish were grouped.

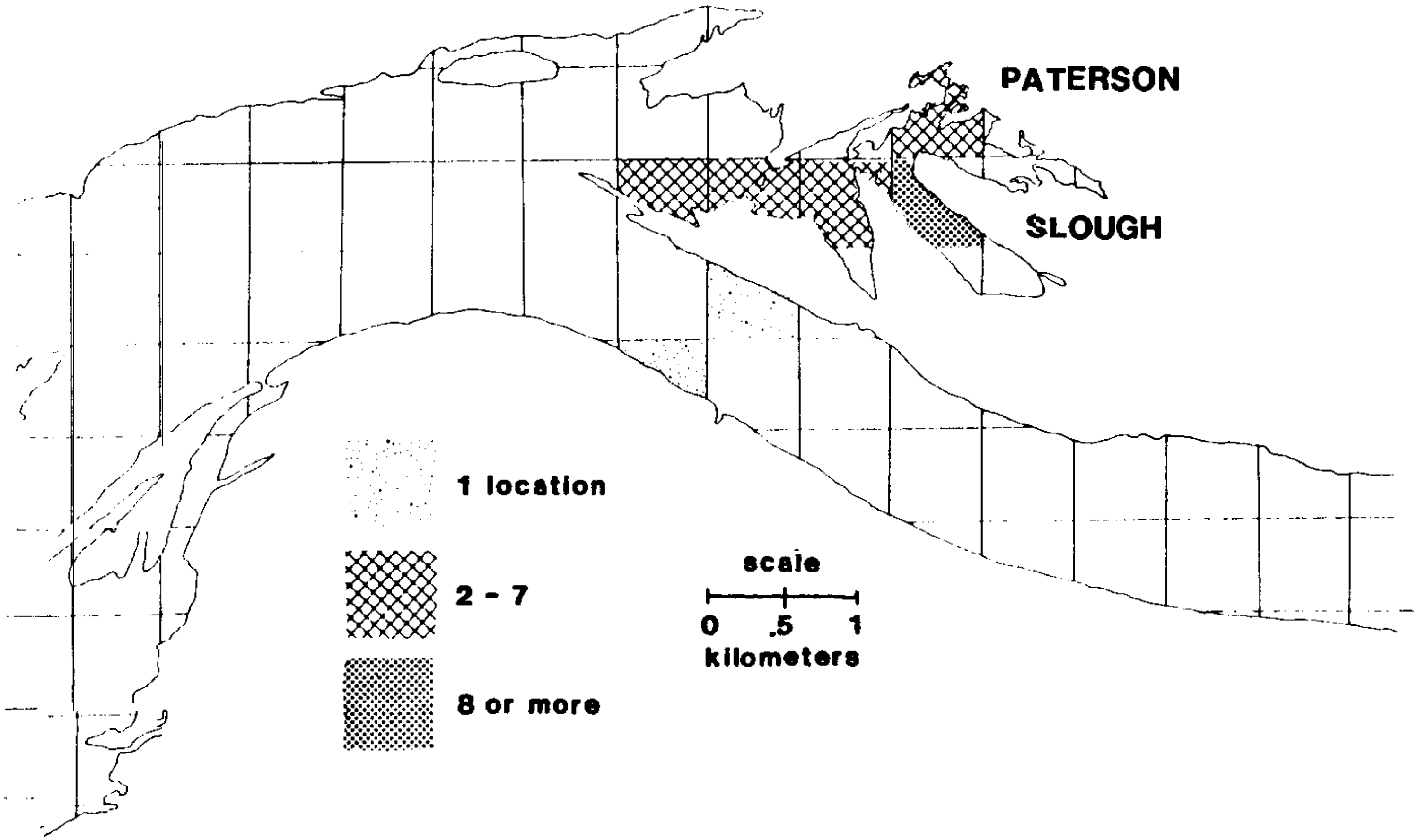

Figure B.2. Distribution of a radiotagged walleye (49.453) located in or near Paterson Slough, December 1983-March 1984.

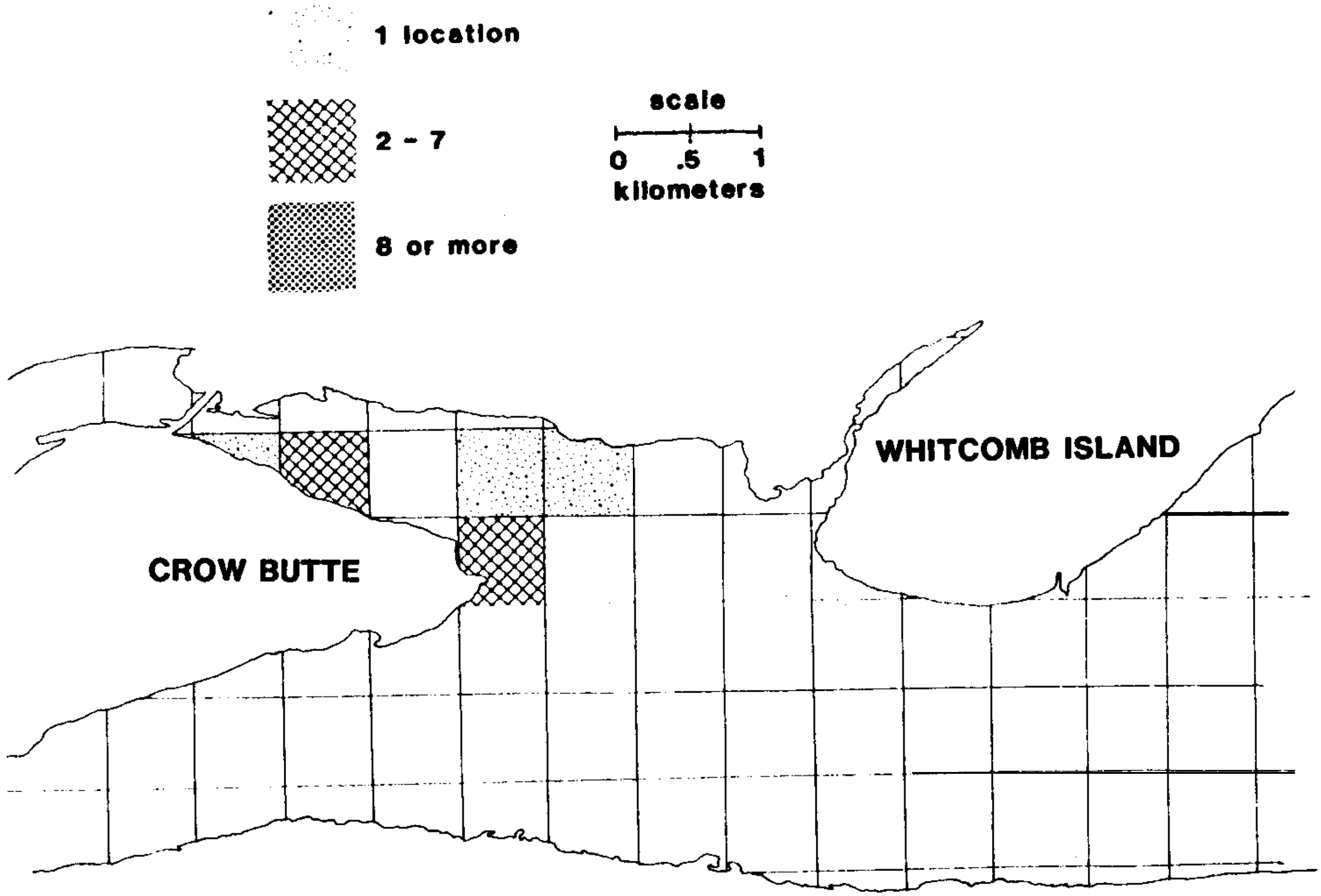

Figure B.3. Distribution of a radiotagged walleye (49.903) located near Crow Butte, December 1983-March 1984.

