FISHERY DATA SERIES NO. 13

MOVEMENT, ABUNDANCE AND LENGTH COMPOSITION OF 1986 TANANA RIVER BURBOT STOCKS

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DECEMBER 1987

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[1]This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-2, Job No. N-8-3.

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ABSTRACT

In an ongoing study of burbot (*Lota lota* Linnaeus) in the Tanana River, a total of 3,541 burbot (greater than or equal to 300 millimeters in total length) were tagged during 1986. Tag returns obtained from area anglers and from continued sampling since 1983 indicate that burbot move upstream more than downstream after being released. The greatest recorded movement was by a burbot that moved 256 kilometers upstream over a period of 1,244 days.

Sampling was conducted using baited hoop traps during 1986 in sub-sections of 11 of 14 Tanana River study sections. Catch per unit of effort (burbot caught per hoop trap per net-night) data were collected for an index of burbot abundance. Average catch per unit of effort ranged from a low of 1.16 burbot per net-night near Fairbanks to a high of 20.0 burbot per net-night near Healy Lake outlet.

A mark recapture population estimate of the number of burbot 300 millimeters and greater was conducted in a 6.4 kilometer subsection of the Tanana River near Rosie Creek. The estimated abundance was 2,892 burbot (standard error = 670). The hoop trap catch per unit of effort in this area was low; 1.49 burbot per net-night.

The mean length of burbot sampled in the Tanana River during 1986 was 635 millimeters. Only slight differences in length frequency of burbot between river sections was documented and no clear segregations of burbot by size to specific areas was noted. Female burbot had a larger maximum length and were longer lived than male burbot. Growth rates of male and female burbot were similar.

KEY WORDS: burbot, *Lota lota* Linnaeus, Tanana River, hoop trap, catch per unit effort, length-at-age, age frequency, migration, tagging, mark-recapture, population estimate.

INTRODUCTION

The Tanana River is a large glacial river formed at the confluence of the Chisna and Nabesna Rivers near Northway, Alaska. From its origin, the Tanana River flows northwesterly for 912 km where it drains into the Yukon River, approximately 6 km east of the village of Tanana (Figure 1). Because of silty water from its glacial origins, sport fishing for most species in the Tanana River is limited to areas near the confluence of clear water tributaries such as the mouths of the Chena and Salcha Rivers.

Burbot (*Lota lota* Linnaeus) in the Tanana River are the object of one of the fastest growing sport fisheries in Alaska. Anglers use both hand-held fishing poles and set lines, with up to 15 hooks. Harvest in 1986 was almost 3,000 burbot; a two-fold increase over the harvest in 1985 (Mills In Prep.).

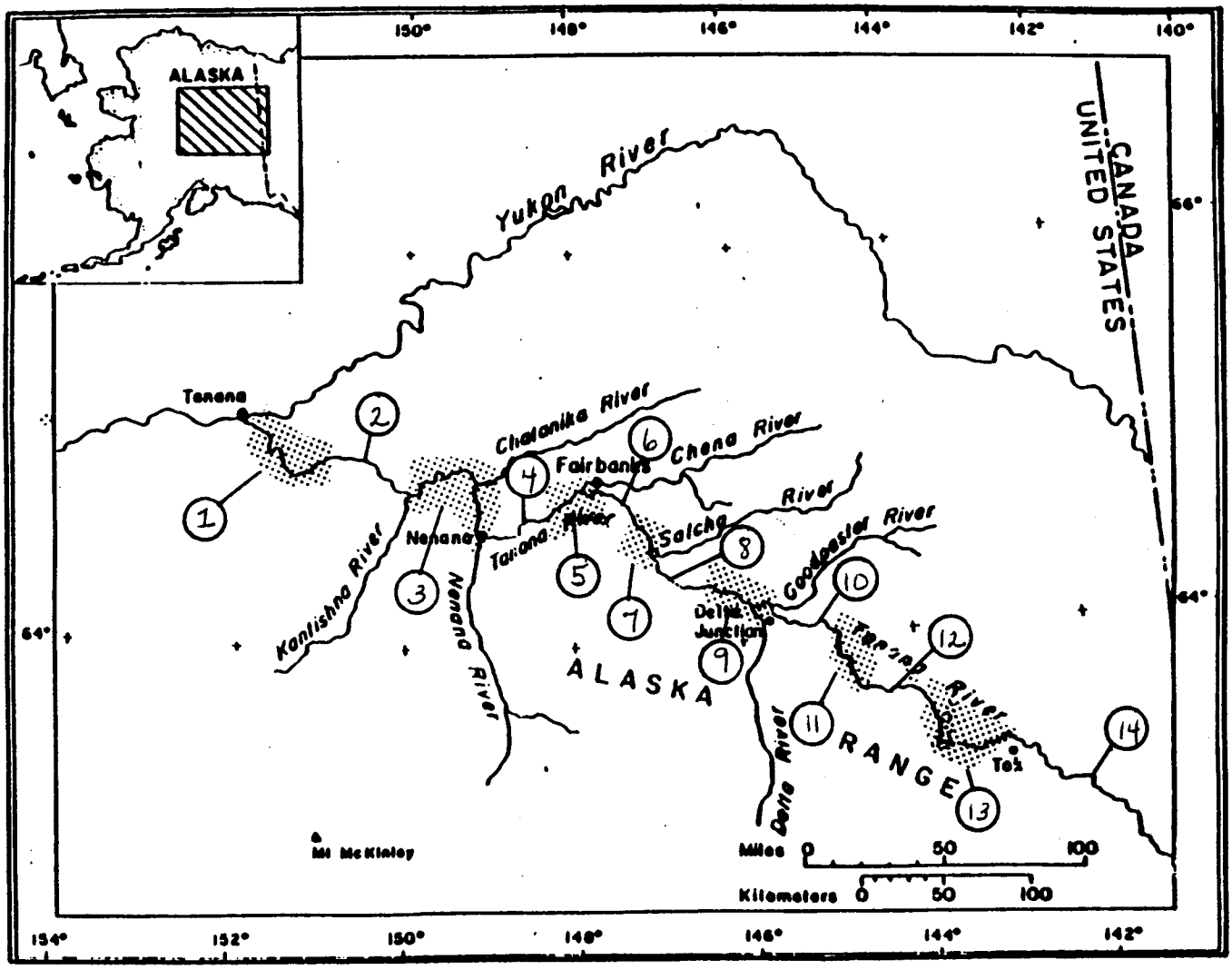

Figure 1. Study sections of the Tanana River.

The Alaska Department of Fish and Game (ADFG) began to assess stock status of the Tanana River burbot population in 1983. Between 1983 and 1985, more than 1,000 burbot were tagged to define migratory behavior and to research potential stock differentiation of burbot in the Tanana River (Hallberg 1986). Population parameters, such as age composition, mean length and weight, growth, sex ratios, relative abundance (hoop trap catch rates), and migration patterns of Tanana River burbot have also been estimated (Hallberg 1985 and 1986). This report summarizes progress of this research endeavor during 1986 and updates information provided by Hallberg (1986).

