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ABUNDANCE AND SIZE COMPOSITION OF CHATANIKA RIVER LEAST CISCO AND HUMPBACK WHITEFISH WITH ESTIMATES OF EXPLOITATION BY RECREATIONAL ANGLERS[1]

By

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ABSTRACT

Mark-recapture experiments were used to estimate abundance of humpback whitefish *Coregonus pidschian* in the Chatanika River during 1988. Humpback whitefish and least cisco *Coregonus sardinella* were captured using a boat-mounted electrofishing unit during their fall spawning migration. Recaptures were obtained from a creel census of the sport fishery. The estimated abundance of humpback whitefish was 41,211. Efforts to estimate the abundance of least cisco failed because the marked component of the population did not mix with the unmarked portion of the population. Estimated rate of exploitation of humpback whitefish by recreational spear fishermen in 1988 was 0.09 which is a reduction from the exploitation rates of 0.17 and 0.16, which occurred in 1986 and in 1987. The mean length of 2,065 humpback whitefish and 1,964 least cisco sampled in the Chatanika River was 396 millimeters and 319 millimeters, respectively. Dominant age classes (age 4 for least cisco and age 5 for humpback whitefish) remained the same as in 1986 and 1987. For both species, males were consistently more common than females.

KEY WORDS: humpback whitefish, *Coregonus pidschian*, least cisco, *Coregonus sardinella*, Chatanika River, mark recapture population estimate, harvest, exploitation.

INTRODUCTION

The Chatanika River originates in the foothills of the White Mountains near the confluences of McManus, Faith and Smith Creeks approximately, 80 km northeast of Fairbanks. From this point the Chatanika River flows southwesterly for 210 km before emptying into the Tolovana River (Figure 1).

Within the Chatanika River are large spawning populations of humpback whitefish *Coregonus pidschian* and least cisco *Coregonus sardinella*. During late summer and fall, these fish migrate upstream to the spawning grounds located in the upper reaches of the Chatanika River. Because of the proximity to Fairbanks and the large size of these spawning runs, the Chatanika River fishery accounts for more than 75% of the total whitefish harvest in the Tanana River drainage (Mills 1986). Most of this harvest occurs during the popular spear fishery on spawning whitefish around the Elliott Highway Bridge and along the Steese Highway. This fishery begins in mid-September and continues until freeze-up (usually in mid-October).

In recent years, human population growth and increasing awareness of the unique spear fishery have led to increases in fishing effort and whitefish harvests. Since 1977 the harvest of whitefish from the Chatanika River has increased 34% (Appendix Table 1), making it one of the fastest growing fisheries in the Tanana River drainage.

Concern about possible overharvest in this rapidly expanding fishery prompted the initiation of this study, the goal of which was to estimate sustainable yields for the humpback whitefish and least cisco stocks of the Chatanika River. To estimate sustainable yields for these whitefish species, accurate and timely estimates of population abundance, age composition, growth rates, harvest, exploitation rates, mortality rates, and recruitment rates are needed.

Stock assessment of the Chatanika River whitefish began in 1986, and a creel census of the spear fishery began in 1984. Side-scan SONAR, counting towers, and mark-recapture experiments were evaluated as estimators of population abundance. Mark-recapture population estimate experiments and the tower counts produced abundance figures that were within 5% of each other. Total estimated run strength in 1986 was 87,912 and 92,038 whitefish from the mark-recapture experiments and from expansions of the tower counts, respectively. No abundance estimate was obtained using SONAR because of difficulties distinguishing upstream versus downstream targets of migrating whitefish. The combined harvest of humpback whitefish and least cisco in the recreational spear fishery in 1986 was an estimated 19,105 fish (Clark and Ridder 1987). Using estimates from the mark-recapture experiment and from the creel census, exploitation rates for least cisco and humpback whitefish were 22.7% and 17%, respectively. The exploitation rates estimated from the tower counts and creel census were 21.8% and 15.9% for least cisco and humpback whitefish, respectively.

In 1987 the counting tower and the mark-recapture experiment were once again used to estimate population abundance. Total estimated run strength in 1987 was 83,785 and 90,165 whitefish from the mark-recapture experiments and from

