The fishery for paddlefish at Intake, Montana, during 1973 and 1974
by Bruce John Rehwinkel

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
Stratified estimates of fishing intensity and harvest of paddlefish in the Yellowstone River at Intake, Montana were made during 1973 and 1974. An estimated 25.9 and 46.3 percent of the fishermen were contacted during 1973 and 1974, respectively. The fishery sustained an estimated 2386 fisherman days of use in 1973 and 3363 days in 1974. The seasonally pooled catch rates were 0.45 and 0.39 fish per hour in 1973 and 1974, respectively. The estimated total number of fish caught was 4544 in 1973 and 4359 in 1974. The weight of fish removed was estimated to be 44.78 and 39.23 metric tons in 1973 and 1974, respectively. The ratio of males to females in the run was estimated to be approximately 2:1 during 1973 and 1974. Males in the catch during 1974 averaged O.889 kg more in weight, 6.4 cm greater in length, and the dominant age group was 1 year older than in 1964. Tag returns were 14.8 percent in 1974; however, only 8.2 and 9.5 percent of males and females were kept in 1974. It is concluded that the current rate of exploitation is not detrimental to the population.

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Date April 18, 1975

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BRUCE JOHN REHWINKEL

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Approved:

William R. Gould
Chairman, Examining Committee

James M. Lechleitner
Head, Major Department

Henry L Parsons
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

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ABSTRACT

Stratified estimates of fishing intensity and harvest of paddlefish in the Yellowstone River at Intake, Montana were made during 1973 and 1974. An estimated 25.9 and 46.3 percent of the fishermen were contacted during 1973 and 1974, respectively. The fishery sustained an estimated 2386 fisherman days of use in 1973 and 3363 days in 1974. The seasonally pooled catch rates were 0.45 and 0.39 fish per hour in 1973 and 1974, respectively. The estimated total number of fish caught was 4544 in 1973 and 4359 in 1974. The weight of fish removed was estimated to be 44.78 and 39.23 metric tons in 1973 and 1974, respectively. The ratio of males to females in the run was estimated to be approximately 2:1 during 1973 and 1974. Males in the catch during 1974 averaged 0.889 kg more in weight, 6.4 cm greater in length, and the dominant age group was 1 year older than in 1964. Tag returns were 14.8 percent in 1974; however, only 8.2 and 9.5 percent of males and females were kept in 1974. It is concluded that the current rate of exploitation is not detrimental to the population.

INTRODUCTION

Paddlefish, *Polyodon spathula* (Walbaum), were once abundant throughout much of the Mississippi drainage and its major tributaries (Coker, 1923; Hussakof, 1910; and Stockard, 1907). However, by a combination of destructive influences, they have now been restricted to only seven known spawning populations (Elser, personal communication). One population traverses the lower Yellowstone River, Montana.

Although a fishery for paddlefish existed in the lower reaches of the Yellowstone River in the early 1900's (Needham, 1968), little utilization was believed to have occurred until 1962 when a sizeable harvest was taken at Intake, Montana. In 1964 the first intensive study of paddlefish in Montana was undertaken to obtain information on this population (Robinson, 1966). Since 1966, personnel of the Montana Fish and Game Department have monitored the paddlefish harvest. Changes in the population structure since 1966 and a need to obtain current information on the run prior to the withdrawals of water from the Yellowstone River for the development of coal resources in southeastern Montana prompted the present study. The objectives of this study were to assess the status of the present fishery and obtain additional information on the life history of the paddlefish in the Yellowstone River. Field work was conducted from May to

September, 1973 and from April to September, 1974 at Intake, Montana.

DESCRIPTION OF STUDY AREA

The Yellowstone River has its headwaters high in the mountains of Yellowstone National Park. It flows approximately 966 kilometers across Montana in a northeasterly direction to its confluence with the Missouri River in North Dakota. Its major tributaries are the Shields, Boulder, Stillwater, Clark Fork, Big Horn, Tongue and Powder Rivers; its drainage basin (U. S. Public Health Service, 1951) covers approximately 183,372 square kilometers.

The Yellowstone River is a free-flowing river, showing considerable changes in physical-chemical parameters with changes in flow. Bicarbonate concentrations vary from 247 mg/l at low flow to 122 mg/l at peak flow (U.S.G.S., 1973). Levels of hardness (Ca, Mg in mg/l) and specific conductance (micromhos) were also higher when flows were reduced while turbidity levels peaked with high flows. The ranges and averages of selected parameters of the river are listed in Table 1. Information from U.S.G.S. indicated flows of the river at Sidney varied about fivefold with peak discharge occurring at about mid-June (Figure 1).

The study area was located on the lower Yellowstone River at Intake, Montana, 32.2 km downstream from Glendive (Figure 2). A large irrigation diversion dam is present which evidently acts as a partial barrier to the paddlefish migration, and concentrates the

TABLE 1. PHYSICAL AND CHEMICAL PROPERTIES OF THE YELLOWSTONE RIVER AT SIDNEY FROM OCTOBER 1972 THROUGH SEPTEMBER 1973 (DATA FROM U.S.G.S.)

	Range	Average
pH	7.6-8.3	8.03
Bicarbonate (mg/1)	122-247	187.08
Total Hardness (mg/1)	100-310	225.83
Specific Conductance (micromhos)	330-1090	720.67
Turbidity (ppm)	40-4400*	
Water Temperature	0.0-21.0°C	9.04

*From April through July at Glendive Water Plant.

fish and makes "snag" fishing more productive than elsewhere. The Yellowstone River at this site is about 244 meters wide at high water, has a maximum depth of 3.05 meters and is very swift and turbulent. The river bed is composed of large boulders and gravel interspersed with sandy areas. Other fish taken at this location include sauger *(Stizostedion canadense)*, walleye *(Stizostedion vitreum)*, channel catfish *(Ictalurus punctatus)*, burbot *(Lota lota)*, shovelnose sturgeon *(Scaphirhynchus platorynchus)*, and pallid sturgeon *(Scaphirhynchus albus)* (Brown, 1971).

