Fishery Data Series No. 07-49

Evaluation of Stocked Rainbow Trout Populations in Interior Alaska, 2005

by

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and

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August 2007

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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

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ABSTRACT

Stocked rainbow trout populations were sampled in 10 lakes in the Tanana River and Copper River drainages during 2005 to evaluate the fish stocking program. Rainbow trout populations in seven lakes had "regional" management objectives and the populations in three lakes had "special" management objectives. Mean length and relative abundance criteria required to meet "regional" and "special" management objectives were calculated for specific length categories and age cohorts using population models that were based on generalized growth curves, survival rates, and preferred stocking strategies. The length categories for "regional" management objectives were < 250 mm and ≥ 250 mm. The length categories for "special" management objectives were < 460 mm and ≥ 460 mm. Rainbow trout populations were evaluated by comparing mean length and relative abundance statistics obtained from population sampling to the management criteria as well as to predicted values calculated from the actual stocking history. Length frequency distributions generated from population models and sampling data were also visually compared.

"Regional" management criteria for mean length were achieved for six out of seven populations for fish < 250 mm FL and for four out of seven populations for fish ≥ 250 mm FL. Birch Lake, Donna Lake, Little Donna Lake, and Sculpin Lake achieved the criteria for both length categories. Criteria for relative abundance by length category were achieved for Birch Lake, Lost Lake, and Sculpin Lake. Age cohorts were determined for only two of seven populations and only Mark Lake achieved the criteria for relative abundance.

"Special" management criteria for mean length were achieved for one out of three populations. Criteria for relative abundance were achieved for all three populations by length category. Age cohorts were determined for only Donnelly Lake which met the relative abundance criteria.

This information, along with ancillary information about lake and fishery characteristics, was used to adjust stocking strategies that specified criteria for the size (length or weight) and number of fish to stock, number of stockings, time of year and whether stockings were biennial or annual. The goal was to create population structures that would provide recreational opportunity and a reasonable expectation or high probability of meeting "regional" or "special" management objectives.

Key words: fish population monitoring, rainbow trout, *Oncorhynchus mykiss*, Mark Lake, Donna Lake, Little Donna Lake, Donnelly Lake, Rainbow Lake, Lost Lake, Birch Lake, Little Harding Lake, Sculpin Lake, Gergie Lake, population structure, stocking evaluation, stock assessment, stocking method, length at age.

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) stocks game fish in 134 lakes and one stream in the Tanana River drainage in Interior Alaska and the Upper Copper/Upper Susitna (UCUS) river drainages in the Glennallen area (Figure 1). The goal of the stocking program is to provide diverse and dependable angling opportunities near population centers and offer alternatives to the harvest of wild fish stocks. The stocking program began in the early 1950s, when lakes along the road system were stocked with rainbow trout *Oncorhynchus mykiss*, or coho salmon *Oncorhynchus kisutch*. Today, the stocking program provides year-round sport-fishing opportunity for rainbow trout, coho salmon, Chinook salmon *Oncorhynchus tshawytscha*, Arctic grayling *Thymallus arcticus*, and Arctic char *Salvelinus alpinus*.

The stocking program has multiple roles and provides many benefits. The program supports consumptive fisheries and creates new angling opportunities along the road system where potential fishing effort is greatest. It also supports rural and remote fisheries where diverse angling opportunity is desired. As a conservation tool, it serves to divert fishing pressure away from wild populations that cannot support high levels of harvest desired by anglers. Anglers and businesses in the Tanana Valley value the stocking program because it provides angling opportunities that normally would not be present and it benefits local economies through the sales of fishing related sporting goods and guiding services. Anglers particularly enjoy opportunities to catch highly desired species such as rainbow trout and Arctic char which are not native to the Tanana Valley.

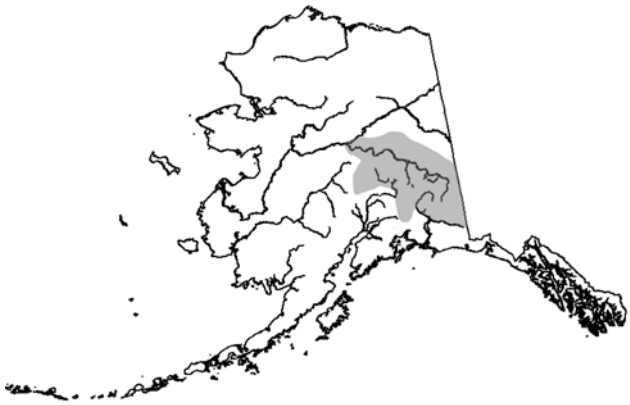

Figure 1.–The Tanana River and Upper Copper/Upper Susitna River drainages (shaded area).

STOCKED WATERS MANAGEMENT PLAN

In 2004 the Board of Fisheries (BoF) adopted two new general management plans for the stocked waters fisheries within Region III (5 AAC 70.065 and 5 AAC 52.065; 2004). The management plans state: "The department shall manage stocked waters in the Arctic-Yukon-Kuskokwim Region [and the Upper Copper River and Upper Susitna River Area] in order to meet public demand for diverse fishing opportunities." The plans outline three management approaches (regional, conservative, and special) and corresponding objectives and regulations for each.

- Regional management approach. Under the regional management approach, stocked waters will be managed so that there will be a reasonable expectation of high catch rates and harvesting a daily bag limit. The bag and possession limit is 10 fish in combination of all stocked species, and only one of those fish may be 18 inches (457 mm TL) or greater in length. The fishing season is open year round and bait may be used.
- Conservative management approach. Under the conservative management approach, stocked waters will be managed so that there will be a reasonable expectation to catch a daily bag limit with a reasonable chance of catching fish 18 inches (457 mm TL) or greater in length. The bag and possession limit is five fish in combination of all stocked species, and only one of those fish may be 18 inches (457 mm TL) or greater in length. The fishing season is open year round and bait may be used.
- Special management approach. Under the special management approach, stocked waters will be managed so that there will be a high probability of an angler catching more than one fish a day that is 18 inches (457 mm TL) or greater in length.

POPULATION STRUCTURE AND STOCKING STRATEGY

Each management approach lists general objectives for numbers and sizes of fish that anglers should have a reasonable expectation to catch and harvest. To meet these objectives we designed a general population structure for each management approach that would provide a reasonable opportunity for an angler to catch and harvest the sizes and numbers of fish described by each approach.

To determine what size of fish would meet anger's expectations we conducted informal interviews with anglers and biologists. General agreement was that most anglers would be "satisfied" catching a rainbow trout that was at least 250 mm (FL) and the minimum length for a "quality" fish was 460 mm.

To support the Regional Management Approach with a high catch rate and liberal bag limit a population structure was designed that emphasized large numbers of fish from 200 mm to 350 mm. Population structures for the Conservative and Special Management Approaches emphasized larger fish from 350 mm to 500 mm and fish from 400 mm to 550 mm, respectively. However, compared to the Regional Management Approach there were fewer fish in these populations. To promote larger fish the Conservative and Special Management Approaches reduced the bag limits to increase survival rates and ADF&G stocked fewer fish per hectare to promote higher growth rates.

A model was used to generate the abundances and length distributions for the various age cohorts that made up a population structure. The abundance and length distributions for an age cohort were calculated using generalized survival rates-at-age and lengths-at-age which were obtained from a review of the literature, past experience, and results from recent population studies. Survival rate-at-age and length-at-age were specific to each management approach (Table 1).

Table 1.–Generalized survival rate-at-age and length-at-age for Regional, Conservative, and Special management approaches.

Approach	Age 1	Age 2	Age 3	Age 4	Age 5
Regional					
Survival	0.10	0.40	0.40	0.20	0.10
Length (mm)	210	300	370	410	450
Conservative					
Survival	0.10	0.50	0.50	0.40	0.40
Length (mm)	230	320	390	440	480
Special					
Survival	0.10	0.60	0.60	0.50	0.40
Length (mm)	250	340	410	460	500

A stocking strategy was then developed for each fishery that would produce the desired population structure. A stocking strategy had goals for the size (length or weight), number of fish to stock, number of stockings each year, time of year, and whether stockings were annual or biennial. These strategies were then used to determine production schedules for the ADF&G fish hatcheries.

FISHERY-SPECIFIC MANAGEMENT CRITERIA

The population structures that we designed for each fishery were used as quantitative targets to measure the success of the stocking program. The successful creation and maintenance of a population structure was used as a surrogate to indicate that we successfully met the management approach objectives.

To compare the observed population structures to the target (management) population structures we established criteria for mean length and relative abundance for each rainbow trout population

based on length categories and age cohorts. The length categories for the Regional Management Approach were < 250 mm and ≥ 250 mm. The length categories for the Conservative and Special Management Approaches were < 460 mm and ≥ 460 mm along with secondary length categories of < 250 mm and ≥ 250 mm. Mean length and relative abundance were then calculated using the management population structures for each fishery.

Because actual stockings were not consistent and often failed to meet all strategy goals for number and size of fish, the observed population structures were also compared to mean length and relative abundance criteria that were predicted from the actual stocking history for each lake.

SINGLE-SAMPLE FISH POPULATION MONITORING

In 2005, rainbow trout populations in 10 lakes were selected for evaluation. Seven lakes had "regional" management objectives and 3 lakes had "special" management objectives.

OBJECTIVES

Research Objective 1:	For each lake sampled, determine if the mean length of rainbow trout within specified length-age categories differs from the desired and predicted values.
Research Objective 2:	For each lake sampled, estimate the length-age composition of the rainbow trout in fisheries listed in Table 1.
Research Objective 3:	For each lake sampled, determine if the population distribution of stocked rainbow trout conform to the desired and predicted distributions.

METHODS

Sampling Procedure

Fish populations in 10 stocked lakes near Fairbanks, Delta Junction, and Glennallen were sampled to determine the population length-age structure (Table 2; Figures 2, 3, and 4). Sampling gear types were fyke nets, hoop traps, and tangle nets.

Fyke nets were set near shore on the lake bottom in 1 to 2 m of water. Fyke nets had openings that were either 0.9 or 1.2 m^2, the body length from opening to cod end was about 5 m, hoop size was 0.9 m diameter, and mesh size was 9 mm^2. Wings measuring 7.5 m long by 1.2 m deep were attached to each side of the open end. The net body was positioned parallel to shore and the wings set to form a "V". Each fyke net was pulled taut from the cod end and held in position with a weight.

Hoop traps were 0.5 m diameter and 1.6 m long with an inward pointing conical funnel at one end. Netting was 6.4 mm Delta weave. Hoop traps were used in water deeper than 2 m. Each hoop trap was attached to a vertical line with a float on one end and a weight on the other. Traps were oriented horizontally (the long axes of the hoop trap parallel to the surface) and baited with unsalted salmon roe. Hoop traps were not set in depths where dissolved oxygen levels were less than 2 ppm.

Table 2.–Description of stocked rainbow trout fisheries sampled in 2005.

Fishery	Hectare (Acre)	Management Category	Stocking Frequency
Birch Lake	324 (800)	Regional	Annual
Donna Lake	23 (58)	Regional	Alternate Year
Donnelly Lake	26 (65)	Special	Alternate Year
Gergie Lake	24 (59)	Regional	Alternate Year
Little Donna Lake	12 (30)	Regional	Alternate Year
Little Harding Lake	22 (54)	Special	Annual
Lost Lake	38 (94)	Regional	Annual
Rainbow Lake	39 (96)	Special	Alternate Year
Sculpin Lake	57 (140)	Regional	Alternate Year
Silver Lake	239 (590)	Regional	Alternate Year

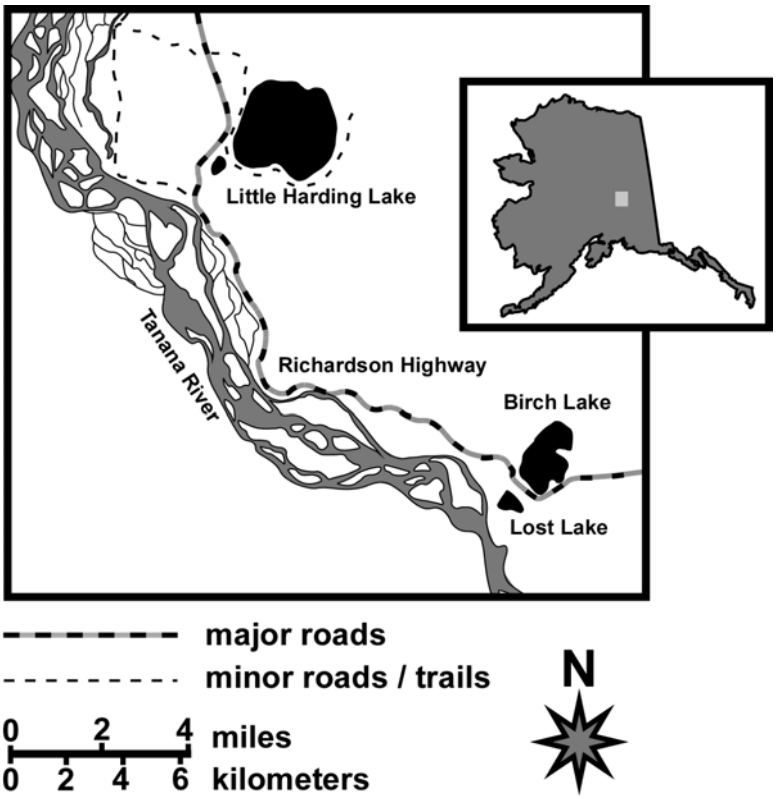

Figure 2.–Lower Tanana Management Area (Fairbanks)–stocked lakes sampled in 2005.