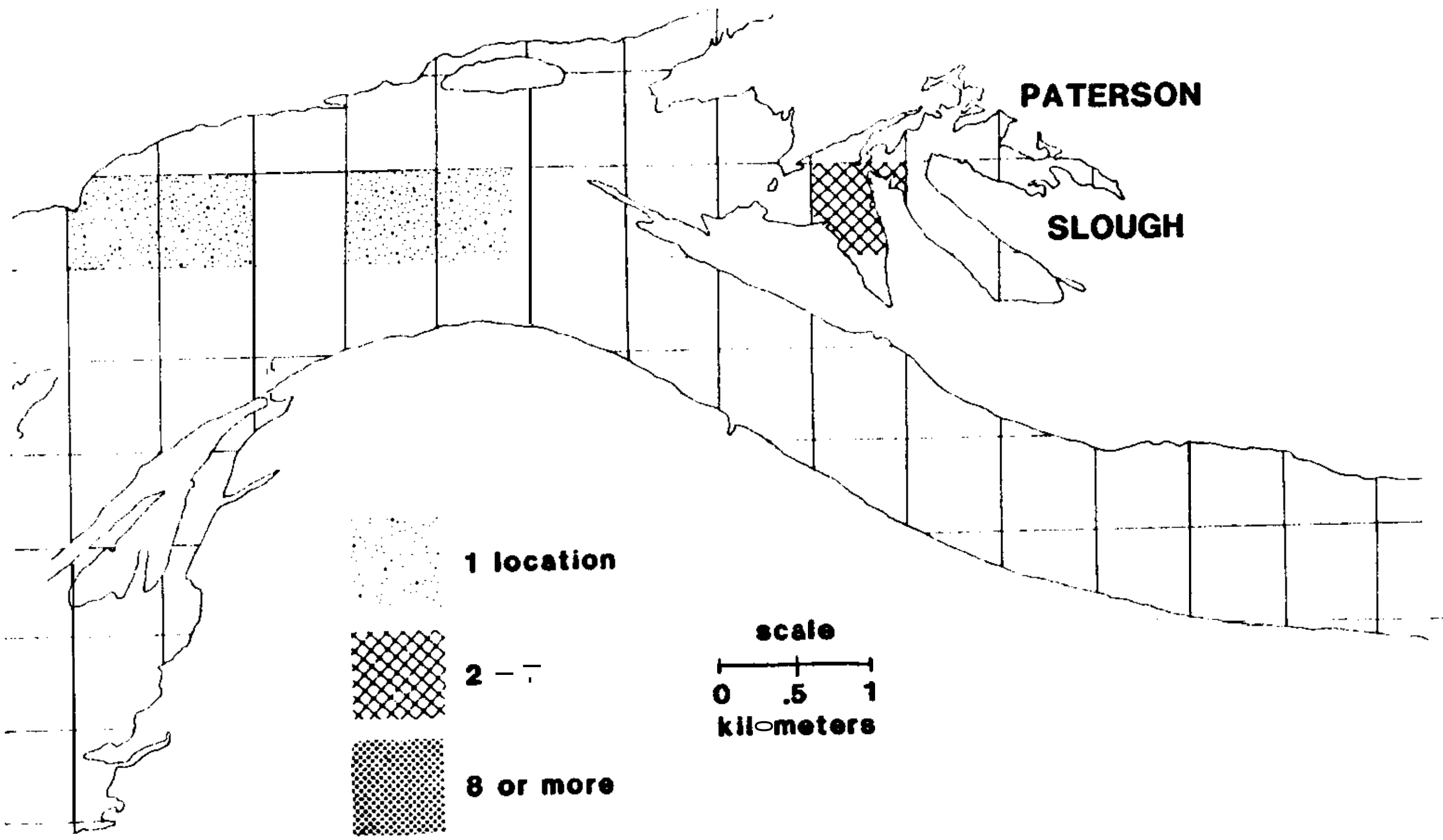

Figure B.4. Distribution of a radiotagged walleye (49.953) that moved out of Paterson Slough after discharge at McNary Dam declined to seasonal lows, December 1983-March 1984.

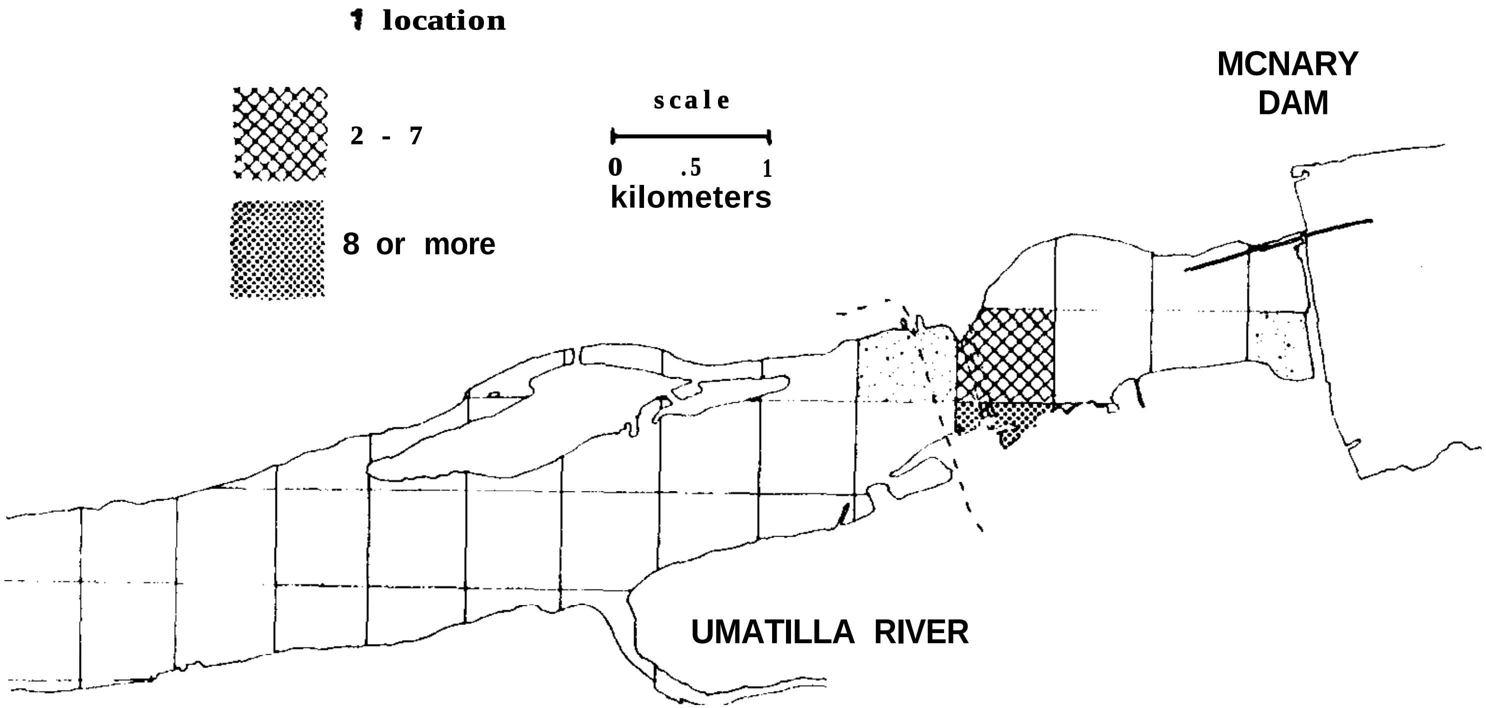

Figure 8.5. Distribution of a radiotagged northern squawfish (48.678) located in small embayments in McNary tailrace, March-August 1584.

