STATE/FEDERAL RESOURCE DAMAGE ASSESSMENT
FINAL DATA SUMMARY REPORT

Project Title:	PRINCE WILLIAM SOUND AND GULF OF ALASKA SPORT FISHERY HARVEST AND EFFORT, 1989
Study ID Number:	Fish/Shellfish Study Number 6
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EXECUTIVE SUMMARY

The sport fisheries of Prince William Sound (PWS), Resurrection Bay, lower Kenai Peninsula, and Kodiak were studied in 1989 as part of a plan to assess potential injury due to the Exxon-Valdez oil spill. These potential impacts were measured by examination of the sport harvest for oil contamination and estimation of selected fishery parameters. In addition, this project provided the means by which information vital to other NRDA programs could be collected.

No visibly discernable contamination was observed on any of the 12,597 salmon, halibut, and rockfish inspected at Valdez, Cordova, Kodiak, Seward, Whittier, and Homer.

Demersal rockfish comprised up to 100% of the sport harvest of rockfish in the sampled ports. Mortality and subsequent hydrocarbon contamination of demersal rockfish were documented in Fish/Shellfish Study No. 17 (Injury to Rockfish in Prince William Sound).

An unprecedented decline in sport fishing effort during 1989 was documented for Seward, a major marine sport fishing port and base of a large charter fleet. Sport fishing effort was significantly ($\alpha = 0.05$) lower than any recorded level of fishing effort dating back to 1968. Also, seven of eight Anchorage air charter operators reported reduced charter flights to PWS during 1989 compared to 1988.

INTRODUCTION

This study was fielded as part of the Natural Resource Damage Assessment (NRDA) programs to provide a timely means by which to assess major impacts to the sport fisheries of Prince William Sound (PWS), Resurrection Bay, lower Kenai Peninsula, and Kodiak as a result of the oil spill from the Exxon Valdez. The recreational fishing industry is a vitally important component of the local economies of Valdez, Whittier, Seward, and Homer (Appendix F). Recreational fishing is also important to residents of and visitors to Cordova and Kodiak. Prior to the 24 March, 1989 oil spill; sport fisheries in PWS, Homer, Seward, and Kodiak were expected to expand in both effort and harvest (Appendix Tables A1 through A19). A concurrent increase in the number of charter boats catering to sport fishermen was also anticipated. Decreases in fish abundance, major shifts in fish distribution, and loss of the pristine character of the area are means by which the oil spill could result in a substantial decrease in participation in the recreational fisheries. This could lead to a serious loss of revenue to the local communities.

The oil spill in Prince William Sound has impacted the groundfish stocks in PWS (Hepler et al. 1990); and also may have impacted stocks in the Homer, Seward, and Kodiak areas. Groundfish harvested by sport anglers include rockfish *Sebastes* and *Sebastolobus spps.*, lingcod *Ophiodon elongatus*, and Pacific halibut *Hippoglossus stenolepis*. Oil contamination of benthic environments could kill these fish or chronically taint them due to persistence of oil in their environment or their food web. The presence of any oiled fish may cause a drop in fishing effort due to perceptions of unpalatable fish or may cause a drop in harvest due to both lethal and sub-lethal effects of ingested oil on fish. Therefore, one goal of this project was to determine the species composition of the groundfish harvest in the marine sport fisheries of PWS, Homer, and Kodiak; and the incidence of oil contamination in these harvests.

In an attempt to document injury to the recreational fisheries, anglers were surveyed at major access points to the PWS, Homer, Seward, and Kodiak areas, and at Eshamy Lagoon in western PWS. Anglers were asked where they fished and how many fish they caught. In some cases, direct comparisons to historic data can be made. However, in most cases these data are intended to supplement NRDA postal sampling; notably, sampling for harvest and effort (Mills 1988) and economics. Addresses were collected from interviewed anglers if they were willing to respond to a follow-up mail questionnaire. In addition, Dolly Varden char *Salvelinus malma* and cutthroat trout *Oncorhynchus clarki* observed during the angler interviews were checked for tags (Fish/Shellfish Study No. 5). Anglers at Eyak River, near Cordova, and at Clear Creek and Alaganik River on the Copper River Delta were also interviewed to determine the tagged to untagged ratio of Dolly Varden char and cutthroat trout in the sport harvest.

OBJECTIVES

This program was operational during the period from late June through September, 1989. Specific objectives of the investigations were:

1. to estimate recreational catch and harvest of salmon *Oncorhynchus spps.*, rockfish, halibut, cutthroat trout, and Dolly Varden char. Specifically we attempted to:

    a. estimate the species composition of the rockfish harvest in the PWS, Seward, Homer, and Kodiak marine sport fisheries. Objective criteria were such that the estimated proportional contribution was within ± 5% of the true proportion 95% of the time.

    b. estimate catch and harvest per boat trip by species for anglers returning to major harbors in PWS, Homer, and Kodiak. Objective criteria were such that the estimated catch and harvest per anger day were within ± 10% of their true values 90% of the time.

    c. estimate the number of fish caught and harvested, by species, by anglers at Eyak Lake and two streams on the Copper River Delta during the period 15 June through 1 October 1989 such that the estimated catch and harvest were within ± 10% of their true values 90% of the time.

    d. estimate the number of fish caught and harvested, by species, by anglers fishing from boats or from shore in Eshamy Lagoon during the period 1 July through 4 September 1989 such that the estimated catch and harvest were within ± 7.5% of their true values 95% of the time.

2. to estimate fishing effort and identify the temporal and spatial distribution and location of origin of angling effort. Specifically we:

    a. estimated fishing effort (in number of angler-hours) at Eyak Lake and two streams on the Copper River Delta during the period 15 June through 1 October 1989 such that the estimated effort was within ± 10% of its true value 95% of the time.

    b. estimated fishing effort (in number of angler-hours) in Eshamy Lagoon by anglers fishing from boats or from shore during the period 1 July through 4 September 1989 such that the estimated effort was within ± 7.5% of its true value 95% of the time.

3. to inspect enough groundfish and salmon such that there will be a 95% chance of finding at least one contaminated animal when at least one fish in 500 (0.005) is tainted.

4. to identify potential alternative methods and strategies for restoration of lost use, populations, or habitat where injury is identified (to be accomplished upon completion of this project).

In addition to the objectives noted above, the following tasks were accomplished:

1. Collect names and addresses of all interviewed anglers who were willing to respond to a follow-up mail questionnaire.

2. Conduct a logbook survey of anglers who accessed PWS from the float-plane base in Anchorage.

3. Inspect harvests in PWS and Homer for Dolly Varden char and cutthroat trout tagged during population studies in PWS, Kodiak, and the Kenai Peninsula.

4. Collect age and length data from rockfish (by species), lingcod, and Pacific halibut harvested in the PWS, Homer and Kodiak marine sport fisheries.