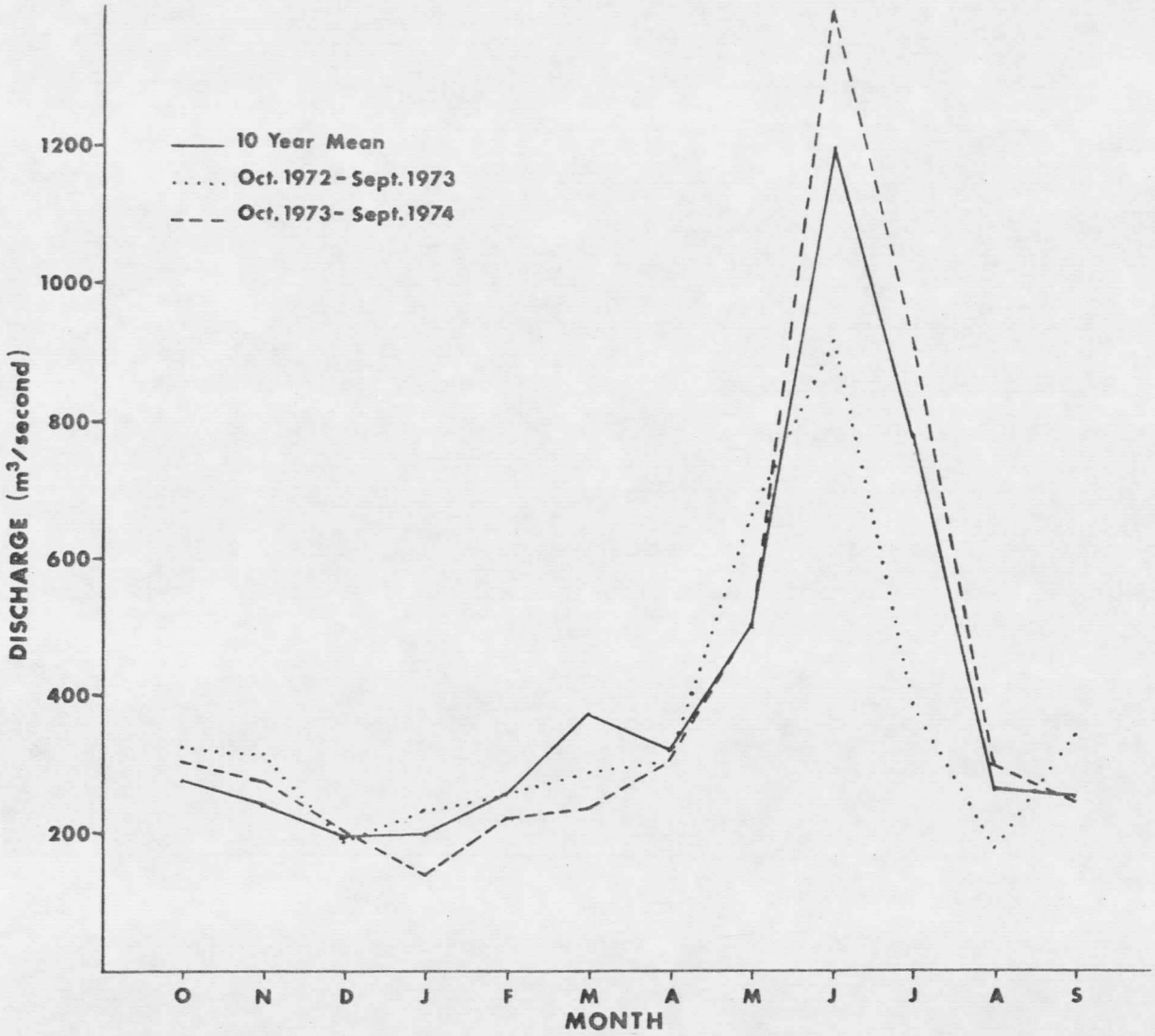

Figure 1. Mean monthly discharge of the Yellowstone River at Sidney, 1965-1974 (U.S.G.S. Data).

Figure 2. Map of the lower Yellowstone River showing the location of the study area.

METHODS

A partial creel census was conducted at Intake from May 1 to July 8, 1973 and from April 25 to July 14, 1974. Each week was divided into two strata. The first stratum consisted of weekdays and the second stratum consisted of weekend days and holidays. Fishermen were censused on three randomly selected weekdays in each week and on all holidays and weekend days. Each fishing day was considered to extend from 5 A.M. to 10 P.M. Daily fishing intensity was determined by counting anglers at eight randomly selected hours from 6 A.M. to 9 P.M. on each census day. Only fishermen actually in the process of snag fishing or repairing tackle were counted.

As many fishermen as practical were interviewed on completion of their fishing day. All fishermen were interviewed individually. The residency, gender, times fishing began and ended, estimated time fished, side of river fished on, number of paddlefish caught, and number of paddlefish kept was obtained in each interview. The length of a fisherman trip, the catch rate, and the overall harvest were estimated from information obtained and analyzed using Formula's 5 through 32 from Spence (1970).

As many of the angler's fish as practical were examined. Weights were determined with a Chattilion spring balance calibrated to the nearest 1.0 pound. Total lengths were measured with a sliding double

yardstick calibrated in tenths of inches. Summary weights and lengths were then converted to metric values. Sex was determined by examination of the gonads. The ages of paddlefish were estimated from segments of their dentary bones prepared and sectioned in the manner described by Adams (1942).

Paddlefish in good condition caught by fishermen who did not wish to keep them, and by creel census personnel were tagged and released to obtain information on movement and harvest. Tags were numbered poultry bands placed on the jaw.

RESULTS

Information from Interviews

Coverage

Both count and interviews were made on 75.4 and 72.8 percent of the fishing days during 1973 and 1974, respectively (Table 2). Interviews, but not counts, were made on additional days in both years.

TABLE 2. STRATUM COVERAGE DURING THE STUDY.

Year	1973			1974		
Stratum	I	II	I & II	I	II	I & II
Number of Days in Season	47	22	69	55	26	81
Number of Days with Counts and Interviews	30	22	52	33	26	59
Number of Days with Interviews Only	2	0	2	16	0	16

The number of fishermen interviewed and the hours spent fishing are presented in Table 3. The length of the fisherman day in each stratum was calculated by dividing the sum of hours fished by the number of individuals fishing as obtained from interviews during the period. During 1973, length of the fisherman day with 95 percent confidence limits was 3.70 (±0.27) hours for Stratum I and 5.08 (±0.35) hours for Stratum II. The length of the fisherman day for the entire season was estimated by combining the weighted strata

TABLE 3. NUMBER OF INTERVIEWS AND HOURS FISHED.

Year	1973		1974	
Stratum	I	II	I	II
Number of Fishermen Interviewed	368	250	784	773
Sum of Hours Reported Spent Fishing (from interviews)	1359.75	1270.25	2416.50	2857.25

values. During 1973, the season estimate was 4.25 (±0.22) hours. In 1974 the length of the fisherman day for Strata I and II was 3.08 (±0.16) and 3.70 (±0.16) hours, respectively, and the season estimate was 3.32 (±0.12) hours.

Catch Rate

The catch rate for each stratum was determined by dividing the number of fish taken by the number of hours expended as reported in interviews of the period. For 1973, the estimated catch rate was 0.62 for fish per hour for Stratum I, 0.26 for Stratum II and 0.45 for the entire season. During 1974, it was 0.44 for Stratum I, 0.32 for Stratum II and 0.39 for the combined strata.

In his study of this paddlefish fishery, Robinson (1966) found catch rates of 2.93 and 1.77 fish per fisherman trip of unstated duration in 1964 and 1965, respectively. In this study, catch rates were 1.90 fish per fisherman trip of 4.25 hours in 1973 and 1.30 fish per fisherman trip of 3.32 hours in 1974.

Sufficient data were collected during 1974 to allow the calculation of a daily catch rate (Figure 3). The daily catch rate fluctuated significantly within short periods of time. Early May, late June and early July contained periods of higher catch rates than from May 15 through June 14.

Purkett (1963) suggested catch rates and possibly movements of paddlefish are related to flows. A correlation of the daily catch rate at Intake (Figure 3) and flows at Sidney during 1974 yield R value of 0.249. Because of the similarity in the shape of their curves, a correlation was run between daily catch rates and turbidity readings of the Yellowstone River at Glendive (Figure 4). The R value for this relationship was 0.611. However, correlating the daily catch rate versus the previous days turbidity increased the R value to 0.675. This suggests that turbidity is affecting movements and not the catchability of the fish directly.

