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A Survey of Sport Fish Use on the Copper River Delta, Alaska

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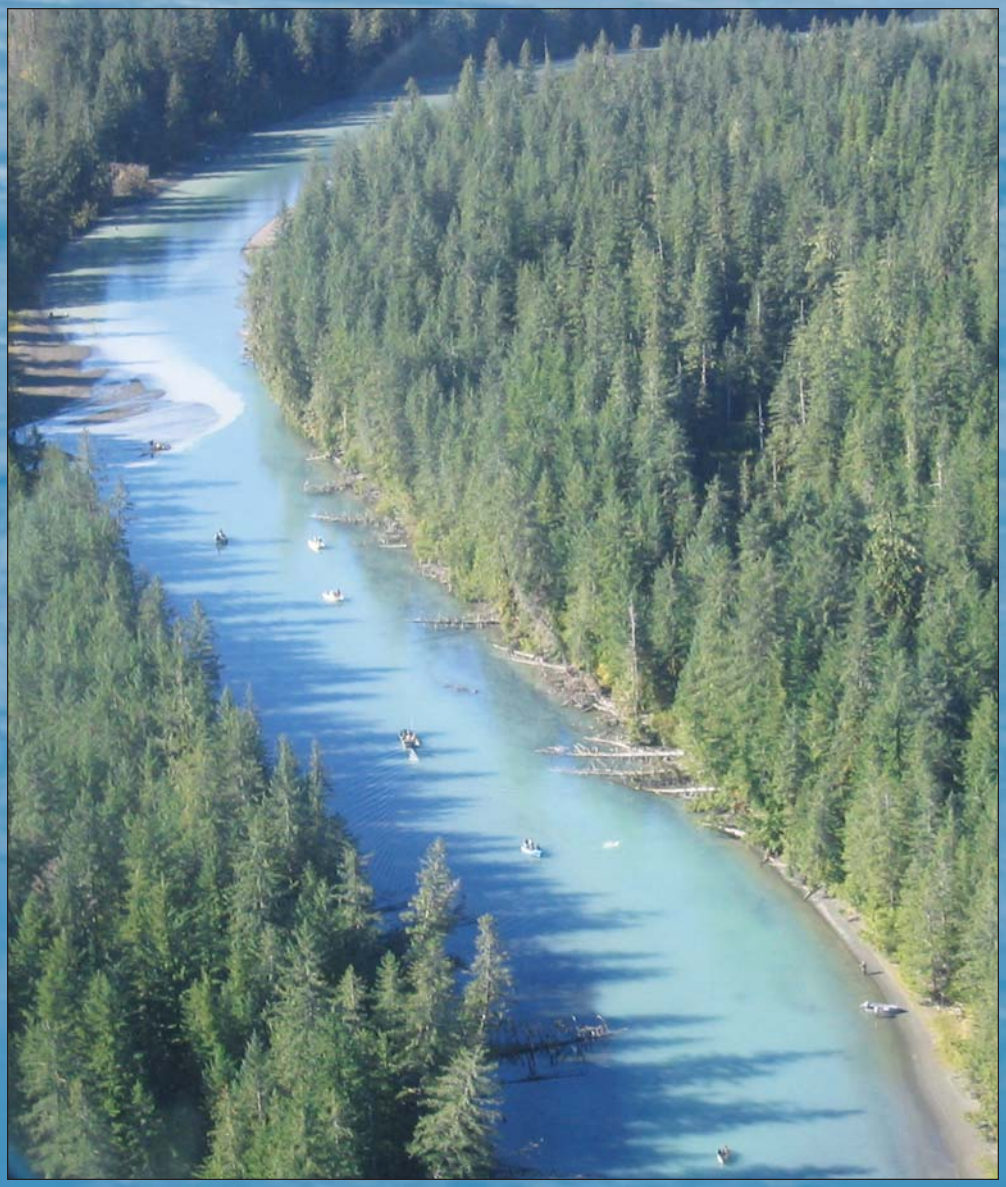

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Gordon Reeves of the Pacific Northwest Research Station (PNW) assisted in the design of this study, the statistical analyses, and commented on all phases of the document. This report complements work being done by the PNW on the Copper River Delta.

Cover photo

Cover photo Dirk Lang; background photo Thomas P. Dunklin.

Abstract

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Aerial counts, in-person interviews, and mail-in questionnaires were used to survey sport fish use during the coho salmon (*Oncorhynchus kisutch* Walbaum) season on the Copper River Delta, Alaska from 2002 through 2006. Angler counts provided an index of use on individual streams and were used to develop a spatial database exhibiting patterns of use. In-person interviews and mail-in questionnaires were used to determine the effort, catch, and harvest of coho salmon by both local residents of Cordova and nonresident anglers. The estimated annual effort for nonresidents ranged from 5,230 to 5,663 angler-days from 2004 through 2006. The highest use occurred in 2005, and it appears that use has risen since 2002, but has remained relatively constant since 2004. Total annual effort for Cordova residents sport fishing on the West Copper River Delta ranged from 2,372 to 4,720 angler-days from 2004 through 2006, and steadily declined over the 3 years. Sport fish use was concentrated on three stream systems of the West Copper River Delta: Eyak River, Ibeck Creek, and Alaganik Slough. Other streams had little to no use. Anglers were generally not found to use areas of streams with key spawning habitats. Coho salmon was the targeted species, and nonresident anglers caught and harvested more fish than Cordova resident anglers. Nonresident angler catches ranged from 15,192 to 28,473 coho salmon and harvests ranged from 6,887 to 10,554 coho salmon over 3 years. Annual catch and harvest of coho salmon by Cordova residents ranged from 2,116 to 6,033 and from 1,454 to 3,493 fish, respectively. For both groups, catch and harvest was highest in 2004 and decreased through time. Selective harvest (catch-and-release) was widely practiced. Visiting anglers released 56 percent of the coho salmon they caught, whereas Cordova residents released approximately 33 percent of their catch. The information provided with this survey will be used to assist in management of the area. Some examples of applications include directing habitat monitoring and protection efforts, focusing interpretive and educational materials toward the correct user population, evaluating human use capacities, assessing access and infrastructure needs, and permitting guides.

Keywords: Recreational use, coho salmon, angler survey, sport fish, Copper River Delta.

Contents

Introduction

Coho Salmon: A Vital Resource on the Copper River Delta

The Copper River Delta, in south-central Alaska, is the largest contiguous wetland on the Pacific coast of North America (fig. 1). This expansive complex of ponds, tidal sloughs, and braided channels is rich with flood-plain and off-channel habitats (fig. 2) and creates excellent conditions for the production of coho salmon (*Oncorhynchus kisutch* Walbaum). These slow-water habitats are preferred rearing areas for juvenile coho salmon and can be especially important for overwinter survival (Bustard and Narver 1975, Cunjak 1996). The amount and quality of this habitat is often reflected in the production of smolts and therefore the potential production of returning adult salmon.

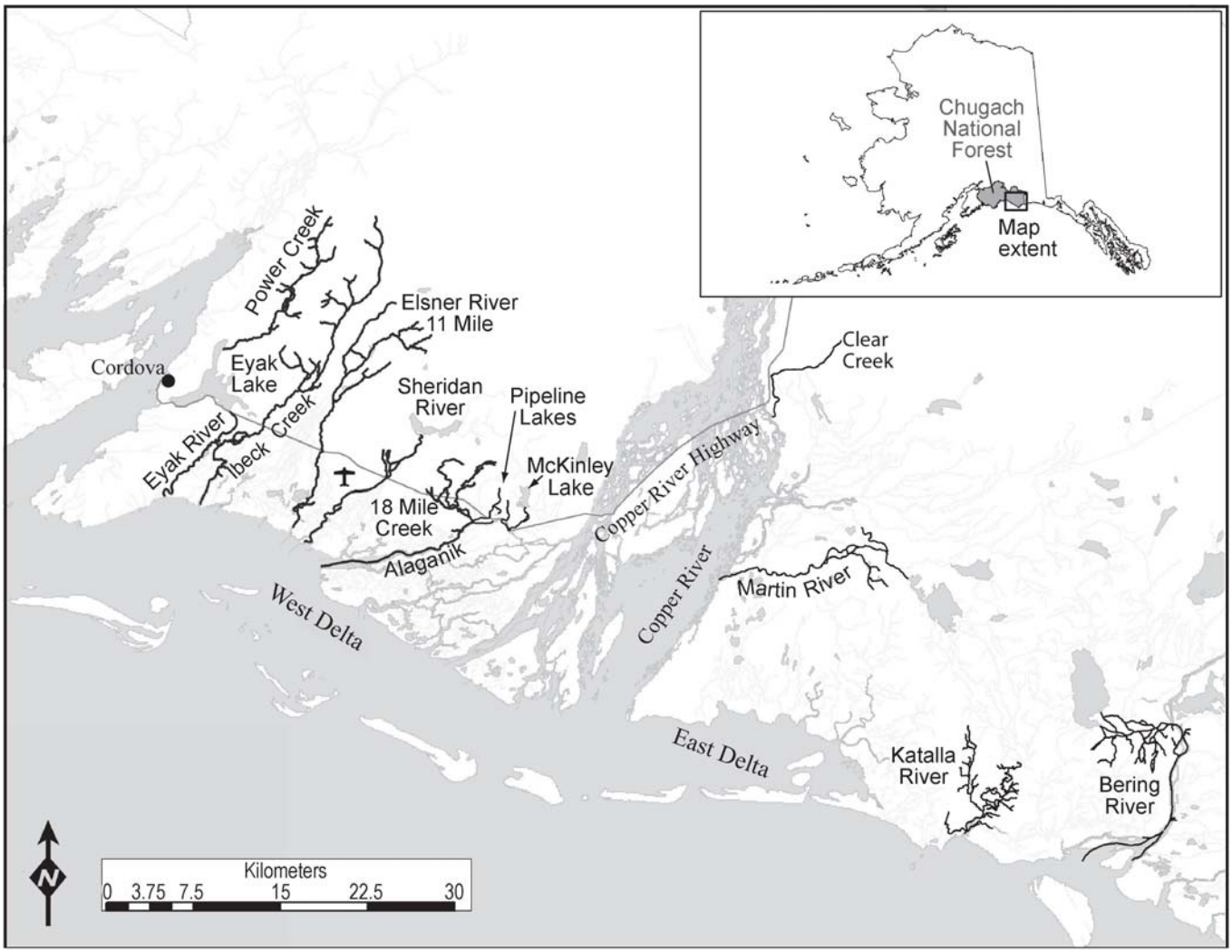

Figure 1—Main stream systems of the Copper River Delta in south-central Alaska. The airplane denotes location of the Merle K. "Mudhole" Smith Airport.

Thomas P. Dunklin

Figure 2—The Copper River Delta showing the myriad ponds and sloughs that create excellent rearing habitat for juvenile coho salmon.

The ex-vessel value for the drift gillnet coho salmon fishery ranged from $57,798 to $7,129,685 over the years 1994 through 2005. The sport fishery provides an important boost to the retail sector of the economy including hotels, restaurants, tackle shops, and other businesses.

Salmon are a keystone species in the Copper River Delta ecosystem. Marine-derived nutrients supplied by spawning coho salmon are an important component of the food web for aquatic (Hicks et al. 2005, Lang et al. 2006) and terrestrial organisms (Ben-David et al. 1997, Carnes 2004, Willson and Halupka 1995). These nutrients are likely critical to the annual production of fish and wildlife resources on the Copper River Delta (Willson et al. 1998).

Cordova is the nearest community to the Copper River Delta, and it depends on the return of coho salmon for a portion of its economy. The ex-vessel value[1] for the drift gillnet coho salmon fishery ranged from $57,798 to $7,129,685 over the years 1994 through 2005 (Hollowell et al. 2007). The sport fishery provides an important boost to the retail sector of the economy including hotels, restaurants, tackle shops, and other businesses. Specific information is not available for Cordova, but in 2007, nonresident anglers in south-central Alaska spent an estimated $427.6 million on fishing trip and equipment expenditures (Southwick Associates Inc. et al. 2008). Statewide, it was estimated that nonresident anglers spent on average $448 per day of fishing compared to $150 spent per day by residents (Southwick Associates Inc. et al. 2008).

[1] Ex-vessel value is the price paid to commercial fishers on delivering fish to a processor.

In recent years, the influx of sport anglers during the coho salmon season has increased. In mid-August, the number of in-bound airline passengers increases, with many of those passengers carrying fishing rod cases. The demand for lodging from August through September often exceeds the available rooms, with many rooms booked far in advance. Restaurants, grocery stores, tackle shops, and other retail shops appear to be busier during these months. The value of the coho salmon sport fishery to Cordova is likely substantial for retailers and is realized at the end of summer when the commercial fishing and tourist seasons are diminishing.

Improved Access to Cordova and the Coho Salmon Sport Fishery

Cordova and the Copper River Delta are isolated, with no road access that would allow people to drive directly to the area from other parts of the state. Nearly all nonresidents come through the airport or ferry terminals. Daily air service to Cordova is provided by Alaska Airlines and ERA Aviation. Some nonresidents arrive in Cordova on a ferry that is part of the Alaska Marine Highway System. The ferry can accommodate cars, recreational vehicles, and passengers. It links Cordova to the rest of the Alaska road system through the ports of Valdez and Whittier. Prior to 2005, the ferry travel time between Whittier and Cordova was approximately 9 hours with only three scheduled sailings per week.

In 2005, access to Cordova greatly increased with improved ferry service. Ferry landings occurred daily, and a new high-speed ferry began to service the area at the end of September. The new ferry (capacity: 250 passengers, 35 vehicles) cruises at a speed of 32 knots and can travel from Cordova to Whittier in about 3 hours. This vessel is stationed in Cordova and operates in Prince William Sound during the summer. The improved service has made travel more convenient from Anchorage and the Kenai Peninsula via Whittier, and from interior Alaska via Valdez.

Further expansion of the Alaska Marine Highway System in Prince William Sound is planned (Brinckerhoff 2001). In 6 to 10 years, a second high-speed ferry is proposed to provide service between ports during the peak summer season, and by 2020 the estimated number of ferry trips between Cordova and the port towns of Valdez and Whittier is expected to increase three- and tenfold, respectively (Brinckerhoff 2001). Annual vehicle capacity on ferries landing at the port of Cordova is estimated to increase by 4,181 vehicles (over 500 percent) under the preferred alternative of the Prince William Sound Transportation Plan (Brinckerhoff 2001).

Improved access to Cordova will likely increase recreational use in the area, including sport fishing. Access has an important influence on the amount of recreational use in a given area (Clark and Gibbons 1991). The number of people participating in sport fishing on streams in the Cordova area increased between the 1980s and 1990s (Miller and Stratton 2001) and catch and harvests are two- to threefold greater from 2000 through 2004 as compared to the 1990s (Marston 2005). Further increases in recreational use are expected with the Alaska Marine Highway's improved ferry service and continued daily flight service to the area. Increasing the service from three ferry landings per week to daily service has doubled the potential number of vehicles that can access Cordova and the Copper River Delta.

