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Region 7

Yellowstone River Paddlefish Investigations

Annual Report for 1997

Submitted by

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Key activities in 1997 included the following:

--Daily sampling at Intake for the 1997 fishing season (May-15-June 30) to collect data for age determination, gonad weight, gonadal fat weight.

--Completion of the age determination and age structure analysis for paddlefish caught during the 1996 and 1997 snagging seasons.

--Continued development/improvement of age structure models for the paddlefish.

--Improvement of young-of-year YOY and yearling indices of abundance (Including tagging of YOY fish)

--Revision of the Montana-North Dakota Data collection document.

-- Compilation and initial assembly of a database for adult tagging data for the Yellowstone-Sakakawea stock.

-- Public education through written and oral presentation at Intake and Makoshika.

--Publication of four paddlefish papers in scientific journals, one on the catch-and-release fishery, another on the response of anglers toward harvest regulations, and two on YOY indices of abundance.

--Sampling and tagging of shovelnose sturgeon at Intake.

Daily sampling at Intake for the 1997 fishing season (May-15-June 30) to collect data for age determination, gonad weight, gonadal fat weight.

Dentaries were obtained from 488 male paddlefish and 297 female paddlefish, or 97% of fish for which lengths were obtained at Intake, and an estimated 73% of all paddlefish caught on the Yellowstone River in 1997 (Stewart 1997). Completed age analyses are reported below. In addition to the acquisition of egg weights in the cleaning trailer by chamber personnel, we obtained weights of testes and male and female gonadal fat for about 85% of all fish for which dentaries were collected. These data were returned to the lab for analyses.

Completion of the age determination for paddlefish caught during the 1996 and 1997 snagging seasons.

In 1996, ages were determined for 630 male paddlefish and 430 female paddlefish. Males ranged in age from 8 to 42 and averaged 12.4. Females ranged in age from 14 to 41 and averaged 25.5. The age structure continued a trend since 1993 for the catch to be dominated by young males. Eighty percent of the males (502 of 630 fish) were younger (ages 8-13) than the youngest female (one at age 14). Males continued to recruit to the fishery at ages 9-11; females did not fully recruit until 17-19. Males showed a characteristic bimodal age distribution with the peak at age 10 and a much lower peak at age 21. Females were rather uniformly aged from 20-35 but had small peaks at about ages 20 and 30 (Figures 1,2).

Results from 1997 were consistent with those of 1996. Ages were determined from 488 male paddlefish and 297 female paddlefish. Males ranged in age from 8 to 37 and averaged 14.1; females ranged from 15 to 41 and averaged 25.6. Sixty-seven percent (327 of 488) of males were younger (ages 8-13) than the youngest female (one at age 15). Males fully recruited at ages 9-11 but females not until 17-19. The age distributions were also similar to 1996 for both sexes (Figures 3,4).

We concluded several things from the results if 1996 and 1997 age determination. First, inasmuch as all fish are aged without knowledge of length or weight, the ages show strongly and unequivocally the differential maturation schedules of male and female fish. The results also add considerable credibility to the usefulness of dentaries for determining the age of these young recruited fish. It is remarkable that 502 males were aged younger than the youngest female in 1996, and 327 males were aged younger than the youngest female in 1997. This result, however, is entirely consistent with results of past years, with other studies, and with what we know about the evolution of sexual size dimorphism in paddlefish. The dentaries continue to be highly useful for aging paddlefish.

The second conclusion is that at Intake, many of the older males born during the reservoir's filling period have either died out or been fished out. The number of males older than 20 is a small fraction of the total male catch. This is an expected outcome of the initial reservoir upsurge and long-term natural and fishing mortality on the paddlefish. The age structure in North Dakota in 1996 and 1997 (Figures 5,6) indicated more old fish, consistent with the hypothesis that the more recent fishery in North Dakota has not yet fished down that less migratory portion of the stock. We are hopeful that the planned analysis of adult tagging data in 1998 will clarify if the stock has partially separated, more and less migratory, components.

Third, the presence of numerous young males in the catch indicates that recruitment of females in future years is a certainty. This result, combined with high numbers of young-of-year fish observed in 1996 and 1997, indicated substantial recruitment will occur in next decade and beyond.

For Fort Peck Reservoir in 1996, dentary samples were taken from 125 males and 220 females. Ages of male paddlefish ranged from 11 to 40 and averaged 20.5; ages of females ranged from 15 to 47 and averaged 26.9. Age structures of this stock showed more gradually declining numbers with age, a pattern characteristic of a more lightly fished stock (Figures 7,8). The allowance for snaggers to release fish from this stock may, however, alter these curves from those of actual abundance. No dentaries were collected above Fort Peck in 1997 because no creel was conducted.

Continued development/improvement of age structure models for the paddlefish.

We continued to work on refining our age structure models for stock assessment. Data from 1996 and 1997 are being incorporated to previous year's data, and effort data are being used to estimate catch per unit effort (CPUE) for this stock. A key issue is to properly adjust catch-per-unit effort (CPUE) estimates for young recruits according to river discharge and according to abundance of older fish in the catch.

Improvement of young-of-year (YOY) and yearling indices of abundance (Including tagging of YOY fish)

As in 1996, abundance of YOY paddlefish was high in 1997, associated with high discharge in the Yellowstone River and high elevation levels in Lake Sakakawea. Young paddlefish were first observed on July 22 and continued to be observed along standard transects until September. A total of 496 wild YOY fish and 23 yearling fish was tagged. This work was done in conjunction with the North Dakota Game and Fish Department, but will enable Montana to validate ages in the future from recoveries of coded-wire tagged fish at Intake. We also collected standard samples of zooplankton along 10 transects in the upper reservoir, as well as data on depth, water clarity, and water temperature. Visual counts were conducted weekly from Late July into September. Similar sampling was conducted at the Upper end of Fort Peck Reservoir, but over a briefer period. Stomach samples were taken from 73 YOY and 10 yearlings as well as from 27 YOY from Fort Peck. Zooplankton and stomach samples are currently being analyzed in the lab to assess food electivity and whether the young fish were filtering or selectively feeding. Preliminary analyses indicated different food habits of YOY in Lake Sakakawea and Fort Peck Reservoir.

Revision of the Montana-North Dakota Data collection document.

At the annual paddlefish working group meeting, revisions to the document were discussed and changes made. There are currently few problems with the document or with the implementation of the sampling program, which is nearly uniform between the two states.

Compilation and initial assembly of a comprehensive database for adult tagging data from

Montana and North Dakota.

In October, D. Scarnecchia obtained the complete historical data base of adult tagging for the Yellowstone river. Earlier data is not on a computerized data base, and is now being developed into a large file which can be combined with data from tagging in Region 6 below Fort Peck and with data from North Dakota. The initial construction of the file about half completed, but there will be considerable error and discrepancy checking of all the tag recovery data before the file can be used. From this file several key pieces of information will be obtained next year, including populations estimates, reproductive periodicity, and migration and movement information.

Public education at through written and oral presentation at Intake and Makoshika.

In mid-June, D. Scarnecchia presented a talk on paddlefish ecology at Makoshika Park as part of their evening program for campers. In late June, he spoke to a Glendive Kiwanis Club to numerous members of the business community. He also made presentations to three or four school and hostel groups at Intake as opportunities arose. In addition, we talked daily with snaggers at Intake about the paddlefish fishery and ecology, and distributed informational brochures to interested public.

Publication of four paddlefish papers in scientific journals, one on the catch and release fishery, another on the response of anglers toward harvest regulations, and two on YOY indices of abundance.

Four papers were published in 1997 related to this research (attached).

Sampling and tagging of shovelnose sturgeon at Intake.

Approximately 220 sturgeon were tagged with cinch-up tags and released in 1997, and an additional group of about 50 fish were creeled and their fins taken for age determination. These fins have been prepared but not yet read. Results will be incorporated in 1998 into a comprehensive report on sturgeon activities to date.