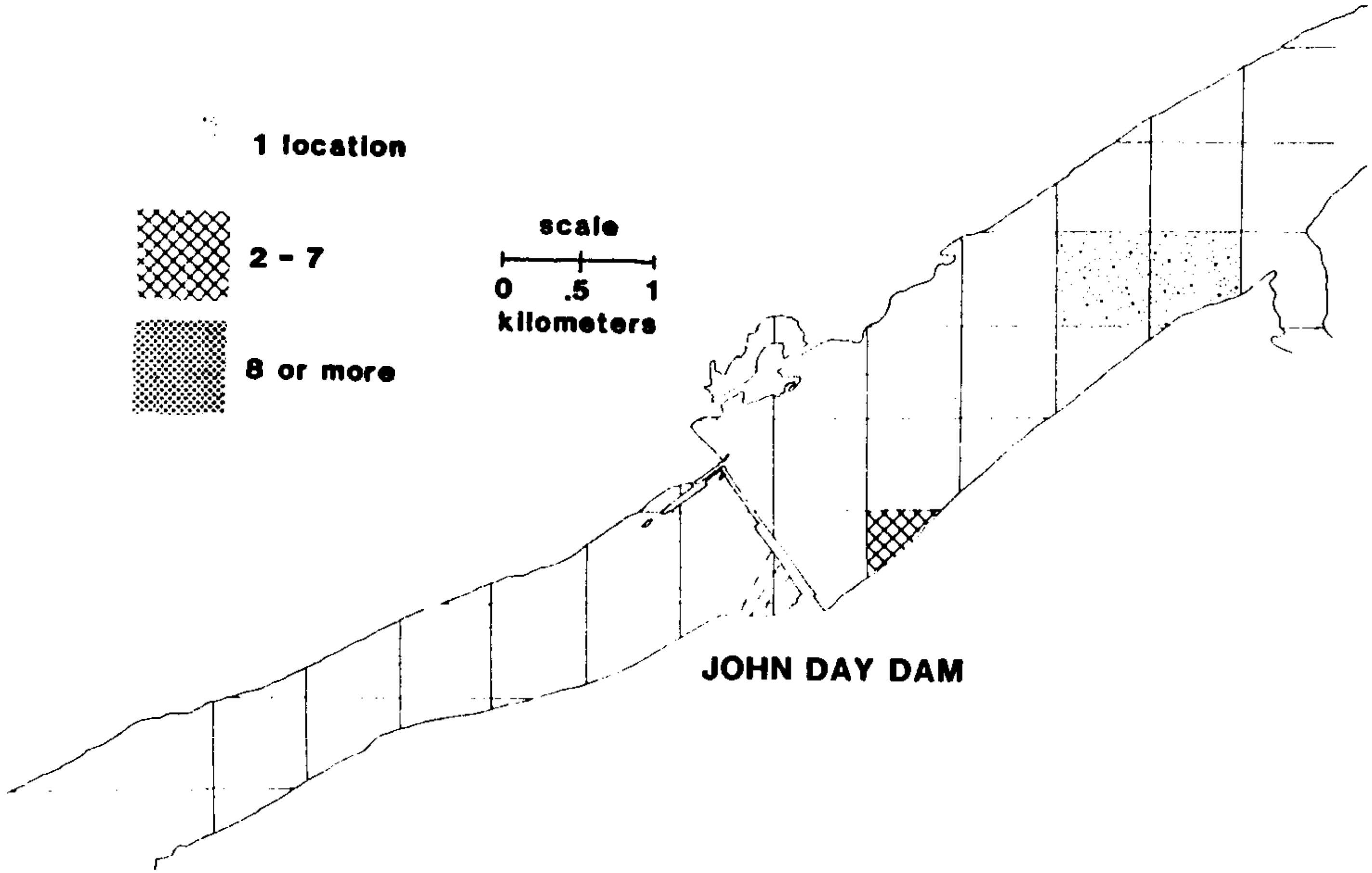

Figure B.6. Distribution of a radiotagged northern squawfish (48.863) located in John Day forebay and the John Day River, March-August 1984.

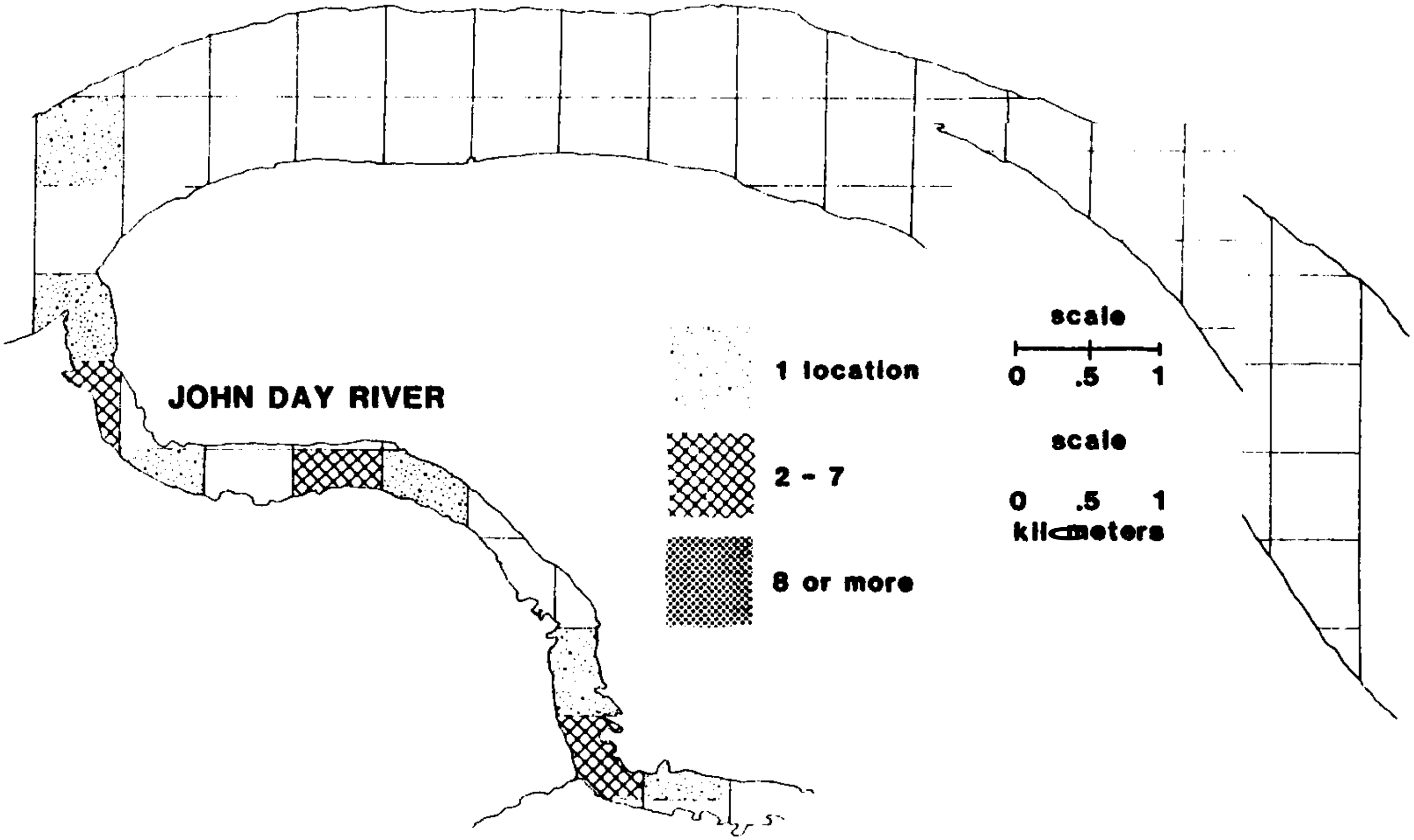

Figure B.6. (Continued).

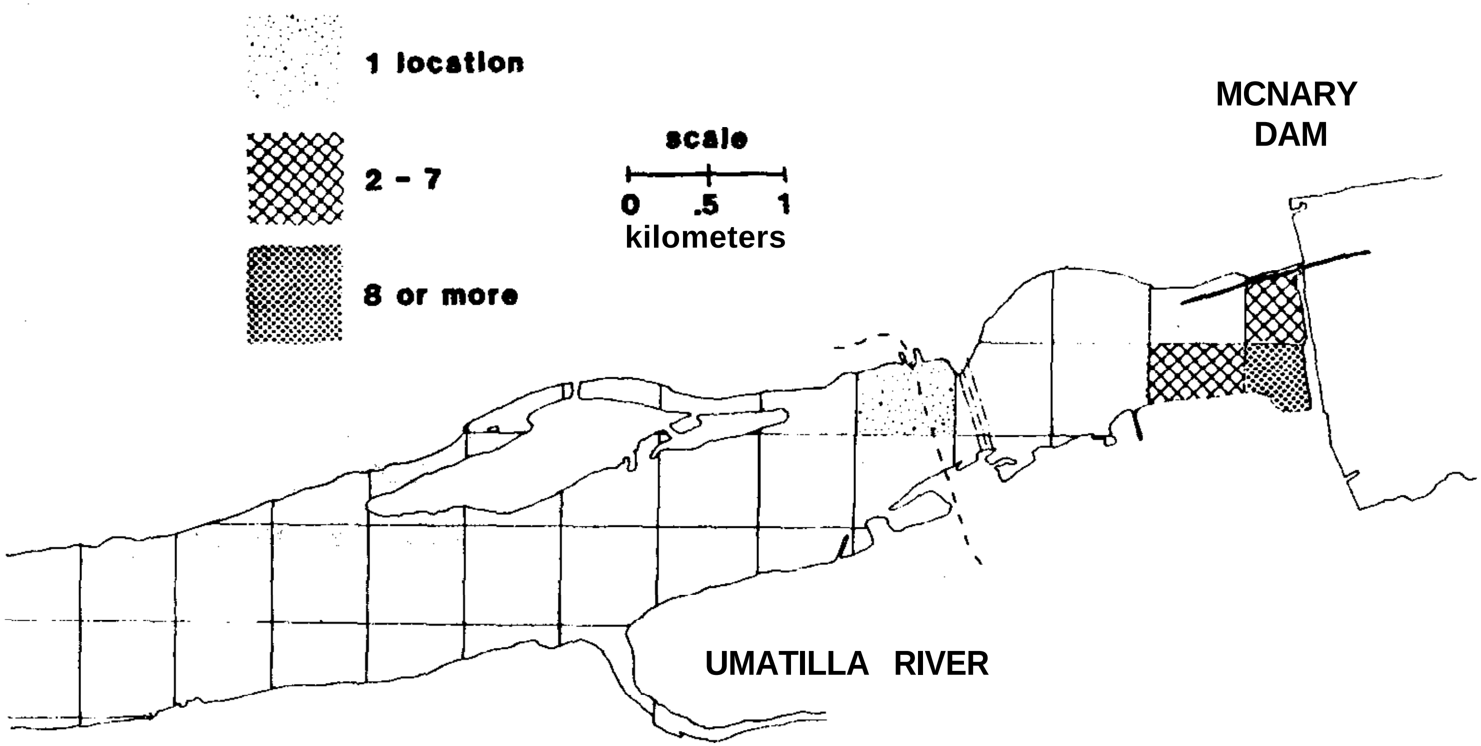

Figure 8.7. Distribution of a radiotagged northern squawfish (48.678) that moved up to the face of McNary Dam after discharge at McNary Dam declined to seasonal lows, March-August 1984.