Sport Fish Use, Fish Habitat, and the Potential for Impacts

Most of the 750,000 acres that make up the Copper River Delta are part of the Chugach National Forest and are managed by the U.S. Forest Service. National forest lands of the Copper River Delta are managed with an emphasis on the conservation of fish and wildlife and their habitats (ANILCA 1980, USDA FS 2002). Much of the area is managed under the 501(b)–2 prescription of the Chugach National Forest Revised Land Management Plan (USDA FS 2002). This prescription emphasizes the conservation of fish and wildlife and their habitats, while providing opportunities for backcountry recreational activities in a more natural landscape (USDA FS 2002).

Increased levels of sport fish use have the potential to affect fish habitat on the Copper River Delta. Concentrated use by anglers can lead to habitat degradation such as bank trampling and erosion.

Increased levels of sport fish use have the potential to affect fish habitat on the Copper River Delta. Concentrated use by anglers can lead to habitat degradation such as bank trampling and erosion (Clark and Gibbons 1991, King 2002). Bank trampling reduces the amount of overhanging vegetative cover in riparian zones (King and Hansen 1999). If vegetation is removed completely, it can reduce food and nutrient inputs into the stream (Wipfli 1997). Erosion can reduce the quality of spawning and rearing habitat through sedimentation of the stream (Suttle et al. 2004, Tappel and Bjornn 1983). Streams with road or easy boat access may be particularly vulnerable because they tend to get more use. Anglers concentrate in easily accessible areas if fish are abundant or holding in large groups.

Recreational anglers can negatively affect fish populations by the harvest of adult fish that are returning to spawn or by killing eggs that are deposited in the streambed gravels after spawning (Roberts and White 1992). Adult coho salmon are aggressive fish that can be easily enticed into biting a fly or lure. There are some streams on the Copper River Delta with small runs of coho salmon where

even a low sport harvest might cause harm to the population. As fishing pressure increases and popular areas become more crowded, some of the small and easily accessible streams could be targeted by anglers looking for less crowded locations. The fish populations in these small streams could be adversely affected by such a shift in pressure. In addition, anglers wading through spawning habitat can kill fish embryos (Roberts and White 1992), and reduce the survival of young fish the following year. Concentrated use by anglers in areas of high-quality spawning habitat may lead to reduced production and therefore affect adult returns to that system. Therefore, it is important to identify the areas of overlap between sport fish use and salmon spawning habitats.

The quality of the fishing experience may also be affected by increased use of a fishing area. The Copper River Delta is an area largely unaffected by human activity where anglers anticipate fishing in relatively wild isolated locations. Crowds can be drawn to easily accessible areas that provide good fishing opportunities, often near road-stream intersections. In extreme cases, anglers can be standing right next to one another competing for fish holding in small pools. This situation can create unwanted conditions for some sport fishers. Additionally, anglers often leave behind trash such as lure packaging, fishing line, food and beverage containers, and cigarette butts. Litter diminishes the natural scenic integrity of the landscape and may reduce the quality of some users' experience.

The Need to Document Current Sport Fish Use

Before 2003, the levels of sport fish use on small streams and the spatial patterns of use on the Copper River Delta were largely unknown. The Alaska Department of Fish and Game (ADF&G) collects use, catch, and harvest data for the area through an annual mail-in survey sent to randomly selected license holders (Howe et al. 1996, Marston 2005). These data provide catch, harvest, and effort estimates for the high-use rivers, but do not provide reliable estimates for small streams because of low response rates. Additionally, there is no spatial information collected with the survey. Fished locations include the entire stream system with no finer scale information to document concentrated use within a given stream.

The Copper River Delta coho salmon sport fishery is expected to grow as people discover the improved access and the area becomes a desirable sport fishing destination (Culver 2002; New York Times 2002, 2003; Richey 2008). Anecdotal information and local knowledge indicate that use has increased in recent years. Problems associated with crowding have developed and created conflicts between local Cordova resident and nonresident users (Cordova Times 2004). The improved

access and increased use may affect national forest resources and users.

Given the importance of the coho salmon resource, land managers will need the best available sport fish use data in order to manage fish resources and provide services to sport fish users within the Chugach National Forest. Detailed data are needed to monitor and evaluate the growth of the sport fishery over time. This information will allow managers to identify the patterns of sport fish use on streams across the Copper River Delta and implement projects that protect fish populations and their habitat from degradation while providing important services to sport fish users. These data will help to assess the need for access and infrastructure projects, evaluate capacity issues, and focus interpretive messages toward the appropriate group at the appropriate locations.

The Chugach National Forest initiated the Copper River Delta Sport Fish Use Survey in 2002. The information and experience gained from the first year helped to modify and expand the survey from 2003 through 2006. This is the final report for all years of the project. The report details the design, data collection methods, analysis, results, management implications, and recommendations based on this sport fish use survey.

Objectives

The main objectives of the survey were to:

- Identify areas of concentrated sport fish use.
- Determine the catch and harvest by species.
- Determine the relative use and harvest between local Cordova residents and nonresident sport fish users.
- Establish baseline data to monitor trends in sport fish use over time.
- Describe the spatial patterns of use with a geographic information system (GIS), and determine overlap of use with known coho salmon spawning habitats.

Three types of surveys were used to collect data on sport fish use on the Copper River Delta: aerial surveys, in-person interviews, and mail-in questionnaires.

Methods

Survey Design

Three types of surveys were used to collect data on sport fish use on the Copper River Delta: aerial surveys, in-person interviews, and mail-in questionnaires. Aerial surveys were used to count and document the location of anglers fishing on streams. These data were used as an index for monitoring use over time, and to examine spatial patterns of use. In-person interviews and mail-in questionnaires

were used to obtain estimates of effort (angler-days spent fishing), catch (number caught), and harvest (number retained) by the nonresident and the local Cordova anglers. The aerial surveys and in-person interviews were conducted in August and September because most sport fishing in the area coincides with the coho salmon returns starting in mid-August and continuing through September. The mail-in questionnaires were sent out on October 1. The interviews were similar in design to completed-trip surveys at an access point (Pollock et al. 1994). With limited access to the area and a small local resident population, this type of design made it possible to obtain estimates of sport fish use from different segments of the angling population: those who are residents (of Cordova) and those who are not. The following describes the methods for each survey type.

Aerial Surveys

In 2003, a pilot project to count anglers by using aerial surveys was initiated. Surveys were done on three randomly selected days each week from August 9 to September 27. The selected days were stratified so that one weekend day and two weekdays were selected each week. The flights covered all fishable water bodies on the West Copper River Delta. The surveys were focused on the West Copper River Delta because it contains most of the road-accessible streams and would most likely experience concentrated use or increased use because of improved road access.

A departure time for each flight was randomly selected for each day. The starting times were stratified into three periods: morning (0700–1000 hours), day (1000–1600 hours), and evening (1600–1900 hours). This stratification allowed for the examination of temporal use patterns during the day and allowed researchers to determine the best time to capture peak use during the surveys. When selecting the departure time, more weight was given to the daytime period, as it contained more hours and was the expected time of peak use. The scheduled start time would occur on the first hour of the selected period for each day.

During surveys, the pilot and one observer flew over each of the following streams and lakes: Power Creek, Eyak River, Eyak Lake, Ibeck Creek, 11 Mile Creek (Elsner), Cabin Lake, 18 Mile Creek, 20 Mile Creek (Goose Meadows), Alaganik Slough, Pipeline Lakes, McKinley Lake, Sheridan River, Black Hole, and Salmon Creek. Generally, a suggested flight path traveling from the Cordova city airport toward the east was flown. During the flights, the entire stream system or lake was covered; however, the flight path was sometimes altered owing to weather conditions. Some flights were also cancelled owing to high winds or fog.

All of the aerial survey data were entered into a GIS database to provide a spatial representation of the anglers counted in the study area. This information was used to visually identify patterns of concentrated use and to identify where use overlapped with known spawning habitat.

The aircraft flew at approximately 152 m (500 ft) elevation over each stream system while the observer determined whether persons on the stream were engaged in sport fishing. If a person had a fishing rod in hand, or was in a boat with fishing gear, they were considered to be sport fishing. The number of boats used for fishing was also recorded. In areas where people were concentrated, the plane circled until all people could be assessed and accurately counted. The number and location of all anglers and boats was recorded on data sheets and on a map during the flights. Some aerial counts on Eyak River were verified by simultaneous on-the-ground counts conducted by ADF&G during the 2004 season.

All of the aerial survey data were entered into a GIS database to provide a spatial representation of the anglers counted in the study area. This information was used to visually identify patterns of concentrated use and to identify where use overlapped with known spawning habitat. The known spawning habitat was obtained from several sources, including the U.S. Forest Service corporate GIS database, the ADF&G Anadromous Waters Catalog, and local knowledge from agency fishery biologists.

From 2004 through 2006, aerial counts were scheduled daily starting on August 9 and continuing through September 30. The start time for each flight was selected randomly between 0800 and 1800 hours. Data from the 2003 surveys indicated that few anglers were seen in the earliest and latest 1-hour periods, and these start times were removed. Flights were scheduled daily to best capture the variation over the season and because some flights would inevitably be cancelled owing to weather. The streams surveyed and other methods were consistent over the entire study period (2003 through 2006).

Airport and Ferry Terminal Interviews

A pilot project was conducted during the 2002 coho salmon return to determine if nonresident sport fish users could be surveyed effectively at the airport terminal. All potential outbound flights were sampled between August 9 and September 30. There were four outbound flights every day except Tuesday and Sunday, when there were only three flights. Some flights were cancelled because of bad weather or schedule changes. The ferry was not sampled in 2002.

The surveys conducted from 2004 through 2006 included both the airport and ferry terminals. Approximately 60 percent of all departure days were randomly

selected to sample without replacement from August 9 through September 30. Surveyors attempted to interview all individuals departing Cordova on these selected departure days.

Surveyors arrived 2 hours prior to each departure on each sampling day. One person interviewed all individuals at the airport, and two persons sampled at the ferry terminal. The surveys were conducted as passengers waited in the lobby or waited in their car to board the ferry. At initial contact, passengers were informed that the survey was voluntary and confidential. Passengers traveling as a group were interviewed together. Refusals to participate in the survey were documented and counted, but no other information was recorded. Local residents were not interviewed at these locations.

The surveys were conducted as passengers waited in the lobby or waited in their car to board the ferry.

All nonresident passengers were asked whether they fished on the Copper River Delta during their visit. For each individual or group that fished, the interviewers recorded the locations, amount of time spent fishing, and how many fish of each species were caught and harvested. A map of the area with the individual stream system names was provided for the respondents to view in order to record accurate locations. The final question asked passengers if they had any comments concerning sport fish use on the public lands of the Copper River Delta.

The number of nonresidents who did not fish, the number of local Cordova residents, and the number of refusals were recorded. The number of passengers who boarded was obtained from the ticket agents immediately after each departure, which provided a method to calculate the number of passengers, if any, who were overlooked during the survey.

The data were analyzed as a simple random sample of departure days sampled from total days available over the period from August 8 through September 30. Based on survey data collected on these sample days, the estimated attributes of interest (effort in angler-days, catch, and harvest) were calculated with equations based on multistage sampling designs for access-point creel surveys used in Alaska (Bernard et al. 1998). The effort, catch, and harvest were estimated with:

$$\hat{Y}_h = D_h \hat{\bar{Y}}_h \; ; \quad \hat{\bar{Y}}_h = \frac{\sum_{i=1}^{d_h} \hat{Y}_{hi}}{d_h}$$

where

h = stratum.

i = first-stage unit.

d = number of sampled days.

D = number of days in total sample period.

v´ = statistic of interest.

and with variance:

$$var(\hat{Y}_h) = (1 - f_{1h})D_h^2 \frac{S_{1h}^2}{d_h} + f_{1h}^{-1} \sum_{i=1}^{d_h} \left[M_{hi}^2 (1 - f_{2hi}) \frac{s_{2hi}^2}{m_{hi}} \right] \qquad f_{1h} = \frac{d_h}{D_h} \qquad f_{2hi} = \frac{m_{hi}}{M_{hi}}$$

$$s_{2hi}^2 = \frac{\sum_{j=1}^{m_{hi}} (y_{hij} - \bar{y}_{hi})^2}{m_{hi} - 1} \qquad S_{1h}^2 = \frac{\sum_{i=1}^{d_h} (\hat{Y}_{hi} - \hat{\bar{Y}}_h)^2}{d_h - 1} \quad \text{or} \quad \frac{\sum_{i=2}^{d_h} (\hat{Y}_{hi} - \hat{Y}_{h(i-1)})^2}{2(d_h - 1)}$$

where

M = number of anglers exiting the fishery during the sampled period.

m = number of anglers interviewed during a sampled period.

f_{1h} = fraction of first stage-units sampled.

f_{2h} = fraction of second-stage units.

s^2 = last-stage sample variance for measurements.

S^2 = first- and second-stage sample variance for totals.

y = statistic of interest measured during the sample period $h_{ij.}$

Mail-in Surveys

Questionnaires were mailed to Cordova residents for the years 2004 through 2006 to estimate sport fish use by the local population. Each year, the current telephone book file was obtained from the Cordova Telephone Cooperative, and all households with phone service were sent surveys. It was assumed that most resident households would have phone service. Businesses were not included in the mailings. The mail-in surveys were sent out in early October to reduce potential problems with recalling the number of fish caught. A second, followup survey was sent to nonresponding households in November. A telephone survey was conducted in 2005 and 2006 in December to estimate sport fish use of those households that did not mail back the survey.

The mail-in surveys asked for the same information as the in-person interviews conducted at the airport and ferry terminals. A cover letter was provided to explain

the purpose of the survey and that it was voluntary and confidential. A map showing the study area and stream systems on the Copper River Delta and a self-addressed return envelope were provided for each of the potential respondents. Respondents were given a section to make comments concerning sport fish use on the public lands of the Copper River Delta. No rewards were offered for returning the surveys as high survey response rates were expected.

The mail-in surveys asked for the same information as the in-person interviews conducted at the airport and ferry terminals.

Telephone surveys of 10 percent and 20 percent of the total nonrespondent households were conducted in 2005 and 2006, respectively. The surveyed households were chosen at random from all nonrespondents to the two mail-in surveys. The questions on the mail-in form were asked by the interviewer and responses were recorded.

In 2004, the estimates of effort, catch, and harvest were generated by expanding the response data to the entire local resident population. In this analysis, the mean attributes for the response population were calculated for a given location (e.g., angler-days per household for Eyak River). This value was then multiplied by the total households sent the surveys (N) to provide the estimated total for a particular attribute (e.g., effort on Eyak River). No variance component was included in this estimate.