From April 25 through May 29, 1974, when flows were below 560 cubic meters per second, catch rates on the Intake and Glendive sides of the river were 0.32 and 0.36 fish per hour, respectively. However, from May 29 through July 14, when flows exceeded 560 cubic meters per second, the catch rates on the Intake and Glendive sides were 0.217 and 0.540, respectively. The higher catch rate on the Glendive side appeared to be related to the presence of a large pool which developed there as a result of the higher discharge.

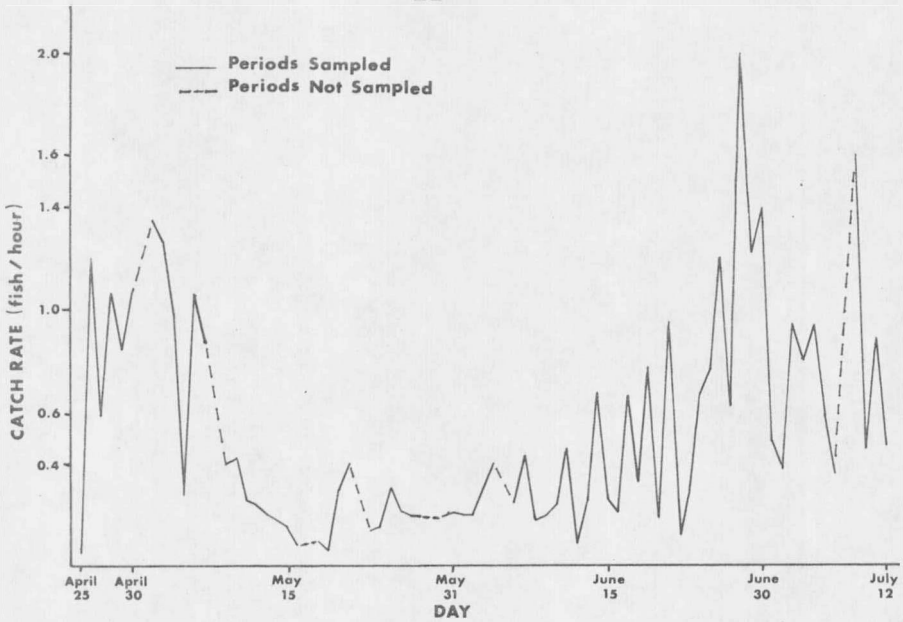

Figure 3. Daily catch rate of paddlefish during 1974.

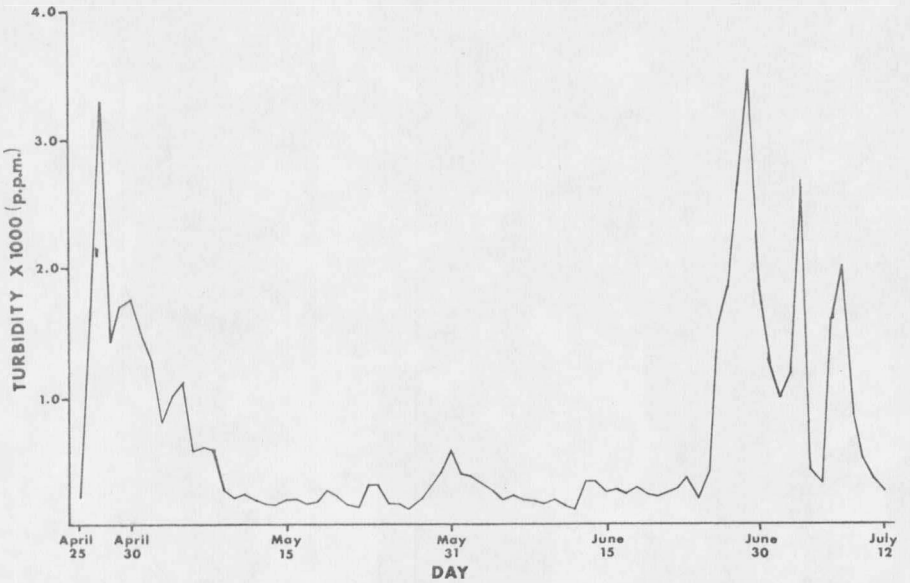

Figure 4. Daily turbidity (ppm) of the Yellowstone River at Glendive during 1974.

An estimate was made of the hourly distribution of the catch of fishermen in Stratum II between May 9 and June 25, 1974. Turbidities between these dates ranged from 128 to 580 ppm, and averaged 243.7 ppm. The times each successful individual fished and the number of fish caught in that period were recorded. The number of fish caught by each individual was plotted in the hour marking the mid-point of his trip. The sum of the fish caught by hour showed the most successful trip mid-points fell between 6 and 7 A.M. and between 5 and 6 P.M. (Figure 5).

Composition of Fishermen

The estimated numbers of fishermen traveling less than 80.45 kilometers (Category 1), between 80.45 and 160.90 kilometers (Category 2), and over 160.90 kilometers (Category 3) in straight line distance to Intake are given in Table 4. Fishermen from Categories 1 and 3 made up the largest and second largest proportions, respectively.

Previously Robinson (1966) found 62 percent of the fishermen came from Category 1, 21 percent came from the Category 2, and 17 percent came from the Category 3. Seasonally weighted estimates indicated non-residents comprised 22.3 and 22.0 percent of the fishermen at Intake in 1973 and 1974, respectively. During Robinson's (1966) study only 5 percent of the fishermen were from other states.

