

SPORT HARVEST AND ENHANCEMENT
EVALUATION OF COHO SALMON (*Oncorhynchus
kisutch*) IN WESTERN PRINCE WILLIAM SOUND,
ALASKA, 1986

By: Kevin Delaney
Richard Sundet and
Kent Roth



STATE OF ALASKA
Steve Cowper, Governor
ALASKA DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner
DIVISION OF SPORT FISH
Norval Netsch, Director



P.O. Box 3-2000, Juneau, Alaska 99802

April 1987

SPORT HARVEST AND ENHANCEMENT
EVALUATION OF COHO SALMON (*Oncorhynchus
kisutch*) IN WESTERN PRINCE WILLIAM SOUND,
ALASKA, 1986¹

By Kevin Delaney
Richard Sundet and
Kent Roth

April 1987

ALASKA DEPARTMENT OF FISH AND GAME
Division of Sport Fish
Juneau, Alaska 99802

¹This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-2, Job Numbers S-22-1.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	ii
LIST OF FIGURES.	iii
LIST OF APPENDIX TABLES.	iv
ABSTRACT	1
INTRODUCTION	1
METHODS.	3
Sport Fishery	3
Study Area	3
Study Design	3
Data Collection.	6
Analysis	7
Juvenile Coho Salmon Production	9
RESULTS.	10
Effort.	10
Harvest Rates	10
Total Effort and Harvest.	10
Angler Characteristics.	15
Adult Coho Salmon Size Composition.	16
Juvenile Salmon Age and Size Composition.	16
CONCLUSIONS.	17
RECOMMENDATIONS.	17
ACKNOWLEDGEMENTS	18
LITERATURE CITED	18
APPENDIX TABLES.	20

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Effort in the Whittier terminal coho salmon fishery, 1986	11
2. Harvest rates in the Whittier terminal coho salmon fishery, 1986.	12
3. Harvest rate by area of residency of shore anglers in the Whittier terminal coho salmon fishery, 1986	13
4. Total estimated effort and harvest by sampling period of coho salmon in the Whittier terminal, fishery, 1986	14

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Fishing effort in the Prince William Sound sport fishery, 1977 to 1985	2
2. Prince William Sound.	4
3. Western Prince William Sound.	5

LIST OF APPENDIX TABLES

<u>Appendix Table</u>	<u>Page</u>
1. Sport fishing boat trips by location that fished in western Prince William Sound for salmon, bottomfish, and shellfish, July 26 to September 14, 1986	21
2. Number of recreational shellfish pot sets by location in western Prince William Sound, July 26 to September 14, 1986	22
3. Descriptive boat data of western Prince William Sound recreational boaters, July 26 to September 14, 1986.	23
4. Shore anglers length of trip to the Whittier terminal coho salmon fishery and recreational boaters length of trip to western Prince William Sound, July 26 to September 14, 1986.	24
5. Residency of shore anglers at the Whittier terminal coho salmon fishery on weekdays and weekends, and of recreational boaters in western Prince William Sound, July 26 to September 14, 1986.	25
6. Response of interviewed shore anglers and recreational boaters at Whittier to the question "If western Prince William Sound is stocked with coho salmon, what is the maximum distance you would boat out of Whittier to harvest them?", July 26 to September 14, 1986	26
7. Length data of adipose fin clipped (coded wire tagged) coho salmon harvested by sport fishermen at the Whittier terminal fishery, July 26 to September 14, 1986.	27
8. Surprise Cove lakes juvenile coho salmon age and size composition, September, 1986	28

ABSTRACT

Efforts to increase sport fishing opportunities in western Prince William Sound were begun in 1978 with the annual stocking of coho salmon (*Oncorhynchus kisutch* Walbaum) smolts in Passage Canal, and has been expanded in recent years to include stocking of coho and chinook salmon (*Oncorhynchus tshawytscha* Walbaum) fry in western Sound lakes and chinook salmon smolts in Passage Canal. Evaluations of these programs (excluding the chinook salmon smolt stocking) were conducted during 1986. Out-migrating juvenile coho salmon from the 1985 stocking were enumerated and biological data collected from two Surprise Cove lakes and Culross Lake during the spring of 1986. Sampling was conducted in September to evaluate growth of the juvenile salmon stocked in 1986 in the Surprise Cove and Granite Bay lakes. A creel survey was conducted on the Whittier terminal area coho salmon fishery. Shore anglers harvested 2,384 coho salmon during the terminal fishery. Shore anglers made up the largest percentage of the anglers. Harvest rates were highest from 18 August through 14 September with most of the harvest recorded during the weekdays. Biological data for harvested coded wire tagged coho salmon are presented. Additional information was gathered describing selected characteristics of the anglers and the sport fisheries. Boat anglers were also interviewed regarding their preferences in western Prince William Sound concerning enhancement and management options. Recommendations for future programs in western Prince William Sound are presented.