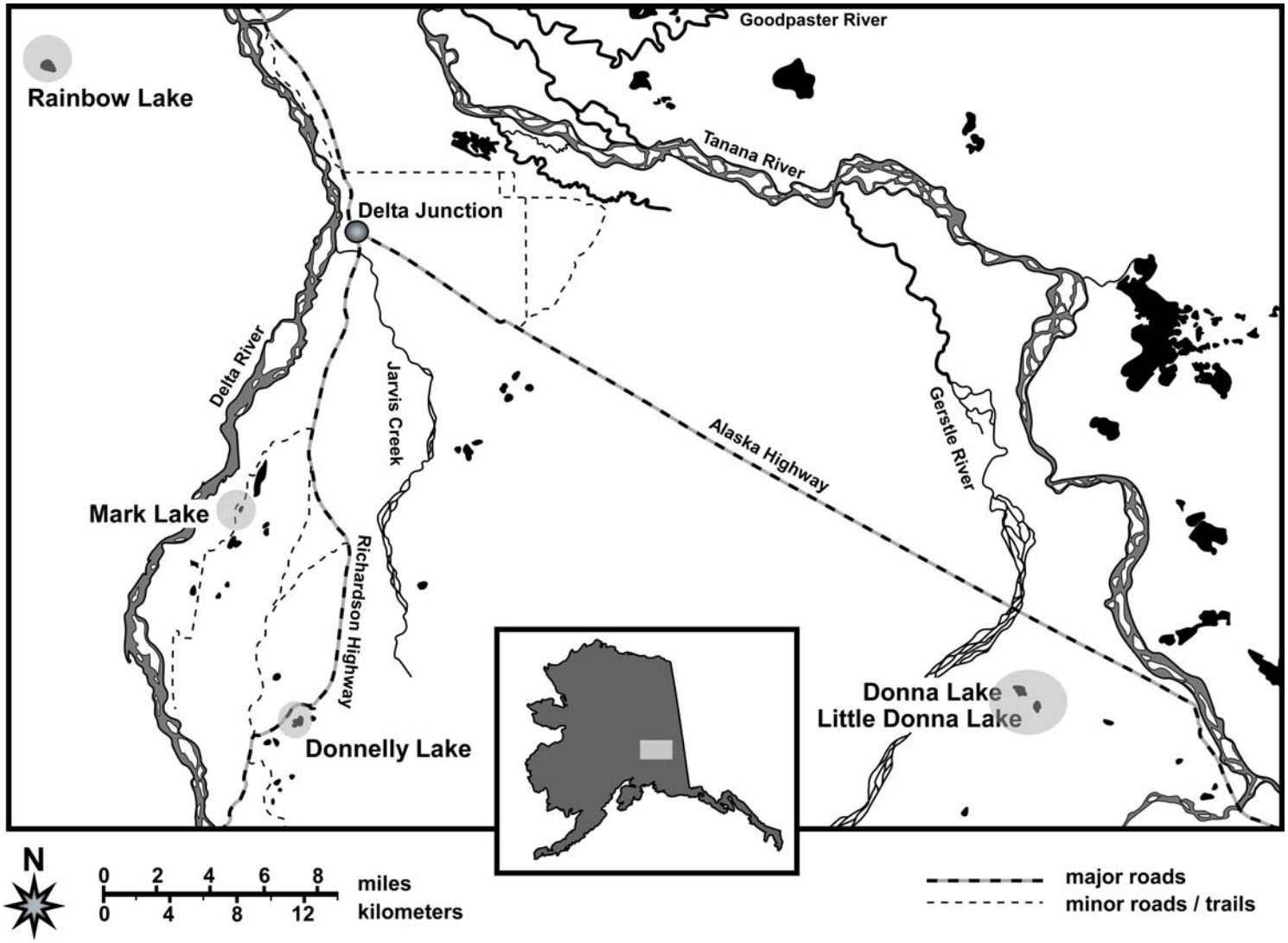

Figure 3.–Upper Tanana Management Area (Delta)–stocked lakes sampled in 2005.

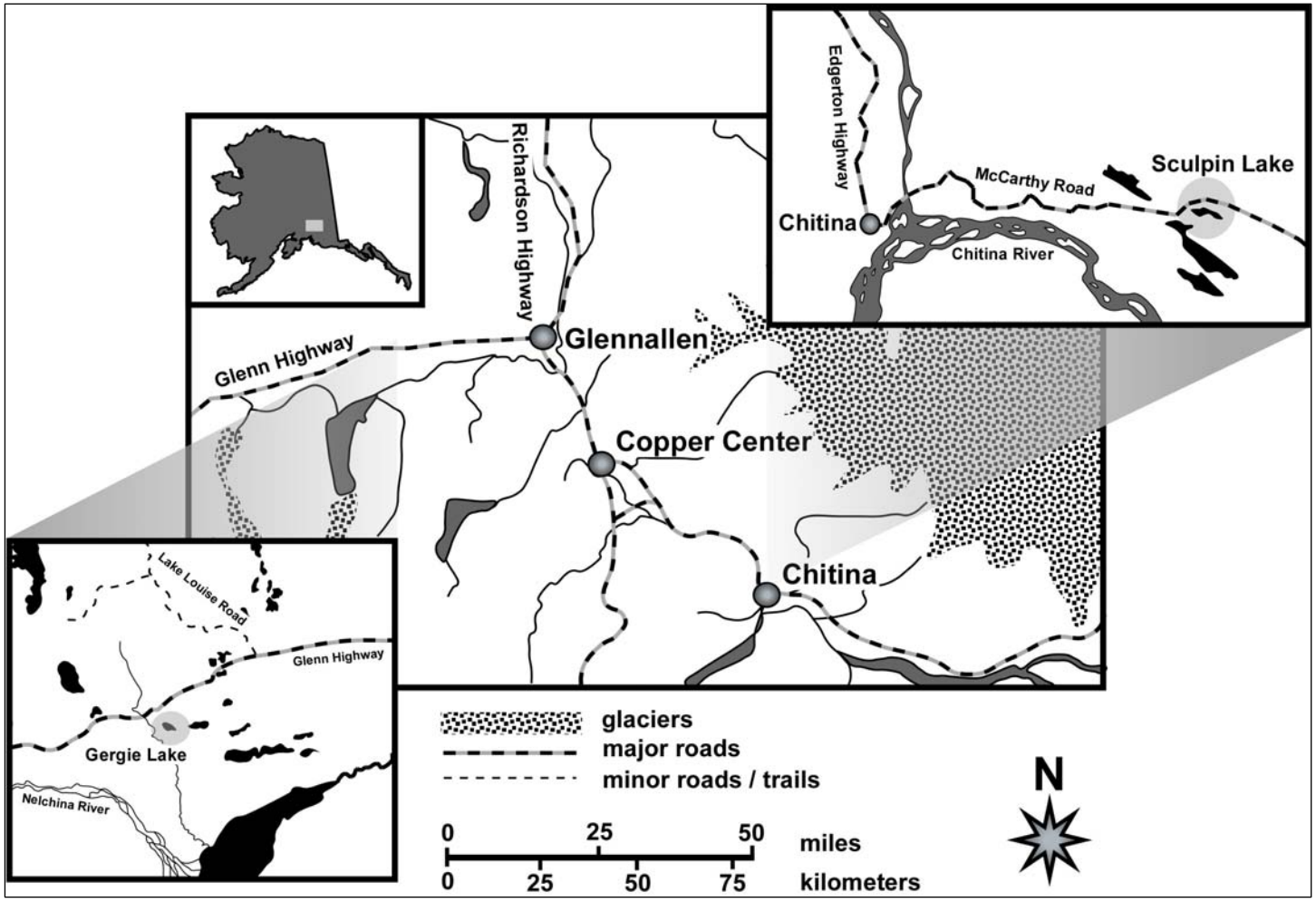

Figure 4.–Upper Copper Upper Susitna Management Area (Glennallen)–stocked lakes sampled in 2005.

Tangle nets were set perpendicular to shore in water deeper than 2 meters. Tangle nets measured 45 m (150 ft) long by 5.4 m (18 ft) deep. The mesh size was 13 mm (½ in) bar and made with fine thread monofilament. Mesh size was small to ensure that fish were captured by entanglement around the mouth and not by the gill covers. Two styles of nets were used. One net was a "floater" - the float line buoyancy was greater than the weight of the lead line. The other net was a "sinker" - the lead line was weighted to overcome the buoyancy of the float line. The "floater" had a triple float line and 13.5 kg (30 lb) lead line. The "sinker" had a double float line and a 31.5 kg (70 lb) lead line. Generally, tangle nets were checked every 20 minutes. The time was then shortened or extended depending on an immediate assessment of the condition of the fish by the field crew leader.

The amount of capture gear and the duration of sampling projects were based on lake size (Table 3). In larger lakes, more capture gear was used and the duration of the project was increased. Sampling was stopped at the end of the allotted time even when a sample size was not achieved.

Table 3.–Amount of capture gear and duration of sampling project by lake size.

Hectare (Acre)	Days	Fyke Nets	Tangle Nets	Hoop Traps
0 to 20 (50)	1	4	1	5
>20 to 40 (100)	2	4	1	5
>40 to 200 (500)	3	4	2	8
>200 to 400 (1,000)	3	6	2	10
>400 (1,000)	3	8	2	10

All captured fish were measured to the nearest mm FL. Fish captured for the first time regardless of gear type were marked by removing a half circle of tissue from the trailing edge of the upper lobe of the caudal fin. The mark was made with a paper punch that produced a 7 mm diameter circular hole. Subsequent recaptures were recorded but the data were not used for analysis.

When more than 50 fish were captured, carbon dioxide was used to anesthetize up to 50 fish at a time. This made the fish easier to handle and minimized injuries to the fish that might result from having to physically subdue an active fish.

Water temperature was monitored daily 1 m beneath the surface and all sampling was conducted when water temperature was < 18°C. This was done to minimize the potential for size bias sampling and is explained further in the Bias section of this report.

Data Reduction and Analysis

Sample data were used to enumerate rainbow trout within specific length categories and to generate length frequency distributions (LFDs) for each rainbow trout population. When possible, age cohorts were identified by visual inspection of LFD plots and the corresponding mean lengths were calculated using the appropriate length data.

The length or age composition of each rainbow trout population was calculated using (Cochran 1977):

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

where:

$\hat{p}_k$ = the proportion (relative abundance) of rainbow trout that belong to length category or age cohort k;

y_k = the number of rainbow trout sampled that belong to length category or age cohort k; and,

n = the total number of rainbow trout sampled.

The unbiased variance of this proportion was estimated as:

$$\hat{V}(\hat{p}_k) = \frac{\hat{p}_k(1-\hat{p}_k)}{n-1} \quad . \tag{2}$$

Observed mean lengths and sampling variances within specific size categories and age cohorts were calculated using standard sample summary statistics (Cochran 1977).