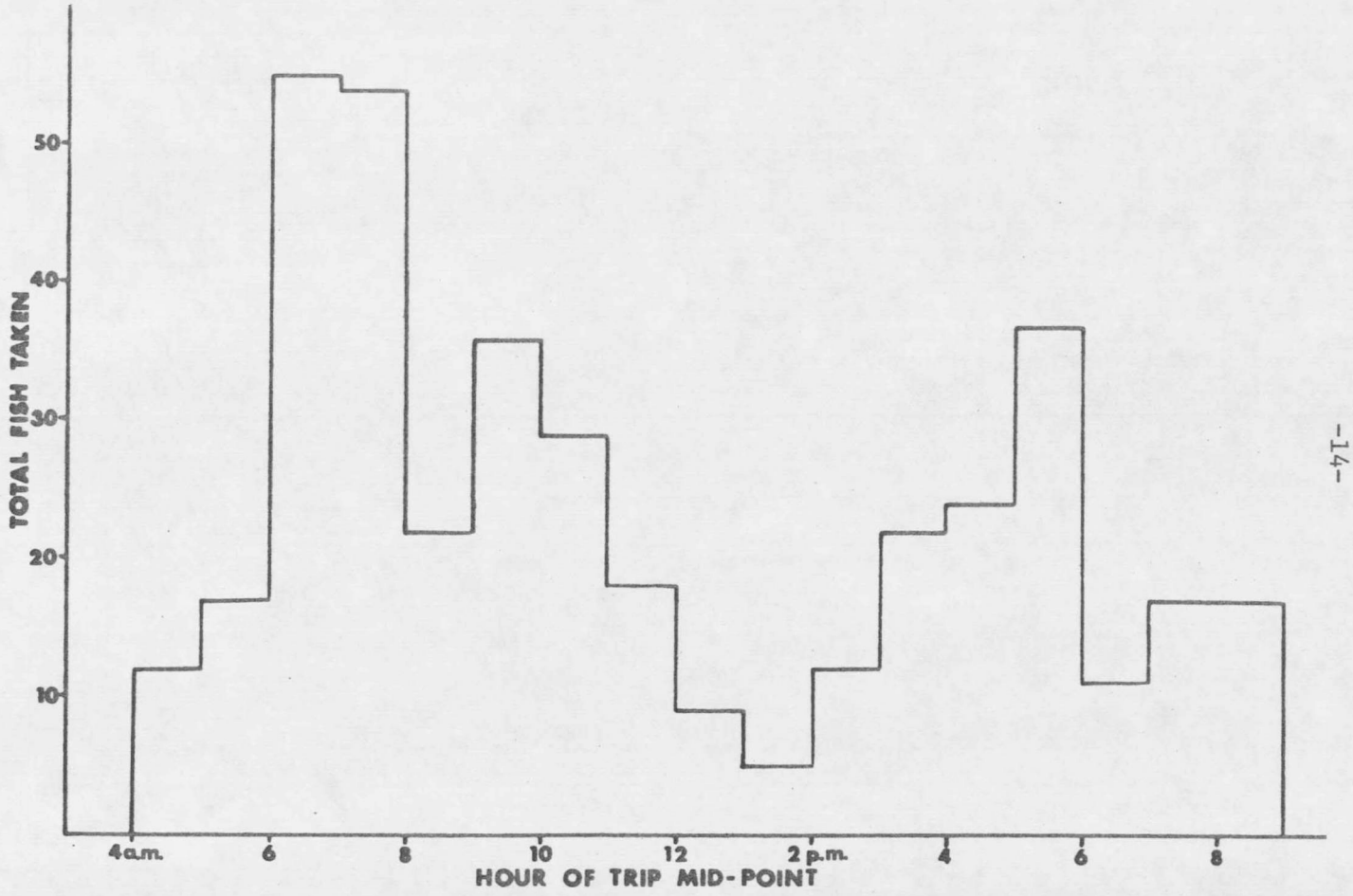

Figure 5. Distribution of catch throughout the day from May 9 through June 25 during Stratum II.

TABLE 4. ESTIMATED NUMBER OF FISHERMEN TRAVELING THREE DISTANCES TO INTAKE. Percents are in parenthesis.

Year	1973			1974		
Stratum	I	II	I & II	I	II	I & II
Category 1: <80.45 km	870 (61.1)	422 (43.9)	1292 (54.2)	1071 (51.6)	471 (36.6)	1542 (45.9)
Category 2: 80.45-160.90 km	128 (9.0)	184 (19.1)	312 (13.1)	400 (19.3)	250 (19.4)	650 (19.3)
Category 3: >160.90 km	426 (29.9)	356 (37.0)	782 (32.7)	604 (29.1)	567 (44.0)	1171 (34.8)

The catch rate (fish per hour) for each of the above categories was calculated by dividing the number of fish taken by the hours expended as reported in interviews of the respective groups. In 1973, the catch rate was found to be 0.657, 0.318 and 0.288 for fishermen in Categories 1, 2 and 3, respectively. The 1974 season showed a similar trend with catch rates of 0.512, 0.481 and 0.340 for the same groups.

The gender of licensed anglers and numbers of unlicensed fishermen are shown in Table 5. It appears more families fished Stratum II than Stratum I. The very large preponderance of men is probably the result of the physical demand of snag fishing.

Distribution of Catch

A high proportion of paddlefish were caught, but not necessarily kept, on relatively few fishermen trips. In 1973, 1.1 percent of the interviewed fishermen caught ten or more paddlefish per trip and

TABLE 5. PERCENT COMPOSITION OF LICENSED AND UNLICENSED FISHERMEN.

Year	1973		1974	
Stratum	I	II	I	II
Men	91.3	85.0	94.9	87.2
Women	5.6	8.1	3.2	7.8
Unlicensed : < 15 years old	3.1	6.9	1.9	5.0

accounted for 11.2 percent of the total fish reported caught. Four or more fish were taken on 10.7 percent of the fishing trips which accounted for 37.6 percent of the total catch. About 18 percent of the trips were unsuccessful; however, this estimate was thought to have been low since it appeared that unsuccessful fishermen were more difficult to contact.

In 1974, only 0.83 percent of the individual fishermen trips yielded ten or more paddlefish per trip, yet they accounted for 9.7 percent of the total fish reported caught. On 8.2 percent of the angler trips four or more paddlefish were landed and these fish accounted for 41.2 percent of the total fish caught. Unsuccessful fishermen made up 45.5 percent of the trips recorded in 1974.

Not all fish caught were kept. The numbers of fish caught and kept during each stratum as recorded on interviews are presented in Table 6. The highest percent of fish kept occurred in Stratum II during 1973 with about equal percent in other strata of both years.

TABLE 6. THE NUMBER OF PADDLEFISH CAUGHT AND THE NUMBER AND PERCENT KEPT.

Year	1973		1974	
Stratum	I	II	I	II
Number Caught	858	327	1055	929
Number Kept	447	233	536	452
Percentage Kept	52.1	71.3	50.8	48.7

Fishing Pressure

The average number of fishermen per count in each Stratum was estimated by dividing the number of fishermen counted by the number of counts. During 1973, the number of anglers per count averaged 6.59 and 13.06 for Strata I and II, respectively. In 1974, averages were 6.84 for Stratum I and 10.76 for Stratum II.

The total fishing pressure in each stratum was estimated by multiplying its mean number of fishermen per count by its total fishing hours. The maximum length of the fishing day was considered to be seventeen hours. Each season's fishing pressure was estimated by summing the fishing pressure estimates of its strata. In 1973 the estimates of the total hours expended in Strata I and II (with 95 percent confidence limits) were 5265 (±535.7) and 4884 (±504.2), respectively. For the entire 1973 study period, the estimate was 10,149 (±735.6) hours. The 1974 estimates of the total man hours spent paddlefish fishing for Strata I, II and the season were 6,400

(±572.6), 4755 (±442.4) and 11,155 (±723.6) hours, respectively. Fishing pressure increased 21.6 percent between 1973 and 1974 in Stratum I and decreased 2.6 percent in Stratum II between these years. Seasonal fishing pressure increased 9.9 percent from 1973 to 1974.

The number of fishermen trips in each stratum (Table 7) was estimated by dividing the total hours expended by the mean length of the trip. Between 1973 and 1974 the number of trips increased 45.7, 33.8 and 41.0 percent for Strata I, II and the season, respectively. Over one-fourth of the estimated fishermen trips in each stratum were accounted for in interviews with coverage being higher in 1974 than in 1973.

TABLE 7. THE ESTIMATED INTERVIEW COVERAGE OF FISHERMEN TRIPS.

