Fishery Data Series No. 09-55

Stock Assessment of Humpback Whitefish and Least Cisco in the Chatanika River, 2008

by

Klaus Wuttig

October 2009

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 09-55

STOCK ASSESSMENT OF HUMPBACK WHITEFISH AND LEAST CISCO IN THE CHATANIKA RIVER, 2008

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ABSTRACT

The abundances of mature-sized humpback whitefish *Coregonus pidschian* and least cisco *Coregonus sardinella* within the Chatanika River during 2008 were estimated using discrete two-sample mark-recapture experiments. Electrofishing boats were used to capture both species within two index areas that comprised the majority of the spawning areas of each species. The Elliot Highway Bridge served as the upstream boundary of both index areas and the reach for humpback whitefish extended 44 miles downstream and the reach for least cisco extended 16 miles downstream. Sampling occurred August 26–September 5 for humpback whitefish, and September 23–October 2 for least cisco. A total of 3,378 humpback whitefish were captured and ranged in length from 275 to 560 mm FL, Estimated abundance of humpback whitefish ≥360 mm FL was 22,490 (SE = 2,777). A total of 2,785 least cisco were sampled and ranged in length from 220 to 409 mm FL. Estimated abundance of least cisco ≥250 mm FL was 15,345 (SE = 1,350) and estimated abundance of least cisco ≥290 mm FL was 11,927 (SE = 1,160). Only 16 of the planned 23 miles were sampled during the second sampling event for least cisco due to river ice conditions. Based on catch rates during the first event, it was estimated that approximately 7.0% of the spawning population was not accounted for between river miles 16 and 23. The abundance of humpback whitefish was the second highest estimated since 1986 and was mostly composed (60%) of large fish ≥440 mm FL. Relatively few smaller-sized fish (i.e., 360-380 mm FL) were present in the sample, indicating short-term recruitment from this may be relatively small in subsequent years. The abundance of least cisco was the smallest estimate on record and was dominated by smaller size classes corresponding to age-3 to -5 fish. Due to the low estimated abundance of least cisco, a conservative harvest management approach is recommended as are periodic (e.g., 3 to 5 years) reassessments of abundance.

Key words: Chatanika River, whitefish, humpback whitefish, abundance estimate, mark-recapture experiment, least cisco, *Coregonus pidschian*, *Coregonus sardinella*, spear fishery.

INTRODUCTION

This report details stock assessments conducted on humpback whitefish *Coregonus pidschian* (HWF) and least cisco *Coregonus sardinella* (LC) on the Chatanika River during 2008. In general, these species migrate over the summer and fall from Minto Flats, a large wetland complex in the lower portion of the drainage, to upriver spawning areas located within an ~20-mi radius of the Elliot Highway Bridge (Figures 1 and 2). Spawning occurs in late September and early October, and downriver migrations occur immediately thereafter. During the 1980s, a significant fall spear fishery developed on these spawning aggregations, primarily between the Elliott Highway Bridge and Olnes Pond Campground (Figure 2). Reported harvests peaked in 1987 (25,074 fish) and were composed of both species because fishers could not discriminate between the two when spearing. Monitoring programs were initiated on this fishery in 1986. In 1987, the fishing regulations went from having no bag limits to a 15-fish (HWF and LC combined) bag limit due to concerns of overexploitation. Complete closures of the fishery occurred in 1991 and during 1994 through 2006. A more complete review of the fishery and attendant research projects is provided by Timmons (1991), Fleming (1996 and 1999), and Brase (2008).

In 2007, a personal use spear fishery in the Chatanika River was established that provided for 100 permits (10-fish/household limit) issued annually and a total allowable harvest of 1,000 fish. The Area Manager identified a need for current information on population abundances to develop a new management plan for this fishery. This management plan seeks to establish an annual harvest level that is sustainable for both species while providing stability in bag limits and the number of permits issued annually. The goal of this study was to estimate population abundances of HWF and LC within defined index areas.

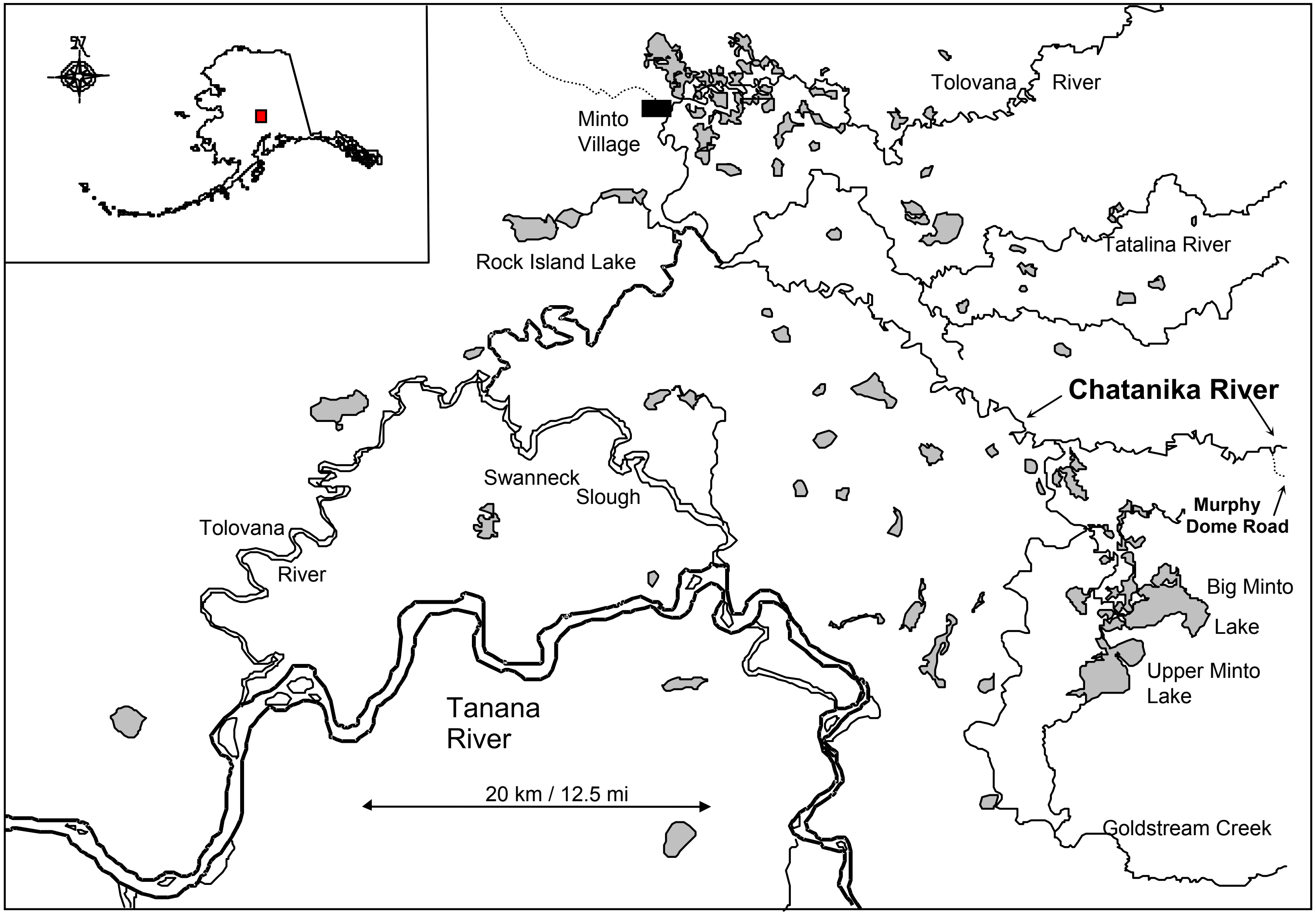

Figure 1.–Map of the Lower Chatanika River and the Minto Flats wetland complex.