METHODS

Marine Catch Sampling

Catch and harvest were sampled at Valdez, Cordova, Whittier, Seward, Homer, and Kodiak. Groundfish (rockfish, lingcod, and Pacific halibut) and salmon were examined for oil contamination. All examined fish were noted as to their species and area of harvest, and the total number of fish inspected by day and species was recorded. The gills and body of the fish were inspected for obvious signs of oil. The gills were further inspected for odor and visual signs of crude oil. The stomachs of rockfish, lingcod, and Pacific halibut were also inspected for ingested oil (tarballs). Otoliths were taken from subsamples of Pacific halibut and rockfish, and finrays were taken from subsamples of lingcod; these fish were also measured (total length). Proportions of each age class were estimated using the procedures outlined by Cochran (1977). Mean length at age with the associated standard errors was estimated using standard statistical procedures (Sokal and Rohlf 1981). Dolly Varden char and cutthroat trout were inspected for a missing adipose fin or a Floy anchor tag. These fish were marked as part of damage assessment studies in PWS, Homer, and Kodiak (Fish/Shellfish Project No. 5). The numbers of Dolly Varden char and cutthroat trout observed each day at each survey site were recorded.

Marine Angler Surveys

Catch and harvest per boat-trip, and selected characteristics of anglers participating in the marine boat sport fisheries of PWS, Homer, and Kodiak were estimated using stratified two-stage surveys. The fishing day was stratified by type of day (i.e., weekend/holiday versus

weekdays) and by period (for example 0900-1600 hrs. for period A and 1601-2300 hrs for period B). Days selected within any stratum represented the primary sampling units (of the two-stage design) and anglers interviewed represented the secondary sampling units. As opposed to the classic two-stage sampling design, we did not know *a priori* the size of our secondary sampling units (i.e., the number of anglers available to sample on a selected day-primary unit). Additionally, we were not able to count all anglers returning on a selected sample day throughout the season. Accordingly, the variance estimation procedures did not involve the use of the within sample (between secondary unit-angler) variance component. However, because we interviewed the vast majority of all anglers in each selected sample, the finite population correction factor (fpc) associated with the secondary stage is close to zero. The resulting within sample variance made an essentially ignorable contribution to the overall variance estimate. This means our estimation procedure collapsed to a stratified random procedure, in which sample means (across all anglers interviewed within a sample) were used as the stratum observation. In Seward, an on-going creel survey was used to collect information for this project (see Carlon and Vincent-Lang 1989 for further details on the Seward marine survey). At each harbor, returning boat anglers that exited each of the fisheries were interviewed. A single angler from each boat was asked how many days the party fished, the number of fish harvested for each species, the number released for each species, and where they fished. Rockfish were not segregated by species except in Seward. Individual anglers were also given a questionnaire requesting their name and address for a follow-up survey.

During each of the marine angler surveys, weekends and three of the five weekdays were sampled each week. The weekdays not sampled were selected by randomly choosing one weekday and then randomly choosing the day before or after it also (in order to allow for two contiguous days-off for staff within each week). This procedure resulted in a constrained random sample of the weekday stratum. The sampling effort allocation proportions were weighted as they actually occurred during each of the marine surveys.

The beginning sampling dates for some of the marine surveys were adjusted due to initial difficulties in finding personnel to fill the survey positions, and sampling schedules and survey ending dates were adjusted if necessary as effort and catch patterns became evident (Appendix Tables B1 through B5).

Catch and harvest per boat-trip were estimated for each day using the methods outlined by Cochran (1977). The catch per unit effort (CPUE) and harvest per unit effort (HPUE) for each harbor were estimated by:

$$\bar{y}_{hi} = \frac{\sum_{i=1}^{m_{hi}} y_{hij}}{m_{hi}} \qquad (1)$$

where:

$\bar{y}_{hi}$ = mean CPUE or HPUE for the ith sampling period in stratum h,

y_{hij} = number of fish caught or harvested by the jth angler interviewed during the ith sampling period in stratum h, and

m_{hi} = number of anglers interviewed in the ith sampling period in stratum h.

The variance was estimated by:

$$v[\bar{y}_{hi}] = s^2_{hi} = \frac{\sum_{i=1}^{m_{hi}} (y_{hij} - \bar{y}_{hi})^2}{m_{hi}\,(m_{hi} - 1)} \qquad (2)$$

$$\bar{y}_h = \frac{\sum_{i=1}^{n_h} \bar{y}_{hi}}{n_h} \qquad (3)$$

where:

$\bar{y}_h$ = mean CPUE or HPUE for stratum h,

y_{hi} = CPUE or HPUE for angler i, and

n_h = number of anglers interviewed in stratum h.

The variance was estimated by:

$$v[\bar{y}_h] = s^2_h = \left(1 - \frac{n_h}{N_h}\right) \frac{s^2_{1h}}{n_h} + \frac{n_h}{N_h} \sum_{i=1}^{n_h} \frac{s^2_{2hi}}{n^2_h\, m_{hi}} \qquad (4)$$

where:

$$s^2_{1h} = \frac{\sum_{i=1}^{m_h} (\bar{y}_{hi} - \bar{y}_h)^2}{n_h - 1} = \text{sample variance of } y_i \text{ in stratum h} \qquad (5)$$

Because there was no significant difference in the CPUE and HPUE between stratum the overall CPUE and HPUE were estimated by:

$$\bar{Y} = \sum_{h=1}^{L} W_h \bar{y}_h \qquad (6)$$

where:

$\bar{Y}$ = overall mean CPUE or HPUE estimate,

h = number of stratum, and

W_h = 1/h.

The variance was estimated by:

$$V[\bar{Y}] = \sum_{h=1}^{L} W_h^2 V[\bar{y}_h] \qquad (7)$$

A description of the sampling dates and procedures specific to each of the marine surveys follows.

Valdez:

The survey of the marine sport fishery operating out of Valdez Harbor was conducted from 15 June through 17 September 1989. At Valdez, the fishing day was stratified into two 7.0 hour time periods defined as A (0900-1600 hrs) and B (1601-2300 hrs). Within each week, two-thirds of the B periods were randomly selected for sampling, without replacement. Days not selected using this process were allocated to the A period. Allocation of sampling effort between the survey periods was based on the assumption that more anglers would return during the evening than during the mornings within a day and that only one period could be sampled per day due to budget and personnel limits. The resultant sampling schedule for the survey is presented in Appendix Table B1.

Whittier:

A survey of the marine sport boat fishery operating out of Whittier was conducted from 24 June through 28 August 1989. At Whittier, the fishing day was stratified into four 3.0 hour time periods defined as A (1000-1300 hrs), B (1301-1600 hrs), C (1601-1900 hrs), and D (1901-2200 hrs). On each day selected for sampling, one period was selected for conducting the survey given the constraint that 50% of the sampling effort was assigned to period C, 25% to period D, 15% to period B, and 10% to A in each strata (weekday or weekend/holiday). Periods were randomly selected for sampling, without replacement. Allocation of sampling effort between the survey periods was based on anticipated angler return patterns and constrained by the fact that only one period

could be sampled per day due to budget and personnel limits. The resultant sampling schedule for the survey is presented in Appendix Table B2.