Year	1973			1974		
Stratum	I	II	I & II	I	II	I & II
Estimated Number of Fishermen Trips	1425 (±178.5)	961 (±119.8)	2386 (±215.0)	2076 (±211.9)	1287 (±132.3)	3363 (251.6)
Number of Interviews	368	250	618	784	773	1557
Percent Coverage	25.8	26.0	25.9	37.8	60.1	46.3

The distribution of hourly fishing intensity was estimated by averaging the counts made at respective hours during each stratum (Figures 6 and 7). During 1973, intensity in Stratum I was bimodal

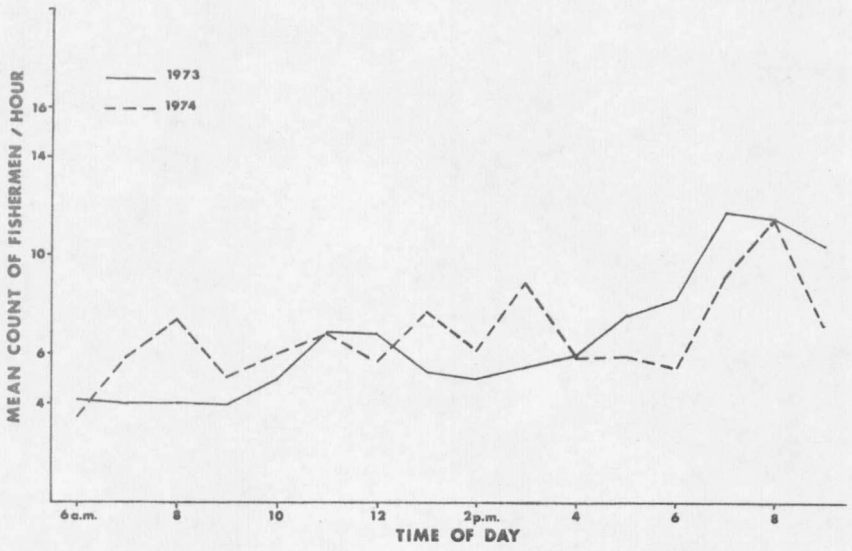

Figure 6. Hourly distribution of fishing intensity in Stratum I, 1973 and 1974.

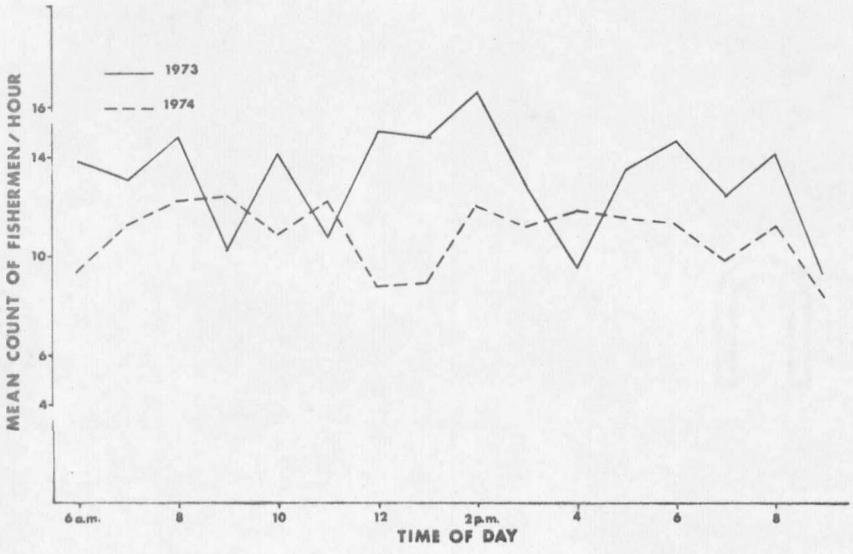

Figure 7. Hourly distribution of fishing intensity in Stratum II, 1973 and 1974.

with peaks of about 7 and 12 fishermen per hour at about 11 A.M. and 7 P.M., respectively. A multimodal distribution of intensity was present in Stratum II with peak numbers of about 14, 16 and 14 fishermen being present at 8 A.M., 2 P.M. and 6 P.M., respectively.

In 1974, intensity in Stratum I was unimodal with a peak of 12 fishermen per hour occurring at 8 P.M. The intensity in Stratum II of that year was bimodal with maximum numbers of 13 and 12 fishermen occurring at 9 A.M. and 2 P.M. The evening modes in Stratum I of both years are probably the result of local fishermen arriving after work. The multimodal intensity seen in Stratum II of both years is the result of fishermen being present and fishing throughout the day.

The seasonal distribution of fishermen was calculated by plotting the daily mean number of fishermen of all count days. Maximum numbers occurred on May 26 and May 28 of 1973 and 1974, respectively (Figures 8 and 9). Both dates fell on the Memorial Day weekends. The high concentrations of fishermen on the two Memorial Day weekends and the low daily fishing success known to have occurred on this holiday in 1974 (0.198 fish per hour), suggest angler concentrations are the result of custom and available time, not high fishing success.

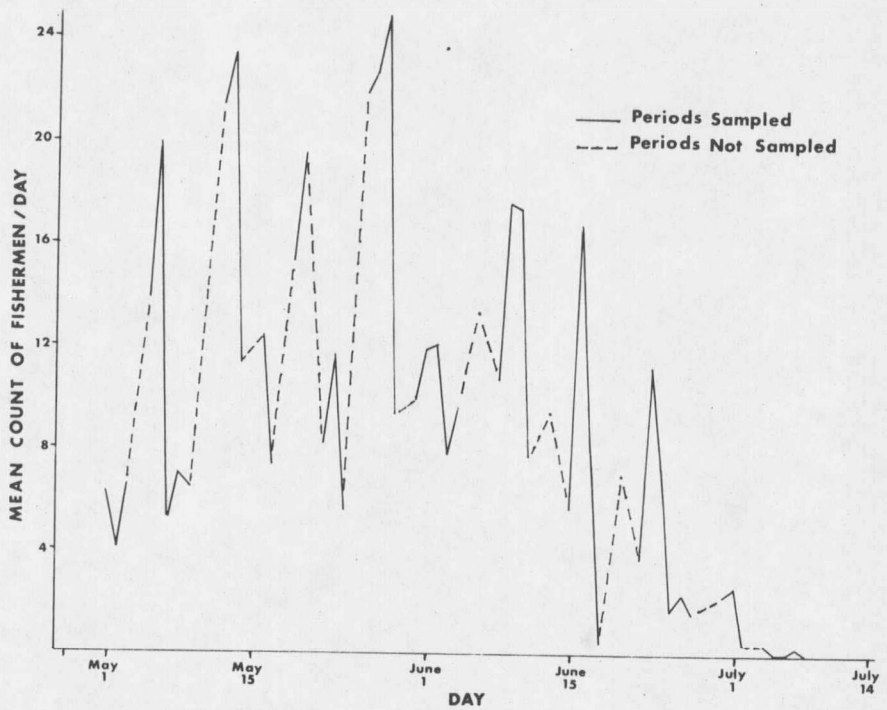

Figure 8. Seasonal fishing intensity for 1973.

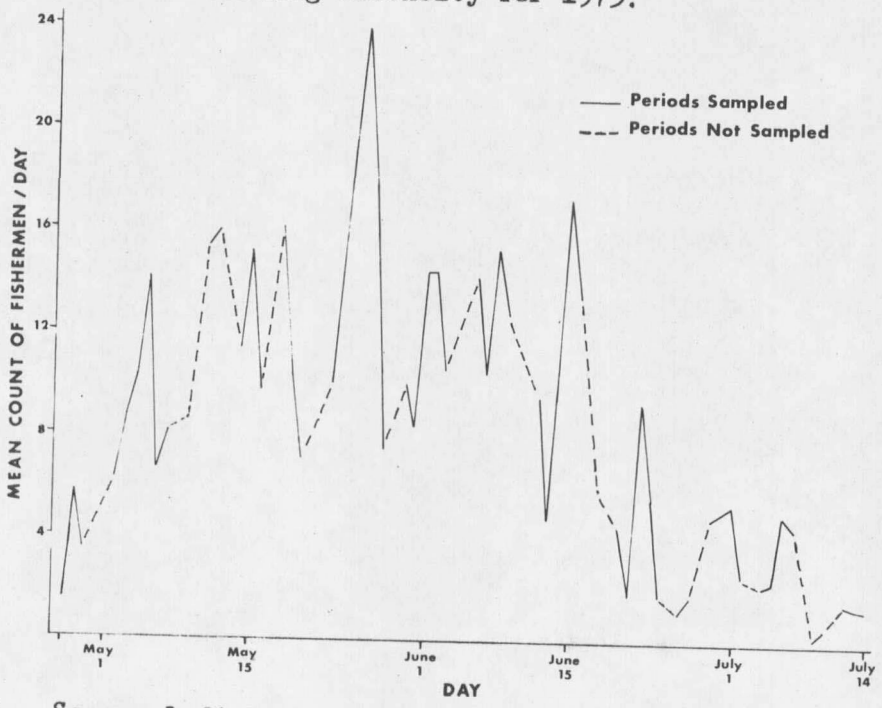

Figure 9. Seasonal fishing intensity for 1974.