Fig. 1- **Age distribution of male paddlefish**
(Intake: Year= 1996)

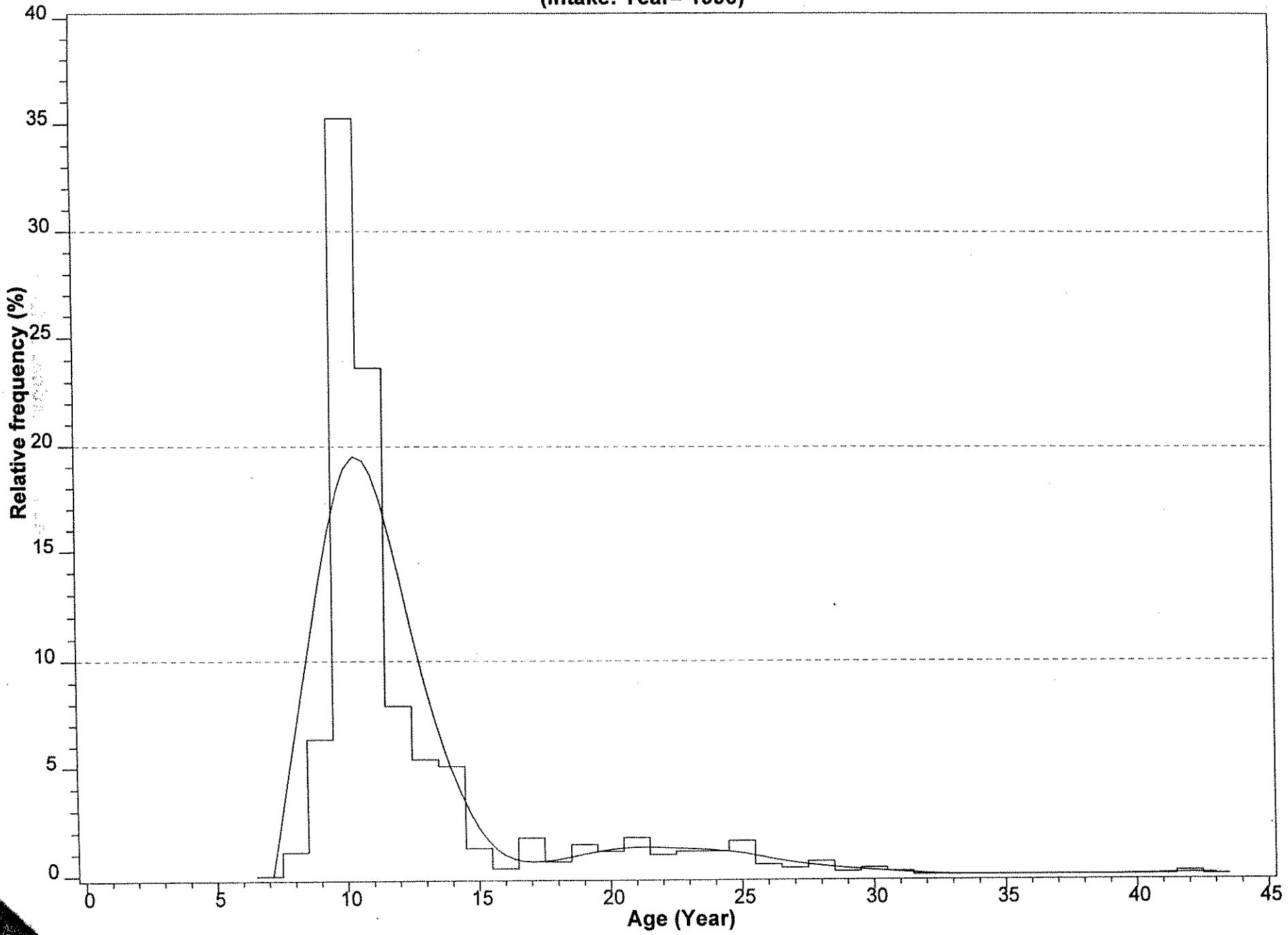


Fig 2: Age distribution of female patients

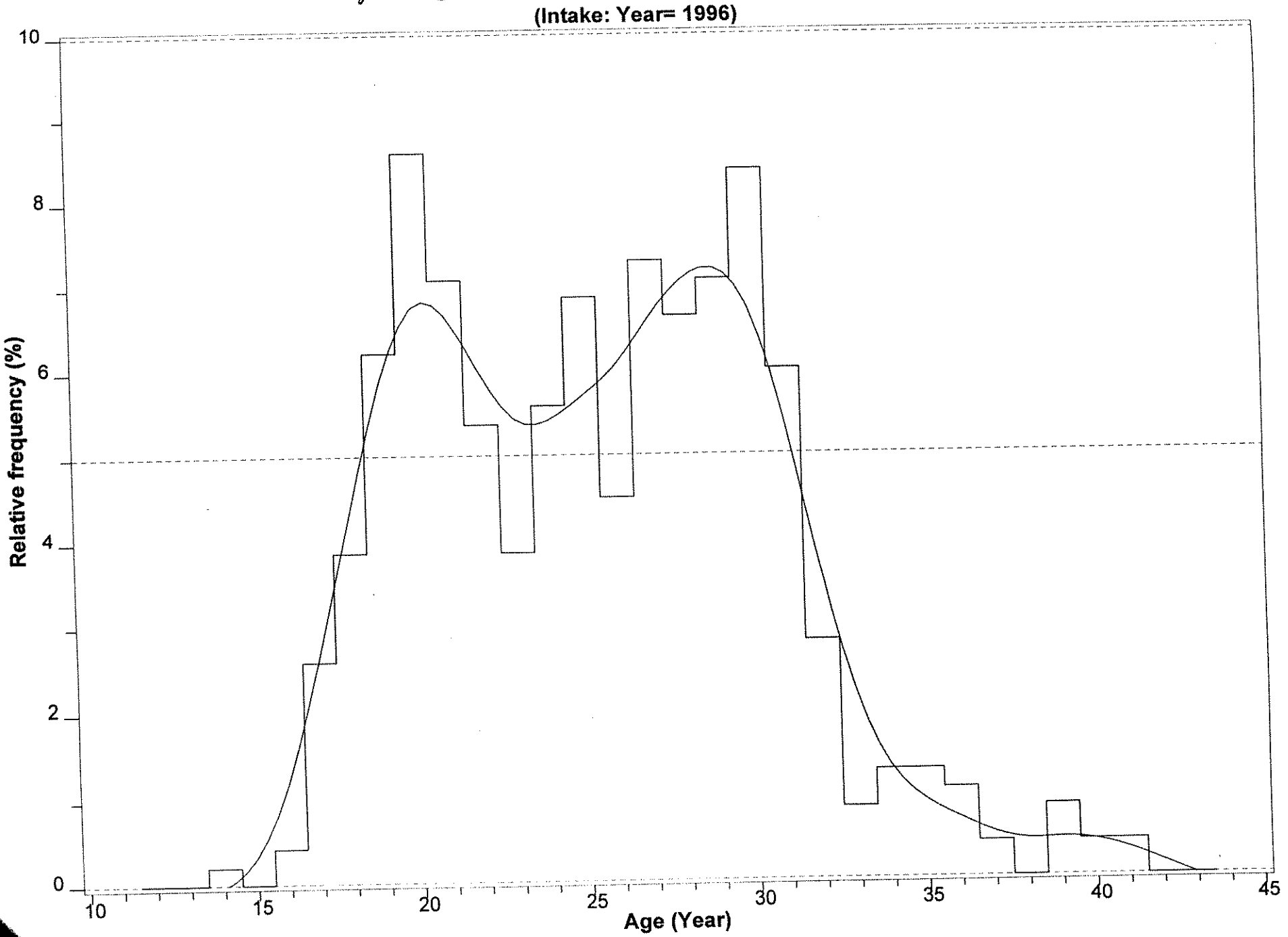


Fig. 3. **Relative frequency of male paddlefish age**
(Intake: Year= 1997)