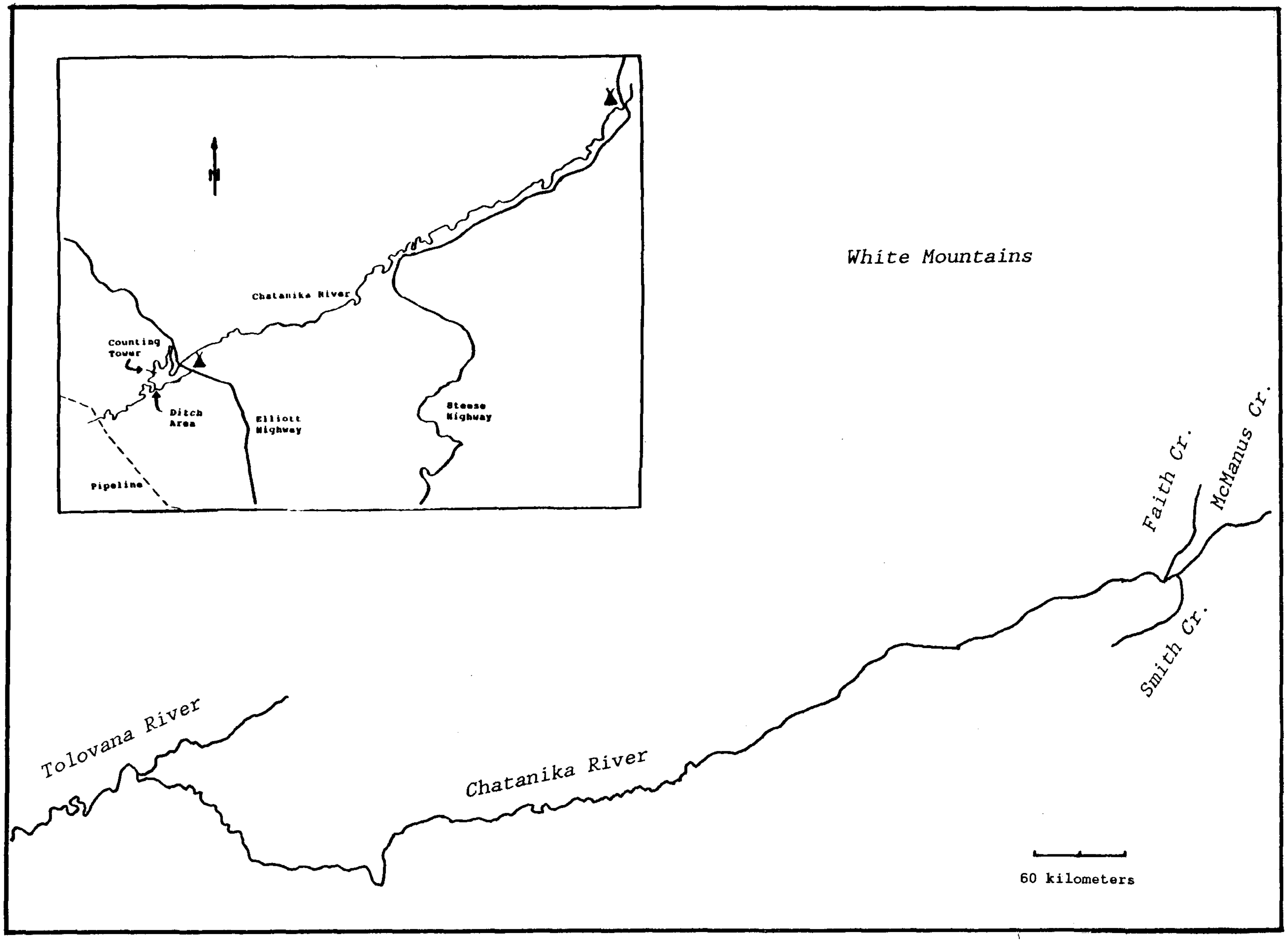

Figure 1. The Chatanika River with an insert showing its proximity to the Steese and Elliott Highways.

expansions of the tower counts, respectively. The expanded harvest in the recreational spear fishery in 1987 was an estimated 23,735 least cisco and 4,577 humpback whitefish. The exploitation rates estimated from the mark-recapture experiment and creel census in 1987 were 43% and 16% for least cisco and humpback whitefish, respectively. The rapidly expanding nature of this fishery and concern that the estimated high exploitation rates (especially for least cisco) may not be sustainable prompted the Alaska Board of Fisheries to establish a daily bag and possession limit of 15 whitefish in the Tanana River drainage. The primary goal of the 1988 whitefish study at the Chatanika River was to obtain abundance estimates and to monitor the spear fishery to determine the effect of the new regulation on harvest and population structure for both least cisco and humpback whitefish.

In 1988 the specific project objectives were to:

1. estimate humpback whitefish and least cisco population abundance prior to the start of the spear fishery in 1988 with a mark-recapture experiment;

2. estimate the age and sex composition of humpback whitefish and least cisco spawning populations; and,

3. estimate the mean length of humpback whitefish and least cisco in the Chatanika River spear fishery during fall, 1988.

In addition, exploitation rates were estimated.

METHODS

Population Abundance Estimates

Humpback whitefish and least cisco were captured within 15 km of the Elliott Highway Bridge using a pulsed-DC electrofishing boat from 17 August to 21 September. Since the initial tagging represented the "mark" used for the population estimate and since the marking took place before the majority of the fishery occurred, the abundance estimates are germane to the time just prior to the start of the marking. To minimize handling mortality, fish were held in a live box with circulating water and sampled as quickly as possible. All humpback whitefish and least cisco were measured to the nearest millimeter fork length (FL), tagged with an individually numbered floy anchor tag, given an adipose fin clip to determine tag loss, and released.

Creel census and catch sampling from 10 September to 16 October of the spear fishery near the Elliott Highway Bridge, the "ditch area" below the Elliott Highway, and near the Steese Highway served as the second sampling event in the mark-recapture experiment. Because the whitefish spear fishery is not size selective (Hallberg and Holmes 1987; Hallberg 1988), and because the length composition of tagged fish was not significantly different from that of recaptured fish (Hallberg 1988), whitefish sampled from the creel were not measured. This allowed creel clerks to maximize angler contacts and catch sampling during the creel census. All fish sampled from the creel were examined for floy tags or fin clips. The creel census sampling design and methodology is outlined in Baker (in press).

