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ABSTRACT

In 1990, 449,627 hatchery-reared fingerling rainbow trout of Big Lake origin were released into Big Lake in the Matanuska-Susitna Valley of Southcentral Alaska. In September and October of 1991, fyke nets were set along the shores of Big Lake. Rainbow trout *Oncorhynchus mykiss* captured in the fyke nets were marked to facilitate a mark-recapture study to estimate the abundance of rainbow trout in the lake. The 1991 abundance estimate for rainbow trout ≥ 130 millimeters was 10,376. The estimated number of age-1 rainbow trout ≥ 130 millimeters was 6,817, of which an estimated 2,497 were from the 1990 stocking for a survival rate of 0.6%. Survival from age 1 in 1990 to age 2 in 1991 was estimated at 46.7%.

KEY WORDS: Southcentral Alaska, Matanuska-Susitna Valley, Big Lake, rainbow trout, *Oncorhynchus mykiss*, fyke net sampling, population estimate, length, age.

INTRODUCTION

Big Lake (Figure 1) consists of several basins which total 1,151 hectares and is located in the Matanuska-Susitna Valley of Southcentral Alaska. Meadow Creek, the principal tributary of Big Lake, drains an extensive watershed that includes over 30 lakes and ponds located north and east of the lake. Minor drainages also enter from the west through Flat and Mirror (Mud) lakes. Fish Creek, the outlet of Big Lake, flows approximately 23 km to the Knik Arm of northern Cook Inlet.

Many private residences and easy public access along the lake have contributed to the growth and popularity of a recreational fishery on Big Lake. Currently, there are 934 lake-front lots with more than 500 private lake-front cabins and residences, two state waysides, a private commercial campground, two boat marinas, and at least seven lounge and restaurant establishments (including three motels) along the shores of the lake. The lake is also the site of an Alaska Department of Fish and Game (ADF&G) hatchery which produces coho salmon *Oncorhynchus kisutch* and sockeye salmon *O. nerka*.

During 1952, the U.S. Fish and Wildlife Service studied fishing pressure on Big Lake. These studies indicated that 10.9% of all sport fishing on the Alaska mainland south of the Alaska Range occurred on Big Lake (Allin 1956). During the period 1977 to 1990, fishing effort on Big Lake, as measured by a statewide postal survey, has averaged approximately 13,100 angler-days annually (Mills 1979-1991). Pronounced reductions in harvest of rainbow trout *O. mykiss* during 1983, 1984, and 1987 (Figure 2) provided the impetus for this investigation.

On 1 June 1988, 24,033 catchable-size (mean fork length 176 mm) rainbow trout of Big Lake origin were stocked into Big Lake. All of the stocked fish were marked, and as they mixed with the wild population served as the marks for a mark-recapture population estimate. The population estimate in June, shortly after the catchables were released, was 10,607 (SE = 627) wild fish. The experiment was repeated in October, allowing a longer hiatus (more time for marked fish to mix with the wild stock), and the estimate at that time was 22,261 (SE = 2,613) wild fish (Havens and Alexandersdottir 1990). These low population estimates, coupled with the reductions in harvest, led to the conclusion that the population was depressed from probable historic levels and was not sufficient to sustain current levels of sport harvest. In 1989, Big Lake rainbow trout abundance was estimated at 8,190 (SE = 1,390) fish ≥ 150 mm (Havens et al. 1991). Rainbow trout stocking was implemented to supplement wild production beginning in 1989 when 216,371 fingerlings were released, of which 72,000 or 33% were adipose finclipped. In 1990, Big Lake rainbow trout abundance was estimated at 7,530 (SE = 618) fish ≥ 130 mm of which an estimated 2,603 (SE = 378) were age-1 trout that had been stocked in 1989 (Havens et al. 1991). This report evaluates the 1990 fingerling stocking.

METHODS

Fingerling rainbow trout were stocked in the summer during both 1990 and 1991. In 1990, 449,627 fingerlings were released, of which 76,869 or 17% were

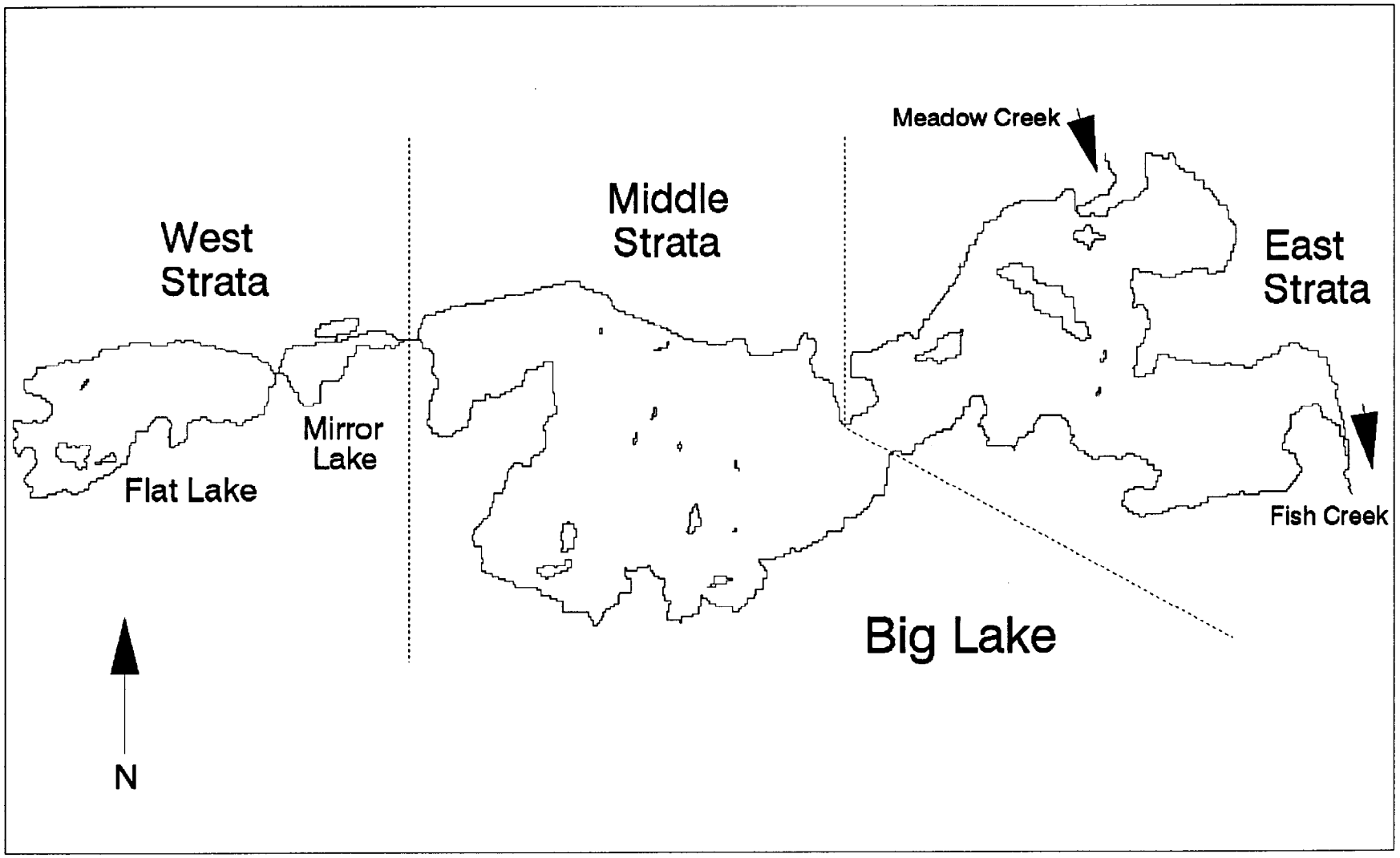

Figure 1. Map of Big Lake partitioned to indicate the three sampling strata.