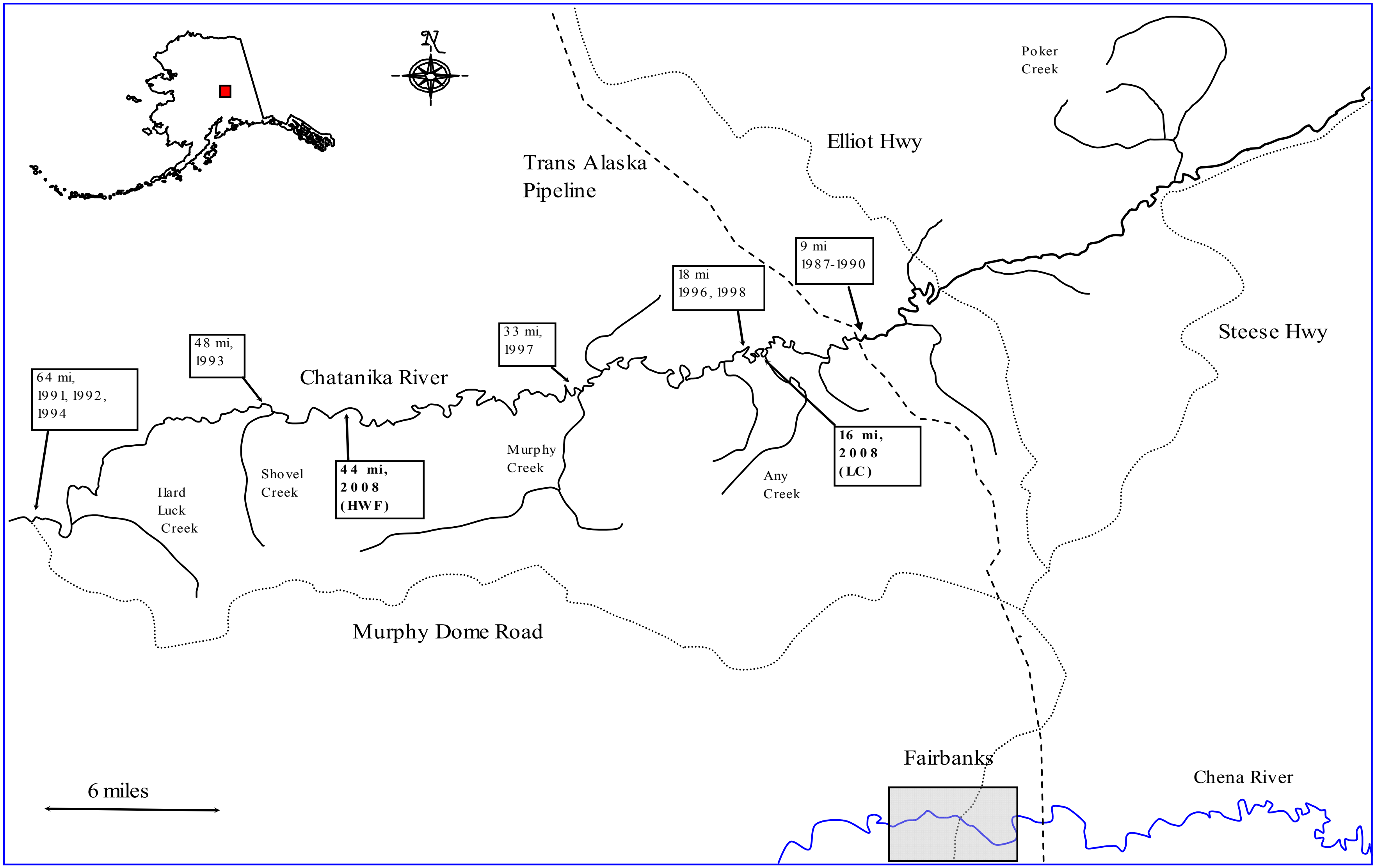

Figure 2. –Chatanika River study areas (1986–2008). Downriver boundaries and area lengths are demarcated, and for all areas; the Elliot Highway Bridge served as an upstream boundary.

OBJECTIVES

The research objectives for 2008 were to:

1. estimate the abundance of humpback whitefish ≥ 360 mm FL in a 45 mi section of the Chatanika River during late August/early September, such that the estimate is within 25% of the true abundance 90% of the time;
2. estimate the abundance of least cisco ≥290 mm FL in a 30 mi section of the Chatanika River during late September/early October, such that the estimate is within 25% of the true abundance 90% of the time; and,
3. Estimate length compositions of humpback whitefish and least cisco in attendant index areas such that all proportion estimates are within 5 percentage points of the true proportion values 95% of the time.

The criteria relative to Objectives 1 and 2 were selected because they were consistent with previous mark-recapture (M-R) experiments of similar design and minimum lengths generally correspond to length at first maturity. The study was designed to attain an index of abundance for use in developing the management plan, rather than estimating the abundance of the entire spawning population. It was recognized that some unknown amount of positive bias in the abundance estimates may occur because the populations being sampled were known to be migrating at the time. Therefore, the design of this study attempted to minimize the amount of bias to acceptable levels (e.g. ≤5-10%) rather than completely eliminate it.

METHODS

EXPERIMENTAL AND SAMPLING DESIGN

This study was designed to estimate abundances and length compositions of humpback whitefish HWF and LC within their respective sampling/index areas of the Chatanika River using two-event Petersen M-R techniques for a closed population (Seber 1982) designed to satisfy the following assumptions:

1. the population was closed (HWF and LC did not enter the population, via growth or immigration, or leave the population, via death or emigration, during the experiment);
2. all HWF and LC had a similar probability of capture in the first event or in the second event, or marked and unmarked fish mixed completely between events;
3. marking of HWF and LC did not affect the probability of capture in the second event;
4. marked HWF and LC were identifiable during the second event; and,
5. all marked HWF and LC were reported when recovered in the second event.

The sampling design and data collected allowed the validity of the five assumptions to be ensured or tested. The specific form of the estimator was determined from the experimental design and the results of diagnostic tests performed to evaluate if the assumptions were met (Appendices B1-B3). The design also ensured that sample sizes were adequate to meet objective precision criteria and to perform reliable diagnostic tests.

The general approach of this study was to sample HWF and LC as they migrated to and arrived at their spawning areas using an electrofishing boat, similar to the standardized M-R experiments conducted during 1991 to 1994 and 1997. The largest design consideration(s) for this approach was to sample two migratory populations/species each having slightly different run timing patterns and spawning areas with varying degrees of accessibility (Table 1).

In previous M-R experiments (1991–1994, and 1997) these considerations were addressed by attempting to sample the entirety of both migratory populations (i.e. during the same experiment) by extending the sampling area 64 river miles from the Elliot Highway all the way to Murphy Dome Road prior to their arrival at the spawning grounds. The first sampling event typically occurred during August 14 to August 19, and the second from August 21 to August 26. The disadvantages of this approach were: 1) the logistical and cost considerations of having to sample a relatively large area; 2) the fact that the lower portion of the study area from river mile (rm) 45 to 64 cannot be effectively fished with an electrofishing boat during normal to low flows; and, 3) the possibility of least cisco still entering the lower boundary of the study area during the experiment (i.e. violation of the closure assumption) despite the relatively large study area.

In 2008, a new approach was attempted to address these design considerations by conducting two separate M-R experiments, one directed at HWF and one at LC (Table 2). The intent of this schedule/approach was to capture a large majority of each spawning population while minimizing the size of the sampling area and bias associated with combined immigration and emigration.

In 2008, new study area boundaries were constructed. For HWF, the study area extended from the Elliot Highway Bridge to a point 44 rm downstream. For LC, the planned study area extended from the bridge to a point 24 rm downstream; however, the onset of heavy frazzle ice precluded sampling below rm 16 during the second event.

Table 1.–Comparison of humpback whitefish (HWF) and least cisco (LC) run timing and spawning characteristics and access considerations important for design of mark-recapture studies.

Characteristic[a]	HWF	LC
Run timing pattern	Migration from Minto Flats to spawning areas from June to early September is protracted with fish arriving at spawning areas as early as July and arriving during August and September.	Migration from Minto Flats is relatively compressed (late July to early September) with fish arriving at spawning areas in late August, but mostly arriving in September.
Spawning Areas	Documented spawning areas located between a point ~30 km upstream of the Elliot Highway bridge and Any Creek.	Spawning areas located primarily between Elliot Highway bridge to Any Creek (~30 km downstream).
Access	Low water levels prohibits sampling spawning areas upstream of Elliot Highway bridge.	Lower water levels does not prohibit sampling downstream of Elliot Highway bridge.

[a] These characteristics are based on a review of previous studies and Fleming 1993-1994 and 1996-1997, Hallberg and Holmes 1987, Hallberg 1988-1989, Timmons 1990-1991, and Townsend Kepler 1974.

Table 2.–Sampling schedule for 2008 mark-recapture experiments.

Species	Event	Dates	Electrofishing crew	Area sampled
HWF				
	1	Aug. 26–29	A	Elliot Highway Bridge (rm 0) to rm 20
			B	rm 20–44
	2	Sept 2	A	Poker Creek (15 rm upstream of Elliot Bridge to Elliot Highway Bridge
	2	Sept. 2–5	A	Elliot Highway Bridge to rm 20
			B	rm 20–44
LC				
	1	Sept. 22	A	3 rm upstream of the Elliot Highway Bridge to Elliot Highway Bridge
	1	Sept. 23–25	A	Elliot Highway Bridge to rm 10
			B	rm 10–23
	2	Sept. 29–Oct. 2	A	Elliot Highway Bridge to rm 8
			B	rm 8–16

For HWF, the timing of the experiment was delayed by one week (compared to previous years) to allow for the study area to "fill up" with fish so that the lower boundary could be adjusted upstream. Previous movement data from tagged fish (HWF and LC) demonstrated relatively large movements (e.g., up to 24 mi) over a one-week period for fish tagged in the lower reaches (e.g. rm 40), and in contrast, much smaller and less discretional movement (e.g. ± 2 mi) for fish tagged in the upper 6 mi of the study area (Fleming 1994). Delaying the experiment another week created the risk of having too many fish upstream of the upper boundary of the study area.