Weight, Length, Sex and Age

Weights and Lengths

The weights and lengths of 1696 and 1910 paddlefish were recorded during 1973 and 1974, respectively. The sex of the 784 and 1073 fish kept by fishermen in 1973 and 1974, respectively, was determined by gonadal examination.

The mean weight of all fish measured was 14.86 kg in 1973 and 16.16 kg in 1974. The mean weight of fish kept also increased from 17.17 kg in 1973 to 17.98 kg in 1974. The weights of both sexes increased between years. Males averaged 10.86 kg in 1973 and 11.09 kg in 1974. Females averaged 25.04 kg and 25.17 kg for 1973 and 1974, respectively. Other weight-length information is given in Table 8.

The average weight of fish processed in this study has increased since 1964 and 1965 when average weights were 9.97 kg and 9.92 kg, respectively. The greater average weight in the current study is largely attributed to females entering the run. However, even in males which composed between 97.1 and 100 percent of the run during Robinson's study, the average weight has increased slightly more than 0.9 kg.

The weights and lengths from 22 and 39 previously tagged paddlefish were obtained in 1973 and 1974, respectively. Their growth since tagging is given in Table 9. In general, the natural growth rate of

TABLE 8. WEIGHTS AND LENGTHS OF PADDLEFISH GROUPS.

	1973			1974		
	Range	Mean	95 Percent Confidence Interval	Range	Mean	95 Percent Confidence Interval
Weights of all Fish Processed	3.63-35.15	14.86	±0.354	3.63-35.38	16.16	±0.340
Lengths of all Fish Measured (cm)	101.60-175.26	137.69	±0.737	105.41-175.01	139.93	±0.686
Weight of Fish Kept (kg)	5.90-35.15	17.17	±0.540	4.76-35.38	17.98	±0.454
Weight of Males (kg)	5.90-25.18	10.86	±0.277	3.63-24.95	11.09	±0.236
Length of Males (cm)	115.57-161.29	130.35	±0.710	107.44-151.13	130.33	±0.610
Weight of Females (kg)	9.75-35.15	25.04	±0.136	13.61-35.38	25.17	±0.286
Length of Females (cm)	124.97-175.26	157.18	±0.710	135.13-174.75	157.23	±0.530

TABLE 9. LENGTH AND WEIGHT CHANGES OF TAGGED FISH.*

1973				1974				Tagged Fall, 1973, Returned Spring, 1974			
Years Since Tagging	Number	Mean Length Change (cm)	Mean Weight Change (kg)	Years Since Tagging	Number	Mean Length Change (cm)	Mean Weight Change (kg)	Years Since Tagging	Number	Mean Length Change (cm)	Mean Weight Change (kg)
1	3	-0.58	-0.66	1	9	+2.29	-0.41	0.67	4	-3.00	-3.18
2	5	+2.18	-0.74	2	13	+2.77	+0.61				
3	1	+4.06	-2.95	3	5	+2.84	+1.52				
4	7	+3.84	+1.93	4	3	-0.08	-0.60				
5	0	--	--	5	2	+5.97	+1.36				
6	2	+2.03	+0.27	6	2	+3.81	+0.91				
7	0	--	--	7	0	--	--				
8	3	+4.65	+1.50	8	0	--	--				
9	1	--	+5.31	9	1	+10.16	+2.27				
10				10	4	--	+4.01				
Total	22				39						

*Positive (+) indicates an increase.
Negative (-) indicates a decrease.

these fish appeared to have been altered by tagging, so marked fish were not used in analysis of growth.

Sex Ratio

Of the paddlefish creeled and sexed during 1973, 55.7 percent were males and 44.3 percent were females. In 1974 the composition was 51.2 percent and 48.8 percent males and females, respectively. Since fishermen often select for larger fish which are predominantly females, the sex ratio of the creel may not necessarily be the sex ratio of the population.

Because the known females weighed more than known males, a one tailed probability could be constructed at the .01 level of significance which allowed assignment of sex to fish weighed, but not sexed. By this method, males in 1973 were estimated to weigh 17.27 kg or less with 99 percent confidence and females were estimated to weigh 17.38 kg or more with the same level of confidence. During 1974, males were calculated to weigh 17.69 kg and below and females 17.38 kg and above by this method. Considering the accuracy of the equipment, complete separation of the sexes was attained in 1973 while over-lap occurred at the 38.5 lbs. in 1974. However, during the latter year no fish were determined to be of this weight. On the basis of weight, the sex composition of all fish weighed was estimated to be 66.4 percent males and 33.6 percent females in 1973. During the 1974 season the composition was 61.9 and 38.1 percent males and females,

respectively.

The sexual composition of the daily catch, based on the assignment of sex by weight, is shown in Figures 10 and 11. As with many other species, males appeared to dominate the early portion of the run during both years of the study. However, no "ripe" or "spent" fish were found during this or (Elser, personal communication) previous investigations.

Age Groups

The ages of 55 female and 44 male paddlefish taken in 1973, and 478 female and 503 male paddlefish taken in 1974, were determined from sections of the dentaries as described by Adams (1942) and K. Graham (personal communication). The age groups and their mean total lengths are given in Table 10. Because of high variability between individuals in an age group, the mean length of fish in those groups with larger numbers are more reliable.

Fish younger than 9 years of age have occurred in earlier runs. Five previously tagged fish taken during this study were estimated by back-calculation to have been originally tagged at ages 5 through 8 years. Robinson (1966) also noted the presence of fish as young as 4 years of age. Although paddlefish younger than 9 years of age were not found during this study, there has been little change in the dominant age group since 1966. Robinson (1966), working almost entirely with males, found the major representation was in age groups

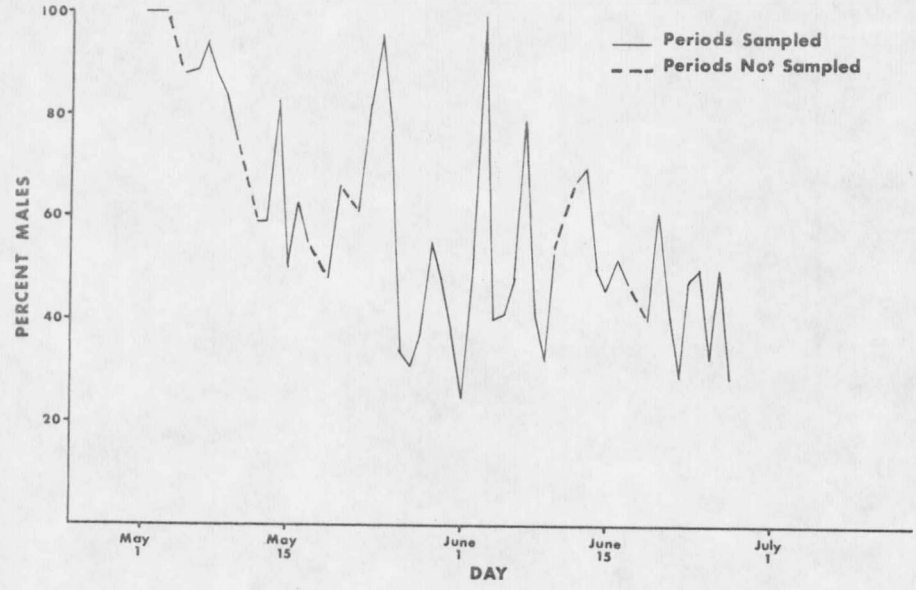

Figure 10. Percent males in daily catch during 1973 (sex assigned by weight).