Potential sampling biases related to run timing and mixing of marked and unmarked fish were evaluated using chi-square contingency table analysis. The appropriate abundance estimator (Chapman's modification of the Petersen estimator) was chosen based on the results of these tests:

$$(1) \qquad \hat{N}^* = \frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} - 1$$

$$(2) \qquad V(\hat{N}^*) = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2(m_2 + 2)}$$

where:

$\hat{N}^*$ = the estimated abundance of whitefish;

n_1 = the number of fish marked in the first sample;

n_2 = the number of fish in the second sample; and,

m_2 = the number of marked fish in the second sample.

Length, Age, and Sex Composition

During initial tagging, scales were removed from the first 600 fish of each species. These scales were cleaned and an impression made on 20 mil acetate sheets. Ages of fish were determined by counting annuli on these scale impressions which were magnified using a microfiche reader.

Age composition was considered a series of proportions, one for each age group for each species, whose sum is one. The maximum likelihood estimate of a marginal proportion in such a multinomial distribution of ages is:

$$(3) \qquad \hat{p}_i = \frac{y_i}{n}$$

where:

y_i = the number of fish of age i in the sample; and,

n = the number in the sample.

The unbiased variance for each proportion is:

$$(4) \qquad \hat{V}[\hat{p}_i] = \frac{\hat{p}_i(1 - \hat{p}_i)}{n - 1}.$$

Abundance of whitefish by age class was estimated by multiplying the estimated proportion within each age class by the total abundance estimate. The variance of this product was estimated as suggested by Goodman (1960):

$$(5) \qquad \hat{N}_i = \hat{p}_i(\hat{N}^*)$$

$$(6) \qquad V(\hat{N}_i) = \sum[\hat{N}^{*2}V(\hat{p}_i) + \hat{p}_i^{\,2}V(\hat{N}^*) - V(\hat{p}_i)V(\hat{N}^*)]$$

where:

N_i = abundance by age class i.

Because all means are distributed normally (according to the Central Limit Theorem), simple averages and squared deviations from the mean were used to calculate mean length for each age class and its variance.

Sex of each least cisco and humpback whitefish was to be determined at the time of initial tagging. However, this method was not successful because no identifiable sex products were present at this time and external sexual characteristics were not reliable. Therefore, no sex composition data were obtained during 1988.

Exploitation Rate Estimates

Exploitation rates by species were estimated by dividing harvest (obtained from the creel census study; Baker in press) by abundance estimates from the mark-recapture experiment. The approximate variance of the exploitation rate was calculated according to the Delta method (Seber 1973):

$$(7) \qquad V[\hat{E}] = \frac{\hat{H}^2}{\hat{A}^2} \left\{ \frac{V[\hat{H}]}{\hat{H}^2} + \frac{V[\hat{A}]}{\hat{A}^2} \right\}$$

where:

H = the estimated harvest; and,

A = the estimated abundance.

RESULTS

Population Abundance Estimates

Time bias in both the marking and recapture events was evaluated using chi-square analyses. The probability of capture during two time periods through the course of the fishery was not significantly different for marked and unmarked humpback whitefish ($\chi^2 = 0.14$; df = 1; P > 0.50), or for marked and unmarked least cisco ($\chi^2 = 0.66$; df = 1; P > 0.25). Differences in the probably of recapture of least cisco marked during the early sampling efforts (17 - 25 August) versus those marked late (after 25 August) were not significant ($\chi^2 = 2.66$; df = 1; P > 0.10). Nor was there any significant difference in the probability of recapture of humpback whitefish during the same two time periods ($\chi^2 = 1.36$; df = 1; P < 0.10). Consequently, no time bias was associated with the capture or the recapture of either humpback whitefish or least cisco. Thus, abundance was estimated using Chapman's modification of the Petersen estimator (Seber 1982).

A total of 2,065 humpback whitefish was tagged between 17 August and 20 September (Table 1). During creel census catch sampling, 1,156 humpback whitefish were examined for tags, of which 57 were recaptured (Table 2). Using these statistics, the estimated abundance of humpback whitefish was 41,211 (SE = 5,155; CV = 12.5%; Table 3), a 46% increase over the 1987 estimate of 28,165 humpback whitefish (Hallberg 1988).

From 17 August to 21 September 1,964 least cisco were tagged with more than 72% (1,432) of these being tagged on the last four days of sampling September 15 to 21 (Table 1). The majority of these fish were tagged downstream of the area where the spear fishery occurs. It was hoped that they would move upstream and enter the fishery. However, during the creel census, 1,582 least cisco were examined for tags of which only 20 were recaptures. A chi-square test indicated that least cisco marked below the fishery were recaptured at a lower rate than those marked in the area where the fishery occurred ($\chi^2 = 6.15$, df = 1, P < 0.025). Consequently, the calculated abundance estimate of 148,123 and standard error of 31,202 for least cisco were not reliable. Because the "Petersen" single mark estimator failed to provide an accurate abundance estimate for least cisco, the Darroch (1961) estimator, stratified by time and area was attempted. However, it also proved unacceptable due to the presence of negative probabilities of capture.

