UCIDA

United Cook Inlet Drift Association

43961 K-Beach Road, Suite E • Soldotna, Alaska 99669 • (907) 260-9436 • fax (907) 260-9438
• info@ucida.org •

RECEIVED
BOARDS

Date: January 24, 2011

Addressee: Alaska Board of Fisheries
PO Box 115526
Juneau, AK 99811

RE: Economic Summary Sheet

Dear Board of Fisheries Members,

Please review this two-page summary of the economic value of commercial fishing activities for the Kenai Peninsula. Numerical values from the Commercial Fisheries Entry Commission.

Thank you,

Roland Maw

Roland Maw, PhD
UCIDA Executive Director

ams

PC 7

The Integrated Fishing Community of the Kenai Peninsula

The Kenai is richly endowed with abundant renewable and non-renewable natural resources. In many ways we are an island community much like Kodiak. The Kenai Peninsula has a huge coastal area that is one of the largest in the United States. The Kenai has some of the most productive fresh and salt water fish habitat areas in Alaska. This productive and diverse resource base provides one of the economic foundations for our communities. Since World War II there have been thousands of families that have made the Kenai home and have economically invested in the infrastructure necessary for the production, harvesting, processing and marketing of these abundant fishery resources. Along with the fishery infrastructure, the families of Alaska and the Kenai have made very large economic investments to build a society comprised of the Borough schools, roads, banks, electrical, medical and transportation infrastructures. We have encouraged many families and small business owners involved in support industries to locate and develop on the Kenai.

Fishing Activity of the Kenai

Halibut:

One out of every three halibut (35%) caught in the entire Pacific Ocean are brought to the docks of the Kenai Peninsula. In 2008, there were 16,766,653 million pounds of halibut delivered. These halibut generate in excess of $300,000,000 of economic activity. As families are paid for harvesting these halibut, they in turn spend these funds throughout the Kenai, Anchorage and Alaskan economy for the purchase of goods and services.

Black Cod (Sablefish):

Most Alaskans are not familiar with this premium quality fishery. In 2008 there were 7,930,892 pounds of sablefish delivered across the Kenai Peninsula docks. These deliveries represent 30% of the total landing generating in excess of $70,000,000 of economic activity. Again, as the harvesters are paid, these families in turn purchase goods and supplies throughout Alaska. The 3,000,000 - 4,000,000 pounds of bait needed to harvest the 26,000,000 pounds of halibut and black cod are purchased locally. This bait industry is integrated into the halibut and black cod production.

Salmon:

The Kenai Peninsula has the second largest sockeye salmon fishery in the world. In 2008 the landings of salmon came to 97,395,505 pounds representing over $225,000,000 in economic activity. Like halibut and sablefish landings, these funds provide for families, schools, roads, professional services and governments all supported by the payment of taxes.

All seafood products from the Kenai or its residents collectively amount to over 158,731,633 pounds of seafood worth over a half a billion dollars. The integration of vessels, fuel stations, docks, ice plants, processing facilities, crews, processing workers, truck drivers, packaging, marketing, management and recordkeeping add thousands of jobs for Alaskan families. Millions of dollars are spent in Anchorage, the Mat-Su and the Kenai by all these harvesters, processors, workers and their families. There are dozens of semi-truck loads of packaging, cardboard boxes and plastic materials purchased in Anchorage in order to prepare these seafood products for shipment to the lower 48.

These harvesters and infrastructure workers are volunteer firemen and paramedics; they sit on assemblies, city councils, school boards, planning commissions and hundreds of local civic groups.

Economic New Money and Indirect Benefits

As seafoods from Kenai residents and the Peninsula enter the larger USA and world economy, there is a transfer of money from their economy to our local economy. These resources bring new money to the Kenai much the same as oil and gas when they are sold outside of Alaska. This new money is much different than money that already exists in the Kenai/Alaskan economy. Economic health and wealth are created as we bring new money to our economy, as compared to trading the same dollar back and forth.

Every semi truck or ocean container that leaves the Kenai loaded with seafood represents a savings for all of us. It costs us all to ship empty semis or containers back to the Lower 48. Every **full** semi or container going south helps to reduce the transportation costs to get groceries and consumable goods delivered into Alaska. This reduced freight subsidy generated by the export of over 3,000 truckloads of seafood annually is an economic blessing to all Alaskan families and businesses.

This 158,700,000 pounds of seafood produced by the Kenai provides for over 190,000,000 meals for Alaskans and families across America. It takes a well-integrated seafood industry to provide this quantity and quality of seafoods.

Kenai Peninsula Borough and Resident Landings 2006-2008

	Number of Fishermen Who Fished			Number of Permits Fished			Total Pounds Landed			Estimated Ex-Vessel Earnings		
Fishery Group	**2008**	**2007**	**2006**	**2008**	**2007**	**2006**	**2008**	**2007**	**2006**	**2008**	**2007**	**2006**
Crab	7	10	11	11	13	13	3,582,223	3,461,323	1,504,821	$8,374,224	$7,824,664	$3,212,603
Halibut	637	661	674	637	664	677	16,766,653	17,431,455	17,762,774	$72,505,702	$76,553,650	$66,897,960
Herring	23	25	33	30	32	42	**	**	**	**	**	**
Other Finfish	0	0	0	0	0	0	0	0	0	$0	$0	$0
Other Groundfish	103	109	88	110	113	93	13,819,943	15,592,780	15,632,269	$7,692,608	$7,717,196	$6,016,077
Other Shellfish	28	18	31	29	18	32	**	**	**	**	**	**
Sablefish	226	241	251	237	251	260	7,930,892	8,814,491	9,975,098	$22,359,199	$21,637,674	$23,556,306
Salmon	1,345	1,213	1,260	1,339	1,214	1,261	97,395,505	124,919,564	76,569,129	$62,429,723	$57,060,439	$37,619,569
Unknown	0	0	0	0	0	0	0	**	**	$0	**	**
Total	1926	1828	2,348	2,393	2,305	2,378	158,731,633	186,621,428	139,263,760	$175,968,454	$172,835,548	$139,225,621

2006 - 2008 **Grand Total Pounds- 484,616,821** **Grand Total Ex-Vessel - $488,029,623**

**Numbers in table are estimated due to confidentiality

Total Expenditures - $2,400,000,000

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JAN 31 2011
BOARDS

Date: January 25, 2011

Addressee: Alaska Board of Fisheries
PO Box 115526
Juneau, AK 99811

RE: 1996 Economic Summary

Dear Board of Fisheries Members,

The attached summary is taken from an economic report from 1996 and is attached for your review. The economic effects to the commercial industry have come true during the last 15 years. The economic impacts of Board of Fisheries decisions are real and must not be ignored any longer.

Sincerely,

Roland Maw

Roland Maw, PhD
UCIDA Executive Director

ams

Executive Summary

Economic Effects of Management Changes for Kenai River Late-Run Sockeye

Institute of Social and Economic Research
University of Alaska Anchorage

January 1996

If fishery managers allowed more late-run sockeye salmon into the Kenai River in July, what would be the economic gains for the sport fishery and the losses for the Upper Cook Inlet commercial fishery?

The Institute of Social and Economic Research at the University of Alaska Anchorage examined that question, under a contract with the Alaska Department of Fish and Game (ADF&G). We looked mainly at the effects of increasing the management target for late-run sockeye by 200,000.

Managers could make that change in a number of ways—but for this study, ADF&G provided us with specific assumptions about what they would do. Different assumptions could change our results. To assess the effects of the management changes we studied, it helps to think about three questions:

(1) What creates the economic effects?

(2) How do we measure those effects?

(3) How do different conditions affect the results?

If 200,000 more sockeye were in the Kenai River, resident sport anglers would take more trips to the Kenai, spend more for those trips, and catch more fish. But while fishing more on the Kenai, they would take fewer fishing trips elsewhere (as Figure 1 shows). Better fishing would also encourage visiting anglers to take more trips to the Kenai and spend more in the economy.

Commercial fishermen would lose some of their harvest and their incomes. Fishermen and processors would work fewer hours, and the fishing and processing industries would buy less from other businesses.

We measured the effects of those changes in two ways: changes in *net economic value* and *economic impacts.*

Net economic value is a measure of benefits minus costs: we add up all the benefits and costs of a change, then subtract the costs. What's left is the net gain or loss in value.

Economic impacts are changes in payroll, jobs, or sales. Impacts are aggregate rather than net measures of change.

Figure 1 shows our estimates of economic effects, when Kenai River sockeye runs and prices paid fishermen are at medium levels.

- *Estimated commercial losses appear somewhat larger than sport gains*—a gain of $1.3 million for the sport side and a loss of $1.7 million for the commercial side. But given the range of uncertainty in our estimates, we can't definitely conclude that actual commercial losses would be larger than sport gains.

- *The Alaska economy would probably lose slightly more jobs than would be created.* A rough estimate is that increased spending for sport fishing would create about 46 jobs, but lost commercial harvests would cost the economy 64 jobs. But given the uncertainty about the future level of visitor spending, the actual number of jobs created on the sport side could range from 13 to 70.

Our results would vary in years of different run sizes and prices. During high runs, managers wouldn't need to make any changes to put 200,000 more sockeye in the river—so there would be no gains or losses.

During low runs, managers would eliminate more commercial fishing time, to make sure extra sockeye reached the Kenai River. Then commercial losses would be larger than sport gains—and the higher the price of sockeye, the larger the losses. When prices were low and runs were medium, sport gains would probably exceed commercial losses.

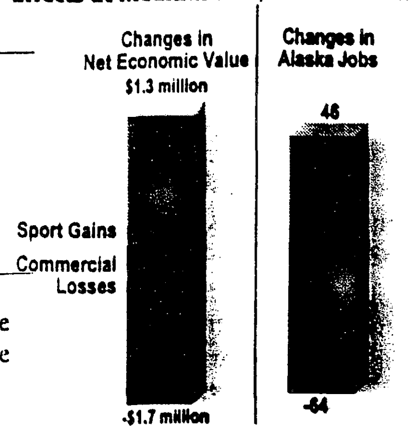
Figure 1. Effects of Increasing Sockeye Sonar Count by 200,000

What Drives Economic Effects?

Sport Fishery
- Roughly 45,000 harvest increase
- 4,000 more resident trips to Kenai
- $550,000 more resident spending for Kenai trips
- 3,400 fewer resident trips to other sites
- $450,000 less resident spending for other trips
- More visitor spending creates jobs (13-70)

Commercial Fishery
- 0-3 fewer openings, depending on run size
- Reduced harvest (0-500,000 salmon), depending on run size
- Lost fishing income of $6-$10 per fish, depending on price
- Fewer hours worked in fishing and processing
- Less spending by fishing and processing industries

Effects at Medium Run, Medium Price



Background

The study originated when the Alaska Legislature appropriated money to ADF&G in 1994 for an economic analysis of "management alternatives for Cook Inlet salmon."

ADF&G decided, based on public interest and other factors, to focus the study on the economic effects of increasing the management target for late-run Kenai River sockeye. The current management target for late-run sockeye is 450,000 to 700,000 sockeye (as measured at the sonar counter below the Soldotna bridge). Increasing the target by 200,000 would raise the range to 650,000 to 900,000. Making such a change would require reducing the Upper Cook Inlet commercial salmon harvest, except in years of high runs. The Alaska Board of Fisheries, which regulates the fisheries, establishes the management target and decides if it will be changed.

Both the sport fishery and the commercial fishery in the Central District of Upper Cook Inlet highly value late-run Kenai River sockeye, which generally begin moving into the river in late June and peak toward the end of July. This run alone makes up about half the total commercial salmon harvest in Upper Cook Inlet. And about three-quarters of the statewide harvest of sockeye is taken from the Kenai River and its tributary, the Russian River.

Sport anglers want more sockeye; commercial fishermen want to keep what they have.

What ISER Studied

We mainly studied the effects of increasing the Kenai River management target by 200,000 late-run sockeye. To help define a range of variation, we also looked at the effects of increasing the sonar count by just 100,000, and of decreasing the sonar count by 100,000.

Specifically, we estimated economic effects on the Kenai River sport fishery, including the Russian River (Map 1, page 5); and on the commercial fishery in the Central District of the Upper Cook Inlet management area (Map 2, page 6).

There are other potential effects of such a change—effects we were asked to recognize but not to quantify. Those include:

• Potential increased damage to riverbanks and fish habitat. Any change that attracts more anglers to the Kenai River—which already sees 100,000 sport anglers in a season—has the potential to increase bank trampling and damage to vegetation and fish habitat.

• Potential overescapement of sockeye. Fishery managers believe that having too many spawning salmon return to a river has the potential to damage future runs, by taxing spawning and rearing areas and food supplies. Biologists haven't established an overescapement estimate for Kenai River late-run sockeye.

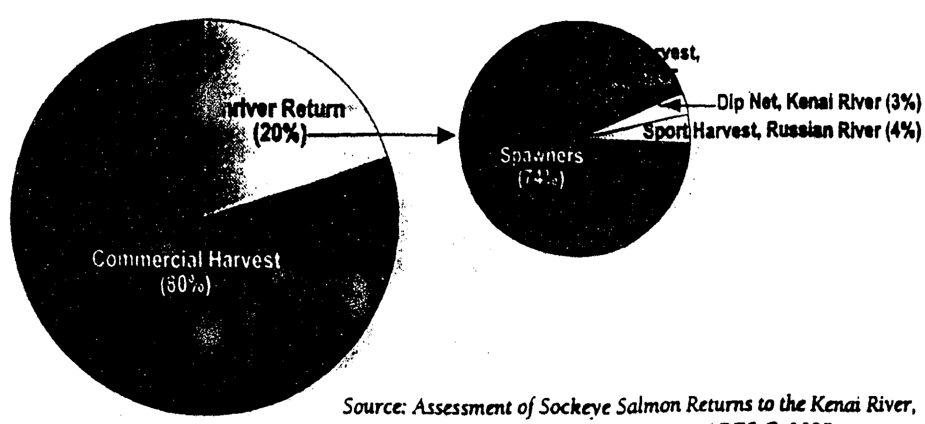
• Potential benefits for commercial setnetters in the Northern District of Upper Cook Inlet and Susitna River sport anglers and personal use dipnetters. Managers assume that during low Kenai River runs they would have to eliminate a regular districtwide opening in the Central District to make sure 200,000 additional sockeye reached the Kenai River. In those circumstances, more salmon would move past the Central District drift fleet and into the Northern District, where some would be harvested. We don't have estimates of how many.

Current Allocation

Figure 2 shows how the late run of Kenai River sockeye has been divided in the 1990s. Commercial drift and setnetters in the Central District of Upper Cook Inlet harvested about 80 percent. Of the sockeye that returned to the river, about 74 percent spawned. Sport anglers on the Kenai River mainstem took about 19 percent and anglers on the Russian River took 4 percent. Dipnetters (who harvested fish under both personal use and subsistence regulations during that period) took about 3 percent.

Since 1990, annual commercial harvests of Kenai River sockeye have varied from just over 1 million to nearly 7 million. Annual sockeye sport harvests on the Kenai and Russian rivers varied between about 120,000 and 270,000.

Figure 2. Allocation of Kenai River Late-Run Sockeye, 1990-1994



Source: Assessment of Sockeye Salmon Returns to the Kenai River, Doug McBride and Steve Hammarstrom, ADF&G, 1995

Measuring Economic Effects

On the front page we defined net economic value as benefits minus costs: the gain or loss after all benefits are added and all costs are subtracted. Changes in net economic value are difficult to calculate, because this measure takes into account not only monetary costs and benefits (like the market price of fish or costs of fishing tackle) but also assigns a dollar value to intangibles (like the pleasure of fishing). On page 8 we describe how we assigned a dollar value to improved Kenai River fishing. Here we just want to point out that net economic value takes into account the substantial non-monetary value in the sport fishery.

General Findings

To assess how changes in run sizes, prices, sport bag limits, and other conditions would affect our results, we developed 10 study scenarios . Assumptions that went into those scenarios, and our findings by scenario, are described on pages 8-12. Here we present general findings not tied to specific scenarios. We found if the Kenai River management target for late-run sockeye were increased by 200,000:

• *The net increase in resident trips to all Alaska sites would be about 650, and the net increase in resident spending for fishing trips would be about $108,000.* Southcentral resident households with sport anglers would make 4,000 additional trips to Kenai River sites and spend $550,000 more in late July. But our analysis showed that in order to make more trips to the Kenai, resident anglers would make fewer trips and spend less elsewhere in Alaska—about 3,400 fewer trips and $450,000 less spending.

• *Most of the increase in the net economic value of the sport fishery for residents is non-monetary:* the value of improved sport fishing. Some is savings—because residents substitute less expensive trips to the Kenai River for more expensive fishing trips to other Alaska sites.

• *Most of the loss in net economic value for the commercial fishery is monetary:* reduced harvest revenue. Some is reduced job satisfaction.

• *As measured by economic impacts, reducing the commercial harvest would probably cost the economy more jobs and payroll than would be created by the improved sport fishery.* One reason is that the commercial fishery creates jobs and payroll in two ways—from the market value of the harvest itself, and from fishery-related spending in other industries. The sport fishery creates jobs only through fishery-related spending. Unlike commercial fishermen, sport anglers don't earn money while they're fishing—although they enjoy a great deal of non-monetary value.

• *How many jobs and how much payroll an improved sport fishery would create statewide would depend mostly on how much more non-resident anglers spent.* As we said earlier, Alaskans would certainly take more trips and spend more for Kenai River fishing, if the fishing were improved—but they would also take fewer trips to other Alaska sites. So most of the additional resident spending would simply be shifted from one place to another within the state. But if better fishing induced non-residents to stay longer and spend more than they otherwise would have, that spending would represent additional money in the economy.

• *Non-residents visiting Alaska might extend their visits to fish more on the Kenai—and spend more in the economy.* That additional spending could be anywhere from $630,000 to $3.3 million more in a season, generating between 13 and 70 jobs. These are rough, order-of-magnitude estimates based on survey responses of the small percentage of non-resident anglers who said they would have stayed longer in Alaska if the fishing were better. We do think this change would probably be much larger than the change in resident spending for sport fishing.

• *A reduction in Cook Inlet sockeye harvests is unlikely to affect Alaska consumers much*—because most Cook Inlet sockeye is sold outside the state.

• *By reducing the supply of sockeye, the proposed reduction in Cook Inlet commercial sockeye harvests could increase prices paid fishermen for Cook Inlet sockeye by as much as 1 cent per pound.* But we think that even such a small price increase is unlikely—because Cook Inlet sockeye make up a relatively small share of all Alaska sockeye, and because the growing supply of farmed salmon worldwide would offset the effects of a smaller Cook Inlet harvest.

Assumptions

Size of Kenai River late sockeye run[illegible]

Low run: Fewer than 2 million
Medium run: 2-5 million
High run: More than 5 million

Ex-Vessel Price (price paid fishermen [illegible] Cook Inlet sockeye

Low price: $1.00/lb.
Medium price: $1.43/lb.
High price: $1.75/lb.

Definitions

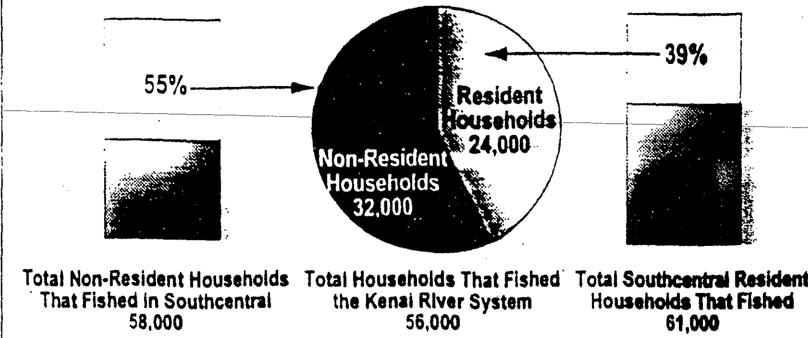
Southcentral Alaska: the Municipality of [illegible], the Kenai Peninsula Borough, and the [illegible] Susitna Borough

Kenai River system (study sites): all fishing [illegible] Kenai River mainstem from the mouth at Cook Inlet to Kenai Lake and including the Russian River [illegible]

Organization of the Summary

Profile of the Sport Fishery

Figure 3. Importance of Kenai River to Sport Fishing, 1993



The Kenai River system sport fishery (including the Russian River) is easily accessible and immensely popular with Alaskans and tourists. In 1993, 39 percent of all the Southcentral households with anglers fished on the Kenai or Russian rivers, and 55 percent of the visiting households that fished in Southcentral Alaska traveled to the Kenai or Russian rivers (Figure 3). Southcentral Alaska includes the Kenai Peninsula Borough, the Municipality of Anchorage, and the Matanuska-Susitna Borough.

The Kenai River has long been known for its king salmon fishing, but in recent times growing numbers of anglers have been going after sockeye. Significant numbers of coho salmon are also harvested in the river.

About three-quarters of the statewide sport harvest of sockeye is taken in the Kenai mainstem and the Russian River. This study look at the economic effects of a change in management of the late-run of sockeye, which generally begins moving into the river in late June and peaks toward the end of July. (The early run is much smaller and is mostly harvested in the Russian River.)

Figures 4 and 5 show the importance of the Kenai and Russian rivers to Southcentral anglers. Half of all households in Southcentral Alaska—61,000 of an estimated 122,000 households—had sport anglers in 1993. Those sport fishing households made nearly 626,000 fishing trips. An estimated 25 percent of those trips were to the Kenai and Russian rivers, by far the most popular sport fishing sites in the region. The average fishing trip by residents to all Southcentral sites lasted 1.8 days and cost $155. Trips to the Kenai River cost residents less—averaging 1.6 days and $105 per trip (Table 1).

Visiting anglers also fish the Kenai heavily. About 58,000 non-resident households made 98,000 sport fishing trips while visiting Southcentral Alaska in 1993. Around 54,000 of those trips were to the Kenai River system. Visitors spent more per trip than residents—an average of $400 for all Southcentral trips and $460 for trips to the Kenai. Their trips were also longer, averaging close to 3 days (Table 1).

Altogether, residents and visitors spent $136 million for 1993 sport fishing trips in Southcentral Alaska, with $34 million of that for trips to the Kenai and Russian rivers (Figure 6). The biggest expense for residents on fishing trips to the Kenai was transportation (including the costs of fuel and other vehicle expenses). Resident anglers on average spent little for guide and charter services; by contrast, non-resident households spent an average of $160 per trip for guides and charters (Figure 7).

How many late-run sockeye do anglers take from the Kenai and Russian rivers? Figure 8 shows that the sport harvest of late-run sockeye in the past decade has varied from less than 40,000 to more than 330,000.

Figure 4. Southcentral Resident Trips by Region, 1993

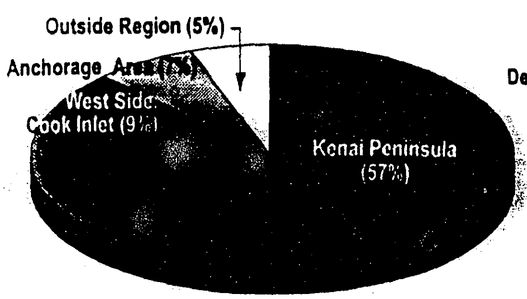
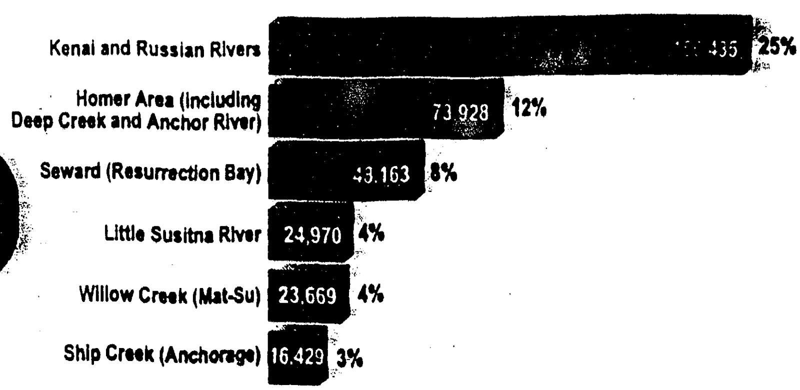


Figure 5. Most Popular Fishing Sites for Southcentral Residents, 1993



*Sources of Table 1, Figures 2-4 and 6 and 7: ISER Surveys

Map I. Kenai River System Sport and Personal Use Fisheries

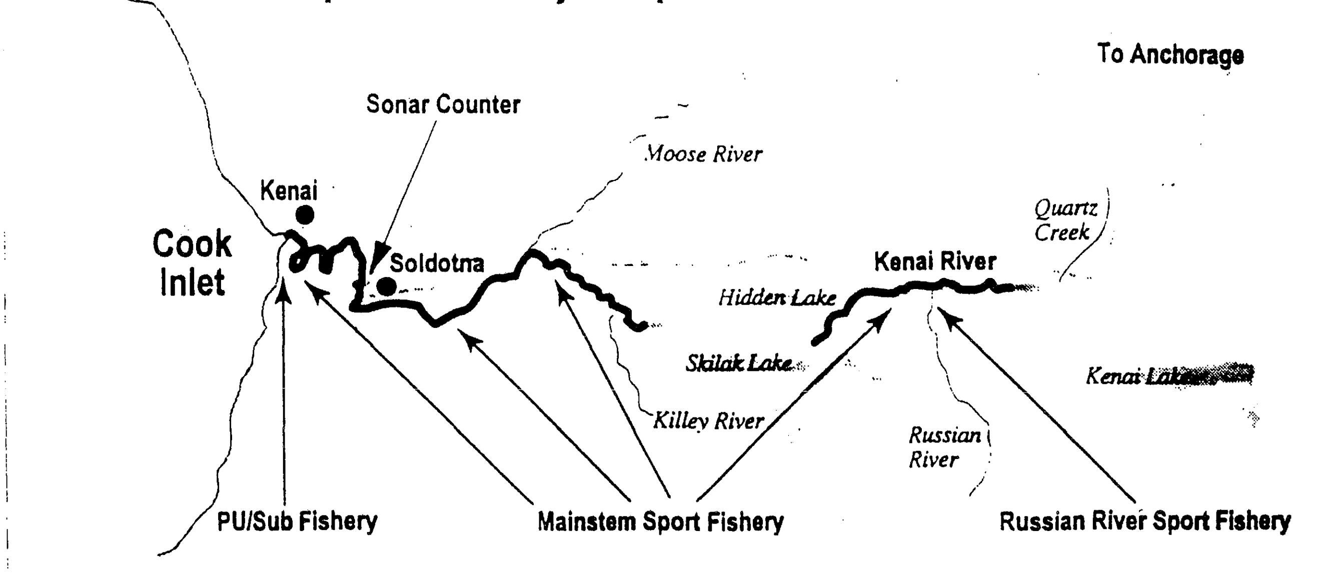


Figure 6. Resident and Non-Resident Spending for Fishing Trips, 1993

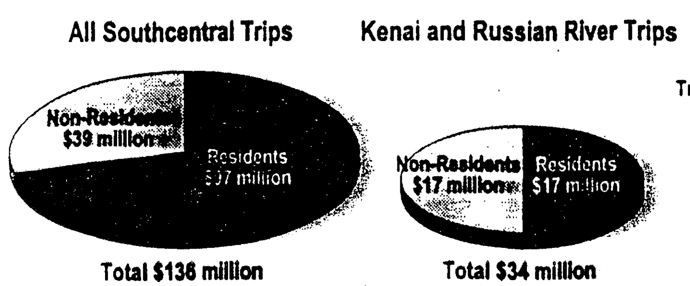


Figure 7. Per Trip Spending for Kenai River Trips

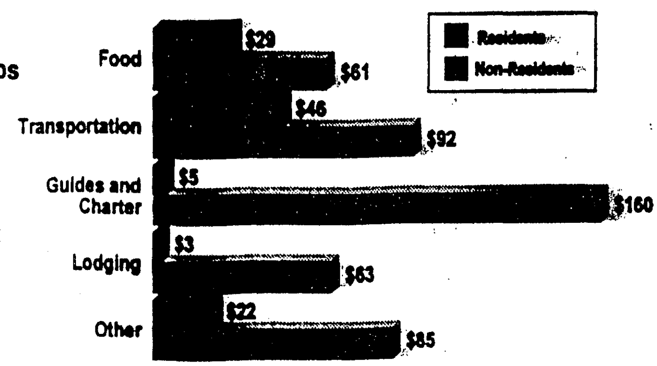
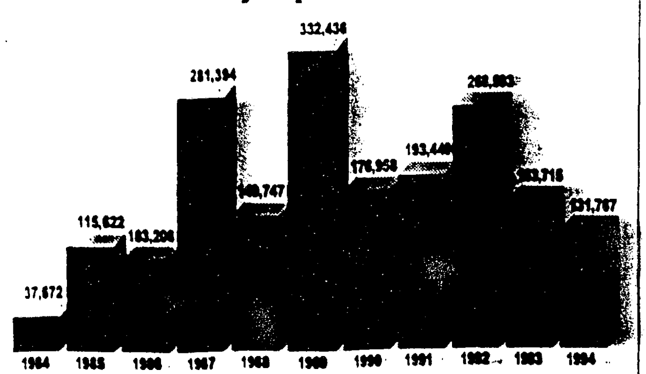


Table 1. Cost and Length of Sport Fishing Trips, 1993

	Resident Households	Non-Resident Households
All Southcentral Trips		
Average Per Trip Spending	$155	$400
Average Number of Trips per Household	10	1.7
Average Length of Trip	1.8 days	2.9 days
Trips to Kenai and Russian Rivers		
Average Per Trip Spending	$105	$460
Average Number of Trips per Household	6.7	0.7
Average Length of Trips	1.6 days	2.7 days

Figure 8. Kenai and Russian River Sockeye Sport Harvests



Source: Assessment of Sockeye Salmon Returns to the Kenai River, Doug McBride and Steve Hammarstrom, ADF&G, 1995

Profile of the Commercial Fishery

Cook Inlet is divided into two commercial fisheries management areas—Upper and Lower Cook Inlet. Anchor Point is the boundary between the two regions. Upper Cook Inlet is in turn divided into two districts—the Central District (from Anchor Point north to Boulder Point) and the Northern District (from Boulder Point north).