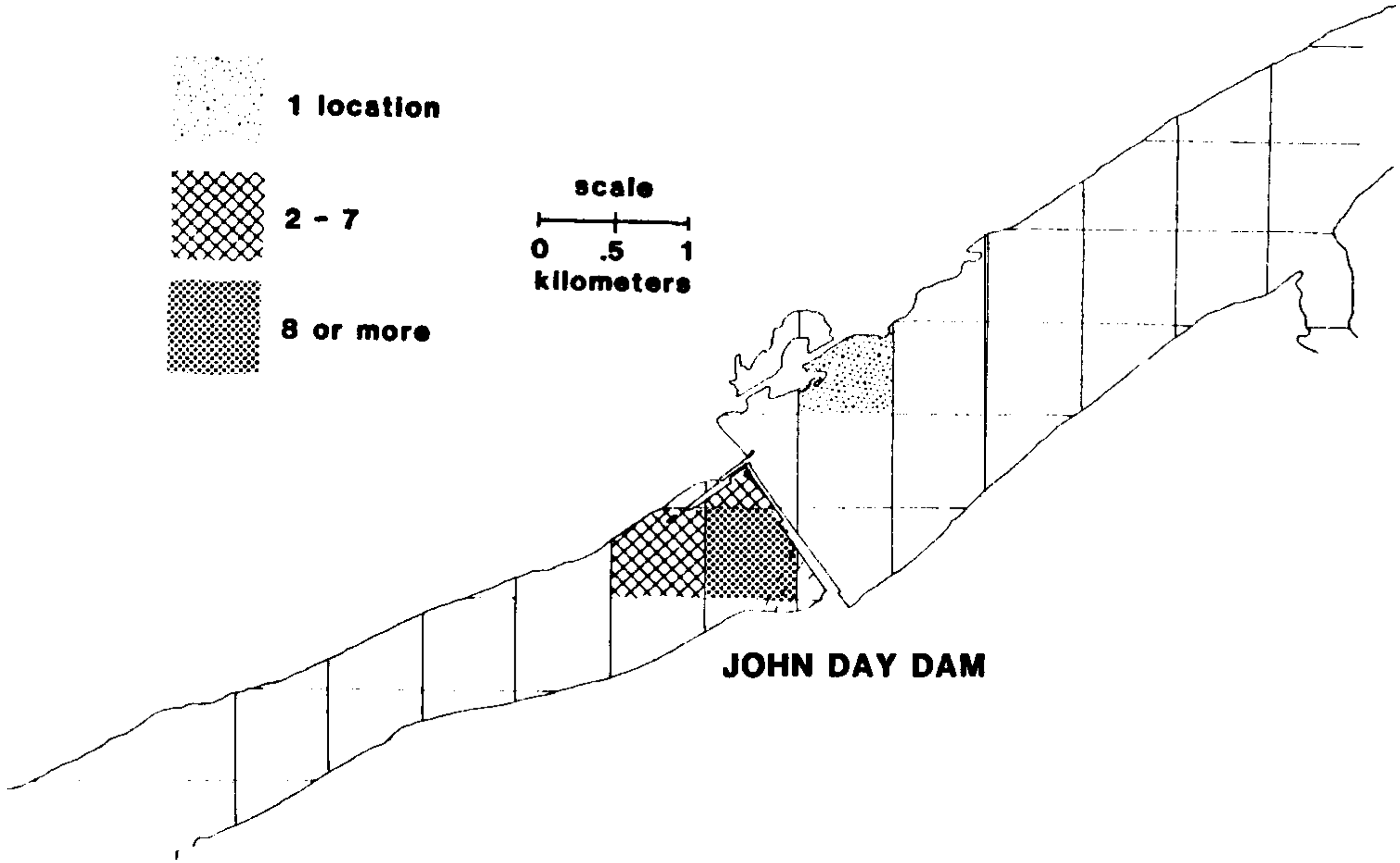

Figure B.8. Distribution of a radiotagged northern squawfish (48.863) located in John Day tailrace after passing John Day Dam, March-August 1984.

Discussion

Walleye radiotagged and released in McNary tailrace in November moved 10 to 40 km downriver in January and February, where they remained throughout spring and summer. Downstream movements by walleye in late winter may have been related to spawning. Seven radiotagged walleye entered Paterson Slough in late March and were concentrated in what may have been a spawning aggregation. Movements out of embayments when flows decreased in July may have preceded fall movements by walleye back into McNary tailrace. Efforts to locate spawning concentrations of walleye in John Day pool will continue in 1985.

Northern squawfish radiotagged and released in McNary tailrace in March remained in the tailrace through spring and most of summer. Four radiotagged northern squawfish moved 30 to 40 km downriver in late May and early June, but three of these returned to the tailrace in July. As with walleye, downstream movements may have been related to spawning. Spawning concentrations of northern squawfish off islands 8 to 10 km below John Day Dam were observed in June 1983.

During spilling at McNary Dam, radiotagged northern squawfish in McNary tailrace were located in embayments and slackwater areas. When spilling ceased in mid-July, radiotagged northern squawfish moved from protected areas to the face of McNary Dam. Movements of northern squawfish to the dam coincided with passage of large numbers of age 0 chinook past the dam. LOW flows after spill closure may have increased residence time of these juvenile salmon in the tailrace and their vulnerability to predation.

Utilization of embayments and slack waters during high spring flows by northern squawfish may reduce their spatial interaction with age 1 chinook salmon and juvenile steelhead. However, it is unknown whether northern squawfish leave protected areas to feed during short term spill closures in spring. Movements of radiotagged northern squawfish in McNary tailrace during short term spill closures will be monitored in spring 1985.

Northern squawfish radiotagged and released in John Day forebay in April and May exhibited two patterns of movement. Four radiotagged northern squawfish moved into the John Day River, presumably to spawn, and three passed by John Day Dam and into the tailrace. Behavior of two radiotagged northern squawfish in John Day tailrace was similar to behavior of northern squawfish in McNary tailrace. Both fish utilized embayments and slack waters during spill and moved to the dam after spill closure.

A stepwise multiple regression will be used in 1985 to determine whether movements of radiotagged walleye and northern squawfish are correlated to specific environmental factors or to juvenile salmonid abundance and distribution. The feasibility of radiotagging smallmouth bass in 1986 to delineate areas where populations can be considered discrete will also be examined.

References

SAS Institute, Inc. 1982. SAS User's Guide: Basics, 1982 edition. A. Allen, editor. Carey, NC, USA.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical Methods, sixth edition. Iowa State University Press, Ames, IA, USA.

Water Budget Center. 1984. 1984 annual report from the Water Budget managers to the Northwest Power Planning Council and Bonneville Power Administration. Annual report to Bonneville Power Administration by the Water Budget Center, Portland, OR, USA.

Table B.l. **Descriptive data on 20 walleye radiotagged and released in McNary tailrace,** 1983.

Transmitter Frequency (MHZ)	Fork Length (mm)	Weight (9)	Release Date	Release River Kilometer
49.613	535	2,080	11-16	464
49.634	591	2,760	11-16	464
49.654	533	1,950	11-17	464
49.674	575	2,540	11-16	470
49.683	724	5,250	11-17	470
49.714	774	6,000	11-17	470
49.734	659	3,280	11-17	470
49.754	598	3,010	11-21	464
49.763	651	3,760	11-21	469
49.774	667	3,240	11-21	469
49.783	572	2,360	11-22	469
49.803	554	2,100	11-22	469
49.843	641	3,000	11-28	469
49.903	566	2,200	11-28	469
49.914	592	2,820	11-29	469
49.944	596	2,920	11-29	469
49.953	628	3,160	11-30	470
49.974	543	1,960	11-30	470
49.983	729	5,400	12-01	470
49.994	627	3,160	12-01	470

Table B.2. Descriptive data on 20 northern squawfish radiotagged and released in John Day pool, 1984.