For LC, no significant spawning had been observed upstream of the Elliot Highway nor below Any Creek (Al Townsend, ADF&G, Habitat Biologist–retired, Fairbanks, personal communication). Delaying the M-R until late September, allowed for nearly the entire population to be sampled with only localized movements at the scale of 1–2 rm expected.

During each of the sampling events in 2008, whitefish were captured by two crews of three persons with each crew operating an outboard-powered river boat equipped with electrofishing equipment as described by Fleming (1994). Each crew was assigned to a given stream reach during both events (Table 2). Effort was uniformly distributed over the study area(s) by operating the electrofishing boats in 5- to 20-min intervals (runs) in a downstream progression. A run was stopped once the sampling tub was full, but did not exceed 20 min. During the first event, the beginning and end points of all runs were recorded using a hand-held global positioning system (GPS) unit and marked with fluorescent flag material. Attempts were made to start and stop at the same boundaries during the second event. Run sections were used as a metric to evaluate variability of capture probabilities and movement at a reasonably small scale.

Lastly, sampling was conducted upstream of the Elliot Highway Bridge during the second event to assess closure, or the presence any significant numbers of HWF and LC outside of the study area (Table 2).

Evaluation of Mark-Recapture Assumptions

Assumption 1: The hiatus of both experiments (HWF and LC) was of short duration (i.e., 3-5 d), and therefore, growth recruitment and mortality were assumed to be insignificant. The assumption of closure was problematic for HWF due to the potential for some fish to migrate above the upper boundary (emigration) or for fish downstream of the study area to migrate into the lower reach of the study area (immigration) during the hiatus. However, movements of recaptured fish in 1991–1994 and 1997 were deemed to be insignificant because the study area was large in relation to the observed movements and it was expected behavior would be similar in 2008. For LC, no movement was expected because the experiment was designed to coincide with the initiation of spawning when all fish should have been relatively stationary.

Assumption 2: Marked and unmarked fish were not expected to mix throughout the study area. Therefore, efforts were made to subject all fish to the same probability of capture during the first or second event by applying uniform levels of electrofishing effort along the sampling reach and by relying on small-scaled movement (localized mixing) to eliminate the potential of isolated pockets of fish avoiding capture during both events.

Assumption 3: The 3- to 5-day hiatus between events allowed marked fish to recover from the effects of handling and marking induced behavioral effects during the first event; therefore, Assumption 3 was deemed valid. Only those fish deemed healthy received a mark.

Assumptions 4 and 5: These assumptions were ensured by the sampling/tagging methods (see Data Collection below).

DATA COLLECTION

At the completion of a run, all captured fish were temporarily held in live wells, measured for length (mm FL), and carefully examined for marks. In the first event, all fish were tagged with an individually numbered Floy™ FD-94 internal anchor tag and were given an upper caudal finclip to identify tag loss. To eliminate duplicate sampling in the second event, all fish were given a lower caudal finclip. All fish in both events were carefully inspected for attendant Floy™ tags and fin clips and GPS capture/release locations were recorded. Fish captured in the first event that exhibited signs of injury or excessive stress were not marked and were censored from the experiment.

DATA ANALYSIS

Abundance Estimate

When capturing fish in a downstream sequence with electrofishing boats, it is inherently difficult to approximate the taking of a simple random sample (i.e., a random sample without replacement). Therefore, samples from the Chatanika River were taken systematically in the sense of progressively moving downstream and sampling proportionally to the abundance of fish present. Under these circumstances the Bailey-modified Petersen estimator (Appendix A; Bailey 1951, 1952) was preferred over the Chapman-modified Petersen estimator (Chapman 1951) for estimating abundance

Violations of Assumption 2 relative to size effects were tested using two Kolmogorov-Smirnov (K-S) tests. There were four possible outcomes of these two tests relative to evaluating size selective sampling (either one of the two samples, both, or neither of the samples were biased) and two possible actions for abundance estimation (length stratify or not). The tests and possible actions for data analysis are outlined in Appendix A1. If stratification by size was required, capture probabilities by location were examined for each length stratum.

The tests for consistency of the Petersen estimator (Seber 1982; Appendix A2) were used to determine if, for each identified length stratum, stratification by location was required due to spatiotemporal effects and to determine the appropriate abundance estimator: the pooled Bailey-modified Petersen estimator, the completely stratified Bailey-modified Petersen estimator, or a partially stratified estimator (Darroch 1961). Documentation of release location by run for each fish permitted the examination of multiple geographic stratification schemes for purposes of assumption testing, and testing was performed at various scales from individual runs to two groups or strata (i.e. upper and lower halves).

Relative to Assumption 1, closure was not tested directly but inferred from examination of the movement of recaptured fish within the study area. The data were examined for evidence of movement away from, towards, or across the boundaries of the study area to provide evidence of immigration and emigration.

Length Composition

Kolmogorov-Smirnov tests for size-selective sampling and outcomes were used to determine if stratification was necessary and if data from the first, second or both events were to be used. Stratification was not necessary and length proportions (i.e. 10-mm length categories) and variances of proportions each species of whitefish were estimated using samples from both events using:

$$\hat{p}_k = \frac{n_k}{n} \tag{1}$$

where:

$\hat{p}_k =$ the proportion of fish that are within length category *k*;

$n_k =$ the number of fish sampled that are within length category *k*; and,

$n =$ the total number of fish sampled.

The unbiased variance of this proportion is estimated as (Cochran 1977):

$$\hat{V}\left[\hat{p}_k\right] = \frac{\hat{p}_k\left(1-\hat{p}_k\right)}{n-1} \tag{2}$$

RESULTS

EVALUATION OF POPULATION CLOSURE ASSUMPTION

Movements of HWF and LC were evaluated at the scale of a run and are approximations accurate to ≤2.0 rm. The scale and accuracy of the fish movement were still considered sufficient for examination of closure and movement patterns within the study area.

The inaccuracy in measuring movement distances between events was due to varying run distances and the "boundary effect". The endpoints of electrofishing runs varied in length between events because of varying catch rates (e.g. high catch rates required stopping after a short distance). Movement was only considered significant if a fish traveled more than one section. For example, because fish were sampled at the end of a run (e.g., at rm 8.9), a movement from rm 8 to 9 could be the result of a fish only moving a short distance downstream across the boundary during the hiatus.

Humpback Whitefish

The catch and movement data provided sufficient evidence to support the assumption that the population was closed at the upstream boundary during the experiment. During sampling at the start of the second event, no HWF were captured between Poker Creek and the Elliot Highway Bridge (a distance of approximately 10 miles), and only four HWF were captured between the bridge and the campground (downstream 1 rm).

Recaptured HFW displayed an upstream movement between sampling events (Figure 3) toward, but not past, the upper boundary of the study area. Immigration likely occurred across the downstream boundary, but its magnitude was likely insignificant based the very low catch rates in the lower sections. Catches within the lower six miles of the study area averaged only two fish per run (Appendix B1). Due to this immigration, estimates of abundance and size composition were considered germane to the second event.

Least Cisco

Examination of movement data was constrained to the 16 miles of the study area sampled during the second event. Evidence based on movements of recaptured fish, catch rates, and observations of spawning condition suggested that the population was closed during the first event and some downstream emmigration occurred during the hiatus and the second event. Therefore, the abundance estimate was germane to the second event.

No LC were captured or observed upstream of the Elliot Highway Bridge during sampling for HWF (i.e., downstream of Poker Creek). Similarly, when sampling for LC in the first event on September 23, no LC were captured for ~ 3 miles upstream of the Elliot Highway Bridge. In addition, only 10 fish were captured within the uppermost 1.5 mi of the study area during both events combined.

Recaptured LC demonstrated a small downstream trend in their movements between events (Figure 3). Of the 108 recaptured fish ≥250 mm FL, two fish moved >2 mi upstream whereas 18 moved >2 mi downstream.