Most interviews were obtained at the rail station as anglers departed Whittier via the train. Additional interviews were obtained as anglers departed their boats at the docks.

Cordova:

A survey of the marine sport boat fishery operating out of the Cordova boat harbor was conducted from 24 June through 3 September 1989. The fishing day at Cordova was stratified into two 7.0 hour time periods defined as A (0800-1500) and B (1501-2200). Each 7 hour stratum was further subdivided into 3.5 hour sampling periods. On each day selected for sampling, anglers were interviewed for 7 hours, divided into two 3.5 hour segments. One quarter of the sampling effort was assigned to period A, and three quarters to period B. Periods were randomly selected for sampling without replacement. Allocation of sampling effort between the survey periods was based on the assumption that more anglers would return during the afternoon and evening than in the morning. The resultant sampling schedule for the survey is presented in Appendix Table B3.

Homer:

A survey of the marine sport boat fishery operating out of the Homer boat harbor was conducted from 1 July through 17 September 1989. The fishing day for Homer was stratified into four periods: A (0630-1000), B (1001-1330), C (1331-1700), and D (1701-2200). Ten percent of the sampling effort was assigned to period A, 25% to period B, 40% to period C, and 25% to period D. Periods were randomly selected for sampling without replacement. During period C, interviews of returning charter boat anglers and returning private boats were conducted. During all other periods, it was attempted to interview an equal proportion of charter boat and private boat anglers. Allocation of sampling effort between the survey periods was based on the assumption that most anglers would return during period C, with few returning in A and moderate numbers returning in B and D. Period D was discontinued beginning 1 September due to the reduced fall daylight hours. The resultant sampling schedule for the survey is presented in Appendix Table B4.

Kodiak:

The survey of the marine sport boat fishery operating out of the Kodiak boat harbor was conducted from 8 July through 17 September 1989. The fishing day for Kodiak was stratified into four periods: A (1000-1400), B (1401-1700), C (1701-2000), and D (2001-2300). Twenty percent of the sampling effort was assigned to period A, 30% to period B, 30% to period C, and 20% to period D. The allocation of sampling effort between the survey periods was based on the best guess of the percent of anglers returning during each period. Period A was discontinued beginning 1

August due to the low number of boats returning during the A period. The resultant sampling schedule for the survey is presented in Appendix Table B5.

Creel Surveys

Effort, catch and harvest rates (in angler-hours), and total catch and total harvest for sport anglers participating in three sport fisheries near Cordova and the sport fishery at Eshamy Lagoon were estimated using stratified two-stage creel surveys. The three creel surveys near Cordova were a survey of two roadside sport fisheries of the Copper River Delta (previously referred to as the Delta fishery): (1) Clear Creek and (2) Alaganik River; and (3) a survey of the sport fishery near Eyak Lake.

Similar to the marine surveys, all weekend/holiday days and three of the five weekday days were sampled each week during each of the creel surveys. The weekdays not sampled were selected by randomly choosing one weekday and then randomly choosing the day before or after it also (in order to allow for two contiguous days-off for staff within each week). Accordingly, weekday samples were weighted as outlined above for the marine surveys. Similarly, the beginning sampling dates for the creel surveys were adjusted due to initial difficulties in finding personnel to fill the survey positions, and in-season sampling schedules and survey ending dates were adjusted as necessary as effort and catch patterns became evident (Appendix Tables B6 through B8).

Angler counts were used to estimate fishing effort in units of angler-hours, and angler interviews were used to estimate catch and harvest rates (number of fish per hour). Angler counts of all anglers actively fishing were conducted during a randomly selected 15-minute interval during the daily sampling period. Counts were considered instantaneous and representative of the effort during that period (Neuhold and Lu 1957). For the purpose of these analyses, the number of anglers interviewed during a given period was substituted for the angler counts for that period when the angler count was zero.

The total number of angler-hours of fishing effort ($\hat{E}_h$) for fishery stratum h in the fishery was calculated in the following manner:

$$\hat{E}_h = D_h H_h \bar{x}_h \qquad (8)$$

where:

D_h = number of sampling periods in stratum h,

H_h = length of a sampling period in hours in stratum h, and

$\bar{x}_h$ = mean angler count for stratum h.

The variance was estimated by:

$$V[\hat{E}_h] = (1 - f_h)\ (D_h\ H_h)^2\ V[\bar{x}_h] \qquad (9)$$

During the remaining time in the period, interviews of individual anglers were conducted. Individual anglers were asked how long they fished, the number of fish by species they caught, the number of fish by species they kept, and whether the interview was a completed-trip interview or not. All fish in their possession were inspected for tags. All interviewed anglers were given a questionnaire requesting their name and address for a follow-up survey.

A Wilcoxson paired-sample test (Zar 1984) was used to determine if there was a difference in catch and harvest rates between complete and incomplete interviews.

The mean CPUE and mean HPUE were estimated using the formulas from Sukhatme et al. (1984):

$$e'_{hij} = \frac{x_{hi}}{\bar{x}_h}\ e_{hij} \qquad (10)$$

$$CPUE_{hij} = \frac{c_{hij}}{e'_{hij}} \qquad (11)$$

$$\overline{CPUE}_h = \frac{\sum_{i=1}^{d_h} \sum_{i=1}^{m_{hi}} CPUE_{hij}}{d_h\ m_{hi}} \qquad (12)$$

where:

d_h = number of days (sampling periods) in stratum h that were sampled,

x_{hi} = angler count for the ith sampling period in stratum h,

$\bar{x}_h$ = mean angler count for stratum h,

c_{hij} = number of fish caught or harvested by the jth angler interviewed during the ith sampling period in stratum h,

e_{hij} = fishing effort (in hours) expended by the jth angler sampled during the ith sampling period in stratum h, and

m_{hi} = number of anglers interviewed during the ith sampling period in stratum h.