In 2005 and 2006, the estimated effort, catch, and harvest by residents were generated from the combined mail-in and telephone surveys. The total households sent the surveys (N) comprised three groups. Let N_1 and N_2 represent the 1st and 2nd respondent households, and N_3 the nonrespondent households. The attributes of interest, effort (angler-days), catch, and harvest, were calculated from the sum of the estimates from the three groups of households;

$$Y = \hat{Y}_1 + \hat{Y}_2 + \hat{Y}_3$$

where

Y_1 and Y_2 are the sum of all attributes given by households that responded to the 1st and 2nd mailings:

$$Y_1 = \sum_{i=1}^{N1} y_{i1}\,;\; Y_2 = \sum_{i=1}^{N2} y_{i2}\,.$$

The responses from these households were treated as completed-trip data of absolute value with no error associated with it (variance = 0).

The sample attributes obtained in the telephone surveys were used to calculate estimates for the nonresponse population (N_3). This method would be more accurate than using attributes from the response population to estimate those from the nonresponse as they can often be much different from each other (Pollock et al. 1994). The total estimate for nonrespondent households was calculated by:

$$\hat{Y}_3 = \hat{N}_3 \mu_3$$

where μ_3 was the mean attribute obtained from the sample population (n_3):

$$\hat{\mu}_3 = \frac{\sum_{i=1}^{n_3} y_{i3}}{n_3}$$

with variance:

$$\hat{V}\left(\hat{Y}_3\right) = N_3{}^2 \left(\frac{\left(N_3 - n_3\right)}{N_3}\right)\left(\frac{s_3{}^2}{n_3}\right)$$

and where:

$$s_3{}^2 = \frac{\sum \left(y_{i3} - \hat{\mu}_3\right)^2}{\left(n_3 - 1\right)} \quad .$$

Results

Aerial Surveys

A total of 144 aerial surveys were flown over the streams of the West Copper River Delta. Only 20 days were surveyed in 2003, which was the pilot project year. The greatest number of days surveyed during a year was 45 in 2004. The number of surveys completed each year was directly related to weather conditions. Some flights were cancelled owing to high winds, rain, and poor visibility. Particularly poor weather occurred in 2006, when only 39 aerial surveys occurred out of a potential 52 scheduled days.

Anglers were readily observable from an airplane flying at 152 m, especially in the open stream systems such as Alaganik Slough (fig. 3a). It was more difficult to spot anglers on streams partially obscured by conifer canopy such as the upper half of the Eyak River (fig. 3b). Multiple passes were made in areas with visual obstacles to ensure that the counts were accurate. The aerial counts were generally

A

D. Lang both photos

B

Figure 3—Anglers on Alaganik Slough (a) and on Eyak River (b) as observed from an aircraft flying at 152.4 m elevation (500 ft).

within one or two anglers of the counts done on the ground by ADF&G (Marston 2004). The ground counts were better able to distinguish boat passengers or others who were not actively fishing from those who were fishing, which occasionally resulted in higher counts from the aerial survey.

The highest counts of anglers consistently occurred during the last week in August and the first week in September. This timing coincides with the Labor Day weekend and is typically when the first big pulse of coho salmon enters these streams as determined by ADF&G aerial surveys.

In total, 6,859 anglers were counted over the course of this study on the streams of the Copper River Delta. The Eyak, Ibeck, and Alaganik stream systems consistently had the highest counts of anglers, whereas other locations had comparatively few anglers (table 1). The highest counts occurred in 2004, which had a peak count of 142 anglers in one survey and seven survey days of over 100 people. The mean counts over the entire West Copper River Delta ranged from 37.6 to 55.7 anglers per flight during the survey years.

Angler counts indicated that there were yearly changes in use for individual stream systems (table 1). On the Alaganik Slough, angler use changed from the lowest levels in 2003 to the highest levels in 2004, and then decreased in 2005 and 2006. Angler counts at Ibeck Creek dropped to 4.1 anglers per flight in 2004 while they increased at both Eyak River and Alaganik Slough that year (table 1).

The highest counts of anglers consistently occurred during the last week in August and the first week in September (fig. 4). This timing coincides with the Labor Day weekend and is typically when the first big pulse of coho salmon enters these streams as determined by ADF&G aerial surveys (see Ashe et al. 2005, Hollowell et al. 2007). The run timing for coho salmon differs slightly between the main rivers, with Eyak River fish generally arriving approximately 1.5 to 2 weeks earlier than in the Alaganik Slough. This variation in run timing can be seen in our angler counts for 2004 and 2005 (fig. 5).

Day-use patterns were observed with the counts as well. There were significantly ($P = 0.02$; one-tailed *t*-test) more anglers counted on weekend days (mean = 56.7) than on week days (mean = 44.7). Generally, most of the anglers (mean = 75 percent) were counted during the daytime periods between 1000 and 1600 hours. However, in 2006 the proportion of angler use in the early morning and late evening was relatively high at 35 percent.

The highest concentrations of anglers were found at locations on the Eyak River, Ibeck Creek, and Alaganik Slough. These stream systems are adjacent to roads and trails where there was easy access for fishing and generally have healthy coho salmon returns (Hollowell et al. 2007). There was also high use at the confluence of clear water tributaries with glacial channels, such as the confluence of 18 Mile Creek and Alaganik Slough. Mean angler densities ranged from 0 to 11.9 anglers per kilometer of stream with the highest densities consistently found in the

Table 1—Mean anglers counted per flight (± 1 SE) and peak counts of anglers on streams on the West Copper River Delta, 2003–2006[a]

	Year							
	2003		2004		2005		2006	
Stream	Anglers/day	Peak	Anglers/day	Peak	Anglers/day	Peak	Anglers/day	Peak
Eyak River	18.1 (2.4)	37	30.0 (2.7)	66	17.7 (1.9)	42	18.0 (2.4)	70
Ibeck Creek	15.3 (2.2)	35	4.1 (0.8)	17	14.3 (2.7)	55	12.5 (2.2)	68
Alaganik Slough	3.7 (0.7)	11	16.8 (2.5)	64	10.7 (1.8)	40	6.4 (1.1)	26
18 Mile Creek	2.7 (0.6)	4	1.2 (0.3)	8	1.7 (0.5)	13	2.4 (0.1)	11
11 Mile Creek	3.5 (0.6)	8	2.0 (0.4)	14	1.6 (0.3)	6	3.1 (0.8)	18
20 Mile Creek	1.3 (0.3)	2	0.6 (0.2)	6	1.7 (0.5)	15	1.0 (0.3)	10
Cabin Lake	0.1 (0.1)	2	0.1 (0.1)	2	0.5 (0.2)	3	0.4 (0.2)	6
Power Creek	0.1 (0.1)	3	0.3 (0.2)	5	0.11 (0.1)	3	0.1 (0.1)	1
Sheridan River	0.1 (0.1)	1	0.2 (0.1)	3	0.1 (0.1)	2	0.2 (0.1)	3
McKinley Lake	0.2 (0.2)	3	0.3 (0.1)	4	0.2 (0.1)	3	0.2 (.01)	3
Eyak Lake	0	0	0.1 (0.1)	3	0.1 (0.1)	2	0	0
Pipeline Lakes	0.3 (0.3)	6	0	0	0	0	0	0
Salmon Creek	0.2 (0.2)	3	0	0	0	0	0	0
Black Hole Creek	0	0	2.5 (1.5)	4	0.1 (0.1)	3	0.2 (0.2)	5
All locations	37.6 (4.5)	70	55.7 (5.3)	142	48.7 (5.3)	111	42.2 (4.4)	118
Total days ≥100		0		7		5		1

[a] Mean anglers counted for all locations for a given year, the peak daily count for a survey during that year, and the total number of days where over 100 anglers were counted in a year is given at the bottom.

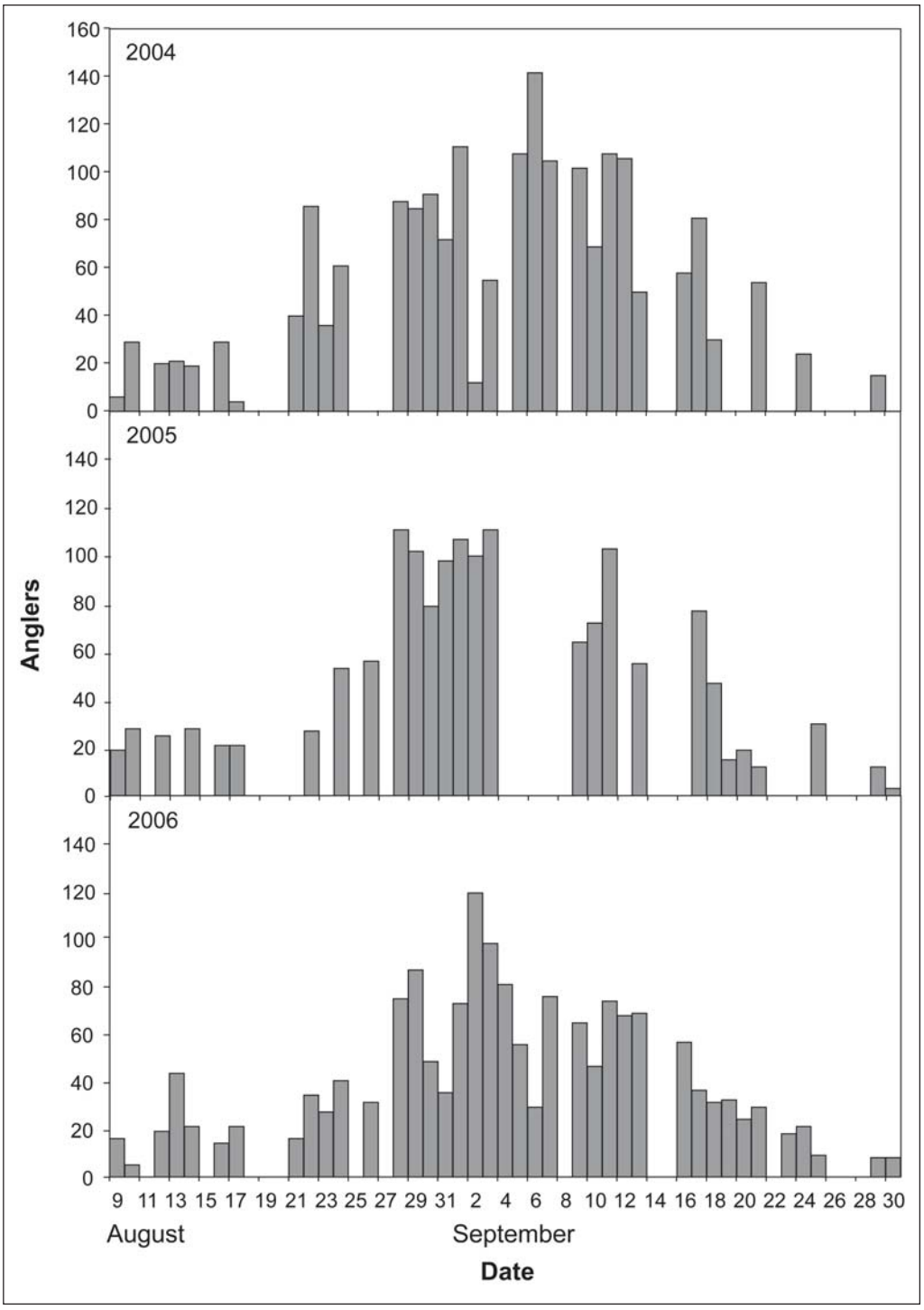

Figure 4—Daily counts of anglers from aerial surveys conducted during the coho salmon season on the West Copper River Delta, 2004 through 2006.

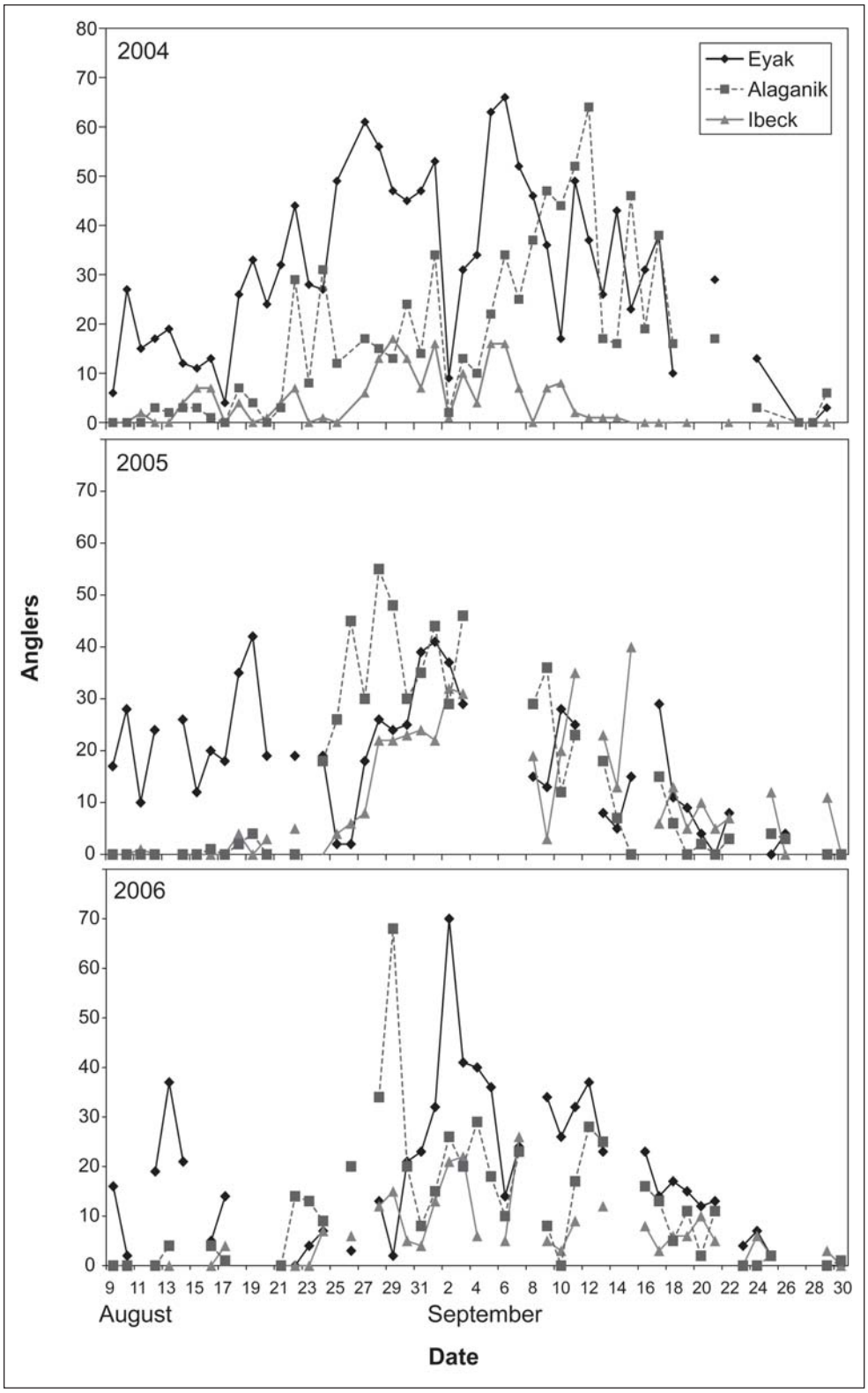

Figure 5—Daily counts of anglers on Eyak, Ibeck, and Alaganik stream systems from aerial surveys conducted during the coho salmon season on the Copper River Delta, 2004 through 2006.