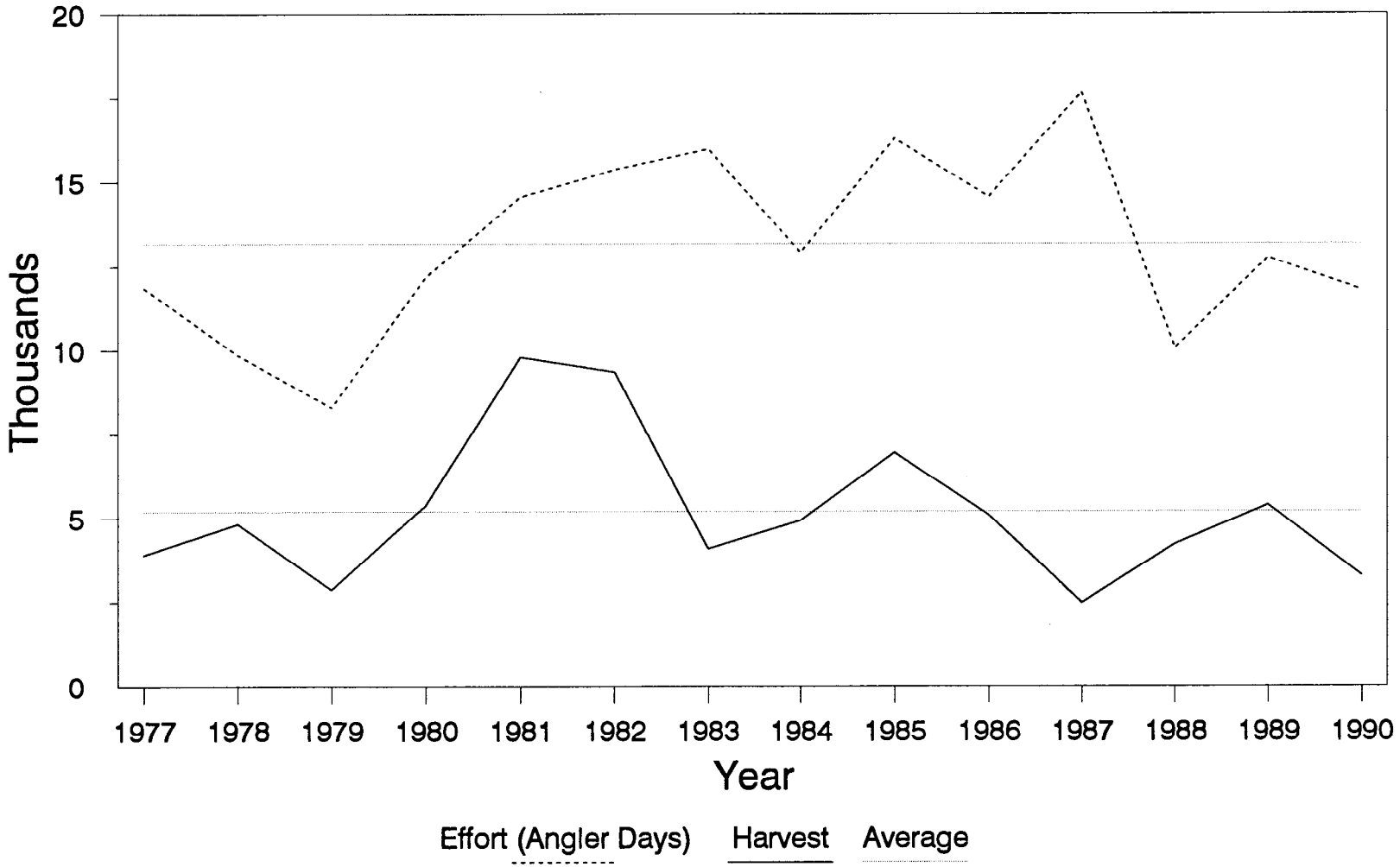

Figure 2. Angler effort and rainbow trout harvest estimates for Big Lake from the statewide postal survey, 1977-1990 (Mills 1979-1991).

adipose finclipped. In 1991, 462,197 fingerlings were released, of which 75,152 or 16% were adipose finclipped. Adipose finclips were used to estimate the hatchery component of the total population estimate.

Data Collection

Mark-recapture experiments were conducted to estimate the abundance of rainbow trout in Big Lake in the fall of 1991. Three samples were taken: two during September and one during early October. Fyke nets were used to capture the fish during all three samples while gill nets were used only during the third sample. Fyke nets were 2.7 m (9 ft) long, 91.4 cm (36 in) in diameter, with two 0.9 m by 6.1 m (3 ft by 20 ft) wings. Internal throats, body, and wings were of 0.48 cm (3/16 in) square mesh knotless nylon. Gill nets were 36.6 m by 1.8 m (120.0 ft by 6.0 ft) variable mesh monofilament composed of six square mesh sizes: 1.3 cm (0.5 in), 1.6 cm (0.6 in), 1.9 cm (0.8 in), 2.5 cm (1.0 in), 3.8 cm (1.5 in), and 5.1 cm (2.0 in) each in a 6.1 m (20.0 ft) panel. Net sampling sites were selected around the shores of Big Lake, Mirror Lake, and Flat Lake; all fyke nets and two gill nets were set near shore, and two gill nets were set in deeper water beginning at the 4.6 m (15.0 ft) depth contour. The lake complex was stratified into three areas: east, middle, and west (Figure 1), and catches from each net in each area were recorded separately. An attempt was made to distribute the tagging and recovery effort as evenly as possible around the shores of the lakes. Approximately 160 fyke net sets were made for each of the three samples and 32 gill net sets were made for the third sample. Nets were fished approximately 24 hours then pulled and relocated. Nine to 10 days were needed to sample the entire lake complex.

All rainbow trout ≥ 130 mm captured in fyke nets were marked with a numbered anchor tag (if not already tagged), given an upper caudal finclip, and released. Captured fish were examined for a mark (either a caudal or adipose finclip or a numbered anchor tag). In each sample, all rainbow trout in at least one fyke net trap load were measured. If there were less than 150 trout ≥ 130 mm in the trap, then a second trap was randomly selected and all the fish in it measured also, and this process continued until at least 150 were measured. During each sample, scales were collected from 500 trout ≥ 130 mm and 150 trout < 130 mm to determine age composition. All rainbow trout captured in gill nets were examined for a mark (either a caudal or adipose finclip or a numbered anchor tag) and measured.

Data Analysis

Population Estimate:

The total population (N) was estimated by Chapman's modification of the Petersen estimator (Seber 1982):

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1, \qquad (1)$$

with variance:

$$V(N) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \qquad (2)$$

where:

M = number of tagged fish released during the first event,

C = number of fish examined for tags during the second event, and

R = number of tagged fish recaptured during the second event.

The following assumptions are necessary for this procedure:

1. tagged and untagged fish have the same probability of capture;

2. marked fish have the same chance of dying or emigrating as unmarked fish;

3. either there is no recruitment or immigration, or there is no death or emigration, or there is no change in the number of fish in the population between events.

4. there is no tag loss; and

5. all fish have the same probability of capture in the marking event or in the recapture event, or marked and unmarked fish mix completely between marking events.

Mortality. We have no evidence that marking with anchor tags causes behavioral changes or increased mortality that would alter the capture probability of the marked fish (assumptions 1 and 2).

Migration. The nearshore area of the lake is not a closed system. Fish can migrate to and from the offshore area. However, we felt that this bias would be minimized by confining our sampling to late fall. We believed that during the turnover of the lake in late fall there would be sufficient movement between the areas of the lake to assure complete mixing of the fish marked near shore and the unmarked offshore population (assumptions 3 and 5). To test this assumption, we sampled the offshore area with gill nets during our third sample. We used contingency table analysis (Sokal and Rohlf 1969) to compare the marked to unmarked ratio in the nearshore fyke nets to that in the offshore gill nets. A significant test indicated that complete mixing had not occurred.