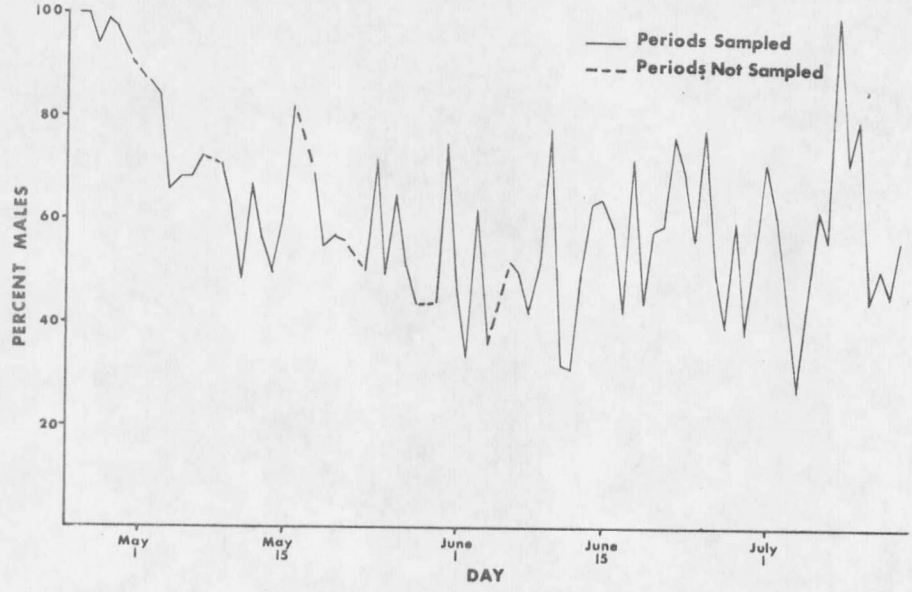

Figure 11. Percent males in daily catch during 1974 (sex assigned by weight).

TABLE 10. AGES AND MEAN LENGTHS OF PADDLEFISH BY SEX.
Sample size given in parenthesis.

	1973		1974	
	Male	Female	Male	Female
Age Group	Length in cm	Length in cm	Length in cm	Length in cm
9	115.90 (3)		117.35 (4)	
10	125.32 (5)		122.43 (26)	
11	126.06 (9)		125.96 (134)	
12	129.06 (12)		129.62 (123)	
13	137.08 (6)		132.77 (86)	
14	143.97 (4)		135.53 (44)	
15	139.70 (1)	150.06 (4)	136.07 (35)	148.67 (3)
16	146.05 (1)	153.77 (16)	138.84 (25)	148.97 (44)
17	136.40 (2)	157.58 (18)	139.29 (15)	154.41 (164)
18	137.16 (1)	159.36 (12)	143.08 (6)	159.13 (144)
19		164.29 (5)	138.43 (2)	162.13 (101)
20				162.31 (21)
26			151.38 (1)	

8 through 12 and in this study the major age groups of males were 10 through 13 years of age.

Information from Tagged Fish

Number Tagged

During this investigation, individually numbered size 11 poultry bands were fastened around the dentaries of 1213 fish. Of the 464 paddlefish tagged at Intake during 1973, 453 were marked during May and June and 11 were tagged between September 26 and October 2. In 1974, 561 fish were tagged at Intake between April 25 and July 14 and 188 fish were tagged at the Fort Peck "Dredge Cuts" (Figure 2) between

August 15 and August 22.

The mean weights of fish tagged at Intake in 1973 and 1974 were 10.26 kg and 12.32 kg, respectively. The weights of these fish were smaller than the average weight of fish in the runs of the respective years (Table 8), again indicating fishermen kept the larger fish. Other information on fish tagged at Intake is given in Table 11.

TABLE 11. THE PADDLEFISH TAGGED, RETURNED, AND KEPT FROM INTAKE.

Statistic	Year 1973	1974
Number Fish Tagged	464	561
Percent Females Tagged	8.2	15.0
Total Number of Tags Returned	54	179
Number of Current Year's Tags Returned	26	83
Percent of Current Year's Tags Returned	5.6	14.8
Overall Percent of Tagged Fish Kept	26.4	59.3
Percent of Current Year's Tags Returned - Female	11.5	16.9
Percent of Current Year's Males Kept	26.1	57.4
Percent of Current Year's Females Kept	66.7	66.7

The approximate threefold increase in return of tagged fish between years was largely the result of more fishermen being made aware of the interest in tagged fish and increased angler coverage. The similarity in the sexual composition of the samples of tagged and returned fish suggests the snagging technique is not size selective.

The 14.8 percent return of fish of both sexes tagged during 1974 was almost threefold higher than the return in 1973, but was similar to the 11.6 percent found by Robinson (1966) in 1964. A higher

proportion of females than males were kept during both years because of their larger size.

Movements of Tagged Paddlefish

A total of 51 of the 54 tagged fish reported to the creel census personnel at Intake during 1973 were tagged at Intake. Two of the remaining three fish were tagged at the Fort Peck "Dredge Cuts"; one about 6 years earlier and the other about 4 years previously. The third fish had been tagged in the Van Hook Arm of Garrison Reservoir by personnel of the North Dakota Game and Fish Department in 1966.

Of the 179 tagged fish obtained during the 1974 season, 173 were initially marked at Intake. The remaining 6 were also tagged at Intake, but returned from other locations. Two were taken in Garrison Reservoir. One of these fish tagged on May 11, 1971 was caught in June. Another had been tagged on May 3, 1973 and was taken in July. Three others were captured from the mouth of the Tongue River at Miles City. These fish traveled approximately 160.9 km in 35, 62 and 17 days, respectively. The remaining fish was taken at Forsyth on about July 8, 9 or 10.

During the seining and tagging at the Fort Peck "Dredge Cuts" (Figure 2) in August 1974, five tagged fish were recaptured. Two had been tagged at Intake, one on May 7, 1973 and the other on May 17, 1964. The other three had been marked at the "Dredge Cuts" in

previous years.

The information on movements obtained from this study is consistent with previous findings. Paddlefish appear to reside in Garrison Reservoir and move up the Yellowstone River each spring. The extent of the movements up the Yellowstone River seem to vary. During 1973 no paddlefish were known to have been at the mouth of the Tongue River, but during 1974 fish were caught there and at Forsyth. The presence of paddlefish in the Fort Peck "Dredge Cuts" only in late July and August and at Intake during the fall of 1973 is not understood.