The Upper Cook Inlet salmon harvest is taken with drift and set gillnets. The drift fleet is restricted to the Central District. Setnetters fish in both the Central and the Northern Districts, but about 70 percent of setnetters are concentrated on the east side of the Central District.

Both the size of the Upper Cook Inlet harvest and its value can change sharply from year to year, depending on the size of salmon runs and the price paid fishermen. The harvest was as small as 3 million and as large as 10 million in the past five years, and the ex-vessel value ranged from less than $20 million to more than $100 million (Figures 9 and 10).

Sockeye make up about 80 percent of the harvest. Kenai River sockeye alone make up about 50 percent of the Upper Cook Inlet commercial harvest (Figure 11). Other sockeye in the harvest include stocks of the Kasilof, the Susitna, and other rivers along Upper Cook Inlet. Those stocks of sockeye—as well as runs of king, coho, and chum salmon—mingle in Upper Cook Inlet, complicating management.

Driftnetters and eastside setnetters in the Central District took about 95 percent of the Upper Cook Inlet sockeye harvest in the 1990s (Figure 12). It is those fishermen who would lose salmon (mostly sockeye but also including other species) if a management change allowed more sockeye into the Kenai River.

Table 2 shows 1994 employment and earnings of drifters and eastside setnetters in the Central District. About 29,000 people worked either as heads of operations (permit holders) or crew members. Harvest revenues totaled $33 million; crew members were paid about 20 percent of that total, mostly through shares.

Table 3 estimates 1994 harvesting costs for Central District permit holders. Variable costs (like food and fuel) totaled $4.2 million for the drifters and $2 million for the setnetters. Fixed costs (like insurance and taxes) totaled $5 million for the drifters and $2 million for the setnetters. Crew payments for drift crews amounted to $2.7 million and setnet crews $3.9 million.

Boats and equipment for the drift fleet were valued at $76 million and at $56 million for eastside setnetters in 1994. Drift permits had an estimated value of about $38 million and setnet permits close to $15 million (Table 4).

Map 2. Upper Cook Inlet Management Districts

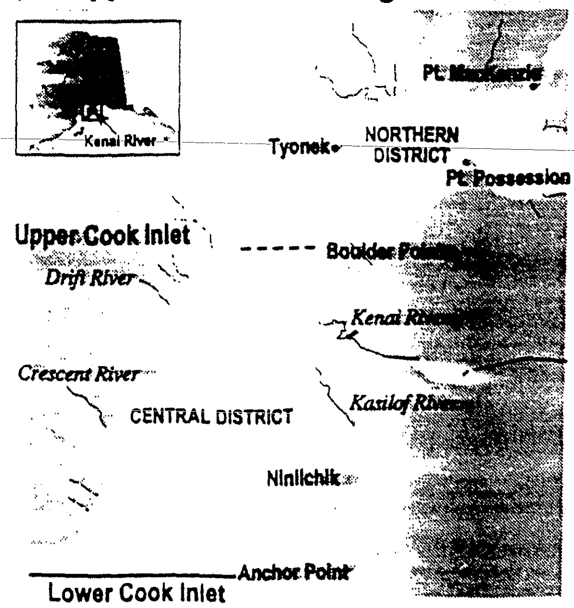


Figure 9. Upper Cook Inlet Commercial Salmon Harvests
(In Millions of Fish)

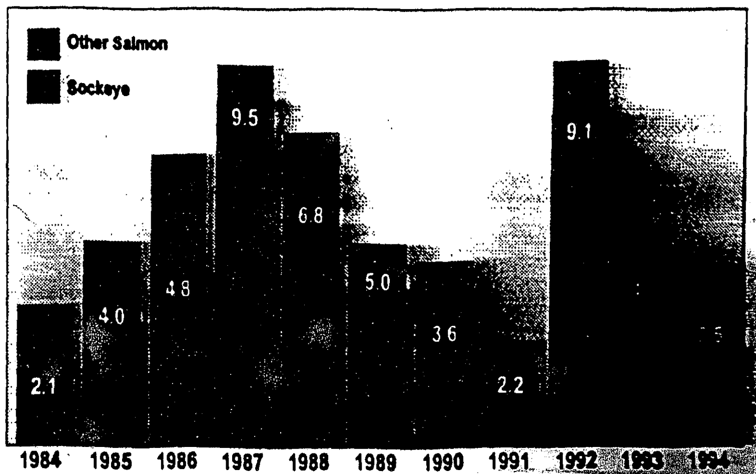


Figure 10. Ex-Vessel Value, Upper Cook Inlet Salmon

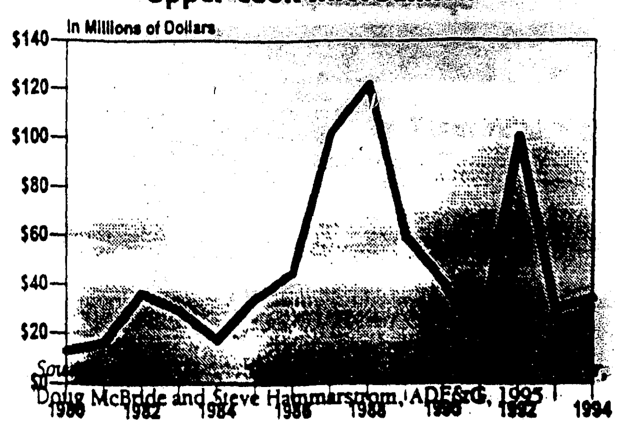


Table 2. Employment and Earnings in Central District, Upper Cook Inlet, 1994

	Driftnet	Eastside Setnet	Total
ESTIMATED NUMBER OF PERMITS FISHED IN 1994	580	514	1,094
ESTIMATED TOTAL OPERATIONS	567	258	825
AVERAGE NUMBER OF FISHERMEN PER OPERATION			
Heads of operations	1.0	1.0	1.0
Crew*	1.6	4.6	2.6
TOTAL	2.6	5.6	3.5
ESTIMATED TOTAL FISHERMEN			
Heads of operations	567	258	825
Crew	884	1,183	2,068
TOTAL	1,451	1,442	2,893
METHOD OF PAYMENT (FOR PERSONS OTHER THAN HEADS OF OPERATIONS)			
Owner	6.1%	13.1%	10.1%
Share	73.3%	62.5%	67.1%
Fixed rate	5.4%	12.7%	9.6%
Family member	6.6%	3.5%	4.8%
Other	5.3%	4.0%	4.5%
Not available	3.3%	4.2%	3.8%
TOTAL	100%	100%	100%
ESTIMATED TOTAL CREW EARNINGS	$2,709,000	$3,941,000	$6,649,000
ESTIMATED TOTAL REVENUES	$19,548,000	$13,508,000	$33,057,000
TOTAL CREW EARNINGS AS % OF TOTAL REVENUES	13.9%	29.2%	20.1%

Source: Estimates based on ISER permit holder and crew surveys.
**Includes a few permit holders other than heads of operations paid as owners.*

Figure 11. Composition of Upper Cook Inlet Salmon Harvest, 1990-1994

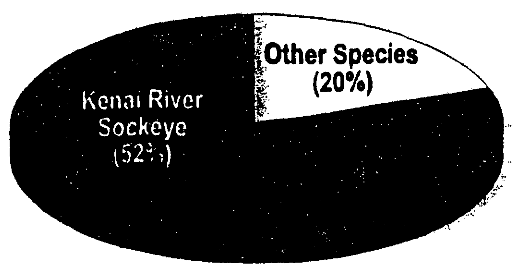


Figure 12. Division of Upper Cook Inlet Sockeye Harvest, 1990-1994

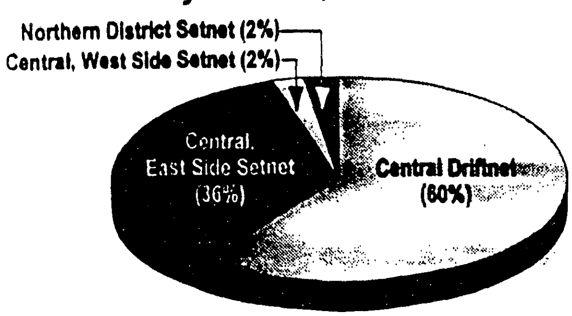


Table 3. Salmon Harvesting Costs for Limited Entry Permit Holders, Central District, 1994

	Drifters	East Side Setnetters
Payments to Crew	$2.7 million	$3.9 million
Variable Costs	$4.2 million	$2.0 million
Fixed Costs	$5.2 million	$2.1 million

Table 4. Value of Limited Entry Permits and Property in Central District, 1994

	Drifters	East Side Setnetters
Boats, Equipment and Property	$76.2 million	$56.3 million
Value of Permits	$37.7 million	$14.6 million

Sources for Tables 2-4: ISER Surveys; CFEC permit price data

Sources for Figures 8-11: Upper Cook Inlet Commercial Fisheries, Annual Management Report, 1993 and 1994, Paul Ruesch, and Jeff Fox, ADF&G Commercial Fisheries Management and Development Division

Methods of Estimating Effects

Changes in Net Economic Value

For both the sport and the commercial fisheries, we used several standard methods to assess changes in net economic value. Our most reliable results use statistical analysis to assess the net benefits people derive from fishing, based on their actual past choices among different options with different costs. Although sport fishermen don't pay for the fish they harvest, they do spend money on food, fuel, bait, and other expenses. The behavior analysis estimates whether people would still go fishing, if it cost them more. Then, the net value of the fishery is what they would be willing to pay, minus their actual costs.

For the sport fishery, we relied heavily on the results of large surveys of sport anglers (Table 5 on page 9). We asked Southcentral anglers where they fished, how often they went, how far they traveled, how much they spent, and other information about fishing trips in 1993. From that information, and from ADF&G data and other sources of information about fishing conditions at different Alaska sites, we built a computer model that estimates how much Southcentral anglers would value improved fishing at the Kenai River. The model works through equations that (1) use information about what people actually spent for fishing trips to different sites under different conditions; (2) relate anglers' choices of where and when to fish to the cost and the quality of fishing (as measured by variables like the sonar fish count, the catch rate, and the weather); and (3) estimate how much anglers would value improved fishing conditions at the Kenai River.

To assess changes in net value for permit holders, we used observations about past landings and participation to develop a model that assesses potential changes in the profitability of fishing, if commercial fishing opportunities were reduced. We relied mainly on ADF&G management information and landings data for 1990 through 1993. To assess changes in net value for crew members, we used responses from a crew survey that asked how they would rank different jobs that paid different amounts to assess how they would value reduced fishing opportunities.

Changes in Economic Impacts

Economic impacts are jobs, income, sales, or other measures associated with some economic activity. Economic impact analysis provides familiar, concrete measures of change—but it doesn't include any intangible value.

To assess changes in economic impacts, we estimated how spending by sport and commercial fishermen would change, and how these changes in spending translate into changes in jobs and income in Alaska. We also estimated direct changes in jobs and income of commercial fishing and processing workers as a result of harvesting and processing fewer fish.

Data Sources

We used three main sources of information for our analysis:

- 1993-95 surveys of commercial fishermen (both permit holders and crew members) and sport anglers, including residents and non-residents. Table 5 shows numbers of respondents, dates, response rates, and estimated margins of error for our surveys.
- ADF&G fisheries data
- ADF&G assumptions about how management changes would be put into effect and the resulting changes in sport and commercial harvests.

Assumptions and Scenarios

For Kenai River sockeye, no two years are alike: the size and timing of the run; the management regulations; sport and commercial fishing activities; prices paid commercial fishermen; and many other factors can vary. So how can we

What About Late-Run Kenai River Kings?

Our contract with ADF&G asked us to look specifically at the economic effects of changing the management target for Kenai River late-run sockeye. Reducing commercial openings to allow more sockeye into the river would also have the effect of increasing the number of late-run king salmon returning to the river. There is no targeted commercial fishery in the Central District for late-run kings, but commercial fishermen catch kings while fishing for sockeye, because the runs overlap.

Our analysis includes the economic effects of extra kings returning to the river, but we did not measure those effects separately. ADF&G biologists estimate that under the management alternatives we studied, increasing the number of sockeye by 200,000 would increase the king return by about 1,600. Part of the reason why the increase in the number of kings wouldn't be larger is the timing of the commercial closures. ADF&G told us to assume that managers would let extra sockeye into the river by eliminating one or more commercial openings during the peak of the sockeye run in late July. Because the king run is more spread out than the sockeye run, eliminating one or two openings wouldn't sharply reduce the incidental commercial catch of kings.

MARK-RECAPTURE POPULATION ESTIMATES OF COHO, PINK, AND CHUM SALMON RUNS TO UPPER COOK INLET IN 2002

By
T. Mark Willette
Robert DeCino
Nancy Gove

Regional Information Report No.[1] 2A03-20

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333 Raspberry Rd.
Anchorage, Alaska 99518-1599

June 2003

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or of the Commercial Fisheries Division.

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AUTHORS

T. Mark Willette is a Research Project Leader for the Alaska Department of Fish and Game, Commercial Fisheries Division, Region II, Upper Cook Inlet, 43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669.

Robert DeCino is a Research Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Division, Region II, Upper Cook Inlet, 43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669.

Nancy Gove is a Biometrician for the Alaska Department of Fish and Game, Commercial Fisheries Division, Region II, 333 Raspberry Rd., Anchorage, AK 99518.

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TABLE OF CONTENTS

Page

Public Comment #8

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

This project estimated the total population sizes, escapements, and exploitation rates for coho, pink, and chum salmon returning to Upper Cook Inlet (UCI) in 2002 as a first step toward determining escapement levels needed to achieve sustained yields for these species. Mark-recapture techniques were used to estimate the total population sizes for each species returning to UCI as a whole. Salmon were tagged along a transect running from Anchor Point to the Red River delta on the west side of Cook Inlet during July and early August. Total population sizes for each species were estimated from recoveries of passive integrated transponder (PIT) tags in commercial fishery harvests. Recoveries of radio telemetry tags were used to estimate the total escapement of coho salmon into all UCI streams for comparison to the estimate derived from PIT tags. Radio telemetry tag data were also used to estimate coho salmon escapements into 33 streams and 5 areas around UCI. Our best PIT tag estimate of the total population size of coho salmon returning to UCI was 2.52 million (95% CI: 2.16-2.87 million). Given a commercial harvest of 0.25 million, the total escapement of coho salmon into all UCI streams was 2.27 million (95% CI: 1.91-2.62 million), and the exploitation rate in the commercial fishery was about 10%. Our radio tag estimate of the total escapement of coho salmon into all UCI streams was 1.36 million (95% CI: 0.98-1.96 million). Thus, our PIT tagging experiment estimated a population size for coho salmon entering UCI streams that was higher than the estimate obtained from radio tagging. Although, the 95% confidence intervals around the two estimates overlapped slightly, the z-test statistic indicated the two estimates were significantly different. Of the total coho salmon escapement into all UCI streams, 56% (0.76 million) returned to the Susitna and Little Susitna River drainages, 19% (0.26 million) returned to streams along the west side of UCI, 17% (0.24 million) returned to streams along Knik Arm, 5% (0.07 million) returned to streams along Turnagain Arm, and 3% (0.04 million) returned to streams on the Kenai Peninsula. However, these estimates for Turnagain Arm and Kenai Peninsula streams do not include the entire escapement, because we stopped tagging before the runs to these areas were complete. Our PIT tag estimate of the total population size of pink salmon returning to UCI was 21.28 million (95% CI: 1.60-40.96 million). However, this estimate was of questionable value due to its very low precision resulting from problems with tag recovery. Therefore, we estimated a maximum exploitation rate on pink salmon in the commercial fishery by simply summing escapements that were actually enumerated in 3 streams. Given a commercial harvest of 0.45 million, the maximum exploitation rate in the commercial fishery was about 12%. However, the actual exploitation rate must have been much lower, because we did not include escapements into numerous other streams around UCI. Our PIT tag estimate of the total population size of chum salmon returning to UCI was 3.88 million (95% CI: 3.30-4.47 million). Given a commercial harvest of 0.24 million, the total escapement of chum salmon into all UCI streams was 3.64 million (95% CI: 3.06-4.23 million), and the exploitation rate in the commercial fishery was about 6%. Despite uncertainty in our salmon population estimates, it is reasonable to conclude that exploitation rates on coho, pink, and chum salmon in the UCI commercial fishery were substantially below optimal rates in 2002.

KEY WORDS: Coho salmon, *Oncorhynchus kisutch*, pink salmon, *O. gorbuscha*, chum salmon, *O. keta*, mark-recapture, passive integrated transponder tags, radio telemetry tags, total population size, escapement, exploitation rate.

INTRODUCTION

Commercial salmon fisheries in Upper Cook Inlet (UCI) generally target sockeye salmon, but coho, pink, and chum salmon are taken incidentally. In its 1999 meeting, the Board of Fisheries (BOF) directed the Alaska Department of Fish and Game (ADF&G) to develop a management plan for pink salmon and management strategies for chum salmon in UCI. Until that time, the BOF directed that no targeted pink salmon fishing would be allowed in UCI. The BOF further directed that no additional fishing periods would be allowed for the drift gillnet fishery outside the Kenai and Kasilof sections of the Upper Subdistrict until significant harvestable surpluses of chum salmon were available. The commercial sockeye salmon fishery in UCI in 2000 experienced a run failure. In August 2000, commercial fishermen petitioned the BOF to open fishing for pink salmon. Their request for an extended commercial fishery was denied, because of lack of escapement information for pink salmon and conservation concerns for coho salmon. At present, the ADF&G does not have a comprehensive program to estimate escapement, exploitation, and sustainable yields for coho, pink, and chum salmon in UCI. Although, escapements of these species are enumerated or partially enumerated at several weirs throughout the area, it is not known to what extent escapements in these systems represent overall production in the area.

The goal of this project was to estimate the total population size, escapement, and exploitation rates for coho, pink, and chum salmon returning to UCI. This project was a first step toward determining escapement levels needed to achieve sustained yields for these species.

Several methods have been used to assess stocks of salmon returning to UCI, but each has its limitations. Weirs have been used to enumerate salmon escaping to spawning grounds on numerous streams around UCI. While these projects can provide accurate estimates of stock size for individual small streams, escapement estimates from weirs on a small number of streams may not be representative of trends over the entire inlet. Mobile hydroacoustic surveys have been used to estimate salmon population size in UCI (Tarbox and Thorne, 1996), but these surveys only provide an estimate of the population size at the time of the survey, so multiple surveys would be required to estimate total run size and residence time would also need to be estimated. Aerial surveys provide a cost effective means to estimate salmon escapements over large areas, but the large number of occluded glacial streams in UCI preclude use of this technique in many systems. Side-scan sonars have been used to enumerate salmon migrating in several large glacial streams around UCI, but accurate estimates are difficult to obtain when species are mixed and migrating throughout the river cross section. Marine mark-recapture experiments can provide total population estimates for individual salmon species enabling escapements to be estimated after subtraction of the commercial harvest.

The methods used to estimate salmon population size by mark-recapture were initially developed in the 1930's and 1940's, but the correct conceptualizations of analysis procedures were largely developed by Seber (1962, 1982). Historically within UCI, Thompson (1930) used mark recapture to investigate salmon migration patterns in the inlet. Likewise, Tyler and Noerenberg (1967) studied salmon migration and noted that nearly all salmon tagged north of Anchor Point were recaptured in UCI. Tarbox (1988) corroborated these findings. Since the late 1970's, the ADF&G has conducted an offshore test fishing (OTF) project to estimate the population size of sockeye salmon returning to UCI during the fishing season. The test fishing vessel fishes a drift gillnet each day during July at 6 stations along a transect running from Anchor Point to the Red River delta on the west side of Cook Inlet (Figure 1). During 11 of the past 14 years, the catch per unit effort from the test fishing vessel has forecast the size of the sockeye salmon run into UCI to within 20% of the actual value (Shields 2003). Although, none of these studies used mark-recapture to estimate the size of salmon populations returning to UCI, they did lay the groundwork for mark-recapture population experiments by demonstrating that nearly all salmon migrating past Anchor Point were destined for streams in UCI.

Marine mark-recapture methods have been used successfully to estimate the size of salmon populations returning to Puget Sound and Kodiak Island. Eames et al (1981, 1983) tagged coho and chum salmon in northern Puget Sound to estimate returns to particular river systems in the region. They demonstrated appropriate use of stratified population estimators when multiple stocks were present and documented that short-term mortality associated with tagging these species in saltwater was insignificant. Likewise, Bevan (1962) estimated the size of sockeye salmon populations returning to Kodiak Island, Alaska, noting that the majority of the sockeye salmon returned to Karluk Lake. Bevan (1962) found that tag loss was about 10%, and that tagged fish exhibited a 48-hour lag before returning to the population. This finding was consistent with results from subsequent ultrasonic tagging studies which demonstrated that tagged salmon initially dive and remain at depth for about 48 hours before returning to the surface layer (Candy et al. 1996).

Most mark-recapture studies have used visible tags, but this approach can introduce an unknown bias into population estimates if fishermen discard tagged fish. To avoid this problem, we used Passive Integrated Transponder (PIT) tags that were injected into the fish and were not externally visible. These tags can also be detected using electronic equipment, so tag recovery in processing plants could be automated and made much less intrusive to processor operations. PIT tags are constructed with an integrated circuit chip connected to a tightly wound copper hoop antenna. The tags can be interrogated by 125 kHz signal from a scanning device. When the scanning device frequency excites the PIT tag, the tag emits a signal back to the receiver with a unique code (10-digit hexadecimal code displayed alphanumerically). The PIT tags are encapsulated in glass and are typically 12-mm long by 2.1-mm wide. PIT tags have been used extensively in research on salmonid survival (Prentice 1990; Skalski et al. 1998), movement (Prentice et al. 1990c, Hildebrand and Kirschner 2000) and behavior (Brannas et. al. 1994), as well as, crustacean research (Prentice et al. 1985; Pengilly and Watson 1994).

When properly injected in the body cavity, PIT tags have high retention rates (Prentice et al. 1990a) and mortality rates of tagged fish are low. Prentice et al. (1990a) found that tag retention rates in males (100%) were slightly higher than in females (99.7%) if egg skeins were not stripped from the fish. Prentice et al. (1990b) described a tagging method developed for Columbia River salmonid research, and Prentice et al. (1990a) noted that all wounds were closed and healing by the third day after maturing Atlantic salmon were PIT tagged. Prentice (1986) compared juvenile chinook salmon and steelhead trout that were PIT tagged with cold branding, coded wire tagging, cold branding and coded wire tagging, and a control group (handling but not tagged) at dams on the Columbia river. He noted no significant mortality of PIT tagged fish when compared to these other tagging methods. Similarly, Quinn and Peterson (1996) found no significant mortality of juvenile coho salmon that could be attributed to PIT tagging.

The fundamental assumptions of a mark-recapture experiment are: (1) the population is closed, (2) all fish have equal probability of being marked during the first sampling event, (3) tagged fish do not suffer greater mortality than untagged fish, (4) fish do not lose their marks, (5) no marks are overlooked, and (6) either marked and unmarked fish are uniformly mixed or the recaptures are a random sample (Seber 1982). Violation of these assumptions may not invalidate estimation of population size by mark-recapture, if the magnitude of the errors is known. We conducted several studies to estimate the magnitude of these sources of error and corrected for their effects on our population estimates.

We also applied radio tags to coho salmon migrating into UCI. This component of the project provided (1) a second estimate of the size of the total coho salmon population entering UCI streams for comparison to our estimate derived from recovery of PIT tags, (2) an estimate of the population size of coho salmon entering each major stream flowing into UCI, (3) estimates of the timing of various stocks of coho salmon migrating past the OTF transect, (4) estimates of the timing of various stocks of coho salmon entering their natal streams, and (5) estimates of the residence time and migration rate of coho salmon in UCI.

OBJECTIVES

1. Estimate short-term tag mortality.
2. Apply PIT and radio tags.
3. Estimate rate of PIT tag loss.
4. Recover PIT tags at processors and estimate PIT tag detection rate.
5. Estimate salmon population sizes and evaluate sources of error.
6. Estimate escapements of coho salmon using radio telemetry.

METHODS

Objective 1: Estimation of short-term tag mortality

In 2001, coho and chum salmon were captured by a chartered purse seine vessel and tagged to estimate short-term tag mortality. Dummy radio tags (n=200) were applied to coho salmon, and PIT tags (n=200) were applied to chum salmon. All tags were uniquely numbered, and the time each fish was tagged was recorded. The study on coho salmon was conducted in a lagoon near the Homer spit, and the study on chum salmon was conducted near the Wally H. Noerenberg hatchery in Prince William Sound. The methods used to handle and tag fish were similar to those used on the tagging vessels in UCI (objective 2). Tagged fish were immediately released to a floating net pen secured along side the tagging vessel and held for 48 hours. All mortalities were retrieved and the time each fish was held in the net pens prior to tagging was recorded. Mortalities were enumerated for 4 lots of 50 sequentially tagged fish, i.e. 0-50, 50-100, 100-150, and 150-200. Lots of 50 fish corresponded to holding times of about 60 mins each, since this was the time required to tag this number of fish. No control group was included in the study, because our goal was to estimate the mortality associated with handling and tagging. The survival of tagged fish in each of the lots was estimated from $S_t = m_t/T_t$, where m_t was the number of live tagged fish from lot t at the end of the experiment, and T_t was the total number of fish tagged in lot t. The standard error of the estimate was calculated as described by Zar (1984).

Objective 2: Application of PIT and radio tags

In 2001, an approximately 52' purse seine vessel (F/V Agave) was chartered from July 1 to July 15. This vessel fished an approximately 200-fm seine (3.5" mesh, 375 meshes deep) to capture salmon for tagging. However, the charter was terminated before the end of the project, so a second 58' purse seine vessel (F/V Infinite Glory) was chartered from July 28 to August 4. This vessel fished an approximately 250-fm seine (3.5" mesh, 375 meshes deep). Lack of vessel support during the entire salmon run precluded our estimation of salmon population sizes in 2001. However, we were able to obtain useful information regarding catch rates, fish handling and tagging methods, tag retention rates, and some preliminary coho salmon escapement distribution data from radio tags. The methods used to capture, handle and tag fish in 2001 were generally similar to those used in 2002.