Length, Age, and Sex Composition

The mean length of the 2,065 humpback whitefish sampled during the electrofishing was 396 mm (range 275 - 515; SE = 0.6). The modal size group (390 - 399 mm) (Figure 2) corresponds to approximately the average size of a six year old fish (Figure 3; Table 4). Humpback whitefish in 1988 ranged in age from 3 to 9 years and, as in 1986 and 1987, age 5 was the dominant age class (Table 4). However, age composition in 1988 was significantly different from that of 1987 ($\chi^2 = 45.59$, df = 6, P < 0.10).

Average length of the 1,964 least cisco sampled during the electrofishing sampling was 319 mm (range 255 - 460, SE = 0.4). The modal size group (310 -

Table 1. Number of least cisco and humpback whitefish tagged per day using a boat mounted DC electrofishing unit, 17 August through 21 September, 1988.

	Number Tagged	
Date	Least Cisco	Humpback Whitefish
17 August	29	301
18 August	0	73
19 August	0	27
22 August	6	83
23 August	40	150
24 August	85	218
25 August	53	302
26 August	40	0
07 September	147	222
08 September	19	177
14 September	113	113
15 September	234	172
19 September	274	167
20 September	600	60
21 September	324	---
Total	1,964	2,065

[1] Although humpback whitefish were captured after 20 September, none were tagged because the sampling goal of 1,350 humpback whitefish had already been reached.

Table 2. Number of humpback whitefish examined for presence of marks (C) during creel census sampling of the Chatanika River spear fishery, number recaptured (R), and estimated population abundance, 10 September to 16 October, 1988.

	Daily		Cumulative		Modified Petersen Abundance Estimate		
Date	C	R	C	R		SE	CV (%)
09/10	2	0	2	0	—	—	—
09/15	3	0	5	0	—	—	—
09/16	4	0	9	0	—	—	—
09/17	14	0	23	0	—	—	—
09/18	1	0	24	0	—	—	—
09/19	28	1	52	1	54,748	30,992	56.6
09/22	30	5	82	6	24,496	8,273	33.8
09/23	23	2	105	8	24,332	7,345	30.2
09/24	16	4	121	12	19,388	4,882	25.2
09/25	1	0	122	12	19,547	4,925	25.2
09/27	42	1	164	13	24,348	5,994	24.6
09/28	98	3	262	16	31,961	7,256	22.7
09/30	105	0	367	16	44,722	10,252	22.9
10/01	112	4	479	20	47,222	9,795	20.7
10/02	24	0	503	20	49,583	10,296	20.8
10/03	124	3	627	23	54,059	10,542	19.5
10/04	0	0	627	23	54,059	10,542	19.5
10/05	47	5	674	28	48,087	8,528	17.7
10/06	21	2	695	30	46,384	7,955	17.1
10/07	124	7	819	37	44,581	6,907	15.5
10/08	114	14	933	51	37,108	4,891	13.2
10/09	43	0	976	51	38,816	5,122	13.2
10/10	95	5	1,071	56	38,854	4,895	12.6
10/11	11	0	1,082	56	39,253	4,947	12.6
10/12	72	1	1,154	57	41,141	5,146	12.5
10/14	0	0	1,154	57	41,141	5,146	12.5
10/15	2	0	1,156	57	41,211	5,155	12.5
10/16	0	0	1,156	57	41,211	5,155	12.5

Table 3. Estimated age specific abundance of humpback whitefish and least cisco in the spawning population of the Chatanika River, 1986, 1987, and 1988.

Age	1986[1]		1987[2]		1988	
	Estimated Abundance	SE	Estimated Abundance	SE	Estimated Abundance	SE
Humpback Whitefish						
3	64	64	780	199	226	133
4	3,213	789	8,170	1,107	6,416	1,023
5	6,554	1,473	10,059	1,329	17,360	2,337
6	2,120	562	5,666	813	11,699	1,663
7	1,221	369	2,217	395	4,076	730
8	1,221	369	739	193	1,057	307
9	386	173	411	137	377	173
10	129	93	123	72		
Total	14,908		28,165		41,211	
Least Cisco						
2	232	166	185	131	N/A	N/A
3	22,633	3,971	10,129	1,516		
4	36,445	6,194	21,916	2,905		
5	10,794	2,055	14,919	2,084		
6	1,973	569	6,722	1,103		
7	929	357	1,289	373		
8			460	211		
Total	73,006		55,620			

[1] From Hallberg & Holmes (1987).
[2] From Hallberg (1988).