We tested for equal probability of capture for fish from all sublocations using contingency table analysis. Contingency table analyses were also used to test for equal mixing of marked and unmarked fish between sampling events (assumption 5).

Tag Loss. All tagged fish in 1991 were given an upper caudal finclip to allow us to recognize fish that had lost a tag.

Size Selectivity. We used two-sample Kolmogorov-Smirnov tests (Daniel 1978) to compare length distributions of all fish ≥ 130 mm released with tags in the first event to the recaptures in the second event. This comparison indicated that there was size selectivity (unequal capture probabilities for different size groups) in the sample from the second event (assumption 5). We also compared the length distribution of all fish released with tags in the first event to all fish captured in the second event. This comparison indicated a difference in size distribution between the two events.

Age Composition:

We estimated the proportional age composition of rainbow trout in our samples using:

$$\hat{P}_a = n_a/n \ , \tag{3}$$

where:

$\hat{P}_a$ = the estimated proportion of age class a,

n_a = the number of fish in age class a in the sample, and

n = the number of scale samples read.

The variance of P_a is equal to:

$$V(\hat{P}_a) = \frac{(\hat{P}_a)(1-\hat{P}_a)}{n} \ . \tag{4}$$

The number of fish in the total population in each age class could then be estimated by:

$$\hat{N}_a = \hat{P}_a\hat{N} \ , \tag{5}$$

where:

$\hat{N}_a$ = the number of fish in age class a, and

$\hat{N}$ = the number of fish in the population.

The variance of $\hat{N}_a$ is equal to (Goodman 1960):

$$V(\hat{N}_a) = V(\hat{N})\hat{P}_a^2 + V(\hat{P}_a)\hat{N}^2 - V(\hat{N})V(\hat{P}_a) \ . \tag{6}$$

Hatchery Contribution:

We estimated the number of age-1 fish of hatchery origin in the population, which represent the survivors of the 1990 fingerling stocking. First we determined the number of age-1 fish with adipose clips in the population:

$$\hat{N}_f = \hat{N}\hat{P}_f \quad , \tag{7}$$

where:

$\hat{N}_f$ = the number of age-1 fish with adipose clips in the population,

$\hat{P}_f$ = the estimated proportion of age-1 adipose clipped fish in the population

= (n_f/n) with variance as for $\hat{P}_s$, above,

n_f = the number of age-1 fish with adipose clips in the sample,

n = the number of scale samples read, and

$\hat{N}$ = as defined above.

The variance for N_f is calculated by substituting P_f and $V(P_f)$ into the equation for the variance of N_a, above.

Then the proportion of the stocked fish released with adipose clips in 1990 was used to estimate the total number of surviving stocked age-1 fish in the population.

$$\hat{N}_s = \hat{N}_f/\theta \quad , \tag{8}$$

where:

$\hat{N}_s$ = the number of age-1 stocked fish in the population, and

θ = the proportion of released fingerlings that were clipped.

The variance of N_s is equal to:

$$V(\hat{N}_s) = V(\hat{N}_f)/\theta^2 \quad . \tag{9}$$

RESULTS

In 1991 three samples were taken, the first from 4 September through 13 September, the second from 17 September through 27 September, and the third from 1 October through 11 October. The lake was divided into three strata (Figure 1). A total of 4,791 rainbow trout were captured in the three samples: 2,485 in the east strata, 1,534 in the middle strata, and 772 in the west strata (Table 1).

Finclips in Trout Under 130 mm

In 1991, 462,197 rainbow trout fingerlings were released into Big Lake, of which 75,152 (16.3%) had been given adipose finclips. During the fall

Table 1. Distribution of sampled rainbow trout, Big Lake 1991.[a]

Sample	Stratum			Total
	East	Middle	West	
Fyke Nets:				
9/4-9/13	525	425	255	1,205
9/17-9/27	1,084	567	257	1,908
10/2-10/11	719	490	242	1,451
All Fyke Nets	2,328	1,482	754	4,564
Gill Nets:				
10/1-10/11	157	52	18	227
All Samples	2,485	1,534	772	4,791

[a] Includes fish < 130 mm which were not included in the population estimate, and includes recaptures of fish that were caught more than once.

sampling, the percentages of fish < 130 mm with adipose clips across all strata ranged from 12.4% to 16.9% (Table 2) and were not significantly different among samples in any strata.

Distribution of Rainbow Trout

As in past years, the rainbow trout were segregated by size class. Proportionally more large fish (≥ 165 mm) were taken from the east strata during all samples (Table 3).

The distribution by size class also changed over time in each strata, with more large (≥ 165 mm) fish taken from all strata during the last sample. These differences in distribution were significant (Table 3).

Population Estimate

For the population estimate, samples 1 and 2 were combined as the release event (event 1), and the third sample was the recapture event (event 2). A total of 1,717 rainbow trout ≥ 130 mm were released with tags in event 1, and 941 were examined in event 2.

Size Selectivity:

To test for gear selectivity, the length distribution of all fish ≥ 130 mm released in the first event was compared to the distribution of all fish ≥ 130 mm captured in the second event using a two sample Kolmogorov-Smirnov test. The two distributions were significantly different at $\alpha = 0.05$ (Table 4, Figure 3). The length distribution of the fish released in event 1 was also significantly different from the length distribution of the tagged recaptures in event 2 (Table 4, Figure 3). This test indicated that there was size selectivity in both events. Because there was size selectivity in both events, we broke the population estimate into two length classes: 130-164 mm, and ≥ 165 mm.

Probability of Capture by Sublocation:

The percent marked by recovery strata was significantly different for rainbow trout 130-164 mm (Table 5), and for rainbow trout ≥ 165 mm (Table 6). However, because the entire margin of the lake was sampled very thoroughly with fyke nets during each event, we assumed that the entire nearshore population was sampled, and equal probability of capture by sublocation was, therefore, not essential. We did not stratify the population estimate by sublocation.

Probability of Capture by Gear Type:

The percent recovered was significantly different between the nearshore fyke nets and the offshore gill nets (Table 7). The percent recovered in the gill nets was lower than the percent recovered in fyke nets. This indicated that complete mixing between nearshore and offshore areas did not occur.

Because complete mixing between nearshore and offshore areas did not occur, our estimate is a minimal estimate of the population at the time of tagging. The estimate is minimal because we had no reason to believe that newly marked

Table 2. Percent of captured rainbow trout under 130 mm with adipose finclips in each Big Lake sampling event, 1991.

Sample	Stratum			Total
	East	Middle	West	
9/4-9/13				
Number	34	48	10	92
Percent	14.0	20.8	14.1	16.9
9/17-9/27				
Number	28	47	17	92
Percent	10.4	16.4	17.3	14.1
10/2-10/11				
Number	14	30	11	55
Percent	10.1	15.7	9.5	12.4

H_o: The percentage of fish with adipose clips is the same among samples.

East:	$\chi^2 = 2.05$ df = 2	$0.25 < P < 0.50$	Fail to reject H_o.
Middle:	$\chi^2 = 2.34$ df = 2	$0.25 < P < 0.50$	Fail to reject H_o.
West:	$\chi^2 = 2.89$ df = 2	$0.10 < P < 0.25$	Fail to reject H_o.

Table 3. Distribution of rainbow trout by size class in Big Lake in 1991.