In 2002, two approximately 58' purse seine vessels (F/V Just-in-Case and F/V Millenium) were chartered (July 2 – August 7) to capture salmon for tagging in UCI. Each vessel fished an approximately 250-fm seine (3.5" mesh, 375 meshes deep). All salmon were tagged within about 5 km of the OTF transect that runs from Anchor Point to the Red River delta. Since, our goal was to tag a representative sample of salmon migrating into UCI, we attempted to tag fish near each of the six OTF stations each day. But, we also focused most of our fishing effort in areas along the OTF transect where salmon catches were highest, because the precision of our population estimate was dependent on the number of fish tagged and recovered. The seine was generally set in an approximate semi-circle, open into the current for 20 minutes at each station. After the seine was pursed, all jellyfish and other debris were removed from the bunt end of the seine. On board the F/V Just-in-Case, captured fish were rolled out of the seine into 1-2 totes along the port side of the vessel, and fish to be tagged were sent down a chute to a second set of totes on the starboard side of the vessel and sorted by species. On board the F/V Millenium, captured fish were generally brailed from the seine onto the deck and fish to be tagged were quickly sorted by species into a set of totes on the starboard side of the vessel. All totes used to hold fish prior to tagging were supplied with re-circulating seawater. Salmon captured in each net set were generally enumerated by species, but if a large number of a particular species was captured the number of that species was visually estimated. The start and stop time of each net set, coordinates (latitude, longitude), wind velocity, and stage of tide were recorded for each net set.

Immediately before tagging, fish were dip-netted from the re-circulating seawater tote into a clove oil bath. Clove oil was used as an anesthetic, because anesthetized fish could be harvested and consumed on the same day (Price and Powell 2000). The number of fish held in the totes and the time they were held was kept to a minimum to reduce mortality. Prior to tagging, each fish was removed from the clove oil bath, inspected to insure it had not already been tagged, measured (total length), and tagged with an individually identifiable PIT or radio tag. The time at which each fish was tagged was also recorded. PIT tags were applied to coho, pink and chum salmon, and radio tags were applied to a subsample of coho salmon each day. Radio tags were applied to coho salmon before fish were PIT tagged. We used 125 kHz cylindrical glass encased PIT tags (20 mm x 3.2 mm). A hypodermic needle was used to inject each PIT tag into the fishes' cheek muscle. The needles were periodically sterilized by immersion in a betadine solution. Radio transmitters (20 mm x 55 mm) were mounted externally on coho salmon about 3-4 cm below the dorsal fin. Two wires were passed through the fish, and the tag fixed by crimping a 2-cm diameter plastic Petersen disc tag (uniquely numbered) onto the wire. We used 729 unique transmitter codes with frequencies ranging from 150.054 – 150.963 mHz and 15 pulse codes within each frequency. Each transmitter weighed about 15 g and had a battery life of about 80 days. Each radio tag was scanned by a receiver to establish that it was transmitting before being attached to a fish. Each PIT tagged fish was scanned prior to release to establish that the tag was retained and detectable. Tagged fish were immediately returned to the sea.

We calculated the geometric mean catch per net set ($CPUE_i$) for sockeye, coho, pink, and chum salmon during five weekly (July 1-6, July 7-13, July 14-20, July 21-27, and after July 28) tag release strata (i) to evaluate the relative abundance of each species and their run timing across the OTF transect.

Objective 3: Estimation of rate of PIT tag loss

In 2001, a double-marking experiment was conducted with sockeye salmon to estimate the rate of PIT tag loss. The sockeye salmon used in this experiment were captured, handled, and PIT tagged using methods described in objective 2, but T- bar anchor/dart tags were also applied to these fish approximately 3-4 cm below the dorsal fin. Double-marked sockeye salmon were recovered by technicians in fish processing plants and by commercial and sport fishermen. An electronic PIT tag reader was used to scan each of these fish for the presence of a PIT tag. If a tag was not detected, the head was dissected to determine if the tag had been damaged and to evaluate how the tag may have been lost. The proportion of fish that retained a readable PIT tag was estimated from $c_L=m_p/m_d$, where m_p was the number of double marked fish that retained a readable tag, and m_d was the number of double-marked fish examined for PIT tags. The standard error of the estimate was calculated as described by Zar (1984).

Objective 4: Recovery of PIT tags at processors and estimation of PIT tag detection rates

Electronic PIT tag readers were installed at each major plant that processed salmon from UCI. The readers were most often installed on chutes immediately below the salmon header machines. These chutes were usually constructed of approximately 25-cm diameter PVC pipe cut longitudinally into half sections. Two hand-held racket antennas were attached to each chute using zipties to provide for redundancy in the detection of PIT tags. The two antennas were attached to the chute at different angles, because tag detection is a function of the angle of the tag in the electromagnetic field created by the antenna. The antennas were also attached as far as possible away from each other and from any metal or electric motors to reduce interference that might reduce tag detection. A PIT tag reader was attached to each antenna by a cable. The two readers needed for the installation on each chute were housed in a tote immediately below the processing line. An external 12V battery was used to power both readers. The configuration of the installation varied among processing plants depending on the design of the processing equipment. We made every effort to maximize tag detection rate given the constraints of the environment at each plant.

Technicians maintained the PIT tag readers and conducted tag detection tests at each processing plant on most days during the fishing season. Upon each visit to the plant, the technicians inspected the readers for any problems with the installation (e.g. loose antenna, error messages on the reader, water damage, etc.). The voltage on the external batteries was tested and the battery replaced with a newly charged one if the voltage dropped below 12V. Upon each visit, the technicians recorded date, time, processor, line number, PIT tag reader serial number, any problems with the reader, battery voltage, and whether the battery had been replaced.

In addition, technicians conducted tag detection tests upon each visit to each processor. These tests involved passing 50 dummy or actual salmon heads that had been previously PIT tagged past the antenna array attached to each chute. Dummy heads were constructed of styrofoam gillnet floats cut laterally in half and shaped like a salmon head. Actual salmon heads were also periodically retrieved from the heading machines, PIT tagged in the cheek and used for detection tests. Detection tests with dummy heads were conducted to monitor relative tag detection rates. Tests with actual heads were used to calibrate relative rates to actual rates. These tests were generally conducted with the processing equipment operating to replicate actual conditions during the heading operation. Detection tests were not conducted with actual heads at all times due to the extra work involved in periodically recycling these heads as they decomposed. Each set of heads used for detection tests was scanned by a PIT tag reader to create a file of the tag codes in the set. The tagged heads were tossed down the chute past the blade of the heading machine to simulate the actual heading process. After each tag detection test, the data from the two PIT tag readers attached to each chute was downloaded to a hand held computer. Later in the laboratory, the data from the hand held computer was downloaded to a desktop or laptop computer and an algorithm run to calculate detection rate. The algorithm compared the tag codes in the detection test set to the tag codes detected by the reader during the test. Tag detection was estimated for each day at each processor from $d = m_d/m_t$, where m_d was the number of detected tags, and m_t was the number of known tagged dummy or actual heads scanned. The algorithm calculated detection rate for each reader and for both readers combined, i.e. if a tag was detected by one reader but not the other. The algorithm wrote these three detection rates and a list of tag codes that were not detected to a file. Lists of undetected tag codes were periodically inspected to determine if specific codes were consistently not detected indicating damage to the tag.

Detection tests were conducted with dummy and actual salmon heads on the same processing lines at each plant on several different days. These data were used to calculate the difference between detection rates estimated using dummy versus actual heads. The Wilcoxon signed ranks test was used to test whether the mean difference of ranks was significantly different from zero (Conover 1999). The actual detection rate at each plant and processing line on each day of the season was estimated from tests conducted with actual heads when available. But, when only tests with dummy heads were conducted, the actual rate was estimated by adjusting the relative detection rate obtained using dummy heads by the mean difference between the rates measured using actual versus dummy heads.

An analysis of variance (ANOVA) was conducted to test whether detection rates differed among processing lines and among five tag recovery strata (July 1-6, July 7-13, July 14-20, July 21-27, July 28-August 3, and after August 4). An interaction term was included in the model, and the least-squares mean detection rate (d_{kj}) and standard error was estimated for each of k processors\lines and j recovery strata.

Objective 5: Estimation of salmon population sizes and evaluation of sources of error

A simple Petersen estimate of the size of the salmon population returning to UCI is given by

$$\hat{N} = \frac{n_1 \cdot n_2}{m_2} \tag{1}$$

where n_1 is the number of valid tagged fish released by the purse seine vessel at time 1, n_2 is the number of fish scanned for tags at time 2, and m_2 is the number of tagged fish recovered at time 2.

The Peterson estimator provides an unbiased estimate of population size when the following conditions are met: (1) all fish in the population have the same probability of being tagged, or all fish have the same probability of being caught in the second recovery sample, or tagged fish mix uniformly with untagged fish, (2) closed population, (3) no tag loss, (4) no tags overlooked, and (5) tagging has no effect on fish behavior. In the present study, we expect that assumption 1 is violated, because at a minimum fish would have to be tagged in proportion to their abundance as they cross the OTF transect, or commercial harvests would have to be randomly distributed, or fish tagged at the beginning of the run would have to mix equally with fish from the end of the run. One solution to this problem is to stratify by time.

A stratified Petersen method (Darroch estimator) was used to estimate the populations of coho, pink and chum salmon returning to UCI. We used a Stratified Population Analysis System (SPAS) software package developed specifically for analysis of data from stratified mark-recapture experiments (Arnason et al. 1996). This software allows researchers to define strata in space or time or both with the s strata in which marking took place differing, if necessary, from the t recovery strata. Arnason et al (1996) provided the following notation for mark-recapture experiments. The number of strata at tagging and recapture are denoted by s and t, and statistics or parameters associated with these events are denoted by c and r. The statistics are as follows:

n_i^c number of fish marked in release stratum i, $i = 1 \ldots s$

n_i^r number of fish taken in recovery stratum j, $j = 1 \ldots t$.

m_{ij} the number of the n_i^c recovered in stratum j

u_j number of unmarked fish recovered in stratum j.

The parameters are as follows:

N_i^c population size at initial (release) stratum i, $i = 1\ldots s$

N_j^r population size in final (recovery) stratum j, $j = 1\ldots t$.

p_i^c probability that a fish in the initial stratum i at capture time is captured in that sample; $i = 1\ldots s$.

p_j^r probability that an fish in final stratum j at recovery time is recaptured in that sample; $j = 1\ldots t$.

θ_{ij} probability that a fish in stratum i at capture is in stratum j at recovery time.

μ_{ij} expected number of fish tagged in strata i that are recovered in strata j.

The above statistics and parameters can be arranged into a matrix (Table 1) with associated population parameters (Table 2). The total population at time of tagging ($N_.^c$) is then given by

$$N_.^c = \sum_{i=1}^{s} N_i^c \tag{2}$$

And, total population at time of recovery ($N_.^r$) is given by

$$N_.^r = \sum_{j=1}^{t} N_j^r \tag{3}$$

It is assumed that no part of the population enters recovery strata without being part of one of the tagging strata. To couple tables 1&2, the usual assumptions associated with mark-recapture experiments are required, and it is also assumed that: (1) fish behave independently of one another with respect to movement among strata, (2) all tagged fish released in a stratum have the same probability distribution of movement to recovery strata, (3) all fish in a recovery stratum behave independently in regard to being caught and all have equal probability of being caught, (4) no tags are lost, and (5) tags are recorded properly and correctly upon detection (Schwarz and Taylor 1998).

In addition, one or both of the following assumptions are made depending on whether the goal of the study is to estimate the number of fish in the tagging or recovery strata: (6a) movement pattern, death, migration rates for both tagged and untagged fish are the same in each tagging stratum (required to estimate the total population in the tagging strata), and (6b) the population is closed with respect to movement among strata (required to estimate the total population in the recovery strata). Given these assumptions the expected values of the statistics in table 1 can be written in terms of the following parameters (Table 3).

Let θ_{ij} equal the probability that a fish captured in tagging stratum i will survive and migrate to recovery stratum j, and let N_{ij} be the corresponding number of fish. If the population is closed, θ_i=1 for i=1,...,s. and by definition

$$\theta_{ij} = \frac{N_{ij}}{N_i^c}, i = 1,\ldots,s, j = 1,\ldots,t \tag{4}$$

There are a total of $st + s + t$ parameters, the movement parameters, the initial capture probabilities, and the recovery probabilities. With these parameters certain functions can be estimated under two different scenarios (Schwarz and Taylor 1998).

First, the number of tagging strata may be less than or equal to the number of recovery strata ($s \leq t$). Given assumption 6a, (same movement patterns of tagged and untagged fish, but not necessarily closure over recovery strata), Banneheka et al. (1997) showed that fish in the population at time of tagging could be estimated.

Public Comment #8

Given this scenario, the above models can be parameterized with *st* +2*s* parameters. The expected number of fish moving from tagging strata *i* to recovery strata *j* that are tagged and recovered (*st* parameters) is given by

$$\mu_{ij} = N_i^c p_i^c \theta_{ij} p_j^r; \tag{5}$$

the odds that a fish will not be captured at tagging stratum *i* (*s* parameters),

$$\beta_i = \frac{1-p_i^c}{p_i^c}; \tag{6}$$

and the expected number of fish tagged in stratum *i* and never recovered (*s* parameters),

$$\gamma_i = \sum_{j=1}^{t} N_i^c p_i^c \theta_{ij} \left(1-p_j^r\right). \tag{7}$$

One can describe the expected values of the observed statistics and the number of fish not seen (Schwarz and Taylor 1998).

The $\{\beta_i\}$ are then essentially weights that can be used to construct a linear combination of the rows of the $E[m_{ij}]$ that equals the $E[u_j]$. Thus, we can solve for the $\{\beta_i\}$ to minimize the sum of squares of the predictions, i.e.

$$\sum_{j=1}^{t}\left(u_j - \sum_{i=1}^{s} \hat{\beta}_i m_{ij}\right)^2. \tag{8}$$

However, we used an alternative iterative maximum-likelihood technique to estimate the $\{\beta_i\}$, because this approach allows uncertainty in the m_{ij} to be included in the estimation procedure (Plante 1990; Plante and Rivest 1995). This procedure finds estimates of the $\{\beta_i\}$ that best predict the $\{u_j\}$ while allowing the $\{m_{ij}\}$ to vary around their observed values in a way that is consistent with observed data but also improves the fit (Schwarz and Taylor 1998).

We also calculated the effective number of tags released in each strata (Arnason et al. 1996) by correcting for tagging-induced mortality $\{S_t\}$ and tag loss $\{c_L\}$, i.e.

$$n\_eff_i^c = n_i^c \cdot S_t \cdot c_L. \tag{9}$$

Two estimates of the coho salmon population were computed. The first estimate was corrected for short-term tag mortality, and the second estimate was corrected for long-term tag mortality. Short-term tag mortality was estimated from our net pen studies (objective 1). Long-term tag mortality was estimated from the ratio of the total number of radio tags recovered and the total number applied to coho salmon. This method provides an estimate of the minimum fraction of tagged coho salmon that survived and migrated through the recovery area (commercial fishing districts).

We further calculated the effective number of tags recovered by correcting for tag detection d_{kj} at each processor (*k*) during each recovery strata (*j*), i.e.

$$m\_eff_{ij} = \frac{m_{ij}}{d_{kj}}. \tag{10}$$

Note that corrections for tag mortality, tag loss, and tag detection were made to minimize bias in the population estimates. However, these corrections add variation that was not accounted for in the standard errors and the confidence intervals for the population estimates (Arnason and Mills 1981).

We initially established weekly tagging and recovery strata (July 1-6, July 7-13, July 14-20, July 21-27, July 28-August 3, and after August 4). Once the model was fit, goodness-of-fit tests were conducted to test whether any of the following conditions were satisfied:

1. the recovery probabilities were constant across strata,
2. the (expected) ratio of marked to unmarked fish was constant across all recovery strata. This could have been achieved in one of several ways. Two possibilities were:
   (a) the proportion of each initial stratum marked was constant across all capture strata and marked and unmarked animals experienced the same migration patterns, or
   (b) the migration pattern of marked and unmarked animals across final strata was independent of their initial strata (Arnason et al. 1996).

A 'complete mixing' test was used to test the hypothesis that the probability of resighting a released animal was independent of its stratum of origin. An 'equal proportions' test was used to test the hypothesis that the ratio of marked to unmarked animals was constant across recovery strata (Arnason et al. 1996). If either test passes (i.e. p>0.05), it should be possible to pool strata, but this is unusual in practice (Arnason et al. 1996). In either case, failure to pass these tests does not preclude pooling, other factors must be considered (Arnason et al. 1996). Pooling strata can increase the precision of the estimate but will introduce bias if done improperly. Other than goodness-of-fit statistics, there are no formal tests to determine if one should pool or drop strata.

The χ^2 and G^2 goodness-of-fit statistics were computed to evaluate model fit, i.e.

$$\chi^2 = \sum_{i=1}^{s}\sum_{j=1}^{t}\frac{(m_{ij}-\hat{m}_{ij})^2}{\hat{m}_{ij}} + \sum_{j=1}^{t}\frac{(u_j-\hat{u})^2}{u_j} + \sum_{i=1}^{s}\frac{(n_i^c - m_{i.} - \hat{\gamma}_i)^2}{\hat{\gamma}_i} \qquad (11)$$

or the

$$G^2 = 2\left[\sum_{i=1}^{s}\sum_{j=1}^{t} m_{ij}\ln\left(\frac{m_{ij}}{\hat{m}_{ij}}\right) + \sum_{j=1}^{t} u_j \ln\left(\frac{u_j}{\hat{u}_j}\right) + \sum_{i=1}^{s}\left(n_i^c - m_{i.}\right)\ln\left(\frac{n_i^c - m_i}{\hat{\gamma}}\right)\right]. \qquad (12)$$

The following factors were considered when identifying strata to pool: (1) elimination of strata with E[m_{ij}]<5, (2) pooling of adjacent strata with similar initial capture or recapture probabilities, and (3) minimization of the standard error of the estimate. Poolings that resulted in a large change in the G^2 statistic or standard error of the population estimate (greater than 1 SE) were considered questionable (Arnason et al. 1996). In addition, strata were dropped if the number of tags released or recovered was very small. This was necessary to minimize the number of cells with E[m_{ij}]<5.

Finally, we conducted 5 analyses to evaluate sources of error in our population estimates. The first 2 analyses were focused on whether the salmon tagged in our study were exclusively migrating north into UCI. We first conducted a chi-square test of the null hypothesis that the probability of recapturing PIT tagged salmon did not differ for fish that were captured north versus south of 59.852° N latitude. Approximately, one half of the salmon PIT tagged in our study were tagged north of this latitude. Second, we conducted a chi-square test of the null hypothesis that the probability of recapturing PIT tagged salmon did not differ for fish that were captured during ebb, flood, or slack tides. Next, we conducted a chi-square test of the null hypothesis that the probability of recapturing PIT tagged salmon did not differ among three groups that were held on the tagging vessels for <30 mins, 30-60 mins, and >60 mins. Since time was recorded when each fish was tagged, we were able to include all of our PIT tag data in this analysis. In these first 3 analyses, separate tests were conducted for each species and for all species combined. A fourth chi-square analysis was conducted to test the null hypothesis that the probability of recapturing PIT tagged salmon did not differ among six length classes (<50 cm, 50-55 cm, 55-60 cm, 60-65 cm, 65-70 cm, >70 cm). This analysis was conducted with all species combined, and the length distribution of each species was also calculated for comparison. A final chi-square analysis was conducted to test the null hypothesis that the ratio of the number of tagged to untagged salmon did not differ among seven processors in UCI. Separate analyses were conducted for each species.

Objective 6: Radio telemetry study on coho salmon

Radio tagged coho salmon were tracked from a fixed-wing aircraft using a receiver interfaced with a data collection computer (Advanced Telemetry Systems) and controlled by an external hand-held computer interfaced with a global positioning system. The coordinates and altitude of the aircraft were continuously logged at user defined distance intervals usually between 50 and 100 m. This system allowed tags to be quickly interrogated with data regarding frequency, pulse code, number of hits, date, time of day, and coordinates of each tag easily logged to a data file in flight. The data collection computer was set to cycle between frequencies at intervals from 1-2 seconds per frequency. In 2002, streams flowing into UCI were surveyed once each week from mid July through September. On August 22 & 29, streams south of the OTF transect were surveyed once to determine if any radio tagged coho salmon migrated southward. This survey covered streams south to Cottonwood Bay on the west side of the inlet and on the east side from Port Graham into Kachemak Bay. Only the lower portions of each watershed were surveyed during these flights to minimize cost and survey time. Later in October 2002, most of the UCI drainage basin was surveyed to document the location of tagged salmon within each watershed. Anchorage area streams and streams south of Big River were not included in these surveys of the entire drainage basin. In 2001, only one aerial survey was conducted to locate any tags that had entered the lower portions of streams flowing into the inlet. In 2001 and 2002, fixed receivers were operated on the Susitna River near Susitna Station and on the Yentna River approximately 3 miles above the Yentna sonar site. Receivers operated by the Sport Fish Division of ADF&G scanned for tags on the Kenai, Kasilof, and Swanson rivers. All of the analyses described below were conducted using data from 2002 except that a map of the distribution of radio tag recoveries around UCI was constructed using data from 2001.

We initially used our radio tag data to estimate the total population size of coho salmon entering UCI streams for comparison to our PIT tag estimate. Radio tag recoveries and coho salmon weir counts were available from five streams flowing into northern Cook Inlet (Deshka R., Little Susitna R., Fish Creek, Cottonwood Creek, and Wasilla Creek). We initially considered those portions of the five streams above the weirs as five recovery strata with a single release stratum. The statistics were the total number of radio-tagged coho salmon located in all UCI streams including those caught in recreational fisheries (n_1), the number of coho salmon counted through each of the j weirs (n_{2j}), and the number of radio-tagged coho salmon located above each of the j weirs (m_{2j}). Radio tags not located in freshwater (i.e. captured in the commercial fishery, etc.) were excluded from this analysis, because we were estimating only the population size of coho salmon that entered freshwater. We next conducted a chi-square test of the null hypothesis of equal marked proportions among recovery strata. The pooled-Petersen method was then used to estimate the total population size of coho salmon entering all UCI streams (N_{Radio}) derived from radio tag recoveries. Since, the sample size was relatively small, an inverse cube root transform of the estimate was used to calculate the confidence interval (Arnason et al. 1991).

Our PIT tag estimate of the total population of coho salmon returning to UCI was then used to calculate the population size of coho salmon entering all UCI streams (N_{PIT}) by subtracting the commercial harvest from the total population. The PIT and radio tag estimates of the population of coho salmon entering all UCI streams were then compared. The z-test statistic was used to test whether the two estimates differed, i.e.

$$z = \frac{N_{PIT} - N_{Radio}}{\sqrt{\mathrm{Var}\left(N_{PIT} - N_{Radio}\right)}}, \qquad (13)$$

where

$$\mathrm{Var}(N_{PIT} - N_{Radio}) = \mathrm{Var}(N_{PIT}) + \mathrm{Var}(N_{Radio}). \quad (14)$$

This test assumes that the two abundance estimates are independent and normally distributed.

The escapement of coho salmon into each of 33 major streams (N_k) was estimated from

$$N_k = p_k \cdot N_T, \quad (15)$$

where p_k was the weighted proportion of the total number of recovered radio tags (m_{ik}) from tagging strata i found in freshwater in each (k) stream, i.e.

$$p_k = \frac{\sum_i w_i m_{ik}}{\sum_k \sum_i w_i m_{ik}}. \quad (16)$$

To correct for apparent unequal tagging proportions among release strata, the number of radio tags (m_i) recovered in each stream was weighted (w_i) by the mean $CPUE_i$ in each (i) release stratum and the inverse of the proportion of tags used in release strata $_i$, i.e.

$$w_i = \frac{CPUE_i \Big/ \sum_i CPUE_i}{m_i \Big/ \sum_i m_i}. \quad (17)$$

The variance of the estimated escapement of coho salmon into each stream, $Var(N_k)$, was estimated from

$$Var(N_k) = N_T^2 Var(p_k) + p_k^2 Var(N_T) - Var(p_k)Var(N_T) \quad (18)$$

(Goodman 1960). An estimate of the variance of p_k was derived from

$$\mathrm{Var}(m_{ik}) = M_i\left(\frac{m_{ik}}{M_i}\right)\left(1 - \frac{m_{ik}}{M_i}\right), \quad (19)$$

$$\mathrm{Var}(w_i m_{ik}) = w_i^2 M_i\left(\frac{m_{ik}}{M_i}\right)\left(1 - \frac{m_{ik}}{M_i}\right), \quad (20)$$

$$\mathrm{Var}\left(\sum_i w_i m_{ik}\right) = \sum_i w_i^2 M_i\left(\frac{m_{ik}}{M_i}\right)\left(1 - \frac{m_{ik}}{M_i}\right), \quad (21)$$

$$\mathrm{Var}(p_k) = \mathrm{Var}\left(\frac{\sum_i w_i m_{ik}}{\sum_k \sum_i w_i m_{ik}}\right), \quad (22)$$

$$\mathrm{Var}(p_k) = \frac{\sum_i w_i^2 M_i\left(\frac{m_{ik}}{M_i}\right)\left(1 - \frac{m_{ik}}{M_i}\right)}{\left(\sum_k \sum_i w_i m_{ik}\right)^2}, \quad (23)$$

where $M_i = \sum_k m_{ik}$ = number of radio tags from strata i recovered in freshwater.

The same method was used to estimate the escapement of coho salmon into 5 areas (Westside, Susitna, Knik Arm, Turnagain Arm, and Kenai Peninsula) around UCI by simply pooling the data from streams within each area. The area called 'Westside' included all streams flowing into UCI west of the Susitna River. Pooling tags recovered in these five areas increased the number of tag recoveries and narrowed the confidence intervals around the estimated population sizes.

We then examined the distribution of radio tag recoveries among the 33 streams flowing into the inlet by their date of release from the tagging vessels. The weighted proportion of the total number of recovered radio tags (in freshwater) found in each stream was plotted on a map of UCI using data for releases prior to and after July 20. This analysis was conducted using data from 2001 as well as 2002 for comparison of distributions between years, but proportions were not weighted in the 2001 analysis due to lack of *CPUE* data throughout the entire run. Next, we examined the timing of seven stocks of coho salmon migrating past the OTF transect by estimating the proportion of total radio tag recoveries in each area by their date of release from the tagging vessel. The seven stocks were defined by the five areas previously described except Susitna R., Yentna R., and Little Susitna R. were treated as separate stocks, because there were sufficient tag recoveries in these streams for the analysis. We conducted a chi-square test of the null hypothesis that the proportion of total tags recovered for each stock did not differ by their date of release. The first release stratum and the Kenai Peninsula stock were omitted from the chi-square analysis, because the small number of tag recoveries in these cells resulted in expected values less than five. We also examined the run timing of these seven stocks of coho salmon into freshwater using the date each radio tag was first detected in each stream. Radio tags returned by recreational fishermen were not included in this analysis, because the date of entry of these fish into freshwater could not be precisely determined. We conducted a chi-square test of the null hypothesis that the proportion of total tags recovered for each stock did not differ by their date of entry into freshwater. Six recovery strata were established for this analysis (July 14-20, July 21-27, July 28-Aug. 3, Aug. 4-10, Aug. 11-17, after Aug. 18). The first and last recovery strata and the Kenai Peninsula and Turnagain Arm stocks were omitted from this chi-square analysis, because the small number of tag recoveries in these cells resulted in expected values less than five. We further examined the migration patterns of coho salmon through UCI by estimating the proportion of total radio tags recovered by their date of release and their date of entry into freshwater. This analysis was conducted for all stocks pooled and for each of the seven stocks separately.

Residence times and migration rates of coho salmon were examined in relation to stock of origin and migration timing across the OTF transect. Residence time was estimated by the difference between the date each fish was first detected in freshwater and its date of release from the tagging vessel. The straight-line distance from the OTF transect to the mouth of each stream was used as a measure of the minimum distance each fish traveled in the inlet. Migration rate was estimated by the ratio of the minimum distance traveled and residence time in the inlet. Two ANOVAs were conducted to test the null hypotheses that mean residence time and mean migration rate did not differ by stock of origin or date of release. Each dependent variable was natural-logarithm transformed prior to the analysis and an interaction term was initially included in the model. Finally, we examined travel times for coho salmon between our fixed radio tag receivers at Sunshine Station and Yentna R. An ANOVA was conducted to test the null hypothesis that travel times (natural-logarithm transformed) did not differ by the date each fish was first detected by the receiver at Sunshine Station.