For visual comparison, LFDs generated using sample data were plotted with the corresponding population curves that were generated from management criteria under a preferred stocking strategy ("management criteria") and predicted results based on the actual stocking history ("predicted criteria"). For each population the observed number of rainbow trout that belonged to a specific length category or age cohort (relative abundance) was compared to numbers corresponding to the management criteria and to the predicted criteria using χ^2 goodness of fit tests (Zar 1984). Observed mean lengths were compared to mean lengths for management and predicted criteria for the same specific length category or age cohort using single sample t-tests (Zar 1984). The χ^2 goodness of fit tests were evaluated using $\alpha = 0.20$ and the t-tests were evaluated using $\alpha = 0.10$.

Management and predicted criteria were considered achieved when the observed mean length or relative abundance was not statistically different from the criteria or, if statistically different, the difference was ≤ 0.10 for relative abundance or ≤ 25 mm for mean length. These differences were judged to be not meaningful to anglers. Management and predicted criteria were also considered achieved when the observed mean length was larger than the criteria regardless of statistical significance.

Assumptions and Bias

One potential concern with using data from this single-sample study design is that inadequate data are collected to evaluate size bias during sampling. An accurate estimate of a population LFD requires that all fish in a population have the same probability of capture. In practice this likely does not happen and this assumption can not be evaluated with a single-sample capture-event. However, a review of the literature and previous mark recapture studies conducted by ADF&G indicate that potential bias may be minimized by avoiding sampling activities during high water temperatures, by sampling different habitat areas, and by using gear that is not size selective.

Researchers have found that water temperature influences rainbow trout distribution in lake systems, and have documented movement of rainbow trout from nearshore to offshore habitats when water temperature exceeds 20°C (Horak and Tanner 1964; Overholtz et al. 1977; Rowe and Chisnall 1995; Rowe 1984). Doxey (1989, 1992; M. Doxey, Sport Fish Biologist, Retired, ADF&G, Fairbanks; personnel communication) noted an influx of rainbow trout to shallow near shore areas as water temperature dropped during fall sampling activities conducted at Birch

Lake, Alaska. Researchers have also noted that rainbow trout preferred depths of 0-4 m in the spring, and avoided shallow water as temperature increased throughout the summer (Overholtz et al. 1977). Additionally, a study conducted by Kwain and McCauley (1978) found that older rainbow trout have a lower temperature preference than do younger fish. Based on these findings, we concluded that larger fish will likely be the first to seek thermal refuge offshore as water temperature in littoral areas increases. To minimize the potential for size bias sampling due to this phenomenon, all sampling during our study was conducted when water temperature 1 m beneath the surface was < 18°C.

Although we expected rainbow trout populations to be distributed nearshore when water temperature w < 18°C, we also sampled both nearshore and offshore habitats to verify the presence or absence of fish in both areas. Previous studies conducted by ADF&G (under similar thermal conditions) found that capture rates for rainbow trout in offshore tangle nets, fyke nets, and hoop traps were lower than those for nearshore fyke nets (Fish and Skaugstad 2004; Havens et al. 1992). Warner and Quinn (1995) found that radio-tagged rainbow trout in Lake Washington were predominantly found in nearshore areas and resided in the top 3 m of the water column 90% of the time during sampling conducted in June, August, September, and October. Similarly, catch rates during our study supported these findings; approximately 88% of all rainbow trout were caught in nearshore fyke nets (Appendix A).

To minimize the potential for size bias due to capture gear we used fyke nets and 13 mm (½ in) bar, fine thread, monofilament tangle nets during our study. Fyke nets are typically fished in shallow waters and have proven effective at catching rainbow trout 50 to > 600 mm (Behr and Skaugstad 2006; Fish and Skaugstad 2004). The length of fish captured in tangle nets is variable and depends on mesh size; however, a 13 mm mesh should be sufficient to capture age-1 and older fish in stocked lakes.

The sampling methods used in this study were similar to those used in previous two-sample mark-recapture experiments conducted by ADF&G in which size bias was examined using either Kolmogorov-Smirnov (K-S) tests (Conover 1980) or chi-square contingency table analyses (Seber 1982). Robust and objective evaluation of size biased sampling is problematic, at best, when fish grow between sampling events. In Interior Alaska, average growth rates of nearly 1 mm per day have been observed for rainbow trout during summer (Doxey 1989).

We reviewed several previous experiments to evaluate the relation between detected size bias during rainbow trout sampling and water temperature. In two-sample experiments where a hiatus of more than two weeks occurred between sampling events (allowing for substantial growth), we re-analyzed experimental data using methods described in Behr and Skaugstad (2006), where unambiguous testing for size bias could only be conducted for first event sampling. In other experiments, where necessary, data were re-analyzed to test for size bias during both sampling events using methods described in Behr et al. (2005). These results may differ from published results in some cases, as we analyzed size data from all rainbow trout captured during these experiments, not just the target age classes.

In 2004, two mark-recapture experiments were conducted at Koole and Rainbow lakes to estimate the abundance of rainbow trout. Sampling procedures for both experiments were similar to those for this study, except that hook and line gear was used to supplement catches at both lakes and hoop nets were used at Rainbow Lake. K-S test results indicated that no significant size bias occurred during the first sampling event at Koole Lake, where the maximum

water temperature recorded was 14°C at a depth of 0.3m during 7-11 June (Behr *Unpublished*). Similarly, no significant size bias was detected for the first sampling event at Rainbow Lake where the highest water temperature recorded was 17.7°C at a depth of 0.5m on 25 August (Behr and Skaugstad 2006, Behr *Unpublished*). During Events 1 and 2, 97% and 99% of samples, respectively, were caught in fyke traps. Age-0 rainbow trout that were stocked in Rainbow Lake prior to sampling and subsequently captured in fyke nets were not used in mark-recapture experiment. Usually the smallest age-0 fish can escape through the fyke net mesh and they are subject to predation by larger fish in the fyke nets. This situation will likely result in an observed probability of capture that is significantly different from that for the other age cohorts. Consequently, age-0 fish were enumerated and measured during population sampling but the data were not used to generate information about population structure.

Only near shore fyke nets were used during a two-sample mark-recapture experiment conducted in mid June and mid August of 2001 at Lisa Lake. K-S test results indicated that size bias for rainbow trout captured during the first event was not significant (Behr et al. 2005). Water temperature during mid June was 17.5°C 1 m beneath the surface (Behr *Unpublished*). In September and October of 2006 a second mark-recapture experiment was performed at Lisa Lake. Offshore tangle nets and nearshore fyke nets were used during both events, and K-S test results indicated that no significant size bias occurred (Skaugstad and Behr *In prep*).Water temperatures at 1 m beneath the surface were 11.1°C during Event 1 and 5.5° during Event 2 (Behr *Unpublished*).

In 2000 four two-sample mark-recapture experiments were conducted at Dune, Bluff Cabin, Donna, and Little Donna lakes (Skaugstad and Fish 2002). Fyke nets, tangle nets, and hook and line gear were used. Sampling was conducted in June and August. Re-analysis of rainbow trout mark-recapture data for Dune Lake provided no significant evidence of size bias sampling during Event 1 ($p = 0.972$) where the water temperature was 16.3°C at a depth of 1.0 m on 15 June (the last day of sampling) (Behr *Unpublished*). Re-analysis of Donna Lake data provided no significant evidence size bias sampling during either Event 1 ($p = 0.196$) or Event 2 ($p = 0.772$). Water temperature was about 10.5°C at a depth of 1 m on 31 August (first day of Event 2 sampling) (Behr *Unpublished*). Similar results were obtained from data from Little Donna Lake for both Event 1 ($p = 0.425$) and Event 2 ($p = 0.978$). While sampling at Little Donna Lake occurred during the same time frame as at Donna Lake, no water temperature data were available. In contrast, re-analysis of Bluff Cabin Lake data indicated significant size bias sampling during both Event 1 ($p < 0.001$) and Event 2 ($p = 0.001$) where the water temperature was 17.2°C at a depth of 1.0 m and 18.6°C at a depth of 0.5 m on 6 June (the first day of sampling) (Behr *Unpublished*).

Two-sample mark-recapture experiments were performed at Quartz Lake in 2001 to estimate the abundance of age-1 rainbow trout and in 2002 to estimate the abundance of age-2 and older rainbow trout (Fish and Skaugstad 2004). Nearshore and offshore fyke nets, hoop nets, and tangle nets were used in 2001 and sampling was conducted 29 May to 1 June (Event 1) and 18 to 22 June (Event 2). Re-analysis of these data indicated significant size bias sampling during both Event 1 ($p < 0.001$) and Event 2 ($p < 0.001$) where the water temperature was 11°C at a depth of 1 m on 31 May and 20°C at a depth of 1 m on 22 June (Behr *Unpublished*). Less than 1% of the rainbow trout were caught in floating fyke nets, hoop nets, and tangle nets deployed in water > 1 m in depth. In 2002, fyke nets and tangle nets were used and sampling was conducted in September. Re-analysis provided no significant evidence of size bias sampling during either

Event 1 ($p = 0.384$) or Event 2 ($p = 0.493$). Water temperature was not recorded during sampling but typically lake temperatures have cooled to < 14°C 1 m below the surface by September. Rainbow Lake (16 km from Quartz Lake) was < 12°C 1 m below the surface in mid September (Behr *Unpublished*). During Event 1 no rainbow trout were caught in tangle nets in deep water and during Event 2 16% of the fish sampled were caught in tangle nets. The size distributions of fish captured with all gear types during Event 1 and Event 2 were not statistically different ($p = 0.734$).

Of the studies reviewed, only one result was inconsistent with our prescription to restrict sampling to when water temperature is < 18°C in order to minimize potential for size biased sampling of rainbow trout. Significant size bias sampling was detected during Event 1 sampling at Quartz Lake in 2001, when water temperatures was 11°C (Behr *Unpublished*). Probability of capture of rainbow trout 170 mm and larger (age 2 and older) was greater than that of smaller rainbow trout (age 1). During Event 1 the larger rainbow trout were concentrated in a few nearshore areas for spawning and later, during the hiatus and Event 2, dispersed throughout the lake. Researchers realized that spawning behavior in spring would likely affect the capture probability of age-2 and older rainbow trout during the course of the study; however, they were interested only in estimating the abundance of age-1 rainbow trout. Future studies of the Quartz Lake rainbow trout population using single-sample methods to estimate relative abundance should be conducted in fall to avoid capture heterogeneity between different size/age cohorts.

For our studies, the bias introduced by unequal capture probabilities for the different length-age cohorts has different effects on estimating length frequency mode location and mode amplitude. Mode location is important for determining the mean length of length-age cohorts while mode amplitude is important for determining the relative abundance of the length-age cohorts in the population. The bias caused by unequal capture probabilities when estimating mode location will be minimal when individuals in each length-age cohort have the same capture probability (i.e., capture probabilities are the same within cohorts but may be different between cohorts).

Bias will likely have a greater influence on estimating mode amplitude and, thus, on estimating proportions of fish in different length-age categories (i.e., relative abundance). Different capture probabilities between length-age cohorts will result in catches that are not representative of cohort abundance in the population. Increasing the sample size will make the modes more prominent but it will not improve the accuracy of the estimate. However, our review of other studies has shown that the likelihood of size bias is low when sampling is restricted to periods when water temperature is < 18°C. It is anticipated that two-sample mark-recapture studies will be conducted periodically for the larger lakes which are stocked on an annual basis and support a number of age cohorts. We will continue to use information from these studies to evaluate potential size bias associated with single-capture sampling.

RESULTS & DISCUSSION

Water temperature 1 m beneath the surface remained < 18°C during population sampling. No adverse weather conditions, high winds or waves occurred during sampling. For the 10 rainbow trout populations surveyed, about 88% of all sampled rainbow trout were captured in fyke nets, 4% in hoop traps, and 8% in tangle nets (Appendix A).

Visual identification of age cohorts using population LFDs was easy for populations maintained with biennial stockings because the LFDs for individual cohorts didn't overlap. However, when stockings happened every year the overlap of individual cohort LFDs was more extensive

making the cohorts less discernible. For populations supported with annual stockings, separating cohorts using visual identification was not useful for age-2 and older cohorts.