Sample	East			Middle			West		
	< 130	130-164	≥165	< 130	130-164	≥165	< 130	130-164	≥165
Fyke Nets									
9/4-9/13									
Number[a]	242	79	196	231	82	100	71	135	48
Percent	47	15	38	56	20	24	28	53	19
9/17-9/27									
Number[b]	269	217	595	286	77	190	98	98	59
Percent	25	20	55	52	14	34	38	38	23
10/2-10/11									
Number[c]	138	124	453	191	78	205	116	60	64
Percent	19	17	63	40	16	43	48	25	27
Gill Nets									
10/1-10/11									
Number[d]	0	23	134	0	2	49	2	5	11
Percent	0	15	85	0	4	96	11	28	61

[a] Twenty-one fish were not measured.
[b] Nineteen fish were not measured.
[c] Twenty-two fish were not measured.
[d] One fish was not measured.

H_o: The distribution by size class is the same among samples.

East: $\chi^2 = 129.73$ df = 4 $P < 0.001$ Reject H_o.
Middle: $\chi^2 = 40.48$ df = 4 $P < 0.001$ Reject H_o.
West: $\chi^2 = 41.81$ df = 4 $P < 0.001$ Reject H_o.

H_o: The distribution by size class is the same among strata.

9/4-9/13: $\chi^2 = 157.67$ df = 4 $P < 0.001$ Reject H_o.
9/17-9/27: $\chi^2 = 194.20$ df = 4 $P < 0.001$ Reject H_o.
10/2-10/11: $\chi^2 = 130.14$ df = 4 $P < 0.001$ Reject H_o.

H_o: The distribution by size class in October is the same in fyke nets as in gill nets.

East: $\chi^2 = 40.11$ df = 2 $P < 0.001$ Reject H_o.
Middle: $\chi^2 = 51.86$ df = 2 $P < 0.001$ Reject H_o.
West: $\chi^2 = 11.96$ df = 2 $0.001 < P < 0.005$ Reject H_o.

Table 4. Comparison of length distributions of rainbow trout from release and recapture events of population estimate in Big Lake, 1991.

	Sample Sizes		Kolmogorov-Smirnov Test		
	1	2	D	Critical D at $\alpha = 0.05$	P[a]
All Fish ≥ 130 mm:					
Event 1 vs. Event 2	1,717	941	0.1031	0.0552	0.0000 *
Release vs. Recapture	1,717	159	0.1389	0.1127	0.0067 *
Fish 130 - 164 mm:					
Event 1 vs. Event 2	615	249	0.0778	0.1022	0.2153
Release vs. Recapture	615	37	0.1010	0.2302	0.8513
Fish ≥ 165 mm:					
Event 1 vs. Event 2	1,102	692	0.0565	0.0660	0.1231
Release vs. Recapture	1,102	122	0.1053	0.1298	0.1637

[a] An * indicates a significant difference between the two length distributions at $\alpha = 0.05$.

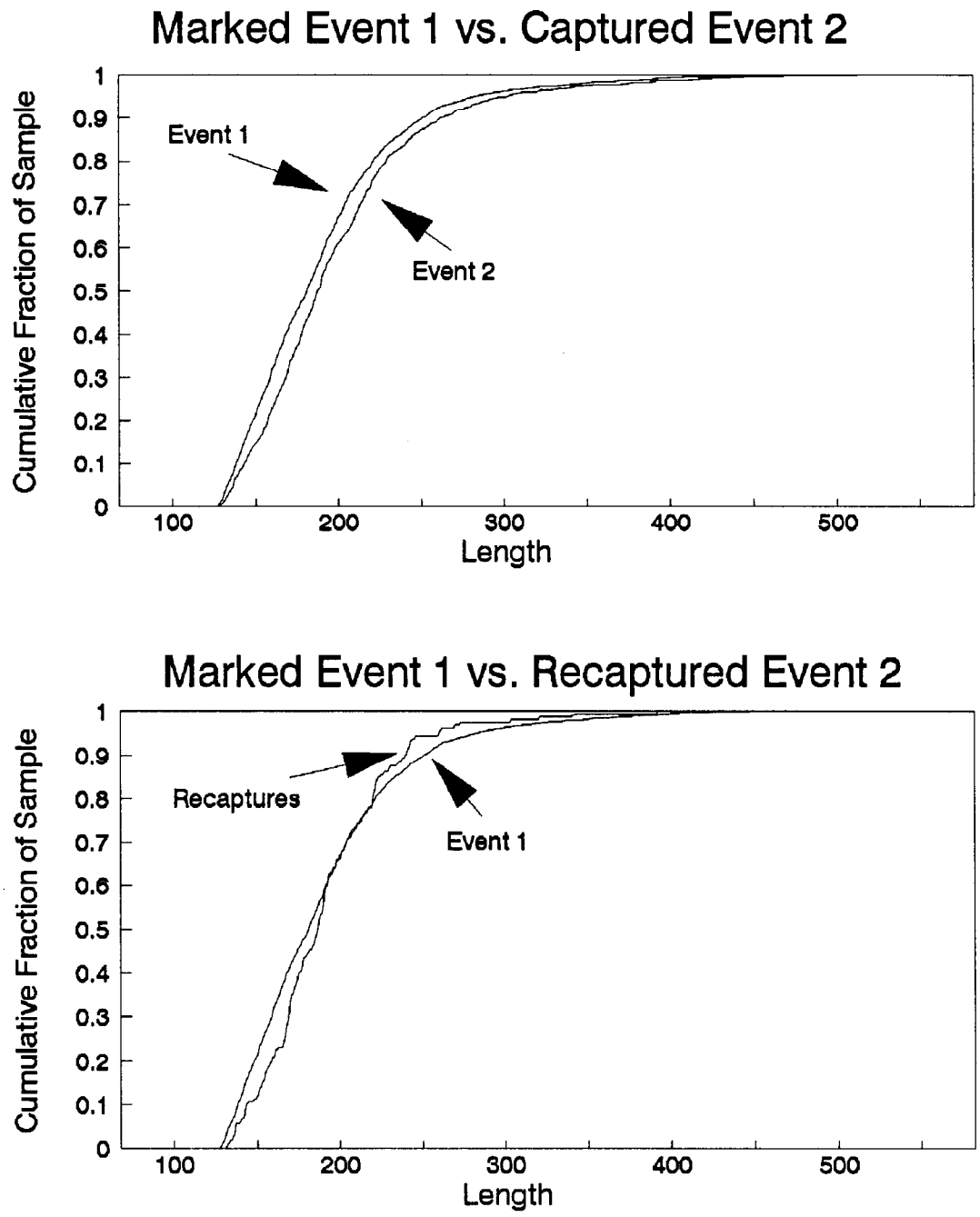

Figure 3. Cumulative length distribution of rainbow trout released in event 1 compared to rainbow trout captured in event 2, and of rainbow trout released in event 1 compared to recaptures in event 2, 1991.

Table 5. Number of tagged rainbow trout 130-164 mm recovered in fyke nets by release and recovery strata in Big Lake, 1991.

Release Stratum	Recovery Stratum			Total Release	Recovered		Not Recovered
	East	Middle	West		Total	Percent	
East	4	7	0	270	11	4.1	259
Middle	0	7	2	138	9	6.5	129
West	1	1	14	207	16	7.7	191
Recovered	5	15	16				
Examined	117	72	60				
Unmarked	112	57	44				
Percent Marked	4.3	20.8	26.7				

H_o: There is no difference in percent marked by recovery strata.

$\chi^2 = 19.410$ df = 2 $P < 0.001$ Reject H_o

Table 6. Number of tagged rainbow trout ≥ 165 mm recovered in fyke nets by release and recovery strata in Big Lake, 1991.

Release Stratum	Recovery Stratum			Total Release	Recovered		Not Recovered
	East	Middle	West		Total	Percent	
East	48	19	3	737	70	9.5	667
Middle	8	23	1	275	32	8.5	243
West	4	0	16	90	20	22.2	70
Recovered	60	42	20				
Examined	430	198	64				
Unmarked	370	156	44				
Percent Marked	14.0	21.2	31.3				

H_o: There is no difference in percent marked by recovery strata.