The long-term goal of the Tanana River burbot investigation is to define sustainable yield of the stock(s) such that rational sport fishery regulations can be developed to maintain the fishery under increasing fishing pressure by anglers. In pursuit of this goal, information is sought about the stock structure, abundance, growth, and mortality of burbot in the Tanana River. Specific objectives for this investigation in 1986 were as follows:

1. To continue the tagging and recapturing burbot program started in 1983 to gain information on growth and movements of individual burbot throughout the Tanana River;

2. To estimate the size composition of burbot > 300 mm in total length (TL) in various sections of the Tanana River;

3. To estimate catch per unit of effort (CPUE) in hoop traps as an index of population abundance of burbot > 300 mm (TL) in sections of the Tanana River; and,

4. To estimate the total number of burbot > 300 mm (TL) and larger residing in a 6.4 km section of the Tanana River.

MATERIALS AND METHODS

The Tanana River was divided into fourteen study sections (Figure 1). These river sections varied in length from 18 to 112 km and usually represented a stretch of river between two tributary streams. Sampling in 1986 was conducted in subsections of eleven different river sections by two two-man crews between 1 June and 30 September. Subsections were small portions of overall river sections and were generally a few kilometers in length (Figure 2). Sampling usually took place in a river subsection toward the center area of an overall river section (Table 1).

Burbot were captured using commercially manufactured hoop traps baited with cut Pacific herring (*Clupea harengus pallasi* Valenciennes) that were placed in a perforated plastic bait container located in the cod end of the hoop trap. Hoop traps were 1 m in diameter and 4 m long with 25 mm square mesh nylon netting attached to seven fiberglass hoops. The hoop nets had finger style throats on the second and fourth hoops. Hoop traps were stretched tight with the use of two 3.3 m pieces of plastic pipe

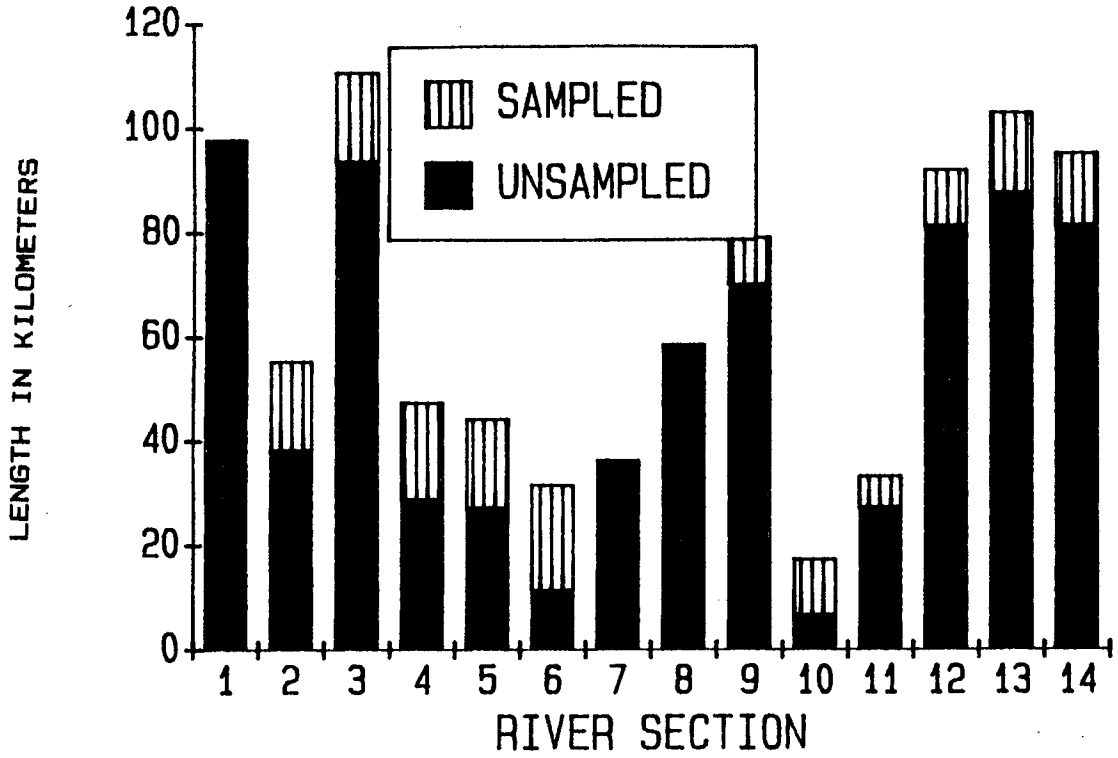

Figure 2. Length of study sections of the Tanana River and length of subsections sampled during 1986.

Table 1. Boundaries of Tanana River study sections and boundaries of the subsections sampled in 1986.

Section Number	Section Location and Boundaries: Map Reference[1]	Km	Mi	Subsection: Boundaries: Km	Mi	Length: Km	Mi
1	Mouth upstream to	0	0				
	Manley Hot Springs Slough	98	62				
2	Manley Hot Springs Slough to	98	62	98	62	17	11
	upstream of Kantishna River	154	97	116	73		
3	Kantishna River upstream	154	97	247	156	17	11
	to Nenana River	265	167	265	167		
4	Nenana River upstream	265	167	265	167	19	12
	to Bonanza Creek	312	197	284	179		
5	Bonanza Creek upstream	312	197	334	211	17	11
	to Chena River	356	225	352	222		
6	Chena River upstream	356	225	356	225	21	13
	to Moose Creek	388	245	377	238		
7	Moose Creek upstream	388	245				
	to Salcha River	425	268				
8	Salcha River upstream	425	268				
	to Delta Creek	483	305				
9	Delta Creek upstream	483	305	523	330	10	6
	to Volkmar River	562	355	532	336		
10	Volkmar River upstream	562	355	553	349	11	7
	to Healy Lake outlet	580	366	564	356		
11	Healey Lake outlet	580	366	578	365	6	4
	upstream to George Creek	613	387	584	369		
12	George Creek upstream	613	387	608	384	11	7
	to Cathedral Bluffs	705	445	619	391		
13	Cathedral Bluffs upstream	705	445	705	445	16	10
	to Tok Bridge	808	510	721	455		
14	Tok Bridge upstream	808	510	889	561	14	9
	to Northway	903	570	903	570		

[1] Refer to Figure 1 for map references.

attached with snaps to the outside of the first and seventh fiberglass hoop. Hoop traps were attached to shore with a rope and they were placed on the river bottom with the trap throats facing downstream. A large outboard-powered riverboat was used to set and retrieve hoop nets. Due to fluctuating water levels, netting locations were selected in the field on a daily basis. Net locations were marked on 1:63,360 USGS maps. All hoop traps were baited with fresh Pacific herring each day. Those traps that caught no burbot were moved daily to a new fishing location within the subsection.