Regional Management Lakes

Birch Lake

Birch Lake is located at Mile 306 on the Richardson Highway (Lower Tanana Management Area). The lake covers 808 surface ha and has been stocked with multiple species since 1966. Current species stocked into Birch Lake include Arctic char, Arctic grayling, Chinook salmon, coho salmon, and rainbow trout. The populations of stocked fish support the second largest lake fishery in the Lower Tanana Management Area and generated 8,601 angler days of fishing effort in 2004 (Jennings et al. 2007). Rainbow trout captured during this experiment were stocked as catchables from 2000 to 2004 (Appendix B).

Visual comparison of LFDs indicated that there were minimal differences between the actual population structure and those based on management and predicted criteria (Figure 5). The battery of statistical tests that compared the population structure to management and predicted criteria found that some differences were significant (Table 4). However, the rainbow trout population met the management and predicted criteria for mean length and relative abundance. Mean lengths for age cohorts were not calculated because distinct age cohorts could not be identified. This was expected due to annual stockings of catchable sized fish.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	310 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.60	0.40	0.63	0.25	0.10	0.02

Recommended Actions:

- Annual stockings of 20,000 catchable rainbow trout (180 g; 250 mm). Stock 10,000 rainbow trout in May and another 10,000 in September.
- Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for regional management.
- Assess the length-age structure of the portion of the population that is harvested in 2010. Harvest data will be used to refine the population model making it a better management tool for assessing population structures and achieving management objectives.

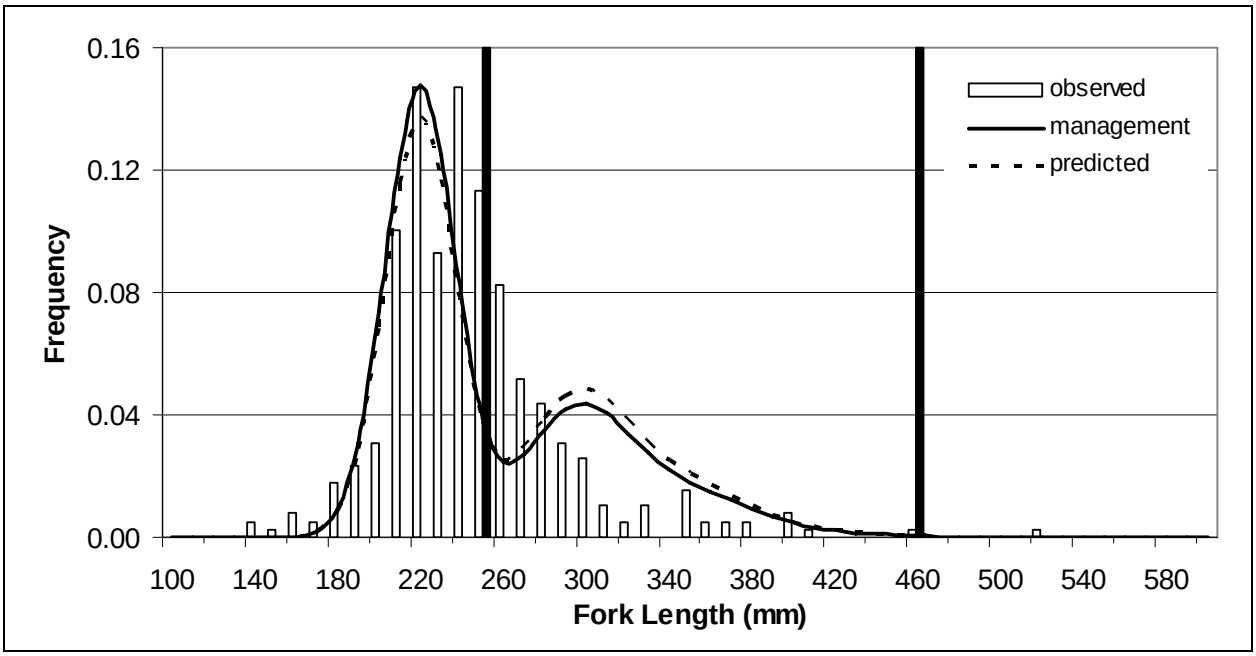

Figure 5.–Birch Lake: observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 4.–Birch Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	262 (0.68 [a])	126 (0.32 [a])	219 mm (1.28 [b])	288 mm (3.98 [b])
Management Criteria	233 (0.60 [a])	155 (0.40 [a])	218 mm	310 mm
Test Stat		9.16	0.93	-5.51
DF		1	261	125
P Value		0.0025	0.35	<0.0001
Predicted Criteria	217 (0.56 [a])	171 (0.44 [a])	218 mm	311 mm
Test Stat		20.92	0.93	-5.76
DF		1	261	125
P Value		<0.0001	0.35	<0.0001

[a] Proportion of catch.

[b] Standard error.

Donna Lake

Donna Lake is located 5.6 km south of the Alaska Highway at Mile 1,391.8 (Upper Tanana Management Area). The lake covers 23.5 surface ha and was first stocked with rainbow trout fingerlings in 1962. Rainbow trout captured during this experiment were stocked as fingerlings in 2001, 2003, and 2004. About 7,600 fish were stocked each year (Appendix B). Fingerling stockings were switched from odd to even years in 2004 to consolidate stocking activities for this area and minimize the costs associated with ground and aerial transport. The consecutive stockings in 2003 and 2004 made it difficult to distinguish between age cohorts (Figure 6).

Visual comparison of LFDs found obvious differences in node amplitudes between actual population structures and those based on management and predicted criteria (Figure 6). The battery of statistical tests that were performed found that all but one test was significant (Table 5). However, the rainbow trout population met the management and predicted criteria for mean length. Management and predicted criteria were not met for relative abundance by length category. Age cohorts could not be reliably identified and no statistical tests were performed.

A consistent biennial stocking schedule would likely produce a population structure that more closely resembled that calculated for management criteria.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	324 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.81	0.19	0.86	0	0.14	0

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 7,600 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2009 or 2010 to determine if the biennial stocking scheme is meeting population structure objectives for regional management.

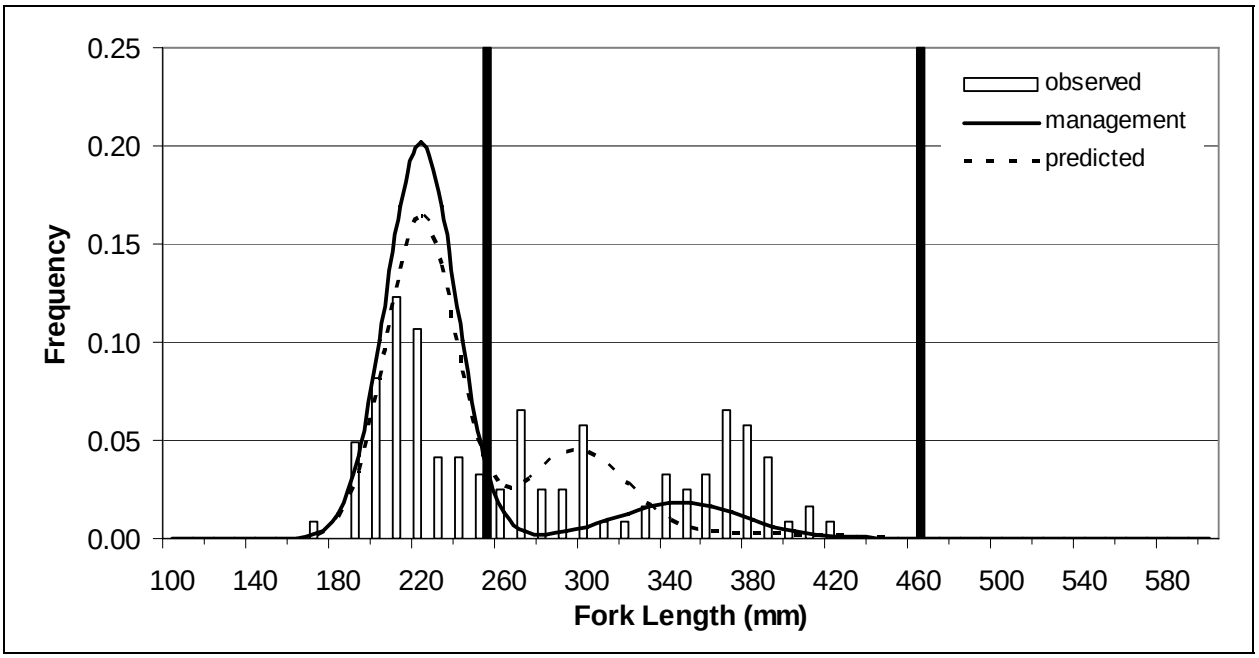

Figure 6.–Donna Lake: observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 5.–Donna Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	58 (0.48 [a])	64 (0.52 [a])	209 mm (2.27 [b])	330 mm (6.00 [b])
Management Criteria	99 (0.81 [a])	23 (0.19 [a])	218 mm	324 mm
Test Stat		88.74	-3.96	1.00
DF		1	57	63
P Value		<0.0001	0.0002	0.32
Predicted Criteria	82 (0.67 [a])	40 (0.33 [a])	218 mm	298 mm
Test Stat		20.89	-0.40	5.33
DF		1	57	63
P Value		<0.0001	0.0002	<0.0001

[a] Proportion of catch.

[b] Standard error.

Gergie Lake

Gergie Lake is located approximately 2.4 km south of the Glenn Highway at Mile 155 (Upper Copper Upper Susitna Management Area). The lake covers 24 surface ha and was first stocked with rainbow trout fingerlings in 1966. Approximately 9,000 rainbow trout fingerlings were stocked into Gergie Lake biennially. Rainbow trout captured during this experiment were stocked in 2001 and 2004 (Appendix B).

The desired sample size of 111 fish was not obtained at Gergie Lake; Only 82 fish were captured. A combination of low abundance and limited time for sampling made it difficult to achieve the sample size.

The LFD of captured rainbow trout did not resemble population structures calculated for management or predicted criteria (Figure 7). The battery of statistical tests that were performed found that all tests were significant (Table 6). Management and predicted criteria for mean length were met for length category < 250 mm; however, they were not achieved for relative abundance by length category. Age cohorts were not identifiable and no statistical tests were conducted.

Age-4 fish were absent from the population and age-1 fish were larger than expected. Gergie Lake has winterkilled in previous years. Dissolved oxygen readings recorded in April of 2001 were 0.07 to 1.48 mg/L (Behr *Unpublished*). Sampling conducted in spring 2001 found no fish present in the lake (T. Taube, Sport Fish Biologist, ADF&G, Glennallen; personal communication). It is likely that Gergie Lake winterkilled in 2002 or 2003 and the fish stocked in 2004 were not subject to predation or competition and exhibited accelerated growth.

Management objectives may not be easily attained due to occasional winterkills; however, an acceptable fishery can be maintained with biennial stockings of fingerling or catchable rainbow trout.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	324 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.81	0.19	0.86	0	0.14	0

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 9,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2009 or 2010 to determine if the biennial stocking scheme is meeting population structure objectives for regional management.