$\chi^2 = 13.927$ df = 2 $P < 0.001$ Reject H_o

Table 7. Number of tagged rainbow trout ≥ 165 mm recovered by gear type in Big Lake, 1991.

Release Stratum	Recovery Gear Type		Total Release	Recovered		Not Recovered
	Fyke net	Gill net		Total	Percent	
East	70	7	737	77	10.4	660
Middle	32	4	275	36	13.1	239
West	20	3	90	23	25.6	67
Recovered	122	14				
Examined	691	189				
Unmarked	569	175				
Percent Marked	17.7	7.4				

H_o: There is no difference in percent of recovered marks by gear type.

$\chi^2 = 11.929$ df = 1 $P < 0.001$ Reject H_o

fish would move offshore at a different rate than unmarked fish, thus the marked to unmarked ratio would not decrease. We assumed that some (but not all) of the offshore fish would mix inshore, thus increasing the marked to unmarked ratio by some amount, but since mixing was not complete it did not increase by enough to account for all of the offshore fish.

Tag Loss:

In the second sample, three fish were captured with an upper caudal clip but no tag. None of the three clips showed any regeneration, so all were judged to be clips from 1991. All three fish were ≥ 165 mm in length. This resulted in an estimate of 6.2% tag loss (SE = 3.5) between the first and second samples for fish ≥ 165 mm. No fish with fresh upper caudal clips and no tag were captured in the fyke nets in the third sample, but two were taken in the gill nets, one < 165 mm and one ≥ 165 mm. This resulted in an estimate of 6.7% tag loss (SE = 6.7) between samples 1 and 2 and the sample 3 gill nets for fish ≥ 165 mm. Only one fish < 165 mm with a tag was taken in the gill nets, so the estimate of tag loss for fish < 165 mm in the gill nets was 50% (SE = 50.0), but this is an extremely unreliable estimate due to the small number of fish involved. Overall, we felt that the rate of tag loss was low enough to be assumed to be insignificant for our population estimates.

Population Estimate:

The abundance estimate for Big Lake rainbow trout 130-164 mm in 1991 was 4,162, and for rainbow trout ≥ 165 mm was 6,214, for a total of 10,376 rainbow trout ≥ 130 mm with the relative precision of the 95% confidence interval at 15% (Table 8). This is similar to the 1989 and 1990 estimates of 8,191 and 7,530 rainbow trout, respectively (Havens et al. 1991).

Age Composition

In all samples, a total of 2,004 rainbow trout were aged: 1,875 taken in fyke nets and 129 in gill nets. The mean length for age-1 rainbow trout taken in fyke nets was 158 mm (SE = 1) (Table 9). Samples from fyke nets and gill nets were not combined due to differences in age compositions between the two gears. The gill net samples consisted of proportionally more age 3, 4, and 5 fish than the fyke net samples (χ^2 = 243.3, df = 1, P < 0.001). Nearly all of the fish from 130 to 164 mm taken in the fyke nets were age 1 (Table 10). Forty-three percent of the fish ≥ 165 mm were age 1. The estimated number of age-1 rainbow trout ≥ 130 mm in the population in 1991 (Table 11) was 6,817 (SE = 645). The estimated number of age-2 fish ≥ 130 mm was 2,869 (SE = 250).

Hatchery Contribution

Age-1 rainbow trout in 1991 consisted of wild fish plus the survivors of the 449,627 hatchery fingerlings that were stocked in 1990. Seventeen percent of the hatchery fingerlings stocked in 1990 were given adipose finclips. Forty of the age-1 fish ≥ 130 mm sampled in 1991 had adipose finclips: 20 in the 130-164 mm length group and 20 in the ≥ 165 mm length group. The percent of age-1 fish with adipose finclips in these two length groups resulted in an estimate of 2,497 stocked fish in the age-1 population ≥ 130 mm in 1991 (Table 12).

Table 8. Estimate of population abundance for rainbow trout ≥ 130 mm in Big Lake in 1991.

Size Group (mm)	Released	Examined	Recaptured	Estimated Abundance	Standard Error	Relative Precision[a]
130-164	615	249	36	4,162	604	28%
≥ 165	1,102	692	122	6,214	477	15%
Total				10,376	770	15%

[a] Relative precision of 95% confidence interval.

Table 9. Mean length at age of Big Lake rainbow trout sampled 4 September to 11 October 1991.

	Age						
	0	1	2	3	4	5	Total
Fyke Net Samples:							
Mean Length (mm)	77.4	158.1	224.7	306.8	389.5	457.0	
SE	0.4	1.0	1.6	5.3	5.9	13.2	
Sample Size	767	724	310	33	30	9	1,875
Minimum (mm)	53	71	135	241	304	403	
Maximum (mm)	151	263	322	367	444	534	
Gill Net Samples:							
Mean Length (mm)		162.6	245.2	341.8	395.1	442.0	
SE		4.9	6.0	5.9	7.9	24.0	
Sample Size	0	17	56	25	19	2	129
Minimum (mm)		106	192	296	344	418	
Maximum (mm)		230	477	416	476	466	

Table 10. Age composition of Big Lake rainbow trout sampled 4 September to 11 October 1991.

	Age						
	0	1	2	3	4	5	Total
Fyke Net Samples:							
Length < 130 mm							
Number Sampled	765	92	0	0	0	0	857
% of Sample	89.3	10.7	0.0	0.0	0.0	0.0	100.0
SE	1.06	1.06	0.00	0.00	0.00	0.00	
Length 130-164 mm							
Number Sampled	2	341	1	0	0	0	344
% of Sample	0.6	99.1	0.3	0.0	0.0	0.0	100.0
SE	0.41	0.50	0.29	0.00	0.00	0.00	
Length ≥ 165 mm							
Number Sampled	0	291	309	33	30	9	672
% of Sample	0.0	43.3	46.0	4.9	4.5	1.3	100.0
SE	0.00	1.91	1.92	0.83	0.80	0.44	
All Fyke Net Fish							
Number Sampled	767	724	310	33	30	9	1,873
% of Sample	41.0	38.7	16.6	1.8	1.6	0.5	100.0
SE	1.14	1.13	0.86	0.30	0.29	0.16	
Gill Net Samples:							
Number Sampled	0	27	56	25	19	2	129
% of Sample	0.0	20.9	43.4	19.4	14.7	1.6	100.0
SE	0.00	3.60	4.38	3.49	3.13	1.09	

Table 11. Estimated number of rainbow trout ≥ 130 mm FL by age, Big Lake, 1991.

	Age					
	0	1	2	3	4	5
Length 130 - 164 mm						
Proportion in Sample (P_a)	0.006	0.991	0.003	0.000	0.000	0.000
$V(P_a)$	0.000016	0.000025	0.000008	0	0	0
Estimated Number (N_a)	24	4,126	12	0	0	0
$V(N_a)$	298	359,170	146	0	0	0
Length ≥ 165 mm						
Proportion in Sample (P_a)	0.000	0.433	0.460	0.049	0.045	0.013
$V(P_a)$	0	0.000365	0.000370	0.000069	0.000063	0.000019
Estimated Number (N_a)	0	2,691	2,857	305	277	83
$V(N_a)$	0	56,725	62,333	3,220	2,893	797
Total						
Estimated Number (N_a)	24	6,817	2,869	305	277	83
$V(N_a)$	298	415,896	62,479	3,220	2,893	797
SE	17	645	250	57	54	28

Table 12. Estimate of the number of stocked fish in the age-1 ≥ 130 mm population, 1991.