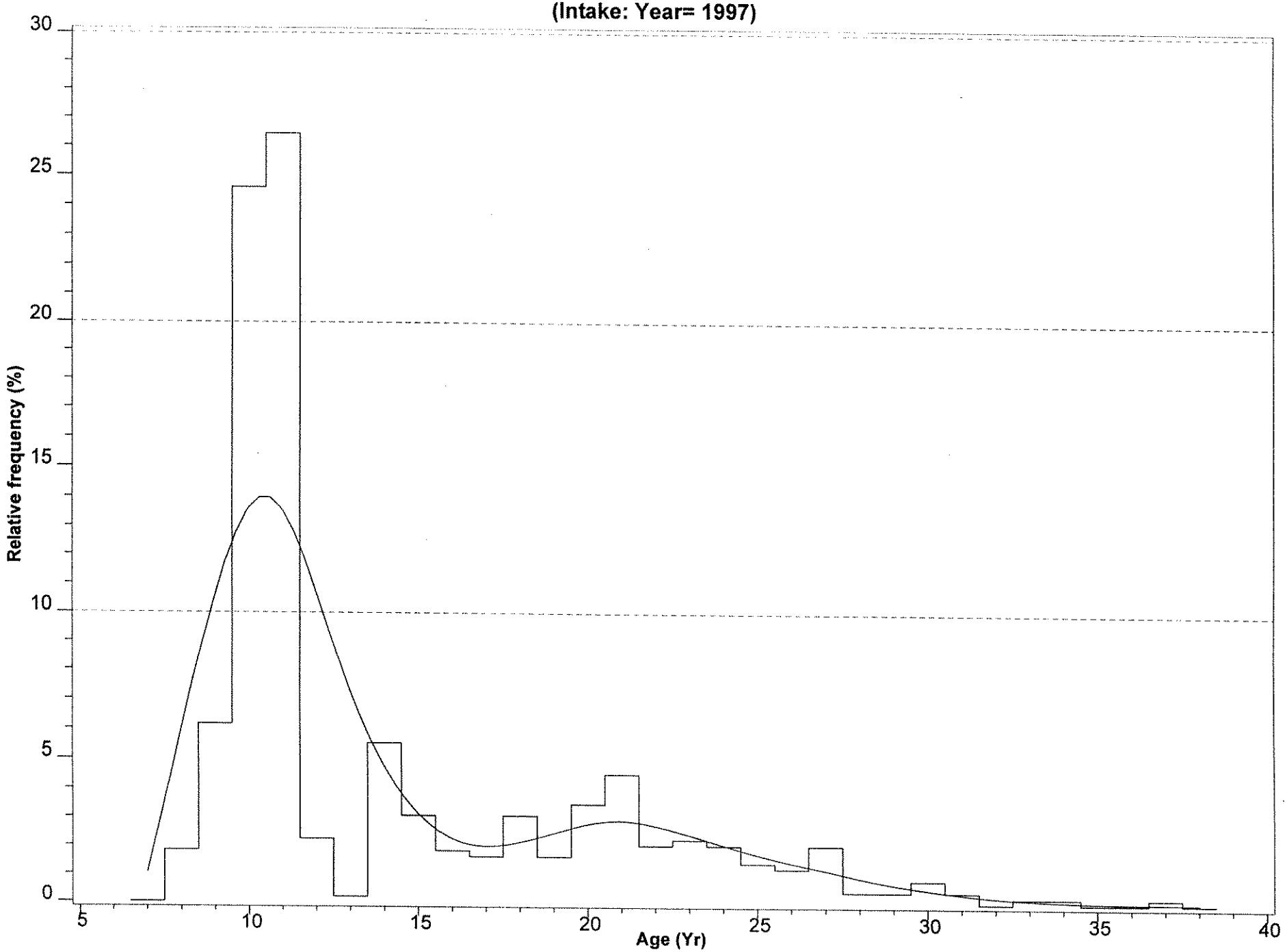


Fig 4. **Relative frequency of female paddlefish age**

(Intake: Year= 1997)

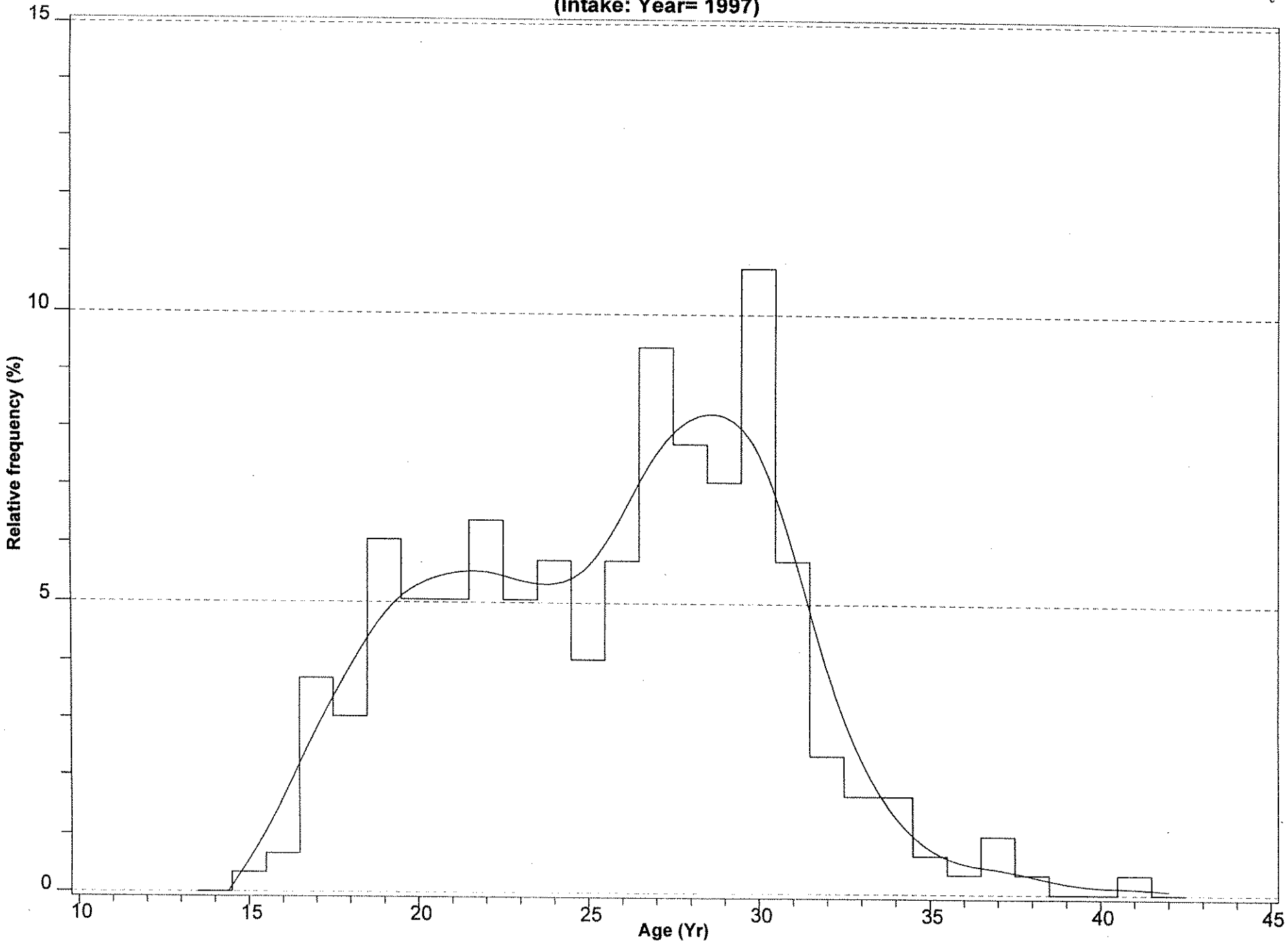


Fig 5. **Relative frequency of male paddlefish age**

(N.Dakota: Year= 1997)