The variance was estimated by:

$$V[\overline{CPUE}_h] = (1 - f_h)\frac{s_{1h}^2}{d_h} + f_h \sum_{i=1}^{d_h} \frac{s_{2hi}^2}{d_h^2 m_{hi}} \quad (13)$$

$$s_{1h}^2 = \frac{\sum_{i=1}^{d_h} (\overline{CPUE}_{hi} - \overline{CPUE}_h)^2}{d_h - 1} \quad (14)$$

$$s_{2hi}^2 = \frac{\sum_{i=1}^{m_{hi}} (CPUE_{hij} - \overline{CPUE}_{hi})^2}{m_{hi} - 1} \quad (15)$$

The final CPUE and HPUE were calculated by:

$$\hat{\overline{CPUE}} = \sum_{h=1}^{L} W_h \overline{CPUE}_h \quad (16)$$

The variance was estimated by:

$$V[\hat{\overline{CPUE}}] = \sum_{h=1}^{L} W_h^2 V[\overline{CPUE}_h] \quad (17)$$

The W_h was calculated by:

$$\hat{A}_h = \frac{\hat{E}_h}{\sum_{i=1}^{d_h} \sum_{j=1}^{m_{hi}} e'_{hij}} \quad (18)$$

$$\hat{W}_h = \frac{\hat{A}_h}{\sum_{t=1}^{L} \hat{A}_h} \quad (19)$$

Because the total number of anglers fishing was unknown, the appropriate weight (W_h) needed to be estimated. By estimating W_h, we are adding some unknown amount of bias into our estimates of mean CPUE for the season. From Sukhatme et al. (1984):

$$\text{Bias}(\overline{\text{CPUE}}) = \sum_{h=1}^{L} (\hat{W}_h - W_h)\, \overline{\text{CPUE}}_h \qquad (20)$$

Total catch and harvest estimates were estimated by:

$$\hat{C}_h = \overline{\text{CPUE}}_h^{*}\, \hat{E}_h \qquad (21)$$

where $\overline{\text{CPUE}}_h^{*}$ is the jacknife mean of the CPUE_{hij} (Efron 1982)

The variance was estimated by:

$$V[\hat{C}_h] = \hat{E}_h^2\, V[\overline{\text{CPUE}}_h] + \overline{\text{CPUE}}_h^2\, V[\hat{E}_h] - V[\overline{\text{CPUE}}_h]\, V[\hat{E}_h] \qquad (22)$$

A description of the sampling dates and procedures specific to each of the creel surveys follows.

Clear Creek:

The creel survey of Clear Creek was conducted from 24 June through 17 September 1989. The fishing day was stratified into three unequal time periods defined as A (0600-0930 hrs), B (0931-1700 hrs), and C (1701-2030 hrs) based on anticipated angler use patterns. Within each stratum, periods were randomly selected for sampling, without replacement given the constraint that only one B period or one each A and C period could be sampled in a day. For the weekday strata, allocation of sampling effort between periods was as follows: 40% each of the available samples for periods A and C and 20% for period B. For the weekend/holiday strata, allocation of sampling effort between periods was as follows: 35% each for periods A and C and 30% for period B.

Allocation of sampling effort between the survey periods during the weekday strata was based on the assumption that more effort would occur during the mornings and evenings than during the midday period. Allocation of sampling effort between the survey periods during the weekend/holiday strata was based on the assumption that effort occurred regardless of time of day. An additional constraint was that only period B or periods A and C could be sampled each day due to budget and personnel limits. Beginning 1 August, the fishing day was stratified into two equal time periods defined as A (1000-1500 hrs) and B (1501-2000 hrs) due to logistical and personnel constraints. The resultant sampling schedule for the survey is presented in Appendix Table B6.

Eyak and Alaganik Rivers:

The creel survey of the sport fisheries on Eyak and Alaganik Rivers was conducted from 24 June through 30 September 1989. The fishing day was stratified into three unequal time periods defined as A (0600-0930 hrs), B (0931-1700 hrs), and C (1701-2030 hrs), based on anticipated angler

use patterns. Within each stratum, periods were randomly selected for sampling, without replacement, given the constraint that only one B period or one each A and C period could be sampled in a day. For the weekday strata, allocation of sampling effort between periods was as follows: 40% each for periods A and C and 20% for period B. For the weekend/holiday strata, allocation of sampling effort between periods was as follows: 35% each for periods A and C and 30% for period B.

Allocation of sampling effort between the survey periods during the weekday strata was based on the assumption that more effort would occur during the mornings and evenings than during the midday period. Allocation of sampling effort between the survey periods during the weekend/holiday strata was based on the assumption that effort would occur regardless of time of day. An additional constraint was that only period B or periods A and C could be sampled each day due to budget and personnel limits. The resultant sampling schedule for the survey is presented in Appendix Table B7.

Eshamy Lagoon:

A creel survey of the Eshamy sport fishery was conducted from 11 July through 4 September 1989. The fishing day was stratified into four 3.5 hour time periods defined as A: 0800-1130 hrs, B: 1131-1500 hrs, C: 1501-1830 hrs, and D: 1831-2200 hrs.

On each day selected for sampling, one period was selected for conducting the survey. Allocation of sampling effort between the survey periods was based on budget and personnel limits which allowed that only one period could be sampled per day. The resultant sampling schedule for the survey is presented in Appendix Table B8.

Anchorage Float-plane Logbook Survey

A logbook survey of anglers who accessed PWS from the float plane base in Anchorage was conducted from 15 June to 15 September 1989 to collect data on selected demographic characteristics and general catch and effort parameters. Days fished, area fished, catch, and harvest was asked of anglers. All major air charter operators out of Anchorage were asked to keep a log for each charter they conducted to PWS. Anglers contacted in this survey were also asked for their name and address if they were willing to respond to a follow-up questionnaire.

STUDY RESULTS AND STATUS OF INJURY ASSESSMENT

Objective 1a: Species Composition of the Rockfish Harvest

Of the 12 species of rockfish reported caught during the 1989 marine surveys, black and yelloweye rockfish comprised 88.2% of the sampled rockfish harvest (Table 1). Demersal species comprised 31.4% of the 1,087 rockfish sampled in the sport harvest (Table 1). As reported by Fish/Shellfish Study No. 17 (Hepler et al. 1990), the sampling to date has shown that all of the dead rockfish recovered have been demersal species and a significant portion of the demersal species sampled tested positive for oil contamination.

Objective 1b: Marine Catch and Harvest Rates

Valdez:

A total of 11,008 fish were caught by anglers interviewed during the survey of the Valdez marine sport fishery of which coho and pink salmon made up 74.8% of the total catch (Table 2). The 1989 boat angler harvest rates for both coho (3.0 fish per boat trip) and pink salmon (4.3 fish per boat trip) were higher than the estimated harvest rates for 1988 (1.5 coho salmon per boat trip and 2.3 pink salmon per boat trip) (Roth and Delaney 1989), however different methods of estimating these rates were used during each of the surveys. To make valid comparisons of these estimates, the 1988 data would need to be reanalyzed according to the estimating procedures used during 1989.

Halibut catch and harvest rates were lower during 1989 (Table 2) than those estimated during 1988 (Roth and Delaney 1989). Halibut catch and harvest rates during 1989 were estimated at 0.6 and 0.4 fish per boat trip, respectively while catch and harvest rates during 1988 were 1.7 and 1.1 halibut per boat trip, respectively. Similar to the estimates of coho and pink salmon harvest, the 1988 data needs to be reanalyzed to allow direct comparisons between seasons.

Cordova:

Of the 250 fish counted during the interviews in the Cordova marine sport fishery during 1989, 59.2% (141 fish) were halibut or coho salmon (Table 3). Halibut and coho salmon catch rates were 1.5 and 0.4 fish per boat trip, respectively. No comparative marine survey data are available for this fishery. The low number of interviews (79) for the Cordova marine survey resulted in numerous strata having only a single interview so that no variance could be calculated. The small sample size also affected the CPUE and HPUE estimates such that the estimates may not reflect the actual catch and harvest rates in this fishery.