Anglers were not observed fishing in areas with known spawning habitat except in the Alaganik watershed, specifically on 18 Mile Creek and around McKinley Lake near the Salmon Creek confluene.

1-km section of Eyak River near the Eyak River Trail terminus, and at Ibeck Creek near the Copper River Highway crossing (fig. 6). However, relatively low densities of anglers were found throughout most of the stream sections on the West Copper River Delta. The densities of anglers and the locations people fished were consistent among years, except for some minor increases observed with the high use in 2004. Also, during the 2006 season, anglers were seen farther upstream on Ibeck Creek than in previous years, but still well below known spawning habitat.

Anglers were not observed fishing in areas with known spawning habitat except in the Alaganik watershed, specifically on 18 Mile Creek and around McKinley Lake near the Salmon Creek confluence (fig. 7). Eighteen Mile Creek contains

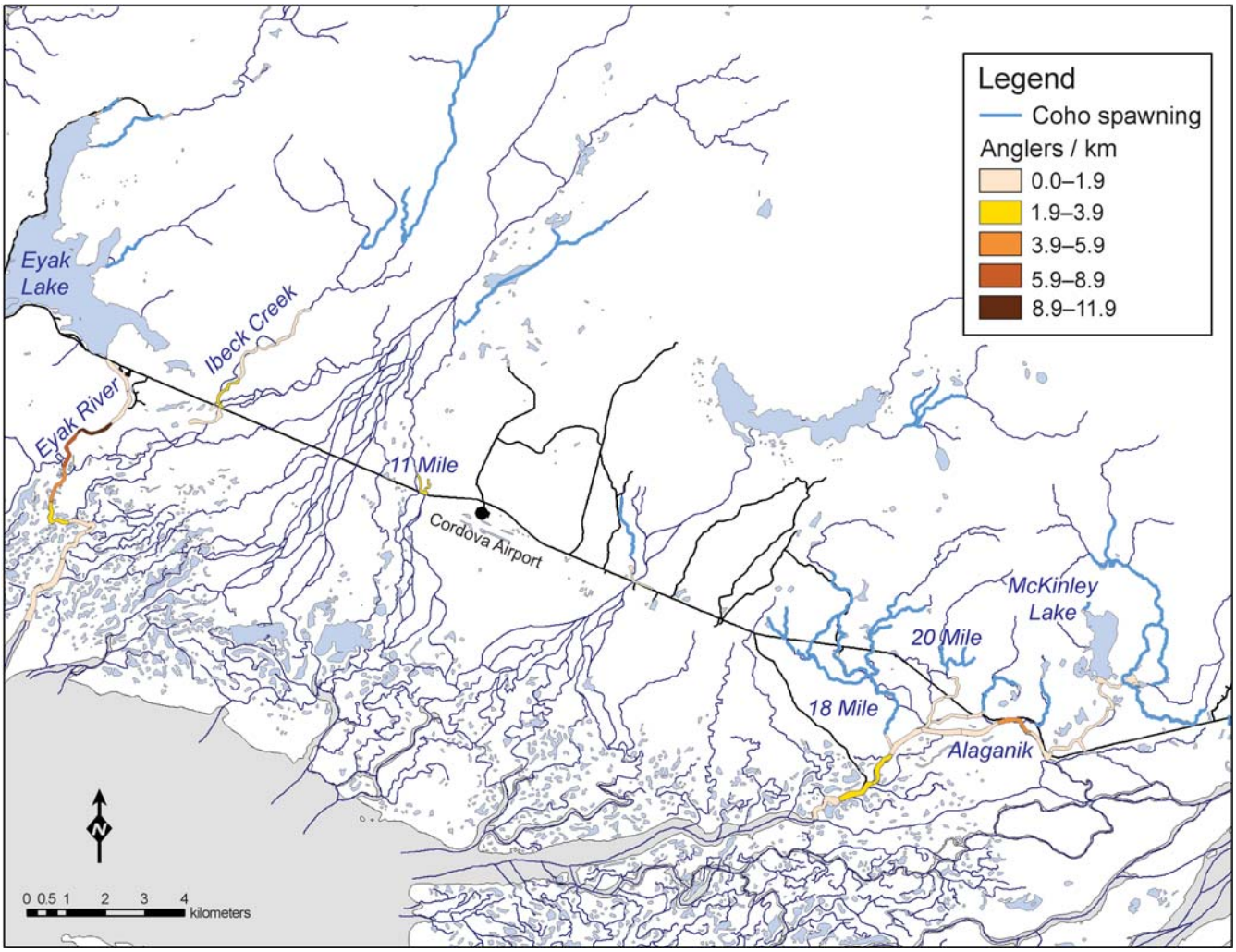

Figure 6—Mean density of anglers counted per aerial survey done on the West Copper River Delta during the 2004 coho salmon season. Streams are divided into 1-km sections, and color-coded densities are shown for each section. The known suitable spawning habitats for coho salmon on the West Copper River Delta are represented by heavier, light blue lines.

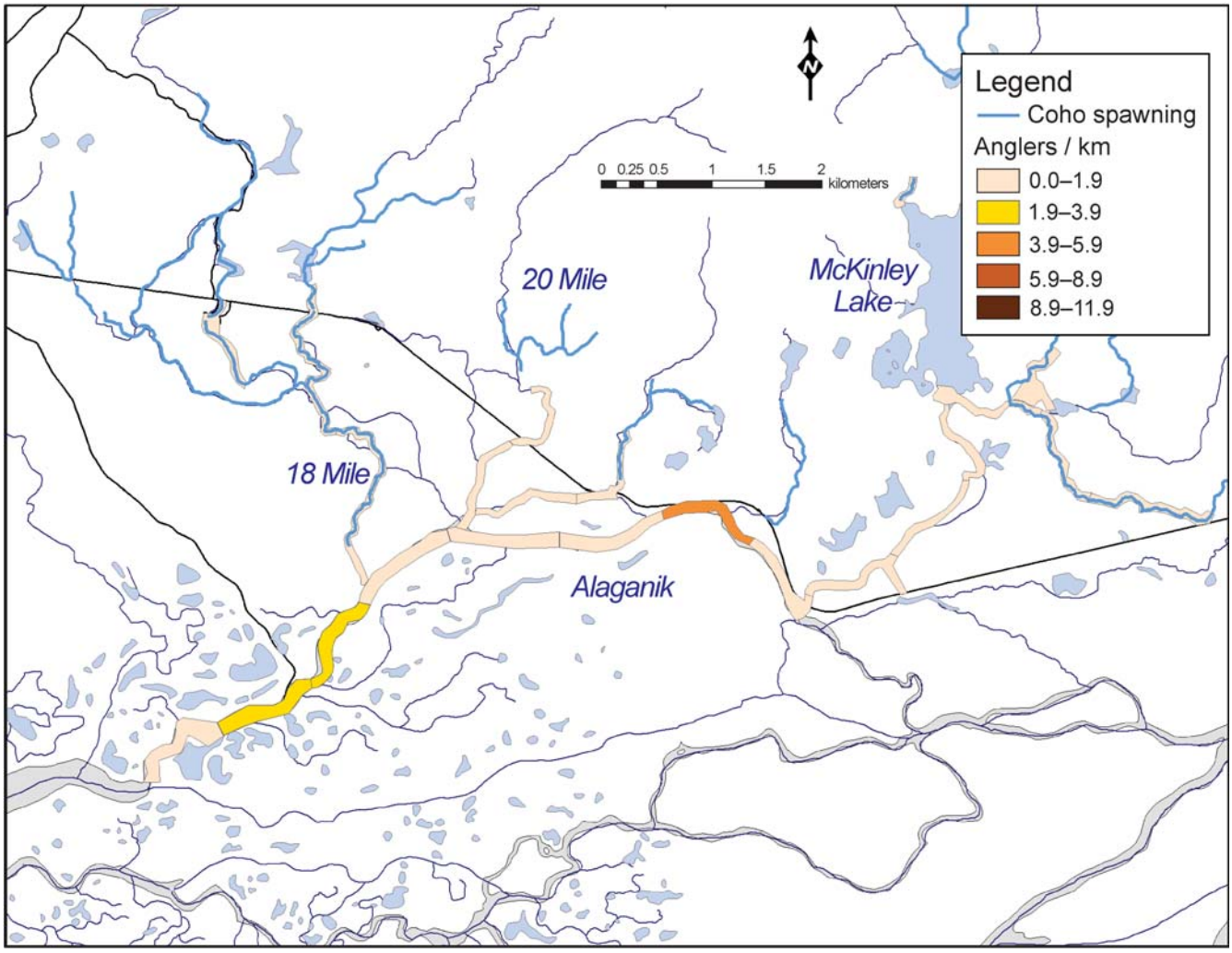

Figure 7—Mean density of anglers counted per aerial survey done on the Alaganik stream system during the 2004 coho salmon season. Streams are divided into 1-km sections, and color-coded densities are shown for each section. The known suitable spawning habitats for coho salmon on the West Copper River Delta are represented by heavier, light blue lines.

excellent spawning habitat throughout its length (Hodges and Buckley 1994, USDA FS 1994–2008) and is accessible.

Airport and Ferry Terminal Interviews

On average, 58 percent of the departure days were surveyed each year. Over the 3 years of this study, 12,722 people were interviewed (table 2). Approximately half of those interviewed fished during their visit. The majority of the nonresidents surveyed who fished, traveled to the region by airplane rather than by ferry (table 2). Overall, very few boarding passengers were missed by the survey crews (2.4 percent), and less than 1 percent of those asked refused to complete the interview.

Table 2—Summary data for the airport and ferry terminal interviews, 2004–2006

Year	Percentage of departure days surveyed	Number surveyed	Number of nonresidents	Nonresidents who fished	Number missed[a]	Number refused[b]
Airport:						
2004	59	3,025	2,242	1,259	106	23
2005	61	3,518	2,915	1,659	60	19
2006	57	2,582	1,993	1,030	26	7
Ferry:						
2004	68	761	412	168	74	6
2005	56	1,476	936	245	28	5
2006	50	1,360	900	203	28	0
Totals:						
2004	64	3,786	2,654	1,427	180	29
2005	57	4,994	3,851	1,904	88	24
2006	54	3,942	2,893	1,233	54	7

[a] Total number of passengers who boarded the plane and were not interviewed at all by Forest Service crews when conducting surveys. The number missed was computed by subtracting the total interviewed by the number that boarded as reported by the ticket agents after each flight departed.

[b] Those who were contacted at the terminals but refused to take the survey.

Based on the interviews, the nonresident anglers fished at many locations.

Based on the interviews, the nonresident anglers fished at many locations (fig. 8). On the West Copper River Delta, the highest numbers fished at Eyak River, Ibeck Creek, and Alaganik Slough. Lower numbers of anglers fished 11 Mile, 18 Mile, 20 Mile, Power Creek, McKinley Lake, Sheridan River, Cabin Lake, and Pipeline Lakes.

Those anglers who fished for salmon in Prince William Sound waters usually fished near the mouth of a stream. Road system streams included Clear Creek on the East Copper River Delta, all the streams on the West Copper River Delta, Fleming Spit, and Hartney Bay. Fleming Spit and Hartney Creek are two streams in Prince William Sound where anglers fished that are accessible by car (fig. 8). Other locations in Prince William Sound were outside of the study area for this project, and those data were not analyzed further.

Nonresident anglers also fished in several streams off the road system, east of the Copper River, including the Kiklukh, Martin, Katalla, and Tsiu Rivers (fig. 8). These rivers are accessible by small planes landing on a beach or lake, or in some cases by boat. The Kiklukh, Katalla, and Tsiu Rivers were fished primarily with

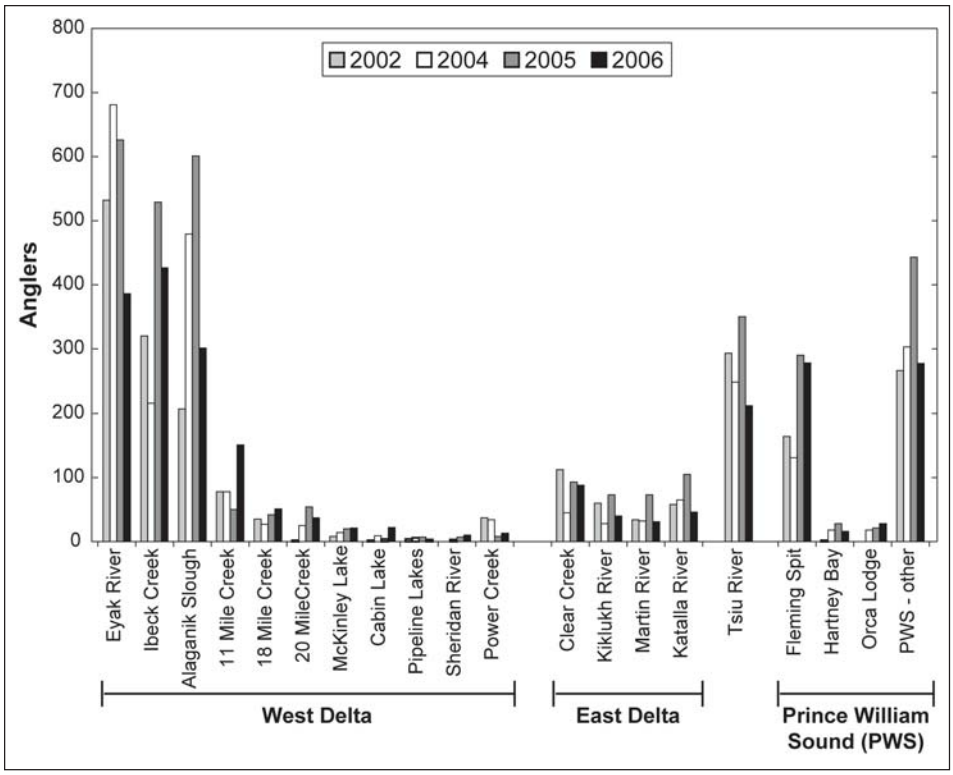

Figure 8—Number of interviewed nonresident anglers and locations that they fished over the years 2002 and 2004 through 2006. Locations are grouped into three regions. The Tsiu River is outside of the Chugach National Forest boundary and not on the Copper River Delta.

guides operating out of lodges. The Tsiu River is not part of the Chugach National Forest and therefore was not included in this analysis. There is a public-use Forest Service cabin that can be rented at the Martin River, but some anglers also camp on the river when the cabin is not available.