RESULTS

Objective 1: Estimation of short-term tag mortality

Survival (S_t) of tagged coho salmon declined from 88% to 56% as holding time increased from less than 83 mins to 251 mins (Table 4). Survival of tagged chum salmon was consistently high and not clearly related to holding time. Since our study on coho salmon was conducted in a shallow lagoon, tagged salmon may have been exposed to anoxic mud near the bottom of the net pen. It is not clear whether this affected our results, but this was not a factor in our study on chum salmon, because it was conducted in a deep bay.

Objective 2: Application of PIT and radio tags

The number of net sets made during five weekly time periods ranged from 34 to 75 (Table 5). The number of sets made each week was lowest during late July, because *CPUE* peaked at this time so fewer sets were required to catch the fish needed for tagging. Also, we restricted the number of PIT tags applied each day during this time to avoid exhausting our supply of tags. The *CPUE* for all 4 species of salmon peaked the third week of July, and it was highest for sockeye salmon (Table 5). The *CPUE* for sockeye and chum salmon declined at a greater rate in late July than it did for coho and pink salmon. PIT tags were applied to 4,925 coho salmon, 5,338 pink salmon, and 5,071 chum salmon (Table 6). Radio tags were applied to 729 coho salmon. The total catch of coho, pink, and chum salmon declined at a slower rate in late July than did the *CPUE*. The number of net sets made each day was increased during this period to maintain the number of tags released.

Objective 3: Estimation of rate of PIT tag loss

One hundred and sixty eight double-marked sockeye salmon were recovered to estimate PIT tag loss. Seventy nine percent of these fish were recovered at processors and the remainder in the escapement or recreational fishery. One hundred and fifty three (c_L=0.91, SE=0.02) of these fish retained a readable PIT tag. We did not find any PIT tags that could no longer be decoded by the electronic PIT tag reader, and we found no difference between the lengths of those fish that retained versus lost the PIT tag.

Objective 4: Recovery of PIT tags at processors and estimation of PIT tag detection rates

PIT tag readers were installed at seven plants that processed salmon harvested in UCI. The configuration of processing equipment at Ocean Beauty and Snug Harbor prevented an effective installation of PIT tag readers prior to July 27. Modifications were made to the equipment at these plants allowing readers to be installed and operated after that date. We scanned 73% of the commercial harvest of coho salmon, 42% of the pink salmon harvest, and 75% of the chum salmon harvest in UCI in 2002. The fraction of the pink salmon harvest that we scanned was relatively low, because several processors did not pass pink salmon through the heading machines.

The mean difference between detection rates estimated using dummy versus actual salmon heads ranged from 0 - 0.47 (Table 7). These mean differences were used to adjust detection rates estimated using dummy heads at the four plants listed in Table 7. The relatively large adjustment factor at Salamantof was only applied prior to July 23 when all tests were conducted with dummy heads. On that date, the configuration of the antenna array at Salamantof was modified, and all subsequent tests were conducted with actual salmon heads. No adjustments were necessary at Ocean Beauty and Snug Harbor, because all detection tests were conducted with actual salmon heads at these plants. An ANOVA indicated that mean detection rates differed significantly ($p<0.001$) among processors and recovery strata. At Icicle Seafoods and Ocean Beauty, detection rates also differed ($p<0.05$) among processing lines. Mean detection rates (d_{kj}) ranged from 0.37 on line 3 to 0.98 on line 2 both at Icicle Seafoods (Table 8). The low rate on line 3 was due to the configuration of the processing equipment. This line was only used to process pink salmon.

Objective 5: Estimation of salmon population sizes and evaluation of sources of error

Of the 4,925 PIT tags applied to coho salmon, we detected 167 at the 7 salmon processors included in our study (Appendix A). When the total number of tags applied was adjusted for short-term tag mortality and tag loss, the effective number of tags released was reduced to 3,944 (Table 9). A short-term survival rate of 0.88 (SE=0.05) was used in this analysis, because this was the survival of coho salmon held less than 83 mins prior to tagging in our net pen study, and most of the coho salmon tagged in UCI were held for less time. When the number of tags recovered was adjusted for tag detection, the effective number of recovered tags was increased to 214. In every case, the peak number of recoveries from each release stratum occurred one week after release, and tags from each release stratum were recovered over a 3-4 week period after release. No tags were recovered from the first release stratum during the first week of July, and no tags were detected at processors during the first two recovery strata. These strata were dropped from the analysis. The remaining strata included 98% of the harvest that was scanned for tags. We attempted several different poolings. The final model, which produced the lowest standard error of the population estimate, involved pooling recovery strata for the weeks beginning July 14 and 21 (Table 10). This model resulted in 1 of 12 cells with $E[m_{ij}]<5$. The G^2 statistic for this model indicated no significant difference ($p=0.08$) between observed and fitted recoveries (m_{ij}). The estimated population size was 3.22 million with a 95% confidence interval from 2.76-3.68 million. The estimated population size was greatest during the middle of July. For comparison, the pooled Petersen population estimate was 3.19 million.

We also estimated the coho salmon population after adjusting the number of tags released for long-term tag mortality and tag loss. Long-term tag mortality was estimated from recoveries of radio-tagged coho salmon. We located 518 of 729 radio-tagged coho salmon released resulting in a long-term minimum survival of 0.71 (SE=0.02). The strata retained and the final pooling were the same as in the previous analysis. The G^2 statistic also indicated no significant difference ($p=0.08$) between observed and fitted recoveries (Table 11). The estimated population size was 2.52 million with a 95% confidence interval from 2.16-2.87 million. The estimated population size was greatest during the middle of July. For comparison, the pooled Petersen population estimate was 2.58 million.

Of the 5,333 PIT tags applied to pink salmon, we detected only 45 at processing plants (Appendix A). When the total number of tags applied was adjusted for short-term tag mortality and tag loss, the effective number of tags released was reduced to 4,809 (Table 12). When the number of tags recovered was adjusted for tag detection, the effective number of recovered tags was increased to 85. This relatively large adjustment to the tag recoveries for pink salmon resulted in large part, because the greatest numbers of pink salmon were processed at Icicle Seafoods, and all of these fish were processed on line 3, which had a fairly low tag detection rate. The peak number of recoveries from most release strata occurred one week after release with one exception. The peak number of recoveries from the last release strata occurred during the same week the fish were released. Also, the period of time over which tags were recovered was less for pink than coho salmon. Tags from each release strata were recovered over a 1-3 week period after release. As with coho salmon, no tags were recovered from the first release stratum, and no tags were detected at processors during the first two recovery strata. These strata were dropped from the analysis. The remaining strata included 99% of the harvest that was scanned for tags. Several different poolings were attempted, the final model involved pooling recovery strata for the weeks beginning July 21 and 28 (Table 13). This model resulted in 6 of 12 cells with $E[m_{ij}]<5$. The G^2 statistic for this model indicated no significant difference ($p=0.61$) between observed and fitted recoveries (m_{ij}). The estimated population size was 21.28 million, but the precision was poor with a 95% confidence interval from 1.60-40.96 million. The estimated population size was greatest during the first week of August. For comparison, the pooled Petersen population estimate was 13.92 million.

Of the 5,071 PIT tags applied to chum salmon, we detected 154 at the 7 salmon processors included in our study (Appendix A). When the total number of tags applied was adjusted for short-term tag mortality and tag loss, the effective number of tags released was reduced to 4,568 (Table 14). When the number of tags recovered was adjusted for tag detection, the effective number of recovered tags was increased to 197. Tags were recovered in all recovery strata. Similar to pink salmon, the peak number of recoveries from most release strata occurred one week after release with one exception. The peak number of recoveries from the last release strata occurred during the same week the fish were released. Recovery strata beginning July 1 and August 4 were dropped from the analysis, because of the relatively small number of chum salmon scanned for tags and small number of tags recovered in these strata. The remaining strata included 92% of the harvest that was scanned for tags. We attempted several different poolings. The final model involved pooling release strata for weeks beginning July 1 and 7, and July 21 and 28. Also, recovery strata were pooled for weeks beginning July 7 and 14, and July 21 and 28 (Table 15). This model resulted in no cells with $E[m_{ij}]<5$. The G^2 statistic for this model indicated no significant difference ($p=0.95$) between observed and fitted recoveries (m_{ij}). The estimated population size was 3.88 million with a 95% confidence interval from 3.30-4.47 million. The estimated population size was greatest during early July. For comparison, the pooled Petersen population estimate was 3.74 million.

The probability of recapturing PIT tagged coho, pink, and chum salmon was not significantly related to the latitude where the fish were captured. However, the probability of recapturing PIT tagged chum salmon was significantly greater ($p<0.01$) when the fish were captured during a flood or slack tide (Table 16). When the data from all species were pooled, recapture probabilities were still significantly related to stage of tide ($p<0.01$). For all 3 species of salmon, the probability of recapturing PIT tagged salmon increased with the time fish were held on the tagging vessel, but the differences were only significant for chum salmon ($p=0.02$) and when data from all species ($p=0.01$) were pooled (Table 17). Results from a chi-square test also indicated that the probability of recapturing PIT tagged salmon was significantly different ($p<0.01$) among six length classes of salmon (Table 18). Comparison of recovery probabilities and salmon length distributions indicated that the numbers of tags recovered from the smaller pink salmon were likely reduced due to the selective nature of gillnet harvests. The tagged-to-untagged ratio for coho salmon did not differ ($p>0.05$) among seven processors, but this ratio did differ ($p<0.05$) among processors for pink and chum salmon (Table 19). This result did not change when the number of tag recoveries was adjusted for tag detection rates measured at each processor. Tagged-to-untagged ratios were consistently higher at Icicle Seafoods and Ocean Beauty.

Objective 6: Radio telemetry study on coho salmon

In 2001, 67 coho salmon were radio tagged and 41 (68%) were later located in the UCI area. Nine percent of these fish were returned from commercial fishery and 54% were found in streams. In 2002, 729 coho salmon were radio tagged and 518 (71%) were later located in the UCI area. Seven percent of these fish were returned from the commercial fishery, 4% were returned from the recreational fishery, 69% were located in freshwater by either an aircraft or fixed receiver, 17% were located by aircraft in the intertidal zone but were not later located in freshwater, and 3% were either returned to ADF&G without any additional information or were imprecisely located by other means. The fates of the tagged salmon were somewhat related to their dates of release from the tagging vessel. Sixty-four percent of the tags returned by commercial fishermen were tagged after July 20, and 63% of the tags found only in the intertidal zone were tagged after July 20.

We first used our 2002 radio tag data to estimate the total coho salmon population entering all UCI streams. Chi-square analysis indicated that we could not reject the null hypothesis (p=0.21) of equal marked proportions of coho salmon returning to the five streams flowing into UCI (Table 20). There was also no apparent relationship between the run timing of coho salmon into each stream and their marked proportions. Thus, we used the pooled-Petersen method to estimate the total population size of coho salmon entering all UCI streams. The point estimate was 1.36 million with a 95% confidence interval of 0.98-1.96 million. When the 2002 commercial harvest of coho salmon in UCI (0.25 million) was subtracted from the total coho salmon population estimated using PIT tags (Table 11), the point estimate for the coho salmon population entering all UCI streams was 2.27 million with a 95% confidence interval of 1.91-2.62 million. Thus, our PIT tagging experiment estimated a population size for coho salmon entering UCI streams that was higher than the estimate obtained from radio tagging. Although, the 95% confidence intervals around the two estimates overlapped slightly, the z-test statistic indicated the two estimates were significantly (p=0.002) different.

We next partitioned our estimate of the total coho salmon escapement to 33 streams flowing into the inlet. The numbers of radio tags recovered in each stream were first weighted (w_i) by the mean $CPUE_i$ in each (i) release stratum: July 1, w_i=0.25; July 7, w_i=0.39; July 14, w_i=1.78; July 21, w_i=1.42; July 28, w_i=0.58. Estimated numbers of coho salmon escaping into the 33 streams ranged from 2,051 in several small streams to 357,991 in the Susitna River (Table 21). Due to the small number of tag recoveries in individual streams, the 95% confidence intervals around these estimates overlapped zero in about 66% of the cases. But, when the data were pooled into 5 areas, the 95% confidence intervals around the estimates did not overlap zero.

Coho salmon migrating past the OTF transect before July 20 returned primarily to the Susitna drainage, while those migrating later in the season returned primarily to other streams around the inlet on both the west and east sides. Of the 67 coho salmon tagged before July 20, 2001, 41 were later found in 7 streams around the inlet and 68% of these were found in the Susitna River drainage (Figure 1). Of the 372 coho salmon tagged before July 20, 2002, 199 were later found in 21 streams around the inlet and 60% of these were found in the Susitna River drainage (Figure 2). Of the 358 coho salmon tagged after July 20, 2002, 178 were later found in 29 streams around the inlet and only 34% of these were found in the Susitna River drainage (Figure 3). Two hundred and seventy one tagged coho salmon were located during aerial surveys of the entire UCI drainage basin in October, 2002 (Figure 4). Tagged coho salmon were found throughout many parts of the Susitna, Little Susitna, and Beluga River watersheds. In the Little Susitna River, 9 tagged coho salmon were found above the weir located near the Parks Highway and 9 were found below the weir.

The timing of coho salmon migrating across the OTF transect was significantly (p<0.001) different among 7 stocks. Greater than 50% of the coho salmon returning to the Westside, Turnagain Arm and Kenai Peninsula migrated across the OTF transect after July 20 (Table 22). The migration of coho salmon returning to the Susitna drainage, Little Susitna River, and Knik Arm peaked during the week of July 14. The timing of entry into freshwater also differed significantly (p<0.001) among these 7 stocks of coho salmon. The migration of coho salmon entering freshwater along the Westside, Knik Arm and the Little Susitna River peaked the week of Aug. 4, while the peak of the migration into freshwater was earlier for salmon returning to the Susitna drainage, and later for salmon returning to Turnagain Arm and Kenai Peninsula (Table 23). Examination of the migration patterns of coho salmon through UCI (all stocks combined) indicated that their migration across the OTF transect peaked the week of July 14 while entry into freshwater peaked from July 28 through Aug. 10 (Table 24). A similar description of the individual migration patterns of these 7 coho salmon stocks is provided in Appendix B.

An ANOVA indicated that the residence time of coho salmon differed significantly (R^2=0.260, df=10, p<0.001) among 7 stocks and 5 release strata. Similarly, ANOVA indicated that the migration rate of coho salmon also differed significantly (R^2=0.414, df=10, p<0.001) among 7 stocks and 5 release strata. The interaction terms were not significant in either of these models. Coho salmon returning to the Susitna drainage exhibited shorter residence times and higher migration rates through UCI than the other 5 stocks included in the analysis (Table 25). The migration rate of coho salmon through UCI increased from 6.7 km/day in early July to 14.9 km/day in late July (Table 26). Finally, the travel times for coho salmon between our fixed receivers at Susitna Station and Yentna River did not differ by their date of arrival at the Susitna Station receiver. The mean travel time between the 2 receivers was 3.5 days and the distance between the 2 sites was 20.5 km.

DISCUSSION

The accuracy of mark-recapture estimates of population size is dependent on the degree to which the underlying model assumptions are satisfied. The pooled Peterson estimator is only valid if all individuals have equal probability of being tagged and recaptured. In our PIT tagging study, this assumption was not satisfied, because fish probably were not tagged in proportion to their relative abundance and recapture probabilities varied over time due to changing exploitation rates in the commercial fishery. Therefore, we used the stratified Darroch estimator to reduce bias resulting from variable initial capture and final recapture probabilities. In our analysis, we also applied correction factors for tagging-induced mortality, tag loss and tag detection. This was done to minimize bias in our population estimates that could otherwise result from violation of model assumptions.

Estimating tagging-induced mortality is problematic due to the difficulty of designing holding studies that simulate natural conditions. Our estimates of short-term mortality were likely a minimum estimate of actual tagging-induced mortality, because net pen studies of this kind cannot measure delayed mortality that may result from the stress of handling. Candy et al. (1996) estimated mortality of purse seine caught chinook salmon using ultrasonic telemetry. They documented a delayed mortality of 23% occurring 8-12 hrs after release and attributed it to stress-related physiological changes induced by hyperactivity during capture. Laboratory studies have shown that the stress of capture causes blood lactic acid levels to increase for up to 4 hrs after capture with mortality occurring if critical levels of lactate are reached (Parker and Black 1959; Parker et al. 1959; Farrell et al. 2000). Candy et al. (1996) found that delayed mortality of chinook salmon increased from zero to 50% for fish held <15 mins versus > 30 mins. To evaluate whether delayed mortality was related to holding time on the tagging vessel, we tested for a difference in the probability of recapture for groups of PIT tagged salmon held for different lengths of time. Holding time was not significantly related to probability of recapture for coho and pink salmon. But, we were surprised to find that the probability of recapture increased slightly with holding time for chum salmon (Table 17). Perhaps the stress of handling caused these fish to become more vulnerable to capture in the gillnet fishery without causing direct mortality. We also used recoveries of radio tags to estimate the maximum long-term mortality of coho salmon. Application of this estimate of tagging-induced mortality produced a minimum PIT tag population estimate for coho salmon (Table 11) since actual mortality was likely not higher. Although, we do not know whether mortality differs between fish that were radio tagged versus PIT tagged, the difference if any may be small since mortality of coho (Farrell et al. 2000) and chinook salmon (Candy et al. 1996) was not strongly related method of handling or obvious injuries.

We were also surprised to find 17% of our radio tagged coho salmon in the intertidal zone near the mouths of several rivers. These fish were never located in freshwater. The transmitters attached to many of these fish emitted a mortality code indicating that the fish were dead or had not moved recently. Some of these fish may have moved into freshwater undetected and later washed downstream after spawning, or they may have died, because they could not osmoregulate successfully in freshwater. If so, it is not clear whether this could have resulted from the stress of tagging, but it has been amply demonstrated that stress interferes with osmoregulation (Clarke and Hirano 1995).

We used PIT tags to estimate the population size of coho, pink, and chum salmon in part because this method eliminated the potential problem of under reporting of tags by fishermen. However, use of PIT tags required correcting for tag detection rates at salmon processing plants. Our approach involved estimating detection rates daily on each processing line at each plant. PIT tag detection rates were affected by the configuration of the processing equipment at each plant. The best detection rates were achieved at plants where the tag reader antennas were not in close proximity to the salmon header machines, because the vibration of these machines sometimes affected tag detection. During the early part of the season, we were unable to effectively scan for tags at three processing plants due to problems with the configuration of the processing lines (Table 8). This reduced the fraction of the total harvest that was scanned for tags. Differences in uncorrected marked proportions among processing plants can also be used to evaluate whether tag detection rates differed among plants. Our chi-square test indicated no difference in the marked proportions among processors for coho salmon but there was a significant difference for pink and chum salmon (Table 19). However, when corrections for measured detection rates at each processor were applied, the results did not change. This suggests that the different marked proportions among processors were due to something other than variable tag detection rates. The highest marked proportions occurred at Icicle Seafoods and Ocean Beauty. We examined whether marked proportions were related to numbers of fish processed from set versus drift gillnet harvests at each processor, but there was no apparent relationship. It may be that different marked proportions among processors were related to locations in the inlet where fish were harvested. But, we were unable to effectively evaluate this, because data on locations of harvests in the drift fishery are not very accurate.

Our PIT and radio tag estimates of the coho salmon population size likely bracket the actual population size. Both methods involved tagging fish using the same gear type in the same area, but the recovery methods were very different. Commercial fishing vessels recovered PIT tagged salmon in saltwater, while radio tagged salmon were located in freshwater by fixed receivers and aircraft. Bias in our pooled-Petersen estimate derived from radio tag recoveries may have been minimal, because any tagging-induced mortality likely occurred before the fish entered freshwater, and there was likely considerable mixing of tagged and untagged fish between their release from the tagging vessel and entry into freshwater. Mixing of coho salmon in the inlet was evident from their relatively long residence times (Tables 25 & 26) and the upper triangular structure in the recovery matrices (Schwarz and Taylor 1998) constructed from our PIT (Table 9) and radio tag data (Table 24). Our coho salmon population estimate could have been biased if the probability of locating radio tags above the weirs was different from the probability of locating all other radio tags found in freshwater. Our last survey to locate radio tags above weirs on streams east of the Susitna River was not conducted until late October due to poor weather earlier in the month. Loss of voltage in the transmitter batteries could have affected our probability of locating tags during this later survey. The battery manufacturer specified a 160-day life for the batteries used in our study, and Advanced Telemetry Systems warranties these batteries for 80 days of operation. About 105 days elapsed between the time these fish were tagged and the last survey. Previous experience with these transmitters has indicated the life of most of the batteries is about two times the warrantied life (pers. comm., Jay Carlon, ADF&G Sport Fish Division, Soldotna, Alaska). To further evaluate this question, we conducted a chi-square analysis to test whether marked proportions differed between Deshka River, which was surveyed in early October, and those streams located east of the Susitna River, which were surveyed in late October. There was no difference (p>0.10).

Our PIT tag coho salmon population estimate could have been biased upward, because we dropped the July 1 release stratum to minimize the number of cells with E[m_{ij}]<5. When release strata are dropped, estimates of β_i (and stratum population estimates) can be biased upwards trying to account for the untagged recovered fish (Schwarz and Taylor 1998). Although our *CPUE* data indicated low relative abundances of coho salmon migrating across the OTF transect during the July 1 release stratum (Table 5), our radio tag data indicated that these fish migrated relatively slowly through the inlet and thus likely contributed to commercial harvests in later recovery strata (Table 25). The population estimate for the July 14+21 recovery stratum (Tables 10 & 11) may have been most affected by this bias, because fish from the first release stratum were most likely to have contributed to the commercial harvests during this time. Nevertheless, the bias resulting from dropping the first release stratum was likely small.

Our estimate of the population size of pink salmon was of questionable value. As with coho salmon, the estimate may have been biased upwards, because we dropped the July 1 release stratum to minimize the number of cells with E[m_{ij}]<5. Size-dependent tag loss may have also caused an upward bias in our pink salmon population estimate. Although, we did not find that tag loss was size dependent in our study using sockeye salmon, many pink salmon were much smaller than sockeye salmon. Although, we do not know whether these smaller fish lost tags at a higher rate, our observations on the tagging vessel suggest that this probably occurred. The precision of our pink salmon population estimate was also substantially reduced, because many processors did not pass pink salmon through their heading machines, and our tag detection rate was low on the one line at Icicle Seafoods where most of the pink salmon harvested in UCI were processed. Finally, we found the probability of recapturing PIT tagged salmon in the commercial gillnet fishery was strongly size dependent (Table 18). Although, gillnet selectivity caused lower recapture probabilities for small tagged pink salmon, it also resulted in lower capture probabilities for small untagged pink salmon. Our pink salmon population estimate was likely not biased significantly by gillnet selectivity, because we used a relatively non-selective gear type to obtain the initial tagging sample, and the sources of selectivity between the capture and recapture samples were independent (Seber 1982). We did not attempt to stratify our pink salmon population analysis by size because of the small number of tags recovered.

Our estimate of the population size of chum salmon may be biased upward, because we did not account for delayed mortality, and chum salmon captured on the ebb tide exhibited a lower tag recapture probability. Other factors do not appear to have biased the estimate. We did not drop any release or recovery strata, our estimate of tag loss from sockeye salmon was likely representative of this rate in chum salmon, and the G^2 statistic indicated a good model fit to the data (Table 15). However, in this analysis we used an estimate of short-term tag mortality obtained from net pen studies. Our studies with coho salmon and others with chinook salmon (Candy et al. 1996) indicate that delayed tag mortality probably occurs. If so, our chum salmon population estimate could be biased upward, but the magnitude of the bias, if any, likely does not exceed that found for coho salmon, i.e. about 28% (Tables 10 & 11). Finally, chum salmon captured on the ebb tide exhibited a lower tag recapture probability (Table 16) suggesting that fewer of these fish migrated into UCI. It is unclear whether this was a tagging effect, or if salmon migrating to areas outside UCI may have been captured at a higher rate on the ebb tide. Burbank (1977) described a cyclonic gyre south of our OTF transect and a northward flowing current along the east side of the inlet in spring and summer. Salmon migrating to areas south of UCI may orient to freshwater flowing into the inlet along the east side (Hasler and Scholz 1983). We attempted to scan catches of salmon harvested in lower Cook Inlet for PIT tags, but were unable to do so, because totes of fish from the entire inlet were mixed together when they were processed. Nevertheless, previous studies have indicated that the majority of chum salmon tagged west of Anchor Point migrated north into Cook Inlet, only 8% migrated to other areas outside of the inlet (Tyler and Noerenberg 1967).

Finally, we used our population estimates for coho, pink, and chum salmon to evaluate the probable ranges of exploitation rates on these species in the commercial fishery and their escapements in 2002 (Table 27). This was done as a first step toward determining escapement levels needed to achieve sustained yields. Our best PIT tag estimate of the total population size of coho salmon returning to UCI was 2.52 million (95% CI: 2.16-2.87 million). Given a commercial harvest of 0.25 million (Fox and Shields 2003), the total escapement of coho salmon into all UCI streams was 2.27 million (95% CI: 1.91-2.62 million), and the exploitation rate in the commercial fishery was 10% (95% CI: 9-11%). However, given the lower range of our radio tag escapement estimate for coho salmon (95% CI: 0.98 – 1.96 million), the exploitation rate could have ranged as high as 20%. This relatively low exploitation can be explained by a decrease in effort (no. of deliveries x hours fished) in the drift gillnet fishery over the past 20 years (Figure 5). Previous investigators estimated exploitation rates on hatchery-reared coho salmon using recoveries of coded-wired tagged fish in the commercial fishery (Hasbrouck and Hoffman 1994, Stratton et al. 1996, Cyr et al. 1997, 1998, 1999, 2001). Their estimates have ranged from 6-93% (Appendix C). We conducted a regression analysis to test whether these coded-wire tag estimates of exploitation rate were related to effort in the drift gillnet fishery, which typically harvests over 70% of the coho salmon in the inlet. We omitted the estimate from Wasilla Creek in 1997, because the weir was removed due to high water before the end of the coho salmon run. Exploitation rate was significantly correlated (R^2=0.367, df=20, p=0.003) with effort in the drift gillnet fishery (Figure 6). Interestingly, effort in 1998 (28,932 boat-hours) was very similar to that in 2002 (30,504 boat-hours), and exploitation rates estimated using coded-wire tags in 1998 (0.15-0.21) were very similar to those estimated in our study.

Since our population estimate for pink salmon was of questionable value, we estimated a maximum exploitation rate on this species by simply summing escapements that were actually enumerated: Kenai River - 2,353,786, Deshka River – 946,255, Yentna River – 414,658 (Westerman and Willette 2003). We used side-scan sonar to roughly estimate the escapement of pink salmon into the Kenai River above river mile 19. The sonar was operated on the south bank of the river until August 29. Sonar counts of pink salmon migrating along the north bank were not considered reliable due to milling fish within the sonar beam, so we assumed the passage rate on the north bank was equal to that on the south bank. Catches of pink salmon in fish wheels operated by the ADF&G Sport Fish Division at river mile 26 through September 26 were used to estimate that the pink salmon run was 43% complete by August 29. We applied this fraction to our sonar count to estimate the pink salmon escapement above the sonar site. A large but unknown number of pink salmon spawned below our sonar site. Summing the escapements from these three rivers and given a commercial harvest of 0.45 million (Fox and Shields 2003), the maximum exploitation rate on pink salmon in the commercial fishery was about 12%. However, the actual exploitation rate must be much lower, since we did not account for pink salmon escapements into numerous other streams around the inlet. A relatively low exploitation rate on pink salmon may be expected since the probability of capture was substantially reduced for small pink salmon that comprised more than one half of the population (Table 17), and fishermen likely avoided this species due to its very low value.

Our PIT tag estimate of the total population size of chum salmon returning to UCI was 3.88 million (95% CI: 3.30-4.47 million). Given a commercial harvest of 0.24 million (Fox and Shields 2003), the total escapement of chum salmon into all UCI streams was 3.64 million (95% CI: 3.06-4.23 million), and the exploitation rate in the commercial fishery was 6% (95% CI: 5-7%). Tarbox (1988) tagged chum salmon in the middle of UCI in 1983 and 52% of these tags were captured in the commercial fishery. Since under reporting of tags by fishermen was likely, Tarbox (1988) estimated that the actual exploitation rate may have been as high as 75%, but this estimate was based on an assumption regarding chum escapements outside of the Susitna River. Typically, 87% of the commercial harvest of chum salmon has been taken in the drift gillnet fishery (Fox and Shields 2003). Since 1983, effort (no. of deliveries x hours fished) in this fishery has declined by nearly 5-fold (Figure 5). In 2002, effort was 28% of that in 1983. Assuming conditions in the fishery (other than the amount of effort) were similar in these 2 years, we calculated an expected exploitation rate on chum salmon in

2002 by applying this ratio (28%) to the fraction of recaptures and the exploitation rate Tarbox (1988) estimated for the 1983 season. The expected exploitation rate ranged from 14-21%. Although, this estimate is higher than the one obtained in our study, the difference is relatively small considering the uncertainty in both estimates. This analysis supports the notion that the difference in exploitation rates estimated in these 2 years was largely due to a 5-fold decline in effort in the fishery.