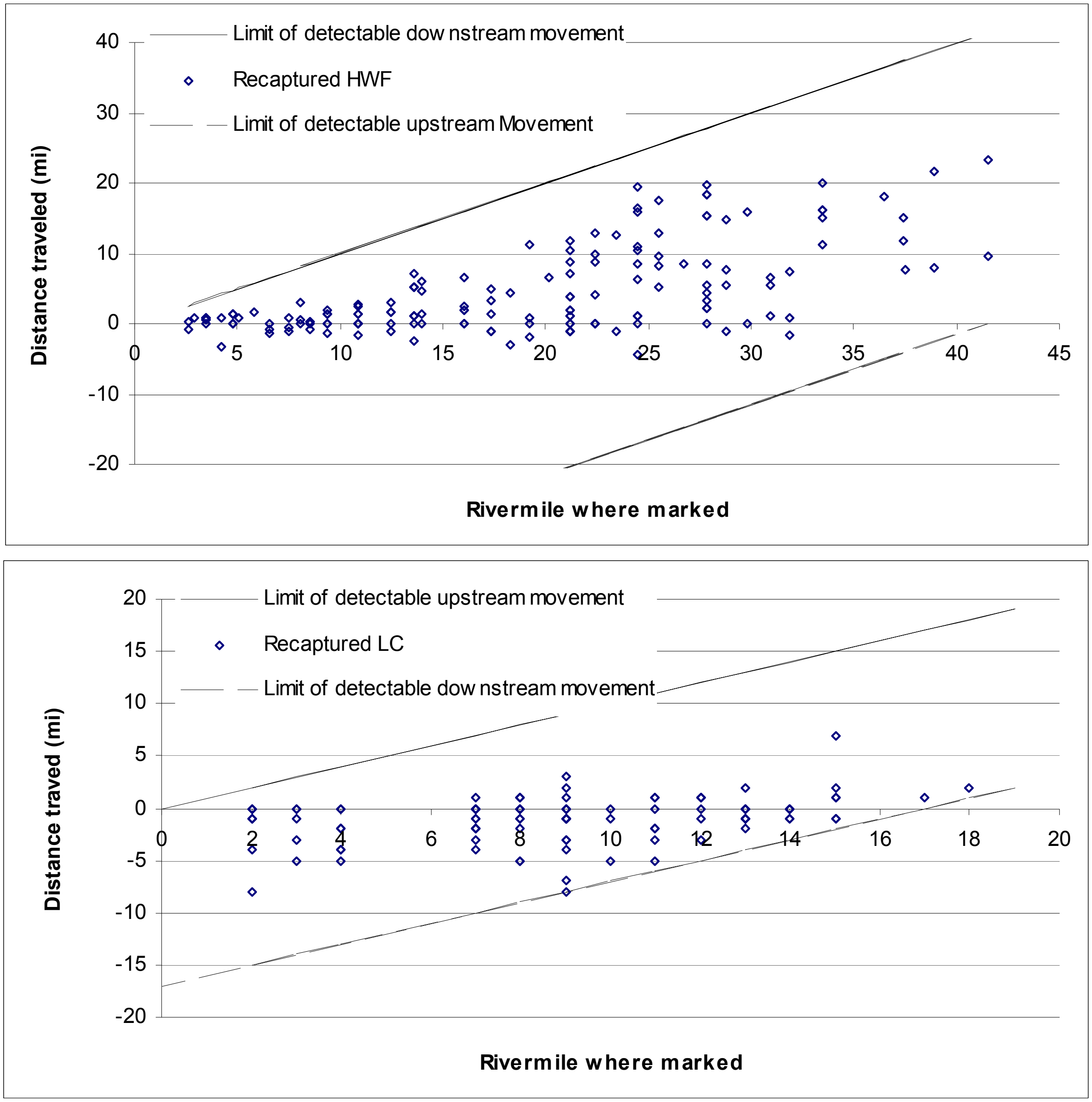

Figure 3.–Distance traveled of recaptured humpback whitefish (upper panel) and least cisco (lower panel) between first and second events by river mile (i.e. run) with limits of detection depicted.

Data on spawning condition (i.e., green, ripe, or spent) for every fish was not specifically collected. However, based on general observations during the first event, spawning activity had initiated, but not peaked, which would coincide with a period of no migratory behavior. During the second event most female fish appeared to be partly spent indicating spawning was nearing completion which corroborates some of the downstream movement observed.

ABUNDANCE

Humpback Whitefish

A total of 3,378 HWF were captured ranging from 275 to 560 mm FL. Of these 3,376 were ≥360 mm FL and the length of the smallest recaptured fish was 360 mm FL. During the first event 1,747 HWF were captured, 1,620 were captured in the second event, and 166 were recaptured. No recaptured fish were noted to have lost their primary mark (Floy tag).

Based on the diagnostic procedures outlined in Appendix A2, K-S test results indicated that sampling was not size selective (i.e. Case I) and stratification by length was not required. No significant differences were observed when comparing n1 vs. m2 (D = 0.089, p-value = 0.174) and n2 vs. m2 (D = 0.092, p-value = 0.150).

Examination of the capture probabilities (first and second event) across a range of geographic strata identified rm 8.1 as a point at which a general increase in capture probabilities occurred (Tables 3 and 4, Appendix B1). Due to significant differences in spatial capture probabilities and movement across the 8.1-rm boundary, a partially-stratified estimator (Darroch 1961) was used to estimate abundance.

The estimated abundance of HWF ≥360 mm FL in the Chatanika study area was 22,490 HWF (SE = 2,777). The stratum estimate for the upper section (rm 0–8.1) was 14,627 HWF (SE=2,847) and for the lower section (rm 8.5 to 43.8) was 7,863 HWF (SE = 684).

Table 3.–Results of consistency tests for the Petersen estimator (Appendix A3) for estimating abundance of humpback whitefish in the Chatanika River study area, 2008.

	Consistency Test		
	I	II	III
Length Strata	Complete Mixing	Equal probability of Capture, 1st Event	Equal Probability of Capture, 2nd Event
≥ 360 mm FL	χ^2 = 93.69 P-value < 0.001	χ^2 = 22.36 P-value < 0.001	χ^2 = 38.94 P-value < 0.001

Table 4.– Number of humpback whitefish ≥360 mm FL marked (n1), examined (n2), and recaptured (m2) by section(s) in the Chatanika River study area, 2008.

		Section where recaptured (rivermile)				
		0 – 8.1	8.5 – 43.8	m_2	n_1	$(m_2/n_1)^b$
Section where marked	0 – 8.1	27	1	28	688	0.04
	8.5 – 43.8	14	124	138	1,059	0.13
	m_2	41	125	166		
	n_2	678	942			
	$(m_2/n_2)^a$	0.06	0.13			

[a] Probability of capture during first event.

[b] Probability of capture during second event.

Least Cisco

The data used to estimate abundance was truncated to include only those fish sampled in the upper 16 river miles.

A total of 2,785 LC were captured and sampled ranging from 220 to 409 mm FL and of these 2,211 (79%) were ≥290 mm FL. Because such a large proportion were smaller than 290 mm FL, the abundance of fish ≥250 mm FL was also estimated. The smallest recaptured fish was 255 mm FL.

K-S test results for both length strata (i.e. ≥250 and 290 mm FL) indicated that sampling was not size selective and stratification by length was not required (Table 5). Results of the consistency tests indicated that geographic stratification was not needed (Tables 6–8, Appendix B2).

The estimated abundance of fish ≥250 mm FL was 15,345 LC (SE = 1,350). The estimated abundance of fish ≥290 mm FL was 11,927 LC (SE = 1,160).

To provide managers with an indication of how many LC were missed during the experiment because of ice conditions, a simple expansion was used to grossly approximate the abundance of fish ≥250 mm FL and ≥290 mm FL between rm 17 and 27, where we were not able to sample in the second event. The first-event capture probability from the adjacent upstream section (rm 9-16) was applied to the numbers of fish captured during first event between rm 17 and 27. The estimate of LC ≥250 mm FL was 1,445 (104 fish/0.072), and the estimate of LC ≥290 mm FL was 808 (63 fish/0.078).

Table 5.–Results of diagnostics used to detect and correct for size-selective sampling (Appendix B) for estimating length and age composition of least cisco in the 16-mi Chatanika River study area, 2008.

Length strata	Comparison and test statistic: M vs. R	Comparison and test statistic: C vs. R	Result
≥250 mm FL	D = 0.09 P-value = 0.98 Fail to reject H_0	D = 0.04 P-value = 0.31 Fail to reject H_0	Case I, do not stratify, use lengths from both events for composition analysis
≥ 290 mm FL	D = 0.05 P-value = 0.96 Fail to reject H_0	D = 0.12 P-value = 0.14 Fail to reject H_0	Case I, do not stratify, use lengths from both events for composition analysis

Table 6.–Results of consistency tests for the Petersen estimator (Appendix A3) for estimating abundance of least cisco in the Chatanika River study area, 2008.

	Consistency Test		
	I	II	III
Length Strata	Complete Mixing	Equal probability of Capture, 1st Event	Equal Probability of Capture, 2nd Event
≥ 250 mm FL	$\chi^2 = 52.37$ P-value < 0.001	$\chi^2 = 6.48$ P-value = 0.01	$\chi^2 = 0.41$ P-value = 0.52
≥ 290 mm FL	$\chi^2 = 93.69$ P-value < 0.001	$\chi^2 = 9.08$ P-value < 0.01	$\chi^2 < 0.01$ P-value < 0.95

Table 7.–Number of least cisco ≥250 mm FL marked (n_1), examined (n_2), and recaptured (m_2) by section(s) in the Chatanika River study area, 2008.