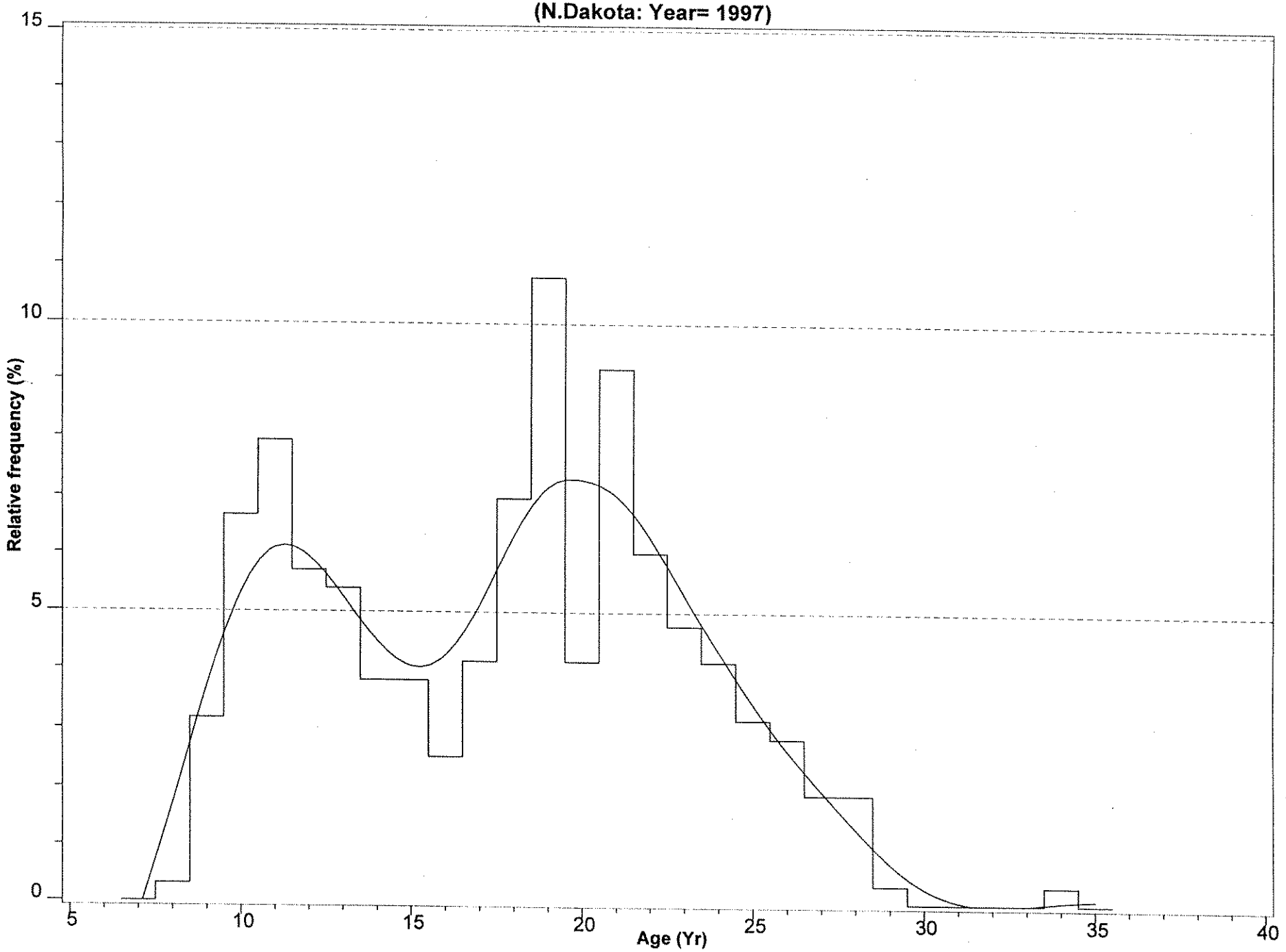


Fig6. **Relative frequency of female paddlefish age**

(N.Dakota: Year= 1997)

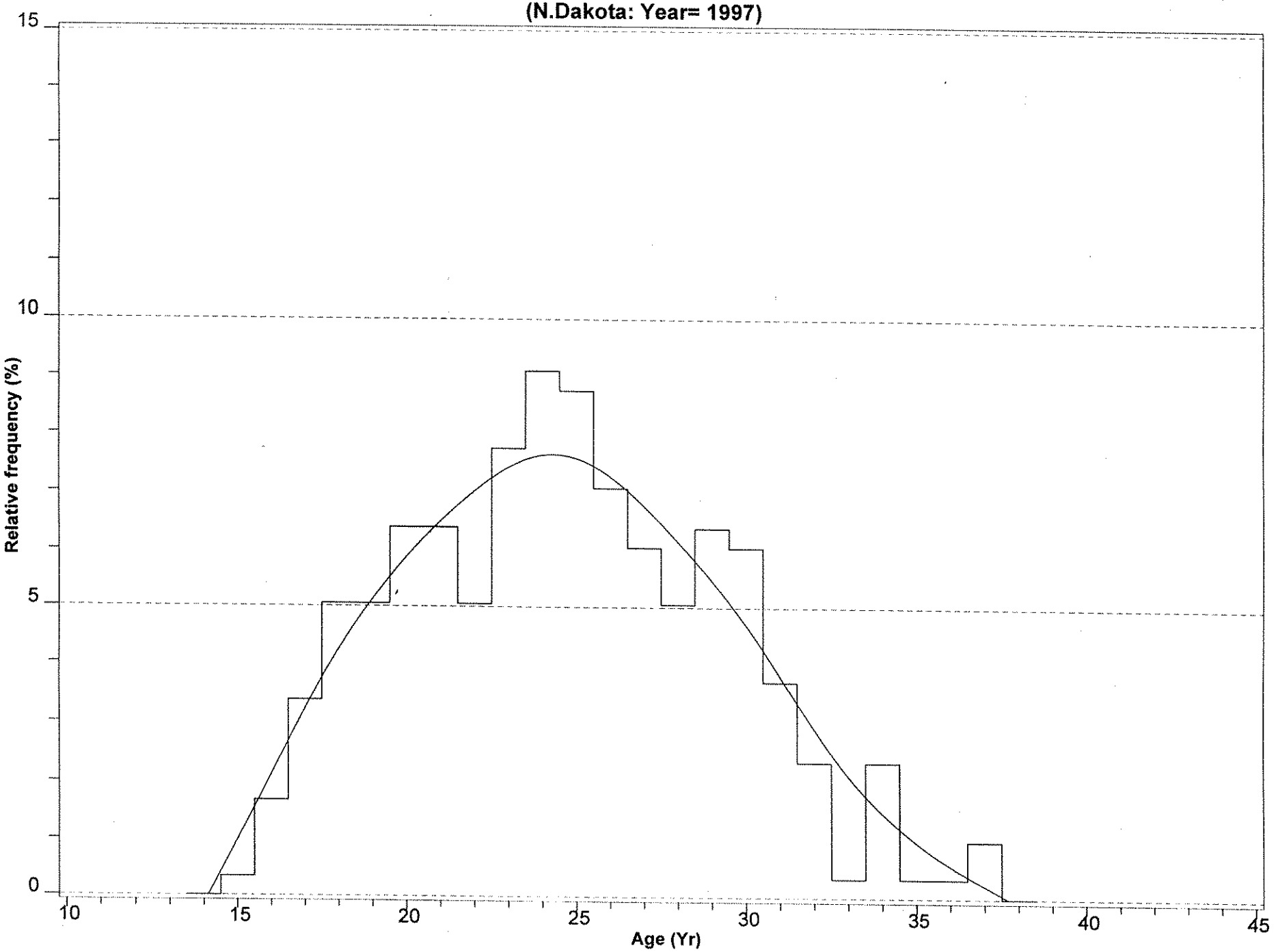


Fig 7. **Relative frequency of male paddlefish age**

(Fort Peck; Year = 1996)