During a sampling week, a single crew typically fished twenty-five hoop traps over a four night period thus averaging 100 net-nights of fishing effort (range: 54 to 351 net-nights) in a subsection of the river. Subsections of eleven different river sections were fished in this manner (Table 1). Nets were set at near equal intervals throughout each subsection during the first night of sampling. Mean CPUE and variance of mean CPUE were calculated from the number of burbot caught per net-night during the <u>first night of sampling only</u> based upon the following equations from Wolter (1984):

$$\overline{CPUE} = \bar{x} = \left\{\frac{1}{n}\right\} \sum_{i=1}^{n} x_i \qquad V[\overline{CPUE}] = \frac{\sum_{i=2}^{n} [x_i-(x_{i-1})]^2}{2n[n-1]}$$

Where:

n = the number of hoop traps fished; and,

x_i = the catch of burbot in the i^{th} hoop trap set in ascending order from downstream to upstream.

Subsequent sets of data (data from the 2nd, 3rd, and 4th night of fishing) were not used in the calculation because catches and catch rates after the first night (and potential mean CPUE if these data were included) were biased because hoop traps with zero catches were moved to new fishing locations.

All burbot greater than 300 mm TL were tagged using Floy internal anchor tags, finclipped (right pelvic), and released near where they had been captured. Otoliths and vertebra were collected from all dead burbot to determine ages of fish. Due to few such samples, age data from all sections were pooled with information collected since 1983.

Abundance of burbot over 300 mm TL in a 6.4 km subsection of Section 5 (Figure 1) near Rosie Creek was estimated through a mark recapture experiment based on the Chapman modification of the Petersen estimator (Ricker 1975). The first sampling event in the experiment took place during a four-night, five-day sampling period using 25 hoop traps for a total of 100 net-nights of fishing effort. The marked burbot were allowed to mix with the rest of the population for a minimum of 10 nights.

Subsequently, two sampling crews worked 25 hoop traps each, on opposite sides of the river for a total of 251 net-nights of fishing effort for the second sampling event.

RESULTS

Tagging Study

More burbot were tagged in 1986 than in all the other years combined (Figure 3). In 1983, 100 burbot were tagged, whereas, in 1984 and 1985, 99 and 841 burbot were tagged, respectively (Hallberg 1986). In 1986, 3,541 burbot greater than 300 mm TL were tagged, bringing the number of burbot tagged in the Tanana River since 1983 to 4,581.

To date, the angling public and ADF&G from subsequent sampling have recovered 131 tagged burbot after 4 to 1,244 days of freedom. Two of the recaptured burbot had moved down the Tanana River 24 and 52 km and subsequently moved 13 to 40 km respectively up the Goodpaster River where they were caught by anglers fishing through the ice. A third burbot that was tagged in the Tanana River near the mouth of the Goodpaster River, was recaptured 24 km up the Goodpaster River during the winter by an angler. These burbot were 500 to 600 mm in length at time of tagging and are considered to be adult burbot that may have moved into the Goodpaster River to spawn. Of the remaining 128 burbot, 64 (50.0%) were recaptured in the same area as they were released, 54 burbot (42.2%) moved upstream, and 10 (7.8%) moved downstream. Burbot that had moved upstream had been on average, at freedom, the longest and had moved the farthest (Table 2). There was no significant difference in the average size of burbot that moved upstream or downstream or that remained relatively stationary. Burbot were recaptured primarily in the vicinity of Fairbanks, Delta, and Northway in Sections 5, 6, 9, and 14 (Figure 4). However, the number of recaptured burbot from sections 5 and 6 are disproportionately large when compared to numbers tagged (Figure 3).

Length and Age Composition

The mean length of 3,769 burbot sampled in 1986 did not vary in a consistent manner along the Tanana River (Figure 5). Burbot sampled from Section 14 had the largest mean and maximum lengths while those sampled from Section 11 had the smallest average and minimum lengths. The average length of all burbot sampled in 1986 was 536 mm TL. The length frequency distribution of all burbot sampled in 1986 had a modal length at 525 mm with the maximum burbot length in excess of 1,100 mm (Figure 6).

Although females were larger than males in the samples collected since 1983 throughout the river (Figure 7), growth rates of males and females were similar (Figure 8). The largest females were more than 1,100 mm TL while the largest males were only 900 mm TL. Burbot of both sexes grew an average of 68 mm annually between age 1 and 6. After age 6, growth rate slowed considerably. Age 6 burbot averaged 506 mm (Table 3). A sample of 27 tagged burbot recaptured and remeasured by the staff showed an average annual growth of 42 mm.

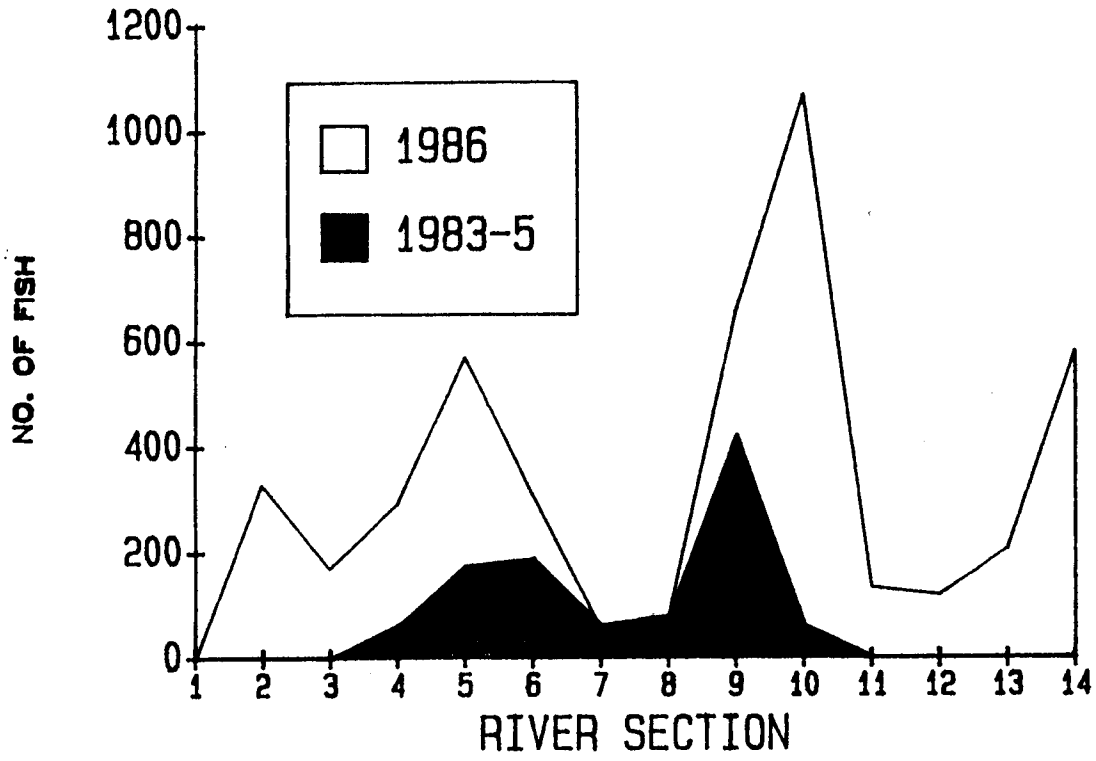

Figure 3. Number of tagged burbot released in each study section of the Tanana River from 1983 through 1986.