Location	Transmitter Frequency (MHz)	Fork Length (mm)	Weight (g)	Release Date	Release River Kilometer
John Day forebay	48.713	458	1,420	3-28	350
	48.863	464	1,220	4-13	350
	48.993	475	1,660	5-03	350
	49.048	470	1,300	5-03	350
	49.093	451	1,514	5-04	350
	49.154	443	1,360	5-04	350
	49.303	508	1,641	5-11	350
	49.318	527	1,320	5-12	350
	49.328	464	1,290	5-15	350
	49.382	467	1,400	5-18	353
McNary tailrace	48.184	470	1,450	3-14	470
	48.210	500	1,910	3-15	470
	48.334	517	1,625	3-15	470
	48.373	467	1,370	3-15	470
	48.412	480	1,400	3-15	470
	48.493	465	1,440	3-20	470
	48.551	495	1,620	3-20	469
	48.637	481	1,330	3-22	470
	48.657	447	1,375	3-27	469
	48.678	466	1,380	3-27	469

APPENDIX C

Angler Survey Data Used to Estimate Angler Harvests

Table C.l. Numbers of days available and surveyed during angler survey in upper John Day pool, March 25-August 31, 1984.

Location/ Period	Weekdays		Weekends and Holidays	
	Available	Surveyed	Available	Surveyed
Oregon shore				
7	10	2	4	3
8	10	2	4	4
9	10	2	4	4
10	10	2	4	4
11	9	2	5	5
12	10	2	4	4
13	10	2	4	4
14	9	2	5	5
15	10	2	4	4
16	15	2	6	4
17	10	2	4	4
Washington shore[a]				
7	10	2	4	3
8	10	2	4	4
9	10	2	4	4
10	10	2	4	4
11	9	2	5	5
12	10	2	4	4
13	10	2	4	4
14	9	3	5	4
15	10	2	4	3
16	15	2	6	4
17	10	2	4	4

[a]Includes Plymouth and Paterson sloughs.

Table C.2. Numbers of angler counts made by time of day and period in upper John Day pool, March 25-August 31, 1984. Dashes indicate times when counts were precluded by darkness. Counts began within one-half hour of the times indicated.

Location/	Period											
Period	7	8	9	10	11	12	13	14	15	16	17	Sum
Oregon shore												
0600	1	3	4	4	4	2	1	5	3	4	1	32
0700	4	3	2	1	3	4	4	2	3	2	5	33
0800	0	0	0	0	0	0	1	0	0	0	0	1
0900	0	0	0	0	0	0	1	2	0	1	0	4
1000	1	3	4	5	4	3	1	4	4	4	1	34
1100	4	3	2	1	3	3	4	1	2	1	5	29
1200	0	0	0	0	0	0	0	0	0	0	0	0
1300	1	3	4	5	4	2	1	5	3	4	1	33
1400	4	3	2	1	3	4	5	2	3	2	5	34
1500	0	0	0	0	0	0	0	0	0	0	0	0
1600	0	0	0	0	0	0	1	2	2	1	1	7
1700	1	3	4	5	4	2	1	4	3	4	1	32
1800	4	3	2	1	3	4	3	1	0	1	4	26
1900	**0**	0	0	0	0	0	0	0	1	0	0	1
2000	0	0	0	0	0	0	1	2	0	0	0	3
Washington shore												
0600	4	3	1	1	3	4	3	3	2	2	4	30
0700	1	3	4	5	4	2	3	3	2	4	2	33
0800	0	0	0	0	0	0	0	1	1	0	0	2
0900	0	0	0	0	0	1	0	2	1	0	0	4
1000	4	2	1	1	3	3	5	3	2	4	4	32
1100	1	3	5	5	4	2	1	2	2	2	2	29
1200	0	0	0	0	0	0	0	0	0	0	0	0
1300	4	3	1	1	3	4	4	3	2	2	4	31
1400	1	3	5	5	4	2	2	4	3	4	2	35
1500	0	0	0	0	0	0	0	0	0	0	0	0
1600	0	0	0	0	0	0	1	1	1	0	0	3
1700	4	3	1	1	3	4	3	3	4	3	4	33
1800	1	3	5	5	4	2	1	3	0	3	2	29
1900	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	1	0	0	0	0	1

Table C.3. Numbers of anglers interviewed in upper John Day pool, March 25-August 31, 1984.

Angler Type	Period 7	8	9	10	11	12	13	14	15	16	17	Sum
Boat, sturgeon	16	23	8	54	42	46	40	93	91	98	89	600
Boat, other	63	160	73	107	108	54	69	81	75	111	76	977
Bank, sturgeon	6	7	30	70	49	54	40	38	18	63	56	431
Bank, shad	2	0	0	0	4	1	8	0	2	0	0	17
Bank, other	30	10	8	24	32	49	48	21	6	3	19	250

Table C.4. **Estimated effort (hours) of anglers in upper John Day pool, March 25-August 31, 1984.**

Location/ Angler Type	Period 7	8	9	10	11	12	13	14	15	16	17	Sum
Main channel												
Boat, sturgeon	430.8	511.7	278.4	529.2	795.0	762.7	903.4	2,489.0	3,361.1	3,949.4	2,214.2	16,224.9
Boat, other	2,092.0	1,877.6	975.4	1,659.0	1,362.8	663.8	667.4	1,488.7	1,307.9	1,801.0	1,339.2	15,234.8
Bank, sturgeon	762.8	973.9	1,039.7	1,814.8	2,213.2	2,626.0	2,519.2	3,696.1	3,120.5	3,881.1	1,864.8	24,512.1
Bank, shad	0.0	0.0	0.0	0.0	0.0	11.0	565.3	2,028.3	927.5	62.6	0.0	3,594.4
Bank, other	280.7	576.7	636.7	933.9	744.4	968.7	729.3	798.6	416.7	573.7	124.9	6,784.3
Plymouth Slough												
Boat, sturgeon	0.0	0.0	0.0	0.0	0.0	3.8	15.6	0.0	0.0	0.0	0.0	19.4
Boat, other	32.0	50.2	104.3	7.7	53.5	74.7	55.6	143.1	0.0	17.4	0.0	538.5
Bank, sturgeon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank, shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank, other	57.4	50.2	52.1	114.6	145.4	212.6	119.1	123.6	73.8	182.8	31.4	1,163.0
Paterson Slough												
Boat, sturgeon	8.6	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	20.6
Boat, other	156.2	302.7	242.3	1,113.6	367.2	408.9	391.2	323.7	150.3	151.0	28.0	3,635.1
Bank, sturgeon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9	0.0	13.9
Bank, shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank, other	236.5	245.7	253.5	573.4	646.4	589.4	194.3	78.0	30.6	50.9	0.0	2,898.7

Table C 5. Catch per hour by anglers of wa eye, northern squawfish and sma mouth bass in upper John Day pool, March 25 August 31, 1984.

Species/ Angler Type	Period											
	7	8	9	0		12	3	4	5	6	7	Sum
Walleye												
Boat, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Boat, other	0.029	0.010	0.028	0.004	0.002	0.004	0	0 008	0.028	0 022	0 088	0.020
Bank, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Bank, shad	--	--	--	--	0	0	0	--	0	--	--	0
Bank, other	0 016	0	0	0	0	0	0	0	0 039	0	0.07	0 00
Northern squawfish												
Boat, sturgeon	0	0.012	0	0.00 4	0.024	0	0.005	0.002	0	0.002	0	0.003
Boat, other	0.015	0.035	0 072	0.00 8	0.014	0 026	0.043	0.045	0.022	0.049	0.0 8	0 031
Bank, sturgeon		0	0	.0 1	0	0	0.009	0.029	0	0	0	0 007
Bank, shad	0-	--	--	0.	0	0	0	--	0	--	--	0
Bank, other	-	0.089	0.223	-	0	0.025	0.066	0.027	0	0	0	0.028
	0			0								
Smallmouth bass												
Boat, sturgeon	0	0	0	0	0	0	0.005	0	0	0	0	0
Boat, other	0.007	0	0	0 006	0.012	0 009	0.007	0 03	0.034	0.007	0.005	0.01
Bank, sturgeon	0		0	0	0	0	0	0	0	0	0	0
Bank, shad	--	0-	--	--	0	0	0	--	0	--	--	0
Bank, other	0	-	0	0	0. 39	0.087	0 059	0. 08	0	0	0	0.057
		0										

Table C.6. Harvest per hour by anglers of walleye, northern squawfish and smallmouth bass in upper John Day pool, March 25-August 31, 1984.