Relatively low exploitation rates on chum salmon may be expected since commercial gillnets in UCI extend only about 4 m deep in the water column. Ultrasonic tracking studies have shown that chum salmon spend a significant amount of time deeper in the water column during their inshore migration (Ishida et al. 1988). The offshore areas of the inlet are about 25-80 m deep, so chum salmon may be less vulnerable to capture in surface drift gillnets. Further studies are needed to determine the vertical distribution of chum salmon migrating though UCI and the distribution of chum salmon escapements around the inlet. We will be initiating studies in 2003 to begin investigating vertical and horizontal distributions of salmon migrating into the inlet and whether interannual changes in their vertical distribution affect catchability in drift gillnets.

Despite uncertainty in our salmon population estimates, it is reasonable to conclude that exploitation rates on coho, pink, and chum salmon in the UCI commercial fishery were substantially below optimal rates in 2002. Our population estimates for coho and chum salmon ranged between 1.23 and 4.23 million, and the commercial fishery harvested about 0.25 million of each species. Uncertainty regarding actual population sizes within this range resulted in little change in estimated exploitation rates (range 6-20%), because exploitation rate was an inverse function of estimated population size (Figure 7). Given that optimal exploitation rates typically range from 50-80% (Chapman 1986), a severe bias in our population estimates for coho and chum salmon would be necessary to approach the optimal range. Our assessment of uncertainties in these data indicates that this level of bias was unlikely. Finally, the exploitation rate on pink salmon in the commercial fishery was certainly far below the optimal rate in 2002, because in our calculation of the maximum rate, we only accounted for pink salmon actually enumerated in 3 streams, while this species was known to escape into numerous other streams around the inlet.

LITERATURE CITED

Arnason, A.N. and K.H. Mills. 1981. Bias and loss of precision due to tag loss in Jolly-Seber estimates for mark-recapture experiments. Can. J. Fish. Aquat. Sci. 38: 1077-1095.

Arnason, A.N., C.J. Schwarz, and J.M. Gerrard. 1991. Estimating closed population size and number of marked animals from sighting data. J. Wildl. Mmgt. 55: 716-730.

Arnason, A.N., C.W. Kirby, C.J. Schwarz, and J.R. Irvine. 1996. Computer analysis of Marking data from stratified populations for estimation of salmonid escapements and the size of other populations. Can. Tech. Rep. Fish. Aquat. Sci. No. 2106.

Banneheka, S.G., R.D. Routledge, and C.J. Schwarz. 1997. Stratified two-sample tag recovery census of closed populations. Biometrics 53: 1212-1224.

Bevan, D.E. 1962. Estimation by tagging of the size of migrating salmon populations in coastal waters. *In* The research program of the Fisheries Research Institute in Bristol Bay, 1945-1958. W.F. Thompson (ed.), University of Washington, College of Fisheries, Contribution no. 105, pp 373-449.

Brannas, E. and five coauthors. 1994. Use of the passive integrated transponder (PIT) in a fish identification and monitoring system for fish behavioral studies. Trans. Amer. Fish. Soc. 123: 395-401.

Burbank, D.C. 1977. Circulation studies in Kachemak Bay and lower Cook Inlet. *In* Environmental Studies of Kachemak Bay and Lower Cook Inlet, vol. III. L.L. Traskey et al. (eds.), Marine Coastal Habitat Management Report, Alaska Dept. Fish and Game, Anchorage, AK.

Candy, J.R., E.W. Carter, T. Quinn, and B.E. Riddell. 1996. Adult chinook salmon behavior and survival after catch and release from purse-seine vessels in Johnstone Strait, British Columbia. N. Amer. J. Fish .Mgmnt. 16: 521-529.

Chapman, D.W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Am. Fish. Soc. 115: 662-670.

Clarke, W.C., and T. Hirano. 1995. Osmoregulation. *In* Physiological Ecology of Pacific Salmon, C. Groot, L. Margolis, and W.C. Clarke (eds.). University of British Columbia Press, Vancouver, BC.

Conover, W.J. 1999. Practical nonparametric statistics. John Wiley & Sons, Inc. New York.

Cyr, P., B. Stratton, and J.J. Hasbrouck. 1997. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 97-3, Anchorage.

Cyr, P., B. Stratton, and J.J. Hasbrouck. 1998. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 98-5, Anchorage.

Cyr, P., B. Stratton, and J.J. Hasbrouck. 1999. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-7, Anchorage.

Cyr, P., B. Stratton, and J.J. Hasbrouck. 2001. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 01-6, Anchorage.

Eames, M., T. Quinn., K. Reidinger, and D. Haring. 1981. Northern Puget Sound 1976 adult coho and chum tagging studies. Wash. Dept. Fish. Tech. Rpt. 64, 217p.

Eames, M., T. Quinn., and M. Hino. 1983. Northern Puget Sound 1977 adult coho and chum tagging studies. Wash. Dept. Fish. Tech. Rpt. 75, 239p.

Farrell, A.P., P. Gallaugher, C. Clarke, N. DeLury, H. Kreiberg, W. Parkhouse, and R. Routledge. 2000. Physiological status of coho salmon (*Oncorhynchus kisutch*) captured in commercial nonretention fisheries. Can. J. Fish. Aquat. Sci. 57: 1668-1678.

Fox, J., and P. Shields. 2003. Upper Cook Inlet commercial fisheries annual management report, 2002. Alaska Department of Fish and Game, Regional Information Report no. 2A03-14.

Goodman, L.A. 1960. On the exact variance of products. J. Amer. Stat. Assoc. 55: 708-713.

Hasler, A.D., and A.T. Scholz. 1983. Olfactory imprinting and homing in salmon. Investigations into the homing and imprinting process. Springer-Verlag, New York..

Hiderbrand, R. H., and J.L. Kershner. 2000. Movement patterns of stream-resident cutthroat trout in Beaver Creek, Idaho–Utah. Trans. Ac. Fish. Soc. 129:1160–1170.

Hoffman, A.G. and J.J. Hasbrouck. 1994. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-45, Anchorage.

Ishida, K., S. Nagahora, Y. Inoue, and T. Watanabe. 1988. Behavior of adult chum salmon (*Oncorhynchus keta*) homing to the coast of Sanriku. Nippon Suisan Gakkaishi 54(8):1279-1287.

Parker, R.R., and E.C. Black. 1959. Muscular fatigue and mortality in troll-caught chinook salmon (*Oncorhynchus tshawytscha*). J. Fish. Res. Bd. Can. 16: 95-106.

Parker, R.R., E.C. Black, and P.A. Larkin. 1959. Fatigue and mortality in troll-caught Pacific salmon (*Oncorhynchus*). J. Fish. Res. Bd. Can. 16: 429-448.

Pengilly D., and L.J. Watson 1994. Automated detection of red king crab at crab processing facilities. Fishery Research. 19: 293-300.

Plante, N. 1990. Estimation de la taille d'une population animale a l' aide d' un modele de capture-recapture avec stratification. M. Sc. thesis, Universite' Laval, Quebec, Que.

Plante, N., and L.-P. Rivest. 1995. Stratified capture-recapture estimation of the size of a closed population. Tech. Rep. 95-03, Departement de mathematiques and de statistiques, Universite Laval, Quebec, Que.

Prentice, E.F. 1986. A new internal telemetry tag for fish and crustaceans. *In* Marine farming and enhancement: Proceedings of the 15th U.S.-Japan meeting on aquaculture, Kyoto Japan, NOAA Tech. Rep. NMFS 85: 1-9.

Prentice, E.F., 1990. A new internal telemetry tag for fish and crustaceans. *In* Marine farming and enhancement; proceedings of the fifteenth U. S.-Japan meeting on aquaculture, Kyoto, Japan, October 22-23. 1986. Sparks, A.K. editor. NOAA technical report NMFS 85, March 1990.

Prentice, E.P., C.W. Sims, and D.L. Park. 1985. A study to determine the biological feasibility of a new fish tagging system. Report to Bonneville Power Administration (Project 83-19), Portland, Oregon.

Prentice, E.F., T. A. Flagg, and C.S. McCutheon. 1990a. Feasibility of using passive integrated transponder (PIT) tags in salmonids. Am. Fish. Soc. Symp. 7: 317-322.;

Prentice, E.F., T. A. Flagg, and C.S. McCutheon. 1990b. PIT-tag monitoring systems for hydroelectric dams and fish hatcheries. Am. Fish. Soc. Symp. 7: 323-334.

Prentice, E.F., T. A. Flagg, C.S. McCutcheon, D.F. Brastow, and D.C. Cross. 1990c. Equipment, methods, and an automated data-entry station for PIT tagging. Am. Fish. Soc. Symp. 7: 335-340.

Price, A., and C. Powell. 2000. Clove oil as an anesthetic for invasive field procedures on adult rainbow trout. N. Amer. J. Fish. Mgmt. 20: 1029-1032.

Quinn, T.P., and N.P. Peterson. 1996. The influence of habitat complexity and fish size on overwinter survival and growth of individually marked juvenile coho salmon (*Oncorhynchus kisutch*) in Big Beef Creek, Washington. Can. J. Fish. Aquat. Sci. 53: 1555-1564.

Schwarz, C.J., and C.G. Taylor. 1998. Use of the stratified-Petersen estimator in fisheries management: estimating the number of pink salmon (*Oncorhynchus gorbuscha*) spawners in the Fraser River. Can. J. Fish. Aquat. Sci. 55: 281-296.

Seber, G.A.F. 1962. The multi-sample single recapture census. Biometrika 49(3-4): 339-350.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. Charles Griffin and Co. Ltd., London.

Shields, P.A. 2003. An estimate of the migratory timing and abundance of sockeye salmon into upper Cook Inlet, Alaska. Alaska Dept. of Fish and Game, Regional Information Report no. 2A03-01, 46p.

Skalski, J.R., S.G. Smith, R.N. Iwamoto, J. GT. Williams, and A. Hoffmann. 1998. Use of passive integrated transponder tags to estimate survival of migrant juvenile salmonids in the Snake and Columbia rivers. Can. J. Fish. Aquat. Sci. 55: 1484-1493.

Stratton, B., J.J. Hasbrouck, and P. Cyr. 1996. Estimates of commercial harvest and escapement of coho salmon stocked in Northern Cook Inlet streams, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 96-4, Anchorage.

Tarbox, K.E. 1988. Migratory rate and behavior of salmon in Upper Cook Inlet, Alaska, 1983-1984. Fishery Research Bulletin 88-05, 56p.

Tarbox, K.E., and R.E. Thorne. 1996. Assessment of adult salmon in near-surface waters of Cook Inlet, Alaska. J. Mar. Sci. 53: 397-401

Thompson, S.H. 1930. Salmon tagging experiments in Alaska, 1929. U.S. Bureau of Fisheries Doc. 1084.

Tyler, R.W., and W.H. Noerenberg. 1967. Salmon tagging in Cook Inlet. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Biological Laboratory, Auke Bay, Alaska, Manuscript Report no. 37, 120p.

Westerman, D.L., and T.M. Willette. 2003. Upper Cook Inlet salmon escapement studies, 2002. Alaska Dept. of Fish and Game, Regional Information Report no. 2A02-17.

Zar, J.H. 1984. Biostatistical Analysis. Prentice-Hall, Inc., Englewood Cliffs, NJ.

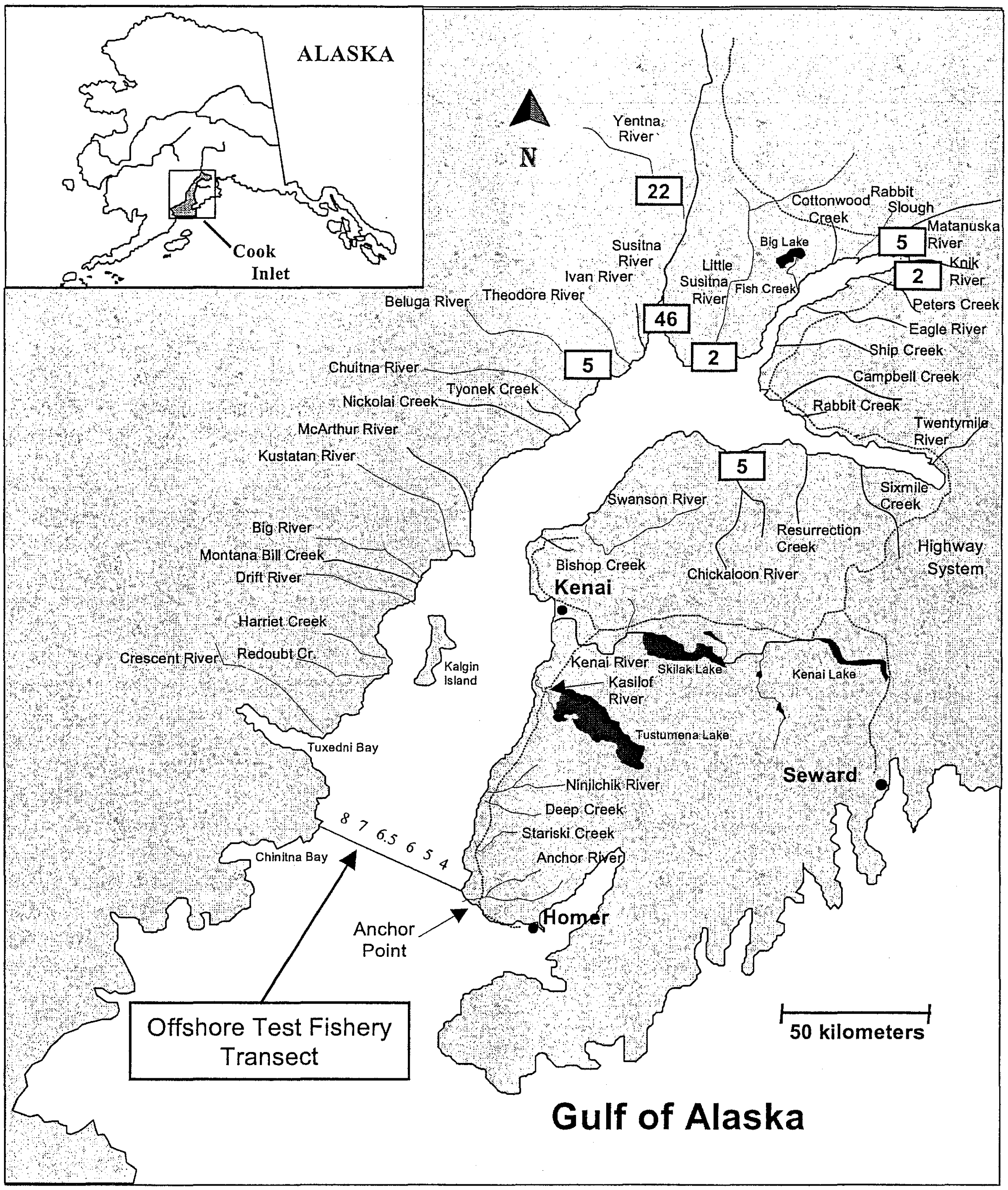


Figure 1. Locations of radio tagged coho salmon found during surveys of the lower portions of Upper Cook Inlet streams in 2001. These fish were tagged along the offshore test fishery transect west of Anchor Point before July 20, 2001. Numbers in boxes indicate percent of total recoveries (in freshwater) occurring in each stream. Numbers along test fishery transect indicate stations.

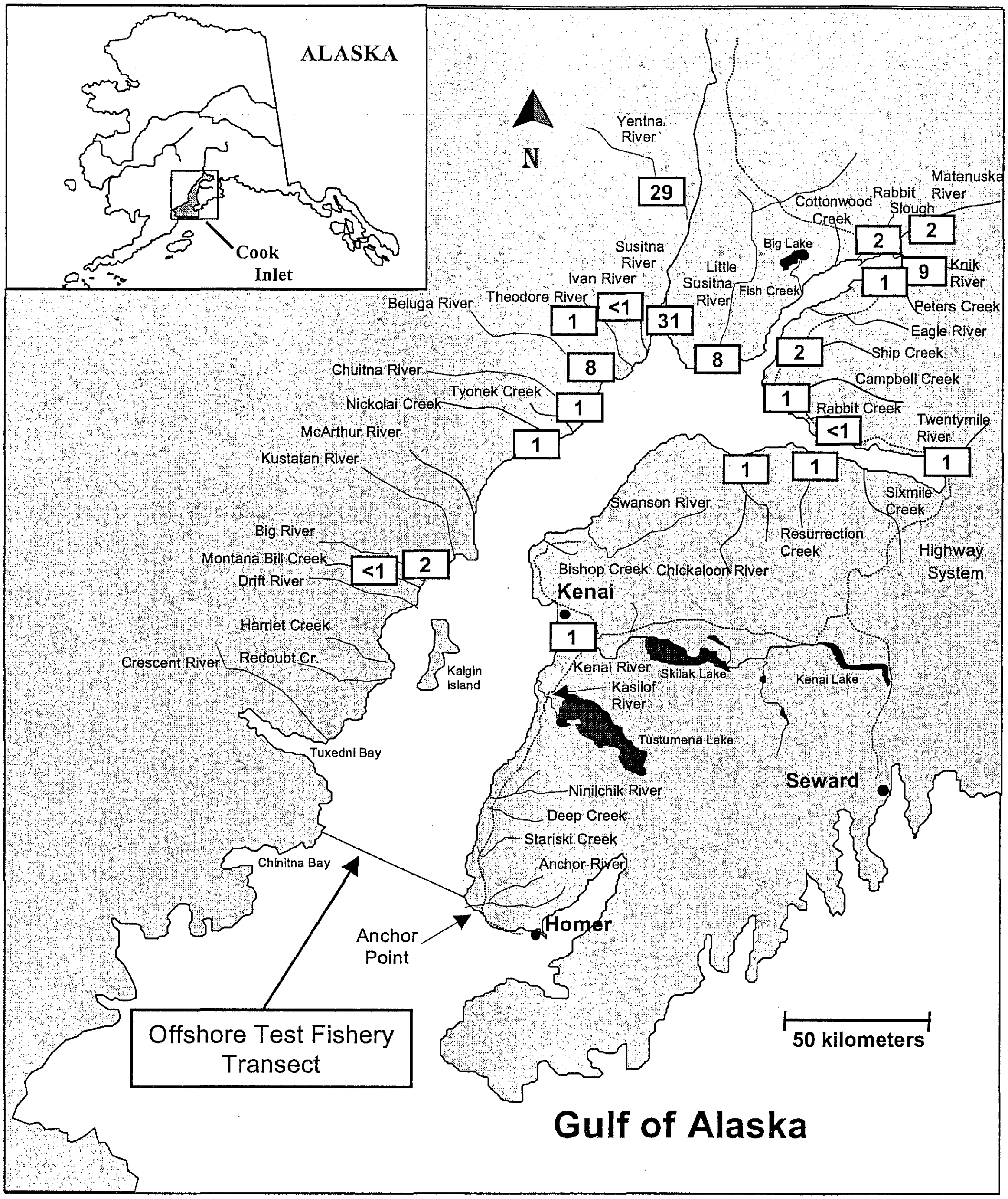


Figure 2. Locations of radio tagged coho salmon found during surveys of the lower portions of Upper Cook Inlet streams in 2002. These fish were tagged along the offshore test fishery transect west of Anchor Point before July 20, 2002. Numbers in boxes indicate percent of total recoveries (in freshwater) occurring in each stream.

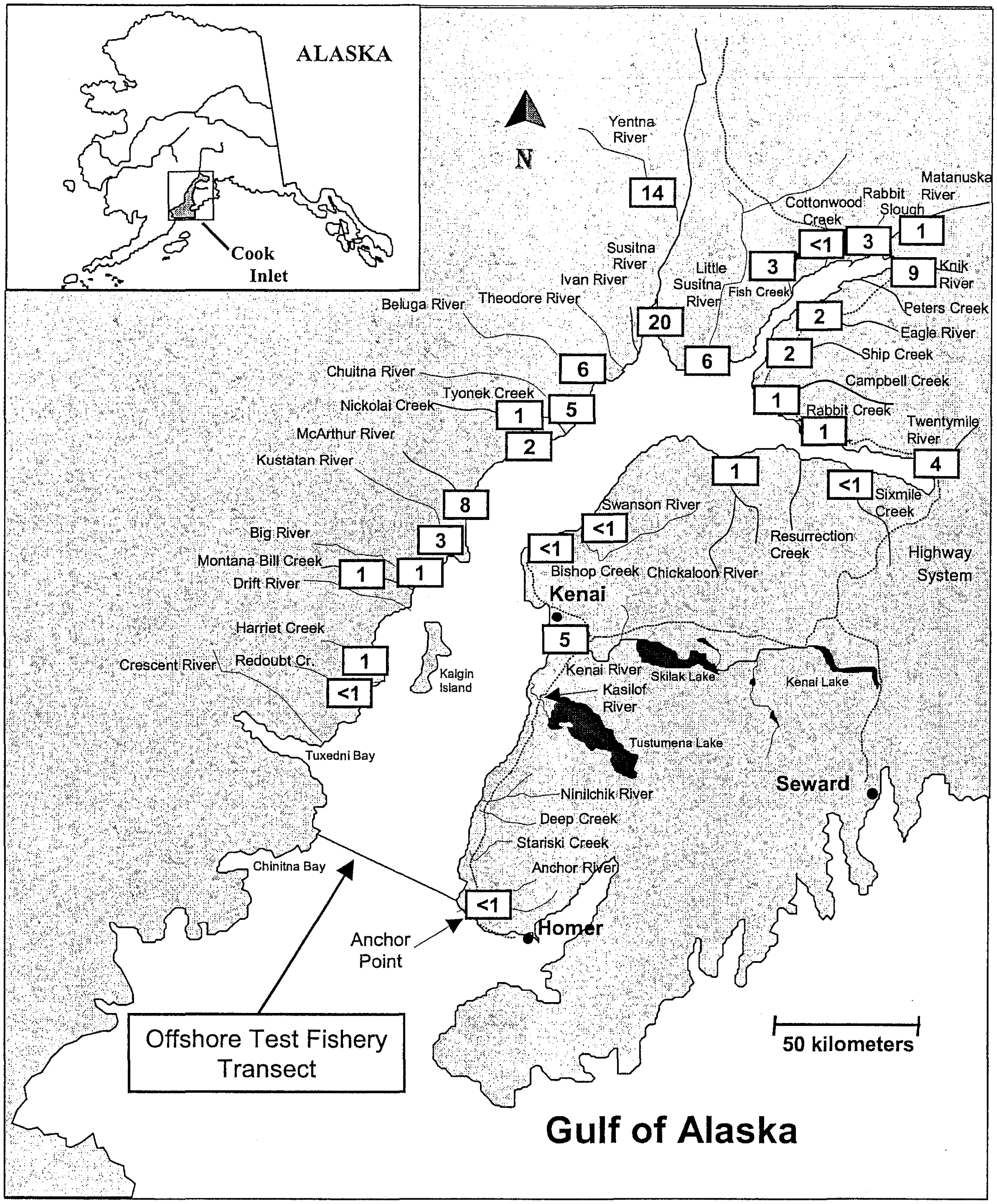


Figure 3. Locations of radio tagged coho salmon found during surveys of the lower portions of Upper Cook Inlet streams in 2002. These fish were tagged along the offshore test fishery transect west of Anchor Point after July 20, 2002. Numbers in boxes indicate percent of total recoveries (in freshwater) occurring in each stream.

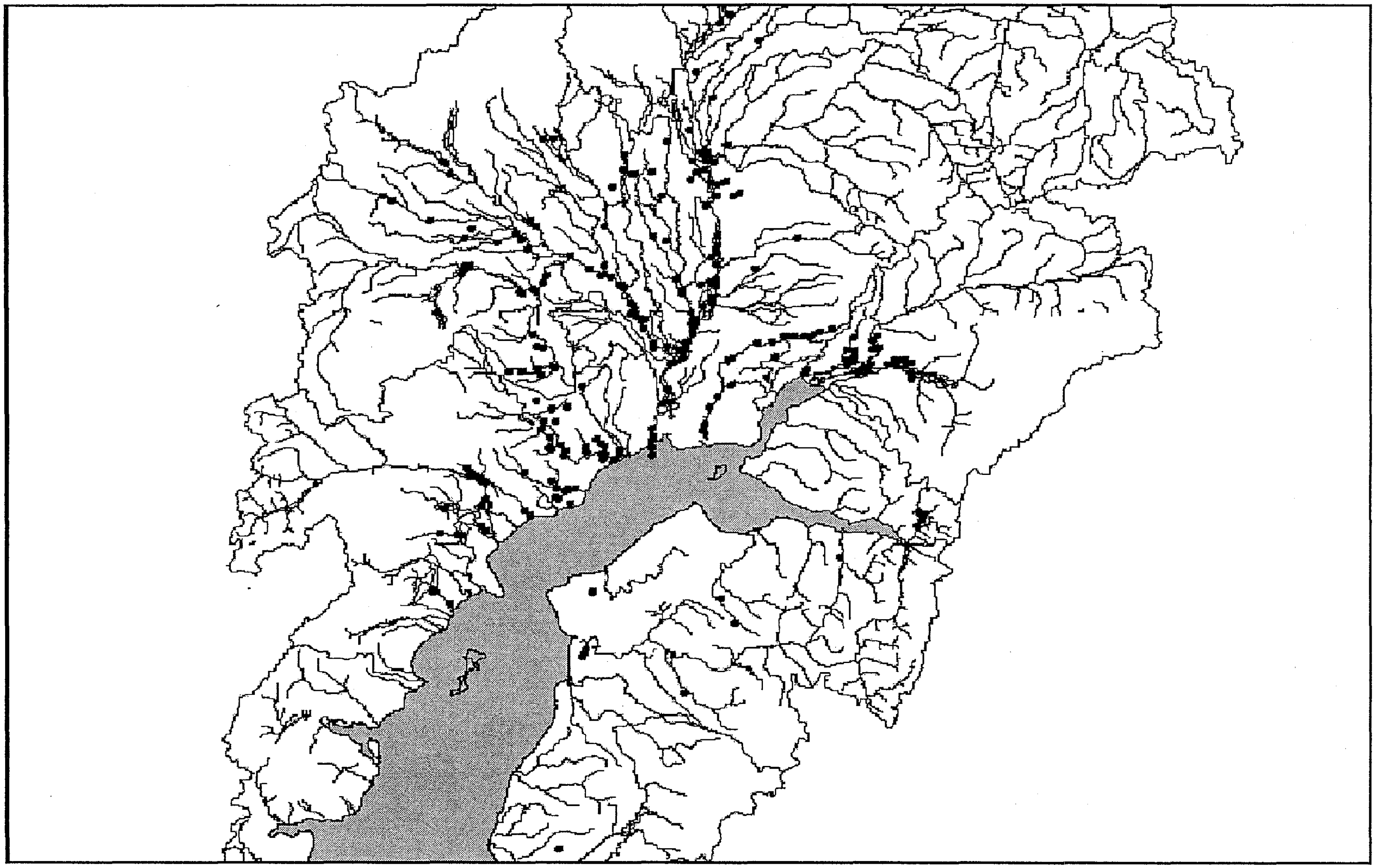


Figure 4. Locations of radio tagged coho salmon (solid circles) found during surveys of the Upper Cook Inlet drainage basin in October, 2002. Streams in the Anchorage area and those south of Big River on the west side of the inlet were not flown during these surveys. The fish were tagged along the offshore test fishery transect west of Anchor Point in 2002.