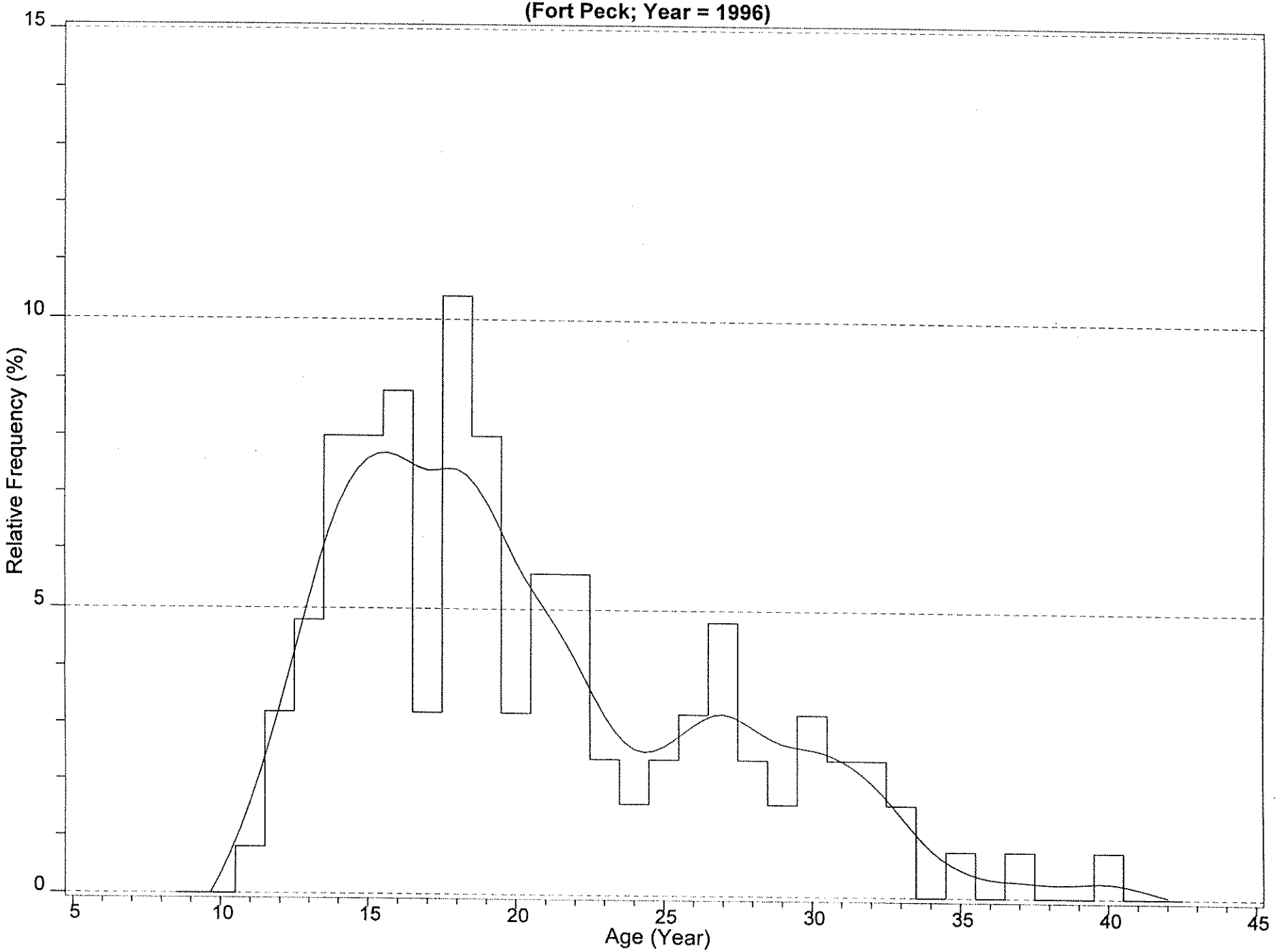
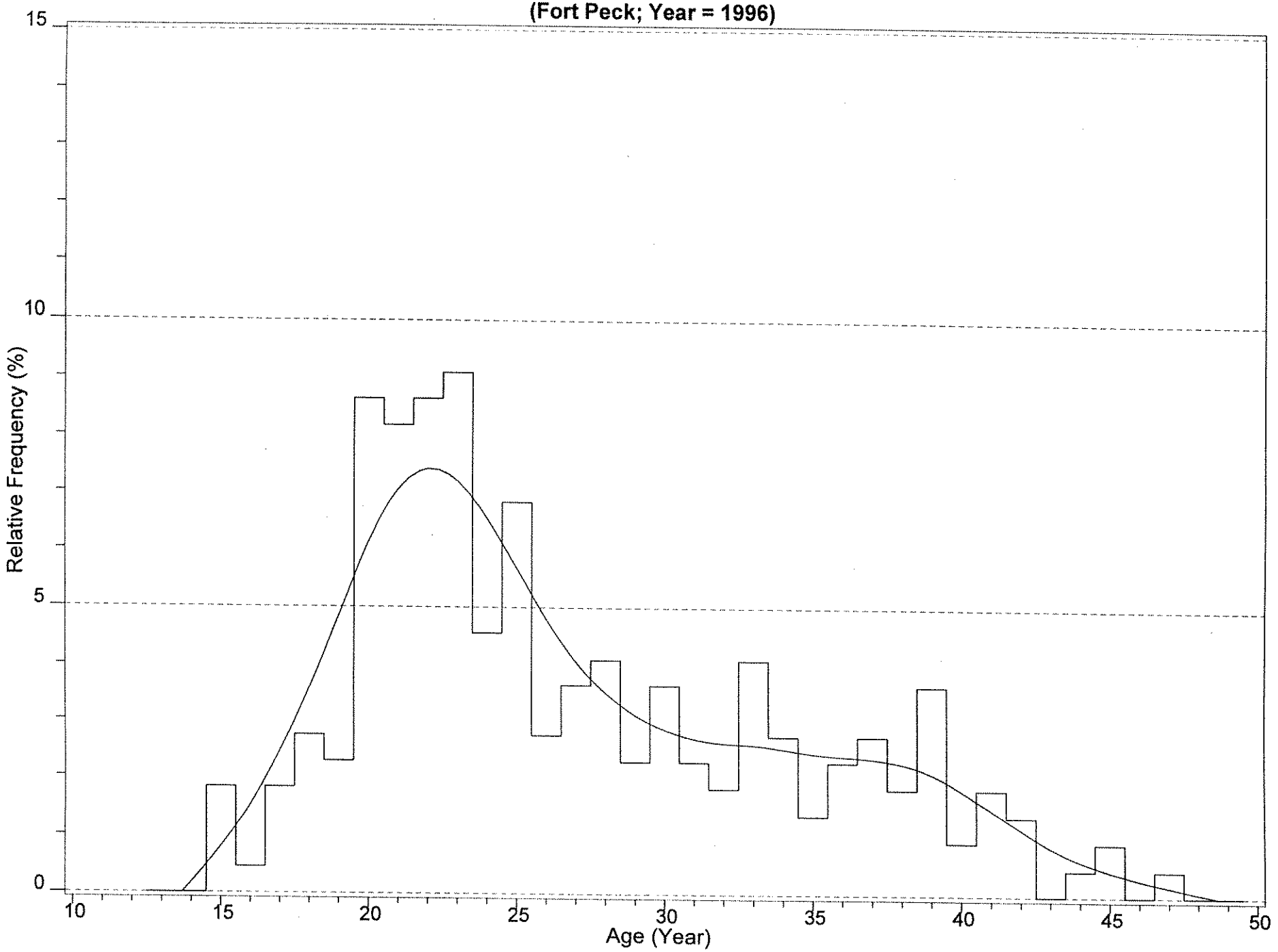


Fig 8. **Relative frequency of female paddlefish age**

(Fort Peck; Year = 1996)



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Implementation and Evaluation of a Catch-and-Release Fishery for Paddlefish

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Abstract.—In 1995 and 1996, a mandatory catch-and-release fishery for paddlefish was conducted 2d/week during the 6-week paddlefish snagging season at the Intake fishing site on the lower Yellowstone River, Montana. The fishery was monitored by trained fisheries personnel to ensure compliance and to obtain information on hooking mortality and angler attitudes. In 1995, snaggers expended 838 angler-hours and caught and released 420 fish, or 0.5 fish/h. In all, 96 fish snagged, tagged, and released in 1995 were recaptured and either creeled or re-released in 1995 or 1996. Sixty-four (15.6%) of the fish inspected had one or more bleeding wounds beyond the hook puncture resulting from the snagging event. Some fish also had old wounds (4.7%) and arc-shaped scars, the latter probably caused by boat propellers. In 1996, snaggers expended 589 angler-hours and caught and released 127 fish, or 0.2 fish/h. Twenty-one fish tagged during catch and release in 1996 were recaptured at Intake in 1996; 19 were creeled and 2 were re-released. A total of 159 snaggers completed the brief written questionnaire on the catch-and-release snag fishery. The most common suggestions for improvement were the optional retention of fish and more days and hours for catch-and-release. Because of evidence of low hooking mortality and high snagger interest, continuation of catch-and-release is planned for future years.

In the last two decades, catch-and-release fishing, either mandatory or volitional, has emerged as valuable tool for management and assessment of recreational fisheries (Barnhart and Roelofs 1977, 1987). Catch-and-release fishing is used routinely in management of fisheries for salmonids (Lewynsky and Bjornn 1987; Turner 1987; Vincent-Lang 1993), largemouth bass *Micropterus salmoides* (Schramm and Heidinger 1988), and other freshwater fishes, as well as for marine game fishes (Epstein 1987; Witzell 1987).

Numerous factors affect the acceptability and success of a catch-and-release regulation, including the life history of the fish (Hunt 1977), its vulnerability to capture (Anderson and Nehring 1984), hooking mortality (Wydoski 1977; Booth et al. 1995), angler effort, and attitudes of anglers (Cordes 1977; Bielak 1987).

Paddlefish *Polyodon spathula* support recreational snag fisheries in several states in the Missouri and Mississippi river drainages (Elser 1986; Gengerke 1986). No mandatory catch-and-release fisheries were identified by Combs (1986). With a few exceptions, such as the Yellowstone River, Montana (Scarnecchia et al. 1995), voluntary release of snagged paddlefish was permitted if the fish was returned immediately to the water. High-grading (i.e., the release of a creeled fish in favor of another one to avoid exceeding a bag limit) was prohibited in 6 of 11 states with recreational paddlefish fisheries (Combs 1986).

In Montana's lower Yellowstone River paddlefish snag fishery (Robinson 1966; Rehwinkel 1978; Scarnecchia et al. 1996b), site of a 500–5,000-fish annual harvest, regulations gradually have become more restrictive since the fishery began in the early 1960s (Scarnecchia et al. 1995). From 1981 through 1993, the annual bag limit was two fish, with mandatory retention of snagged fish. In 1994, the annual bag limit was reduced to one fish. Licensed snaggers were required to purchase paddlefish tags which were attached to each fish captured. Written questionnaire surveys of snaggers (Scarnecchia and Stewart 1996; Scarnecchia et al. 1996a) at the main snag fishing site indicated strong support for catch-and-release fishing in addition to, but not in place of, the one-fish annual bag limit. In response, two 6-h catch-and-release periods were established weekly (Wednesdays and Sundays, 1500–2100 hours) during the 15 May–30 June snagging season. The intent was to provide additional recreational opportunity without additional paddlefish harvest.