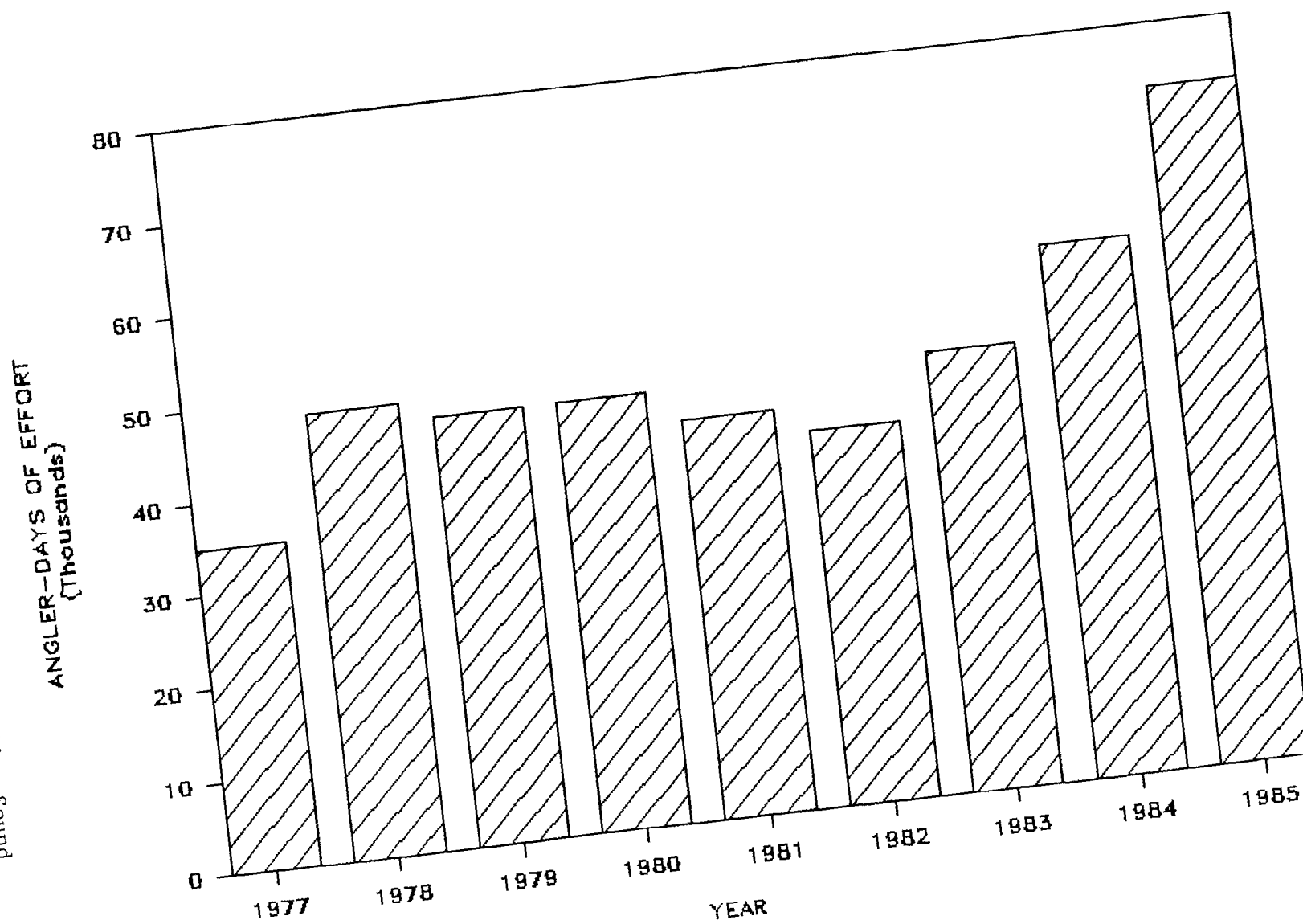
Key Words: Coho salmon, chinook salmon, Dolly Varden, creel survey, effort, harvest, stocking, Prince William Sound, Culross Lake, Granite Bay lakes, Surprise Cove lakes, Whittier, Passage Canal, sport fishing, out-migration, terminal fishery.

INTRODUCTION

Prince William Sound sport fisheries received a relatively stable 35,000 to 50,000 angler-days of effort annually (Mills 1979-1986) during the years 1977-1983 (Figure 1). Modest variation between years can be attributed to fluctuations in salmon run strength in both Prince William Sound and the surrounding fisheries of Cook Inlet and the Upper Copper River. Beginning in 1984, and more substantially in 1985, a significant increase in effort was observed in two specific sport fishing areas; Valdez Arm in northern Prince William Sound and Passage Canal in the western Sound. The community of Whittier¹, home port for many privately owned pleasure boats and a growing charter fleet, provides access to Passage Canal and the waters of western Prince William Sound.

¹ Access to Whittier is primarily through the Alaska Railroad from Portage.

Figure 1. Fishing effort in the Prince William Sound
sport fishery, 1977 to 1985.
2



Western Prince William Sound (WPWS) produces numerous strong runs of pink (*Oncorhynchus gorbuscha* Walbaum) and chum (*Oncorhynchus keta* Walbaum) salmon. No native chinook salmon (*Oncorhynchus tshawytscha* Walbaum) are present. Coho salmon (*Oncorhynchus kisutch* Walbaum) are scarce and sockeye salmon (*Oncorhynchus nerka* Walbaum) are present only in select lake systems. In an effort to increase sport fishing opportunities in the western Sound, coho salmon smolts have been stocked in Passage Canal annually since 1978, and chinook salmon smolt stocking was begun in 1981. The stocking programs have provided good angling opportunities in the Whittier terminal area of Passage Canal. The coho salmon stocking program was expanded to include Culross Lake in 1983 and Surprise Cove Lakes in 1985. In 1986, juvenile chinook salmon were stocked into two Granite Bay (Esther Island) lakes (Figure 2).

A creel survey was conducted at Whittier to estimate the sport effort and harvest of coho salmon in the terminal fishery and collect biological data from returning coded wire tagged fish². Additional information was gathered describing selected characteristics of the sport fisheries including boat types, distances traveled, and targeted species and anglers' preferences in WPWS regarding enhancement and management options.

Out-migrating stocked juvenile coho salmon were sampled at the outlets of the two Surprise Cove lakes and at the outlet of Culross Lake during the spring of 1986 to determine the size, abundance, overwintering survival, and timing of out-migration. The stocked juvenile coho salmon populations in the Surprise Cove lakes and the stocked juvenile chinook salmon populations in the Granite Bay lakes were sampled in the fall of 1986 to determine the relative abundance, size, and age composition.

METHODS

Sport Fishery

Study Area:

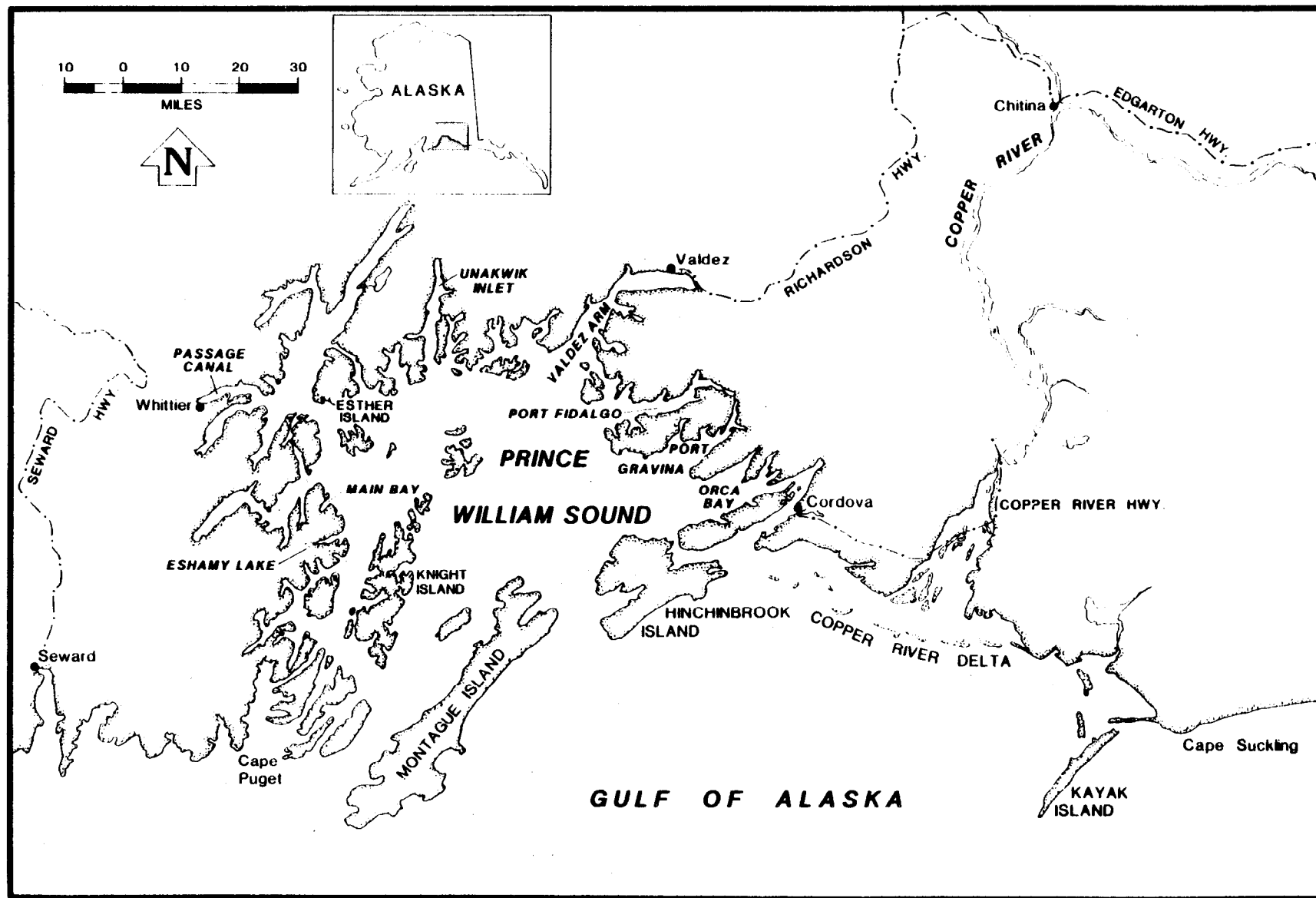
The study area includes all coastal and marine waters of Prince William Sound from Port Wells to Eshamy Lagoon (Figure 3). The Whittier creel survey was conducted along the shoreline between the tank terminal and Cove Creek, and between the docks entrance/exit and the loading area for the Alaska Railroad shuttle.

Study Design:

The Whittier creel survey was conducted from 26 July through 14 September. The fishing-day was 16.5 hours long and was defined to be from 0530 to 2200 hours with 15 time periods defined in each day.

² All stocked coho salmon smolt were coded wire tagged and adipose fin clipped.

Figure 2. Prince William Sound.