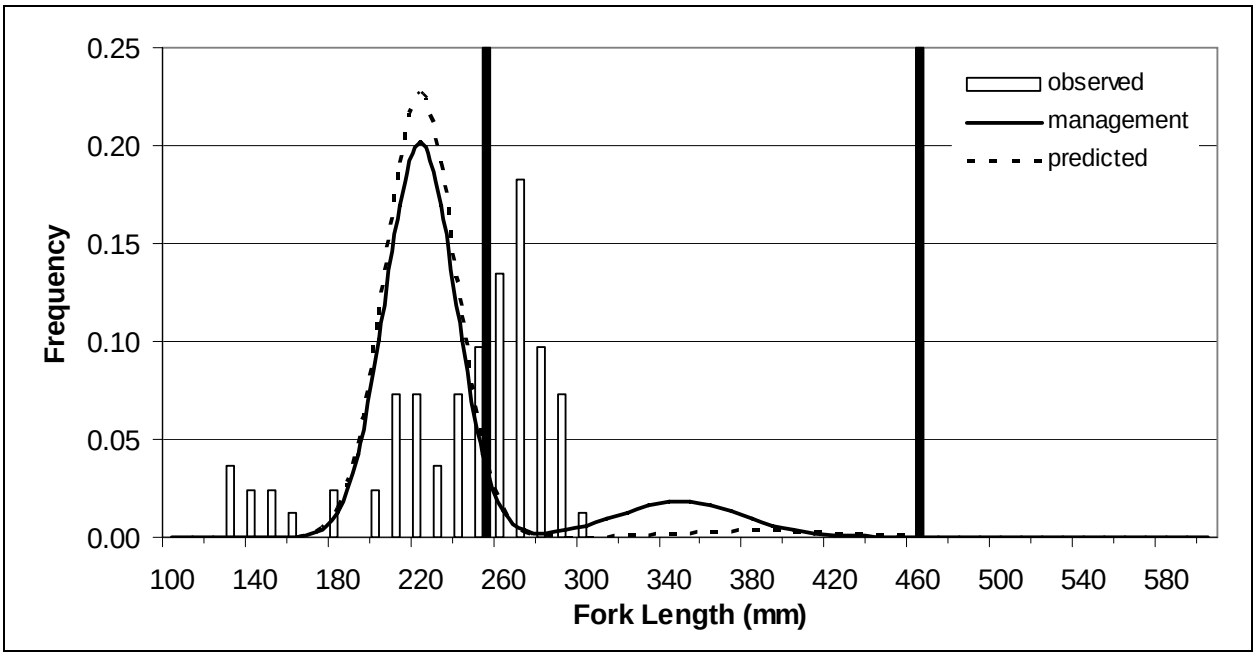

Figure 7.–Gergie Lake: observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 6.– Gergie Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	39 (0.48 [a])	43 (0.52 [a])	204 mm (6.22 [b])	268 mm (1.75 [b])
Management Criteria	66 (0.81 [a])	16 (0.19 [a])	218 mm	324 mm
Test Stat		59.58	-2.25	-31.93
DF		1	38	42
P Value		<0.0001	0.030	<0.0001
Predicted Criteria	75 (0.92 [a])	7 (0.08 [a])	218 mm	304 mm
Test Stat		220.022	-2.25	-20.53
DF		1	38	42
P Value		<0.0001	0.030	<0.0001

[a] Proportion of catch.

[b] Standard error.

Little Donna Lake

Little Donna Lake is located near Donna Lake, 7.2 km south of the Alaska Highway at Mile 1,391.8 (Upper Tanana Management Area). The lake covers 12 ha and was first stocked with rainbow trout fingerlings in 1963. Rainbow trout captured during this experiment were stocked as fingerlings in 2001, 2003, and 2004, (Appendix B).

Only 43 fish were captured in Little Donna Lake and few were < 250 mm. This was unexpected because 4,000 fish were stocked each year in 2003 and 2004. Stockings for Little Donna Lake were switched from odd to even years in 2004 to reduce costs associated with aerial transport.

The LFD of captured rainbow trout did not resemble population structures calculated for management or predicted criteria (Figure 8). The battery of statistical tests that were performed comparing the population structure to management and predicted criteria found that all results were significant except the management and predicted mean lengths calculated for length category < 250 mm (Table 7). Management and predicted criteria were not achieved for mean length category > 250 mm or for relative abundance. Age cohorts were not identifiable and no statistical tests were conducted.

The small sample size and consecutive fingerling stockings in 2003 and 2004 made it difficult to distinguish between age cohorts. The absence of small fish in the sample may indicate poor survival of the age-1 cohort (stocked in 2004) or better than anticipated growth. Generally, the captured fish were larger than expected.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	324 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.81	0.19	0.86	0	0.14	0

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 4,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2009 or 2010 to determine if the biennial stocking scheme is meeting population structure objectives for regional management.

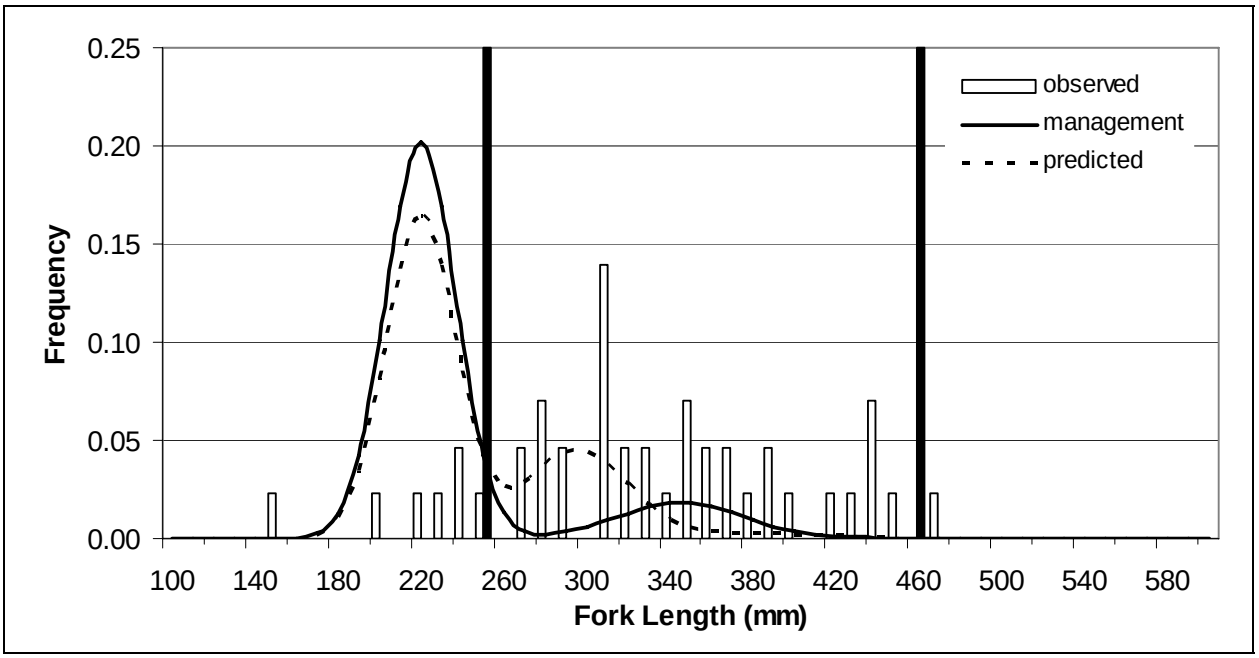

Figure 8.–Little Donna Lake: Rainbow observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 7.–Little Donna Lake: test results by age cohort**.**

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	7 (0.16 [a])	36 (0.84 [a])	214 mm (12.96 [b])	346 mm (9.30 [b])
Management Criteria	35 (0.81 [a])	8 (0.19 [a])	218 mm	324 mm
Test Stat		117.04	-0.31	2.36
DF		1	6	35
P Value		<0.0001	0.77	0.024
Predicted Criteria	29 (0.67 [a])	14 (0.33 [a])	218 mm	298 mm
Test Stat		50.033	-0.31	5.16
DF		1	6	35
P Value		<0.0001	0.77	<0.0001

[a] Proportion of catch.

[b] Standard error.

Lost Lake

Lost Lake is 88 km southeast of Fairbanks and 1.2 km south of the Richardson Highway on Lost Lake Road. The lake covers 38 ha and was first stocked with rainbow trout fingerlings in 1952. Species stocked into Lost Lake between 2000 and 2004 include Arctic char, Chinook salmon, lake trout, and rainbow trout. Rainbow trout captured during this experiment were stocked as catchables annually from 2001 through 2004 (Appendix B).

Visual inspection of LFDs indicated that age-1 fish were larger than expected and older cohorts were absent (Figure 9). The battery of statistical tests that were performed comparing the population structure to management and predicted criteria found that all differences were significant (Table 8). The rainbow trout population met the management and predicted criteria for mean length for length category < 250 mm but not for length category ≥ 250 mm. Management criteria were also achieved for relative abundance by length category but predicted criteria were not met. Mean lengths for age cohorts were not calculated because distinct age cohorts could not be identified. This was expected due to annual stockings of catchable sized fish.

Catchable size fish were stocked into Lost Lake because the harvest level cannot be sustained by fingerling stockings. A Boy Scout camp occupies the south shore and the camp is active all summer hosting various groups. Angling is a major activity and anglers are allowed to keep 10 fish per day.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	310 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.60	0.40	0.63	0.25	0.10	0.02

Recommended Actions:

- Annual stockings of 11,500 catchable rainbow trout (180 g; 250 mm). Stock 5,000 rainbow trout in mid May, 3,000 in mid June, and another 3,000 in September.
- Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for regional management.
- Assess the length-age structure of the portion of the population that is harvested in 2010. Harvest data will be used to refine the population model making it a better management tool for assessing population structures and achieving management objectives.

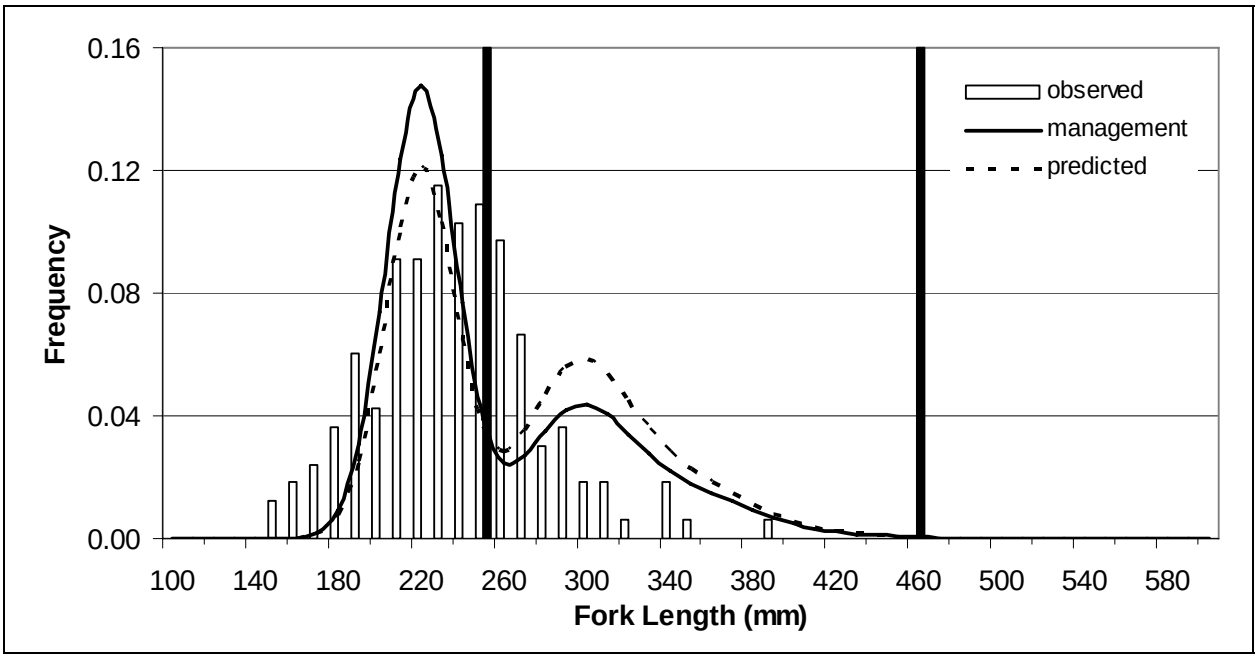

Figure 9.–Lost Lake: observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 8.–Lost Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	100 (0.67 [a])	66 (0.33 [a])	213 mm (2.41 [b])	276 mm (3.96 [b])
Management Criteria	100 (0.60 [a])	66 (0.40 [a])	218 mm	310 mm
Test Stat		3.90	-2.078	-8.58
DF		1	111	53
P Value		0.050	0.040	<0.0001
Predicted Criteria	83 (0.50 [a])	83 (0.50 [a])	218 mm	311 mm
Test Stat		20.26	-2.078	-8.84
DF		1	111	35
P Value		<0.0001	0.040	<0.0001

[a] Proportion of catch.

[b] Standard error.

Mark Lake

Mark Lake is located in the Donnelly Training Area (DTA) near Delta Junction (Upper Tanana Management Area). The lake lies 8.5 km down Meadows Road, west of the Richardson Highway at Mile 257.6. Mark Lake is approximately 1.5 ha and was first stocked with rainbow trout fingerlings in 1964. Species currently stocked include Arctic char, coho salmon, and rainbow trout. Rainbow trout captured during this experiment were stocked as fingerlings in 2001 and 2004 and as catchables in 2004 (Appendix B).