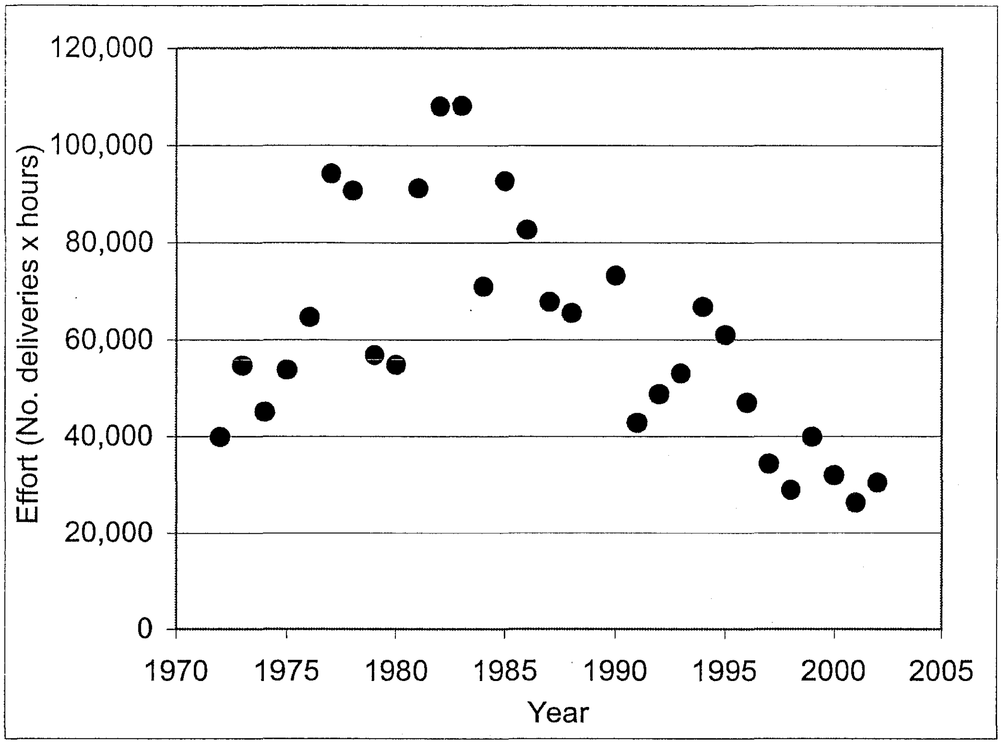


Figure 5. Historical effort (number of deliveries x hours fished) in the drift gillnet fishery (district wide openings only), 1972-2002.

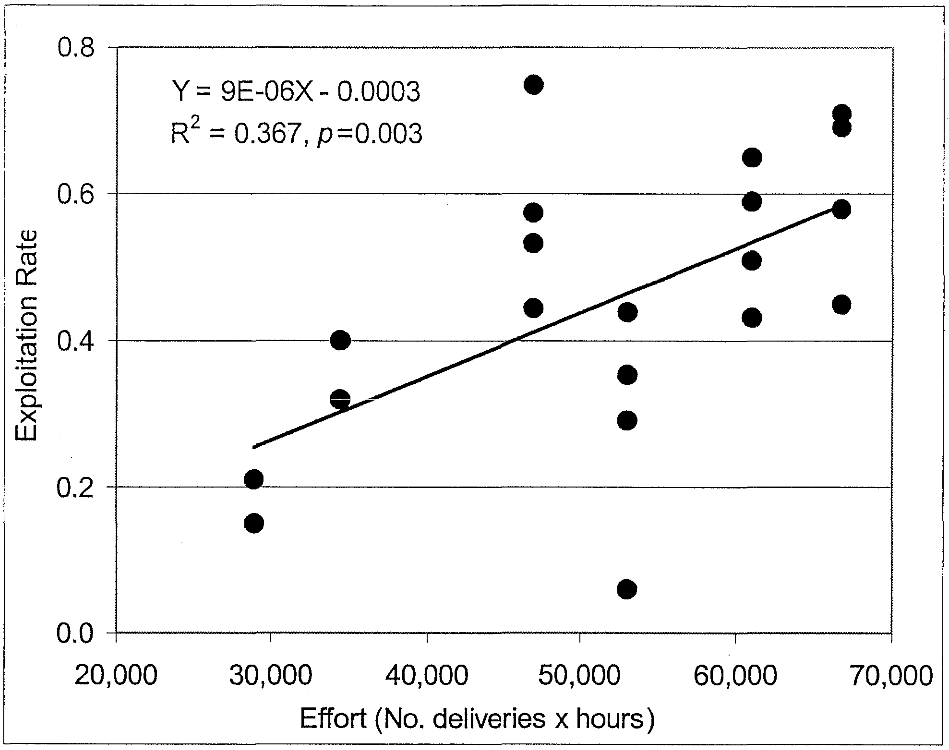


Figure 6. Relationship between commercial fisheries exploitation rate on coho salmon (estimated from coded wire tags) and effort (number of deliveries x hours fished) in the drift gillnet fishery (district wide openings only), 1993-1998.

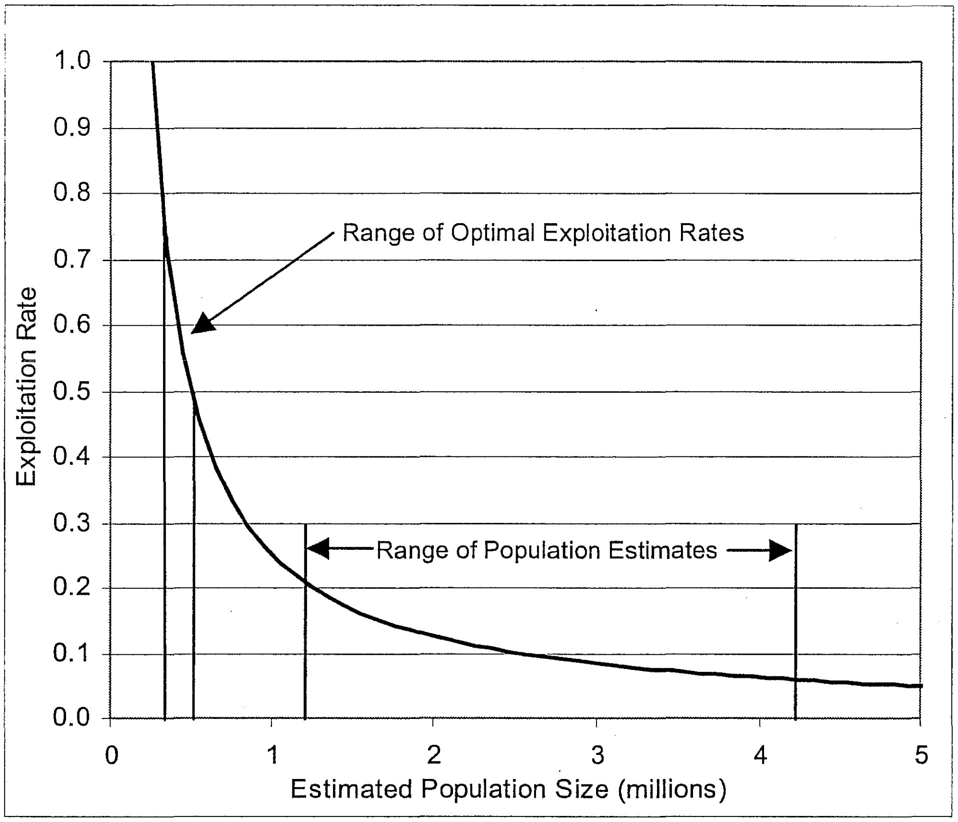


Figure 7. Relationship between exploitation rate and the uncertainty in estimated salmon population sizes assuming a harvest of 0.25 million (example for coho and chum salmon).

Table 1. Statistics collected from a stratified mark-recapture experiment (Schwarz and Taylor 1998).

Tagging stratum	Fish tagged	Recovery stratum 1	2	…	t	Not recovered
1	n_1^c	m_{11}	m_{12}	…	m_{1t}	$n_1^c - m_{1.}$
2	n_2^c	m_{21}	m_{22}	…	m_{2t}	$n_2^c - m_{2.}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	n_s^c	m_{s1}	m_{s2}	…	m_{st}	$n_s^c - m_{s.}$
Total of untagged fish		u_1	u_2	…	u_t	

Table 2. Population parameters from a stratified mark-recapture experiment (Schwarz and Taylor 1998).

Tagging stratum	Total Fish	Recovery stratum 1	2	…	t	Died or did not move to recovery stratum
1	N_1^c	N_{11}	N_{12}	…	N_{1t}	$N_1^c - N_{1.}$
2	N_2^c	N_{21}	N_{22}	…	N_{2t}	$N_2^c - N_{2.}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	N_s^c	N_{s1}	N_{s2}	…	N_{st}	$N_s^c - N_{s.}$
Total	$N_.^c$	$N_{.1} = N_1^r$	$N_{.2} = N_2^r$	…	$N_{.t} = N_t^r$	

Table 3. Expected value of statistics in Table 1 (Schwarz and Taylor 1998).

Tagging Stratum	Fish tagged	Recovery statum 1	2	…	t	Not recovered
1	$N_1^c p_1^c$	$N_1^c p_1^c \theta_{11} p_1^r$	$N_1^c p_1^c \theta_{12} p_2^r$	…	$N_1^c p_1^c \theta_{1t} p_t^r$	$N_1^c p_1^c - \sum_{j=1}^{t} N_1^c p_1^c \theta_{1j} p_j^r$
2	$N_2^c p_2^c$	$N_2^c p_2^c \theta_{21} p_1^r$	$N_2^c p_2^c \theta_{22} p_2^r$	…	$N_2^c p_2^c \theta_{2t} p_t^r$	$N_2^c p_2^c - \sum_{j=1}^{t} N_2^c p_2^c \theta_{2j} p_j^r$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	$N_s^c p_s^c$	$N_s^c p_s^c \theta_{s1} p_1^r$	$N_s^c p_s^c \theta_{s2} p_2^r$	…	$N_s^c p_s^c \theta_{st} p_t^r$	$N_s^c p_s^c - \sum_{j=1}^{t} N_s^c p_s^c \theta_{sj} p_j^r$
Total untagged fish		$\sum_{i=1}^{s} (1 - p_i^c) N_i^c \theta_{i1} p_1^r$	$\sum_{i=1}^{s} (1 - p_i^c) N_i^c \theta_{i2} p_2^r$	…	$\sum_{i=1}^{s} (1 - p_i^c) N_i^c \theta_{it} p_t^r$	

E [fish not tagged or recovered] = $E\left[N_.^c - n_.^c - u_.\right] = \sum \sum N_i^c \left(1 - p_i^c\right) \theta_{ij} \left(1 - p_j^r\right)$

Table 4. Short-term tag mortality of coho and chum salmon estimated from net pen studies.

Species	Cum. Holding Time (mins)	Number Tagged	Number Survived	Survival	SE
Coho	83	50	44	0.88	0.05
	136	50	33	0.66	0.07
	199	50	29	0.58	0.07
	251	50	28	0.56	0.07
Chum	83	50	50	1.00	0.00
	146	50	49	0.98	0.02
	208	50	50	1.00	0.00
	266	50	49	0.98	0.02

Table 5. Total number of net sets and geometric mean catch per net set for sockeye, coho, pink, and chum salmon during five weekly tag release strata, 2002. Numbers in parentheses indicate the standard error of the mean.

Release	Number	Geometric mean catch per net set			
Strata	Net Sets	Sockeye	Coho	Pink	Chum
July 1	70	5.9 (0.2)	0.3 (0.1)	0.4 (0.2)	1.8 (0.2)
July 7	75	74.0 (0.2)	7.2 (0.1)	6.6 (0.2)	13.3 (0.2)
July 14	43	145.6 (0.3)	32.1 (0.2)	27.3 (0.2)	24.5 (0.2)
July 21	34	37.0 (0.3)	22.3 (0.2)	18.5 (0.3)	12.7 (0.2)
July 28	69	7.7 (0.2)	11.8 (0.1)	13.2 (0.2)	7.4 (0.1)
Mean		54.0	14.7	13.2	12.0

Table 6. Total catch and number of coho, pink, and chum salmon tagged with PIT and radio tags during five weekly tag release strata, 2002.

Release	Coho			Pink		Chum	
Strata	Catch	No. PIT	No. Radio	Catch	No. PIT	Catch	No. PIT
July 1	52	27	12	49	46	428	399
July 7	861	648	181	904	850	1,617	1,480
July 14	1,997	1,606	179	4,201	997	3,010	995
July 21	1,311	1,137	156	1,089	1,068	1,023	1,020
July 28	1,714	1,507	202	2,381	2,377	1,178	1,177

 Public Comment #8

Table 7. Mean difference between PIT tag detection rates estimated using dummy versus actual salmon heads by processor and line, 2002. Numbers in parentheses indicate the standard error of the mean.

Processor	Line	Mean Difference	n	*p*-value
Deep Creek	1	0.15 (0.00)	1	-
Icicle Seafoods	1	0.11 (0.05)	12	0.023
Icicle Seafoods	2	0.00 (0.03)	11	0.787
Icicle Seafoods	3	0.16 (0.03)	11	0.004
Inlet Salmon	1	0.10 (0.02)	18	0.000
Pacific Star	1	0.02 (0.03)	13	0.033
Salamantof	1	0.47 (0.11)	2	0.500

Table 8. Mean PIT tag detection rate by processor and processing line during six weekly tag recovery strata, 2002. Numbers in parentheses indicate the standard error of the mean.

		Recovery strata (week beginning)					
Processor	Line	July 1	July 7	July 14	July 21	July 28	August 4
Deep Creek	1	0.79 (0.09)	0.66 (0.05)	0.78 (0.05)	0.83 (0.05)	0.83 (0.05)	0.82 (0.05)
Icicle Seafoods	1	0.76 (0.07)	0.68 (0.05)	0.75 (0.05)	0.64 (0.05)	0.66 (0.05)	0.72 (0.03)
Icicle Seafoods	2	0.98 (0.07)	0.88 (0.05)	0.94 (0.05)	0.95 (0.05)	0.92 (0.05)	0.91 (0.03)
Icicle Seafoods	3	- -	0.64 (0.05)	0.50 (0.05)	0.38 (0.05)	0.43 (0.05)	0.37 (0.03)
Inlet Salmon	1	0.79 (0.06)	0.64 (0.05)	0.78 (0.05)	0.83 (0.05)	0.86 (0.05)	0.79 (0.04)
Ocean Beauty	1	- -	- -	- -	0.86 (0.08)	0.91 (0.03)	0.89 (0.02)
Ocean Beauty	2	- -	- -	- -	0.78 (0.08)	0.88 (0.03)	0.67 (0.02)
Pacific Star	1	0.94 (0.06)	0.93 (0.05)	0.95 (0.05)	0.91 (0.05)	0.94 (0.05)	0.92 (0.06)
Salamantof	1	0.48 (0.06)	0.50 (0.05)	0.52 (0.05)	0.66 (0.05)	0.95 (0.05)	0.94 (0.06)
Snug Harbor	1	- -	- -	- -	0.94 (0.01)	0.71 (0.05)	0.86 (0.06)

Table 9. Summary statistics for coho salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002. The number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	22	0.0	0.0	0.0	0.0	0.0	0.0
July 7	519	0.0	0.0	10.7	9.5	2.6	0.0
July 14	1,286	0.0	0.0	19.5	40.4	20.5	3.8
July 21	911	0.0	0.0	0.0	5.5	43.8	7.7
July 28	1,207	0.0	0.0	0.0	0.0	19.7	30.8
Total untagged		406	3,497	41,173	46,795	57,822	29,518
Total recoveries		406	3,497	41,211	46,864	57,930	29,571

Table 10. Detailed results from a maximum likelihood Darroch estimate of the population size of coho salmon returning to Upper Cook Inlet, 2002 (final pooling) and test results for completing pooling. In this analysis, the number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

(A) Detailed results from analyzing PIT tag data for coho salmon: final pooling.

Release		Observed recoveries (m_{ij}) with fitted values beneath			
Strata	Fish tagged	July 14+21	July 28	August 4	Total
July 7	519	20.2	2.6	0.0	
		26.7	3.1	0.0	
July 14	1,286	59.9	20.5	3.8	
		53.2	18.9	3.1	
July 21	911	5.5	43.8	7.7	
		5.7	44.8	8.2	
July 28	1,207	0.0	19.7	30.8	
		0.0	19.8	31.0	
Population size		1,584,230	715,180	918,700	3,218,111
SE (Population size)		209,021	201,280	202,445	233,466
Probability (recapture)		0.0556	0.081	0.0322	
SE (Prob. recapture)		0.0073	0.0228	0.0071	
G^2 test for goodness of fit:		G^2=3.16, df=1, *p*-value=0.08.			

(B) Test results for completing pooling.

	χ^2	df	*p*-value
Test for complete mixing	9.0	3	0.03
Test for equal proportions	9.1	2	0.01

Table 11. Detailed results from a maximum likelihood Darroch estimate of the population size of coho salmon returning to Upper Cook Inlet, 2002 (final pooling) and test results for completing pooling. In this analysis, the number of tagged fish released (n_i^c) has been adjusted for long-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

(A) Detailed results from analyzing PIT tag data for coho salmon: final pooling.

Release Strata	Fish tagged	Observed recoveries (m_{ij}) with fitted values beneath: July 14+21	July 28	August 4	Total
July 7	419	20.2	2.6	0.0	
		26.7	3.2	0.0	
July 14	1,038	59.9	20.5	3.8	
		53.3	18.8	3.2	
July 21	735	5.5	43.8	7.7	
		5.7	44.8	8.1	
July 28	974	0.0	19.7	30.8	
		0.0	30.9	31.0	
Population size		1,270,539	623,448	621,766	2,515,872
SE (Population size)		165,823	165,063	168,732	181,164
Probability (recapture)		0.0693	0.0929	0.0476	
SE (Prob. recapture)		0.009	0.0246	0.0129	
G^2 test for goodness of fit:		G^2=3.14, df=1, *p*-value=0.08.			

(B) Test results for completing pooling.

	χ^2	df	*p*-value
Test for complete mixing	4.7	3	0.20
Test for equal proportions	14.5	2	0.00

Table 12. Summary statistics for pink salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002. The number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	41	0.0	0.0	0.0	0.0	0.0	0.0
July 7	766	0.0	0.0	10.0	0.0	0.0	0.0
July 14	898	0.0	0.0	14.0	2.6	0.0	0.0
July 21	962	0.0	0.0	0.0	2.6	28.1	2.7
July 28	2141	0.0	0.0	0.0	0.0	17.3	7.7
Total untagged		142	3,016	31,593	38,883	107,960	72,476
Total recoveries		142	3,016	31,620	38,889	108,010	72,487

Table 13. Detailed results from a maximum likelihood Darroch estimate of the population size of pink salmon returning to Upper Cook Inlet, 2002 (final pooling) and test results for completing pooling. In this analysis, the number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

(A) Detailed results from analyzing PIT tag data for pink salmon: final pooling.

Release		Observed recoveries (m_{ij}) with fitted values beneath			
Strata	Fish tagged	July 14	July 21+28	August 4	Total
July 7	766	10.0	0.0	0.0	
		11.2	0.0	0.0	
July 14	898	14.0	2.6	0.0	
		12.8	2.6	0.0	
July 21	962	0.0	30.7	2.7	
		0.0	30.8	2.8	
July 28	2141	0.0	34.6	7.7	
		0.0	34.6	7.6	
Population size		2,163,366	1,254,682	17,863,404	21,281,600
SE (Population size)		447,972	3,947,598	13,416,101	10,039,425
Probability (recapture)		0.0146	0.1171	0.0041	
SE (Prob. recapture)		0.003	0.3684	0.003	

G^2 test for goodness of fit: G^2=0.25, df=1, p-value=0.61.

(B) Test results for completing pooling.

	χ^2	df	p-value
Test for complete mixing	11.3	3	0.01
Test for equal proportions	23.1	2	0.00

Table 14. Summary statistics for chum salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002. The number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	359	1.0	6.4	3.0	0.0	0.0	0.0
July 7	1,333	0.0	1.5	45.0	2.2	1.5	0.0
July 14	896	0.0	0.0	12.1	25.7	0.0	0.0
July 21	919	0.0	0.0	0.0	8.2	41.9	0.0
July 28	1,060	0.0	0.0	0.0	0.0	41.0	7.6
	Untagged	7,800	21,730	52,256	42,007	38,864	5,239
	Total recoveries	7,801	21,739	52,323	42,047	38,958	5,247

Table 15. Detailed results from a maximum likelihood Darroch estimate of the population size of chum salmon returning to Upper Cook Inlet, 2002 (final pooling) and test results for completing pooling. In this analysis, the number of tagged fish released (n_i^c) has been adjusted for short-term tag mortality and tag loss. Number of tagged fish recovered (m_{ij}) has been adjusted for tag detection rate.

(A) Detailed results from analyzing PIT tag data for chum salmon: final pooling.

Release		Observed recoveries (m_{ij}) with fitted values beneath		
Stratum	Fish tagged	July 7+14	July 21+28	Total
July 1+7	1,692	55.9	3.7	
		56.0	3.7	
July 14	896	12.1	25.7	
		12.0	25.5	
July 21+28	1,979	0.0	91.1	
		0.0	91.3	
Population size		2,129,903	1,755,510	3,885,413
SE (Population size)		274,161	168,816	300,451
Probability (recapture)		0.0348	0.0461	
SE (Prob. recapture)		0.0045	0.0044	
G^2 test for goodness of fit:	G^2=0.00, df=1, p-value=0.95.			

(B) Test results for completing pooling.

	χ^2	df	p-value
Test for complete mixing	2.7	2	0.26
Test for equal proportions	10.3	1	0.00

Table 16. Results from a chi-square test of the null hypothesis that the probability of recapturing PIT tagged coho, pink, and chum salmon did not differ for fish that were captured during ebb, flood, or slack tides.

		Stage of Tide		
Species		Ebb	Flood	Slack
Coho salmon				
	Number not recovered	1355	2642	770
	Number recovered	34	105	28
	Percent recovered	2.45	3.82	3.51
	Chi-square test:	χ^2=5.37, df=2, p-value=0.07		
Pink salmon				
	Number not recovered	1837	2789	677
	Number recovered	16	24	5
	Percent recovered	0.86	0.85	0.73
	Chi-square test:	χ^2=0.11, df=2, p-value=0.95		
Chum salmon				
	Number not recovered	1638	2697	591
	Number recovered	38	84	32
	Percent recovered	2.27	3.02	5.14
	Chi-square test:	χ^2=12.72, df=2, p-value<0.01		
Pooled				
	Number not recovered	4830	8128	2038
	Number recovered	88	213	65
	Percent recovered	1.79	2.55	3.09
	Chi-square test:	χ^2=13.02, df=2, p-value<0.01		

Table 17. Results from a chi-square test of the null hypothesis that the probability of recapturing PIT tagged coho, pink, and chum salmon did not differ among three groups that were held on the tagging vessels for <30 mins, 30-60 mins, and >60 mins.

		Holding time (mins.)		
Species		< 30	30-60	>60
Coho salmon				
	Number not recovered	3474	950	334
	Number recovered	118	35	14
	Percent recovered	3.29	3.55	4.02
	Chi-square test:	χ^2=0.63, df=2, p-value=0.73		
Pink salmon				
	Number not recovered	3777	1165	351
	Number recovered	26	14	5
	Percent recovered	0.68	1.19	1.40
	Chi-square test:	χ^2=4.17, df=2, p-value=0.12		
Chum salmon				
	Number not recovered	3319	1087	511
	Number recovered	91	37	26
	Percent recovered	2.67	3.29	4.84
	Chi-square test:	χ^2=7.76, df=2, p-value=0.02		
Pooled				
	Number not recovered	10570	3202	1196
	Number recovered	235	86	45
	Percent recovered	2.17	2.62	3.63
	Chi-square test:	χ^2=11.00, df=2, p-value<0.01		

Table 18. Results from a chi-square test of the null hypothesis that the probability of recapturing PIT tagged coho, pink and chum salmon (pooled) did not differ among six length classes (<50 cm, 50-55 cm, 55-60 cm, 60-65 cm, 65-70 cm, >70 cm). The length distribution for each species tagged is also indicated for comparison.

(A) Test of null hypothesis that probability of tag recovery was independent of length.						
	Length class (cm)					
	50	50-55	55-60	60-65	65-70	>70
Number not recovered	2,080	2,409	2,718	4,620	2,829	312
Number recovered	10	39	77	167	66	7
Percent recovered	0.48	1.59	2.75	3.49	2.28	2.19
Chi-square test:	χ^2=66.05, df=5, p-value<0.01					
(B) Length distribution (percent of total sample) of tagged coho, pink, and chum salmon.						
Coho salmon	2.3	10.5	29.8	43.7	12.5	1.3
Pink salmon	36.9	35.8	20.8	6.3	0.3	0.0
Chum salmon	0.1	0.4	4.4	45.4	44.6	5.1

Table 19. Ratios of the number of tagged and untagged coho, pink and chum salmon recovered at seven plants processing salmon returning to Upper Cook Inlet, 2002. Tag ratios adjusted for tag detection rates at each processor are included for comparison.

	Coho		Pink		Chum	
Processor	Ratio	Adj. Ratio	Ratio	Adj. Ratio	Ratio	Adj. Ratio
Deep Creek	0.00088	0.00107	-	-	0.00097	0.00118
Icicle Seafoods	0.00100	0.00137	0.00035	0.00077	0.00137	0.00189
Inlet Salmon	0.00075	0.00090	0.00011	0.00013	0.00054	0.00065
Ocean Beauty	0.00128	0.00165	0.00022	0.00026	0.00224	0.00262
Pacific Star	0.00082	0.00088	-	-	0.00078	0.00083
Salamantof	0.00067	0.00090	-	-	0.00058	0.00092
Snug Harbor	0.00108	0.00144	0.00003	0.00004	0.00130	0.00181

Table 20. Results from a chi-square test of the null hypothesis that there was no difference in the ratio of the numbers of radio tagged to untagged coho salmon returning to five streams flowing into northern Cook Inlet for which salmon escapement estimates were available in 2002. The date at which 50% the total escapement passed the weir is included for comparison.

Stream	Date for 50% of Total Escapement	Number Radio Tags	Total Escapement
Deshka River	August 8	10	24,612
Little Susitna River	September 1	9	47,938
Fish Creek	August 21	3	14,651
Cottonwood Creek	August 21	0	3,957
Wasilla Creek	August 23	6	13,195
Sum		28	104,353
Chi-square test:	χ^2=5.89, df=4, p-Value=0.21		

Table 21. Estimated total escapement (with 95% confidence intervals) of coho salmon into 33 streams and 5 areas around Upper Cook Inlet, 2002. The number of tags weighted by the catch per unit effort of coho salmon in each release stratum is also indicated, as well as, the weighted percent of total tags (recovered in freshwater) found in each stream or area (Page 1 of 2).

Area	Stream	Number Tags	Weighted No. Tags	Weighted Percent	Total Escapement	Lower 95% CI	Upper 95% CI
Westside	Beluga R.	27	26.6	6.9	94,345	43,410	145,280
Westside	Big R.	3	5.0	1.3	17,617	0	38,084
Westside	Chuitna R.	10	10.0	2.6	35,328	8,716	61,941
Westside	Harriet Cr.	1	1.4	0.4	5,020	0	14,794
Westside	Ivan R.	2	0.8	0.2	2,794	0	6,685
Westside	Kustatan R.	6	5.1	1.3	18,247	1,450	35,045
Westside	McArthur R.	14	12.3	3.2	43,566	15,458	71,674
Westside	Montana Bill Cr.	3	1.6	0.4	5,501	0	11,944
Westside	Nikolai Cr.	5	4.9	1.3	17,473	0	35,378
Westside	Redoubt Cr.	1	0.6	0.2	2,051	0	6,054
Westside	Theodore R.	2	2.2	0.6	7,695	0	20,361
Westside	Tyonek Cr.	2	2.0	0.5	7,072	0	17,748
Total		76	72.4	18.9	256,709	148,132	365,286
Susitna	Yentna R.	85	86.1	22.4	305,240	181,798	428,681
Susitna	Susitna R.	94	101.0	26.3	357,991	216,752	499,230
Susitna	Little Susitna R.	26	26.9	7.0	95,262	43,555	146,969
Total		205	213.9	55.8	758,492	478,088	1,038,897
Knik Arm	Cottonwood Cr.	1	0.6	0.2	2,051	0	6,054
Knik Arm	Eagle R.	3	3.4	0.9	12,092	0	26,765
Knik Arm	Fish Cr.	6	4.3	1.1	15,278	1,321	29,235
Knik Arm	Knik R.	27	33.4	8.7	118,472	57,173	179,771
Knik Arm	Matanuska R.	5	5.8	1.5	20,411	0	41,522
Knik Arm	Peters Cr.	1	1.8	0.5	6,298	0	18,584
Knik Arm	Rabbit Slough	8	9.2	2.4	32,503	5,781	59,225
Knik Arm	Ship Cr.	7	7.9	2.1	28,137	3,568	52,706
Total		58	66.3	17.3	235,242	131,985	338,500

Table 21. Continued (Page 2 of 2).