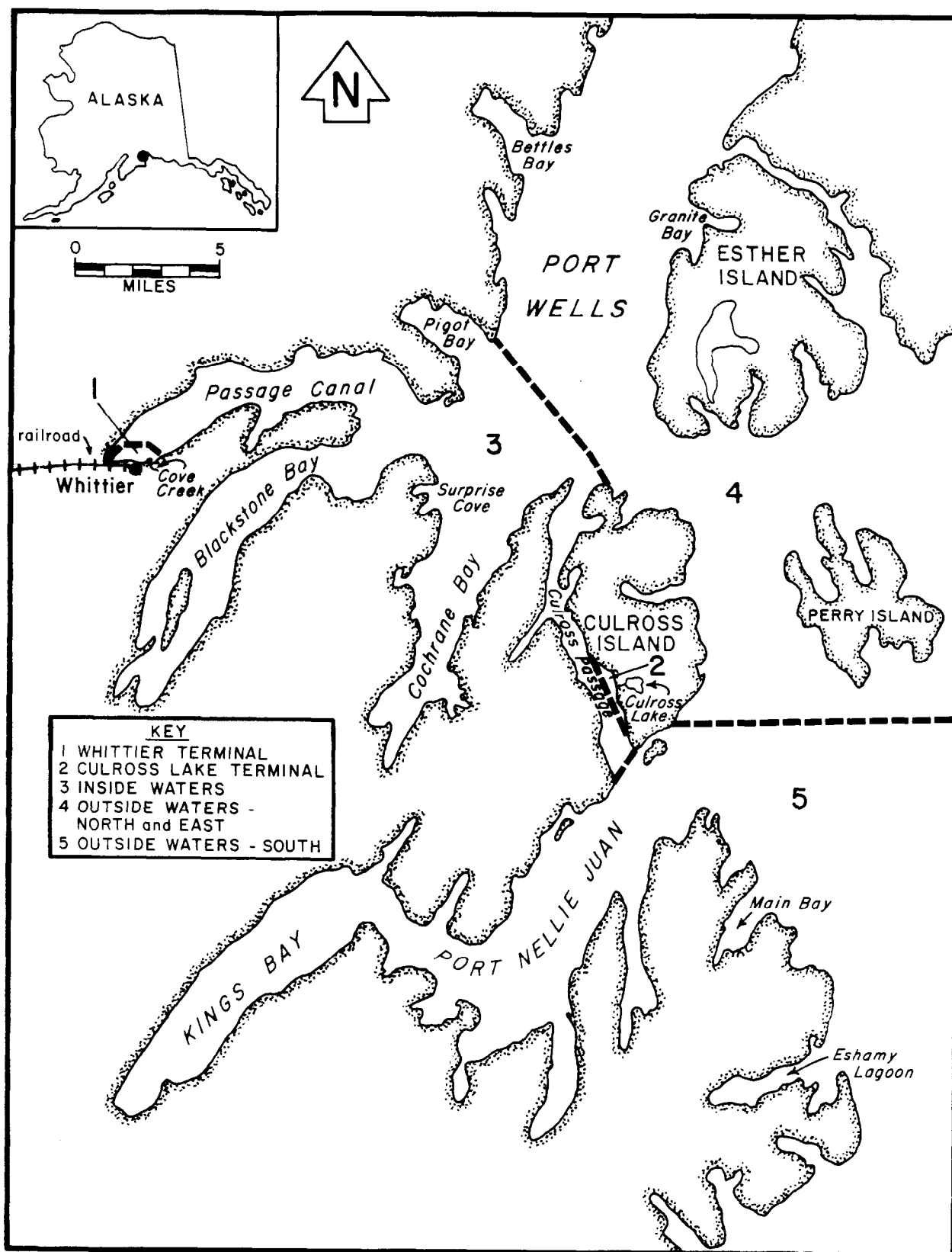


Figure 3. Western Prince William Sound.

The basic experimental design for conducting angler counts and collecting angler interviews followed a two-stage random sample design. Days were considered the primary sample units, and hours in a day for the angler counts and anglers for the interviews were the secondary units. Days and times to sample were randomly selected without replacement.

Several assumptions were necessary for this sampling design and are as follows:

1. Angler counts made during the same day and on consecutive days are assumed to be independent.
2. No significant fishing effort occurs during the hours 2200-0530.
3. Interviewed anglers are representative of the total angler population.
4. The number of anglers interviewed during any day in a stratum is proportional to the effort on that day.
5. Fishing effort does not influence catch per unit effort.

Data Collection:

Interviews during the creel survey program were conducted on all Saturdays, Sundays, and holidays and one randomly selected weekday each week. The survey day was separated into 15 periods, 12 which were 1 hour in length and three which were 1.5 hours in length, to accommodate the train schedule. The daily sampling schedule was designed to consistently begin its periods 1 hour (or 1.5 hours depending on the sampling period) before the train was expected to leave Whittier to allow adequate time to interview all departing anglers. During each survey day, six periods were randomly selected without replacement to conduct interviews between the docks and the train to interview completed boaters. Another two periods each survey day were randomly selected without replacement to conduct interviews between Cove Creek and the tank terminals to interview both completed and incompleted shore anglers. Shore and boat angler counts (the number of anglers on the boats) in the Whittier terminal area were also conducted during these periods.

Shore anglers were individually asked to report the length of time they fished (in hours) for salmon and the number of salmon by species they had harvested. Anglers from a random subsample of boats were collectively asked to report the areas of WPWS they had fished, the target fishery, harvest by species, total hours fished, and the number of anglers per boat.

During the survey in Whittier, observed adipose finclipped coho salmon were sexed and measured mid-eye to fork of tail to the nearest millimeter. Heads of all sampled adipose finclipped fish were

collected and sent to the Fishery Rehabilitation, Enhancement, and Development (FRED) Division tag lab for decoding.

A random subsample of both boat and shore anglers were asked a series of demographic questions to determine residence, length of trip, and the willingness to boat outside of the Whittier terminal area to fish for enhanced stocks of coho salmon. A random subsample of boaters were further asked to identify the size and type of their boat, the type of moorage used, the number of people on the boat, and if sport fishing was the primary reason for their recreational boating.

Analysis:

Effort (angler-hours), harvest rates, and harvest were estimated for shore anglers at the Whittier terminal area coho salmon fishery by weekdays and weekends for two time periods coinciding with the first and second half of the fishery, 7/26-8/17 and 8/18-9/14. Effort and harvest rates were estimated using a two-stage sampling design with a finite number of primary sample units and an unknown number of secondary sample units (Sukhatme et al. 1984). Harvest rate data were computed from completed and incompleted trip angler interview data for each strata.

Angler Counts. The mean number of shore anglers per count and the total effort of shore anglers in angler-hours at the Whittier terminal fishery were computed by weekend/holiday and weekday strata for the first and second half of the survey period. The following conventions are used for analytical notation:

subscript i = days,

subscript j = sample on day i ,

d = total number of days on which sampling was conducted,

D = total number of possible days in a half of the survey,

N = total number of possible hours of fishing in a half of the survey,

y_{ij} = an angler count j for day i ,

$\bar{Y}_i$ = mean angler count for day i ,

$\bar{Y}$ = mean angler count for that half of the census,

m_i = number of angler counts on day i ,

M = total number of angler counts for a half of the survey.

The mean number of anglers on a boat at the Whittier terminal fishery was computed for the entire survey using data collected during the

interviews. This was determined by dividing the sum of the boat anglers by the total number of boats.

Effort. Effort in angler-hours, E, was estimated for shore anglers by weekday and weekend/holiday strata for each half of the survey as:

$$\hat{E} = \bar{Y}N$$

The variance of E was estimated as:

$$V(\hat{E}) = N^2 V(\bar{Y}), \text{ where (Sukhatme et. al. 1984)}$$

$$V(\bar{Y}) = [1 - (d/D)](s^2_B/d) + [\sum_{i=1}^d (s^2_{Wi}/m_i)]/dD, \text{ (equation 1) and}$$

$$s^2_B = [\sum_{i=1}^d \bar{Y}_i - \bar{Y})^2]/(d-1), \text{ and}$$

$$s^2_{Wi} = [\sum_{j=1}^{m_i} (Y_{ij} - \bar{Y}_i)^2]/(m_i - 1).$$

Total boat effort was not computed as the data were not collected in a form suitable for this analysis.

Harvest rates. Harvest rates of shore anglers were computed for each sampled day and for each half of the survey as defined for the analysis of the effort data. For each half of the survey, the following conventions are used for analytical notation:

C = total catch by interviewed anglers during that half of the survey,

F = total effort (angler-hours) by interviewed anglers in that half of the season,

$\bar{C}$ = mean catch per angler,

$\bar{F}$ = mean effort per angler,

M = number of anglers interviewed in that half of the season,

s^2_C = two-stage variance estimate for $\bar{C}$,

s^2_F = two-stage variance estimate for $\bar{F}$,

r = correlation coefficient for C and F.