Recently, anglers have expressed concern about the small size of fish in Mark Lake. Visual inspection of LFDs indicated that fingerlings and catchables stocked in 2004 were smaller than expected (Figure 10). The battery of statistical tests that were performed comparing the population structure to management and predicted criteria found that all differences were significant (Tables 9 and 10). The rainbow trout population did not meet any of the management or predicted criteria for mean length. Age cohorts were identified and management and predicted criteria were achieved for relative abundance by age cohort but not for mean length by age cohort.

Biologists conducting population sampling activities noted that the captured rainbow trout were "thin" compared to other rainbow trout populations in other lakes. A population of "thin" fish may indicate low food availability, overstocking, or a combination of both. Mark Lake was previously reported to be 7.2 hectares but it was approximately 1.5 hectares at the time of sampling in 2005. Smaller lake size and reduced habitat likely resulted in less available food resources which may explain the limited growth observed.

The number and size of fish to stock into a lake roughly corresponds to lake size, depth, and angler use. Because there was a drastic reduction in lake size, the number of fish stocked should be decreased. Mark Lake is popular with anglers; however, it may no longer be able to provide sufficient numbers of catchable fish from fingerling stockings to meet demand. Annual stockings of catchable rainbow trout should be considered to sustain the fishery, but, the state hatcheries cannot supply adequate numbers of catchable rainbow trout to meet current angler demand. Until more catchable fish are available, fingerling stockings should continue but the number should be reduced to match the current lake size.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 250 mm	≥ 250 mm	1	2	3	4
Mean Length (FL)	218 mm	310 mm	220 mm	295 mm	345 mm	385 mm
Relative Abundance	0.60	0.40	0.63	0.25	0.10	0.02

Recommended Actions:

- Annual stockings of 500 catchable rainbow trout (180 g; 250 mm).
- Or, biennial stockings of 1,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for regional management.

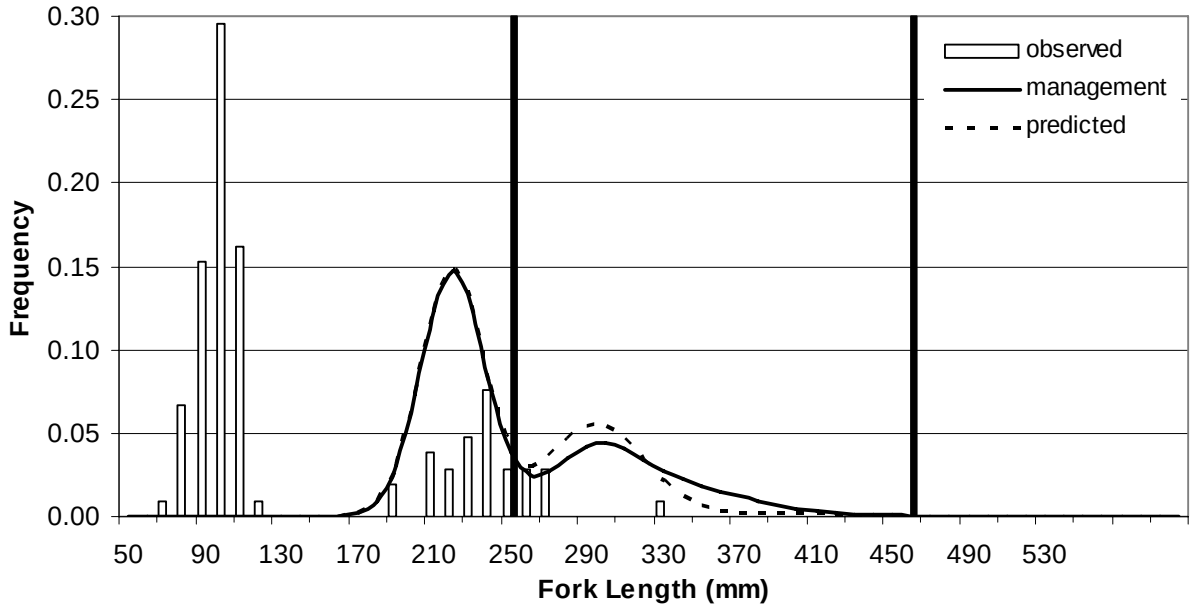

Figure 10.–Mark Lake: observed rainbow trout length frequency distribution compared to management and predicted criteria, 2005.

Table 9.–Mark Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	98 (0.93[a])	42 (0.07[a])	127 mm (5.90[b])	270 mm (10.19 [b])
Management Criteria	63 (0.60[a])	42 (0.40[a])	218 mm	310 mm
Test Stat		48.61	-15.44	-3.93
DF		1	97	6
P Value		<0.0001	<0.0001	<0.0001
Predicted Criteria	64 (0.61[a])	41 (0.39[a])	218 mm	298 mm
Test Stat		46.14	-15.44	-2.75
DF		1	97	6
P Value		<0.0001	<0.0001	0.033

[a] Proportion of catch.

[b] Standard error.

Table 10.–Mark Lake: test results by age cohort.

	Relative Abundance (χ2 test)					**Mean Length** (t test)				
	age-1	age-2	age-3	age-4	age-5	age-1	age-2	age-3	age-4	age-5
Observed	73 (0.70[a])	33 (0.30[a])	0	0	0	127 mm (5.90[b])	270 mm (10.19[b])	-	-	-
Management Criteria	66 (0.63[a])	26 (0.25[a])	11[c] (0.10[a])	2[c] (0.02[a])	0[c]	220 mm	295 mm	345 mm	385 mm	420 mm
Test Stat		14.83[c]				-15.78	-2.45	-	-	-
DF		2[c]				72	31	-	-	-
P Value		0.0006[c]				<0.0001	0.020	-	-	-
Predicted Criteria	66 (0.63[a])	37 (0.35[a])	0[c]	2[c] (0.02[a])	0[c]	220 mm	295 mm	-	385 mm	-
Test Stat		3.42[c]				-15.78	-2.45	-	-	-
DF		2[c]				72	31	-	-	-
P Value		0.18[c]				<0.0001	0.020	-	-	-

[a] Proportion of catch.

[b] Standard error.

[c] Too few fish to produce meaningful test results. Values for age-3, 4, and 5 fish combined for statistical analysis.

Sculpin Lake

Sculpin Lake is located 0.4 kilometers south of the McCarthy Road at Mile 12.6 (Upper Copper Upper Susitna Management Area). The lake covers 76.5 hectares and was first stocked with rainbow trout fingerlings in 1968. Rainbow trout captured during this experiment were stocked as fingerlings in 2001 (Appendix B).

Visual inspection indicated that the population structure and predicted LFDs were similar but the population mean length was larger (Figure 11). The battery of statistical tests that were performed comparing the population structure to management and predicted criteria found that all differences were significant (Tables 11 and 12). However, the rainbow trout population met all predicted criteria for mean length and relative abundance. All management criteria were met except relative abundance by age cohort.

All fish in the population were age 4. The management objective for 2005 was to have 93% of the population made up of age-2 fish with age-4 fish making up the rest. However, the lake was not stocked in 2003 because sufficient numbers of fingerling rainbow trout were not available from the hatchery.

Population Length-Age Structure:

	Length Category			Age Cohort			
	< 250 mm	≥ 250 mm		1	2	3	4
Mean Length (FL)	238 mm	303 mm	220 mm	295 mm	345 mm	385 mm	
Relative Abundance	0.97	0.03	0	0.93	0	0.07	

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 14,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for regional management.

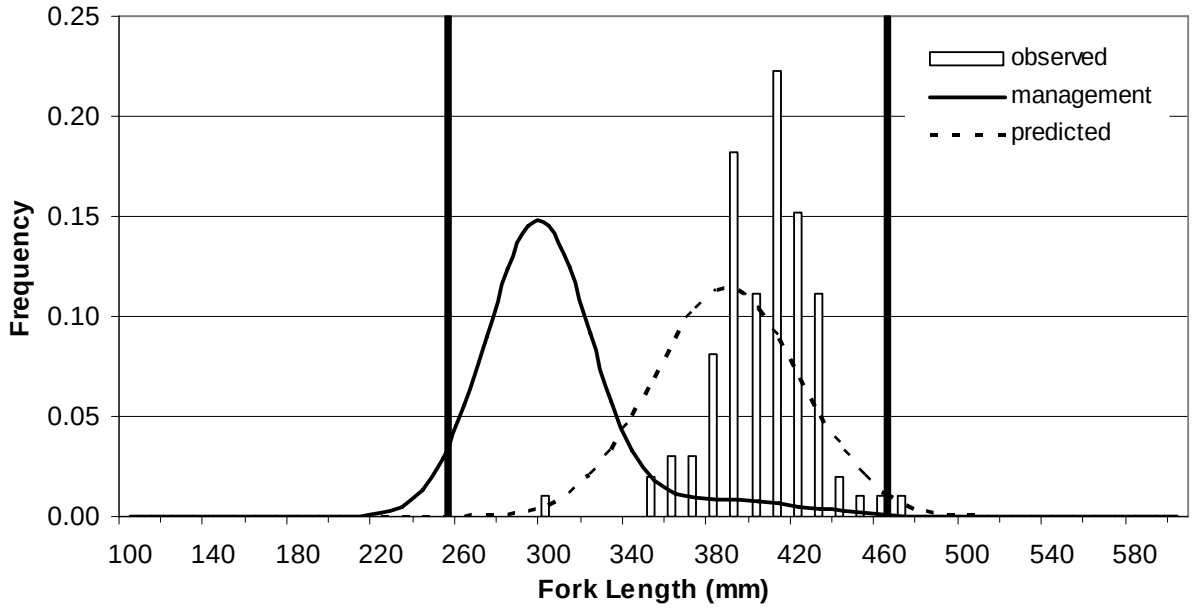

Figure 11.–Sculpin Lake: observed rainbow trout length frequency distribution compared to management objectives and predicted criteria, 2005.

Table 11.–Sculpin Lake: test results by length category.

	Relative Abundance (χ^2 test)		**Mean Length** (t test)	
	<250 mm	≥250 mm	<250 mm	≥250 mm
Observed	0	99 (1.0[a])	- -	400 mm (2.40 [b])
Management Criteria	3 (0.03[a])	96 (0.97[a])	238 mm	303 mm
Test Stat		3.062	-	40.42
DF		1	-	98
P Value		0.080	-	<0.0001
Predicted Criteria	0	99 (1.0[a])	239 mm	385 mm
Test Stat		No test performed.	-	6.25
DF		-	-	98
P Value		-	-	<0.0001

[a] Proportion of catch.

[b] Standard error.

Table 12.–Sculpin Lake: test results by age cohort.

	Relative Abundance (χ2 test)					**Mean Length** (t test)				
	age-1	age-2	age-3	age-4	age-5	age-1	age-2	age-3	age-4	age-5
Observed	0	0	0	99 (1.0[a])	0	-	-	-	400 (2.40[b])	-
Management Criteria	0[c]	92 (0.93[a])	0[c]	7 (0.07[a])	0[c]	220 mm	295 mm	345 mm	385 mm	420 mm
Test Stat		1315.29[c]				-	-	-	6.25	-
DF		1[c]				-	-	-	98	-
P Value		<0.0001[c]				-	-	-	<0.0001	-
Predicted Criteria	0	0	0	99 (1.0[a])	0	-	-	-	385 mm	-
Test Stat		No test performed				-	-	-	6.25	-
DF		-				-	-	-	98	-
P Value		-				-	-	-	<0.0001	-

[a] Proportion of catch.

[b] Standard error.

[c] Zero values not used in statistical analysis.

Special Management Lakes

Donnelly Lake

Donnelly Lake is located approximately 0.8 km east of the Richardson Highway at Mile 244.6 (Upper Tanana Management Area). The lake covers 12 ha and was first stocked in 1973. Donnelly Lake was classified as a special management lake by the Board of Fish in 2004 and corresponding bag restrictions were implemented in 2005. In 2000 and 2002, approximately 13,000 and 11,500 rainbow trout fingerlings, respectively, were stocked into Donnelly Lake (Appendix B). In 2004, the number of fingerling rainbow trout stocked into Donnelly Lake was reduced to 6,000 biennially to adjust to expected lower annual harvests and to promote faster growth.