	Length		
	130-164	> 165	Total
Population Estimate (N)	4,162	6,214	
V(N)	365,083	227,603	
Total Aged (n)	344	672	
Number Age 1 with Finclips in Sample (n_f)	20	20	
Proportion Age 1 with Finclips in Sample (P_f)	0.058	0.030	
$V(P_f)$	0.000159	0.000042	
Estimated No. Age 1 with Finclips (N_f)	242	185	427
SE (N_f)	63	43	76
Number Released in 1991			449,627
Number Released with Finclips			76,869
Proportion Released with Finclips (θ)			0.17
Estimated No. Age-1 Stocked Fish ≥ 130 mm in 1991 (N_s)			2,497
SE (N_s)			445
Relative Precision 95% Confidence Interval			35%

There were also age-1 fish that were < 130 mm (Table 10). In the age sample, 92 of the 724 age-1 fish were < 130 mm, and 14 of those had adipose finclips. Therefore 12.7% of the sample of age-1 fish were < 130 mm. If we assume no sampling bias on smaller fish, and this percentage is added to the population estimate of 6,817 age-1 fish ≥ 130 mm (Table 11), then the estimate of the number of age-1 fish in the entire population (Table 13) increases to 7,683 (SE = 651). The estimate of the number of age-1 stocked fish increases by 28 to 2,525 (SE = 445).

The estimated survival of the fingerlings from the 1990 stocking to the fall of 1991 was only 0.6% (Table 14). Survivals estimated from fall 1990 to fall 1991 were 46.7% for 1990 age-1 fish, 48.8% for age 2, 56.2% for age 3, and 44.4% for age 4. Survivals for fish older than age 1 were much higher for the period from 1990-91 than for 1989-90 (Table 14).

Computerized data files used to generate these analyses are listed in Appendix A.

DISCUSSION

Estimated survivals of stocked fingerlings to age 1+ were low for fish planted in 1989 and 1990, at 1.2% and 0.6%, respectively. These low survivals of rainbow trout fingerling may have been the result of a reduction in available food due to overgrazing by high densities of coho salmon stocked in Big Lake in past years (Figure 4), and by possible direct competition for food and habitat with 2,047,000 coho salmon fingerlings stocked in 1988 and 433,077 coho salmon fingerling stocked in 1990 (Figure 5). In 1989, for example, during the second sample period of the rainbow trout population estimate from 19 September through 6 October, we counted 653 rainbow trout and 12,071 juvenile coho salmon captured in 160 shoreline fyke net sets. The ratio of coho salmon to rainbow trout was fairly consistent among all sample areas along the entire 26 miles of Big Lake shoreline, including islands (Figure 6).

Rainbow trout stocking density experiments in Matanuska-Susitna Valley land-locked lakes indicated a relationship between rainbow trout stocking density and fingerling survival (Havens 1990, 1991, *In prep.*). At stocking densities of 400 trout per surface acre or greater, average survivals were less than 15%, while survivals averaged approximately 35% when fingerlings were stocked at 200, 100, or 50 per acre (Figure 7). In 1988 and 1990, coho salmon fingerling stocking densities in Big Lake were 611 and 152 fish per surface acre, respectively. These coho salmon, combined with the rainbow trout stockings, may have exceeded the carrying capacity of the lake, and may have caused the poor survival rates observed for rainbow trout.

Attempts to increase the abundance of rainbow trout in Big Lake through fingerling plants may have been started 2 to 3 years early. The Big Lake hatchery stopped releasing coho salmon fingerlings in 1991 and instead began releasing coho salmon smolts directly into Fish Creek, the Big Lake outlet stream that flows into Cook Inlet. In fall 1992, we plan to continue our nearshore sampling. If our theory is correct we should see a higher survival for the rainbow trout fingerling stocked in July 1991 when the only coho salmon present in Big Lake were naturally spawned coho salmon and age-1+ hatchery coho salmon planted in 1990.

Table 13. Estimate of the number of age-1 fish < 130 mm and the number of age-1 stocked fish < 130 mm in the population, 1991.

Population Estimate age 1 > 130 mm (N_a)	6,817
$V(N_a)$	415,896
Total age 1 in sample (n_a)	724
Number age 1 < 130 mm in sample (n_{a1})	92
Proportion age 1 < 130 mm in sample (P_{a1})	0.127071
$V(P_{a1})$	0.000153
Estimated number age 1 < 130 mm (N_{a1})	866
$V(N_{a1})$	13,772
Estimated total Age 1 (N_{at})	7,683
$V(N_{at})$	423,579
$SE(N_{at})$	651
Number age 1 < 130 mm with finclips in sample (n_{a1s})	4
Proportion age 1 < 130 mm with finclips in sample (P_{a1s})	0.005524
$V(P_{a1s})$	0.000007
Estimated number age 1 < 130 mm with finclips (N_{a1sf})	5
$V(N_{a1sf})$	6
Proportion released with finclips (θ)	0.17
Estimated number age 1 stocked fish < 130 mm in 1991 (N_{a1s})	28
$V(N_{a1s})$	205
$SE(N_{a1s})$	14
Relative Precision 95% Confidence Interval	100%

Table 14. Summary of Big Lake rainbow trout stocking and population estimates, 1988-1991.

Year	Number and Type Stocked	Population Estimate by Age: 0	1 Wild	1 Hatchery	1 Total	2	3	4	5	Total	Relative Precision	95% C.I.
1988	24,033 catchables											
June		na[a]	na	24,033	na	na	na	na	na	34,640	all fish	12 %
October		na	na	24,033	na	na	na	na	na	46,294	all fish	23 %
1989	216,371 fingerlings	0	5,452	0	5,452	1,616	501	537	84	8,190	≥ 150 mm	28 %
1990	449,627 fingerlings	0	3,540	2,603	6,143	625	493	187	82	7,530	≥ 130 mm	16 %
% survival 1989 - 1990				1.2[b]		11.5[c]	30.5[c]	37.3[c]	15.3[c]			
1991	462,197 fingerlings	0	4,320	2,497	6,817	2,869	305	277	83	10,377	≥ 130 mm	15 %
% survival 1990 - 1991				0.6[b]		46.7[c]	48.8[c]	56.2[c]	44.4[c]			

[a] na - not available.
[b] Survival from spring stocking to fall the following year.
[c] Survival from one fall to the next.