Approximately 90 percent of the sport fish effort (angler-days) by nonresidents was directed at Ibeck Creek, Eyak River, and Alaganik Slough (table 3). Effort was greatest in 2004. The Eyak River had the greatest effort for 2 out of the 3 years (table 3). Effort remained at a similar level from 2004 through 2006, but appears to be higher than the effort observed in 2002 (fig. 9). The increase in effort could not be attributed to ferry passengers over the 3 years (fig. 9, table 3).

The estimated catch of coho salmon by nonresident anglers on the West Copper River Delta ranged from 15,192 to 31,473 fish (airport and ferry estimates combined, tables 4 and 5). There was a steady decrease in the number of fish

Table 3—Estimated sport fish effort on the Copper River Delta by nonresidents based on interviews at the airport and the ferry terminals from 2004–2006

	Airport (angler days for year [SE])			Ferry terminal (angler days for year [SE])		
Stream system	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**
West Delta:						
Eyak River	2,399 (305)	1,649 (166)	1,653 (180)	344 (49)	160 (28)	216 (51)
Ibeck Creek	419 (92)	1,855 (286)	1,472 (198)	70 (17)	262 (56)	334 (80)
Alaganik Slough	1,199 (148)	1,172 (150)	738 (129)	330 (51)	247 (59)	127 (35)
11 Mile Creek	155 (26)	27 (5)	383 (63)	45 (12)	57 (16)	114 (24)
18 Mile Creek	71 (17)	65 (19)	153 (39)	5 (2)	8 (4)	5 (3)
20 Mile Creek	68 (15)	68 (19)	56 (12)	4 (2)	2 (1)	4 (2)
Cabin Lakes	9 (3)	12 (3)	28 (10)	—	—	—
Sheridan River	3 (1)	—	11 (4)	—	—	—
Pipeline Lakes	7 (2)	7 (2)	5 (3)	3 (1)	1 (1)	2 (1)
Power Creek	36 (8)	12 (5)	18 (6)	1 (1)	—	7 (5)
McKinley Lake	13 (3)	27 (10)	35 (17)	4 (1)	8 (5)	21 (10)
West Delta total	4,420 (378)	4,942 (489)	4,605 (464)	810 (79)	746 (114)	832 (136)
Road system	4,612 (377)	5,875 (533)	5,497 (492)	867 (82)	919 (130)	1,212 (203)
East Delta:						
Clear Creek	54 (12)	93 (38)	131 (25)	3 (1)	6 (4)	36 (10)
Martin River	150 (38)	121 (59)	129 (36)	—	1 (1)	52 (23)
Katalla River	378 (80)	671 (194)	429 (99)	6 (3)	—	11 (7)
East Delta total	590 (132)	895 (301)	699 (167)	9 (3)	7 (3)	102 (41)

— = None of the anglers surveyed fished this location in this year.

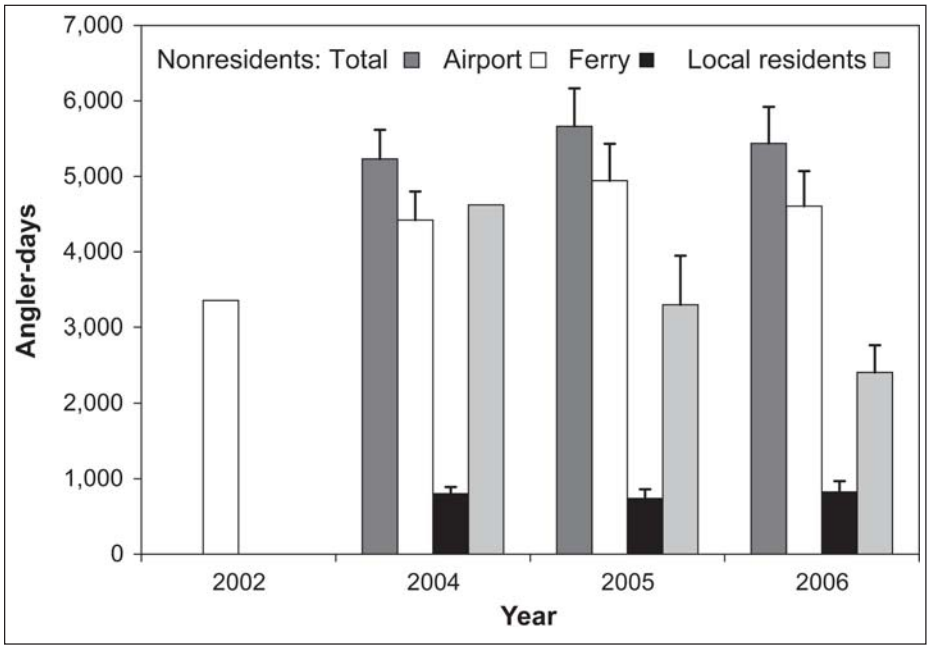

Figure 9—Estimated sport fish effort (angler-days ± 95 percent confidence interval)—by nonresidents and local residents on the West Copper River Delta during the coho salmon seasons of 2002 and 2004 through 2006.

Table 4—Estimated catch and harvest of coho salmon on the Copper River Delta by nonresidents who arrived by air, 2004–2006

	Year					
	2004		2005		2006	
Stream system	Catch (1 SE)	Harvest (1 SE)	Catch (1 SE)	Harvest (1 SE)	Catch (1 SE)	Harvest (1 SE)
West Delta:						
Eyak River	15,405 (1695)	5,574 (501)	4,428 (701)	2,700 (367)	5,846 (1317)	2,844 (385)
Ibeck Creek	1,758 (438)	640 (184)	8,748 (1454)	4,320 (733)	4,565 (745)	1,768 (290)
Alaganik Slough	9,543 (1343)	2,702 (373)	4,406 (734)	2,079 (335)	1,687 (440)	848 (176)
11 Mile Creek	572 (129)	282 (67)	18 (7)	16 (6)	597 (105)	436 (75)
18 Mile Creek	383 (87)	100 (24)	314 (116)	131 (48)	543 (166)	231 (70)
20 Mile Creek	294 (82)	78 (19)	255 (100)	134 (51)	79 (33)	34 (11)
Cabin Lakes	20 (13)	2 (1)	10 (6)	3 (2)	23 (12)	18 (11)
Sheridan River	0	0	81 (51)	32 (20)	16 (6)	4 (2)
Power Creek	0	0	0	0	27 (12)	7 (5)
McKinley Lake	78 (35)	8 (3)	59 (28)	26 (13)	14 (7)	4 (2)
West Delta total	28,136 (3,118)	9,448 (881)	18,360 (2,444)	9,346 (1,221)	13,218 (2,152)	6,030 (713)
Road system	29,784 (3,267)	9,941 (923)	20,034 (2,518)	10,530 (1,288)	15,300 (2,173)	7,189 (732)
East Delta:						
Clear Creek	253 (77)	32 (19)	160 (41)	87 (23)	228 (75)	45 (14)
Martin River	2,135 (687)	100 (38)	715 (252)	69 (20)	1151 (93)	392 (25)
Katalla River	9,467 (3,231)	565 (127)	6,151 (1,612)	920 (347)	2,668 (718)	409 (126)
East Delta total	11,954 (401)	717 (193)	7,030 (1913)	1,093 (389)	4,071 (912)	864 (178)

SE = Standard error.

Table 5—Estimated catch and harvest of coho salmon on the Copper River Delta by nonresidents who arrived by ferry, 2004–2006

	Year					
	2004		2005		2006	
Stream system	Catch (1 SE)	Harvest (1 SE)	Catch (1 SE)	Harvest (1 SE)	Catch (1 SE)	Harvest (1 SE)
West Delta:						
Eyak River	1,537 (223)	563 (79)	214 (60)	169 (48)	369 (108)	249 (95)
Ibeck Creek	189 (51)	35 (17)	1,029 (297)	435 (113)	1,355 (570)	434 (157)
Alaganik Slough	1,395 (460)	392 (97)	164 (44)	127 (40)	149 (65)	97 (38)
11 Mile Creek	160 (56)	76 (29)	146 (70)	40 (18)	81 (35)	81 (35)
18 Mile Creek	31 (21)	4 (2)	37 (24)	3 (2)	0	0
20 Mile Creek	9 (3)	7 (3)	0	0	18 (12)	4 (2)
West Delta total	3,337 (572)	1,106 (164)	2,233 (561)	1,073 (217)	1,974 (597)	857 (222)
Road system	3,643 (504)	1,127 (142)	2,454 (585)	1,223 (235)	2,496 (655)	1,205 (298)
East Delta:						
Clear Creek	3 (2)	0	10 (6)	7 (4)	84 (38)	18 (12)
Martin River	—	—	2 (1)	0	179 (71)	11 (5)
Katalla River	235 (132)	3 (2)	—	—	90 (60)	22 (14)
East Delta total	238 (132)	3 (2)	12 (6)	7 (4)	373 (180)	52 (34)

— = None of the anglers surveyed fished this location in this year.

SE = Standard error.

Nonresident anglers harvested approximately 44 percent of their catch of coho salmon on the West Copper River Delta. The estimated harvest by this group ranged from 6,887 to 10,554 fish.

caught over the 3 years, with the highest catch in 2004 and the lowest in 2006 (fig. 10; tables 4 and 5). Most fish were caught in the Eyak River, Ibeck Creek, and Alaganik Slough. There was no apparent trend in the number of fish caught at these locations. Eyak River had the highest catch in 2004 and 2006, whereas Ibeck Creek had the highest catch in 2005.

Nonresident anglers harvested approximately 44 percent of their catch of coho salmon on the West Copper River Delta. The estimated harvest by this group ranged from 6,887 to 10,554 fish (tables 4 and 5). There was also a steady decrease in the number of fish harvested over the 3 years (table 4 and 5). The harvest was greatest on the Eyak River and Ibeck Creek, except in 2004 when Alaganik Slough had the second highest harvest (table 4). More fish were released rather than harvested (the practice of selective harvest) in years with higher catches (i.e., 2004). The catch and harvest estimates were much higher for nonresidents than for the local resident population (figs. 10 and 11).

The East Copper River Delta had much less effort than on the West Copper River Delta (table 3). The majority of this effort was on the Katalla River, and most of the nonresidents fishing on the East Copper River Delta arrived by airplane (table 3). However, there was a slight increase in use on the East Copper River Delta by the ferry passengers in 2006 (table 3).

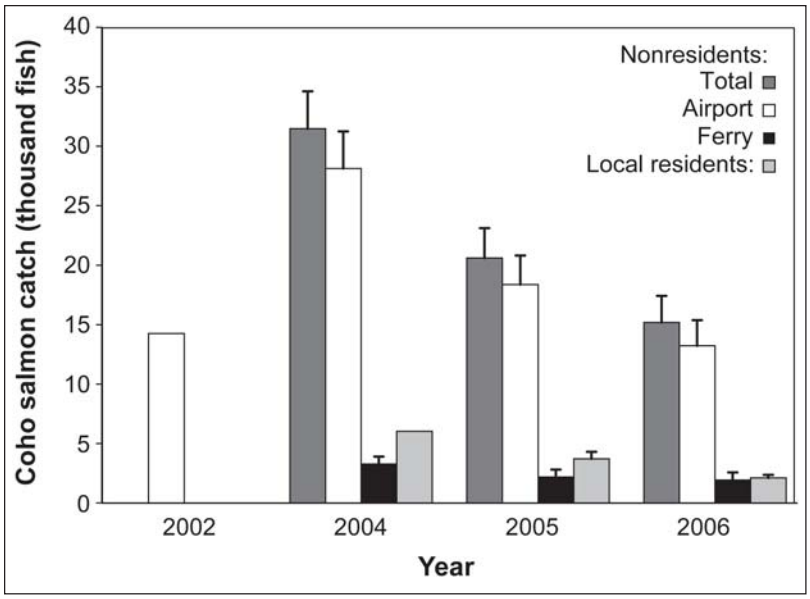

Figure 10—Estimated catch of coho salmon (± 95 percent confidence interval) by nonresidents and local residents on the West Copper River Delta during the coho salmon seasons of 2002 and 2004 through 2006.

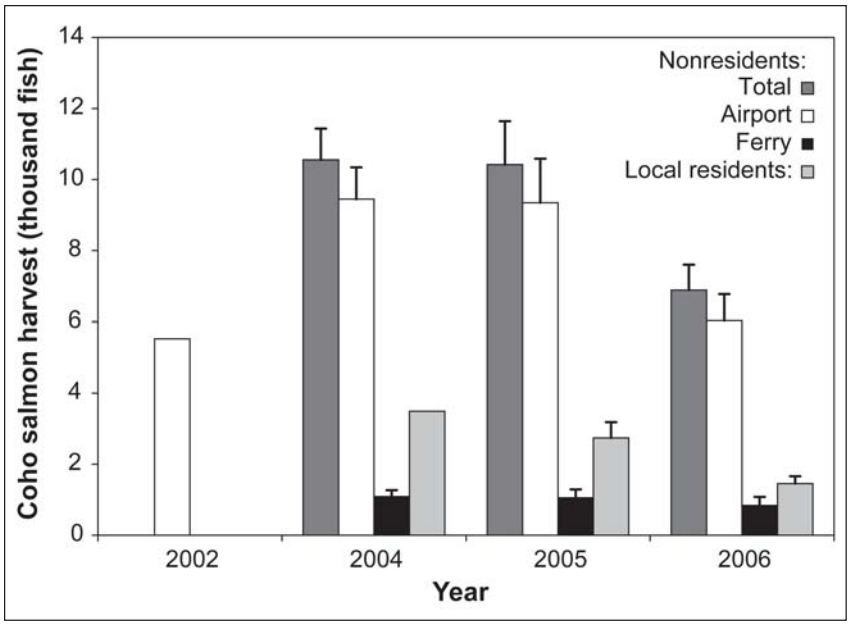

Figure 11—Estimated harvest of coho salmon (± 95 percent confidence interval) by nonresidents and local residents on the West Copper River Delta during the coho salmon seasons of 2002 and 2004 through 2006.

The estimated catch and harvest by nonresident anglers on the East Copper River Delta was also less than on the West Copper River Delta (tables 4 and 5). Annual catch ranged from 4,444 to 12,192 coho salmon (airport and ferry estimates combined). The Katalla River accounted for the majority of the catch. Anglers harvested approximately 12 percent of the catch on the East Copper River Delta, indicating high levels of selective harvest for this region. Nonresidents' harvests of coho salmon ranged from 720 to 1,100 fish, with most fish harvested from the Katalla River.

Most of the anglers who were interviewed at the airport and ferry targeted coho salmon, but several other fish species were caught and harvested. These species included cutthroat (*O. clarki* Richardson) and rainbow trout (*O. mykiss* Walbaum), Dolly Varden (*Salvelinus malma* Walbaum), and pink (*O. gorbuscha* Walbaum), chum (*O. keta* Walbaum), and sockeye (*O. nerka* Walbaum) salmon and grayling (*Thymallus arcticus* Pallas) (table 6). Some anglers targeted nonsalmon species in stream systems without salmon, such as Pipeline Lakes, or in areas where fishing for salmon is prohibited, such as Power Creek.