		Section where recaptured (rivermile): 0 – 8	Section where recaptured (rivermile): 9 – 16	m_2	n_1	$(m_2/n_1)^b$
Section where marked	0 – 8	34	12	46	360	0.13
	9 – 16	4	58	62	546	0.11
	m_2	38	71	108		
	n_2	868	992			
	$(m_2/n_2)^a$	0.04	0.07			

[a] Probability of capture during first event.

[b] Probability of capture during second event.

Table 8.–Number of least cisco ≥290 mm FL marked (n_1), examined (n_2), and recaptured (m_2) by section(s) in the Chatanika River study area, 2008.

		Section where recaptured (rivermile)				
		0 – 8	9 – 16	m_2	n_1	$(m_2/n_1)^b$
Section where marked	0 – 8	28	11	39	320	0.12
	9 – 16	3	46	49	397	0.12
	m_2	31	57	88		
	n_2	759	735			
	$(m_2/n_2)^a$	0.04	0.07			

[a] Probability of capture during first event.

[b] Probability of capture during second event.

LENGTH COMPOSITION OF HUMPBACK WHITEFISH AND LEAST CISCO

For HFW ≥360 mm FL, the most frequent length category was 450-459 mm FL. Approximately 60% of the HWF sampled were ≥440 mm FL. Relatively few smaller-sized fish (i.e., 360-380 mm FL) were present in the sample, indicating recruitment will likely be relatively small in subsequent years (Figure 4, Appendix B3). For LC ≥250 mm FL, the most frequent length category of fish sampled was 330-339 mm FL and the sample was dominated by smaller size classes likely corresponding to age 3-5 fish (Figure 5, Appendix B4 and B5).

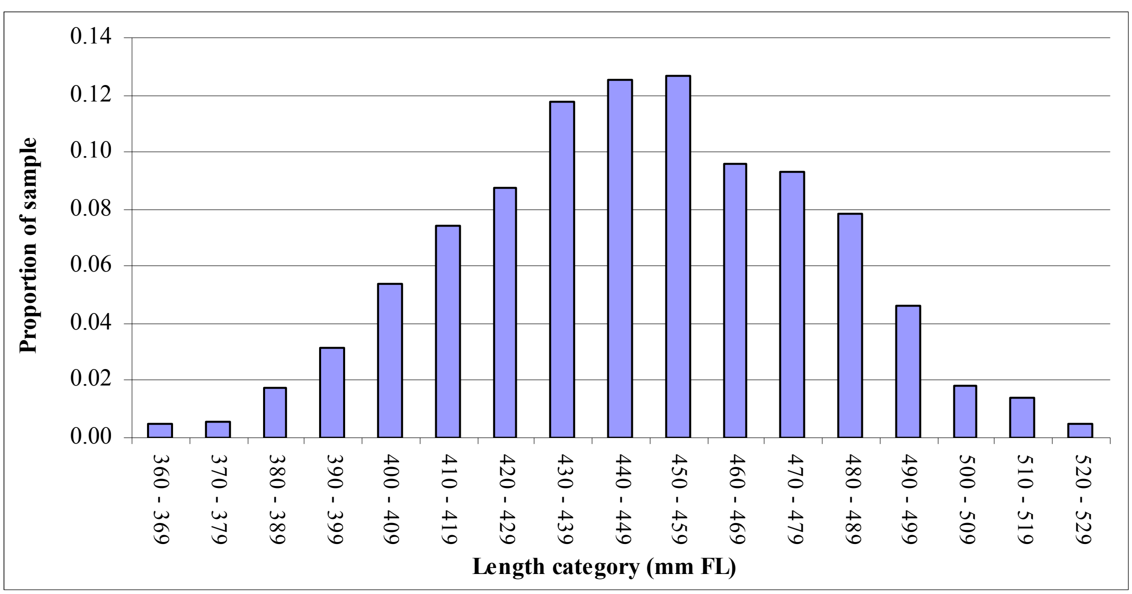

Figure 4.–Length-frequency distribution of humpback whitefish sampled in the Chatanika River study area, 2008.

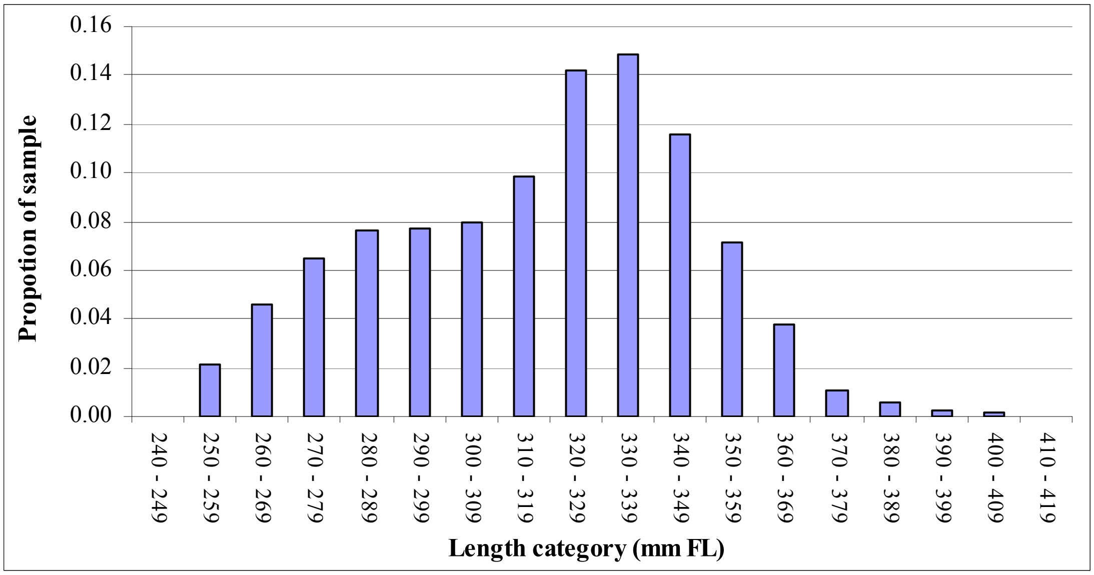

Figure 5.–Length-frequency distribution of least cisco sampled in the Chatanika River study area, 2008.

DISCUSSION

The general approach used in this study to estimate abundance of HWF and LC is recommended for future stock assessments. Delaying the projects from August to September resulted in each population concentrated into a smaller reach that simplified logistics, made the entire spawning stock available to sampling, and adequately addressed bias relative to closure violations. The use of a single electrofishing boat per stream reach resulted in good sample sizes. Focusing efforts on a single species eliminated overwhelming numbers of fish from being handled. The abnormally early onset of winter conditions (i.e. heavy frazzle ice) prevented the entire LC study area (i.e. ~24 mi) from being sampled, but the estimate was sufficient for evaluating trends because the proportion of the population missed was judged to be relatively small (i.e. ~7%). Specific recommendations in future years include:

- Maintain upstream study area boundaries at Elliot Highway Bridge for both species.
- Continue to use a single electrofishing boat per stream reach.
- For HWF, sampling should be conducted after September 1 and the study area need not extend downstream of Shovel Creek (~rm 30).
- For LC, sampling should be conducted between September 15 and 30 and need not extend downstream of Any Creek (~rm 18).

Examination of population trends (Figure 6) should consider changes in the study design and attendant uncertainty in abundance estimates. During 1986 to 1989 population assessments were conducted in a much smaller index area (15-km reach with its upstream boundary at the Elliot Highway Bridge) and these estimates are suspect because the sampling protocols were not yet fully refined and the studies did not adequately account for biases that were likely present (i.e.

closure violations). Therefore, abrupt changes in the abundance estimates, such as HWF in 1988 may not be accurate. During 1990 and 1991, sampling protocols were refined and much larger index areas (64 mi) were developed and all estimates thereafter are judged to more accurately reflect population abundances (Figure 2).

The population status of HWF in 2008 was judged to be healthy based on observed trends in abundance estimates (Figure 6). The ability of the population to sustain significant harvest in the future remains uncertain because HWF in the Chatanika River are relatively long-lived (e.g., 30 years). Based on a concurrent study examining maturity schedules for Chatanika HWF, the four largest lengths classes (430–469 mm FL) composing 47% of the population corresponded to otolith-based fish ages ranging from 10 to 16 years. The same concurrent study showed fish ≥500 mm FL to have otolith-based ages ranging from 12 to 27 years (Lorena Edenfield, fisheries graduate student, University of Alaska-Fairbanks, personal communication). Previous stock assessments identified recruitment into the mature population occurring at ages 5 to 8 years or length classes ranging between ~380 and 409 mm FL (Fleming 1999). In 2008 the population was mostly composed (60%) of large fish ≥440 mm FL. Compared to 1996 and 1997, relatively few smaller-sized fish (i.e., 360-380 mm FL) were present in the sample, indicating recruitment of this cohort may be smaller in the near future (Figure 7).