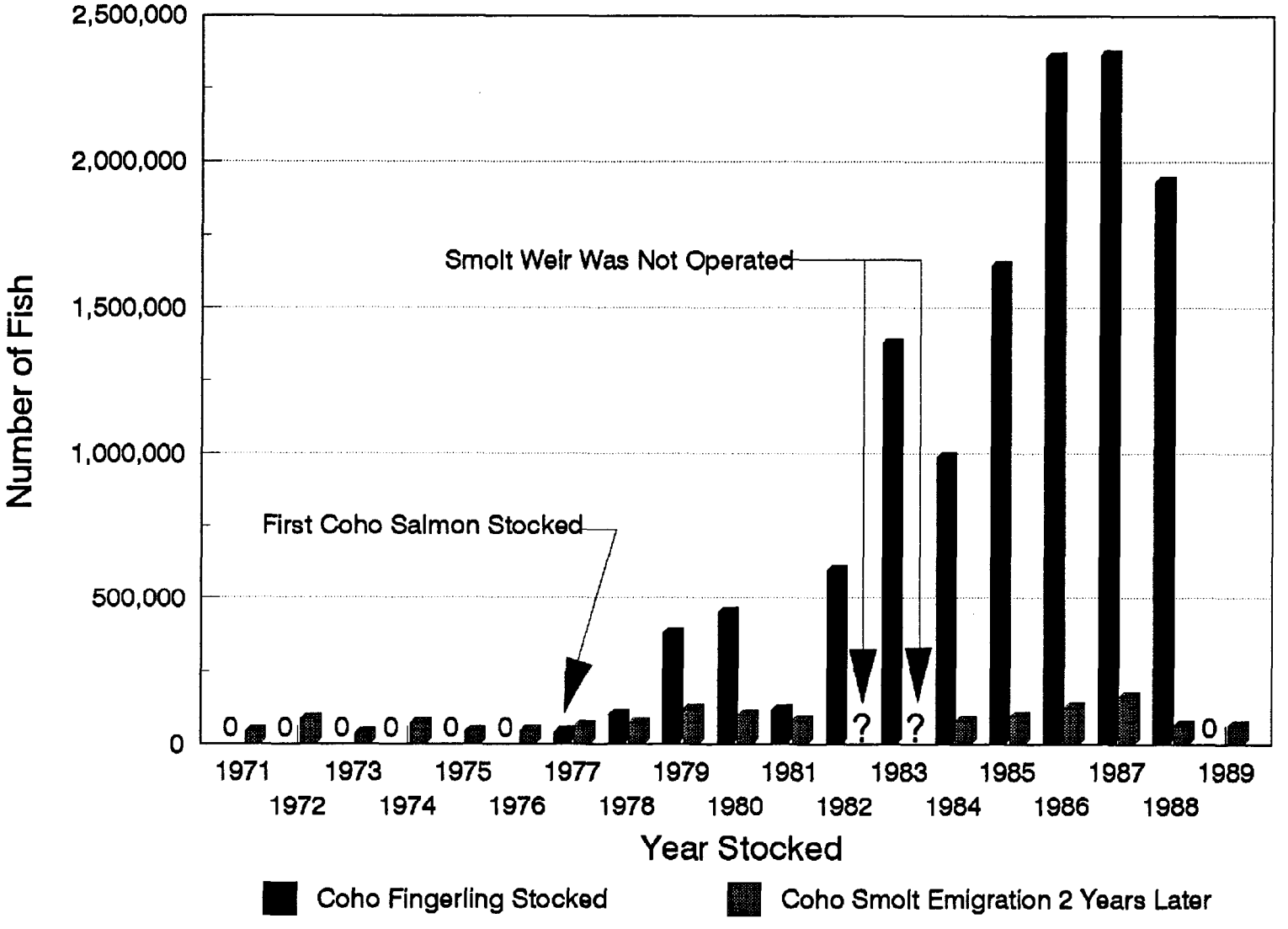

Figure 4. Coho salmon smolt emigration from Big Lake 1971-1989 versus numbers of coho salmon fingerlings stocked in the Big Lake drainage 1977-1988 (Chlupach 1990, Peltz personal communication).

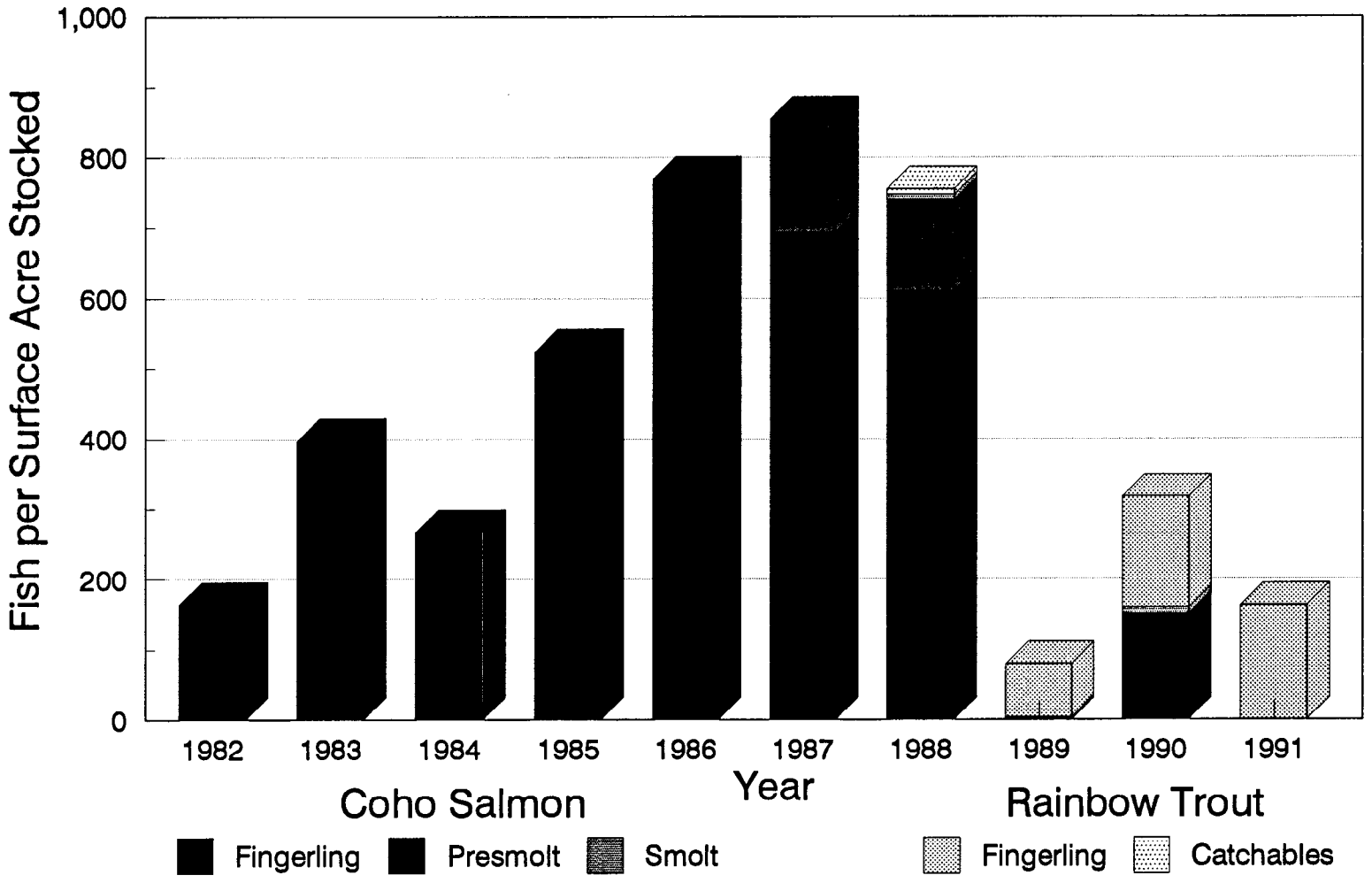

Figure 5. Combined stocking densities for coho salmon and rainbow trout in Big Lake, 1982-1991.