Kodiak:

A total of 2,208 fish were counted during interviews of anglers fishing the area waters near Kodiak of which 844 (38.2%) were halibut (Table 4).

Halibut and coho salmon catch rates were 1.7 and 0.6 fish per boat trip, respectively. Mills (1985-1989) reported estimated average harvests of 9,012 halibut and 7,444 coho salmon annually for the period 1984 through 1988 (Appendix Tables A13 and A18). No comparative marine survey data are available for this fishery.

Whittier

Salmon comprised 78.9% of the total fish counted during interviews conducted at Whittier during 1989 (Table 5). The highest estimated catch rates (3.7 fish per angler-hour) were for pink salmon. Anglers reported harvesting essentially all of the halibut; rockfish; and coho, sockeye, and king salmon they caught. Data on the Whittier sport fishery were also collected during 1986 (Delaney et al. 1987), however the rates reported were in boat-hours and are not directly comparable to the estimates for the 1989 survey in which rates were estimated in boat trips. Also, the 1989 survey was discontinued prior to the end of the coho salmon terminal fishery in Passage Canal. Reanalysis of the 1986 data over the same time period and in the same units of effort is necessary to allow direct comparison of the two season's data.

Homer:

A total of 33,231 fish were counted during interviews conducted during the 1989 marine survey in Homer of which 14,226 fish (42.8%) were harvested. Halibut comprised 85.9% of the total harvest with harvest rates averaging 8.3 halibut per boat trip (Table 6). Anglers harvested approximately 50% of the halibut they caught in Homer during 1989. Salmon made up only 3.3% of the total catch in Homer during the 1989 survey. No comparative marine survey data are available for this fishery.

Seward:

Seward is the only site surveyed during 1989 which is presently directly comparable to historic data. During 1989, angler effort decreased 25-49% compared to the levels recorded during 1988 (Table 7) (Carlon and Vincent-Lang 1989). This is a significant ($\alpha = 0.05$) decrease compared to previous effort estimates for the Seward boat fishery. Only once in the past 22 years (1975) has the confidence interval around the effort estimate fallen within the intervals of the 1989 estimate (Table 8) (Carlon and Vincent-Lang 1989, Vincent-Lang et al. 1988, Vincent-Lang 1987). Similarly, estimates of total harvest were well below (38-46% decrease) the 1988 levels in all fisheries except the coho salmon and lingcod boat fisheries. However, the estimated harvest of coho salmon in the 1989 boat fishery (14,861 fish) is only slightly higher than the three year average for the period 1986 through 1988 (13,585 fish) (Mills 1987-1989) (Appendix Table A13).

Objective 1c: Creel Survey Catch and Harvest

The Wilcoxson test (Zar 1984) showed that estimated catch and harvest for complete versus incomplete angler interviews during the 1989 creel surveys were not significantly different (overall $\alpha = 0.05$), so the data were pooled for each of the creel survey sites for the analyses. As 1989 was the first year that these Cordova area roadside fisheries were open to sport fishing for salmon, no comparative catch and harvest rate data are available.

Alaganik River:

Anglers fishing Alaganik River during 1989 were targeting primarily on coho salmon. Catch and harvest rates were 1.1 and 0.7 coho salmon per angler-hour, respectively (Table 9). Anglers caught an estimated 2,556 coho salmon during the 1989 survey period of which they harvested (kept) 66% (1,697 fish). Anglers harvested from 45 to 58% of the pink salmon, Dolly Varden, and cutthroat trout they caught while no sockeye salmon were reported released during the survey period. Anglers harvested 59% of the total reported sport catch at Alaganik River during 1989. Alaganik River supported the largest cutthroat trout fishery of the three Cordova area streams surveyed during 1989 accounting for 90% of the cutthroat trout catch (Table 9).

Clear Creek:

Sockeye salmon were the target species of most anglers fishing Clear Creek during the 1989 survey period. Anglers caught an estimated 2,211 sockeye salmon (CPUE = 1.3 fish per angler-hour) and harvested 785 sockeye salmon (HPUE = 0.2 fish per angler-hour) (Table 10). Of the remaining 1,429 fish caught by anglers fishing Clear Creek during 1989, coho salmon and Dolly Varden comprised 45% and 53%, respectively. Anglers harvested approximately 37% of the total catch reported during the 1989 survey. Clear Creek supported the largest Dolly Varden char fishery of the three Cordova area streams surveyed during 1989 accounting for 60% of the Dolly Varden char catch (Table 10).

Eyak River:

Similar to Alaganik River, most anglers fishing Eyak River were targeting coho salmon. Catch and harvest rates for coho salmon were 0.3 coho per angler-hour, and the estimated total catch and harvest was 2,114 and 1,866 coho salmon, respectively (Table 11). Estimates of coho salmon harvest in Eyak River for the period from 1984 through 1988 have averaged 1,234 coho annually (Mills 1985-1989) (Appendix Table A3). Anglers harvested approximately 72% of the total catch of all species in Eyak River during 1989.

Objective 1d: Eshamy Catch and Harvest

Catch and harvest rates for sockeye salmon during the 1989 sport fishery at Eshamy were 1.1 and 0.8 sockeye per angler-hour, respectively (Table

12). This is much higher than the catch and harvest rates recorded during 1988 (Roth and Delaney 1989). The higher rates during 1989 are possibly due to the high escapement into Eshamy because of the closure of the Eshamy district to commercial fishing in 1989. Estimates of total sockeye salmon catch and harvest were also higher in 1989 compared to previous seasons. For the period from 1984 through 1987, the average estimated sockeye salmon harvest was 567 fish annually (Mills 1985-1988) (Appendix Table A4). During 1988, the estimated sockeye salmon harvest was 959 fish (Roth and Delaney 1989) while the estimated harvest was 1,170 sockeye during 1989 (Table 12).

Similar to 1988, anglers released most of the pink salmon they caught at Eshamy during 1989. Estimates of pink salmon catch and harvest rates and total catch and harvest were higher during 1989 than in 1988 (Table 12). Catch and harvest data were also collected on chum salmon at Eshamy during 1989 showing anglers released essentially all of the estimated 297 chum salmon they caught.

Objective 2a: Creel Survey Effort

Eyak River had the highest estimated effort (4,232 angler-hours) of the three Cordova area roadside sites surveyed during 1989 (Table 13). Most of the effort at this site was recorded during August during the peak of the coho salmon run (Appendix Table C3). After August, effort in Eyak River dropped off substantially due to heavy rains and high, turbid water conditions which reduced fishing success at this site. At Clear Creek, most of the angling effort was recorded from mid-July through August during the peak of the sockeye salmon return (Appendix Table C2). The highest angler counts on Alaganik River were recorded during late August and early September during the peak of the coho salmon run (Appendix Table C1). As these three roadside fisheries were first opened to sport fishing for salmon beginning in 1989, no comparative effort data are available.