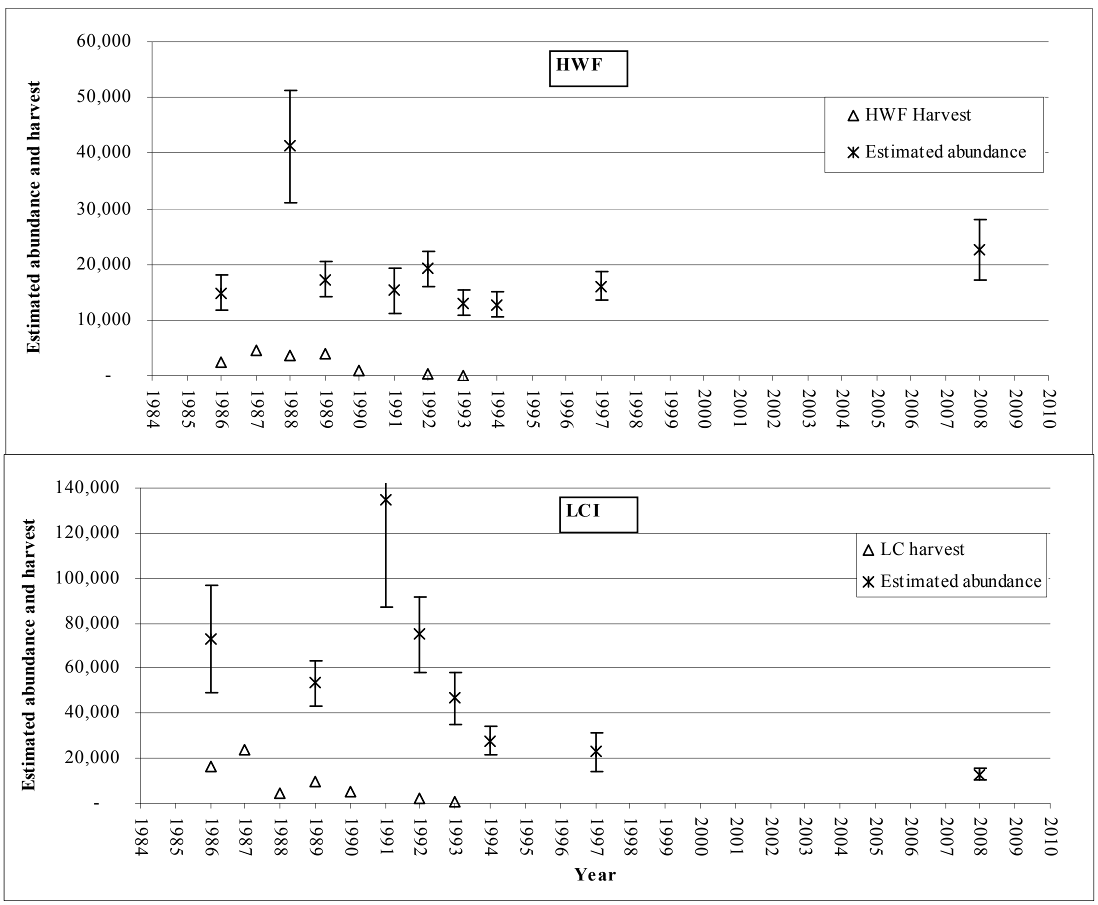

Figure 6.–Estimated abundance and harvest of humpback whitefish ≥360 mm FL and least cisco ≥290 mm FL in the Chatanika River from 1986 to 2008.

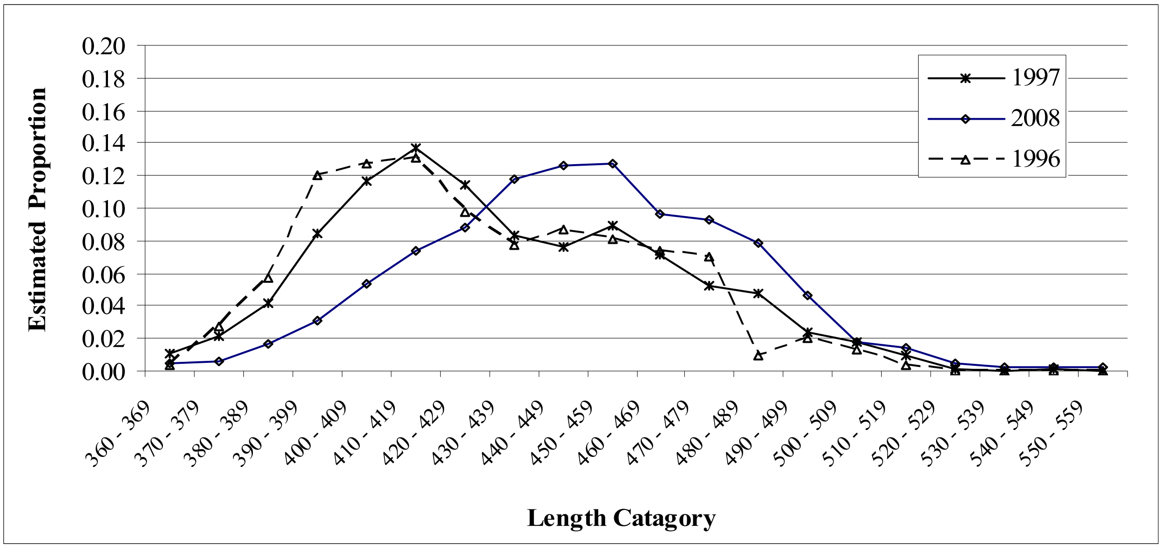

Figure 7.–Length composition of humpback whitefish sampled in the Chatanika River. The years 1996 and 1997 were interpreted as having potentially good recruitment.

The estimated abundance of LC in 2008 was the lowest estimate on record and was substantially lower than estimates obtained during the 1980s (Figure 6). LC are shorter lived (e.g., 15 years) and annual variation in abundance can be driven more strongly by recruitment (e.g. 260-300 mm FL or age 3-5) than for HWF. In 2008, the relatively large proportion of fish between 250 and 290 suggested that, relative to the total population abundance, strong recruitment was occurring (Figure 8).

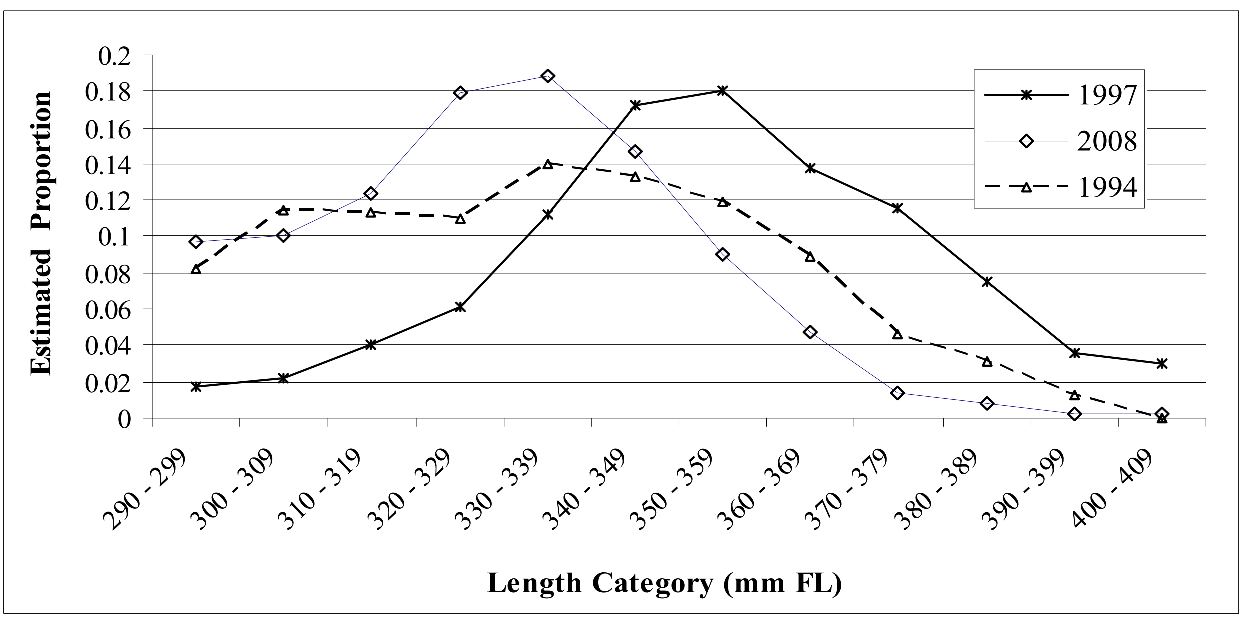

Figure 8.–Length composition of least cisco sampled in the Chatanika River. The years 1994 and 2008 were interpreted as having potentially good recruitment, whereas 1997 was poor recruitment.