Catch per effort, C/F , was computed for each stratum and its variance, $\hat{V}(C/F)$, approximated as the quotient of two random variables (Jessen 1978) as:

$$\hat{V}(C/F) = (\bar{C}/\bar{F})^2 [(s_C^2/\bar{C}^2) + (s_F^2/\bar{F}^2) - (2rs_Cs_F/\bar{C}\bar{F})].$$

The variance for mean catch, $\bar{C}$, and mean effort, $\bar{F}$, were computed using the two-stage random sampling formulae defined for mean angler counts in equation 1 (Von Geldern and Tomlinson 1973). The Y_{ij} 's in this case represent the effort or catch of an interviewed angler and m_i 's represent the number of anglers interviewed on day i .

Total Harvest. Total harvest, H , by shore anglers for the weekday and weekend/holiday strata in each half of the survey was computed as:

$$H = \hat{E}(\bar{C}/\bar{F}),$$

and variance, $V(H)$, as (Goodman 1960):

$$V(H) = [E^2 \hat{V}(\bar{C}/\bar{F})] + [(\bar{C}/\bar{F})^2 \hat{V}(E)] - [\hat{V}(E) \hat{V}(\bar{C}/\bar{F})].$$

Estimates of effort and harvest for all strata were considered independent, therefore, seasonal totals for estimates and variances are the sum of these quantities for all strata.

Estimates of harvest rate for boat anglers in the Whittier terminal coho salmon fishery are computed for the entire season. The harvest rate estimate for boat anglers is presented as mean harvest per boat-hour. This was calculated by dividing the sum of the harvest by the sum of the boat-hours.

Angler characteristics were tabulated for the entire season. Mean mid-eye to fork lengths with associated 95% confidence intervals were calculated by sex for coded wire tagged adult coho salmon harvested at Whittier.

Juvenile Coho Salmon Production

Out-migrant weirs were operated by FRED Division from 4 May through 11 June at the outlets of the two Surprise Cove lakes. A weir was also operated at the outlet of Culross Lake from 7 May through 17 June to sample the out-migrating juvenile chinook salmon. These

lakes were stocked with fry during the spring of 1985. All juvenile salmon collected were enumerated by species and a subsample taken to estimate mean lengths (total length to the nearest millimeter) and weights (to the nearest 0.1 grams).

Sampling of juvenile salmon was conducted in Surprise Cove lakes 1 and 2 and Granite Bay lakes 1 and 2 during September. Ten baited traps were set in each lake. All fish collected were enumerated by species and mean fork lengths with 95% confidence intervals calculated for each age class of juvenile salmon collected. Ages were determined from analysis of the length frequency distribution.

RESULTS

Effort

The estimated mean shore angler counts and total shore angler effort for the Whittier terminal area coho salmon fishery by weekday, weekend, and seasonal time strata are presented in Table 1. Shore angler counts and total effort were highest during the second half of the season. Approximately 68% of the effort occurred during the second half of the season.

Harvest Rates

Harvest rate estimates for shore anglers were much higher during the second half of the season and anglers fishing the weekdays did consistently better than those fishing the weekends (Table 2). Shore anglers were generally more successful than boat anglers. The highest harvest rate for shore anglers of 0.58 coho salmon per angler-hour was estimated for weekdays during the second half of the survey. The harvest rate for boat fishermen was estimated at 0.29 coho salmon per boat-hour for the entire season.

Whittier residents were much more successful as a group (0.79 fish/angler-hour) than were other Alaska residents or non-residents, 0.31 and 0.28 fish/angler-hour, respectively (Table 3).

Total Effort and Harvest

Total effort and coho salmon harvest for shore anglers for the weekend, weekday, and seasonal strata are presented in Table 4. The Whittier terminal area coho salmon shore fishery supported an estimated 5,894 angler-hours in 1986. Most (68%) of the effort was recorded during the last half of the survey. Over the entire season, 74% of all shore effort occurred during the weekdays.

Shore fishermen harvested an estimated 2,384 coho salmon in the 1986 Whittier terminal area fishery with 84% of the harvest recorded during the second half of the season. Over the entire season, 73% of the total harvest by shore anglers was recorded during the weekdays.

Table 1. Effort (angler-hours) in the Whittier terminal coho salmon fishery, 1986.

Angler Type	Time Frame ¹	Strata	Number	Number	Number	Counts		Effort	
			of Counts	of Days Possible	of Days Sampled	Mean	Std Err	Total	Std E
Shore	WD	7/26-8/17	5	15	3	4.2	1.2	1,039.5	307
Shore	WE	7/26-8/17	13	8	7	6.4	2.9	842.8	379
Shore	WD	8/18-9/14	8	19	4	8.0	4.2	2,508.0	1,307
Shore	WE	8/18-9/14	16	9	9	10.1	2.0	1,503.6	297
Shore	WD & WE	Total	42	51	23			5,893.9	1,427

1 WD = Weekday

WE = Weekend

Table 2. Harvest rates (coho salmon per hour) in the Whittier terminal coho salmon fishery, 1986.

Angler Type	Time Frame ¹	Strata	Number of Interviews	Number of Days Possible	Number of Days Sampled	Effort		Harvest				
						Mean	Std Err	Mean	Std Err	Eff Corr	CPUE	Std.Err
Shore	WD	7/26-8/17	70	15	3	1.82	0.63	0.50	0.11	0.47	0.28	0.01
Shore	WE	7/26-8/17	282	8	8	2.44	0.13	0.30	0.05	0.19	0.12	0.00
Shore	WD	8/18-9/14	180	19	4	2.05	0.26	1.19	0.29	0.27	0.58	0.01
Shore	WE	8/18-9/14	416	9	9	3.01	0.13	1.06	0.09	0.28	0.35	0.00
Boat	WD & WE	7/26-9/14	97	51	16	Mean Harvest Per Boat-Hour					0.29	

¹ WD = Weekday
WE = Weekend

Table 3. Harvest rate (coho salmon per angler-hour) by area of residency of shore anglers in the Whittier terminal coho salmon fishery, 1986.

	Whittier Resident	Non-Whittier Alaska Resident	Non-Alaska Resident
Harvest Rate	0.79	0.31	0.28
Relative Precision ¹	3.4%	1.0%	17.9%

¹ Relative precision for a 95% confidence interval.

Table 4. Total estimated effort and harvest by sampling period of coho salmon in the Whittier terminal fishery, 1986.