Nonresident anglers traveling through the airport and ferry terminals had a wide variety of comments regarding sport fish use on the Copper River Delta. The

Table 6—Reported catch and harvest of fish species other than coho salmon, in number of fish, on the Copper River Delta by nonresidents based on interviews at the airport and ferry terminals, 2004–2006

	Year					
	2004		2005		2006	
Species	Catch	Harvest	Catch	Harvest	Catch	Harvest
West Delta:						
Dolly Varden	723	97	897	105	607	63
Cutthroat trout	110	8	206	28	163	11
Rainbow trout	1	0	1	0	1	0
Pink salmon	33	2	99	22	29	1
Sockeye salmon	23	6	30	19	163	31
Chum salmon	0	0	4	0	2	0
East Delta:						
Dolly Varden	476	12	252	5	381	13
Cutthroat trout	100	1	124	1	38	0
Rainbow trout	27	0	24	0	17	0
Pink salmon	301	0	1437	31	129	0
Sockeye salmon	54	9	10	3	58	0
Chum salmon	13	1	20	0	1	0
Grayling	0	0	0	0	2	0
Total Copper River Delta:						
Dolly Varden	1,199	109	1,149	110	988	76
Cutthroat trout	210	9	330	29	201	11
Rainbow trout	28	0	25	0	18	0
Pink salmon	334	2	1536	53	158	1
Sockeye salmon	77	15	40	22	221	31
Chum salmon	13	1	24	0	3	0
Grayling	0	0	0	0	2	0

comments were made by 28 parties. The issues and general concerns associated with the comments fell into the five categories listed here:

1. Law enforcement and regulations—Some felt that the current regulations on bag limits, licenses, and selective harvest are not being enforced. The lack of law enforcement presence was a concern.

2. Conservation—Respondents were concerned with the viability of the coho salmon runs in Alaganik Slough. There was some concern that the limits were too high and that spawning grounds were getting trampled by sport fish users.

3. Crowds and concentrated use—Respondents expressed the concern that the concentrated use had created unsafe conditions. There are conflicts between anglers and boat traffic on Eyak River.

4. Information and education—Interviewees wanted more information regarding the fishing locations, such as maps with information about where to fish and better signs to find locations.

5. Public services and infrastructure—Some felt that more public services and infrastructure are necessary. Many said that cleaning stations on Eyak River would be desirable. The boat launch at Eyak River needed improvement for flow of traffic and to add more launch space to prevent long lines. Facilities such as toilets, trash cans, camping areas, boat ramps, and parking areas may be needed, or the current ones may need to be improved. Alternatively, several nonresident anglers expressed concern with current levels of use and did not want any development for fear of increasing the use further. Others thought the current levels were acceptable, but that no new development should occur. Some nonresidents wanted to maintain the natural wilderness setting.

Cordova residents indicated that they fished at a number of locations on the Copper River Delta and in Prince William Sound.

Mail-in Surveys

Over the 3 years, the mail-in questionnaires were sent to 2,216 households in Cordova and 1,101 responded to either the first or second mailing (50 percent). The response rate was highest in 2004 and lowest in 2005 (table 7a). The response households contained 2,729 people, and 854 people in those households fished in the Cordova area during August and September. An additional 115 households were called by telephone in 2005 and 2006. Household attributes were similar between the mailings and the telephone interview data (table 7b).

Cordova residents indicated that they fished at a number of locations on the Copper River Delta and in Prince William Sound (fig. 12). The highest number of residents fished on the West Copper River Delta, including Eyak River, Ibeck Creek, and Alaganik Slough. Many residents also fished for returning hatchery coho salmon at Fleming Spit, which is not far from downtown Cordova.

The estimated sport fish effort by Cordova residents on the West Copper River Delta ranged from 2,392 to 4,720 angler-days (table 8). In general, there was a decreasing trend in effort from 2004 through 2006 in all stream systems except Ibeck Creek, which had higher levels of effort in 2005 (table 8, fig. 10). Eyak River, Ibeck Creek, and Alaganik Slough had the most effort and made up approximately 90 percent of all effort reported on the West Copper River Delta. The East Copper River Delta received much less use, with effort ranging from 22 to 144 angler-days. Effort was greatest in 2004 for both regions of the Copper River Delta.

Table 7—Household response information (a) and mean response attributes for the responding households (b) that were sent mail-in questionnaires, 2004–2006

(a)

Year	Households sent survey	Households responding to mailing 1	Households responding to mailing 2	Households surveyed by telephone	Households responded	Households that fished
2004	711	264	125	NA[a]	55%	50%
2005	746	259	84	40	46%	44%
2006	759	267	102	75	49%	35%
Total	2216	790	311	115	—	—

[a] Telephone surveys were not done in 2004.

— = Total percentages not calculated.

(b)

	Year							
	2004		2005			2006		
	Mailing 1	Mailing 2	Mailing 1	Mailing 2	Telephone	Mailing 1	Mailing 2	Telephone
Percentage of households that fished	49	50	43	44	33	37	32	37
Angler-day/ household	6.2	3.6	3.5	5.3	5.1	3.1	3.9	3.2
People/ household	2.5	2.7	2.4	2.7	2.9	2.4	2.1	2.6
People fished/ household	1	1.1	0.8	0.8	0.9	0.7	0.5	0.8

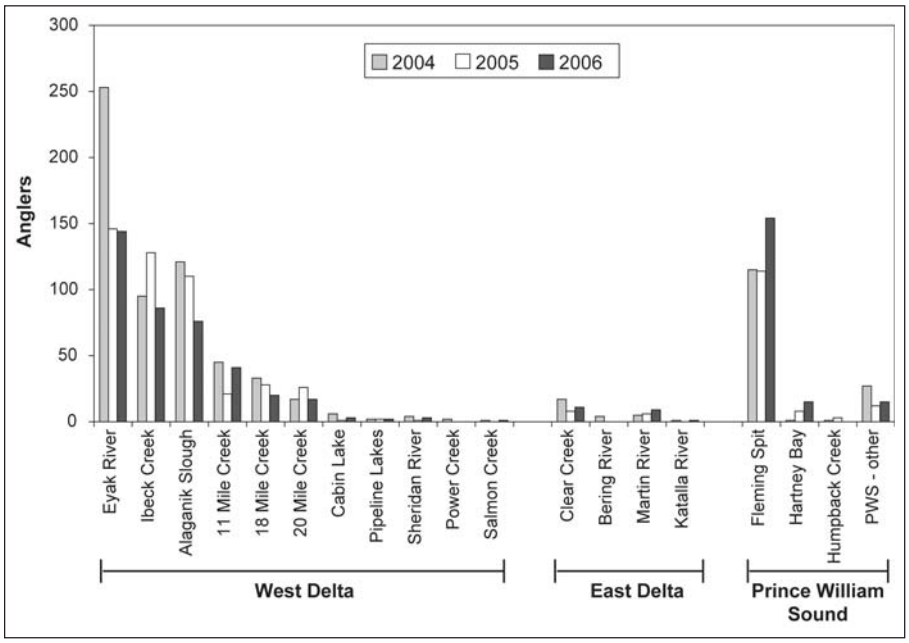

Figure 12—Number of Cordova resident anglers and locations that they fished over the years 2004 through 2006. Locations are grouped into three regions.

Table 8—Estimated effort for Cordova residents on the Copper River Delta during the coho salmon fishing season in August and September, 2004–2006

	Angler-days for year (SE)		
Location	**2004**	**2005**	**2006**
West Delta:			
Eyak River	3,073	1,081 (608)	1,038 (186)
Ibeck Creek	538	1,327 (550)	717 (194)
Alaganik Slough	625	550 (126)	383 (106)
11 Mile Creek	212	163 (111)	149 (28)
18 Mile Creek	124	48 (0)	49 (9)
20 Mile Creek	111	111 (56)	48 (28)
Cabin Lake	11	1 (0)	5 (0)
Sheridan River	6	1 (0)	3 (4)
Pipeline Lakes	4	2 (0)	1.5 (0)
Salmon Creek	2	—	0.5 (0)
Power Creek	11	—	—
West Delta total	4,720	3,298 (650)	2,392 (361)
Road system	5,969	3,987 (656)	3,695 (330)
East Delta:			
Clear Creek	56	16 (9.2)	40 (24)
Martin River	85	7 (0)	18 (0)
Katalla River	4	—	1 (0)
East Delta total	144	22 (9)	53 (24)

— = No anglers reported fishing this location in this year.

SE = Standard error.

On average, local anglers harvested 64 percent of all fish that were caught annually.

The catch of coho salmon on the West Copper River Delta by local anglers ranged from 2,116 to 6,033 over the 3 survey years (table 9), while annual harvests ranged from 1,454 to 3,493. On average, local anglers harvested 64 percent of all fish that were caught annually. Yearly catch and harvest numbers for residents decreased from 2004 through 2006 (table 9). Most coho salmon were caught on the West Copper River Delta streams, especially in Eyak River, which contributed 55 percent of the whole Copper River Delta catch (table 9).

Some of the other fish species caught and harvested by Cordova resident anglers included cutthroat trout, rainbow trout, Dolly Varden, pink salmon, and sockeye salmon (table 10). Dolly Varden, cutthroat trout, and sockeye salmon were mainly caught in the Eyak River, Ibeck Creek, and Alaganik Slough. Cutthroat and Dolly Varden were also taken in 18 Mile and 20 Mile Creeks. The rainbow trout were caught in Martin River on the East Copper River Delta. Cutthroat trout appear

Table 9—Estimated catch and harvest of coho salmon (± 1 SE) by Cordova residents on the Copper River Delta in August and September, 2004–2006

	Year					
	2004[a]		2005		2006	
Stream system	Catch	Harvest	Catch	Harvest	Catch	Harvest
West Delta:						
Eyak River	4,396	2,478	1,377 (325)	468 (189)	1,003 (190)	690 (154)
Ibeck Creek	400	230	930 (254)	769 (184)	497 (122)	307 (92)
Alaganik Slough	813	543	765 (165)	637 (189)	254 (80)	224 (80)
11 Mile Creek	112	77	184 (23)	159 (20)	118 (23)	83 (23)
18 Mile Creek	241	127	108	75	65 (5)	45 (5)
20 Mile Creek	37	31	333 (231)	111 (50)	119 (83)	99 (83)
Cabin Lake	4	0	3	0	0	0
Sheridan River	26	7	1	0	52 (46)	0 (0)
Pipeline Lakes	0	0	0	0	0	0
Salmon Creek	0	0	—	—	3	3
Power Creek	0	0	—	—	—	—
West Delta total	6,033	3,493	3,712 (595)	2,741 (442)	2,116 (245)	1,454 (207)
Road system	8,078	4,413	4,403 (627)	3,245 (453)	3,056 (283)	2,145 (243)
East Delta:						
Clear Creek	236	28	33 (28)	32 (28)	49 (41)	49 (41)
Martin River	22	7	15	4	86	10
Bering River	18	2	—	—	—	—
Katalla River	11	11	—	—	5	0
East Delta total	312	75	48 (28)	36 (28)	140 (41)	59 (41)

[a] There was no variance component in the 2004 estimates.

— = No anglers reported fishing this location in this year.

SE = Standard error.

Table 10—Reported catch and harvest of species other than coho salmon (in number of fish) by Cordova residents[a] on the Copper River Delta in August and September, 2004–2006

	Year					
	2004		2005		2006	
Species	Catch	Harvest	Catch	Harvest	Catch	Harvest
West Delta:						
Dolly Varden	163	31	120	40	117	24
Cutthroat trout	146	70	96	55	46	31
Rainbow trout	0	0	0	0	0	0
Pink salmon	6	1	67	9	4	2
Sockeye salmon	172	165	60	54	169	134
East Delta:						
Dolly Varden	21	2	5	4	13	10
Cutthroat trout	43	0	5	0	4	0
Rainbow trout	5	0	0	0	7	0
Pink salmon	0	0	0	0	1	0
Sockeye salmon	146	70	0	0	1	0
Total Copper River Delta:						
Dolly Varden	184	33	125	44	130	34
Cutthroat trout	189	70	101	55	50	31
Rainbow trout	5	0	0	0	7	0
Pink salmon	6	1	67	9	5	2
Sockeye salmon	318	235	60	54	170	134

[a] Data based only on those households responding to the survey and not estimated for all Cordova households.

to be targeted for harvest on the West Copper River Delta by some local anglers. Approximately 54 percent of the cutthroat trout caught were harvested. Most of the cutthroat trout harvest occurred on Eyak River, Alaganik Slough, and 18 Mile and 20 Mile Creeks.

The state of Alaska's participation, catch, and harvest data (http://www.sf.adfg.state.ak.us/Statewide/ParticipationAndHarvest/main.cfm) had similar catch and harvest estimates for select streams on the Copper River Delta (table 11). However, the effort estimates in the ADF&G sport fish mail-in survey were generally higher (table 11) as the survey includes all potential users over the entire year rather than just the 2-month period during the coho salmon season as in this study. It is important to note that the ADF&G mail-in surveys require a minimum number of responses at a given location before reliable estimates are made for that location. Thus, only those streams with reliable estimates on the Copper River Delta are shown and compared in table 11.

Cordova residents also had a wide variety of comments regarding sport fish use on the Copper River Delta. The comments were made by a total of 91 households.

Table 11—Alaska Department of Fish and Game (ADF&G)[a] and U.S. Forest Service (USFS)[b] comparison of sport fish effort and catch and harvest of coho salmon on select streams of the Copper River Delta, 2004–2006

	Year								
	2004			2005			2006		
Stream system	Angler-days	Catch	Harvest	Angler-days	Catch	Harvest	Angler-days	Catch	Harvest
ADF&G									
Eyak River	7,982	25,746	10,234	4,832	10,639	5,228	5,332	6,579	3,328
Ibeck Creek	—	—	—	1,615	4,120	2,437	1,066	1,803	913
Alaganik Slough	2,629	13,032	3,843	1,754	4,049	1,777	2,255	2,237	1,236
USFS									
Eyak River	5,816	21,338	8,615	2,890	6,019	3,337	2,907	7,218	3,783
Ibeck Creek	1,027	2,347	905	3,441	10,707	5,524	2,523	6,417	2,509
Alaganik Slough	2,154	11,751	3637	1,969	5,335	2,760	1,248	2,090	1,169

[a] ADF&G estimates were generated from the annual state of Alaska mail-in sport fish survey, and cover an entire year. Source: http://www.sf.adfg.state.ak.us/Statewide/ParticipationAndHarvest/main.cfm.

[b] USFS estimates are the summation of both resident and nonresident anglers over the 2-month period (August through September) of each year.

— = Responses were not sufficient to develop estimates for this location for this year.

The issues and general concerns associated with the comments fell into the same five categories as those for the nonresident anglers, even though some of the subject matter differed.