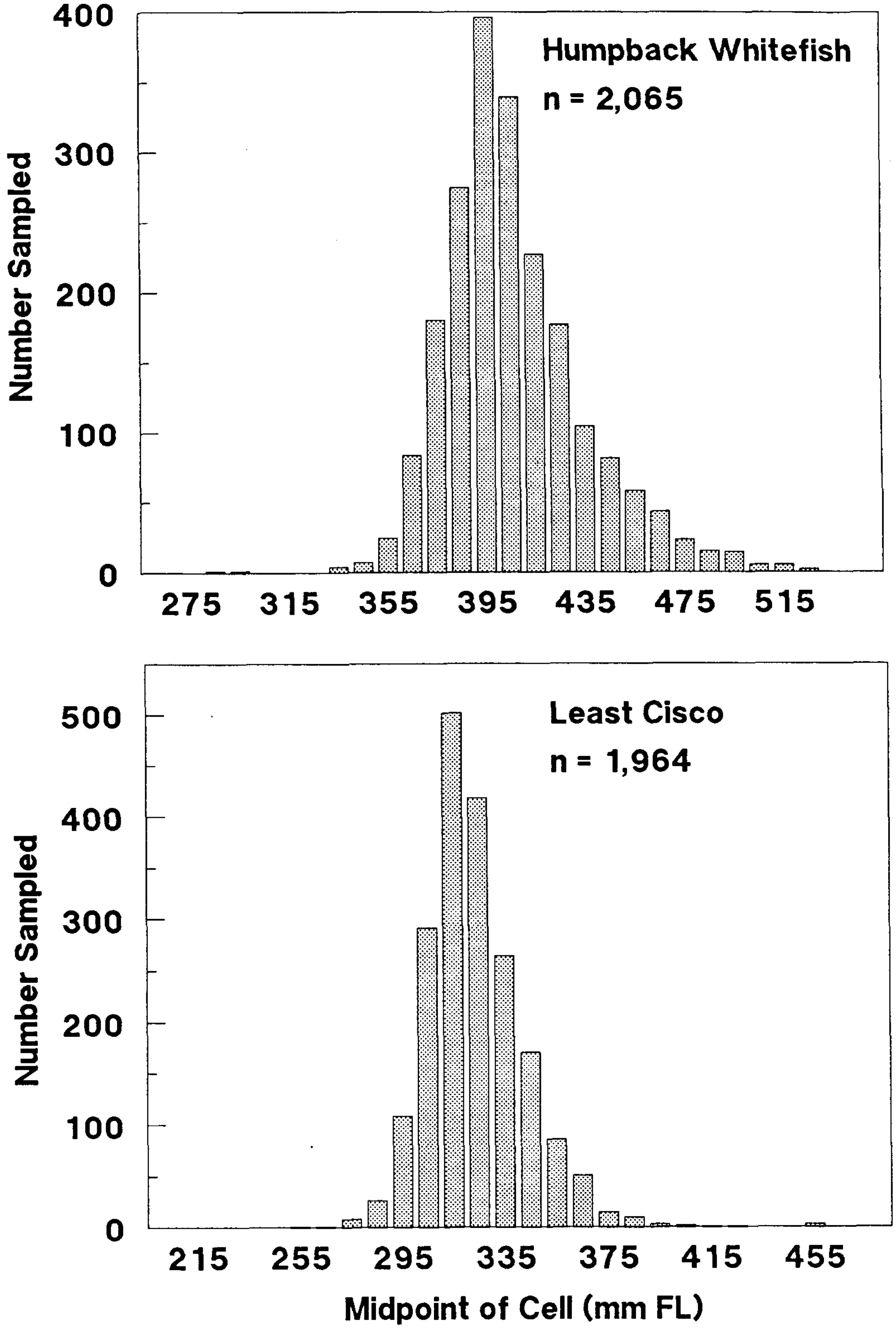

Figure 2. Length frequency distribution for least cisco and humpback whitefish sampled from the Chatanika River in 1988.