Species/ Angler Type	Period 7	8	9	10	11	12	13	14	15	16	17	Sum
Walleye												
Boat, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Boat, other	0.029	0.010	0.016	0.004	0.002	0.004	0	0.008	0.028	0.019	0.088	0.019
Bank, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Bank, shad	--	--	--	--	0	0	0	--	0	--	--	0
Bank, other	0.016	0	0	0	0	0	0	0	0.039	0	0.071	0
Northern squawfish												
Boat, sturgeon	0	0	0	0	0.024	0	0.005	0	0	0	0	0.002
Boat, other	0.004	0	0.056	0	0.007	0	0.017	0.006	0.009	0.011	0.003	0.008
Bank, sturgeon	0	0	0	0	0	0	0.009	0	0	0	0	0.001
Bank, shad	--	--	--	--	0	0	0	--	0	--	--	0
Bank, other	0	0	0	0	0	0	0.059	0.027	0	0	0	0.015
Smallmouth bass												
Boat, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Boat, other	0.004	0	0	0.004	0.012	0.004	0.003	0	0.012	0.007	0.003	0.005
Bank, sturgeon	0	0	0	0	0	0	0	0	0	0	0	0
Bank, shad	--	--	--	--	0	0	0	--	0	--	--	0
Bank, other	0	0	0	0	0.139	0.080	0.053	0.108	0	0	0	0.054

Table C.7. Mean hours fished per angler trip in upper John Day pool, March 25-August 31, 1984. Boat anglers were interviewed upon completion of trip. Bank anglers were interviewed before trip's completion.

Angler Type	Period											Sum
	7	8	9	10	11	12	13	14	15	16	17	
Boat, sturgeon	5.8	3.8	4.5	3.9	4.0	5.8	4.8	4.8	6.4	5.6	5.2	5.2
Boat, other	4.5	3.7	3.6	4.5	4.3	4.3	4.5	4.3	4.5	5.1	5.2	4.4
Bank, sturgeon	1.7	2.2	3.9	5.0	3.9	3.6	5.8	5.5	5.8	4.4	4.1	4.5
Bank, shad	--	--	--	--	9.4	0.4	2.4	--	2.5	--	--	4.0
Bank, other	2.1	2.2	1.1	2.2	2.3	3.3	3.2	1.8	4.3	1.3	3.0	2.6

APPENDIX D

Mark and Recapture Data Used to Estimate Population Abundances

Table D.l. Walleye catch, recapture, marking and removal data in John Day pool, April 8-August 31, 1984. Includes fish between 250 and 475 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals Marked	Removals Unmarked	Marked Fish at Large
250-475	8	4	0	3	0	0	0
	9	8	0	7	0	1	3
	10	23	0	20	0	2	10
	11	21	3	17	1	1	30
	12	26	4	21	0	2	47
	13	26	1	19	0	6	67
300-525	14	26	1	16	2	11	86
	15	11	1	7	1	10	100
	16	8	0	5	3	8	106
	17	7	1	0	2	22	108
Total		**160**	**11**	**115**	**9**	63	

Table D.2. Walleye catch, recapture, marking and removal data in John Day pool, April 8-August 31, 1984. Includes fish larger than 475 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals Marked	Removals Unmarked	Marked Fish at Large
>475	8	124	0	111	3	24	0
	9	29	0	26	6	16	108
	10	121	0	111	1	18	128
	11	59	2	53	0	7	238
	12	136	1	120	3	16	291
	13	77	3	62	0	11	408
>525	14	39	1	25	3	23	470
	15	22	2	8	5	51	492
	16	24	0	12	1	36	495
	17	40	1	1	6	109	506
Total		671	10	529	28	311	

Table 0.3. Northern squawfish catch, recapture, marking and removal data in John Day pool, March 25-August 31, 1984. Includes fish between 250 and 375 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals Marked	Removals Unmarked	Marked Fish at Large
250-375	7	8	0	8	0	2	0
	8	85	0	52	0	32	8
	9	117	0	82	0	50	60
	10	164	3	109	0	52	142
	11	260	4	126	1	133	251
	12	265	2	185	1	71	376
	13	235	5	135	7	115	560
	14	156	3	89	2	74	688
	15	270	2	186	4	80	775
	16	243	3	129	1	116	957
	17	246	0	5	0	114	1,085
Total		2,049	22	1,106	16	839	

Table 0.4. Northern squawfish catch, recapture, marking and removal data in in John Day pool, March 25-August 31, 1984. Includes fish larger than 375 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals		Marked Fish at Large
					Marked	Unmarked	
>375	7	28	0	27	0	6	0
	8	126	1	45	1	79	27
	9	137	2	98	0	78	71
	10	274	4	148	1	116	169
	11	216	7	140	0	76	316
	12	409	6	245	2	150	456
	13	243	8	186	19	92	699
	14	147	6	138	5	26	866
	15	275	3	265	4	12	999
	16	324	11	160	3	166	1,260
	17	280	8	14	2	74	1,417
Total		2,459	56	1,466	37	875	

Table D.5. Smallmouth bass catch, recapture, marking and removal data in lower John Day pool, April 8-August 31, 1984. Includes fish larger than 199 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals Marked	Removals Unmarked	Marked Fish at Large
>199	8	14	0	13	0	0	0
	9	76	2	74	0	0	13
	10	135	3	127	5	1	87
	11	156	14	137	4	1	209
	12	123	15	105	7	1	342
	13	235	26	194	12	3	440
>249	14	31	8	22	17	0	622
	15	47	18	28	9	1	627
	16	16	8	10	4	0	646
	17	62	17	16	5	12	652
Total		895	111	726	63	19	

Table 0.6. Smallmouth bass catch, recapture, marking and removal data in upper John Day pool, April 8-August 31, 1984. Includes fish larger than 199 mm fork length at the start of the survey.

Length (mm)	Period	Catch	Recaptures	Number Marked	Removals		Marked Fish at Large
					Marked	Unmarked	
>199	8	70	0	66	0	0	0
	9	8	0	8	0	0	66
	10	52	2	42	5	14	74
	11	56	6	38	11	73	111
	12	163	14	128	6	146	138
	13	73	9	52	6	59	260
>249	14	22	5	17	7	100	306
	15	26	9	13	7	13	316
	16	38	5	28	7	10	322
	17	10	2	1	4	1	343
Total		518	52	393	53	416	