The issues and general concerns associated with the comments fell into the same five categories as those for the nonresident anglers, even though some of the subject matter differed. For instance, in the law enforcement category, some local respondents wanted limits on the total amount of fish that are taken by nonresident users. Others were dissatisfied with guides bringing large groups of anglers out onto the Copper River Delta. In the crowds and concentrated use category, several respondents felt that the area has become too crowded, and consequently, they no longer enjoy the fishing experience.

Discussion

This study provides some of the first information on the amount, timing, and spatial patterns of sport fish use across national forest lands of the Copper River Delta. Similar studies have used aerial count surveys in conjunction with access site creel surveys to provide estimates of effort, catch, and harvest over a large area or body of water (McNeish and Trial 1991, Pollock et al. 1994). Lockwood et al. (2001) used aerial counts and interviews to determine sport use attributes in Isle Royale National Park, Michigan. The main concern in that study was the sport harvest of a sensitive fish species. The Copper River Delta study describes sport fish use across a large land and river network that has a special management emphasis on the conservation of fish and wildlife resources (ANILCA 1980). The baseline

data obtained will help to proactively manage sport fish use and the critical coho salmon resources of the area as access and popularity as a sport fishing destination increase. This data collection was an important first step in documenting current conditions so that future trends can be monitored and accurately evaluated.

The aerial counts were done to provide an index of sport fish use rather than to generate estimates of effort. Usually estimates of effort are computed from the expansion of point count data taken during aerial surveys (Lockwood et al. 2001, Pollock et al. 1994). Index counts, on the other hand, provide measures such as mean counts per flight and peak counts for the season. These attributes can be compared over time to monitor general trends. The large study area would have required great effort to conduct on-the-ground interviews in conjunction with the aerial flights. This study relied on other survey methods to estimate the effort, catch, and harvest of the sport fishery, whereas the aerial counts focused on trend monitoring.

The aerial angler counts were affected by weather, but the results still provide an index of use and capture peak periods of fishing. Flights did not occur during periods of poor weather, but it was assumed that use was likely lower in poor weather, and that peak use most likely occurred during the best weather when flights were conducted. Peak use is important to know when dealing with index counts, trend monitoring, and carrying capacity issues. Ground counts of anglers during days that flights are canceled could be done in the future to verify the assumption that use was low during periods of poor weather.

The high use observed in 2004 can be attributed to strong returns of fish, good weather conditions, and low water that improved fishing. Aerial survey counts by ADF&G in 2004 estimated 54,585 coho salmon in the three main river systems (Eyak, Ibeck, and Alaganik) (Ashe et al. 2005). This estimate was well above the 10-year-average (1994–2003) escapements for coho salmon. Precipitation was well below normal for August and the first two weeks of September (NOAA Satellite and Information Service: http://cdo.ncdc.noaa.gov/pls/plclimprod/poemain.cdobystn). The lack of heavy precipitation resulted in low, clear water conditions in the streams, producing excellent fishing and attracting large numbers of anglers.

The amount of sport fish use was closely linked to run timing in the major stream systems. Anglers went to locations where fish were present.

Not surprisingly, the amount of sport fish use was closely linked to run timing in the major stream systems. Anglers went to locations where fish were present. What is surprising is that it appears nonresidents are as aware of the locations and run timing as residents. This information about where the “fish are in” is probably transferred to anglers quickly through word of mouth from angler to angler and

Our results indicate that a large majority of the nonresident anglers arrived by airplane rather than the ferry, and that current levels arriving via air could be at maximum capacity.

through the hotels and lodges where they stay. Many nonresidents may also be fishing or staying with residents, and thus have the benefit of local knowledge regarding run timing and locations.

Our results indicate that a large majority of the nonresident anglers arrived by airplane rather than the ferry, and that current levels arriving via air could be at maximum capacity. At the airport, the number of nonresidents surveyed, the percentage who fished, and their levels of effort were relatively constant across the survey years (2004 to 2006). The departing airplanes appeared to be full during much of the coho salmon season. It seems possible that seat capacity on the arriving and departing airplanes may play a major role in the amount of sport fish use on the Copper River Delta. The availability of hotel or other lodging amenities may also be a factor. At the ferry, over twice as many nonresidents were surveyed in 2005 and 2006 compared to 2004. More nonresidents came to Cordova via the ferry when the service increased, but they did not fish. The percentage of nonresidents who fished decreased in the 2005 and 2006 ferry surveys. There appears to be an increase in nonresident visitors to Cordova via the ferry as was expected; however, there has not yet been a subsequent increase in sport fish use from this population.

Effort by local residents decreased over the 3 years of the survey, while the nonresident effort remained at approximately the same level. Participation by local resident anglers may have decreased for a number of reasons including dissatisfaction with the fishing experience and recent changes in the federal subsistence regulations. Some comments by local residents referred to the crowded conditions, especially in 2004 on the Eyak River. The decreasing trend may also have resulted from higher than normal numbers of anglers in 2004 simply because of the good fishing conditions. In 2005, the Forest Service began to issue federal subsistence permits to local residents. Residents with this permit could fish for salmon with a hook and line during the season, and were required to report harvests to the Forest Service (Joyce 2005). The decreasing trend might occur if more local residents were using subsistence permits and those individuals did not respond to the mail-in survey. However, this is unlikely based on the reported effort by subsistence users (Joyce 2005).

Nonresident anglers caught, harvested, and selectively harvested more coho salmon than resident anglers. Nonresident anglers released approximately half of the coho salmon that they caught, whereas local anglers harvested more fish than they released. It is possible that local anglers fished to harvest fish, and did not continue to fish long after a limit was obtained. Nonresident anglers who might

not be accustomed to high catch rates continued to catch and release fish after limits were obtained. At least at the airport, many of the nonresident anglers seemed to be in Cordova specifically to fish and had plenty of time to spend fishing on the streams. The different fishing attitudes regarding retention and release of salmon between local and nonresident anglers may also contribute to conflicts between the user groups.

In 2003, the Alaska State Board of Fisheries enacted special handling regulations on the Copper River Delta that require all fish to remain in the water at all times prior to release (http://www.sf.adfg.state.ak.us/statewide/regulations/2005/southcentral/PDFs). This regulation was an attempt to increase the survival of released fish by reducing injury and stress. It is not known how many users are complying with the regulation. Fish and wildlife enforcement on the Copper River Delta is handled by ADF&G, the Alaska State Troopers, and the Forest Service. However, it is a large area and both local and nonresident respondents commented on the lack of enforcement of the current regulations regarding limits and selective harvest. To help inform sport fish users of the regulations, the Forest Service and ADF&G have created brochures that include detailed methods for selectively harvesting fish.

The mortality associated with the selective harvest of fish was not included in the harvest estimates for this study, although some level of mortality most certainly occurred.

The mortality associated with the selective harvest of fish was not included in the harvest estimates for this study, although some level of mortality most certainly occurred. Fish mortality from selective harvest depends on many factors (Muoneke and Childress 1994), including fish size (Bendock and Alexandersdottir 1993, Wertheimer 1988), water temperature (Dempson et al. 2002), and fishing methods (Bendock and Alexandersdottir 1993). On the Copper River Delta, wide ranges of fishing methods are employed and the environmental conditions can differ at fishing locations during the coho salmon season. A detailed study of selective harvest methods across the delta would be necessary to accurately determine the additional mortality of coho salmon in this sport fishery.

The mail-in surveys may not have reached all households in Cordova as not all residents may have had phone service. The assumption that all local households had a telephone may underestimate the levels of use for residents. From 711 to 759 households were sent surveys each year based on the Cordova Telephone Cooperative file. The U.S. Census data indicated that 957 households were present in Cordova in the year 2000 (U.S. Census Bureau 2000). However, recent population estimates made by the state of Alaska indicated a slight drop in the local population since 2000. The smaller number of households surveyed than indicated by the 2000 census could be due to a reduced population and because some households did not have phone service.

The telephone service database did provide all the information needed to reach most Cordova households and complete followup telephone interviews with nonrespondents. At the time of this survey, cell phone coverage was limited in the area, and most residents still relied on land-based phone lines for communication (i.e., most households had a phone line). In the future, improved cell phone coverage may reduce the number of individuals with local phone service and thereby make it impossible to estimate local use with the same methods.

Other methods for estimating local sport fish use were considered, including using the state of Alaska sport fishing license file. This was ultimately rejected because the license information was for the previous year, which could interject recall bias. Also, the sport fishing file did not have complete addresses or telephone numbers of all the license purchasers, information which was necessary to do a complete survey of local residents and obtain followup telephone interviews.

Results of this study differed from those of the ADF&G mail-in surveys regarding use at Ibeck Creek during the years 2005 and 2006. Our effort, catch, and harvest estimates were much higher, with Ibeck Creek showing the greatest use in 2005. Other reports of human use in the area also indicate that levels were high in 2005. The Copper River Watershed Project, a local nonprofit organization, monitored vehicle use at locations on the West Copper River Delta during the 3 years of this study. They reported that vehicle counts at Ibeck Creek in 2005 were some of the highest observed (FishWatch 2007). Ibeck Creek may have been an underreported fishing location in the ADF&G mail-in survey because it is known by several names (Ibeck Creek, Ibeck River, 7 Mile Creek). It is also close to the Eyak River, which might cause confusion for nonresidents. Even with a map it may be difficult for those unfamiliar with the area to accurately report this location unless they talked with someone familiar with the area in person as was done in this survey.

The comments from local and nonresident respondents indicate that sport fish use is important to the local community as well as nonresidents to the area. Conflicts between the two user groups appear to be growing and are expected to continue (Campbell 2007, Cordova Times 2004). Addressing the issues raised in these comments may help reduce user conflict in the future.

Management Implications

Concentrated Use

The Chugach National Forest Revised Land and Resource Management Plan provides direction for the management of recreation on the Copper River Delta.

The Recreational Opportunity Spectrum (ROS) classes found within this plan are a conceptual management tool that places possible mixes or combinations of activities, settings, and probable experience opportunities along a spectrum or continuum (Clark and Stankey 1979). The continuum ranges from Primitive to Urban, with Semi-Primitive Motorized (SPM) lying in the middle of the continuum. In the SPM ROS class, recreational opportunities are generally available within half a mile of a road or moderately traveled waterway and the recreational user is expected to come in contact with 6 to 10 parties per day (USDA FS 1986).

In some years, the observed level of use on Eyak River, Ibeck Creek, and Alaganik Slough came close to meeting maximum carrying capacity standards based on the designated ROS classification. The peak aerial counts during the study were 70 (Eyak), 68 (Ibeck), and 64 (Alaganik) people at one time within 3- to 4-km sections of these rivers. Using the methods developed for the Chugach National Forest, the estimated carrying capacity for a 4-km stretch of river on the West Copper River Delta would have an upper limit of approximately 50 people at one time (USDA FS 1994). Peak counts at Eyak River and Ibeck Creek were over 50 people in 2 out of 4 years, and it is likely that flights missed some periods of peak use.

Some of the highest levels of sport fish use were observed in 2004. That year, use was concentrated at Eyak River, and some anglers expressed dissatisfaction with the fishing experience. Aerial counts found that use was at or above carrying capacity (over 50 people at one time) for several days during the 2004 season. Low water conditions had most of the fish concentrated in deep pools or channels and anglers targeted those locations. Even though 50 people may be counted in a 3- to 4-km section of river, there may be 20 to 30 people fishing at one pool, very close to each other. For some anglers this situation was not desirable and this level of use may be above the desired conditions set forth in the Revised Land and Resource Management Plan (USDA FS 2002). However, this level of use only occurred over a very short period: a few days or weeks of the entire year, assuming use at other times of the year was less. Most fishing locations on the rest of the West Copper River Delta had far less use, and anglers wishing to encounter fewer people had plenty of options.

Habitat Degradation

Concentrated recreation often affects fisheries habitat when banks get trampled and eroded such that channels are widened, sediment is flushed into spawning gravels,

Current levels of recreational use are causing some localized habitat degradation on the three main river systems, but the overall impact on the habitat is small.

or both (Clark and Gibbons 1991, King and Clark 2004). Current levels of recreational use are causing some localized habitat degradation on the three main river systems, but the overall impact on the habitat is small. The main fishing areas are downstream of spawning habitat, so the potential for erosion and sediment to affect egg and embryo survival is low.

Where use is concentrated on the three stream systems, there are already high erosion and sediment loads owing to natural processes. The concentrated use occurs in stream reaches characterized by low gradient glacial channels in the GO1 channel type (glacial outwash flood-plain side channel) (USDA FS 1992). These channels frequently migrate across the floodplain and contain a large amount of naturally eroded and unstable streambanks. In addition, recent tectonic activity (the 1964 earthquake) in the area uplifted the Copper River Delta approximately 1.8 m (6 ft), resulting in down-cutting of the stream channels and further bank erosion. If angler use remains in the lower reaches of these channels, the potential for shoreside habitat degradation will be low. Hardened trails and other means of bank protection such as revegetation could minimize impacts at selected high traffic areas.

Most of the sport fish use on Eyak River was from boats, so there is very little concern about bank trampling from high volume foot traffic along the streambanks. When anglers were out of boats, they tended to stand on sandbars within the stream channel and thus not affect the riparian bank area. At Alaganik Slough, most of the anglers use a Forest Service access trail to reach the stream. This trail directs people to several open sandbars where anglers tend to stay. These stream sections are dominated by sand substrates and are used as a migratory corridor, but not for spawning by salmon.

Some areas on the West Copper River Delta are susceptible to habitat degradation if use increases or expands in the future. In 2006, anglers fished further upstream on Ibeck Creek than had been previously observed, but still below coho salmon spawning habitats. During aerial surveys, observers noted that angler trails were being established over the course of the season, which could lead to riparian and bank damage. Angler use does overlap with spawning habitats on 18 Mile Creek and some of the upper Alaganik system. These flood-plain channel types provide important juvenile salmon rearing habitat and can be susceptible to impacts from concentrated use (USDA FS 1992). These areas should be monitored closely in the future.

Coho Salmon Populations and Harvest Levels

Based on ADF&G estimates, there were strong returns of coho salmon to the Copper River Delta streams over the 3 years of the surveys (Botz et al. 2008). The return of 2004 was particularly large (685,060 fish), which corresponds with the highest catch and harvest estimates during this study. Ibeck Creek had consistently high numbers through the 3 years, with peak counts of 32,000 to 36,300 coho salmon (Botz et al. 2008). Sport fish harvest levels on this system were relatively small and likely would not adversely affect the population.

At Alaganik Slough and Eyak River, escapement indices indicate that coho salmon numbers decreased over the 3 years (Botz et al. 2008), and there was a concurrent decrease in the levels of fish taken through sport harvest. However, harvests on these streams in 2005 and 2006 made up a relatively large fraction of the escapement. On Eyak River, the sport harvest surpassed the escapement index in both years (ADF&G escapement indices = 2,852 and 2,460, respectively). The actual number of fish in the system was likely greater because the escapement indices are only peak counts, and they greatly depend on weather, water conditions, and observer efficiency (Botz et al. 2008). All of these factors probably contributed to the low escapement numbers observed in these systems, given the amount of sport fish catch and harvest.