Six of 11 fish tagged at Intake in the fall of 1973 were caught there during the spring of 1974. The 54.5 percent return of these fish is over fourteen times the rate of return of fish marked in the spring of 1973 and taken in the spring of 1974 (3.8 percent). This higher rate of return on fish marked in the fall and the loss of weight shown in Table 9 may indicate an over-wintering in the river system.

Harvest and Yield

The estimate of the harvest (fish caught) for each stratum was calculated by multiplying the appropriate estimated catch rate (fish per hour) by the hours expended. The total harvest for each year was calculated by adding the estimates of harvest from its strata. The

95 percent confidence limits are given in parenthesis.

In 1973, the estimated harvest in Stratum I was 3287 (±592.6) fish and in Stratum II was 1257 (±221.4) fish. The season estimate was 4544 (±632.6) fish. During 1974, the harvest was estimated to be 2834 (±392.0) fish in Stratum I and 1525 (±247.7) fish in Stratum II. The estimate for the season was 4359 (±463.8) fish. Harvest in 1974 showed a 13.8 percent decrease for Stratum I and a 21.3 percent increase in Stratum II. For the season the harvest decreased 4.1 percent in 1974.

The biomass of the catch in each season was estimated by multiplying the estimate of the number of fish caught by the average weight of fish caught in that season. The biomass of the catch was estimated to be 67.529 and 70.434 metric tons in 1973 and 1974, respectively.

The yield (number of fish removed) was calculated by multiplying the total fish caught in a stratum by the percent of the fish kept (Table 5) during that time as obtained from interview information. Strata estimates were summed to give seasonal estimates. The weight removed was calculated by multiplying the estimated number of fish removed during the season by the average weight of a fish kept.

During 1973, 1712 and 896 fish were kept in Strata I and II, respectively, with a total of 2608 being removed over the season. Based on the weights of 784 fish kept, the mean weight of a fish

removed during this season was 17.17 kg. From these estimates the biomass removed was determined to be 44.778 metric tons.

In 1974, 1440 paddlefish were kept during Stratum I and 742 during Stratum II. The yearly total of fish removed was 2182. Based on a sample of 1090 fish kept, the average weight was 17.98 kg. The estimate of biomass removed during this year was 39.225 metric tons.

Comparisons of the estimated number of fish taken and mass of fish caught during this study and previous years are presented in Figure 12. While this fishery did not produce the largest number of paddlefish in 1974, it did produce the largest weight of paddlefish caught.

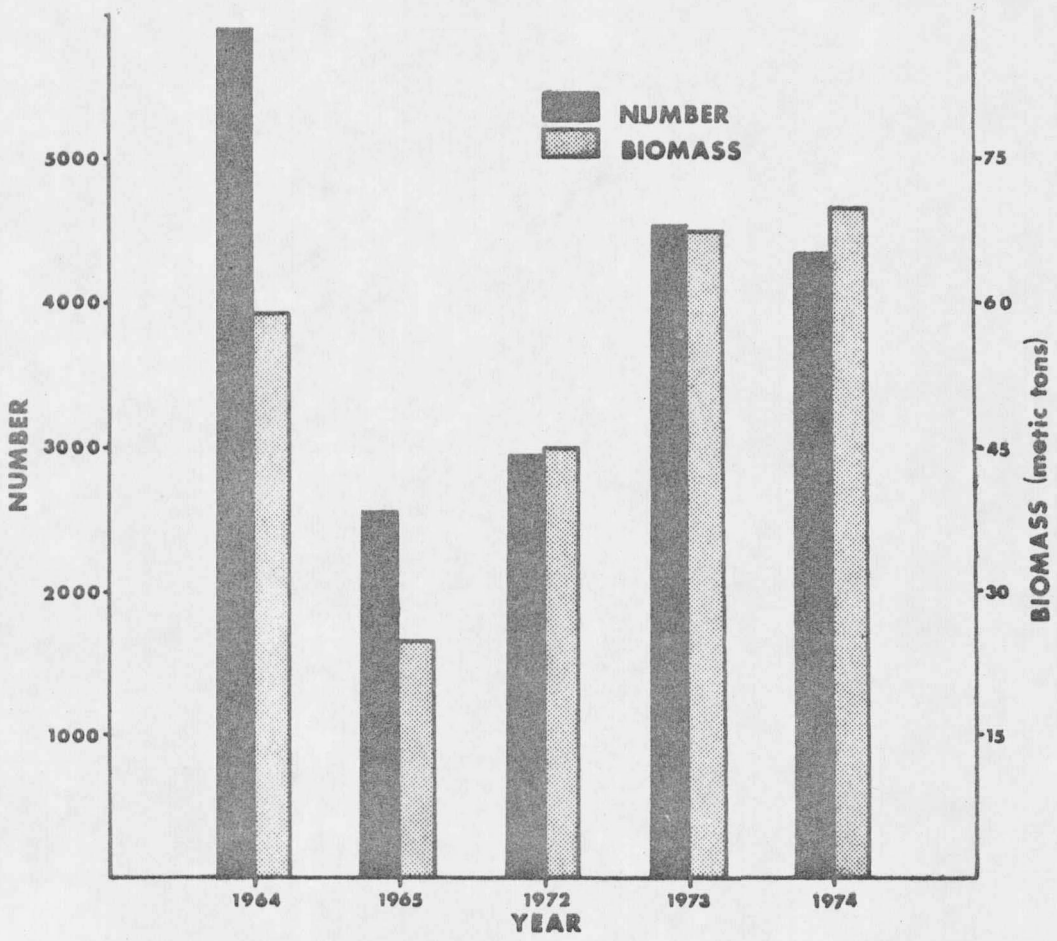

Figure 12. Numbers and weights of paddlefish caught at Intake during 5 years.

DISCUSSION

The information obtained in this study indicates the paddlefish population at Intake is vigorous and the current rate of exploitation is not excessive. The average weight, average total length and dominant age group of males in the catch has increased 0.889 kg, 6.40 cm and 1 year, respectively, since 1964. Additionally, the biomass in the catch has increased since 1965.

Of the 935 fish tagged by Robinson in 1964, only 13.2 percent were returned in the 11 following seasons. This rate of return does not approach the excessive exploitation rate of 24.5 percent in three years following tagging noted in the Osage paddlefish population (Purkett, 1963). If over exploitation does occur in the population at Intake it will probably be first seen in the females which are selected for by fishermen.

Habitat alteration probably represents a greater potential threat to the paddlefish than does the present rate of fishing. Presently the run appears to move mainly up the Yellowstone and not the Missouri River. The stimuli causing the fish to select the Yellowstone River are not well understood, but research suggests discharge, turbidity, and temperature influence their movement. A comparison of these parameters on the Yellowstone and Missouri Rivers (U.S.G.S., 1973) the week prior to the arrival of fish at Intake showed the

Yellowstone had the highest discharge, highest suspended load, and warmest water. Alteration of these parameters on the Yellowstone River for the development of coal may change paddlefish movements and possibly interfere with their reproduction.

An increased understanding of the biology of the paddlefish population is needed for more complete management. Possibly a joint effort with the North Dakota Game and Fish Department could be undertaken to attempt an estimate of the population size on Garrison Reservoir, its age structure, spawning periodicity, and early spring behavior related to running. The identification and description of spawning sites is also important; this goal may not be achieved until a transmitter can be applied that will not change the behavior of the spawners.

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