Objective 2b: Eshamy Effort

The angler effort estimated for Eshamy for the 1989 survey period was 1,504 angler-hours (variance = 10,650; 95% C.I. = 1,302 - 1,706 angler-hours). This estimate is lower than the effort estimated for 1988 (2,572 angler-hours; variance = 205,209; 95% C.I. = 1,684 - 3,460 angler-hours), however the methods of estimating these effort data were different between the two seasons. Direct comparisons of these data will require the reanalyzing of the 1988 data using the techniques outlined for 1989.

Objective 3: Catch Inspection for Oil Contamination

A total of 12,597 fish comprised of salmon, halibut, rockfish, lingcod, and cod were examined for oil contamination during the marine surveys (Table 14). No visibly discernable contamination was observed on any of the samples inspected.

Task 1: Follow-Up Questionnaire

A total of 608 names and addresses of persons willing to participate in a follow-up survey were collected during the marine angler surveys, the creel surveys, and the Anchorage float plane logbook survey. These data were forwarded to the economic study group.

Task 2: Anchorage Log Book Survey

Information was obtained from eight Anchorage area charter aircraft operators concerning the charters they conducted to PWS during 1989. Response to this survey was low although limited information was obtained from all of the charter operators surveyed. Only one of the eight operators (12.5%) reported 1989 charters to PWS at levels similar to those recorded during 1988. All other surveyed operators reported a decrease in the number of charters for fishing, hunting, or flightseeing trips to PWS during 1989 compared to previous seasons. One operator noted that a total of 36 foreign anglers who had chartered fishing trips to PWS cancelled their charters or changed their destinations to sites other than PWS because of the information they received about the oil spill.

The primary reasons given by the operators for reduced levels of charter flights to PWS during 1989 were: 1) bad weather during the peak of the sockeye and coho salmon fishing seasons, 2) air traffic patterns in PWS were too congested, and Coast Guard control of the airways in PWS made confirmation of flight clearance difficult, and 3) fishing was good at sites outside of PWS. Also, three of the operators noted that they were busy flying research or support crews and supplies or other contract work to PWS during 1989.

Task 3: Dolly Varden and Cutthroat Tag Monitoring

Two hundred eighteen Dolly Varden char and 117 cutthroat trout were counted during the 1989 angler interviews (Table 15). Anglers kept 53.7% of the char and 70.1% of the trout they caught. No tags or adipose fin clips were observed on any of the harvested char or trout inspected.

Task 4: Rockfish Age and Length Data

Age and length data collected at the marine survey sites for black rockfish, halibut, and lingcod are presented in Appendix Tables E1 through E14. 1987 and 1988 lingcod age and length data collected in Seward are also presented for any future comparisons of mean length at age and age composition. Age and length data for the remaining rockfish species will be presented after ages are determined.

DISCUSSION

The goal of this study was to provide a timely means by which to assess major impacts to the sport fisheries of Prince William Sound, Resurrection Bay, lower Kenai Peninsula, and Kodiak as a result of the oil spill from the Exxon Valdez. Much of these data were not intended to stand on their own, but rather to supplement the annual statewide harvest survey, the results of other impact studies, and the results of the economic survey. Along with information on the 1989 sport fisheries at the selected sites, this program provided on-site inspection of the sport harvest of salmon and groundfish for visible signs of oil contamination.

A significant reduction in sport fishing effort was observed for the Seward sport fishery during 1989 compared to previous years. Effort in the boat fishery was less than any recorded level of effort dating back to 1968. Seward is the only marine port where direct comparisons to historic data can presently be done and would be an important site to assess the duration of this decline and its resulting economic impact. Comparisons to historic data are possible at Eshamy, Whittier, and Valdez, but the historic data collected at these sites will have to be reanalyzed using the estimation techniques outlined for the 1989 data analysis. Most Anchorage air charter operators surveyed reported a decreased number of charter flights to PWS compared to previous seasons.

None of the 12,597 fish examined for oil contamination during the marine surveys showed visibly discernable contamination. However, Fish/Shellfish Study No. 17 documented mortality and subsequent hydrocarbon contamination of demersal rockfish. Species composition of the rockfish sport harvest showed that 31% of the harvest was comprised of demersal rockfish species. The duration of this contamination and the potential human health concerns should continue to be investigated.

Surveys of the marine sport fisheries in Valdez, Kodiak, Homer, Whittier, and Seward should continue during 1990 to maintain the sampling of marine species harvested in the respective fisheries. In addition, effort data for the Seward boat fisheries is needed to evaluate the magnitude of the impact to the sport fishery at this site. Continued histopathological sampling of rockfish is necessary to determine the extent of contamination. Also, surveys should continue to monitor the marine sport fisheries to compare the percent composition of demersal rockfish in the total rockfish harvest.

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Table 1. Percent species composition of the rockfish sport harvest by site for the marine surveys, 1989.

Species	Survey Site (Sample Size) Cordova (8)	Valdez (146)	Whittier (5)	Homer (48)	Kodiak (42)	Seward (838)	TOTAL (1,087)
Brown	0.0	0.7	0.0	0.0	0.0	0.0	0.1
Copper	62.5	22.6	0.0	0.0	0.0	0.2	3.7
Dusky	0.0	7.5	0.0	0.0	28.6[1]	0.0	2.1
Quillback	0.0	13.0	0.0	0.0	0.0	1.9	3.2
Black	37.5	0.0	0.0	75.0	71.4	73.2	62.7
China	0.0	0.0	0.0	2.1	0.0	0.8	0.7
Yelloweye	0.0	36.2	100.0	22.9	0.0	21.4	25.5
Pacific Ocean Perch	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Silvergray	0.0	0.0	0.0	0.0	0.0	0.6	0.5
Vermilion	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Tiger	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Bocaccio	0.0	0.0	0.0	0.0	0.0	1.8	1.2
Pelagic	100.0	30.1	0.0	75.0	100.0	73.5	68.6
Demersal	0.0	69.9	100.0	25.0	0.0	26.5	31.4

1 Some of these fish may have been black rockfish

Table 2. Estimated catch and harvest per boat-trip by species from 830 interviews in the Valdez marine sport fishery, 15 June through 17 September, 1989.