Table 2. Summary statistics for movements of recaptured burbot in the Tanana River[1].

Category		Movement Exhibited by Burbot: None	Downstream	Upstream
Number of Burbot Recaptured by:	Anglers	46	10	31
	Hoop Traps	18	0	23
	Combined	64	10	54
Mean Length (mm TL)		572	628	563
Standard Error (mm TL)		17	41	17
Mean Kilometers Traveled			2.4	53.5
Median Kilometers Traveled			2	29
Maximum Kilometers Traveled			6	254
Mean Days of Freedom		175	88	263
Standard Error (Days)		22	29	37

[1] Does not include three burbot that were recaptured in the Goodpaster River.

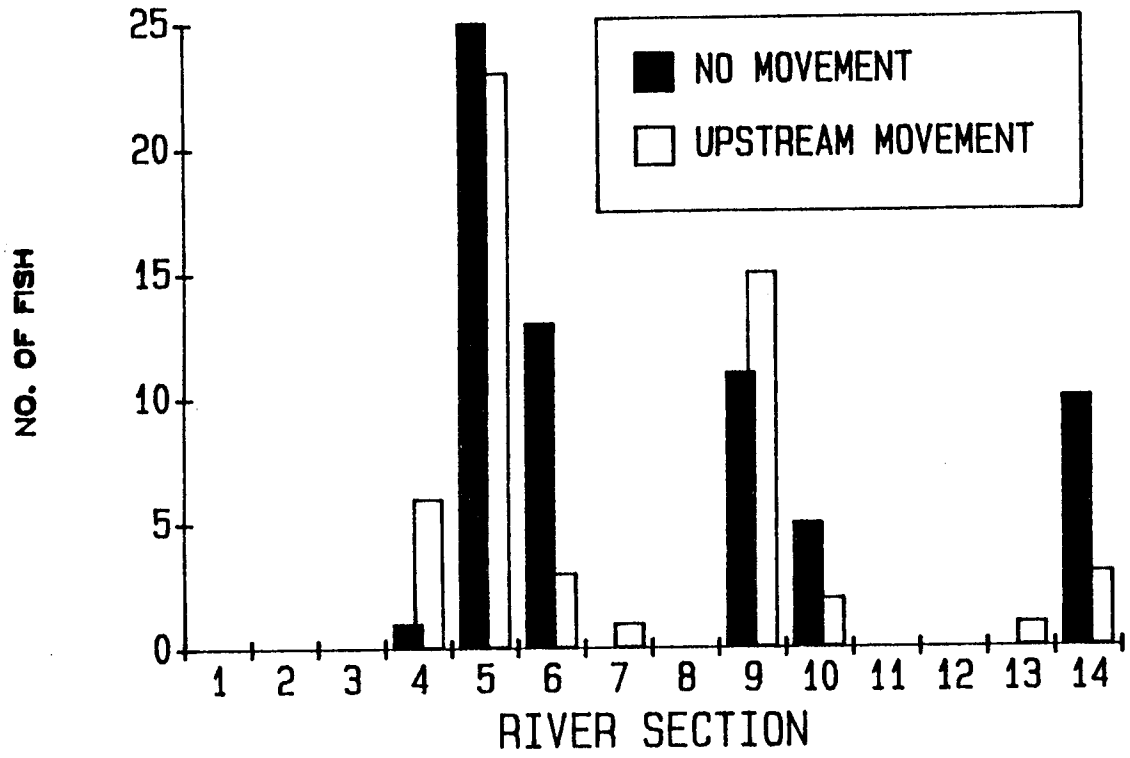

Figure 4. Number of burbot that were recaptured according to Tanana River section of release.