Area	Stream	Number Tags	Weighted No. Tags	Weighted Percent	Total Escapement	Lower 95% CI	Upper 95% CI
Turnagain Arm	Campbell Cr.	3	2.9	0.8	10,401	0	24,178
Turnagain Arm	Chickaloon R.	3	3.6	0.9	12,715	0	28,997
Turnagain Arm	Rabbit Cr.	4	2.1	0.6	7,552	0	15,273
Turnagain Arm	Resurrection Cr.	1	1.8	0.5	6,298	0	18,584
Turnagain Arm	Sixmile Cr.	1	0.6	0.2	2,051	0	6,054
Turnagain Arm	Twentymile R.	10	7.8	2.0	27,730	6,621	48,840
Total		22	18.8	4.9	66,748	27,774	105,722
Kenai Peninsula	Anchor R.	1	0.6	0.2	2,051	0	6,054
Kenai Peninsula	Bishop Cr.	1	0.6	0.2	2,051	0	6,054
Kenai Peninsula	Kenai R.	13	10.4	2.7	36,855	11,731	61,979
Kenai Peninsula	Swanson R.	1	0.6	0.2	2,051	0	6,054
Total		16	12.1	3.2	43,008	15,881	70,135

Table 22. Percent of total radio tags recovered (in freshwater) for seven stocks of coho salmon in Upper Cook Inlet, 2002 by release strata.

	Recovery Area (stock)								
Release Strata	Westside	Susitna River	Yentna River	L. Susitna River	Knik Arm	Turnagain Arm	Kenai Peninsula	Total	Weighted No. Tags
July 1	0.0	0.0	0.6	0.0	0.4	0.0	0.0	0.2	0.7
July 7	6.5	13.7	13.7	8.8	4.8	4.2	0.0	9.6	36.6
July 14	31.9	54.5	59.8	52.9	45.5	37.7	14.6	47.7	183.0
July 21	35.2	26.7	16.5	21.1	36.3	15.0	23.4	26.6	101.9
July 28	26.4	5.2	9.4	17.2	13.1	43.0	62.0	16.0	61.3
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	383.6

Table 23. Percent of total radio tags recovered (in freshwater) for seven stocks of coho salmon in Upper Cook Inlet, 2002 by recovery strata.

Recovery	Recovery Area (stock)								Weighted
Strata	Westside	Susitna River	Yentna River	L. Susitna River	Knik Arm	Turnagain Arm	Kenai Peninsula	Total	No. Tags
July 14	1.1	4.8	5.8	1.6	0.0	0.0	0.0	3.0	10.8
July 21	15.3	36.53	25.7	0.0	0.7	14.7	0.0	19.9	71.8
July 28	34.0	33.15	48.8	30.5	23.9	0.0	0.0	33.2	120.0
Aug. 4	37.3	20.44	15.8	40.4	41.0	19.2	0.0	26.7	96.6
Aug. 11	8.1	4.15	3.2	25.2	18.5	42.5	6.3	10.0	36.2
Aug. 18	4.2	0.98	0.7	2.3	15.9	23.6	93.7	7.3	26.3
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	361.7

Table 24. Percent of total radio tagged coho salmon recovered in streams flowing into Upper Cook Inlet, 2002 by release and recovery strata (all stocks combined).

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.7
July 7	1.5	4.5	2.5	0.5	0.3	0.3	9.7	35.1
July 14	1.5	13.8	21.1	8.8	2.5	1.0	48.6	175.9
July 21	0.0	1.6	9.0	12.1	2.0	2.0	26.6	96.3
July 28	0.0	0.0	0.5	5.1	5.3	4.0	14.9	53.8
Sum	3.0	19.9	33.2	26.7	10.0	7.3	100.0	361.7

Table 25. Geometric mean residence time and migration rate for seven stocks of radio tagged coho salmon in Upper Cook Inlet.

Area	Residence Time (days)	Migration Rate (km/day)
Westside	13.5(1.1)	10.5(1.1)
Susitna River	12.0(1.1)	17.8(1.1)
Yentna River	11.9(1.1)	19.9(1.1)
Little Susitna	16.2(1.1)	12.2(1.1)
Knik Arm	19.7(1.0)	13.0(1.1)
Turnagain Arm	19.1(1.1)	12.0(1.1)
Kenai Peninsula	31.0(1.2)	3.0(1.2)

Table 26. Geometric mean residence time and migration rate for radio tagged coho salmon in Upper Cook Inlet by release strata.

Release strata	Residence Time (days)	Migration Rate (km/day)
July 1	28.0(1.3)	6.7(1.3)
July 7	19.1(1.1)	9.9(1.0)
July 14	15.5(1.1)	12.2(1.0)
July 21	12.9(1.1)	14.1(1.1)
July 28	12.2(1.0)	14.9(1.0)

Table 27. Estimated population sizes (millions), escapements, and exploitation rates on coho, pink and chum salmon returning to Upper Cook Inlet in 2002 derived from mark-recapture studies.

Species	Estimate (95% Conf. Int.)	Population Size	Comm. Fish. Harvest	Estimated Escapement	Estimated CF Exploitation Rate
Coho	Radio telemetry - lower	1.23	0.25	0.98	0.20
Coho	Radio telemetry - point	1.61	0.25	1.36	0.15
Coho	Radio telemetry - upper	2.21	0.25	1.96	0.11
Coho	PIT tag - lower	2.16	0.25	1.91	0.11
Coho	PIT tag - point	2.52	0.25	2.27	0.10
Coho	PIT tag - upper	2.87	0.25	2.62	0.09
Chum	PIT tag - lower	3.30	0.24	3.06	0.07
Chum	PIT tag - point	3.88	0.24	3.64	0.06
Chum	PIT tag - upper	4.47	0.24	4.23	0.05
Pink	PIT tag - lower	3.72	0.45	3.27	0.12
Pink	PIT tag - point	21.28	0.45	20.83	0.02
Pink	PIT tag - upper	40.96	0.45	40.51	0.01

Appendix A: Summary statistics for coho, pink, and chum salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002 without any adjustments for tag mortality, tag loss, or tag detection rate.

Appendix A.1. Summary statistics for coho salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002 without any adjustments for tag mortality, tag loss, or tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	27	0	0	0	0	0	0
July 7	648	0	0	8	8	2	0
July 14	1,606	0	0	16	30	15	3
July 21	1,137	0	0	0	4	35	6
July 28	1,507	0	0	0	0	17	23
Total untagged		406	3,497	41,187	46,822	57,861	29,539
Total recoveries		406	3,497	41,211	46,864	57,930	29,571

Appendix A.2. Summary statistics for pink salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002 without any adjustments for tag mortality, tag loss, or tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	46	0	0	0	0	0	0
July 7	850	0	0	5	0	0	0
July 14	997	0	0	7	1	0	0
July 21	1,068	0	0	0	1	16	1
July 28	2,377	0	0	0	0	9	5
Total untagged		142	3,016	31,608	38,887	107,985	72,481
Total recoveries		142	3,016	31,620	38,889	108,010	72,487

Appendix A.3. Summary statistics for chum salmon PIT tagged in Upper Cook Inlet and recovered in processors, 2002 without any adjustments for tag mortality, tag loss, or tag detection rate.

Release		Recovery strata (week beginning)					
Strata	Fish tagged	July 1	July 7	July 14	July 21	July 28	August 4
July 1	399	1	5	2	0	0	0
July 7	1,480	0	1	35	2	1	0
July 14	995	0	0	10	20	0	0
July 21	1,020	0	0	0	7	33	0
July 28	1,177	0	0	0	0	31	6
Total untagged		7,800	21,733	52,276	42,018	38,893	5,241
Total recoveries		7,801	21,739	52,323	42,047	38,958	5,247

Appendix B: Percent of total radio tags recovered by release and recovery strata for seven stocks of coho salmon.

Appendix B.1. Percent of total radio tags recovered by release and recovery strata for Kenai Peninsula coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 14	0.0	0.0	0.0	0.0	0.0	19.2	19.2	1.8
July 21	0.0	0.0	0.0	0.0	0.0	30.7	30.7	2.8
July 28	0.0	0.0	0.0	0.0	6.3	43.9	50.1	4.6
Sum	0.0	0.0	0.0	0.0	6.3	93.7	100.0	9.2

Appendix B.2. Percent of total radio tags recovered by release and recovery strata for Knik Arm coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.2
July 7	0.0	0.7	2.1	1.4	0.0	0.7	4.8	2.8
July 14	0.0	0.0	21.8	21.8	0.0	3.1	46.8	26.6
July 21	0.0	0.0	0.0	17.4	12.4	5.0	34.8	19.8
July 28	0.0	0.0	0.0	0.0	6.1	7.1	13.2	7.5
Sum	0.0	0.7	23.9	41.0	18.5	15.9	100.0	57.0

Appendix B.3. Percent of total radio tags recovered by release and recovery strata for Little Susitna River coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 7	1.6	0.0	3.2	1.6	1.6	0.0	8.0	2.0
July 14	0.0	0.0	21.6	21.6	7.2	0.0	50.4	12.4
July 21	0.0	0.0	5.7	17.2	0.0	0.0	22.9	5.7
July 28	0.0	0.0	0.0	0.0	16.4	2.3	18.7	4.6
Sum	1.6	0.0	30.5	40.4	25.2	2.3	100.0	24.7

Appendix B.4. Percent of total radio tags recovered by release and recovery strata for Susitna River coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 7	1.2	8.7	3.6	0.0	0.0	0.4	13.9	13.8
July 14	3.6	25.0	19.6	3.6	3.6	0.0	55.3	55.1
July 21	0.0	2.8	10.0	12.8	0.0	0.0	25.6	25.5
July 28	0.0	0.0	0.0	4.1	0.6	0.6	5.2	5.2
Sum	4.8	36.5	33.2	20.4	4.2	1.0	100.0	99.5

Appendix B.5. Percent of total radio tags recovered by release and recovery strata for Turnagain Arm coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 7	0.0	2.7	0.0	0.0	2.7	0.0	5.4	0.8
July 14	0.0	12.1	0.0	0.0	24.1	0.0	36.2	5.3
July 21	0.0	0.0	0.0	19.2	0.0	0.0	19.2	2.8
July 28	0.0	0.0	0.0	0.0	15.7	23.6	39.3	5.8
Sum	0.0	14.7	0.0	19.2	42.5	23.6	100.0	14.7

Appendix B.6. Percent of total radio tags recovered by release and recovery strata for Westside coho salmon.

Release	Recovery Strata (week beginning)							Weighted
Strata	July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	No. Tags
July 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July 7	1.1	3.9	1.1	0.0	0.0	0.6	6.6	4.7
July 14	0.0	7.5	15.0	10.0	0.0	0.0	32.4	23.1
July 21	0.0	4.0	17.9	11.9	0.0	2.0	35.8	25.5
July 28	0.0	0.0	0.0	15.4	8.1	1.6	25.2	17.9
Sum	1.1	15.3	34.0	37.3	8.1	4.2	100.0	71.2

Appendix B.7. Percent of total radio tags recovered by release and recovery strata for Yentna River coho salmon.

Release Strata	Recovery Strata (week beginning) July 14	July 21	July 28	Aug. 4	Aug. 11	Aug. 18	Total	Weighted No. Tags
July 1	0.0	0.3	0.3	0.0	0.0	0.0	0.6	0.5
July 7	3.7	4.6	3.2	0.9	0.5	0.0	12.9	11.0
July 14	2.1	20.8	33.3	4.2	0.0	0.0	60.4	51.5
July 21	0.0	0.0	10.0	6.6	0.0	0.0	16.6	14.2
July 28	0.0	0.0	2.0	4.1	2.7	0.7	9.5	8.1
Sum	5.8	25.7	48.8	15.8	3.2	0.7	100.0	85.3

Appendix C. Summary of historical coded-wire tag estimates of coho salmon exploitation rates in Upper Cook Inlet, 1993-1998.

Appendix C.1. Historical coded-wire tag estimates of commercial fisheries exploitation rates on coho salmon in Upper Cook Inlet and effort (number of deliveries x hours fished) in the Central District drift gill net fishery (district wide openings only), 1993-1998.

Year	Stream	Exploitation Rate	Effort	Reference
1993	Campbell Creek	0.35	53,040	Hoffman and Hasbrouck, 1994
	Little Susitna River	0.44		
	Bird Creek	0.29		
	Ship Creek	0.06		
1994	Campbell Creek	0.71	66,680	Stratton et al., 1996
	Little Susitna River	0.69		
	Bird Creek	0.58		
	Ship Creek	0.45		
1995	Campbell Creek	0.65	60,948	Cyr et al., 1997
	Little Susitna River	0.59		
	Bird Creek	0.51		
	Ship Creek	0.43		
1996	Campbell Creek	0.75	46,932	Cyr et al., 1998
	Little Susitna River	0.57		
	Bird Creek	0.45		
	Ship Creek	0.53		
1997	Bird Creek	0.32	34,404	Cyr et al., 1999
	Anchorage Urban Streams	0.40		
	Wasilla Creek	0.93		
1998	Campbell Creek	0.21	28,932	Cyr et al., 2001
	Bird Creek	0.15		
	Ship Creek	0.21		

UCIDA

United Cook Inlet Drift Association

43961 K-Beach Road, Suite E • Soldotna, Alaska 99669 • (907) 260-9436 • fax (907) 260-9438
• info@ucida.org •

RECEIVED
JAN 27 2011
BOARDS

Date: January 25, 2011

Addressee: Alaska Board of Fisheries
PO Box 115526
Juneau, AK 99811

RE: Ninilchik Harbor

Dear Board of Fisheries Members

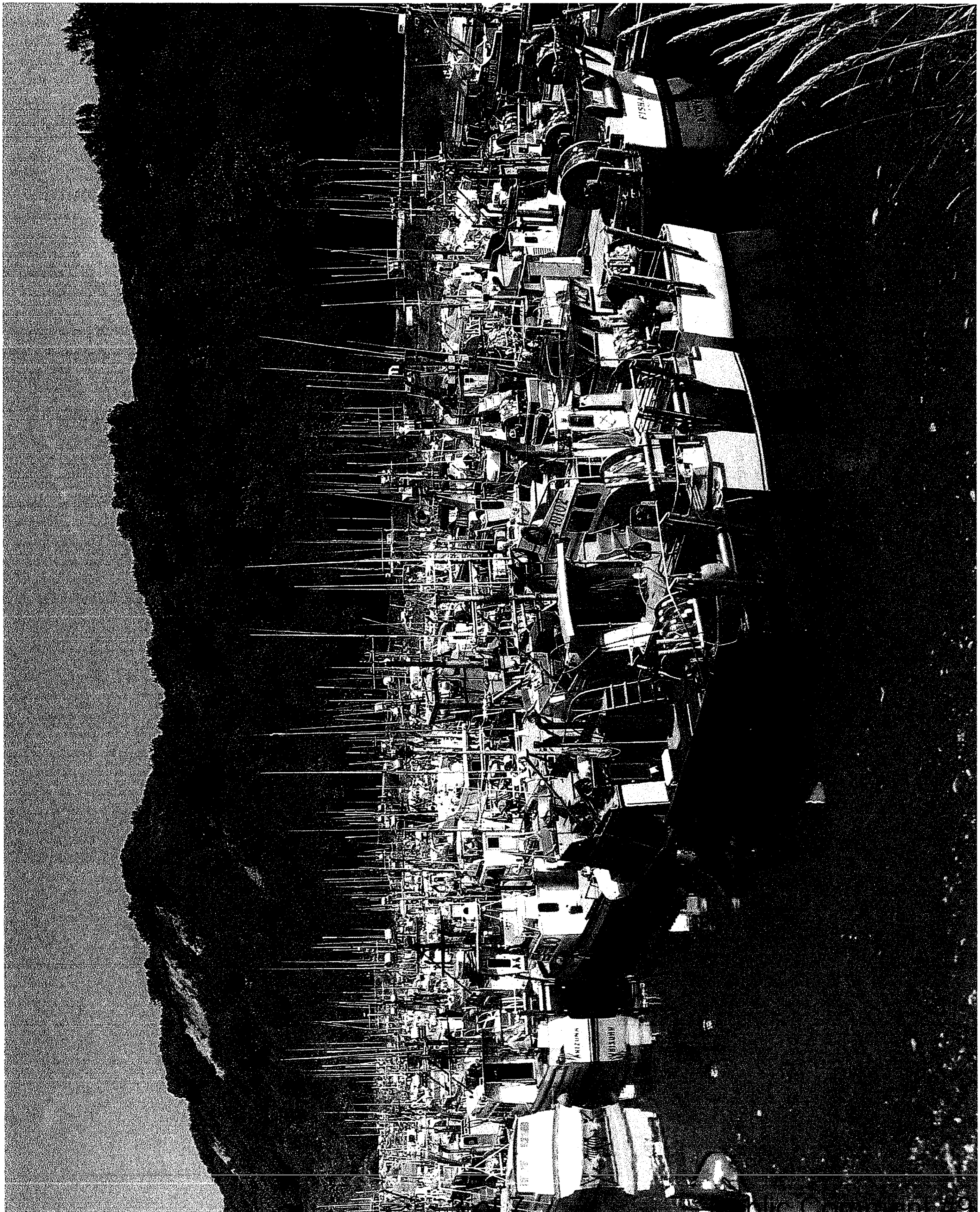
For your reference, enclosed are a few pictures of the Ninilchik Harbor and the commercial drift fleet. Almost all of these vessels are commercial fishermen of Russian, or Native Alaskan descent. This fleet will regularly fish salmon throughout the Upper Cook Inlet.

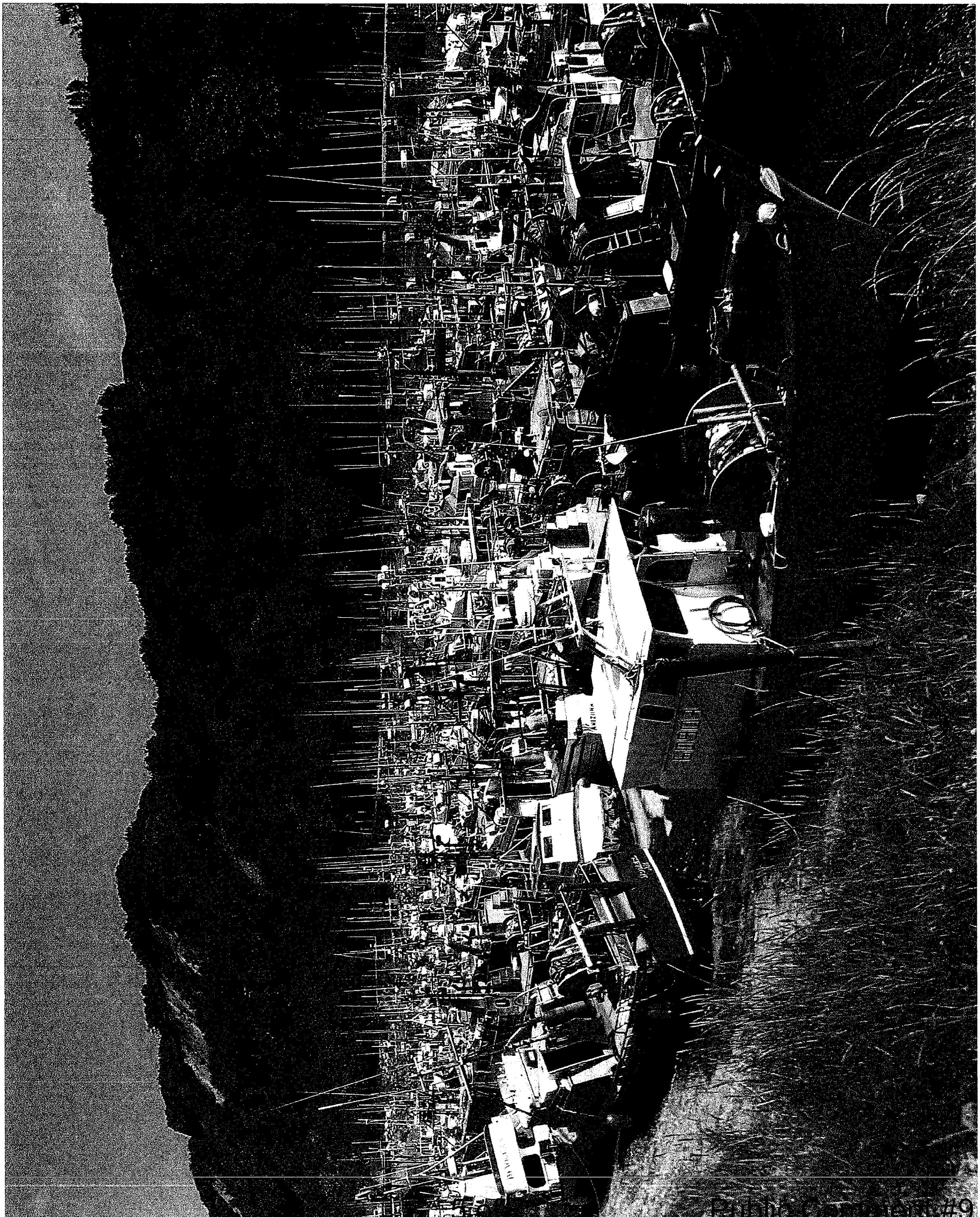
Sincerely,

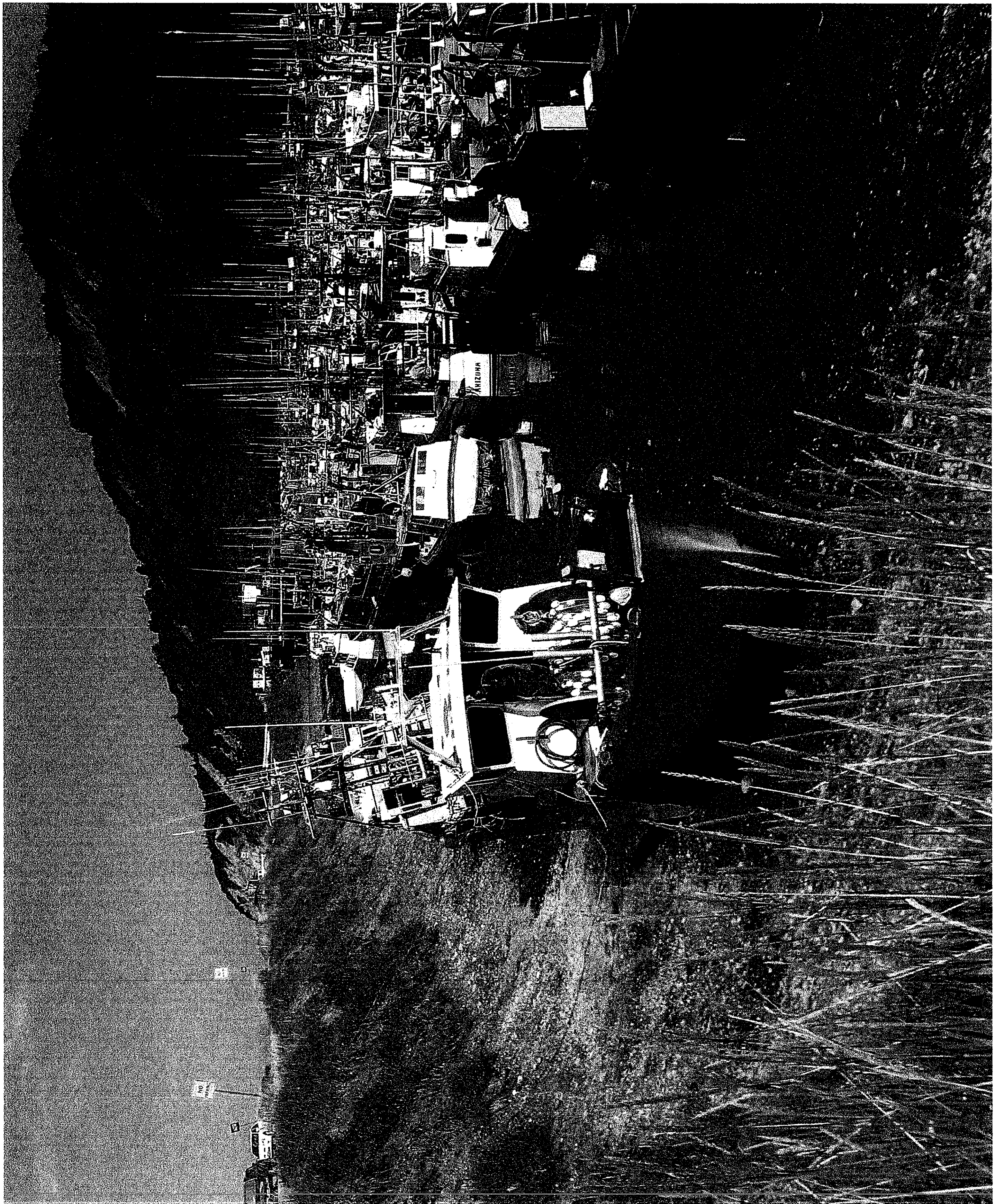
Roland Maw

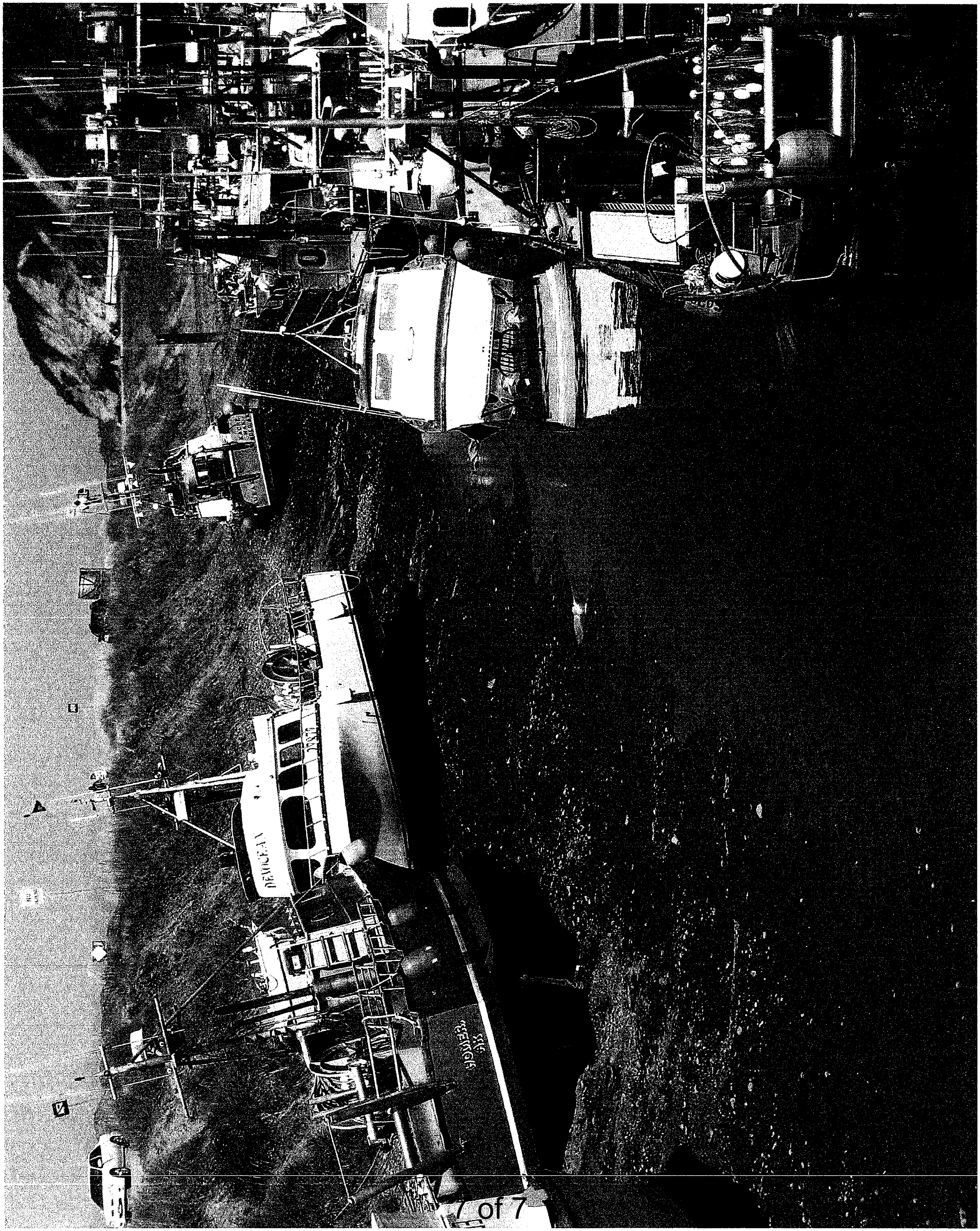
Roland Maw, PhD
UCIDA Executive Director

ams









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JAN 27 2011
BOARDS

David Coray, West Cook Inlet resident
PO BOX 3234
Soldotna, Alaska 99669
davidcoray@aol.com, (907) 252-5504

Boards Support Section
Alaska Dept of Fish and Game
PO Box 115526, Juneau Alaska 99811-5526

Dear State of Alaska Board of Fisheries:

I am writing in support of Cook Inlet proposals numbers 21 and 127, which address the issues of Coho stock on the west side of Cook Inlet, in the western sub-district.