	Catch and Harvest From Interviewed Anglers					
Species	Catch	Harvest	CPUE	Variance	HPUE	Variance
Halibut	637	458	0.58	0.00753	0.44	0.00484
Coho Salmon	5,150	4,681	3.21	0.28368	3.00	0.21873
Pink Salmon	3,085	2,237	7.68	3.37880	4.29	0.42404
King Salmon	46	37	0.04	0.00010	0.03	0.00010
Sockeye Salmon	94	94	0.14	0.00590	0.14	0.00590
Chum Salmon	332	199	1.28	0.39613	0.32	0.00293
Rockfish	313	244	0.58	0.03381	0.36	0.00883
Cod/Pollock	1,066	282	0.92	0.03300	0.33	0.01357
Lingcod	15	7	0.01	0.00003	0.01	0.00002
Flounder	55	39	0.08	0.00022	0.04	0.00012
Sculpin	180	1	0.20	0.00414	0.00	0.00000
Skate	8	1	0.00	0.00000	0.00	0.00000
Dolly Varden Char	27	23	0.04	0.00017	0.03	0.00011
Octopus	2	2	0.00	0.00000	0.00	0.00000
ALL SPECIES COMBINED	11,008	8,305	14.72	1.92050	8.99	0.21166

Table 3. Estimated catch and harvest per boat-trip by species from 79 interviews in the Cordova marine sport fishery, 24 June through 3 September, 1989.

	Catch and Harvest From Interviewed Anglers					
Species	Catch	Harvest	CPUE	Variance	HPUE	Variance
Halibut	107	73	1.46	0.00901	1.00	0.00578
Coho Salmon	41	41	0.40	0.01763	0.40	0.01763
Pink Salmon	14	10	0.10	0.00784	0.05	0.00201
Rockfish	18	12	0.57	0.00044	0.28	0.00032
Cod/Pollock	50	7	0.40	0.00215	0.09	0.00051
Lingcod	2	1	0.01	0.00002	0.00	0.00001
Flounder	13	0	0.80	---	0.00	0.00000
Sculpin	5	0	0.01	0.00016	0.00	0.00000
ALL SPECIES COMBINED	250	144	3.75	0.03977	1.84	0.02368

Table 4. Estimated catch and harvest per boat-trip by species form 368 interviews in the Kodiak marine sport fishery, 8 July through 17 September, 1989.

	Catch and Harvest From Interviewed Anglers					
Species	Catch	Harvest	CPUE	Variance	HPUE	Variance
Halibut	844	515	1.67	0.06324	1.10	0.00903
Coho Salmon	165	157	0.60	0.02017	0.55	0.00957
Pink Salmon	103	52	0.55	0.00030	0.04	0.00027
King Salmon	1	1	0.00	0.00000	0.00	0.00000
Sockeye Salmon	18	18	0.20	0.00007	0.20	0.00007
Rockfish	333	183	0.25	0.00311	0.09	0.00056
Cod/Pollock	40	12	0.18	0.00505	0.04	0.00072
Lingcod	40	10	0.01	0.00002	0.00	0.00000
Flounder	72	31	0.14	0.00130	0.06	0.00021
Sculpin	523	2	1.18	0.02191	0.01	0.00006
Skate	13	0	0.01	0.00011	0.00	0.00000
Rainbow Trout	1	1	0.01	0.00006	0.01	0.00006
Cutthroat Trout	27	27	0.04	0.00070	0.04	0.00070
Dolly Varden Char	28	16	0.19	0.00012	0.02	0.00012
ALL SPECIES COMBINED	2,208	1,005	5.00	0.12114	2.15	0.02705

Table 5. Estimated catch and harvest per boat-trip by species from 244 interviews in the Whittier marine sport fishery, 1 July through 28 August, 1989.

	Catch and Harvest From Interviewed Anglers					
Species	Catch	Harvest	CPUE	Variance	HPUE	Variance
Halibut	146	145	0.48	0.02307	0.47	0.02307
Coho Salmon	220	218	1.31	0.05332	1.30	0.05335
Pink Salmon	821	576	3.86	0.34550	2.64	0.08500
King Salmon	6	6	0.06	0.00254	0.06	0.00254
Sockeye Salmon	263	263	0.83	0.08138	0.83	0.08138
Chum Salmon	45	20	0.24	0.00418	0.11	0.00248
Rockfish	76	76	0.14	0.00158	0.14	0.00158
Cod/Pollock	179	17	0.52	0.01371	0.02	0.00011
Flounder	29	25	0.04	0.00047	0.03	0.00047
Sculpin	43	5	0.08	0.00071	0.00	0.00002
Dolly Varden Char	38	22	0.15	0.00858	0.15	0.00855
ALL SPECIES COMBINED	1,866	1,374	7.50	0.23673	5.74	0.23783

Table 6. Estimated catch and harvest per boat-trip by species from 1,313 interviews in the Homer marine sport fishery, 2 July through 17 September, 1989.

	Catch and Harvest From Interviewed Anglers					
Species	Catch	Harvest	CPUE	Variance	HPUE	Variance
Halibut	24,844	12,222	16.09	0.26187	8.26	0.09075
Coho Salmon	132	125	0.14	0.00178	0.13	0.00139
Pink Salmon	262	172	0.11	0.00089	0.06	0.00044
King Salmon	9	9	0.00	0.00000	0.00	0.00000
Sockeye Salmon	429	377	0.73	0.02785	0.64	0.02335
Rockfish	297	143	0.15	0.00148	0.08	0.00030
Cod/Pollock	3,750	925	2.47	0.03902	0.50	0.00724
Lingcod	58	38	0.06	0.00158	0.05	0.00126
Flounder	344	63	0.18	0.00077	0.04	0.00007
Sculpin	2,962	137	1.74	0.03555	0.05	0.00012
Skate	127	5	0.08	0.00017	0.00	0.00000
Dolly Varden Char	4	2	0.00	0.00000	0.00	0.00000
Octopus	12	8	0.01	0.00003	0.01	0.00001
ALL SPECIES COMBINED	33,231	14,226	21.77	0.42574	9.82	0.10328

Table 7. Estimates of effort and harvest by fishery for the Seward marine sport fishery, 1989.

Fishery	Effort[1]	% Change from 1988	Harvest	% Change from 1988
Chinook Salmon Beach Fishery	6,963	-36%	826	-38%
Coho Salmon Beach Fishery	8,614	-49%	2,555	-46%
Coho Salmon Boat Fishery	5,022	-25%	14,861	+51%
Halibut Boat Fishery[2]	5,022	-25%	2,117	-45%
Lingcod Boat Fishery[2]	5,022	-25%	3,546	+21%
Rockfish Boat Fishery[2]	5,022	-25%	10,072	N/A[3]

1 Effort for beach fisheries is in number of angler-hours; Effort for boat fisheries is in number of boat-trips.

2 These data cover the period from 1 July through the end of the survey for both 1988 and 1989 as the period prior to 1 July was not sampled during 1988.

3 Rockfish harvest was not estimated during 1988.

Table 8. Sport effort statistics for the Seward marine sport boat fisheries, 1968-1989.