Visual inspection of LFDs showed that the shape of the population structure was similar to those for management and predicted criteria except that the mean lengths for age-1 and age-3 cohorts were smaller (Figure 12). No fish ≥ 460 mm were captured in Donnelly Lake, however few were expected based on the biennial stocking schedule. The battery of statistical tests that were performed comparing the population structure to management and predicted criteria found that all differences were significant except for mean length for size category ≥ 250 mm (Tables 13 and 14). The management criteria for mean length for size category ≥ 250 mm and the management and predicted criteria for relative abundance for length categories < 460 mm and ≥ 460 mm were met. Management and predicted criteria were achieved for relative abundance by age cohort but not for mean length by age cohort.

With the new stocking schedule we expect growth rates will increase as the population abundance decreases. The population structure should begin to resemble the management LFD within three years.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 460 mm	≥ 460 mm	1	2	3	4
Mean Length (FL)	285 mm	486 mm	250 mm	340 mm	410 mm	460 mm
Relative Abundance	0.98	0.02	0	0.76	0	0.24

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 6,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2008 or 2009 to determine if the new stocking scheme is meeting population structure objectives for special management.

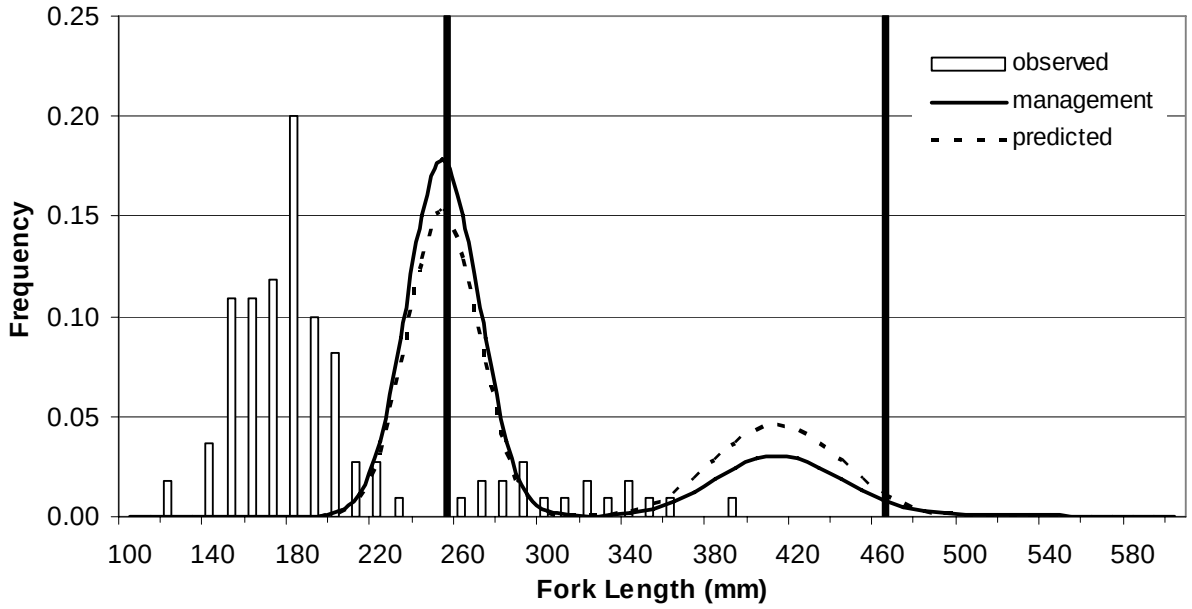

Figure 12.–Donnelly Lake: observed rainbow trout length frequency distribution compared to management objectives and predicted criteria, 2005.

Table 13.– Donnelly Lake: test results by length category.

	Relative Abundance (χ2 test)				**Mean Length** (t test)			
	<250 mm	≥250 mm	<460 mm	≥460 mm	<250 mm	≥250 mm	<460 mm	≥460 mm
Observed	92	18	110	0	170 mm	307 mm	192 mm	-
	(0.84[a])	(0.16[a])	(1.0 [a])		(2.24[b])	(8.27[b])	(5.37[b])	-
Management Criteria	37	73	108	2	235 mm	316 mm	285 mm	486 mm
	(0.34[a])	(0.66[a])	(0.98[a])	(0.02[a])				
Test Stat		120.77		2.24	-29.072	-1.089	-17.31	-
DF		1		1	91	17	109	-
P Value		<0.0001		0.13	<0.0001	0.29	<0.0001	-
Predicted Criteria	32	78	108	2	235 mm	334 mm	302 mm	473 mm
	(0.29[a])	(0.71[a])	(0.98[a])	(0.02[a])				
Test Stat		159.48		2.24	-29.072	-3.26	-20.47	-
DF		1		1	91	-17	109	-
P Value		<0.0001		0.13	<0.0001	0.0046	<0.0001	-

[a] Proportion of catch.

[b] Standard error.

Table 14.–Donnelly Lake: test results by age cohort.

	Relative Abundance (χ2 test)					**Mean Length** (t test)				
	age-1	age-2	age-3	age-4	age-5	age-1	age-2	age-3	age-4	age-5
Observed	92 (0.84[a])	0	18 (0.16 [a])	0	0	170 (2.24[b])	- -	307 (8.27[b])	- -	- -
Management Criteria	84 (0.76[a])	0[c]	25 (0.23[a])	0 [c]	0[c] (0.01[a])	220 mm	295 mm	345 mm	385 mm	420 mm
Test Stat		2.95[c]				-35.78	-	-12.46	-	-
DF		1[c]				91	-	17	-	-
P Value		0.086[c]				<0.0001	-	<0.0001	-	-
Predicted Criteria	72 (0.65[a])	0[c]	39 (0.35[a])	0[c]	0[c]	250 mm	-	410 mm	-	-
Test Stat		16.79				-35.78	-	-12.46	-	-
DF		1				91	-	17	-	-
P Value		<0.0001				<0.0001	-	<0.0001	-	-

[a] Proportion of catch.

[b] Standard error.

[c] Zero values not used in statistical analysis.

Little Harding Lake

Little Harding Lake is located a short distance off the Richardson Highway at Mile 318 (Lower Tanana Management Area). The lake covers approximately 22 ha and was first stocked in 1963. Little Harding Lake has had a daily bag and possession limit of one fish 18 in (457 mm) or larger since 1994. Between 2000 and 2005 approximately 800 catchable rainbow trout were stocked into Little Harding Lake annually, with the exception of 2004 when only 300 catchables were stocked (Appendix B).

Visual inspection of LFDs showed that the shape of the population structure was similar to those for management and predicted criteria except that the abundance of larger fish in the population was less than expected (Figure 13). No fish ≥ 460 mm were captured and age cohorts could not be determined. The battery of statistical tests that were performed comparing the population structure to management and predicted criteria produced mixed results (Table 15). Differences were not significant between sample mean lengths and management and predicted criteria for rainbow trout < 250 mm. The sample relative abundance estimates by length category 250 mm were not significantly different from management criteria. All other differences were statistically significant. Sample estimates met the predicted criteria for mean length < 460 mm and for management and predicted criteria for mean length < 250 mm. Both management and predicted criteria were met for relative abundance for 250 mm and 460 mm length categories..

Little Harding Lake has direct road access and is situated next to Harding Lake, a weekend destination for many local residents. As a result, Little Harding Lake is popular with local anglers. The fish ≥ 435 mm in Little Harding Lake were likely harvested. Fish lengths presented in this report are based on FL. The length regulation for the fishery, however, is based on total length (TL). A rainbow trout that was at least 435 mm FL would likely meet the minimum length limit (18 in TL or 460 mm TL).

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 460 mm	≥ 460 mm	1	2	3	4
Mean Length (FL)	321 mm	487 mm	250 mm	340 mm	410 mm	460 mm
Relative Abundance	0.91	0.09	0.40	0.24	0.22	0.14

Recommended Actions:

- Annual stockings of 1,200 catchable (250 mm) and 300 broodstock (410 mm) rainbow trout by mid May. The addition of broodstock will increase the number of large fish available in the fishery.

Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for special management.

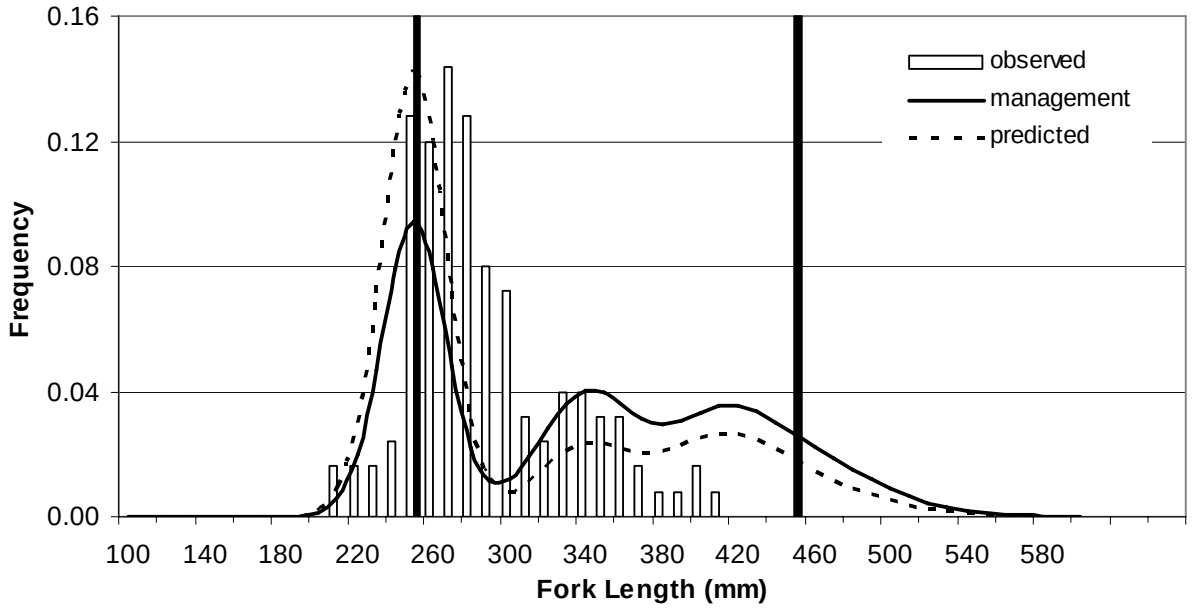

Figure 13.–Little Harding Lake: observed rainbow trout length frequency distribution compared to management objectives and predicted criteria, 2005.

Table 15.–Little Harding Lake: test results by length category.

	Relative Abundance (χ2 test)				**Mean Length** (t test)			
	<250 mm	≥250 mm	<460 mm	≥460 mm	<250 mm	≥250 mm	<460 mm	≥460 mm
Observed	21	104	125	0	235 mm	293 mm	284 mm	-
	(0.17[a])	(0.83[a])	(1.0[a])		(2.99[b])	(3.72[b])	(3.68[b])	-
Management Criteria	23	103	114	11	235 mm	358 mm	321 mm	487 mm
	(0.18[a])	(0.82[a])	(0.91[a])	(0.09[a])				
Test Stat		0.12		12.36	0.0000	-17.48	-10.050	-
DF		1		1	20	103	124	-
P Value		0.73		0.0004	1.0000	<0.0001	<0.0001	-
Predicted Criteria	34	91	119	6	235 mm	334 mm	297 mm	486 mm
	(0.27[a])	(0.73[a])	(0.95[a])	(0.05[a])				
Test Stat		6.60		6.58	0.0000	-11.029	-3.53	-
DF		1		1	20	103	124	-
P Value		0.010		0.010	1.0000	<0.0001	0.0006	-

[a] Proportion of catch.

[b] Standard error.

Rainbow Lake

Rainbow Lake is located approximately 16 km southwest of Quartz Lake near Delta Junction (Upper Tanana Management Area). The lake covers 39 ha and has been stocked with rainbow trout fingerlings since 1971. Rainbow Lake was classified as a Special Management lake by the Board of Fish in 2004 and corresponding bag restrictions were implemented in 2005. Rainbow trout captured during this study were stocked as fingerlings in 2001 and 2004 (Appendix B). Aerial stockings for Rainbow Lake were switched from odd to even years in 2003, resulting in a two year gap in stockings. This change was done to consolidate aerial stockings for this area and minimize transportation costs.