Angler Type	Time Frame ¹	Strata	Effort		Harvest Rate		Total Harvest		
			Total	Rel Pre ²	Mean	Rel Pre ²	Total	Std Err	Rel Pre ²
Shore	WD	7/26-8/17	1,039.5	57.9%	0.28	7.3%	286	85.0	58.3%
Shore	WE	7/26-8/17	842.8	88.3%	0.12	1.8%	103	46.4	88.3%
Shore	WD	8/18-9/14	2,508.0	102.2%	0.58	3.5%	1,463	762.8	102.2%
Shore	WE	8/18-9/14	1,503.6	38.7%	0.35	0.8%	532	105.3	38.8%
Shore	WD & WE	Total	5,893.9	47.5%			2,384	776.1	63.8%
Boat	WD & WE	7/26-9/14			0.29 ³				

1 WD = Weekday

WE = Weekend

2 Relative Precision at = 0.05

3 Mean Harvest Per Boat-Hour

Angler Characteristics

During the 1986 survey, 94% of the boat-trips in the Whittier and Culross areas (Figure 3, areas 1 and 2) were directed toward the coho salmon terminal fisheries (Appendix Table 1). The number of boats sport fishing was evenly distributed between salmon, bottomfish, and shellfish in the three remaining areas. However, over twice as many boat-trips were expended for bottomfish than for salmon in area 4, north and east of Pigot Bay. Fishing for shellfish was conducted primarily in areas 3 and 5 (Appendix Table 2).

WPWS boaters were grouped into two categories: those whose primary reason for boating was to sport fish and those who boated there primarily for other reasons. The frequency of boat type, length, and moorage location by user group is summarized in Appendix Table 3. Sport fishermen most frequently used cabin cruiser type boats over 20 feet in length. Kayaks or ocean canoes were the most common boat type among other recreational boaters. Sport fishermen tended to moor their boats in private and transient slips in the Whittier boat harbor while most other boaters transported their boat via the train for each trip.

Sixty-five percent of the 337 boat operators interviewed in 1986 travelled out of Whittier seeking recreation other than sport fishing. However, 44% of these boats were used for sport fishing during their trip in WPWS. The number of people per boat averaged 2.6 of which 80% sport fished during their trip to WPWS.

Most shore anglers (73%) spent only 1 day fishing in Whittier while 65% of the boaters who travelled to WPWS to sport fish spent at least 2 days in the area (Appendix Table 4). Sport anglers tended to make shorter trips than other recreational boaters. Sport anglers made up only 19% of the boaters whose length of stay in WPWS was 3 or more consecutive days.

Alaska residents other than those from Whittier made up 77% of the shore anglers at the Whittier terminal fishery and 68% of the recreational boaters in WPWS (Appendix Table 5).

During the survey, the question "If western Prince William Sound is stocked with coho salmon, what is the maximum distance in miles would you boat out of Whittier to harvest them?" was asked of recreational boaters. Most (63%) of the recreational boaters who had come to WPWS primarily to sport fish would boat out 30 miles to participate in a terminal coho fishery (Appendix Table 6). The recreational boaters who were in WPWS for other reasons than sport fishing comprised the majority (89%) of the boaters who would not travel to fish for coho salmon or were not interested in fishing for coho salmon. Approximately one-half of the shore anglers indicated that they would participate in a terminal coho fishery outside of the Whittier terminal area.

Adult Coho Salmon Size Composition

Sex and length data collected on adipose finclipped (coded wire tagged) adult coho salmon harvested by sport anglers in the Whittier terminal fishery are presented in Appendix Table 7. The mean lengths of males (623.6 mm) and females (623.4 mm) were nearly identical.

Juvenile Salmon Age and Size Composition

The peak out-migration of juvenile coho salmon from the north Surprise Cove lake was from 31 May through 4 June. A total of 2,092 coho were enumerated from the north lake indicating a survival from stocking of 3.1%. These fish averaged 87 mm total length with a mean weight of 5.2 grams. In the south lake, peak out-migration was recorded from 26 May through 30 May. The weir at this site was not a complete barrier so that not all out-migrants were enumerated. A total of 4,702 coho juveniles were enumerated and had a mean length of 92 mm and averaged 6.6 grams. Survival from stocking to out-migration in the south lake was estimated at 6.1%. The north and south lakes were restocked on 10 July, 1986 with 20,053 and 38,698 coho salmon fry (2.3 grams mean weight), respectively.

A total of 28,995 coho salmon smolts were enumerated from 7 May through 17 June at Culross Lake. This represents 29% of the total fry released in the lake in 1985. Peak out-migration was recorded from 22 May through 31 May. During the first portion of the out-migration, the coho averaged 97 mm fork length and 8.2 grams, while by the end of the out-migration, they averaged 104 mm and 10.6 grams. Culross Lake was restocked with 99,600 coho salmon fry (55 mm mean length and 1.6 grams mean weight) on 7 June, 1986.

Using minnow traps, 386 juvenile coho salmon were collected in the north Surprise Cove Lake and 310 coho in the south Surprise Cove Lake. Age 0+ fish comprised 91% of the north lake sample and 85% of the south lake sample. Mean fork length by age class was similar for the two lakes (Appendix Table 8). It appears that some of the juvenile coho salmon stocked in 1985 did not out-migrate during 1986 but rather remained in the lakes for a second season. This is attributed to the relatively slow growth experienced in these lakes so that a portion of the coho salmon did not attain a size sufficient to initiate out-migration. These fish will probably out-migrate during 1987. The percent survival calculated for the coho salmon from stocking to out-migration will increase with the addition of these holdovers.

In addition to juvenile coho salmon, 62 Dolly Varden were captured in the north lake and 88 in the south lake. The Dolly Varden were of the stunted resident variety ranging in length from 60 to 140 mm.

No juvenile salmon were collected during sampling in the two Granite Bay lakes, however stunted Dolly Varden were numerous. The juvenile chinook salmon stocked in the Granite Bay lakes in June of 1986 were almost at the smolting size at the time of stocking. Apparently these fish out-migrated shortly after stocking.

CONCLUSIONS

Generally, sport fishing in western Prince William Sound is evenly distributed for salmon, bottomfish, and shellfish. However, the presence of a terminal coho fishery at Whittier causes a major redirection of the sport fishing effort.