Year	Boat Trips	Standard Error	95% Confidence Interval		
1968	8,518	89.3	8,343	-	8,693
1969	7,717	160.6	7,402	-	8,032
1970	8,921	133.9	8,659	-	9,183
1971	8,041	110.8	7,824	-	8,258
1972	9,297	183.1	8,938	-	9,656
1973	7,730	117.6	7,500	-	7,960
1974	7,520	141.3	7,243	-	7,797
1975	5,351	108.1	5,139	-	5,563
1976	5,953	87.7	5,781	-	6,125
1977	7,113	131.6	6,855	-	7,371
1978	6,280	124.0	6,037	-	6,523
1979	7,163	151.0	6,867	-	7,459
1980	7,657	191.4	7,282	-	8,032
1981	6,682	134.4	6,419	-	6,945
1982	7,948	164.5	7,626	-	8,270
1983	8,479	139.9	8,205	-	8,753
1984	6,996	128.7	6,744	-	7,248
1985	6,848	209.6	6,437	-	7,259
1986	6,319	274.7	5,781	-	6,857
1987	7,661	352.4	6,970	-	8,352
1988	6,654	227.5	6,208	-	7,100
1989	5,022	123.0	4,781	-	5,263

Table 9. Estimates of sport catch and harvest rates (fish per angler-hour), total catch (fish kept plus fish released), and total harvest (fish kept only) of sockeye, coho, and pink salmon; Dolly Varden; and cutthroat trout in Alaganik River, 24 June through 30 September, 1989.

	Catch						Harvest					
Species	Rate	Variance	95% C.I.	Total	Variance	95% C.I.	Rate	Variance	95% C.I.	Total	Variance	95% C.I.
Sockeye Salmon	0.01	0.0001	(0.01)- 0.03	30	418	(10)- 70	0.01	0.0001	(0.01)- 0.03	30	418	(10)- 70
Coho Salmon	1.13	0.0251	0.82 - 1.44	2,556	109,647	1,907 - 3,205	0.66	0.0141	0.43 - 0.89	1,697	64,435	1,199 - 2,195
Pink Salmon	0.04	0.0011	(0.02)- 0.10	72	3,910	(51)- 195	0.02	0.0004	(0.02)- 0.06	36	1,308	(35)- 107
Dolly Varden	0.07	0.0005	0.02 - 0.12	177	3,004	70 - 284	0.03	0.0002	0.00 - 0.06	79	1,742	(3)- 161
Cutthroat Trout	0.18	0.0018	0.10 - 0.26	466	11,447	256 - 676	0.10	0.0013	0.03 - 0.17	271	8,839	87 - 455

Table 10. Estimates of sport catch and harvest rates (fish per angler-hour), total catch (fish kept plus fish released), and total harvest (fish kept only) of sockeye and coho salmon, Dolly Varden, and cutthroat trout in Clear Creek, 24 June through 17 September, 1989.

	Catch						Harvest					
Species	Rate	Variance	95% C.I.	Total	Variance	95% C.I.	Rate	Variance	95% C.I.	Total	Variance	95% C.I.
Sockeye Salmon	1.28	0.1060	0.64 - 1.92	2,211	1,386,439	(97)- 4,519	0.20	0.0183	(0.07)- 0.47	785	265,239	(224)- 1,794
Coho Salmon	0.23	0.0143	0.00 - 0.46	645	101,013	22 - 1,268	0.08	0.0009	0.02 - 0.14	255	8,372	76 - 434
Dolly Varden	0.23	0.0036	0.11 - 0.35	759	105,746	122 - 1,396	0.16	0.0017	0.08 - 0.24	397	68,590	(116)- 1,272
Cutthroat Trout	0.03	0.0009	(0.03)- 0.09	25	654	(25)- 75	0.00	0.0000	0.00 - 0.00	0	0	0 - 0

Table 11. Estimates of sport catch and harvest rates (fish per angler-hour), total catch (fish kept plus fish released), and total harvest (fish kept only) of sockeye, coho, and pink salmon; Dolly Varden; and cutthroat trout in Eyak River, 24 June through 30 September, 1989.

Species	Catch						Harvest					
	Rate	Variance	95% C.I.	Total	Variance	95% C.I.	Rate	Variance	95% C.I.	Total	Variance	95% C.I.
Sockeye Salmon	0.00	0.0000	0.00 - 0.00	5	25	(5)- 15	0.00	0.0000	0.00 - 0.00	5	25	(5)- 15
Coho Salmon	0.34	0.0048	0.20 - 0.48	2,114	216,270	1,203 - 3,025	0.29	0.0040	0.17 - 0.42	1,866	179,404	1,036 - 2,696
Pink Salmon	0.02	0.0000	0.01 - 0.03	105	401	66 - 144	0.01	0.0001	0.01 - 0.01	66	29	56 - 76
Dolly Varden	0.05	0.0003	0.02 - 0.08	324	16,329	74 - 574	0.01	0.0000	0.00 - 0.02	60	770	6 - 114
Cutthroat Trout	0.01	0.0000	0.00 - 0.02	28	175	2 - 54	0.01	0.0000	0.00 - 0.02	12	61	(3)- 27

Table 12. Estimates of sport catch and harvest rates (fish per angler-hour), total catch (fish kept plus fish released), and total harvest (fish kept only) of sockeye, pink, and chum salmon at Eshamy, 11 July through 4 September, 1989.

Species	Catch						Harvest					
	Rate	Variance	95% C.I.	Total	Variance	95% C.I.	Rate	Variance	95% C.I.	Total	Variance	95% C.I.
Sockeye Salmon	1.08	0.0335	0.72 - 1.43	1,624	93,216	1,026 - 2,222	0.79	0.0050	0.65 - 0.93	1,170	22,899	873 - 1,467
Pink Salmon	0.88	0.0186	0.61 - 1.15	924	43,999	503 - 1,325	0.38	0.0009	0.33 - 0.44	196	1,650	114 - 274
Chum Salmon	0.19	0.0007	0.14 - 0.24	297	2,330	202 - 392	0.00	0.0000	0.00 - 0.00	2	2	(1)- 5

Table 13. Estimates of sport effort (angler-hours) for the Cordova area creel surveys, 1989.

Survey Site	Effort	Variance	95% C.I.
Alaganik River	1,995	31,524	1,647 - 2,343
Clear Creek	2,328	95,725	1,722 - 2,934
Eyak River	4,232	154,499	3,462 - 5,002

Table 14. Number of fish examined for oil contamination by survey area, 1989.

Location	Halibut	Salmon	Rockfish	Lingcod	Cod
Homer	1,020	64	53	30	81
Kodiak	210	336	45	4	0
Cordova	105	59	8	1	1
Whittier	0	52	5	0	0
Valdez	418	7,935	218	0	313
Seward	350	12	831	446	0
Total - All Sites	2,103	8,458	1,160	481	395

Table 15. Reported catch and harvest by survey site of Dolly Varden and cutthroat trout, 1989.

Site	Dolly Varden		Cutthroat Trout	
	Catch	Harvest	Catch	Harvest
Alaganik River	30	22	79	48
Clear Creek	51	19	1	0
Eyak River	40	13	10	7
Homer	4	2	0	0
Kodiak	28	16	27	27
Cordova	27	23	0	0
Whittier	38	22	0	0
Total - All Sites	218	117	117	82