Visual inspection of LFDs showed little resemblance between the population structure and management and predicted criteria (Figure 14). The management LFD was based on biennial stockings while the predicted LFD was based on stockings in 2001 and 2004. The battery of statistical tests that were performed comparing the population structure to management and predicted criteria were all significantly different except for mean lengths for < 250 mm (Table 16). However, the management and predicted criteria for mean length were all met. Relative abundance for management and predicted criteria were met for < 460 mm and ≥ 460 mm, but not for < 250 mm and ≥ 250 mm.

Few fish ≥ 460 mm were captured in Rainbow Lake; however, few were predicted due to a two year gap between fingerling stockings. Despite the two year gap, age cohorts could not be identified and few small fish were present in the sample (Figure 14). Fingerling rainbow trout stocked in 2004 may have grown faster than expected, but the relatively small sample size of 70 fish made it difficult to draw inferences about this population.

Although few fish were captured, they were larger than expected and their relative condition (based on visual assessment) indicated the population was not stressed by disease or lack of food.

Population Length-Age Structure:

	Length Category		Age Cohort			
	< 460 mm	≥ 460 mm	1	2	3	4
Mean Length (FL)	285 mm	486 mm	250 mm	340 mm	410 mm	460 mm
Relative Abundance	0.98	0.02	0.76	0	0.24	0

Values in table were calculated for odd years. Values for even years will be different.

Recommended Actions:

- Biennial stockings of 8,000 fingerling rainbow trout (2 g) by mid June.
- Assess the population structure in 2010 to determine if the new stocking scheme is meeting population structure objectives for special management.

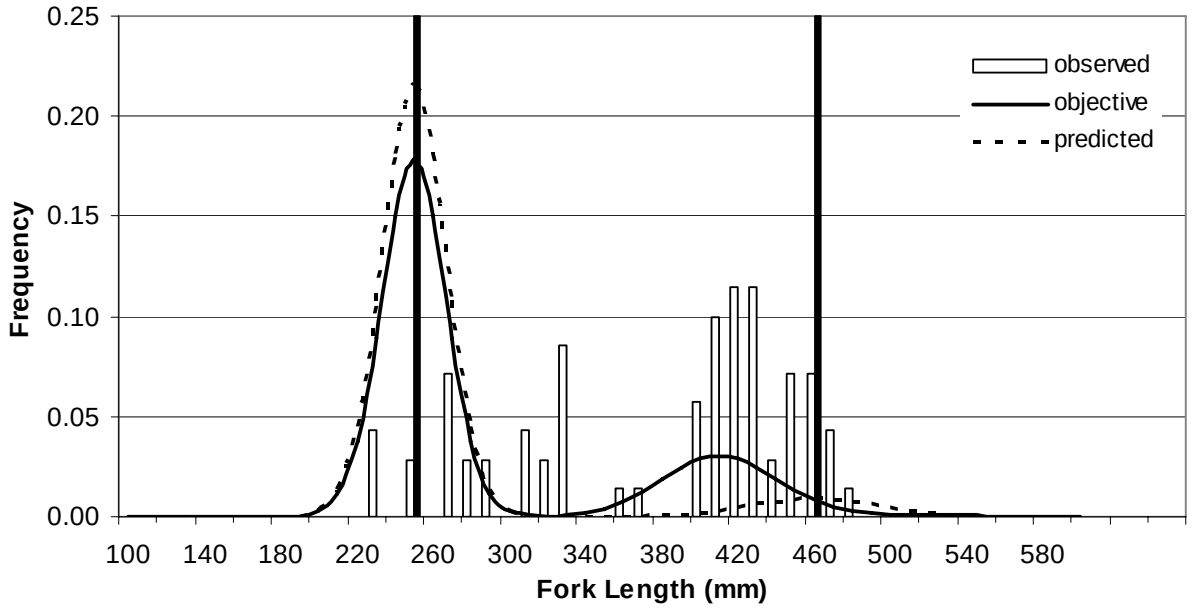

Figure 14.–Rainbow Lake: observed rainbow trout length frequency distribution compared to management objectives and predicted criteria, 2005.

Table 16.–Rainbow Lake: test results by length category.

	Relative Abundance (χ2 test)				**Mean Length** (t test)			
	<250 mm	≥250 mm	<460 mm	≥460 mm	<250 mm	≥250 mm	<460 mm	≥460 mm
Observed	5	65	65	5	235 mm	386 mm	369 mm	467 mm
	(0.07[a])	(0.93[a])	(0.93[a])	(0.07[a])	(5.23[b])	(8.00[b])	(8.87[b])	(3.14[b])
Management Criteria	24	46	69	1	235 mm	316 mm	285 mm	486 mm
	(0.34[a])	(0.66[a])	(0.98[a])	(0.02[a])				
Test Stat		22.50		9.45	0.0000	8.75	9.47	-6.051
DF		1		1	4	64	64	4
P Value		<0.0001		0.0021	1.00	<0.0001	<0.0001	0.0038
Predicted Criteria	29	41	67	3	235 mm	288 mm	257 mm	486 mm
	(0.41[a])	(0.59[a])	(0.96[a])	(0.04[a])				
Test Stat		33.17		1.80	0.0000	12.25	-6.051	-
DF		1		1	4	64	4	-
P Value		<0.0001		0.18	1.00	<0.0001	0.0038	-

[a] Proportion of catch.

[b] Standard error.

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APPENDIX A
COUNTS OF RAINBOW TROUT CAPTURED BY GEAR TYPE

Appendix A.–Counts of rainbow trout captured by gear type. Length range (FL) of fish captured using each capture gear is in parentheses.

Lake	Fyke Net	Hoop Net	Tangle Net	Total
Birch Lake	387 (140-513 mm)	0 -	1 (294 mm)	388
Donna Lake	97 (166-409 mm)	11 (265-415 mm)	14 (250-388 mm)	122
Donnelly Lake	108 (114-348 mm)	0 -	2 (354-383 mm)	110
Gergie Lake	58 (122-283 mm)	5 (219-276 mm)	19 (245-295 mm)	82
L Donna Lake	17 (145-462 mm)	3 (399-445 mm)	23 (263-432 mm)	43
L Harding Lake	95 (220-402 mm)	11 (205-324 mm)	19 (224-366 mm)	125
Lost Lake	166 (145-382 mm)	0 -	0 -	166
Mark Lake	102 (68-330 mm)	3 (106-234 mm)	0 -	105
Rainbow Lake	49 (226-470 mm)	9 (303-477 mm)	12 (288-428 mm)	70
Sculpin Lake	70 (300-470 mm)	11 343-455	18 (379-442 mm)	99

APPENDIX B
LAKE STOCKING HISTORIES

Appendix B.–Stocking histories from 2000-2005 for lakes sampled in 2005.

Lake	Species	Date	Number	FL (in)	FL (mm)	Lifestage
Birch Lake	LT	18-May-00	4,181	7.3	185	C
Birch Lake	RT	18-May-00	13,322	8.5	216	C
Birch Lake	RT	6-Jul-00	2,778	8.2	208	C
Birch Lake	SS	20-Jul-00	27,471	3.6	91	F
Birch Lake	SS	3-Aug-00	15,365	3.7	94	F
Birch Lake	RT	29-May-01	16,468	8.7	221	C
Birch Lake	GR	19-Jun-01	4,148	6.9	175	C
Birch Lake	AC	31-Aug-01	7,034	4.2	107	S
Birch Lake	GR	13-Jun-02	5,000	7.1	180	C
Birch Lake	RT	13-Jun-02	8,278	8.9	226	C
Birch Lake	SS	13-Jun-02	40,000	2.7	69	F
Birch Lake	KS	17-Sep-02	8,895	7.1	180	C
Birch Lake	KS	23-Oct-02	3,020	8.3	211	C
Birch Lake	AC	22-May-03	6,261	9.1	231	C
Birch Lake	RT	22-May-03	5,886	9.4	239	C
Birch Lake	RT	30-May-03	2,631	9.8	249	C
Birch Lake	RT	2-Jul-03	2,027	9.7	246	C
Birch Lake	KS	18-Sep-03	9,926	7.5	191	C
Birch Lake	RT	25-May-04	3,833	8.8	224	C
Birch Lake	RT	26-May-04	4,788	9.3	236	C
Birch Lake	RT	26-Aug-04	1,013	10.6	269	C
Birch Lake	KS	20-Sep-04	10,550	7.8	198	C
Birch Lake	RT	10-Feb-05	290	10.3	262	C
Birch Lake	AC	13-May-05	5,982	9.1	231	C
Birch Lake	RT	13-May-05	3,497	8.7	221	C
Birch Lake	RT	13-May-05	4,886	8.9	226	C
Birch Lake	KS	22-Sep-05	10,977	8.4	213	C
Donna Lake	RT	3-Aug-01	7,600	1.7	43	F
Donna Lake	RT	20-Aug-03	7,600	2	51	F
Donna Lake	RT	14-Jul-04	7,600	1.9	48	F
Donnelly Lake	RT	1-Aug-00	13,000	1.8	46	F
Donnelly Lake	RT	14-Aug-02	11,522	1.9	48	F
Donnelly Lake	RT	17-Aug-04	6,513	2.1	53	F
Gergie Lake	RT	22-Aug-01	9,000	2.2	56	F
Gergie Lake	RT	9-Aug-04	9,000	2	51	F
Little Donna Lake	RT	3-Aug-01	4,000	1.7	43	F
Little Donna Lake	RT	20-Aug-03	4,000	2	51	F
Little Donna Lake	RT	14-Jul-04	4,000	1.9	48	F
Little Harding Lake	RT	26-Jun-00	1,021	9.2	234	C
Little Harding Lake	RT	26-Jun-00	102	13	330	B
Little Harding Lake	RT	23-May-01	800	8.6	218	C
Little Harding Lake	RT	29-May-01	150	12.3	312	B
Little Harding Lake	RT	19-Jun-02	800	9.1	231	C
Little Harding Lake	RT	5-Jun-03	764	9.9	251	C
Little Harding Lake	RT	22-Jun-04	300	9	229	C
Little Harding Lake	RT	19-May-05	400	8.6	218	C
Little Harding Lake	RT	19-May-05	400	8.6	218	C

-continued-

Appendix B.–Page 2 of 2.

Lake	Species	Date	Number	FL (in)	FL (mm)	Lifestage
Lost Lake	RT	6-Jul-00	4,700	7.9	201	F
Lost Lake	LT	5-Jun-01	500	8.8	224	C
Lost Lake	RT	5-Jun-01	3,034	10.1	257	C
Lost Lake	RT	23-May-02	4,602	8.7	221	C
Lost Lake	KS	17-Sep-02	2,283	7.1	180	C
Lost Lake	RT	27-May-03	4,783	9.2	234	C
Lost Lake	AC	16-Jun-03	596	9.2	234	C
Lost Lake	AC	16-Jun-03	604	12.1	307	C
Lost Lake	RT	25-May-04	4,204	8.8	224	C
Lost Lake	RT	26-Aug-04	1,006	10.3	262	C
Lost Lake	KS	20-Sep-04	2,000	7.8	198	C
Lost Lake	RT	13-May-05	3,179	8.7	221	C
Lost Lake	KS	22-Sep-05	2,311	8.4	213	C
Mark Lake	RT	8-Aug-01	3,600	1.8	46	F
Mark Lake	SS	30-Jul-02	3,600	3	76	F
Mark Lake	SS	28-May-04	1,532	2.2	56	F
Mark Lake	RT	2-Jun-04	500	9.1	231	C
Mark Lake	RT	17-Aug-04	3,621	2.1	53	F
Mark Lake	AC	19-Aug-04	200	2.6	66	F
Mark Lake	SS	8-Jun-05	4,888	2.6	66	F
Mark Lake	AC	24-Aug-05	200	3.6	91	F
Rainbow Lake	RT	8-Aug-01	8,600	1.8	46	F
Rainbow Lake	RT	14-Jul-04	12,000	1.9	48	F
Sculpin Lake	RT	22-Aug-01	14,000	2.2	56	F
Sculpin Lake	RT	9-Aug-05	14,015	1.6	41	F

AC	Arctic char	*Salvelinus alpinus*
GR	Arctic grayling	*Thymallus articus*
KS	King / Chinook salmon	*Oncorhynchus tshawytscha*
LT	Lake trout	*Salvelinus namaycush*
RT	Rainbow trout	*Oncorhynchus mykiss*
SS	Silver / Coho salmon	*Oncorhynchus kisutch*

F	Fingerling
S	Subcatchable
C	Catchable
B	Broodstock