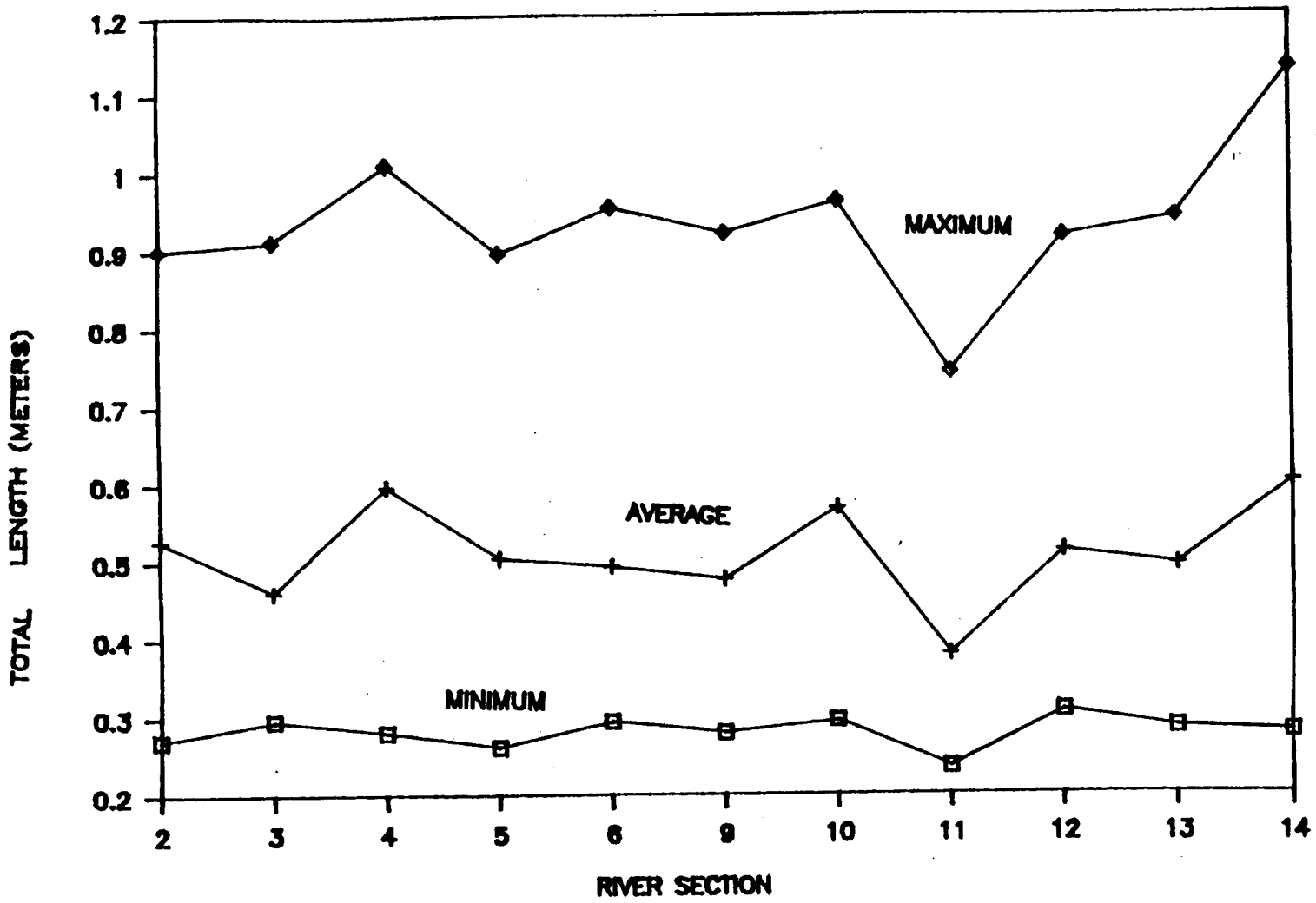

Figure 5. Minimum, maximum, and mean lengths of burbot sampled in a subsection of each of 11 Tanana River sections in 1986.

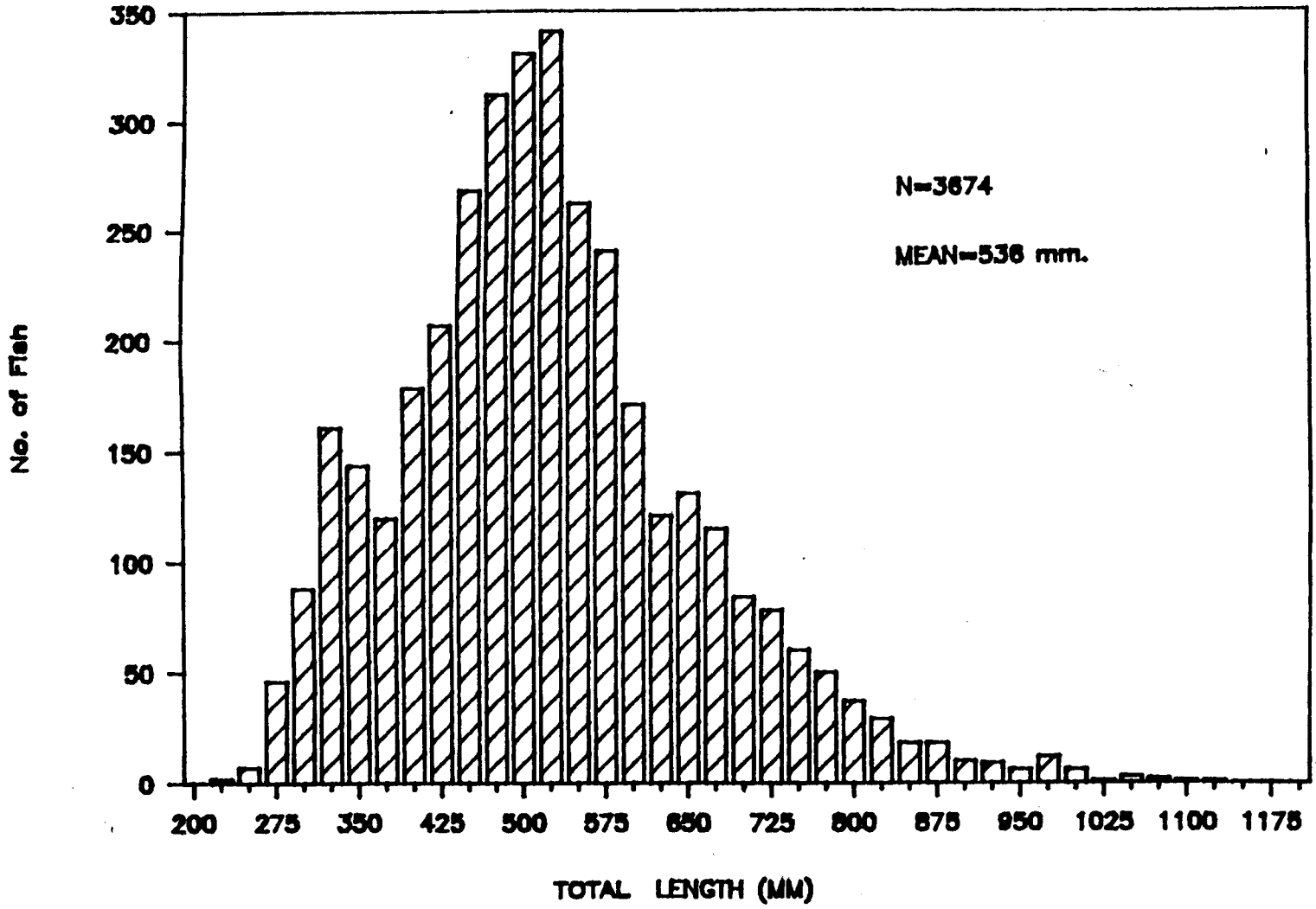

Figure 6. Length frequency distribution for sampled Tanana River burbot during 1986.