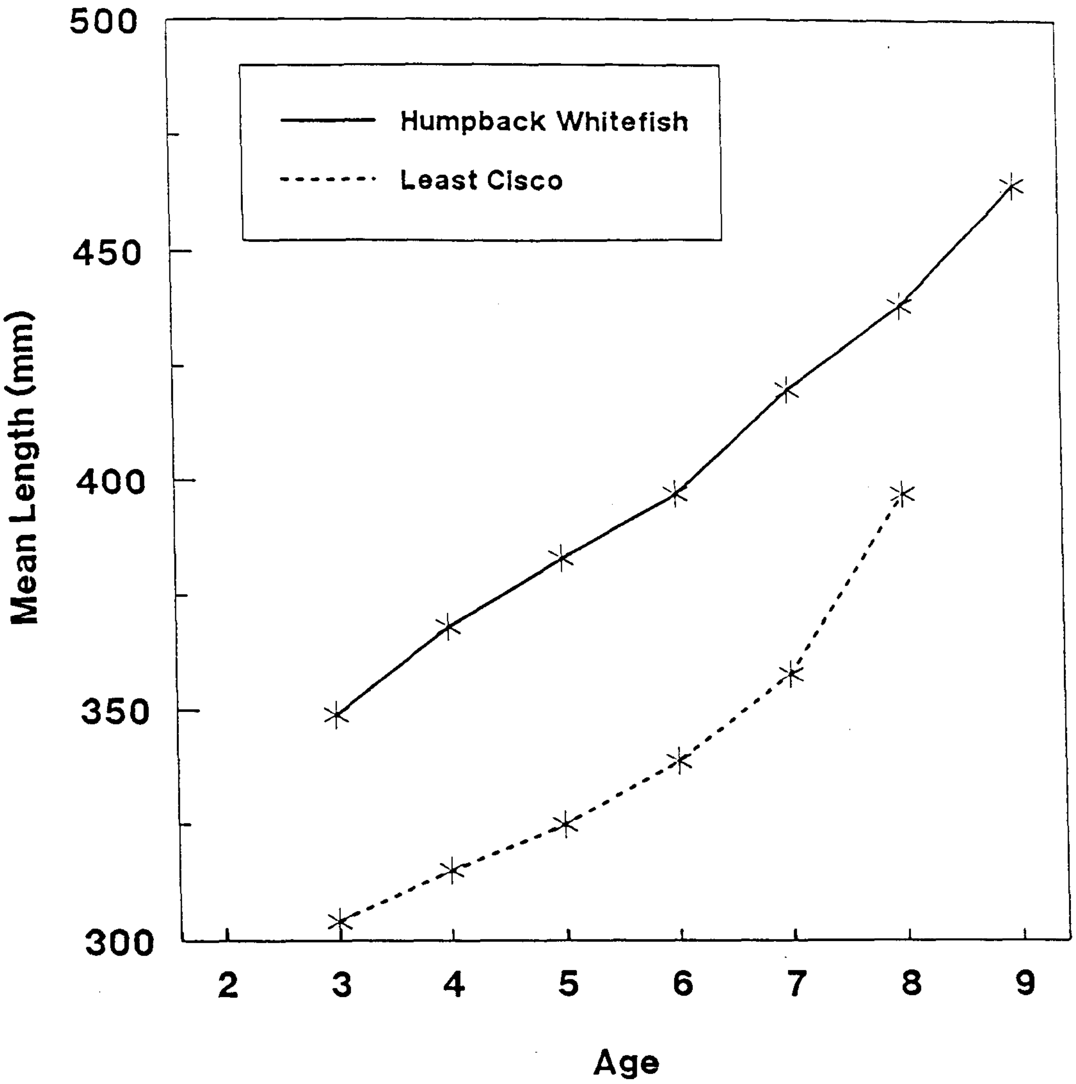

Figure 3. Mean length (FL) at age for least cisco and humpback whitefish sampled from the Chatanika River in 1988.

Table 4. Mean length-at-age and proportional age composition of humpback whitefish and least cisco sampled from the Chatanika River in 1988.

Age	Sample Size	Mean Length (mm)	SE (mm)	Length Change (mm)	p	SE (p)
Humpback Whitefish						
3	3	349	2.7		0.01	<0.01
4	85	368	1.7	19	0.16	0.02
5	230	383	0.9	15	0.42	0.02
6	155	397	1.2	14	0.28	0.02
7	54	420	2.2	23	0.10	0.01
8	14	438	5.3	18	0.03	0.01
9	5	464	8.5	26	0.01	<0.01
Total	546					
Least Cisco						
3	76	304	1.3		0.13	0.01
4	199	315	0.8	11	0.35	0.02
5	208	325	0.9	10	0.36	0.02
6	68	339	1.8	14	0.12	0.01
7	19	358	4.3	19	0.03	0.01
8	4	397	16.4	39	0.01	<0.01
Total	574					

319 mm) (Figure 2) corresponds to the size of a four year old fish (Figure 3; Table 4). Ages of least cisco in the spawning run ranged from 3 to 8 (Table 4). Since all fish that were sampled were from the spawning run, these size and age compositions can be assumed to represent that of mature fish.

In both 1986 and 1987, age 4 was the dominate year class (Hallberg 1987). In 1988, however, the age composition was bimodal with age 4 (34.7%) and age 5 (36.2%) nearly equally represented. The overall age composition in 1988 was significantly different from that of 1987 ($\chi^2 = 15.31$, df = 4, $P < 0.10$).

Estimates of age specific abundance (for humpback whitefish only) were calculated as the product of the estimated age class proportions and the abundance estimates. Strong year classes were apparent, but a relatively constant decline in year class strength after age 5 (the age of full recruitment) occurred for humpback whitefish in all three years (Table 3).

Growth of individual whitefish prior to maturity is quite rapid but slows after maturity. Age 3 humpback whitefish (the youngest age class represented in the spawning run) averaged 349 mm in length, while the average length of a 9 year old fish (the oldest age class) was only 115 mm longer (Table 4). This represents an average growth of 19 mm annually from age 4 through 10. Lengths obtained from 25 humpback whitefish tagged in 1987 and recaptured in 1988 documented an average annual growth of 11.8 mm (SE = 1.8) (Table 5). The average measured growth of 12 humpback whitefish tagged in 1986 and recaptured in 1988 (two years) was 21.2 mm (Table 6).

Age 3 least cisco (the youngest age class represented in the spawning run) averaged 304 mm in length, while 8 year old fish (the oldest age class represented in the sample) were only 93 mm longer on average (Table 4). This represents an average annual growth of 18.6 mm for adult least cisco. Annual growth obtained from five least cisco that were tagged in 1987 and recaptured in 1988 documented an average annual growth of 20.4 mm (SE = 2.4) (Table 5). The average measured growth of three least cisco tagged in 1986 and recaptured in 1988 (two years) was 17.6 mm (Table 6).

Exploitation Rate Estimates

The estimated harvest of humpback whitefish during the sport fishery was 3,571 (SE = 293; Baker in press). The estimated abundance of humpback whitefish prior to the fishery was 41,211 (SE = 5,155). Therefore the estimated exploitation rate for humpback whitefish was 0.09 (SE = .05). Because abundance estimates for least cisco were biased we were unable to estimate the exploitation rate.