APPENDIX E

Population Length-Frequency and Age-Frequency Distributions

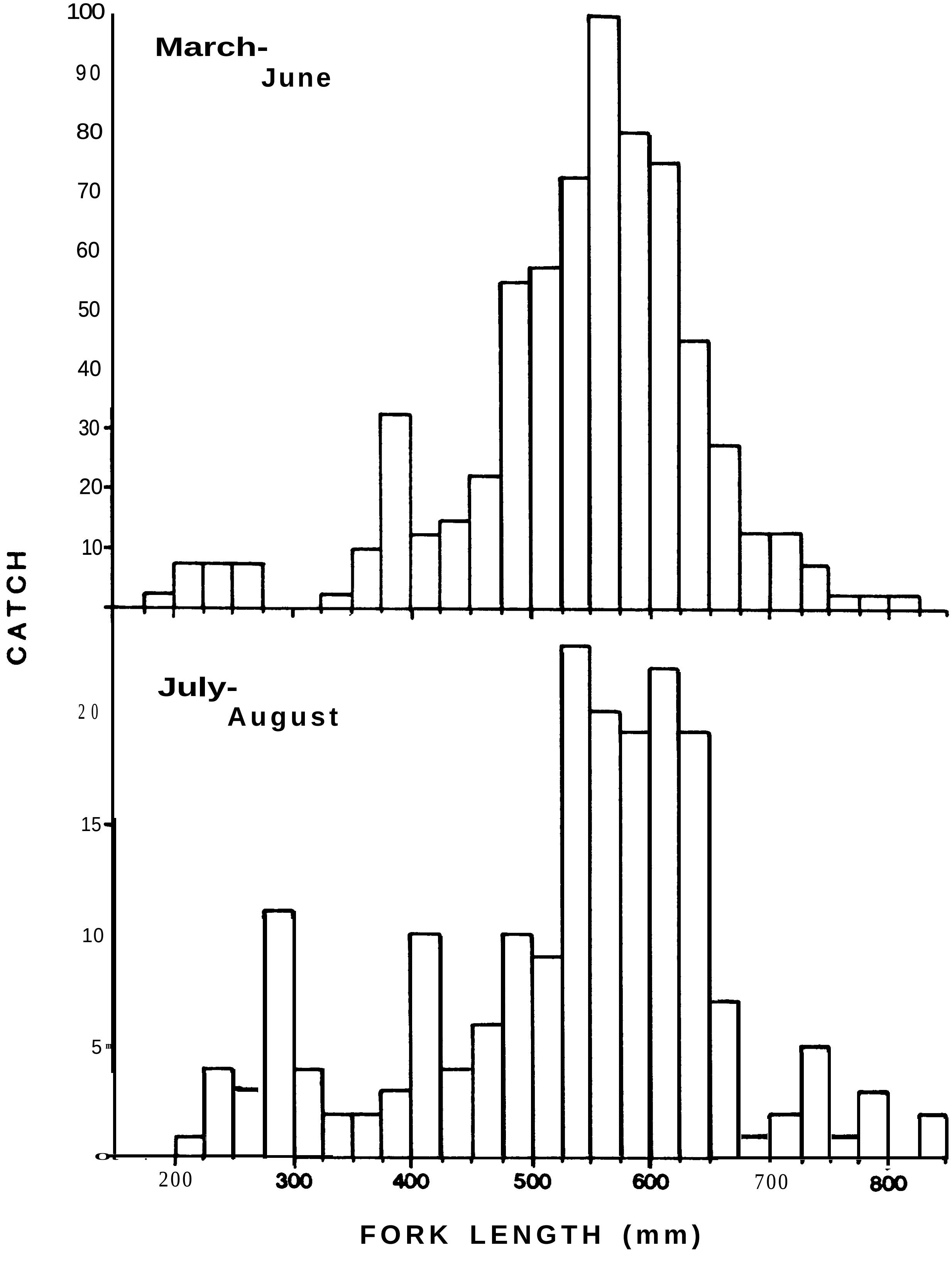

Figure E.l. Length-frequency distributions of walleye collected in John Day Reservoir, 1984.

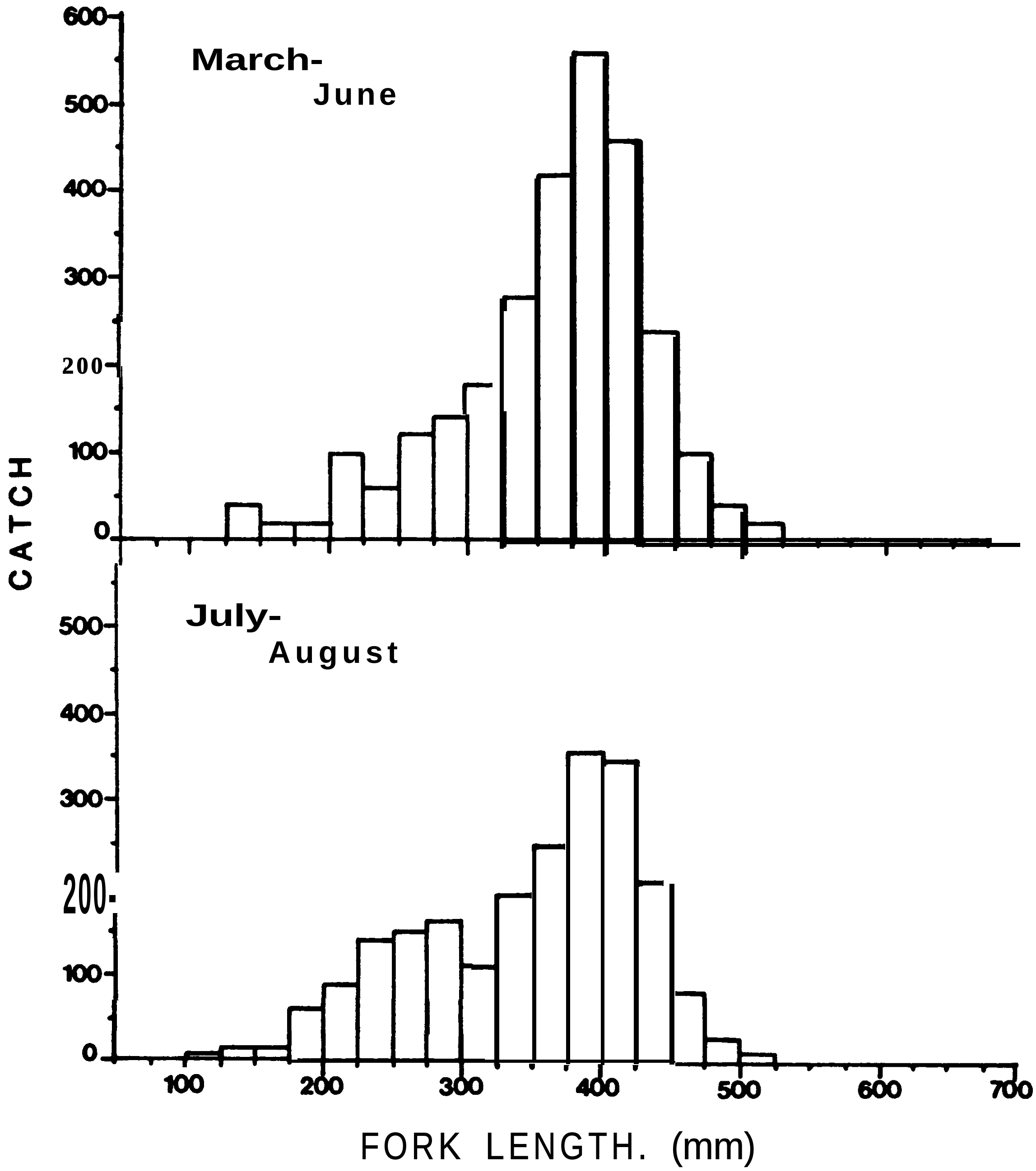

Figure E.2. Length-frequency distributions of northern squawfish collected in John Day Reservoir, 1984.

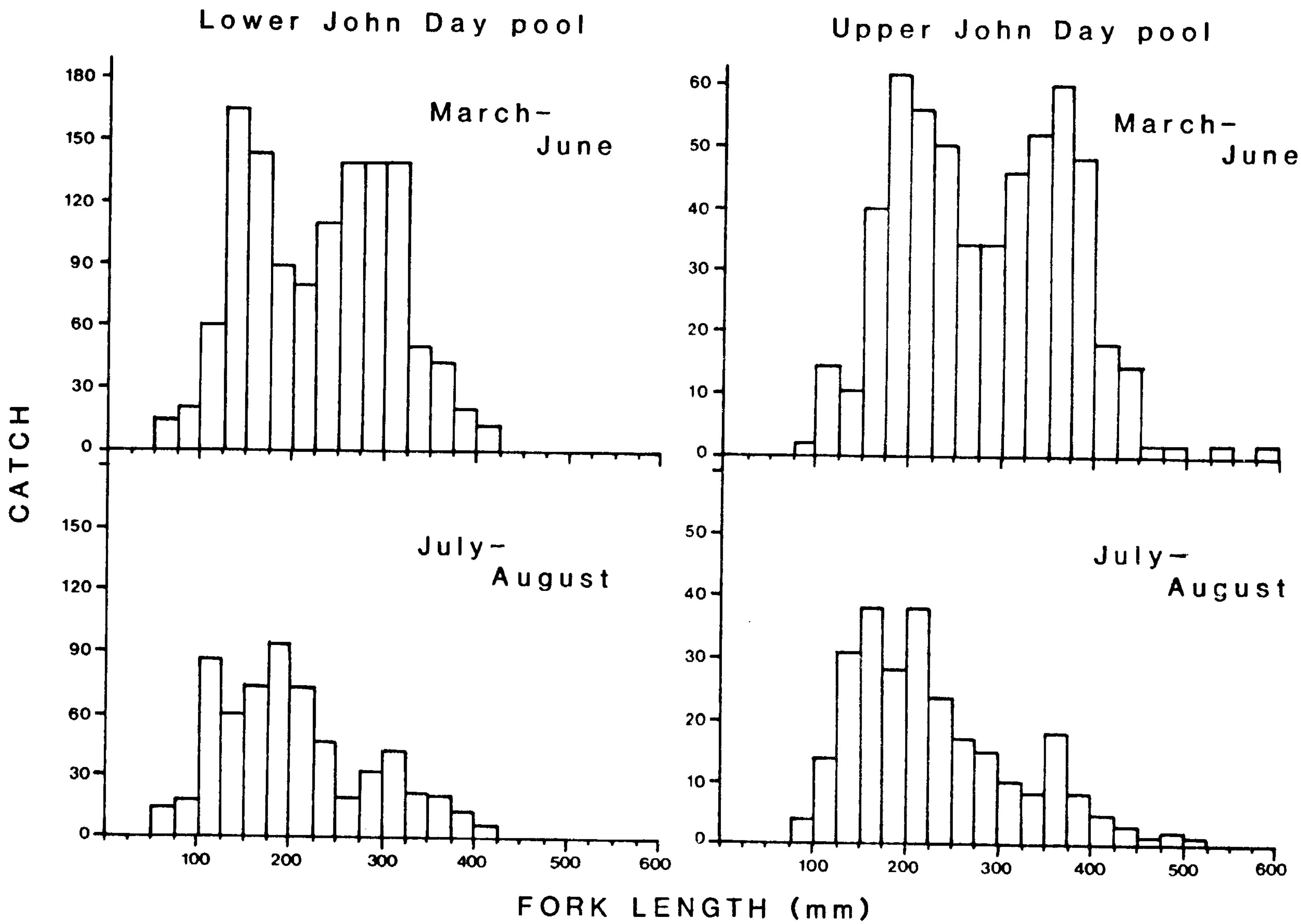

Figure E.3. Length-frequency distributions of smallmouth bass collected in John Day Reservoir, 1984.