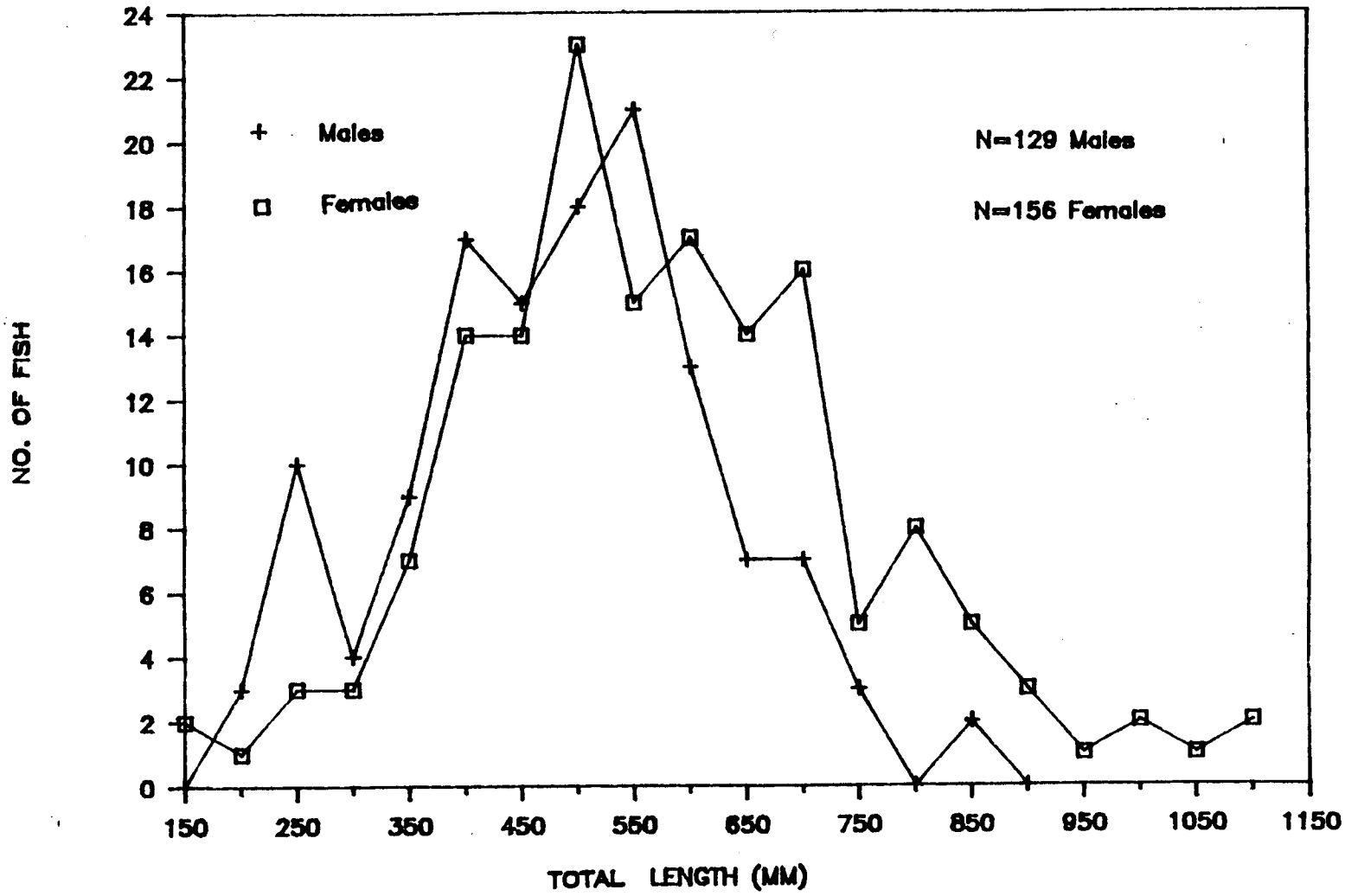

Figure 7. Length frequency distribution by sex for sampled Tanana River burbot during 1986.

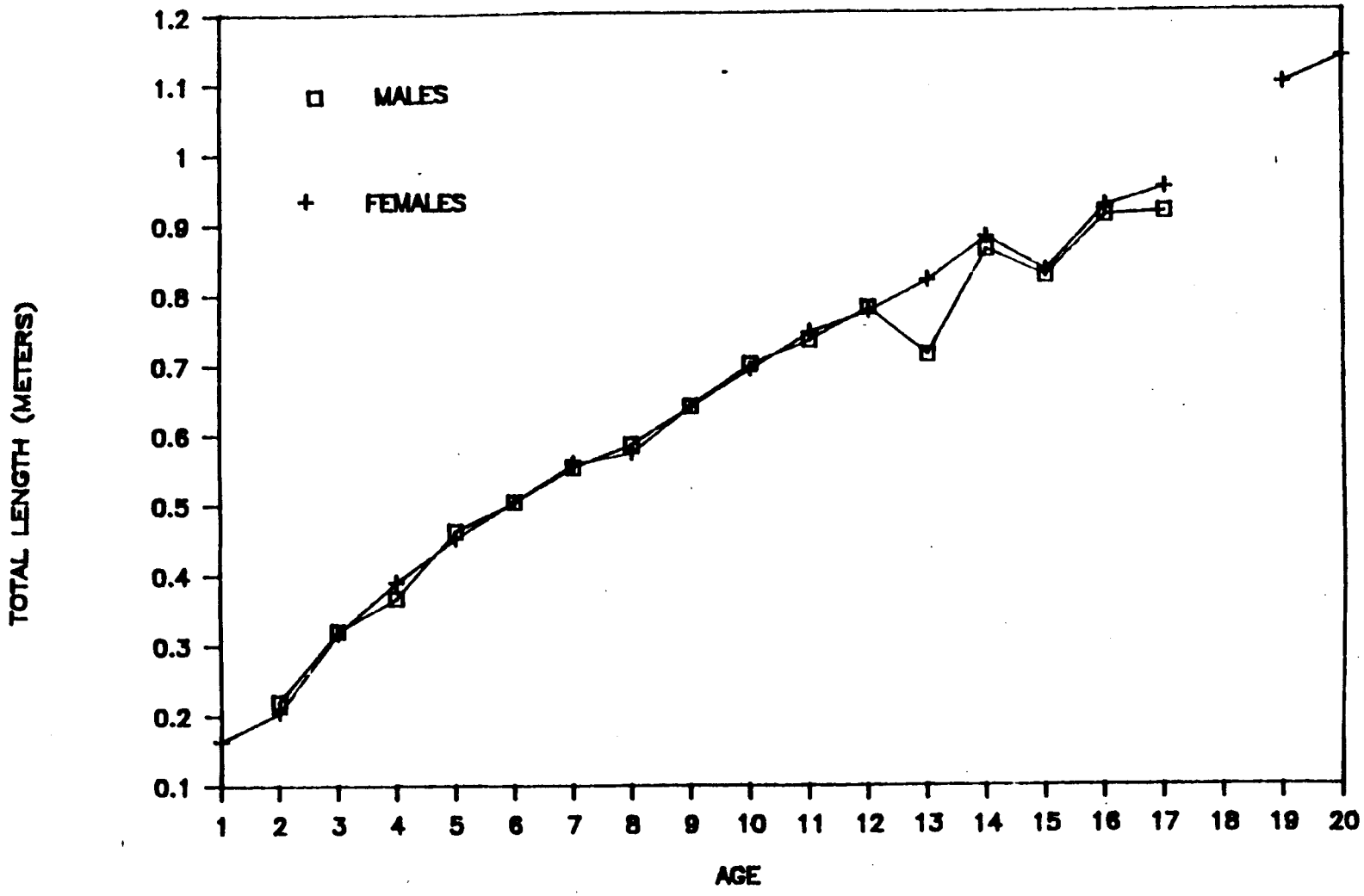

Figure 8. Mean length at age for male and female Tanana River burbot sampled from 1983 through 1986.