Inasmuch as snaggers are often disparaged as meat fishers (Catchings 1985), the development of a biologically and socially acceptable catch-and-release snag fishery is unusual. Important concerns to be addressed included immediate and delayed

Of 409 fish inspected after capture and released, 64 (15.6%) had one or more bleeding wounds beyond the hook puncture resulting from that snagging event. The open wounds consisted mainly of flesh tears resulting from hooks (11.2% of released fish) and circular necrotic lesions (2.2% of released fish). Flesh tears were usually less than 2 cm long but occasionally up to 10 cm long. The cause of observed circular necrotic lesions, which were usually 2–3 cm in diameter, was not confirmed, but probably resulted from tissue necrosis around hooks previously lodged in the flesh over long periods. No fungal growth was observed on either flesh tears or circular lesions.

Old wounds, healed or partially healed, found on 4.7% of the caught-and-released fish, consisted mainly of circular and arc-shaped scars. Circular scars (2.7% of fish) appeared as discolored spots on the skin and were the about same diameter as necrotic lesions. Eight fish (2.0%) had arc-shaped scars, typically multiple and in a row, and usually on the side or back of the fish. These scars were similar in appearance to wounds identified in previous years as having been caused by boat propellers.

No evidence of paddlefish mortality was found in the two 19-km surveys downriver in June following catch-and-release days. No dead or dying paddlefish were reported by paddlefish anglers commonly snagging downriver.

1996.—In 1996, anglers expended 589 h of effort and caught and released 127 fish, or 0.2 fish per hour. Of those 127 fish, 122 were tagged for the first time and released; the other 5 fish had been tagged previously. Two of the 122 newly tagged fish were recaptured once later in the season and released again, and 19 (15.6%) were creeled by snaggers later in 1996 during mandatory retention periods (Table 1). Recaptured fish were creeled from 1 to 35 d after tagging. Five fish tagged during the catch-and-release period in 1995 were recaptured in 1996 either during catch-and-release or mandatory retention periods; four of these fish were caught at Intake and one was caught downriver in North Dakota.

There was one immediate mortality from snagging. This fish was snagged on the underside in the area of arteries supplying the gills (Danforth 1912), resulting in a large loss of blood. The fish died shortly after being beached. Another snagged fish was visibly stressed after being snagged in an eddy and requiring 30 min to land. No dead paddlefish were reported by downstream snaggers.

Attitude Survey

One-hundred fifty-nine persons, an estimated 60% of all participating catch-and-release snaggers, completed the questionnaire. The most common positive comments received were that snaggers appreciated the opportunity to catch more than one fish (98 responses), and that keeping catch and release as a regular program was a good idea (54 responses). The most common negative comments were that mandatory release of large fish was undesirable because snaggers would have chosen to keep them (46 responses), and that too few days or hours were allocated to catch and release (34 responses). The most preferred regulation changes would have allowed more days and hours for catch and release (44 responses) and made catch and release voluntary, so that snaggers under their bag limit could have elected to keep a fish (40 responses). If snaggers were to be required to purchase a second tag for catch and release, 62% indicated they still would participate in catch and release and 38% said they would not.

Discussion

One major concern about the catch-and-release fishery was immediate and delayed hooking mortality of paddlefish. Although facilities were unavailable for holding snagged paddlefish in confinement, several pieces of evidence suggest high survival rates for adult fish in the Intake fishery, and elsewhere, if fish are handled carefully, and the gills are avoided. First, the numerous recaptures of caught-and-released fish in 1995 and 1996 at Intake (Table 1) within a month of initial capture, and the absence of dead or moribund paddlefish downriver indicated significant short-term survival. Long-term survival is also high. In 1984, 1986, and 1988, 860 paddlefish were snagged at Intake by volunteers in order to obtain adult fish for jaw-tagging. As of 1995, 336 (39%) of these fish had been recovered in creel censuses, 232 of them after being at large for one or more years (Table 2).

The idea that survival of snagged paddlefish can be high is supported by other sources elsewhere. Gengerke (1978) reported that of 2,012 paddlefish known to be snagged and released from the upper Mississippi River, at least 387 were later recaptured. Moen et al. (1992) found that snagged paddlefish implanted with radio transmitters generally survived to provide useful information on habitat use. In both of these studies, fish generally were snagged in winter and early spring when water temperatures were below 10°C. Our results indi-

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Capturing and Tagging Wild Age-0 and Age-1 Paddlefish in a Great Plains Reservoir

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Abstract.—Over the period 2–15 August 1996, age-0 and age-1 paddlefish *Polyodon spathula* were captured with long-handled dip nets in Lake Sakakawea, a Missouri River mainstem reservoir in North Dakota. Catch rates varied from about 20 fish/boat-hour (a boat-hour is defined as a 1-h effort by a boat driver and two netters) at the beginning and end of the sampling period to 50 fish/boat-hour during the middle of the sampling period. Previously untagged age-0 fish (2,346) were marked with binary coded wire tags implanted in their rostrums. This capture and tagging procedure has promise in Lake Sakakawea and elsewhere as a stock assessment tool for wild paddlefish.

Assessment of reproductive success and recruitment of paddlefish *Polyodon spathula* stocks necessitates effective sampling of age-0 and age-1 fish. Although successful sampling of wild adult paddlefish has been conducted with several gears, including gill nets (Rosen et al. 1982; Alexander et al. 1987; Hageman et al. 1988), trammel nets (Pasch et al. 1980), electrofishing (Berg 1981), and snag fishing (Moen et al. 1992; Scarnecchia et al. 1996), sampling of age-0 and age-1 fish has been much less successful. Ruelle and Hudson (1977) successfully used a bottom trawl to capture age-0 paddlefish of 15–212 mm body length (BL; front of eye to fork of caudal fin) in Lewis and Clark Lake, a Missouri River mainstem reservoir. Pasch et al. (1980) reported limited success in sampling larvae with an epibenthic sled and age-0 fish with small-mesh gill nets in Old Hickory Reservoir, Tennessee. Wallus (1986) collected larvae in the Cumberland and Tennessee river systems by towing several different types of fine-meshed nets. We describe a procedure to capture and tag (with binary coded wire tags) age-0 and age-1 paddlefish in Lake Sakakawea, a 156,000-ha Missouri River mainstem reservoir in western North Dakota.

Investigations in Lake Sakakawea (Fredericks 1994; Scarnecchia et al. 1995) indicated that age-0 paddlefish (100–300 mm fork length, FL) and age-1 paddlefish (350–550 mm FL) could be observed in large numbers near the surface at the upper end of the reservoir in July and August. The method of observation was to travel slowly by boat (8–9.5 km/h; Fredericks 1994) and observe fish off the bow and sides. Fish startled by the boat swam to the surface, where they could be counted (Fredericks 1994). Counts of age-0 fish in some years were sufficiently high (e.g., 1,756 fish in 1993; Fredericks 1994) to indicate that it would be possible to capture (with dip nets) and tag large numbers of fish in years with high reproductive success. Age-1 paddlefish also could be observed in the same manner but numbers of fish observed were much lower (less than 50 in 1992 and 1993; Fredericks 1994).

On 1 August 1996, a visual survey of 43 km of the reservoir (river kilometers, RKM, 2,433–2,476) indicated the presence of numerous age-0 and age-1 paddlefish, especially in the section from RKM 2,447 to RKM 2,457 where our sampling occurred. Over the period 2–15 August, 2,360 age-0 fish and 61 age-1 paddlefish were captured with long-handled 0.64-cm-mesh dip nets. Secchi depths in the area sampled were 33–38 cm on 1 August but increased to 86–89 cm by 17 August. Catch rates, estimated as catch/boat-hour (a boat crew defined as a driver and two netters) ranged from a low of 20–23 fish/h at the beginning and end of the sampling period to a high of 50 fish/h during the middle of the sampling period (Table

TABLE 1.—Catch and catch per unit effort for age-0 and age-1 paddlefish in Lake Sakakawea, 2–15 August 1996. Total catches by day include recaptured fish (number recaptured are also shown in parentheses). Recaptured age-0 fish had been tagged earlier in the sampling period. Recaptured age-1 fish were hatchery-reared fish that had been tagged and released in 1995.

Date	Total capture of:		Effort:	
	Age-0 fish:	Age-1 fish:	Boat-hour	Catch/boat-hour
Aug 2	104	9	5.0	23
Aug 5	199 (1)	2	9.0	22
Aug 8	133	1	3.5	38
Aug 9	148	1	3.0	50
Aug 12	564 (2)	15 (1)	21.0	27
Aug 13	616 (4)	6 (1)	19.0	33
Aug 14	329 (3)	15	16.0	22
Aug 15	267 (4)	12	14.0	20

1). The water surface varied by location and time of day from calm to wave heights of up to 1 m. Fish were captured in both calm and rough water. We estimated that, overall, about 33% of the age-0 fish and 10% of the age-1 fish observed were captured. Larger age-0 fish were stronger swimmers than smaller age-0 fish and were better able to avoid capture, and yearlings were even better at avoiding capture.