Table E.1. Age-frequency distribution by length interval of a subsample of walleye from John Day pool, March-June 1984.

Fork Length Interval (mm)	Age 1	2	3	4	5	6	7	8	9	10	11	12	Sum
201-225	3												3
226-250	6												6
251-275	9												9
276-300	1												1
301-325	1			1[a]									2
326-350		3											3
351-375		8							1[a]				9
376-400		8	2										10
401-425		9	1										10
426-450		2	7						1[a]				10
451-475			7	3									10
476-500			5	2	2	1							10
501-525			1	3	5	1							10
526-550				2	8								10
551-575				1	6	1	2						10
576-600				1	3	4	1	1					10
601-625					6		1	1		1	1		10
626-650					4	2	1		2	1			10
651-675					3	2	3			1		1	10
676-700					2	3	2	1	1	1			10
701-725						1	5	1	1	1			9
726-750							1	1		4	1		7
751-775							2				1		3
776-800										1	2		3
801-825										1	1		2
826-850													0
851-875										1			1

[a]Excluded from calculations of age-frequency distribution.

Table E.2. Age-frequency distribution by length interval of a subsample of northern squawfish from John Day pool, March-June 1984.

Fork Length Interval (mm)	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Sum
126-150		6	1												7
151-175		3													3
176-200		1	11												12
201-225		1	13	6											20
226-250			4	13	3										20
251-275				9	9	1			1						20
276-300				5	12	3									20
301-325					8	7	4		1						20
326-350						8	4	5	2						19
351-375				1		1	8	5	4	1					20
376-400					1		1	4	3	8	1	2			20
401-425							1		4	9	3	2	1		20
426-450									4	7	7	1	1		20
451-475										5	5	5	5		20
476-500									1	4		2	3	1	11
501-525											1	2		2	5

Table E.3. Age-frequency distribution by length interval of a subsample of of smallmouth bass from lower John Day pool, March-June 1984.

Fork Length Interval (mm)	Age 1	2	3	4	5	6	7	8	9	10	Sum
51- 75	6										6
76- 100	6	1									7
101-125	5	8									13
126-150		20									20
151-175		18									18
176-200		12	1								13
201-225		4	8	3	1						16
226-250			3	9	7	1					20
251-275				12	8						20
276-300			1	7	12						20
301-325					18	2					20
326-350					8	3	2				13
351-375					5	4	3				12
376-400				1	3	2	4				10
401-425						1	3				4

Table E.4. Age-frequency distribution by length interval of a subsample of smallmouth bass from upper John Day pool, March-June 1984.

Fork Length Interval **(mm)**	Age 1	2	3	4	5	6	7	8	9	10	11	12	**Sum**
101-125	1												1
126-150													
151-175		5	1										6
176-200		10											10
201-225		10											10
226-250		8	2										10
251-275		1	9										10
276-300			3	7									10
301-325			1	7	2								10
326-350				10									10
351-375				3	7								10
376-400				4	3	2	1						10
401-425							6	1					7
426-450						2	4	3	1				10
451-475								1					1
476-500											1[a]		1

[a]Excluded **from calculations of age frequency distribution.**

APPENDIX F

An Approach for Modeling the Dynamics of Predator Populations and Their Impact on Juvenile Salmonids in John Day Reservoir

The combined goal of this study and that by USFWS (BPA #82-3) is to estimate the extent of predation on juvenile salmonids and evaluate management strategies for reducing losses of juvenile salmonids to predation if losses are deemed significant. To address this goal, we will use a model to predict how changing predator abundance, prey abundance and environmental conditions affect losses of salmonids and future predator abundance. The model will have two components (Figure F.1); a predation component in which the number of juvenile salmonids consumed by predators within a given unit of time is estimated as the product of predator abundance and the number of salmonids consumed per predator, and a population component which predicts future predator abundance as the number of predators surviving plus the number of newly added individuals of predatory size (recruitment). Efforts in 1985 will focus on development of the model using methods described in the literature (Table F.1).

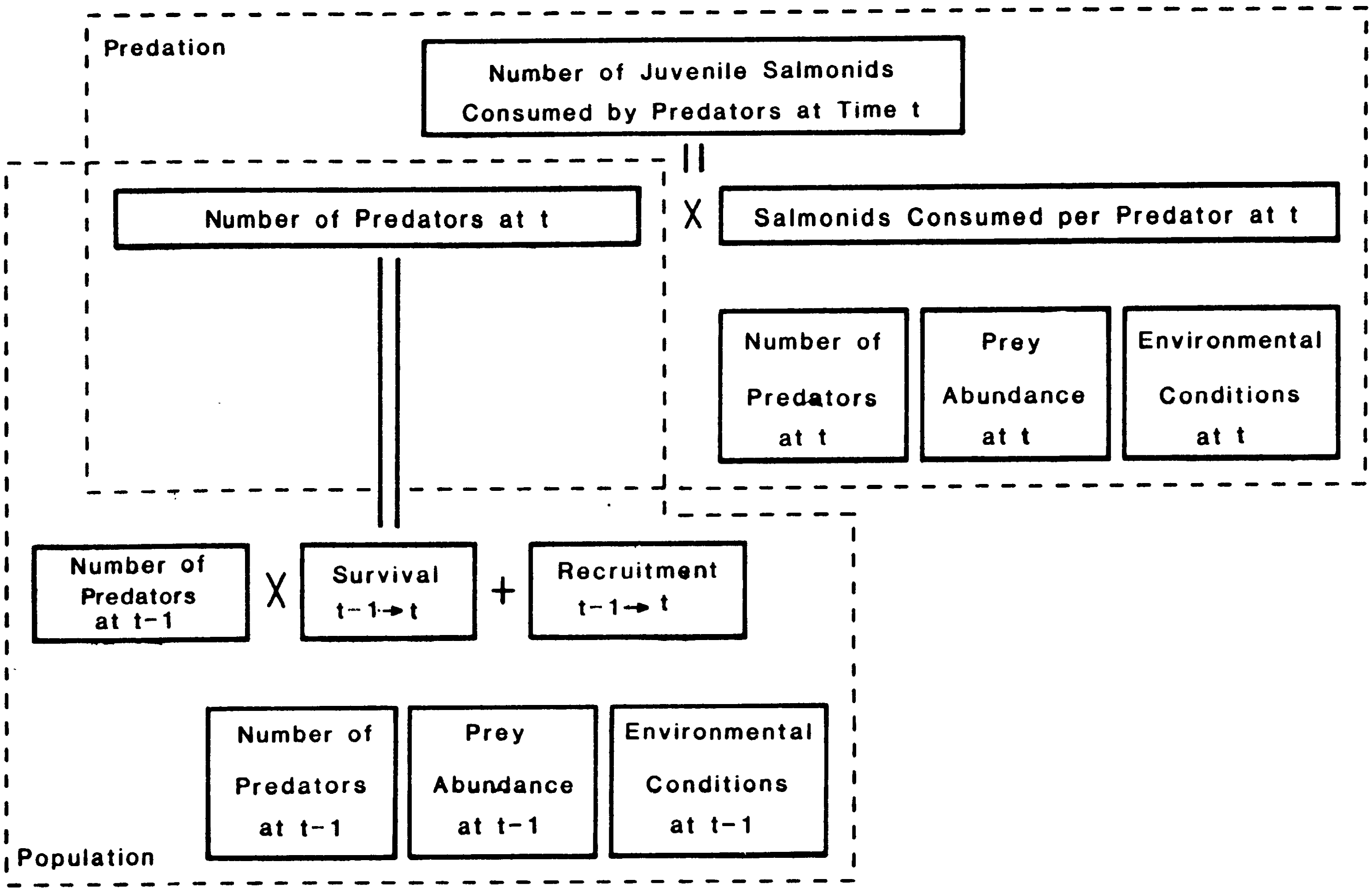

Figure F.1. A schematic of interactions between major components of the predation and population dynamics model.

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