Table 3. Age frequency and mean length at age for 381 Tanana River burbot sampled from 1983 through 1986.

	Length (mm TL):				
Age	Mean	SE	Range	Number	Percent
0	141	5.5	133-152	4	1.0
1	172	4.6	162-184	10	2.5
2	300		300	1	0.3
3	311	20.7	200-470	14	3.7
4	387	10.6	290-547	29	7.7
5	446	11.5	297-634	32	8.4
6	506	7.2	316-648	61	16.1
7	550	10.6	426-865	54	14.2
8	576	8.7	436-711	42	11.1
9	626	9.4	450-762	43	11.3
10	689	11.8	510-915	34	9.0
11	737	14.4	560-830	20	5.3
12	781	12.9	715-819	8	2.1
13	779	10.5	620-882	9	2.3
14	880	40.6	785-1,035	7	1.9
15	869	58.6	825-950	3	0.8
16	920	50.1	822-1,020	4	1.0
17	932	47.3	915-950	2	0.5
18				0	0
19	1,099	50.1	1,080-1,117	2	0.5
20	1,135		1,135	1	0.3
Totals				380	100.0

Of the 381 burbot sampled from the Tanana River since 1983 for which ages were estimated, 61% were between age 6 and 10, 15% were between age 11 and 20, and the remaining 24% were less than 6 years old (Figure 9). The oldest sampled burbot was 20 years old.

Catch Per Unit of Effort

In 1986, mean CPUE were obtained in subsections of eleven of the fourteen Tanana River sections (Table 4). Catch per unit of effort ranged from a low of 1.16 burbot per net-night in Section 6 to 20.00 burbot per net-night in Section 10. Mean CPUE was below 6.00 burbot per net night in all sections but one.

Burbot Population Estimate

A mark recapture population estimate was conducted on a 6.4 km section of the Tanana River near the mouth of Rosie Creek, approximately 10 km below the confluence of the Chena and Tanana Rivers (Figure 1). During late July, 100 net-nights of fishing effort were expended to catch, mark and release 154 burbot. The recapture sampling event was conducted in mid-August and allowed for a minimum of 10 nights for mixing of marked and unmarked burbot in the study area. During the recapture event, 251 net-nights of fishing effort were expended to capture 279 burbot, of which 14 were marked burbot from the first event. Five of these tagged burbot were caught at least one km downstream from their point of release, six were caught at least one km upstream from their point of release and three were caught within one km of where they had been released. The maximum recorded movement of any recaptured burbot during the mark recapture experiment was 4.8 km. Size selectivity was evaluated using a chi-square analysis of the capture frequency of burbot smaller than 450 mm in length versus those 450 mm and greater for burbot caught during the first and second sampling events and for recaptured burbot. Differences in capture frequency were not significant ($X^2 = 0.92$, DF = 2, $p > 0.95$). Therefore, data from all size groups were pooled for the population estimate to obtain an estimate of 2,892 burbot (SE = 670) greater than 300 mm TL in the 6.4 km study area. The 90% confidence interval of this estimate was 1,789 to 3,996 burbot (± 38%).

DISCUSSION

Prior to this study, little was known about burbot movements and migratory behavior, especially in large rivers such as the Tanana River. Morrow (1980) reported that burbot are generally sedentary. Studies conducted in the Susitna River, Alaska, suggested that burbot migrate considerable distances to and from spawning grounds, but showed little movement at other times of the year (Sundet and Wenger 1984). Results of this study may confirm the spawning migration hypothesis put forward by Sundet and Wenger (1984) in that three burbot migrated up the Goodpaster River apparently to spawn. However, definitive conclusions will not be reached until additional data are collected in future years. Additionally, we

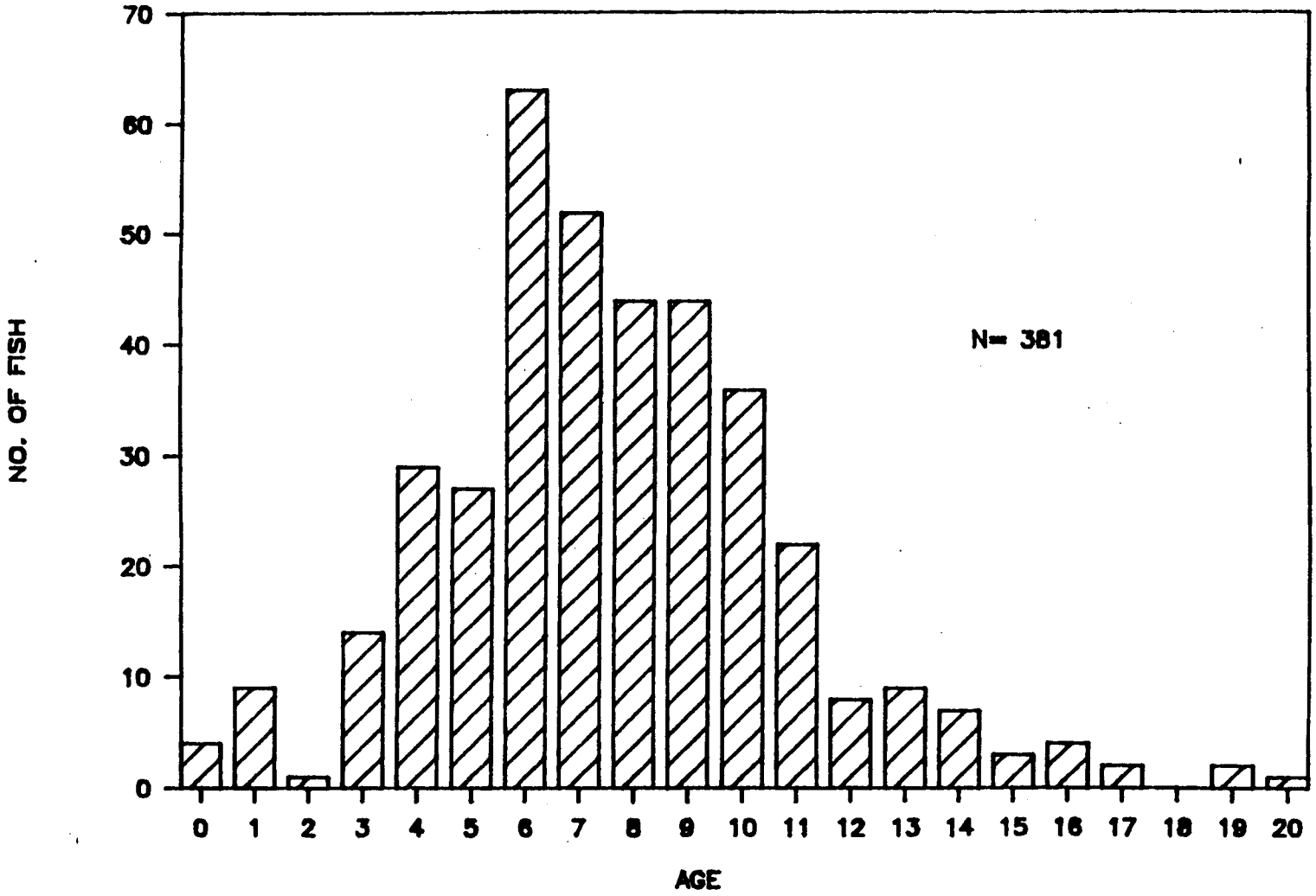

Figure 9. Age frequency distribution for Tanana River burbot sampled from 1983 through 1986.