The rate of tag recovery during creel sampling was significantly higher for humpback whitefish (2.7%) than least cisco (1.0%; $\chi^2 = 16.29$; df = 1; $P > 0.5$). The rate of voluntary tag returns was also much higher for humpback whitefish (2.7 %) than for least cisco (0.5%).

Table 5. Annual growth increments of individual humpback whitefish and least cisco tagged during population sampling in 1987 and recaptured during population sampling in 1988.

HUMPBACK WHITEFISH			
Tag Number	Length in 1988 (mm FL)	Length in 1987 (mm FL)	Annual Increment of Growth (mm FL)
54424	460	453	7
54434	380	370	10
54438	379	368	11
54480	393	385	8
54496	420	411	9
54514	365	365	0
54540	410	407	3
54543	438	427	11
54558	419	415	4
54614	370	349	21
54705	422	412	10
54708	393	378	15
54869	430	422	8
54998	430	400	30
55073	368	355	13
55080	372	342	30
55212	397	370	27
55281	470	460	10
55366	438	432	6
55991	490	490	0
73820	400	391	9
73834	405	395	10
73938	385	353	32
73960	425	421	4
73983	386	380	6
Average 1 Year Growth			11.8 SE (1.8)
LEAST CISCO			
44012	330	305	25
48242	330	302	28
48689	315	302	13
55696	308	291	17
55746	352	333	19
Average 1 Year Growth			20.4 SE (2.4)

Table 6. Annual growth increments of individual humpback whitefish and least cisco tagged during population sampling in 1986 and recaptured during population sampling in 1988.

HUMPBACK WHITEFISH

Tag Number	Length in 1988 (mm FL)	Length in 1986 (mm FL)	Annual Increment of Growth (mm FL)
10107	435	428	7
29226	395	354	41
29251	411	405	6
29257	393	380	13
29768	410	400	10
29889	430	408	22
29905	432	408	24
29943	377	344	33
29979	420	413	7
33158	455	410	45
33321	445	416	29
34054	436	418	18
Average 2 Year Growth			21.2 SE (3.7)

LEAST CISCO

	Length in 1988 (mm FL)	Length in 1986 (mm FL)	Growth (mm FL) after 2 years
33742	355	335	20
33745	335	321	14
34339	353	334	19
Average 2 Year Growth			17.6 SE (1.5)

DISCUSSION

Run timing and segregation of the species on the spawning ground present potential biases to accurate estimation of whitefish abundance using mark-recapture experiments. Tagging data indicate that humpback whitefish have a protracted upstream run with fish reaching the Elliott Highway area as early as 10 August and continuing well into September. Least cisco, on the other hand, arrive in a large pulse in mid-September. Thus, tagging of the least cisco population can occur in a relatively short time span, whereas humpback whitefish are often tagged over the course of a month or more.

In 1988 mark-recapture estimates of abundance for humpback whitefish appeared to be relatively free of bias. It was determined in 1986 and again in 1987 (Hallberg and Holmes 1987; Hallberg 1988) that no size selectivity occurred between marked (electrofishing) and recaptured (spear fishery harvest) fish. For this reason, no further testing for size bias was conducted in 1988. In addition, there was no apparent difference in the probability of recapture of humpback whitefish through the course of the fishery. Also, there was no sampling bias associated with the time of tagging of humpback whitefish, as humpback whitefish tagged during the early period had equal probability of being speared as those tagged in the late time period. Therefore, the Petersen abundance estimate was valid. The estimated abundance of humpback whitefish in 1988 (41,211) represents a 32% increase in the population over the 1987 estimate of 28,165.

Efforts to estimate abundance of least cisco in 1988 failed because marked least cisco did not mix with the unmarked component of the population and the recapture effort was not randomly conducted throughout the population. As in both 1986 and 1987, the majority of least cisco did not enter the upper Chatanika River until mid to late September. Thus, the majority of least cisco have always been tagged in a relatively short time in an area that extended up to 10 km below the fishery. In 1988, 1,432 (73%) least cisco were tagged during the last four days of sampling, all of which occurred downstream of the fishery. In 1986 and 1987, fish that were tagged below the fishery continued to migrate upstream where they became available to the fishery. In 1988, however, adequate mixing did not occur and thus abundance estimates were biased high. In the future, the second sampling event should be conducted throughout the sample area using an electrofishing boat.

Whitefish abundance estimates have varied substantially during the course of this study. The estimated abundance of humpback whitefish in 1987 was almost twice that of 1986. On the other hand, estimated least cisco abundance dropped between 20% and 30% from 1986 to 1987, depending on the estimator. The tower count and mark-recapture estimates obtained in 1986 (particularly the humpback whitefish estimate) were thought to be low due to the late start of the counting tower, flooding which caused an early close of counting tower operations and the fishery, and insufficient coverage in the creel census which caused biased recapture sampling and low harvest estimates (Holmes and Hallberg 1987). The large increase in humpback whitefish abundance in 1987 therefore, is likely due, not to any significant increase in run size, but to the underestimate in 1986. The decline in least cisco abundance between the two years is more likely due to an actual population decline resulting from over-exploitation in prior years.