Periodic assessments HWF and LC (e.g., 5 year interval) are recommended. This will serve to help identify natural variation in population sizes since 1987 and will serve to further refine the management plan. Because of the low observed abundance of LC, an assessment for this species within the next 3 years is recommended to ensure the population size does not decline further.

The absence of HWF between Poker Creek and the Elliot Highway bridge was of interest because of previously documented spawning occurring upstream of the bridge, most notably one called "Humpy Heaven" located approximately 1–2 mi downstream of Poker Creek. This relatively large aggregation was observed in the late 1970's during which the whitefish population may have been substantially larger (Al Townsend, Habitat Biologist-retired, Alaska Department of Fish and Game, Fairbanks, personal communication). During our limited sampling, we found no evidence of any spawning fish upstream of the bridge. Our observation was also supported by a concurrent (2008) study by a University-of-Alaska graduate student where no mature-sized radio-tagged HWF (from a sample of 38 fish) were tracked upstream of the Elliot Highway bridge during the entire fall spawning period. Reasons for their absence are unclear but may be related to expansion of spawning areas during years of very high abundance. Therefore, in years when the HWF population appears to be very large, sampling in the vicinity of Poker Creek is recommended to provide insight into the use patterns of this spawning habitat.

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APPENDIX A

Appendix A1.–Procedures for detecting and adjusting for size or sex selective sampling during a 2-sample mark recapture experiment.

Overview

Size and sex selective sampling may result in the need to stratify by size and/or sex in order to obtain unbiased estimates of abundance and composition. In addition, the nature of the selectivity determines whether the first, second or both event samples are used for estimating composition. The Kolmogorov-Smirnov two sample (K-S) test (Conover 1980) is used to detect significant evidence that size selective sampling occurred during the first or second sampling events and contingency table analysis (Chi-square test) is generally used to detect significant evidence that sex selective sampling occurred during the first or second sampling events.

K-S tests are used to evaluate the second sampling event by comparing the length frequency distribution of all fish marked during the first event (M) with that of marked fish recaptured during the second event (R), using the null test hypothesis (H_o) of no difference. The first sampling event is evaluated by comparing the length frequency distribution of all fish inspected for marks during the second event (C) with that of R. Chi-square tests are used to compare the counts of observed males to females between M&R and C&R according to the null hypothesis that the probability that a sampled fish is male or female is independent of the sample. When the proportions by gender are estimated for a subsample (usually from C), rather than observed for all fish in the sample, contingency table analysis is not appropriate and the proportions of females (or males) are compared using a two sample test (e.g. Student's t-test).

Mark-recapture experiments are designed to obtain sample sizes sufficient to 1) achieve precision objectives for abundance and composition estimates and 2) ensure that the diagnostic tests (i.e., tests for selectivity) have power adequate for identifying selectivity that could result in significantly biased estimates. Despite careful design, experiments may result in inadequate sample sizes leading to unreliable diagnostic test results due to low power. As a result, detection and adjusting for size and sex selectivity involves evaluating the power of the diagnostic tests.

The protocols that follow are used to classify the experiment into one of four cases. For each case the following are specified: 1) whether stratification is necessary, 2) which sample event's data should be used when estimating composition, and 3) the estimators to be used for composition estimates when stratifying. The first protocols assume adequate power. These are followed by supplemental protocols to be used when power is suspect and guidelines for evaluating power.

Protocols Given Adequate Power

Case I:

M vs. R	**C vs. R**
Fail to reject H_o	Fail to reject H_o

There is no size/sex selectivity detected during either sampling event. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated after pooling length, sex, and age data from both sampling events.

Case II:

M vs. R	**C vs. R**
Reject H_o	Fail to reject H_o

There is no size/sex selectivity detected during the first event but there is during the second event sampling. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the first sampling event without stratification. If composition is estimated from second event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the M vs. R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type formula.

-continued-

Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case III:

M vs. R	**C vs. R**
Fail to reject H_o	Reject H_o

There is no size/sex selectivity detected during the second event but there is during the first event sampling. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the second sampling event without stratification. If composition is estimated from first event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the C vs. R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case IV:

M vs. R	**C vs. R**
Reject H_o	Reject H_o

There is size/sex selectivity detected during both the first and second sampling events. The ratio of the probability of captures for size of sex categories can either be the same or different between events. Data must be stratified to eliminate variability in capture probability within strata for at least one or both sampling events. Abundance is calculated using a Petersen-type model for each stratum, and estimates are summed across strata to estimate overall abundance. Composition parameters may be estimated within the strata as determined above, but only using data from sampling events where stratification has eliminated variability in capture probabilities within strata. If data from both sampling events are to be used, further stratification may be necessary to meet the condition of capture homogeneity within strata for both events. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance.

When stratification by sex or length is necessary prior to estimating composition parameters, an overall composition parameters (p_k) is estimating by combining within stratum composition estimates using:

$$\hat{p}_k = \sum_{i=1}^{j} \frac{\hat{N}_i}{\hat{N}_\Sigma} \hat{p}_{ik} \text{, and} \tag{A1-1}$$

$$\hat{V}[\hat{p}_k] \approx \frac{1}{\hat{N}_\Sigma^2} \left(\sum_{i=1}^{j} \hat{N}_i^2 \hat{V}[\hat{p}_{ik}] + \left(\hat{p}_{ik} - \hat{p}_k \right)^2 \hat{V}[\hat{N}_i] \right) \tag{A1-2}$$

where:

j = the number of sex/size strata;

$\hat{p}_{ik}$ = the estimated proportion of fish that were age or size k among fish in stratum i;

$\hat{N}_i$ = the estimated abundance in stratum i;

$\hat{N}_\Sigma$ = sum of the $\hat{N}_i$ across strata.

Protocols when Power Suspect (re-classifying the experiment)

When sample sizes are small (guidelines provided in next section) power needs to be evaluated when diagnostic tests fail to reject the null hypothesis. If this failure to identify selectivity is due to low power (that is, if selectivity is actually present) data will be pooled when stratifying is necessary for unbiased estimates. For example, if the both the M vs. R and C vs. R tests failed to identify selectivity due to low power, Case I may be selected when Case IV is true. In this scenario, the need to stratify could have been overlooked leading to biased estimates. The following protocols should be followed when sample sizes are small.

Appendix A2.–Tests of consistency for the Petersen estimator (from Seber 1982, page 438).

TESTS OF CONSISTENCY FOR PETERSEN ESTIMATOR

Of the following conditions, at least one must be fulfilled to meet assumptions of a Petersen estimator:

1. Marked fish mix completely with unmarked fish between events;
2. Every fish has an equal probability of being captured and marked during event 1; or,
3. Every fish has an equal probability of being captured and examined during event 2.

To evaluate these three assumptions, the chi-square statistic will be used to examine the following contingency tables as recommended by Seber (1982). At least one null hypothesis needs to be accepted for assumptions of the Petersen model (Bailey 1951, 1952; Chapman 1951) to be valid. If all three tests are rejected, a geographically stratified estimator (Darroch 1961) should be used to estimate abundance.

I.-Test For Complete Mixing [a]

Section	Section Where Recaptured				Not Recaptured
Where Marked	**A**	**B**	**…**	**F**	(n_1-m_2)
A					
B					
...					
F					

II.-Test For Equal Probability of capture during the first event[b]

	Section Where Examined			
	A	**B**	**…**	**F**
Marked (m_2)				
Unmarked (n_2-m_2)				

III.-Test for equal probability of capture during the second event[c]

	Section Where Marked			
	A	**B**	**…**	**F**
Recaptured (m_2)				
Not Recaptured (n_1-m_2)				

[a] This tests the hypothesis that movement probabilities (θ) from section *i* (*i* = 1, 2, ...s) to section *j* (*j* = 1, 2, ...t) are the same among sections: H_0: $\theta_{ij} = \theta_j$.

[b] This tests the hypothesis of homogeneity on the columns of the 2-by-t contingency table with respect to the marked to unmarked ratio among sections: H_0: $\Sigma_i a_i \theta_{ij} = kU_j$, where *k* = total marks released/total unmarked in the population, U_j = total unmarked fish in stratum *j* at the time of sampling, and a_i = number of marked fish released in stratum *i*.

[c] This tests the hypothesis of homogeneity on the columns of this 2-by-s contingency table with respect to recapture probabilities among sections: H_0: $\Sigma_j \theta_{ij} p_j = d$, where p_j is the probability of capturing a fish in section *j* during the second event, and d is a constant.