Prior to 2004, it was determined by Alaska State Fisheries biologists that Coho stocks destined for west and upper Cook Inlet waters were showing signs of decline and a restriction of commercial salmon drift gillnetting efforts was imposed, closing those waters beyond August 9th. This was in place until 2004, and as long term residents in the remote area of Silver Salmon Creek, we began seeing healthier returns of Coho and it appeared that the problem was addressed. However, in 2005, the closure beyond August 9th was lifted, due to political maneuvering between the Kenai River Sportfish Assn and the Cook Inlet Drifters Assn. This has resulted again in the rapacious and indiscriminate harvesting of west Cook Inlet Coho, to the detriment of streams such as Silver Salmon Creek and Shelter Creek.

Since it was once determined that there was a RESOURCE issue with respect to declining Coho stocks, this needs to be revisited and my proposal #127 addresses this by proposing a reversion back to the August 9th cut-off for commercial salmon gill-netters in the western subdistrict of Cook Inlet. It is important to note that I also proposed #21, which reduces the sportfishing bag limit from a legal limit of 3 to 2. So this is an across-the-board effort, mandating that BOTH commercial and sportffishing join in protecting Coho stocks in Cook Inlet. This is not an effort to single out one user group but to jointly work together in this important resource issue.

As residents living in this area for 27years, since 1983, we have witnessed the steady and disturbing decline of silver salmon stocks, and see the commercial fleet as largely responsible. We only ask that the closure rule beyond August 9th be re-instated but are willing and agreeable to compromise so that if a slightly later date, such as August 16 is suggested, that may be reasonable as a start in reducing the overall harvest levels.

I have included a petition signed by almost 100 people who frequent the Silver Salmon Creek area who have also been witness to the declining stocks and are in support of this proposal. We urge you to please take action before the concerning resource issue becomes critical. Thank you for your time.

Sincerely, David Coray   David Coray

RECEIVED

27 2009

BOARDS

Petition for the Alaska Board of Fisheries

We, the undersigned, support a restriction of commercial salmon drift gill net activities in the western sub-district of Cook Inlet near Silver Salmon Creek and Shelter Creek. We ask that the Board of Fisheries reinstate the closure of drift gill-net fishing beyond August 9, as was the case prior to 2004, in order to protect returning Coho stocks, due to five consecutive years of declining Coho, or silver salmon, returns.

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
Teresa Duddy	1821 Lambeth Ln Concord, CA 94518	(415) 828-7602	8/20/09	[signature]
Margaret Robinson	5401 Calle de Ricardo Torrance, CA 90505	310-378-7245	"	[signature]
Franc Vanderven	14290 Foothill Circle	3039699150	8/20/09	[signature]
Grant Stegehuis	12985 West 61st Circle Arvada CO 80004	(303) 565-7432	8/20/09	[signature]
Robert Amoroso	14515 Sunningdale Way Orlando, FL 32828	407-808-7414	8/20/09	[signature]
W.F. Richardson	21671 N Old Barrington Barrington IL 60010			[signature]
Mike Idalski	921 Waxen Way Grand Ledge, MI 48837	517-627-0972	8-20-09	[signature]
Bob Idalski	11330 Wood Rd Dewitt Mich 48820	517-669-1374	8-20-09	[signature]
Mel Comeau	7759 Chadwick Laingsburg MI 48848	517-651-5842	8/20/09	[signature]
Jennifer Hammes	Box 1038 Soldotna, AK	252-4090	8/20/09	[signature]
David Coray	P.O. Box 3234 Soldotna AK 99669	262-4839		[signature]
Drew Hilterbrand	P.O. Box 1038, Soldotna, AK 99669			[signature]
Terry Stegehuis	12985 W. 61st Circle Arvada CO 80004	303-421-2338	8/20/09	[signature]
Jason Vandermeer	222 W. River St. Grand Ledge, MI 48837	517-712-8785		[signature]
	W5722 Stumlin Rd	608-857-3615		

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
Simeon D. Bateman	POB 191009 Anchorage, AK 99519	(907) 227-1066	23 AUG 2009	[signature]
Curtis Smith	325 Ardussi Saginaw, MI	989-284-6686	24 Aug 2009	[signature]
Evan Cicinelli	12503 Spencer Saginaw, MI 48609	989-284-1547	8/24/09	[signature]
Gerald Bauer	Littleton, Co 80127 34 ELK LN	303 979 6089	8/24/09	[signature]
Chantelle Smith	8908 Ridgeview Johnston, IA	515/334-7496	8/24/09	[signature]
Rodney Wildrick	8908 Ridgeview Johnston, IA	507 334-7496	8/24/09	[signature]
Dennis Nishimine	1406 E. ALLUVIAL FRESNO CA 93720		8/24/09	[signature]
Oliver Coray	PO 3234 Soldotna, AK 99669	(907) 394-8704	24th, August 2009.	[signature]
Tom G Alpaney	4055 Oldenburg Ln Yorba Linda CA 92886	(714) 970 0092	8/25/09	[signature]
Francis J. Zonay	2507 Eastwood Ave Evanston, IL 60201	(847) 869 6027	8/25/09	[signature]
WM J. KIRVEN III 8/26/09	5214 S. Ironton Wy Englewood, CO	303.771.4883	8/26/09	[signature]
MIKE COIL	125 W. MENDENHALL BOZEMAN, MT 59715	406-586-8949	"	[signature]
HENRY C. CLEVELAND III	6700 W. DORADO DR #23 LITTLETON CO.	303 798 8244		[signature]
James O Thomas	900 S. Kearney St #203 Denver, CO 80224	333 2859		[signature]
Tom Chisholm	13956 E. Bellewood Drive Aurora, Co. 80015			[signature]

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
OWEN OLIVER	2777 BERRY TURN GOLDEN, CO. 80401	303-414 4463	8/26/09	[illegible]
PAUL HESSE	2401 N. 119th LAFAYETTE, CO.	303-665 2400	9/1/09	Paul Hesse
STEVEN TOTH	1618 TANAGA CIRCLE KENAI AK 99611	907 283-1631	9/1/09	Steven Toth
LAWRENCE DUNCAN	2353 NAPLES AVE. MENTONE, CA 92359		9/1/09	Lawrence Duncan
ANDREW B LEE	1350 Knoll Rd Ca 92373		9-1-09	[illegible]
Kenneth B Lee	9387 SW 92nd Ct Ocala Fl 34476			[illegible]
Randall Gossman	4213 Deepwater Ln Tampa FL 33615			
Ron Croft	7190 Seminole Blvd, Seminole, FL 33772		9/1/09	[illegible]
JEANIE GOSSMAN	4213 DEEPWATER LN TAMPA FL			Jeanie Gossman
Joel Condren	538 CR 63 South Fork, CO 81154			[illegible]
DUANE LARSON	6779 Bear Pt TRL, GOLDEN, CO 80403			[illegible]
OLE P. DRANGSHOLT	BANEHEIVN 21, KRS, NORWAY		09/01/09	Ole P Drangsholt
Tom Dyring (TOM DYRING)	Brevik Br. 1455 N.Frogn, Norway			Tom Dyring
Bent Olsen	Østre Strandgt. 28, 4610 Kr.Sand, Norway			[illegible]
Ana Kelly	2551 Jamestown Rd B'ham, AL 35235			Ana P. Kelly
Chris Cuff	PO 7161 Nikiski AK 99635	394-1427	9-3-09	Chris Cuff
Larry Kissinger	12604 Sand Beach Dr Grand TMI 49327	231-834-5215	9-5-09	[illegible]
Dean Kissinger	11629 Midget Ivan's MI 49644	231-266-5694	9-5-09	[illegible]
Jim Manning	800 W. LAKE FOREST LN. SANFORD, MI 48657			[illegible]
Jim Meehan (James D. Meehan)	1928 Va Ave Mclean Va 22101	7032372715	9/5/09	[illegible]
Shirley Meehan (Shirley Meehan)	1928 Virginia Ave McLean, VA 22101		9/5/09	[illegible]

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
Scott Cooper	Holmen, WI W5722 Shanton	608-857-3615	8/17/10	Scott Cooper
BOB IDALSKI	11330 WOOD RD DEWITT, MICH 48820	517-669-1374	8/17/10	Bob Idalski
JASON VANDERMEER	222 W RIVER ST GD. LEDGE MI.	5177128785	8/17/10	[signature]
Franc Vanderven	14290 Foothill Circle Golden CO 80401		8/16/10	[signature]
William Ruston	2770 Dobie Rd; Mason		8/16/10	[signature]
Eric Khamst	6902 Poco Bueno Circle		8/16/10	Eric Khamst
James Kursar	6534 Rey Del Sierra ~~[illegible]~~ Sparks NV 89436			James Kursar
Rebecca Sattgast	565 B Devon Dr Estes Park, CO 80517		8/19/10	Rebecca Sattgast
SANDY RICHARDS	Box 563 ALAMO, CA 94507		8/19/10	Sandra S Richards
Melody Curtis	6404 Frontier Flower Mound TX 75022		8/19/10	Melody Curtis
RICHARD CURTIS	6404 FRANTIER FLOWER-MOUND TX 75022		8/19/10	[signature]
Curt EVERSAN	949 Parkridge Parkway Spring Creek NV 89815		8/24/10	[signature]
Joel P. Sorenson	W11120 446th Ave. Prescott, WI 54021		8/24/10	Joel P. Sorenson
BOB ROPER	8185 W [illegible] Littleton, CO 80128		8/24/10	[signature]
Alex Martinez	5395 S. LOGAN [illegible] Greenwood Village CO		8/24/10	[signature]
THOMAS BERLIN	460 ARBORVIEW VENICE FL. 34292		8/24/10	[signature]
Joy Berlin	460 ArborView VENICE FL 34292		8/24/10	Joy Berlin
Todd Tucker	4037 7th Ave Suite 101 [illegible]		8/28/10	[signature]
BILL HARTMAN	136 MOSSWOOD DR SAVANNAH GA 31405	912-349-5975	9/2/10	[signature]
DANIEL J. COX	810 N. Wallace, Bozeman, MT 59715			[signature]

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
Roger R. [illegible]	[illegible] Castle Rock CO 80104	303-720-[illegible]	9-5-09	[signature]
Gary McKay	1196 Preserve Circle Golden CO 80401	3038884821	9/5/09	[signature]
John Hohl	Box 421 Soldotna AK 99669		9/14/09	[signature]
[illegible]	[illegible] Centerport, N.Y. 11721		9/14/09	[signature]
Peter R. Corbin	607 Holly Ridge Lane Hilliard, FL 32046		9/19/09	[signature]
Charles C. Corbin Jr	3247 Olde Dekelbway Atlanta GA 30340		9/19/09	[signature]
Andrew Maxwell	24 Lodgepole Dr. Windsor, CO 80550		9/19/09	[signature]
Nancy E. Farrer	[illegible] Anchorage AK 99517		10/7/09	[signature]
[illegible]	2704 W. 30th Ave [illegible]		[illegible]	[signature]
Elijah Carney	39820 E Beach [illegible]		10-25-09	[signature]
Joanne Edmundo	[illegible] Golden, Colo		10/26/09	[signature]
[illegible]	[illegible]		[illegible]	[signature]
Linda A. Amato	3435 S. County Rd 137 Bennett Co [illegible]		1/9/10	
Robin Bua	[illegible] E. [illegible] Dr Aurora Co 80011		1/9/10	[signature]
[illegible]	[illegible] Ave Denver, CO 80211		1/9/10	[signature]
Suzanne Philippus	321 Rosalie Rd Bailey, CO 80421		1/9/10	[signature]
Eric Pellish	7375 Tabor St Arvada, CO 80005		8-15-10	[signature]
Allen Brownington	1404 NW 61st Terrace Gainesville FL		8/15/10	[signature]
Harry M. Walker	6828 Cape Lisburne Anchorage AK 99504		8/15/10	[signature]
Danielle Elliott	3522 Olsen Rd Helena, MT 59602		8/16/10	[signature]

NAME	ADDRESS	PHONE #	DATE	SIGNATURE
Lisabeth Kierkegaarde	7471 SW Barbur Blvd Portland, OR 97219	503-246-8447	9/3/10	[signature]
Mark Wilson	7471 SW Barbur Blvd Portland OR 97219	503 246 8447	9/3/10	[signature]
Bonnie Wilsey	1402 Crestwood Dr Oconomowoc WI 53066	262.567.5762	9-4-10	Bonnie Wilsey
David McDonough	13103 Evanston Street Rockville MD 20853 USA	301-275-4593	9-4-10	[signature]
Sue Wolfe	150 Sabine St #235 Houston TX 77007	832 541 2458	9/4-10	W. Sue Wolfe
Jim Cote	15704 Overbrook Stanley KS 66224		9/4/2010	[signature]
Pam Cote	15704 Overbrook Stanley KS 66224		9/4/2010	Pam Cote
Lysbeth Corsi	5570 Inverness Santa Rosa CA 95404		9/4/2010	Lysbeth Corsi
Gerald Corsi	5570 Inverness Av. Santa Rosa CA		9/4/2010	[signature]
Tanya Cox	810 N. Wallace Suite E Bozeman, MT 59715		9/5/2010	[signature]
Mark McDonough	4 Broughton St Lockleys Sth Australia		9/5/2010	[signature]
DAVE WROBLEWSKI	186 NATHANIEL DR. MARTINSBURG W.V. 25403		9/5/10	[signature]
Yvonne + David Bennett	10518 W Arch Ave Milwaukee, WI 53224		9/6/10	Yvonne Bennett
MARGIE K. CARROLL	161 VALLEYWOOD CT CANTON, GA 30115		9/8/10	[signature]
David N. Altman	8 Tuscarora Dr. Centerport, NY 11721		9/16/10	[signature]
Lori Vanderwal	207 Sunnyview Grandville MI 49418	616 457 2245	9-19-10	Lori Vanderwal
David Vanderwal	"		"	[signature]

USDA United States Department of Agriculture | Forest Service | Chugach National Forest | 3301 'C' Street Suite 300 Anchorage, AK 99503-3998

File Code: 2600
Date: JAN 28 2011

Mr. Vince Webster
Chair, Alaska Board of Fisheries
Board Support Section
PO Box 115526
Juneau, AK 99811-5526

Dear Mr.Webster:

This is to provide comments on Board of Fish Proposal 243, submitted by the Alaska Department of Fish and Game, proposing a special provision that will require anglers to "closely attend" harvested fish in the Russian River Area. While the Chugach National Forest supports the concept of this proposal, as presently written we do not support Proposal 243. We recommend the Board of Fish consider a consistent definition of "closely attended" by adopting federal regulation language attached. We believe inconsistencies in the language will lead to confusion related to enforcement.

The Chugach National Forest coordinates with Kenai National Wildlife Refuge, Alaska Department of Fish and Game, Alaska Department of Natural Resources, Cook Inlet Region Incorporated, and the Kenaitze Indian Tribe (also known as the Russian River Interagency Coordination group) natural resource management issues related to the Russian and Kenai River confluence area. The Russian River forms a shared boundary between the Refuge and the Chugach National Forest and is an extremely popular fishery. A current focus of this group is developing cooperative approaches for managing human-bear interactions within the Kenai-Russian River Complex area to protect public and employee safety, while providing recreational opportunities and conserving fish and wildlife resources.

The Chugach National Forest strongly supports development of consistent, complementary and coordinated regulations and natural resource management efforts within the scope of our respective missions and regulatory processes. To further the goal related to public and employee safety, efforts to reduce the availability of harvested fish, food, refuse and other attractants to bears in this area as a means of reducing potential for negative human-bear interactions is important. In fact, existing federal regulations partly address this issue and are in place for this area.

Specifically, in 2010 the we issued Forest Order 10-04-030-10-02 Russian River and Angler Trail Area, and the Kenai National Wildlife Refuge issued a "Temporary Restriction Order" (both attached) requiring that recreational anglers keep lawfully retained fish within 12 feet, and food, beverages and garbage and the equipment used to transport or store these attractants within 3 feet (unless stored in vehicles, campers or bear-resistant containers). The language within these Federal Orders was developed in coordination to ensure a measurable and consistent regulatory approach among our agencies. We both included specific distances to aid enforcement of the regulation by clearly defining the idea of "closely attended". In addition, we believe that our regulations covering all attractants will be most effective in reducing the potential for negative human-bear interactions.

We support the US Fish and Wildlife Service to reissue a Temporary Restriction Order in 2011 that will be consistent with the ongoing Chugach National Forest Order.

Thank you for your consideration and for the opportunity to comment.

Sincerely,

TERRI MARCERON
Forest Supervisor

cc: Travis Moseley, John Eavis, Chris Lampshire, USFWS Andy Loranger

CHUGACH NATIONAL FOREST
Seward Ranger District
Seward, Alaska
Order No. 10-04-30-10-02

FOREST ORDER

Russian River and Angler Trail Area

Pursuant to 36 CFR 261.50(a), the following acts are prohibited on the Chugach National Forest in the Russian River area. These restrictions are in addition to those enumerated in Subpart A, 261 Title 36 Code of Federal Regulations and become effective when signed, and will remain in effect until rescinded or revoked.

Prohibited Acts:

36 CFR 261.58 – Occupancy and Use

Possessing or storing any food or refuse, as specified by the order [Title 36, 261.58 (cc)]

Leaving unattended wildlife attractants such as food, beverages, garbage, and equipment used to cook or store food (example: coolers/backpacks) unless it is acceptably stored in a vehicle, in a camping unit made of solid, non-pliable material, or retained and in no case more than 3 feet from the person. This includes National Forest System lands within or partially within Sections 33 thru 35, T5N, R4W; Sections 4 and 9, T4N, R4W, SM as shown on attached Exhibit A.

36 CFR 261.58 – Occupancy and Use

Possessing, storing, or transporting any bird, fish, or animal parts thereof, as specified by the order [Title 36, 261.58 (s)]

Leaving unattended any lawfully retained fish; unless it is closely attended which is no case more than **12** feet from the person. This includes National Forest System lands within or partially within Sections 33 thru 35, T5N, R4W; Sections 4 and 9, T4N, R4W, SM as shown on attached Exhibit A.

36 CFR 261.53 – Special Closures

Public Health and Safety [Title 36, 261.53 (e)]

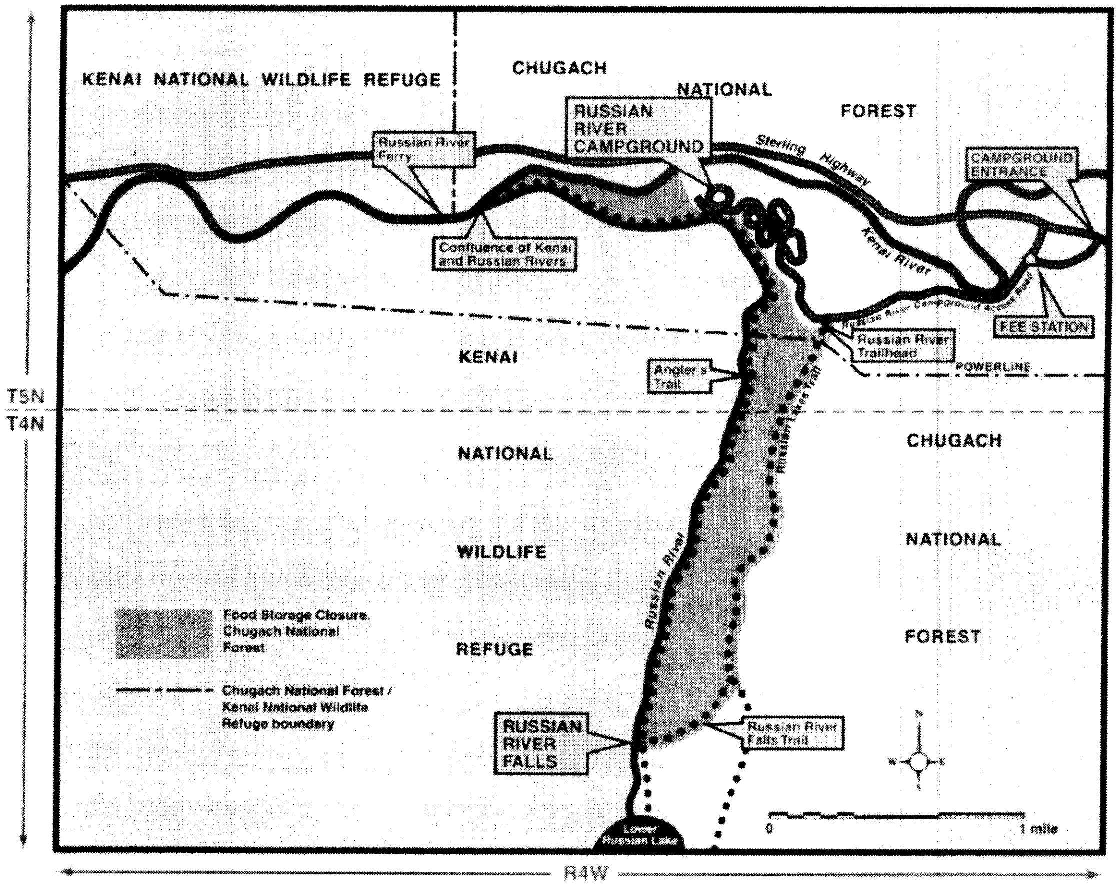
Possessing, transporting, or allowing entrance of pets; unless they are on a leash no greater than six (6) feet in length. This includes National Forest System lands within or partially within Sections 33 thru 35, T5N, R4W; Sections 4 and 9, T4N, R4W, SM as shown on attached Exhibit A.

Definitions:

(1) **"Attractant"** means any substance, natural or man-made, including but not limited to items of food, beverage, personal hygiene, or odiferous refuse that may draw, entice, or otherwise cause a bear, or other wildlife to approach.
(2) **"Food"** means any substance, solid or liquid, which is or may be eaten or otherwise taken into the body to sustain health or life, provide energy, or promote growth of any person or animal. Includes items such as soft drinks, alcoholic beverages, gum, candy, canned foods, pet foods, and all lawfully retained portions of processed fish meant for human consumption.
(3) **"Acceptably stored"** means
   a. Retained on the person or within the subject's immediate control, but in no case more than 3 feet from the place a person is located at the time in question; or
   b. Located within the closed area of a motor vehicle such as a trunk or passenger compartment; or within a camper unit made of solid, non-pliable material.
   c. Containment within a commercially produced and certified bear-resistant container.
(4) **"Closely Attended"** means in no case more than 12 feet from the place a person is located at the time in question.
(5) **"Possession"** means to have personal control.

Exhibit A

All National Forest System land along the Kenai and Russian River and along the Russian River Trail, as shown in the gray shaded area on the Exhibit B Map. This area is within or partially within Sections 33 thru 35, T5N, R4W; Sections 4 and 9, T4N, R4W, SM.



Exceptions:
Pursuant to Title 36 CFR 261.50 (e) the following are exempt from this order:

1. Any person with a permit authorizing the otherwise prohibited act or omission.
2. Any Federal, State, or local officer, or member of any organized rescue or fire fighting force in the performance of an official duty.
3. Any Federal, State, or local law enforcement officer in the performance of an official duty.

These prohibitions are in addition to the general prohibitions in 36 CFR Part 261, Subpart A.

This order is effective only during the following time period: May 1 through October 1.

Nancy Peak
Nancy Peak
Forest Supervisor
Chugach National Forest

April 5, 2010
Date

Executed in Anchorage, Alaska, this Fifth day of April 2010.

Penalty:
Violations of these Prohibitions are punishable by a fine of not more than $5,000 for an individual or $10,000 for an organization, or imprisonment for not more than six months or both. [16 U.S.C. 551, and 18 U.S.C. 3559 and 3571]

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kenai National Wildlife Refuge
P.O. Box 2139
Soldotna, AK 99669

IN REPLY REFER TO:

TEMPORARY RESTRICTION ORDER

ISSUED: May 7, 2010

Kenai National Wildlife Refuge
Soldotna, Alaska

AUTHORITY: 50 CFR 36.42(f)

To reduce the likelihood of negative bear and human encounters, and risk of harm to people and bears, the following restriction is put in place as of 12:00am on 05/15/2010:

1) On all lands and waters within ¼ mile of the Russian and Kenai Rivers, extending from the Russian River Falls downstream to the confluence of the Kenai River, then proceeding downriver on the mainstream Kenai River to the crossing of the powerline:

   a. all food, beverage, garbage and all equipment used to transport or store these items (for example, coolers and backpacks) must be locked in a hard-sided vehicle or camper, in a commercially produced bear resistant container, or within immediate grasp which means within 3 feet of the person at all times.
   b. all lawfully retained fish must be locked in a hard-sided vehicle or camper, in a commercially produced bear resistant container, or closely attended which means within 12 feet of the person.
   c. Pets must be kept on a leash no greater than 6 feet in length.

This temporary restriction will remain in effect until 12:00 pm October 1, 2010, unless extended, or rescinded prior to that time by the Refuge Manager.

Exempted people:
(1) Any Federal, State, or local officer, or member of an organized rescue or fire fighting force in the performance of an official duty;
(2) Any Federal, State or local law enforcement officer in the performance of an official duty.
(3) Any person with permit specifically authorizing the otherwise prohibited act or omission.

Questions regarding this temporary restrictions order should be directed to the Kenai National Wildlife Refuge, Janet Schmidt at (907) 262-7021 or janet_schmidt@fws.gov.

Andy Loranger
Andy Loranger
Refuge Manager
Kenai National Wildlife Refuge

7 MAY 2010
Date

January 31, 2011

RECEIVED
JAN [illegible] 2011
BOARDS

Jim Marcotte
Board Support Section, ADF&G

We would like to show our support or non support of the following proposals:

Kasilof River Proposal

Prop. 255
Prohibit fishing from a boat in "Peoples Hole" adjacent to Crooked Creek **(We Support)**

Kenai River Proposal's

Prop. 189 Kenai/Soldotna AC
Prohibit retention of 1 king salmon in the personal dip net fisheries lower Kenai River. **(We reject)**

Prop. 209 KAFC Prop.
Modify guide hours from 6A.M. to 7A.M and 6P.M. to 7P.M. **(We Support)**

Prop. 229 KAFC Prop.
Extend boundaries of the Slikok Creek Sanctuary to protect declining stocks of salmon. Extend upriver to ¼ mile. Extend down river to include 1 mile to Sunken Island. **(We Support)**

Prop. 235 Greg. Bush Prop.
Extend the king salmon slot limit through July 31 and change slot limit to 40" to 52". **(We Support)**

Prop 246 KAFC Prop.
Add an additional "drift boat only" day on Thursday. **(We Support)**

Prop. 247 KAFC Prop.
Allow use of a motor on drift boats to be used to exit the fishery from Cunningham Park on "drift boat only" days. **(We support)**

Wayne, Sandra and Mark Johnson

We are and have been fishermen of both of these rivers for over 25 years and support all protection and stock improvement that is a benefit to our environment. We are members of KAFC. We also own a home at mile 16 of the Kenai River.