While the exploitation rate of 17% for humpback whitefish during 1986 and 1987 was below the maximum (about 20%) that the Department believes is sustainable, such was not the case with least cisco, which had exploitation rates of 23% and 43% in 1986 and 1987, respectively. Therefore, the Sport Fish Division submitted a proposal in 1987, that was subsequently adopted by the Alaska Board of Fisheries. This regulation established a bag and possession limit of 15 whitefish in the Tanana River drainage (Hallberg 1988). Analysis of catch distribution data indicated that this bag limit would have reduced harvest in 1987 by 11,000 whitefish and exploitation rates would have decreased to 18%. Creel census information collected in 1987 indicated that 82% of the spear fishermen took less that 15 whitefish per trip. Consequently, a 15 fish bag limit would affect only a small proportion of the spear fishermen. Estimation of whitefish abundance and harvest should be continued to further evaluate how this bag limit is affecting both least cisco and humpback whitefish populations.

In 1988 the new bag limit appeared to have the desired effect. While an abundance estimate of least cisco was not obtained in 1988, a harvest of 4,456 least cisco was estimated to have taken during the spear fishery (Baker in press). This was an 81% reduction in the harvest of least cisco over the 1987 estimate of 23,735. For humpback whitefish, the combination of a 46% increase in estimated abundance and 22% decrease in harvest over 1987, resulted in a decrease in the estimated rate of exploitation to 8.6%.

Hallberg (1988) reported that inadequate creel census coverage in 1987 probably resulted in underestimates of both harvest and abundance. In 1988 the creel census was modified to include three sampling areas: the "campground area" located at the Elliott Highway bridge, the "ditch area" located downstream of the campground area, and the "Steese Highway area". Sixty-eight percent of the least cisco harvest occurred at the ditch area, which is the farthest downstream area in the fishery, while only 32% were taken at the campground and none were harvested at the Steese Highway area. By contrast, the majority of angler effort (56%) occurred at the campground, 36% at the ditch area, and only 8% occurred along the Steese Highway.

Tag returns from the Steese Highway area in both 1986 and 1987 also indicated that humpback whitefish migrate farther upstream than least cisco. No least cisco recaptures were obtained from the Steese Highway area. In the 1987 creel census sample, nearly 60% of humpback whitefish, both tagged and untagged, were sampled during the last 10 days of the fishery, 8 - 17 October (Hallberg 1988). This would indicate that a majority of humpback whitefish were available to the spear fishermen at the Elliott Highway area only during the outmigration which occurs just before freezeup.

However, creel census returns in 1988 indicated a different harvest pattern of humpback whitefish. Sixty-three percent of the total harvest and 64% of all effort occurred during the 12 day period near the middle of the fishery (23 September through 4 October; Baker in press). This shift to a higher harvest earlier in the season may have been due to spear fishermen harvesting humpback whitefish which were enroute to spawning grounds. It may also be that humpback whitefish could have spawned and begun to out-migrate earlier than was expected, thus accounting for a larger portion of the harvest to be taken earlier than in other years. Kepler (1972) reported that whitefish in the Chatanika River begin to spawn as early as 19 September and that the peak of spawning occurs the last week of September. Finally, no creel census was performed at the Steese Highway area in prior years. Having a creel census there in 1988 probably also increased the estimated proportion of the harvest that occurred earlier in the season. In 1988, about 15% of the total harvest of humpback whitefish occurred at the Steese Highway area.

For both species age composition in 1988 was significantly different from 1987, indicating that either variable recruitment occurs or that harvest in recent years has affected age class composition. However, the dominate age class was 5 for least cisco, representing 36% of the sample, where age 4 represented 35%. Age 5 was the dominant year class for humpback whitefish for the third year in a row. This indicates that these are the ages at which 100% of all fish become sexually mature. Sex composition of the spawning populations of both species was not obtained in 1988, because the sex of whitefish could not be determined at the time of tagging. If sex ratios are needed in future years, sex of whitefish should once again be determined during the creel census when identification of sex is easily obtained.

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APPENDIX

Appendix Table 1. Estimated annual harvest of whitefish from the Chatanika River, Tanana River drainage, and all of Alaska obtained from the statewide postal harvest surveys, and estimated whitefish harvest obtained from the Chatanika River on-site creel census, 1977-1988.

	Whitefish Harvest			
	Chatanika River			
Year	Postal Survey[1]	On-Site Creel Census	Tanana R. Drainage[1]	Statewide[1]
1977	1,635	986[2]	3,378	6,748
1978	6,013	5,517[2]	6,573	11,731
1979	3,021	2,183[2]	5,159	9,666
1980	3,340	1,587[2]	5,958	11,464
1981	3,185	No CC	4,873	9,251
1982	6,640	No CC	8,643	15,433
1983	5,895	No CC	8,311	16,872
1984	9,268	5,758[2]	11,658	16,719
1985	14,350	4,561[2]	20,230	30,337
1986	22,038	19,105[2]	26,810	39,718
1987	25,074	28,312[3]	26,435	32,602
1988	--[4]	8,027[3]	--[4]	--[4]

1 From Mills (1979-1987).
2 Harvest estimate is for the Elliott Highway area only.
3 Harvest estimate includes the Elliott Highway Bridge (campground and ditch area) as well as the Steese Highway area, Baker 1989 (in prep).
4 Data not available.