The Whittier terminal coho salmon shore fishery supported 5,894 angler-hours in 1986 and sport fishermen harvested an estimated 2,384 coho salmon. Shore anglers were almost three times as numerous and were more successful than boat anglers at the Whittier terminal fishery in 1986.

The development of additional terminal fisheries in western Prince William Sound was supported by boat anglers. A high percentage of boaters indicated that they would travel out at least 30 miles to participate in a terminal coho salmon fishery.

Stocking efforts should continue in Culross Lake as this site provides good possibilities for enhancement to increase recreational opportunities in this portion of WPWS. Presently, the United States Fish and Wildlife Service and FRED Division are interested in maintaining this program and are primarily responsible for its continuation. Important data for all interested agencies will continue to be obtained as Culross Lake approaches more stable rearing conditions. Data concerning optimum stocking densities and frequencies still need to be determined. Although a poor sport fishery was reported in 1986, a good sport fishery resulted from this stocking program in 1985. There were unconfirmed reports of anglers catching coho salmon in Culross Passage in 1986 and rumors that many of the fish may have been harvested by commercial fishermen in the area.

RECOMMENDATIONS

1. Continue to stock coho salmon at the Whittier terminal area. An annual return of 4,000 to 5,000 adult coho salmon is recommended to maintain a quality and orderly terminal fishery. A creel survey program should be conducted again in 3 to 5 years to determine if increased stocking or regulation changes are necessary to maintain the success of this program.
2. Initiate a creel survey in the spring of 1987 similar to the survey conducted in 1986 to determine the effort and harvest of stocked chinook salmon at the Whittier terminal fishery, and characteristics of those anglers and recreational boaters in western Prince William Sound during that seasonal period.
3. Continue to stock coho salmon fingerlings in Culross Lake and coho smolt or presmolt in the two Surprise Cove lakes. Continuation of these plants should include efforts to insure that a significant percentage of the fish returning to these terminal fisheries are available to the sport fishing public. Each

terminal area should receive at least 500 returning adult coho and juvenile monitoring should be reduced to a minimal cost.

4. Discontinue stocking chinook salmon juveniles in lakes at the Granite Bay terminal fishery until such time that Ester Island Hatchery chinook returns and the subsequent fisheries are established.
5. Continue to promote angler awareness of the terminal fisheries in western Prince William Sound.

ACKNOWLEDGEMENTS

We would like to extend our appreciation to the following individuals and organizations for their valuable assistance in the collection and preparation of the data. Our thanks to Kurt Nelson (USFS) for the use of the living facilities in Whittier and for the collection of the Culross Lake out-migration data and to Larry Peltz (ADF&G, F.R.E.D. Division) who conducted the out-migrant studies at the Surprise Cove lakes. Our appreciation is also extended to James Mauney and Stuart Granier for their assistance in the creel survey. We are grateful to Drew Crawford, Robert Conrad, Sandra Sonnichsen, and Doug McBride for their careful review and helpful suggestions on this document. We thank Carol Hepler for her cartography contributions and Gail Heineman and the Sport Fish RTS staff for their technical assistance.

LITERATURE CITED

- Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 66:708-713.
- Jessen, R. J. 1978. Statistical survey techniques. John Wiley and Sons, New York. 520 pp.
- Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report 1978-1979, Project F-9-11, 20(SW-I-A). 122 pp.
- . 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21(SW-I-A). 65 pp.
- . 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22(SW-I-A). 78 pp.

LITERATURE CITED (Continued)

- _____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22(SW-I-A). 107 pp.
- _____. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23(SW-I-A). 115 pp.
- _____. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24(SW-I-A). 118 pp.
- _____. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25(SW-I-A). 122 pp.
- _____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26(SW-I-A). 135 pp.
- _____. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27(RT-2). 137 pp.
- Sukhatme, P. V., B. U. Sukhatme, S. Sukhatme, and C. Asok. 1984. Sampling theory of surveys with applications. Iowa State University Press, Ames, Iowa. 526 pp.
- Von Geldern, C. E. and P. K. Tomlinson. 1973. On the analysis of angler catch rate data from warmwater reservoirs. California Fish and Game 59(4):281-292.

APPENDIX TABLES

Appendix Table 1. Sport fishing boat-trips by location that fished in western Prince William Sound for salmon, bottomfish, and shellfish, 26 July to 14 September, 1986.¹

Species Groupings	Location					Total # of Boat Trips by Fishery	Percent
	Area 1	Area 2	Area 3	Area 4	Area 5		
	Whittier Terminal Area	Culross Terminal Area	Rest of Passage Canal and Culross Passage, & Pigot, Cochrane and Blackstone Bays	North and east of Pigot Bay Including Perry and Naked Islands	South of Culross Passage		
Salmon	89 (92.7%)	14 (100.0%)	61 (44.2%)	16 (37.2%)	42 (43.3%)	222	57.2
Bottomfish	6 (6.3%)	0	36 (26.1%)	18 (41.9%)	35 (36.1%)	95	24.5
Shellfish	1 (1.0%)	0	41 (29.7%)	9 (20.9%)	20 (20.6%)	71	18.3
Total # of Boat Trips by Location	96	14	138	43	97	388	100.0

¹ For this analysis, only completed-trip boat angler data were used. There were 272 completed-trip boats interviewed of which 116 also fished for more than one of the species or in more than one of the areas.

Appendix Table 2. Number of recreational shellfish pot sets by location in western Prince William Sound, 26 July to 14 September, 1986.¹

	Location					Total
	Area 1	Area 2	Area 3	Area 4	Area 5	
	Whittier Terminal Area	Culross Terminal Area	Rest of Passage Canal and Culross Passage, & Pigot, Cochrane and Blackstone Bays	North and east of Pigot Bay Including Perry and Naked Islands	South of Culross Passage	
Number of Pot Sets	1 (0.1%)	0 (0.0%)	309 (40.7%)	145 (19.1%)	304 (40.1%)	759

¹ For this analysis, only completed-trip boat angler data were used.

Appendix Table 3. Descriptive boat data of western Prince William Sound
recreational boaters, 26 July to 14 September, 1986.