Table 4. Summary of hoop trap catch per unit of effort for burbot by Tanana River section during 1986.

River Section	Sampling Date	Effort NN[2]	Total Catch	CPUE:[1] Mean	CPUE:[1] SE	Total Tagged	Length (mm): Mean	Length (mm): Range
2	6/23 to 6/27	104	332	2.65	0.48	330	527	270-990
3	7/7 to 7/11	100	173	2.12	0.38	172	460	295-912
4	8/19 to 8/22	67	250	3.09	0.38	233	596	280-1010
5	7/29 to 8/2 & 8/11 to 8/15	351	439	1.49	0.30	399	507	261-896
6	9/8 to 9/12	115	126	1.16	0.39	117	493	294-954
9	8/8 to 8/8	54	252	5.31	0.76	239	477	279-921
10	8/11 to 8/15	90	1090	20.00	3.30	1007	568	295-962
11	7/7 to 7/11	100	162	2.92	0.98	134	380	235-742
12	9/8 to 9/12	73	131	2.19	0.37	120	511	307-912
13	7/29 to 8/2	108	221	2.67	0.42	207	493	285-940
14	7/23 to 7/27 & 9/16 to 9/20	194	595	4.28	0.56	581	600	279-1131

[1] These data are based on the burbot catch during the first night of sampling only in each subsection; see text for explanation (average = 25 net-nights).

[2] NN = hoop trap net nights of sampling effort.

have not sampled burbot in mid-winter (spawning season), so movements associated with spawning have entirely depended upon tag returns from anglers. Most other recaptured burbot in this study either did not move or they moved upstream. Mean upstream movement was 53.5 km over an average of 262 days and mean downstream movement was only 2.4 km over an average of 88 days. The greatest recorded movement was by an individual burbot that moved upstream 256 km over a period of 1,244 days.

As yet, there are too few data to distinguish separate stocks of burbot in the Tanana River. About a thousand tagged burbot were at large prior to the 1986 field season. Several thousand additional burbot were tagged during 1986. A clearer picture of the stock structure of burbot in the Tanana River will be obtained during future years due to tagging success in 1986. However, information on age and growth of burbot may be considered as sufficient conditions for the argument that burbot in the Tanana River are a single stock. No consistent difference in size of burbot in upstream versus downstream river sections were apparent. Also, the length of burbot in river sections near Fairbanks did not demonstrate obvious declines that might be attributed to fishing. Burbot recruit to the sport fishery at age 5 and at a length of about 450 mm TL. About 85% of the burbot sampled from the Tanana River since 1983 were of catchable size.

Catch per unit of effort for burbot caught in standardized hoop trap sets is being evaluated as a cost effective method of indexing burbot population abundance. Annual sampling in established index subsections of the Tanana River using standard hoop trap sets provides a catch rate that hopefully can be used for comparative purposes to describe fluctuations in burbot population abundance. How hoop trap CPUE relates to actual burbot abundance remains to be answered. Significant variability in hoop trap catch rates between river sections was observed. The CPUE in Section 10 (20.0 burbot per net-night) was over three times that of the next highest catch rate observed in other river subsections sampled during 1986. Sampling in the subsection of river section 10 was primarily in the area of Healy Lake outlet where an abundance of forage species may be available. The two lowest average CPUE were in Sections 5 and 6, located near Fairbanks. Heavy sport fishing pressure over a period of several years in Sections 5 and 6 may have reduced population levels causing the observed lower burbot catch rates in hoop traps. However, CPUE in Sections 7 and 8 which were sampled during 1985 (Hallberg 1986), had lower average CPUE than did those observed in Sections 5 and 6 sampled a year later. Sections 7 and 8 are relatively remote and therefore, lower angling pressure would be expected. The Tanana River in Sections 5 through 8 is generally wide (averaging 1.6 km) and is braided with numerous islands. Current velocity tends to be greater in these sections and backwater areas and pools are less frequent. These differences in habitat character may cause fewer burbot to inhabit these areas or may reduce hoop trap fishing efficiency. Either could result in lower burbot catch rates in hoop traps.

Unfortunately, the population estimate could be biased due to one or more of several factors of unknown importance. The single population estimate

conducted in 1986 was in an area of low average CPUE. The estimated population in this subsection was relatively high; 452 burbot per km. For an unbiased population estimate, population closure and complete mixing of marked and unmarked fish are required. The movements of the 14 recaptured burbot in this experiment indicates that mixing of tagged and untagged burbot had probably taken place. However, the distance that these fish had moved opens the possibility that marked fish had moved out of the subsection between sampling events. If some tagged burbot left the study area and some new burbot entered the study area between the marking and recapture sampling events, the population estimate would be biased high. Some sampling was performed upstream and downstream from the area where burbot were tagged and released; no marked burbot were caught outside of the study area.

Additional population estimates need to be performed in other sections of the Tanana River and the possible biases associated with these estimates should be evaluated to quantify the relationship between average CPUE and population abundance. In addition, hoop trap sampling within each river subsection should be increased to improve precision of CPUE estimates and to eventually improve the relationship between average CPUE and estimates of abundance of burbot.

ACKNOWLEDGEMENTS

The authors extend their thanks to the sport fishermen in the Tanana Drainage who have assisted in this study by returning tags and providing data concerning these tagged burbot and who have assisted by providing burbot carcasses for age analysis. The authors extend their thanks to both Matt Evenson and to Al Mathews who assisted with much of the field work associated with this study. The authors thank David R. Bernard for his assistance with parts of the statistical procedures, data analysis, and editing included in this report. Appreciation is extended to John H. Clark for support and guidance in conceiving and implementing aspects of the Tanana River burbot research. Thanks to Doug Vincent-Lang and Dave Watsjold for providing technical editing. The authors thank the United States Fish and Wildlife Service for partial funding support through the Federal Aid in Fish Restoration Act (16 U. S. C. 777-777K) under Project F-10-2, Job Number N-8-3.

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