The sport harvest of coho salmon on the Copper River Delta over the study period was only a small fraction of the total commercial harvest. Commercial harvests of coho salmon on the Copper River District were 467,859 in 2004, 263,465 in 2005, and 318,285 in 2006 (Botz et. al 2008). With this study, the sport harvest on the Copper River Delta over the same 3 years was estimated to be 15,077 in 2004, 14,301 in 2005, and 9,298 in 2006 (East and West Delta combined). The average sport harvest was 3.8 percent of the commercial harvest during this time.

Cumulative effects from commercial and sport fish harvests, and the potential for habitat degradation on small streams, are a concern for the delta's coho salmon populations. Water turbidity and canopy cover make escapement estimates on some of these streams using aerial surveys difficult. On years with low escapement, concentrated sport, commercial, and subsistence effort and harvest on stocks bound for small streams can limit spawning numbers and therefore reduce juvenile production potential for the next 1 to 2 years. Harvest and escapement monitoring programs should continue or be improved in some small systems in order to document levels of use and evaluate population trends. Ensuring escapement into these small systems will help to maximize the production of smolts for future returns.

Cumulative effects from commercial and sport fish harvests, and the potential for habitat degradation on small streams, are a concern for the delta's coho salmon populations.

The ADF&G mail-in surveys are the best monitoring tool for coho salmon harvest in large systems where the response rates are high. The Forest Service does not need to duplicate this effort in the future. However, in small streams that have low levels of use, and if overharvest becomes a concern owing to small population size, there should be an alternative method for obtaining estimates. Additional efforts to monitor coho salmon harvests and escapements on the Copper River Delta should concentrate on these small populations and be headed by the ADF&G. In such cases, onsite creel surveys targeting a particular stream would probably be best, and the Forest Service could provide valuable assistance in data collection with these surveys.

User Conflicts, Safety, and Infrastructure

Conflict between boat traffic and anglers standing in the river channel on Eyak River is increasing. This river is relatively shallow with meandering deep channels. It is primarily accessed by boat and has considerable boat traffic during the coho salmon fishing season. Many of the boats are powered with water jet units because of the shallow water. Jet boats operate best at high speed in shallow waters to prevent grounding and for additional maneuverability. During low-water periods, shore-based anglers are able to wade into the main channels, creating a hazard for both the jet boat operator and the angler. There have been instances of boats nearly running over anglers (Cordova Times 2004). To address the safety concerns of the boats and anglers, interpretive signs were installed at access points to the river, and brochures that warned of the hazards and recommended preventative actions were created and distributed to anglers.

Limited vehicle parking at the Ibeck Creek Bridge on the Copper River Highway has created unsafe conditions for anglers. The highway and a small segment of adjacent land is a state right-of-way managed by the Alaska Department of Transportation. Up to 30 vehicles have been parked along the road at one time (FishWatch 2007). The highway shoulder does not provide sufficient room for parked vehicles to remain totally clear of the highway surface. Pedestrian traffic can be heavy in the area as well. This unsafe condition needs to be addressed to reduce the potential for serious accidents.

Access problems, congestion, and unsafe conditions at the Eyak River and Alaganik Slough boat ramps also exist. Both ramps are Forest Service recreation sites. The Eyak ramp is poorly located, making it difficult to launch boats. Traffic flow is not directed in the parking and ramp area, which also complicates launching boats. The boat ramp at Alaganik Slough has buckled and deteriorated, and the

exposed reinforcement bar makes launching a boat difficult. Sand has covered most of the lower section of the boat ramp, rendering it unusable during low water. Many boaters back their boat trailer off the side of the ramp through large rocks to access water deep enough to launch a boat. The boat ramp area is also used as a camping site during the peak coho salmon season, which reduces the parking area available for vehicles and boat trailers.

Options for Managers

The fishery for coho salmon on the West Copper River Delta provides valuable recreational opportunities for residents and visitors. Additionally, it generates economic benefits to the local community. Potential options to protect and sustain this fishery include:

1. Aerial surveys could be conducted every 3 years to monitor sport fish use and changes over time on the West Copper River Delta.
2. Detailed stream surveys could be done to document current habitat conditions on streams where spawning areas overlap with current sport fish use (e.g., 18 Mile and Upper Alaganik).
3. All coho salmon spawning habitat on the West Copper River Delta could be documented. Sport fish users could be made aware of these areas by signs, maps in fishing brochures, and notification of guides and lodges. Users could be encouraged to avoid spawning areas: this information could be added to the ADF&G Anadromous Waters Catalog to provide necessary protection.
4. Work could be done with a local citizen action group to discuss issues and assist in management of the sport fish use in the area. Issues include safety on Eyak River, selective harvest, enforcement, interpretive and education opportunities, and improvements at sites.
5. Agency presence on the Eyak River, Ibeck Creek, and Alaganik Slough could be increased by hiring hosts or interpreters. These individuals could provide interpretation and education services to nonresidents, including current regulations and proper catch-and-release methods. They could also document and report violations to the appropriate law enforcement officers. The presence of an authority figure might deter potential illegal activities.
6. Law enforcement presence could be increased, and salmon harvest and selective harvest regulations enforced on Eyak River, Ibeck Creek, and Alaganik Slough.

7. Work with the Forest Service recreation and engineering departments, and the Alaska State Department of Transportation could improve access safety while considering long- and short-term recreation use goals.

8. A study on the mortality associated with selective harvest of coho salmon using several gear types could be developed with ADF&G.

9. The Forest Service could collaborate with ADF&G and the Copper River Watershed Project's Fish Watch Program to develop a small-stream monitoring crew that conducts ground escapement counts in stream systems where it is difficult to count fish with aerial surveys. This would result in a more accurate estimate of spawning numbers, which could be used to improve management of small stocks at risk of overharvest and habitat degradation.

10. The data reported in this study, and all future data, could be made available to other resource agencies and to the public through open meetings, written reports available upon request, and electronically through the Chugach National Forest Web site.

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English Equivalents

When you know:	Multiply by:	To find:
Kilometers (km)	0.621	Miles
Meters (m)	3.2808	Feet

References

Alaska National Interest Lands Conservation Act [ANILCA] of 1980; 94 Stat. 2371; 16 U.S.C 410.

Ashe, D.; Lewis, B.; Merizon, R.; Moffitt, S. 2005. Prince William Sound Management Area 2002 annual finfish management report. Regional Information Report No. 2A05-05. Anchorage, AK: Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. 200 p.

Ben-David, M.; Hanley, T.A.; Klein, D.R.; Schell, D.M. 1997. Seasonal changes in diets of coastal and riverine mink: the role of spawning Pacific salmon. Canadian Journal of Zoology. 75: 803–811.

Bendock, T.; Alexandersdottir, M. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management. 13: 540–549.

Bernard, D.R.; Bingham, A.E.; Alexandersdottir, M. 1998. The mechanics of onsite creel surveys in Alaska. Special Publ. No. 98-1. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. 136 p.

Botz, J.; Brenner, R.; Hollowell, G.; Lewis, B.; Moffit, S. 2008. 2006 Prince William Sound finfish management report. Regional Information Report No. 08-30. Anchorage, AK: Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. 213 p.

Brinckerhoff, P. 2001. Prince William Sound area transportation plan. Alaska Department of Transportation and Public Facilities. Final edition. 82 p. http://www.dot.state.ak.us/stwdplng/areaplans/pub/pwsfinal7-01.pdf. (15 October 2009).

Bustard, D.R.; Narver, D.W. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Salmo clarki*). Journal of the Fisheries Research Board of Canada. 32: 667–680.

Campbell, B. 2007. Personal communication. Special use permit officer, USFS Chugach National Forest, Cordova Ranger District, P.O. Box 280, Cordova, AK 99574.

Carnes, J.C. 2004. Wolf ecology on the Copper and Bering River Deltas, Alaska. Moscow, ID: University of Idaho. 386 p. Ph. D. dissertation.

Clark, R.N.; Gibbons, D.R. 1991. Recreation. In: Meehan, W., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society: 459–481.

Clark, R.N.; Stankey, G.H. 1979. The recreation opportunity spectrum: a framework for planning, management, and research. Gen. Tech. Rep. PNW-98. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 32 p.

Cordova Times. 2004. First alarming signs of combat fishing appear on the Eyak. September 16; Page 5: (col. 1-5), Page 7: (col. 1-3).

Culver, R. 2002. Coho awakening. Silvers in the salt. Fish Alaska Magazine. 2(7): 50.

Cunjak, R.A. 1996. Winter habitat of selected stream fishes and potential impacts from land-use activity. Canadian Journal of Fisheries and Aquatic Sciences. 53(Suppl. 1): 161–180.

Dempson, J.B.; Furey, G.; Bloom, M. 2002. Effects of catch and release angling on Atlantic salmon, *Salmo salar* L., of the Conne River, Newfoundland. Fisheries Management and Ecology. 9(3): 139–147.

FishWatch. 2007. Five year summary report 2002–2006: habitat and water quality monitoring in the Copper River Watershed. On file with: Copper River Watershed Project, 511 First Street, Cordova, AK 99574. www.copperriver.org. (15 October 2009).

Hicks, B.J.; Wipfli, M.S.; Lang, D.W.; Lang, M.E. 2005. Marine-derived nitrogen and carbon in freshwater-riparian food webs of the Copper River Delta, southcentral Alaska. Oecologia. 144(4): 558–569.

Hodges, K.; Buckley, K. 1994. Mile 18 Creek habitat survey and application of a coho salmon production model. Unpublished report. On file with: USDA Forest Service, Chugach National Forest, Cordova Ranger District, 612 2nd Street, Cordova, AK 99574.

Hollowell, G.; Lewis, B.; Merizon, R.; Moffitt, S. 2007. 2005 Prince William Sound Area finfish management report. Fishery Management Report No. 07-33. Anchorage, AK: Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. 203 p.

Howe, A.L.; Fidler, G.; Bingham, A.E.; Mills, M.J. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Fisheries Data Series Report No. 96-32. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. 146 p.

Joyce, T. 2005. Personal communication. Subsistence biologist, Cordova Ranger District, Chugach National Forest, 612 2nd Street, Cordova, AK 99574.

King, M.A. 2002. Kenai River riparian habitat studies. Anchorage, AK: Alaska Department of Fish and Game. 76 p.

King, M.A.; Clark, R. 2004. Kenai River riparian habitat assessment. Report to the Alaska Board of Fisheries, 2005. (December 2004) Anchorage, AK: Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. 34 p.

King, M.A.; Hansen, P. 1999. Assessment of angler impacts to Kenai River riparian habitats, 1997. Fishery Data Series Report No. 99-9. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. 69 p.

Lang, D.W.; Reeves, G.H.; Hall, J.D.; Wipfli, M.S. 2006. The influence of fall-spawning coho salmon (*Oncorhynchus kisutch*) on growth and production of juvenile coho salmon rearing in beaver ponds on the Copper River Delta, Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 63(4): 917–930.

Lockwood, R.N.; Peck, J.; Oelfke, J. 2001. Survey of angling in Lake Superior waters at Isle Royale National Park, 1998. North American Journal of Fisheries Management. 21: 471–481.

Marston, B.H. 2004. Personal communication. Area sportfish biologist, Alaska Department of Fish and Game, P.O. Box 669, Cordova, AK 99574.

Marston, B.H. 2005. Area management report for the recreational fisheries of the Prince William Sound Management Area, 2005. Fishery Management Report No. 05–61. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. 75 p.

McNeish, J.D.; Trial, J.G. 1991. A cost-effective method for estimating angler effort from interval counts. American Fisheries Symposium. 12: 236–243.

Miller, M.A.; Stratton, B.L. 2001. Area management report for the recreational fisheries of the Prince William Sound Management Area, 2000. Fishery Management Report No. 01-8. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. 88 p.

Muoneke, M.I.; Childress, W.M. 1994. Hooking mortality: a review for recreational fisheries. Reviews in Fisheries Science. 2(2): 123–156.

New York Times. 2002. Good Alaska fishing comes with time. September 22. Outdoors section.

New York Times. 2003. If a bear knocks, don't answer. August 24. Travel section.

Pollock, K.H.; Jones, C.M.; Brown, T.L. 1994. Angler survey methods and their applications in fisheries management. Special Publication 25. Bethesda, MD: American Fisheries Society. 371 p.

Richey, J.D. 2008. Cordova's roadside coho. Fish Alaska Magazine. 8(2): 48.

Roberts, B.C.; White, R.G. 1992. Effects of angler wading on survival of trout eggs and pre-emergent fry. North American Journal of Fisheries Management. 12(3): 450–459.

Southwick Associates Inc.; Romberg, W.J.; Bingham, A.E.; Jennings, G.B.; Clark, R.A. 2008. Economic impacts and contributions of sportfishing in Alaska, 2007. Professional Paper No. 08-01, Anchorage, AK: Alaska Department of Fish and Game.

Suttle, K.B.; Power, M.E.; Levine, J.M.; McNeely, C. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications. 4: 969–974.

Tappel, P.D.; Bjornn, T.C. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management. 3(2): 123–135.

U.S. Census Bureau. 2000. Census 2000, Summary table DP-3; Geographic area: Cordova City, Alaska. http://censtats.census.gov/data/AK/1600217410.pdf. (15 October 2009).

U.S. Department of Agriculture, Forest Service [USDA FS]. 1986. 1986 ROS book. Washington, DC. 265 p.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1992. A channel type users guide for the Tongass National Forest. R10-Tp-26. Juneau, AK: Alaska Region.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1994. Recreation use carrying capacity analysis for the Cordova Ranger District. Cordova, AK: Alaska Region. 40 p.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1994-2008. Unpublished database of coho salmon escapement counts, 18 Mile Creek. On file with: Chugach National Forest, Cordova Ranger District, 612 2nd Street, Cordova, AK 99574.

U.S. Department of Agriculture, Forest Service [USDA FS]. 2002. Revised Land and Resource Management Plan: Chugach National Forest. Alaska Region Management Bulletin R10-MB-480c. Anchorage, AK: Chugach National Forest.

Wertheimer, A. 1988. Hooking mortality of Chinook salmon released by commercial trollers. North American Journal of Fisheries Management. 8: 346–355.

Willson, M.F.; Halupka, K.C. 1995. Anadromous fish as keystone species in vertebrate communities. Conservation Biology. 9: 489–497.

Willson, M.F.; Gende, S.M.; Marston, B.H. 1998. Fishes and the forest: expanding perspectives on fish-wildlife interactions. BioScience. 48: 455–462.

Wipfli, M.S. 1997. Terrestrial invertebrates as salmonid prey and nitrogen sources in streams: contrasting old-growth and young-growth riparian forests in southeastern Alaska, U.S.A. Canadian Journal of Fisheries and Aquatic Science. 54: 1259–1269.

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