Untagged age-0 fish (2,346 individuals) were tagged in the rostrum with a Northwest Marine Technology hand-held tagger using batch, double-length, binary coded wire tags. Tags were implanted at least 1 cm from the tip of the rostrum amid the median rostral bones that support the flatter, stellate bones (Grande and Bemis 1991). Tags were injected at a 45° angle from the rostrum tip axis along the edge of the rostrum. About three age-0 fish could be processed per minute. When fish were weighed as well as tagged, the process speed was 2.5 age-0 fish/min.

The relative size of age-0 fish sampled increased during the 2-week netting and tagging period. Mean length of age-0 fish increased from 206 mm on 2 August to 241 mm on 15 August. Yearlings ranged in length from 370 to 520 mm FL; too few were captured during the period to assess trends in length over time.

We intend to continue this procedure in future years, to mark and recapture tagged fish in order to assess age, growth, harvest rates, and other aspects of paddlefish ecology necessary for their effective management. The capture method described here also was used successfully in Fort Peck Reservoir, Montana, in 1995 (W. Wiedenheft, Montana Department of Fish, Wildlife and Parks, personal communication). It is hoped that this procedure will have application for paddlefish research and management in other parts of the species' range.

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Angler Response to Harvest Regulations in Montana's Yellowstone River Paddlefish Fishery

Abstract

A written, 15-question survey of anglers snagging for paddlefish (Polyodon spathula) *was conducted at a popular fishing site on the Yellowstone River, Montana. Its purpose was to obtain opinions and preferences on specific regulations, including the reduction in the annual bag limit from two to one fish, catch-and-release fishing, and on the possible implementation of a harvest quota for the stock. Questionnaires were completed by 258 snaggers over the six-week (May 15-June 30) fishing season in 1994. Snaggers were split (30% for, 44% against) in their opinions on whether the reduction to a one-fish bag limit was justified, and whether the paddlefish stock would benefit from the reduced bag limit. Seventy-three percent of all respondents favored the opportunity to catch and release paddlefish. Support for a harvest quota was not strong but of the three quota options presented (Tag Limitation, Inseason Closure, and a Five-Year Quota), support was strongest for Inseason Closure (44%) followed by Tag Limitation (25%). Results of this questionnaire have been used in conjunction with stock assessments to reduce the bag limit and establish catch-and-release periods in the fishery.*

Key words: paddlefish, Polyodontidae, Montana, fisheries management, Yellowstone River, fishing

Introduction

Although paddlefish *(Polyodon spathula)* snag fisheries exist in several states (Combs 1986), more information is needed on attitudes of snaggers toward harvest regulations (Scarnecchia et al. 1996a). Since the early 1960s, the paddlefish fishery on the Yellowstone River has supported an important recreational fishery on the Yellowstone River, Montana (Robinson 1966; Scarnecchia et al. 1996b). The fishery is centered at Intake, Montana, at a low-head irrigation-diversion dam 27 km downriver from Glendive (Rehwinkel 1978). Over the period 1962-1993, between 500 and 5,000 paddlefish have been harvested annually at Intake (Scarnecchia et al. 1996b).

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A two-fish-per-person annual bag limit and mandatory retention regulations (i.e., prohibition of catch-and-release) were implemented in 1981 in response to concerns about mortality of mishandled, released fish (Elser 1986) and because of overcrowding of snaggers at the shoreline fishing sites. These regulations remained in effect until 1994 when an increase in mean age of the stock and an expanding fishery for the same migratory stock in North Dakota prompted the enactment of a one-fish-per-person annual bag limit in Montana (Scarnecchia et al. 1996b).

Several regulatory options have been considered for the Montana fishery, including catch-and-release fishing in conjunction with the one-fish bag limit. Catch-and-release has been used successfully in many fisheries for other species (Barnhart 1989), but has not been formally implemented anywhere for paddlefish. Release of snagged paddlefish is permitted,

however, in other fisheries (Elser 1986), including the Missouri River in Montana above Fort Peck Dam. In addition, quotas on total catch were also considered as a harvest option. Quotas, often called Total Allowable Catches (TACs), have been used commonly and successfully in marine fisheries throughout the 1970s and 1980s (Gough 1993; Parsons 1993).

The concentration of paddlefish at Intake attracts numerous snaggers each May and June who can be surveyed regarding fishing regulations and management policies (Matlock 1991; Pollock et al. 1994). Our objective was to obtain information on attitudes and preferences of snaggers on three fishery management options: a one-fish bag limit, catch-and-release, and harvest quotas.

Methods

Sampling Assumptions and Limitations

A 15-item self-administered questionnaire was administered to snaggers daily at Intake throughout the entire 1994 paddlefish snagging season (May 15-June 30). Although our preference would have been to query only one person per fishing party, low participation in snagging throughout much of the season made it necessary to survey all snaggers encountered. More than 95% of the snaggers approached were willing to spend the 5-7 minutes needed to complete the questionnaire. Non-responses were less than 1.5% for each question.

Because of a recent reduction in the annual bag limit combined with poor fishing in 1994, some snaggers probably avoided Intake entirely, resulting in a somewhat less disgruntled, more conservation-minded pool of respondents than would have been polled otherwise. For our study, the population of interest was defined as those licensed anglers who actually snagged for paddlefish at Intake, not the larger number of persons who purchased licenses and tags but did not fish. Questionnaires were completed by 258 snaggers, or an estimated 49% of the estimated total number of paddlefish snaggers at Intake in 1994.

The Questionnaire

The first three questions sought information on the state of residence (Montana resident versus non-resident), age, and sex of the snagger. The next three questions sought information on their primary and secondary fishing sites, i.e., how often they snagged for paddlefish at Intake, in the Missouri River above Fort Peck Dam, or elsewhere. Three questions concerned the effects of reduced bag limit (from two to one fish per person per year); two of the three questions concerned effects on the paddlefish stock and on snagger participation and a third question asked if the reduced bag limit had been justified. One question assessed their attitude toward catch-and-release for the paddlefish fishery.

To insure that snaggers understood the three quota options, Tag Limitation, Inseason Closure and Five-Year Quota, we summarized the options briefly for them on the questionnaire before the pertinent questions on quota options. Under Tag Limitation, annual harvest would be limited in each state by limiting the number of tags sold. Under Inseason Closure, an annual quota would be set and an unlimited number of tags sold. The fishing season would be closed when the quota was reached. Under a Five-Year Quota, once the total quota had been reached, the fishery would be closed for the remainder of that five-year period. The Five-Year Quota could thus result in some years with no paddlefish snagging season.

The last two questions asked if snaggers would prefer to have their quota divided as a two-fish or one-fish bag limit. Finally, snaggers were asked to write any comments at the end of the questionnaire.

Responses were summarized and analyzed with a Chi-Square statistic according to age (age 34 years and younger versus 35 years and older), sex and state of residence (Montana resident versus non-resident). For all questions, P=0.05 was required for statistical significance.

Results

Of the 258 snaggers who completed the questionnaire, 235 (91%) were male and 23 (9%) were female, 139 (54%) were younger than 35 years and 119 (46%) were 35 years or older, 154 (60%) were Montana residents and 97 (38%) were non-residents (2% unknown).

Most snaggers responding to questionnaires fished only at Intake (Table 1). More than one-fourth of the respondents had fished at Intake in each of the previous five years and most had fished there in more than one of the previous five years.

Table 1. *Number of years over the period 1990-1994 that respondent had snagged paddlefish a) at Intake, b) in North Dakota, and c) in the Missouri River above Fort Peck Dam.*

	Intake		North Dakota		Fort Peck	
Years fished during 1990-94	No.	%	No.	%	No.	%
None	NA	NA	227	88.0	230	89.1
One	87	33.8	10	3.9	17	6.6
Two	53	20.5	11	4.3	6	2.3
Three	28	10.9	7	2.7	3	1.2
Four	23	8.9	2	0.8	0	0.0
Five	67	26.0	1	0.4	2	0.8

NA= not applicable. All surveyed snaggers had fished at least once, i.e., the current year.

Snaggers were nearly equally split among all five response choices (Table 2) in their response to the statement "I would be less likely to return to Intake to fish for just one paddlefish than for two paddlefish." No significant differences were found according to age (P=0.33), sex (P=0.91), or state of residence (P = 0.14).