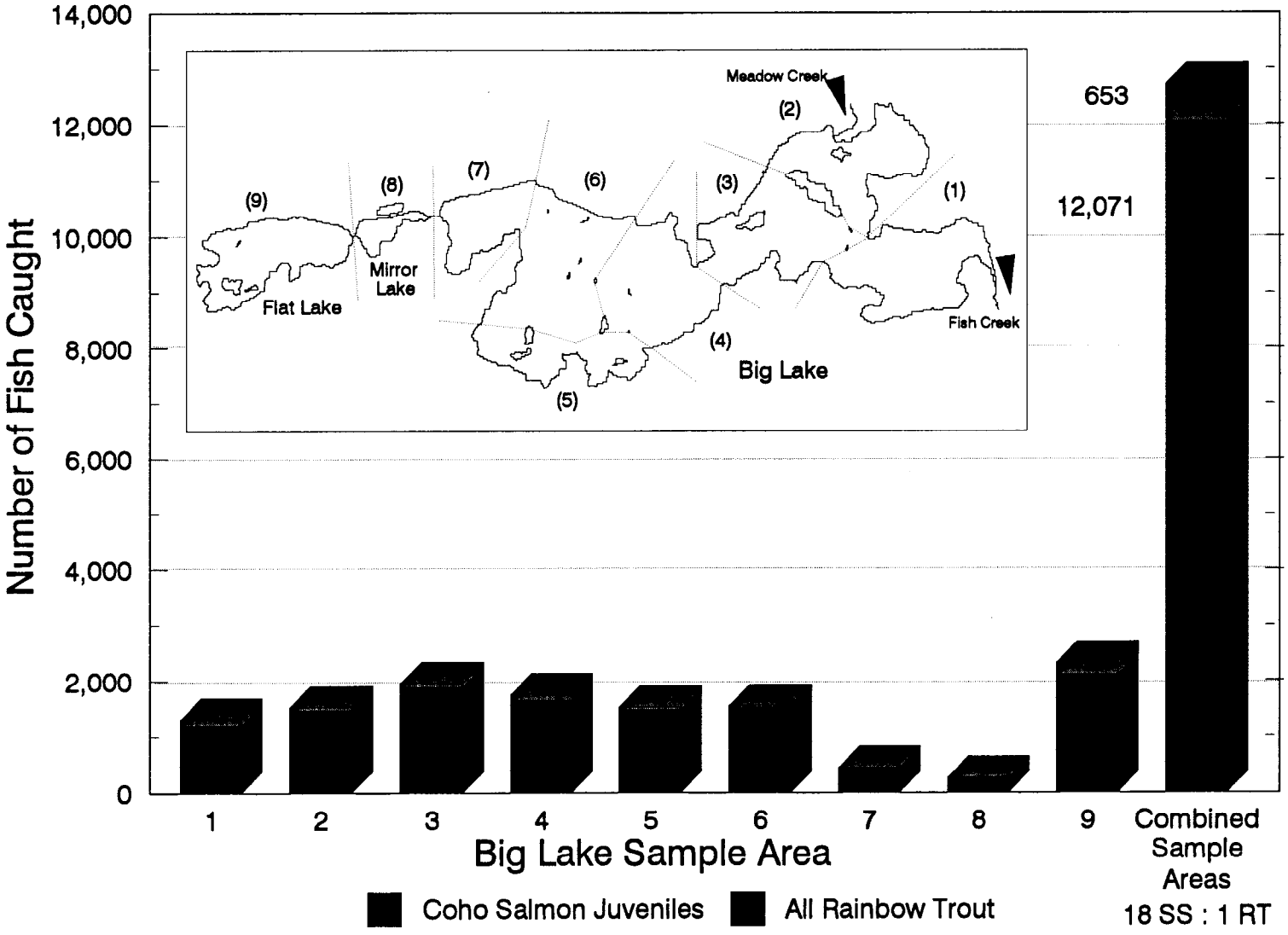

Figure 6. Fyke net catch of coho salmon and rainbow trout in Big, Mirror, and Flat lakes, September 1989.

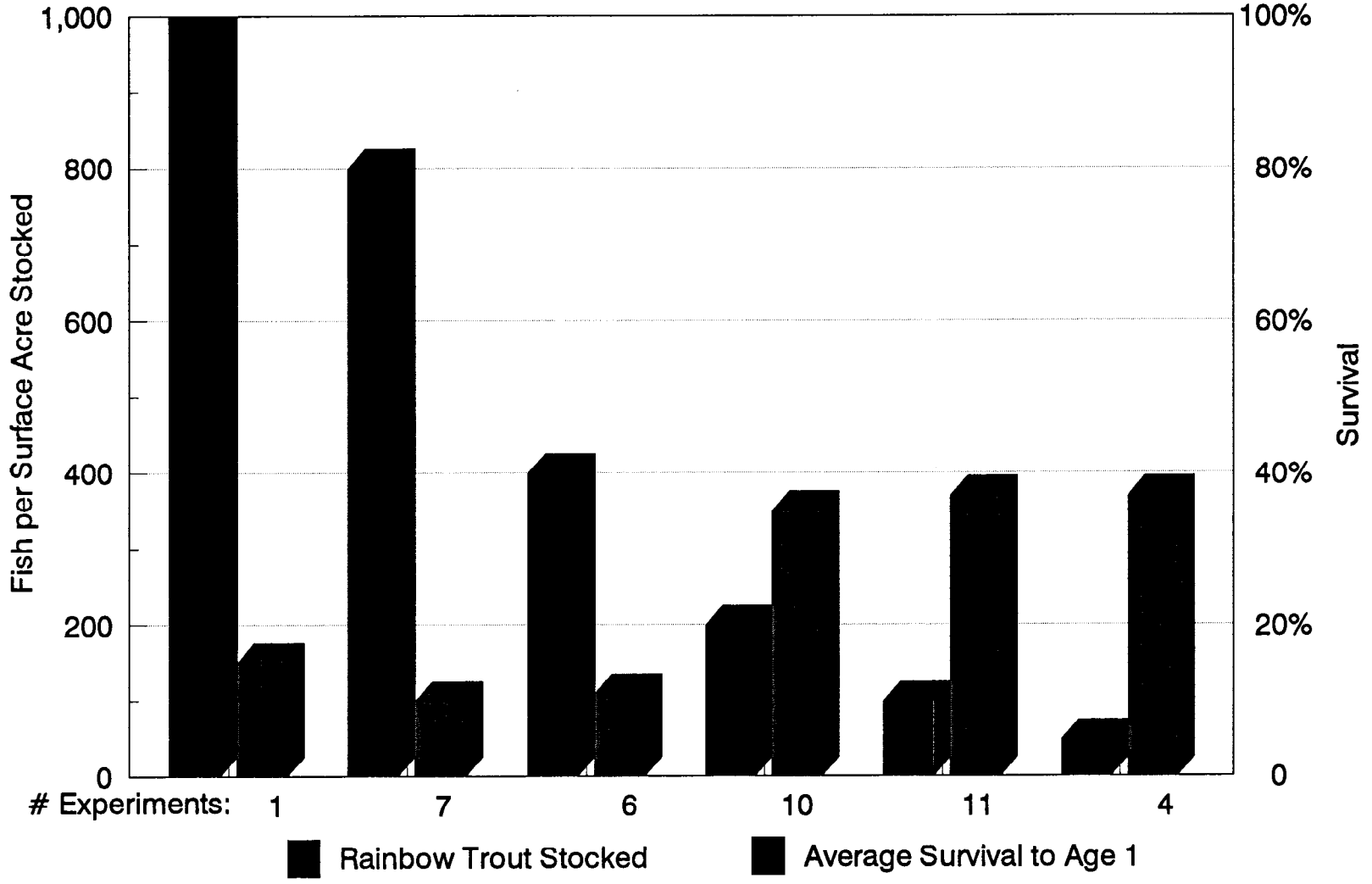

Figure 7. Average survival to age 1 for Swanson River rainbow trout by stocking density in landlocked Matanuska-Susitna Valley lakes, 1989-1991.

We plan to sample Big Lake in May 1992 as an additional recapture event for the 1991 abundance estimate using all the rainbow trout tagged in September and October 1991 as the mark group. We did not get equal mixing between fyke nets and offshore gill nets in October for fish marked in September, and we anticipate that after 7 additional months of mixing we will get an estimate that better reflects the abundance of Big Lake rainbow trout in the entire lake.

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APPENDIX A

Appendix A. Data files developed for the rainbow trout studies in Big Lake, Alaska, 1991.

K012ARB1.DTA	-	Lengths, ages, finclips and tag numbers from sample 1.
K012ARC1.DTA	-	Lengths, ages, finclips and tag numbers from sample 2.
K012ARD1.DTA	-	Lengths, ages, finclips and tag numbers from sample 3 fyke nets.
K012ORA1.DTA	-	Lengths, ages, finclips and tag numbers from sample 3 gill nets.

These data files are all archived with Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518-1599. Contact Gail Heineman or Donna Buchholz (267-2369) for copies of the files and descriptions of the file formats.