Recreational Boaters	Boat Type			n
	Cabin Cruiser (fixed canopy) and Sailboats	Kayak and Canoe	Skiff (open canopy) and Inflatables	
Those Primarily Sportfishing	84 (71.2%)	1 (0.8%)	33 (28.0%)	118
Other	78 (35.6%)	116 (53.0%)	25 (11.4%)	219
Total	162 (48.1%)	117 (34.7%)	58 (17.2%)	337

Recreational Boaters	Boat Length			n
	Less than or equal to 10 ft.	More than 10 ft. and less than or equal to 20 ft.	More than 20 ft.	
Those Primarily Sportfishing	1 (0.8%)	47 (40.2%)	69 (59.0%)	117
Other	2 (0.9%)	140 (63.9%)	77 (35.2%)	219
Total	3 (0.9%)	187 (55.7%)	146 (43.4%)	336

Recreational Boaters	Boat Moorage				n
	Slip (Own or Transient)	Load Onto Train	Park in Whittier	Rent	
Those Primarily Sportfishing	65 (56.5%)	39 (33.9%)	11 (9.6%)	0	115
Other	58 (26.5%)	94 (42.9%)	10 (4.6%)	57 (26.0%)	219
Total	123 (36.8%)	113 (39.8%)	21 (6.3%)	57 (17.1%)	334

Appendix Table 4. Shore anglers length of trip (in days) to the Whittier terminal coho salmon fishery and recreational boaters length of trip (in days) to western Prince William Sound, 26 July to 14 September, 1986.

Angler Type/ Boater Type	Number of Days on Trip							Total # Interviewed
	1	2	3	4	5	6 to 10	10 or more	
Shore Anglers								
Non-Whittier Alaska Resident	176 (73.0%)	46 (19.1%)	11 (4.6%)	8 (3.3%)	0	0	0	241
Non-Resident	24 (96.0%)	1 (4.0%)	0	0	0	0	0	25
Total Shore Anglers	200 (72.5%)	47 (17.0%)	11 (4.0%)	8 (2.9%)	0	0	0	266
Recreational Boaters								
Those Primarily Sportfishing	39 (35.1%)	40 (36.0%)	23 (20.7%)	3 (2.7%)	3 (2.7%)	3 (2.7%)	0	111
Other	38 (17.6%)	44 (20.4%)	52 (24.1%)	21 (9.7%)	8 (3.7%)	25 (11.5%)	28 (13.0%)	216
Total recreational boaters	77 (23.6%)	84 (25.7%)	75 (22.9%)	24 (7.3%)	11 (3.4%)	28 (8.6%)	28 (8.6%)	327

Appendix Table 5. Residency of shore anglers at the Whittier terminal coho salmon fishery on weekdays and weekends, and of recreational boaters in western Prince William Sound, 26 July to 14 September, 1986.¹

Shore Angler or Recreational Boater	Time Period ²	Residency			
		Whittier Resident	Non-Whittier Alaska Resident	Non-Resident	n
Shore Anglers	WD	21 (29.2%)	43 (59.7%)	8 (11.1%)	72
	WE	33 (11.8%)	228 (81.1%)	20 (7.1%)	281
	Total				
	WD & WE	54 (15.3%)	271 (76.8%)	28 (7.9%)	353
Recreational Boater					
Those Primarily Sportfishing	WD & WE	12 (19.7%)	48 (78.7%)	1 (1.6%)	61
Other	WD & WE	5 (4.4%)	71 (62.8%)	37 (32.7%)	113
Total Recreational Boaters	WD & WE	17 (9.8%)	119 (68.4%)	38 (31.9%)	174

¹ For the analysis of shore anglers' residency, only shore interview data were used. For the analysis of boaters' residency, only data collected during interviews on weekdays and periods on weekends that did not coincide with the train schedule were used. Sampling for boat residency data was done collectively; in cases where people had different residencies in a single boat, the majority dictated what residency was recorded for that boat.

² WD = Weekday, WE = Weekend

Appendix Table 6. Response of interviewed shore anglers and recreational boaters at Whittier to the question "If western Prince William Sound is stocked with coho salmon, what is the maximum distance (in miles) you would boat out of Whittier to harvest them?", 26 July to 14 September, 1986.¹

Angler Type/ Boater Type	5 miles	10 miles	20 miles	30 miles	Would not Participate	Total # of Interviews
Shore Anglers						
Whittier Resident	35 (29.7%)	12 (10.2%)	7 (5.9%)	20 (16.9%)	44 (37.3%)	118
Non-Whittier Alaska Resident	117 (21.5%)	33 (6.0%)	32 (5.9%)	82 (15.1%)	280 (51.5%)	544
Non-Resident	7 (10.4%)	4 (6.0%)	0	7 (10.4%)	49 (73.1%)	67
Total Shore Anglers	159 (21.8%)	49 (6.7%)	39 (5.4%)	109 (14.9%)	373 (51.2%)	729
Recreational Boaters						
Those Primarily Sportfishing	9 (7.9%)	8 (7.0%)	14 (12.3%)	72 (63.2%)	11 (9.7%)	114
Other	20 (9.3%)	20 (9.3%)	22 (10.2%)	61 (28.2%)	93 (43.0%)	216
Total Recreational Boaters	29 (8.7%)	28 (8.5%)	36 (10.9%)	133 (40.3%)	104 (31.5%)	330

¹ Response by shore anglers was by individual and by boaters was collectively (only one response per boat determined by the owners response).

Appendix Table 7. Length (mid-eye to fork in millimeters) of adipose fin clipped (coded wire tagged) coho salmon harvested by sport anglers at the Whittier terminal fishery, 26 July to 14 September, 1986.

Sex	n	Mean	Variance	Standard Error	Relative Precision	95% C.I.	Range
Male	30	623.6	1896.2	8.0	2.6%	+/- 16.3	495-695
Female	31	623.4	509.0	4.1	1.3%	+/- 8.3	565-660
Total	61	623.5	1171.0	4.4	1.4%	+/- 8.8	495-695

Appendix Table 8. Surprise Cove lakes juvenile coho salmon age and size composition, September, 1986.¹

Site	Age 0+				Age 1+			
	n	Mean Length	Range of Lengths	95% C.I.	n	Mean Length	Range of Lengths	95% C.I.
North Lake	351	67.5	50 - 80	+/- 0.5	35	87.1	82 - 96	+/- 1.2
South Lake	262	68.3	53 - 80	+/- 0.7	48	93.0	82 - 113	+/- 1.8

¹ Size data are presented as fork length in millimeters.