Slightly more snaggers agreed than disagreed with the conservation value of the bag limit reduction (Table 2). This split response occurred even though the rationale for the reduction in the annual bag limit from two to one fish had been presented at public meetings in eastern Montana. No significant differences were found in this response according to age (P=0.25), sex (P=0.93), or state of residence (P=0.26).

Table 2. *Percent responses to questions related to one fish bag limit and catch-and-release fishing. For responses, SD = strongly disagree, D= disagree, N = neutral, A=agree, and SA = strongly agree.*

Statement	Response (%)				
	SD	D	N	A	SA
I am less likely to return to Intake to fish for just one paddlefish than to fish for two paddlefish. (N = 256)	18	20	20	21	21
I think the paddlefish population will benefit from the reduced bag limit. (N = 257)	17	20	20	25	18
The reduction in catch from two to one fish is justified. (N = 257)	24	20	26	18	12
I would like to see some catch-and-release opportunities at Intake. (N =258)	8	7	12	21	52

Snaggers were split equally on whether the reduction from two fish to one fish was justified (Table 2). No significant differences were found in this response according to age (P=0.36), sex (P=0.99), or state of residence (P =0.08).

Seventy-three percent of the snaggers supported catch-and-release; only 15% did not favor some version of a catch-and-release regulation. Although all types of snaggers tended to support catch-and-release, support was significantly stronger among younger (<35 years) snaggers than older (35 or more years) snaggers (P=0.05).

Support for no quota option was strong, but snaggers most favored Inseason Closure (Table 3). No significant differences in response to the Inseason Closure option were detected by age (P=0.42), sex (P=0.96), or state of residence (P=0.94).

Table 3. *Percent responses to three quota options listed in Paddlefish Management Plan. For responses, SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree.*

Statement	Response (%)				
	SD	D	N	A	SA
If the number of snaggers and their expected catch exceeded Montana's quota, I would favor a lottery drawing for paddlefish tags [Tag Limitation](N = 251)	39	23	13	16	9
I would prefer that the season be closed each year when the quota is reached. [Inseason Closure] (N = 252)	25	14	17	26	18
I would prefer a five-year quota, even if it meant that the season might be closed entirely in some years. [Five-Year Quota] (N = 247)	49	22	15	8	6

Tag Limitation was the second choice; 25% of respondents agreed or strongly agreed with this option but more than 60% disagreed or strongly disagreed with it. No significant differences in response to Tag Limitation were detected by age (P=0.94), sex (P=0.35) or state of residence (P=0.59).

The Five-Year Quota option was preferred least; nearly half of the respondents strongly disagreed and 22% disagreed with it. Although no significant differences in response were detected by age (P=0.44) or sex (P=0.28), non-resident snaggers showed a much stronger and highly significant preference for this option than did Montana residents (P=0.01).

Snaggers were split on whether a two-fish or one-fish annual bag limit would be preferable under a quota system (Table 4). Thirty-eight percent of respondents agreed or strongly agreed with a one-fish limit under a quota system and 38% disagreed or strongly disagreed. No significant differences in response were detected by age (P=0.52), sex (P=0.35), or state of residence (P=0.46). Preference for a two-fish bag limit under a quota system was weaker than for a one-fish limit. Half (50%) of respondents disagreed or strongly disagreed with the two-fish bag limit under a quota system and only 29% agreed or strongly agreed. No significant differences in response were found by age (P=0.27), sex (P=0.94), or state of residence (P=0.41).

Table 4. *Percent responses to one-fish and two-fish bag limits under a hypothetical quota system. For responses, SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree.*

Statement	Response (%)				
	SD	D	N	A	SA
I would prefer to have Montana's quota divided up among snaggers so that each snagger's bag limit would be one fish. (N = 250)	21	17	24	26	12
I would prefer that Montana's quota be divided up among snaggers so that each snagger's bag limit would be two fish, even if it meant lower chances of successfully drawing for a tag. (N = 248)	28	22	21	19	10

The most common open-ended comments (total of 100 responses on 258 questionnaires) were recommendations for catch-and-release snagging (24 responses), a preference for a two-fish over a one-fish bag limit (19), and a preference for the one-fish bag limit (10).

Discussion

Although Inseason Closure was the preferred option if a quota were necessary, none of the three quota options received strong support. Inasmuch as respondents were split on whether the reduced bag limit from two to one fish was justified and if the reduction would help the paddlefish stock, it is understandable that they would resist any effort to establish quotas. Support for quotas may also be lacking because the processed-yield of paddlefish fillets is low (33.5%, including the less desirable red meat; Decker et al. 1991). For such interjurisdictional fisheries, however, quotas have a history of success (Gough 1993). According to Parsons (1993), "Catch quotas were chosen as a primary regulatory instrument because it was easier to implement national allocations under a system of catch quotas than under a system of effort limitations." With the coexisting fishery in North Dakota for this stock (Scarnecchia et al. 1996b), total harvest may be controlled best by allocating a quota of fish separately to each state.

The reason for the greatest support for the Inseason Closure option is probably a result of two factors. Inseason Closure would permit the purchase of paddlefish tags by all applicants, unlike tag limitation, and guarantee at least some fishing each year, unlike the Five-Year Quota. Although Tag Limitation is practiced for some big game mammals in Montana and other states, it has seldom been used for fish. A one-fish bag limit in combination with a tag drawing may not justify a trip to Intake.

From a management standpoint, several aspects of Inseason Closure would need to be addressed if it were implemented. Although it would be possible to monitor daily catches at Intake and at the Yellowstone-Missouri River confluence, which is the primary North Dakota fishing site, off-site harvest, now estimated post-season, would have to be estimated inseason. Second, the prospect of inseason closure induces fishermen to fish as early in the season as possible (Parsons 1993). Such a shift might create crowding problems, especially in years of more successful fishing and resulting higher demand for tags. Third, this option would shift catch and effort to earlier in the season, making comparison with past years less appropriate. Because the quality and consistency of the historical data base are important to stock assessment, it would be preferable if the fishery were not altered greatly in its seasonal pattern.

Under Tag Limitation, historical catch rates of tag holders could be used to estimate probable catch, and the appropriate number of tags could be sold. The crowding and stock assessment problems created under Inseason Closure would not occur.

Snaggers preferred a one-fish bag limit to a two-fish bag limit under a quota system (Table 4). These responses seem to contradict the common open-ended comment (19 responses) that suggested a return to a two-fish bag limit. Our interpretation of their responses is that if the stock could withstand the pre-1994 management system of a two-fish bag limit, no quota, and unlimited tag sales, this would be the preferred approach. With a quota, however, a latent concern is evidently that the quota will be so low that many people will not be able to obtain tags. Thus, the opportunity to catch and keep one fish might be preferable to not drawing a tag at all.

A combination of the one-fish bag limit enacted in Montana in 1994 and the low spring discharge in the Yellowstone River resulted in an all-time low catch and effort at the Intake fishery in 1994. This reduction in catch and effort raises the question of whether a quota, which is considered undesirable by snaggers (Table 3), would be

necessary under present fishing interest and a one-fish bag limit.

The strong support (73% of respondents) for catch-and-release is interpreted as support for catch-and-release *in addition to* rather than *in place of* harvest. Since 1981, retention of snagged paddlefish on the Yellowstone River has been mandatory. In Montana, mandatory catch-and-release was first enacted in 1978 for trout (Salmonidae) on a stretch of the Madison River (Wells 1987); it has become common practice nationwide for warmwater, coldwater, and selected marine fishes since the 1980s (Barnhart and Roelofs 1977, 1987; Barnhart 1989).

Few of several thousand paddlefish landed at Intake during the period 1991-1994 and examined by us showed any overt signs of external damage from snagging. Some fish developed roundish, 1-3 cm diameter skin lesions, probably a result of sloughing of an imbedded hook. The most common form of damage was from boat propellers. Although other fish species have exhibited high stress levels, such as rainbow trout, *Oncorhynchus mykiss;* (Ferguson and Tufts 1992) and even disrupted spawning, as in smallmouth bass, *Micropterus dolomieui* (Kieffer et al. 1995) from hooking and handling, more information is needed on their potential effects on pre-spawning paddlefish.

Mandatory catch-and-release paddlefish snagging was enacted at Intake in 1995 for two six-hour periods per week during the May 15 to June 30 fishing season. At all other times, mandatory retention of paddlefish remained in force. Catch-and-release of each fish was monitored by trained state fishery personnel and excessive handling of paddlefish avoided. Snagged paddlefish were tagged immediately with jaw tags to provide information in the future on harvest rates and population abundances (Qualia 1987). In future years, effects of catch-and-release snagging will be evaluated through inspections of recaptured fish and with searches for dead or distressed paddlefish. Results from this study are being used in conjunction with fish stock assessments (Scarnecchia et al. 1996b) to set harvest regulations for the fishery.

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