Appendix A3.–Equations for calculating estimates of abundance and its variance using the Bailey-modified Petersen estimator.

The Bailey-modified Petersen estimator (Bailey 1951 and 1952) is used because the sampling design calls for a systematic downstream progression and it effect results in sampling without replacement.

The estimator and its variance are:

$$\hat{N} = \frac{n_1(n_2+1)}{(m_2+1)} \quad \text{and} \qquad \text{(A3-1)}$$

$$V[\hat{N}] = \frac{n_1^{\,2}(n_2+1)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \qquad \text{(A3-2)}$$

where:

n_1 = the number marked during the first sampling event;

n_2 = the number examined during the second sampling event; and,

m_2 = the number captured during the second sampling event with marks from the first sampling event.

The Bailey modification to the Petersen estimator may be used even when the assumption of a random sample for the second sample is false and a systematic sample is provided:

1) there is uniform mixing of marked and unmarked fish; and,
2) all fish, whether marked or unmarked, have the same probability of capture (Seber 1982).

APPENDIX B

Appendix B1.– Number of Humpback Whitefish ≥360 mm FL marked (n_1), examined (n_2), and recaptured (m_2) by section in the Chatanika River study area, 2008.

Section Endpoint	First event			Second event		
(River mile)	(n_1)	(m_2)	(n_1/m_2)	(n_2)	(m_2)	(n_1/m_2)
2.2	72	0	0.00	84	2	0.02
2.6	58	2	0.03	87	3	0.03
2.9	54	1	0.02	58	2	0.03
3.5	72	6	0.08	122	6	0.05
4.25	63	2	0.03	55	2	0.04
4.75	120	6	0.05	65	3	0.05
5.1	50	1	0.02	30	2	0.07
5.8	38	1	0.03	9	0	0.00
6.6	46	3	0.07	12	3	0.25
7.5	57	3	0.05	46	4	0.09
8.1	58	3	0.05	110	14	0.13
8.5	58	4	0.07	45	8	0.18
9.4	68	7	0.10	96	12	0.13
10.9	99	10	0.10	52	10	0.19
12.5	72	5	0.07	87	12	0.14
13.6	71	10	0.14	51	7	0.14
14	37	4	0.11	51	9	0.18
16	73	6	0.08	43	6	0.14
17.3	32	5	0.16	45	6	0.13
18.3	39	2	0.05	72	9	0.13
19.2	29	4	0.14	20	4	0.20
20.2	22	1	0.05	21	3	0.14
21.2	63	17	0.27	29	5	0.17
22.4	27	7	0.26	30	11	0.37
23.4	17	2	0.12	17	4	0.24
24.5	32	11	0.34	31	5	0.16
25.5	32	5	0.16	24	4	0.17
26.75	27	1	0.04	28	0	0.00
27.8	32	12	0.38	8	1	0.13
28.8	22	4	0.18	28	1	0.04
29.8	40	2	0.05	70	4	0.06
30.95	18	3	0.17	30	2	0.07
31.9	21	3	0.14	18	1	0.06
33.5	40	5	0.13	18	1	0.06
36.5	14	1	0.07	12	0	0.00
37.4	11	2	0.18	4	0	0.00
37.5	33	1	0.03	0	0	
38.9	14	2	0.14	8	0	0.00
41.5	8	2	0.25	1	0	0.00
42.6	6	0	0.00	2	0	0.00
43.8	2	0	0.00	1	0	0.00
Total	1,747	166		1,620	166	

Appendix B2.–Number of least cisco ≥250 mm FL marked (n1), examined (n2), and recaptured (m2) by section in the Chatanika River study area, 2008.

Section Endpoint	First event			Second event		
(River mile)	(n_1)	(m_2)	(n_1/m_2)	(n_2)	(m_2)	(n_1/m_2)
1	6	0	0.00	4	0	0.00
2	69	8	0.12	145	3	0.02
3	66	5	0.08	254	5	0.02
4	47	7	0.15	114	3	0.03
5	7	0	0.00	97	6	0.06
6	90	14	0.16	153	10	0.07
7	75	12	0.16	101	11	0.11
8	127	22	0.17	164	11	0.07
9	35	3	0.09	219	16	0.07
10	42	7	0.17	57	7	0.12
11	45	6	0.13	86	3	0.03
12	82	13	0.16	134	12	0.09
13	41	6	0.15	134	13	0.10
14	54	6	0.11	79	5	0.06
15	45	0	0.00	119	6	0.05
16	30	1	0.03	8	1	0.13
17	27	1	0.04			
18	25	1	0.04			
19	5	0	0.00			
20	6	0	0.00			
21	9	0	0.00			
22	3	0	0.00			
23	2	0	0.00			

Appendix B3.–Estimated length composition of humpback whitefish ≥360 mm FL in the Chatanika River study area, 2008**.**

Length category (mm FL)	n	$\hat{P}$	SE ($\hat{P}$)	$\hat{N}$	SE ($\hat{N}$)
350 - 359	0	-	-	-	-
360 - 369	17	0.01	0.001	114	14
370 - 379	20	0.01	0.001	134	16
380 - 389	58	0.02	0.002	387	48
390 - 399	105	0.03	0.003	701	87
400 - 409	181	0.05	0.004	1,209	149
410 - 419	249	0.07	0.005	1,663	205
420 - 429	295	0.09	0.005	1,971	243
430 - 439	397	0.12	0.006	2,652	327
440 - 449	423	0.13	0.006	2,826	349
450 - 459	427	0.13	0.006	2,852	352
460 - 469	324	0.10	0.005	2,164	267
470 - 479	314	0.09	0.005	2,097	259
480 - 489	264	0.08	0.005	1,763	218
490 - 499	155	0.05	0.004	1,035	128
500 - 509	61	0.02	0.002	407	50
510 - 519	47	0.01	0.002	314	39
520 - 529	17	0.01	0.001	114	14
530 - 539	7	0.00	0.001	47	6
540 - 549	1	0.00	0.000	7	1
550 - 559	4	0.00	0.001	27	3
560 - 569	1	0.00	0.000	7	1
570 - 579	0	-	-	-	-

Appendix B4.–Estimated length composition of least cisco ≥250 mm FL in the 16-km Chatanika River study area, 2008.

Length category (mm FL)	n	$\hat{P}$	SE ($\hat{P}$)	$\hat{N}$	SE ($\hat{N}$)
350 - 359	0	0.00	0.000	0	0
360 - 369	17	0.01	0.001	114	14
240 - 249	0	0.00	0.000	0	0
250 - 259	59	0.02	0.003	322	28
260 - 269	130	0.05	0.004	710	63
270 - 279	182	0.06	0.005	994	88
280 - 289	215	0.08	0.005	1,175	103
290 - 299	216	0.08	0.005	1,180	104
300 - 309	224	0.08	0.005	1,224	108
310 - 319	276	0.10	0.006	1,508	133
320 - 329	399	0.14	0.007	2,180	192
330 - 339	418	0.15	0.007	2,284	201
340 - 349	325	0.12	0.006	1,776	156
350 - 359	201	0.07	0.005	1,098	97
360 - 369	105	0.04	0.004	574	50
370 - 379	31	0.01	0.002	169	15
380 - 389	17	0.01	0.001	93	8
390 - 399	6	0.00	0.001	33	3
400 - 409	4	0.00	0.001	22	2
410 - 419	0	-	-	-	-

Appendix B5.–Estimated length composition of least cisco ≥290 mm FL in the 16-km Chatanika River study area, 2008.

Length category (mm FL)	n	$\hat{P}$	SE ($\hat{P}$)	$\hat{N}$	SE ($\hat{N}$)
290 - 299	216	0.10	0.006	1,491	131
300 - 309	224	0.10	0.006	1,547	136
310 - 319	276	0.12	0.007	1,906	168
320 - 329	399	0.18	0.008	2,755	242
330 - 339	418	0.19	0.008	2,886	254
340 - 349	325	0.15	0.007	2,244	197
350 - 359	201	0.09	0.006	1,388	122
360 - 369	105	0.05	0.005	725	64
370 - 379	31	0.01	0.002	214	19
380 - 389	17	0.01	0.002	117	10
390 - 399	6	0.00	0.001	41	4
400 - 409	4	0.00	0.001	28	2
410 - 419	0	-	-	-	-

APPENDIX C

Appendix C1.–Data files for humpback whitefish and least cisco sampled from the Chatanika River during 2008.

Data file[a]	Description
HWF data_2008.xls	File includes all humpback whitefish sampled and analysis for the mark-recapture experiment from the Chatanika River during fall 2008.
LC data_2008.xls	File includes all least cisco sampled and analysis for the mark-recapture experiment from the Chatanika River during fall 2008.

[a] Data files were archived at and are available from the Alaska Department of Fish and Game, Sport Fish Division, 1300 College Road, Fairbanks, Alaska 99701.