1990 SALMON GILLNET FISHERIES OBSERVER PROGRAMS IN PRINCE WILLIAM SOUND AND SOUTH UNIMAK ALASKA

FINAL REPORT

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By

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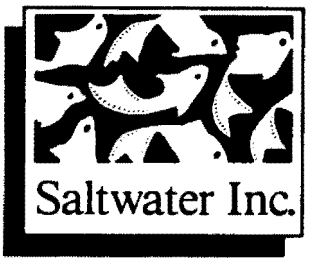

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I. INTRODUCTION

I. INTRODUCTION

In 1990 the National Marine Fisheries Service (NMFS) sponsored observer programs nationwide to acquire knowledge about the incidental take of marine mammals in commercial fishing operations. In Alaska, NMFS contracted Saltwater Inc. to design and implement observer programs in three salmon gillnet fisheries: the Prince William Sound driftnet fishery, the Prince William Sound setnet fishery, and the South Unimak driftnet fishery. This report describes the methods used and the results from those observer programs.

BACKGROUND

In 1972 the U.S. Congress passed the Marine Mammal Protection Act (MMPA) to ensure that marine mammal species and population stocks are not permitted to diminish below their optimum sustainable population (OSP). The MMPA generally prohibits the taking of marine mammals, but amendments to the Act passed in 1988 allow an exemption for the incidental take of certain marine mammals during commercial fishing operations. The exemption for commercial fisheries extends until 1 October 1993. During that time the amendments require the Secretary of Commerce to provide observer coverage in Category I fisheries.

Category I fisheries are those with a suspected or reported "frequent" incidental take of marine mammals. Take is considered "frequent" if it "is highly likely that more than one marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period" [FR 54(96):21915]. Although NMFS considers all definitions of "take" when categorizing fisheries, Congress interpreted "incidental take" to mean "the entanglement, serious injury or death of a marine mammal in the course of normal fishing operations" (U.S. Senate Rept 100-592, 1988).

The purpose of the observer programs in the Category I fisheries is to collect data on the species, number, and condition of marine mammals taken or interacted with, biological data on marine mammals and sea birds killed, and data on fishing effort. The Secretary of Commerce through NMFS will use the data from these observer programs to verify fishermen's logbook reports, determine if fisheries are appropriately categorized, and formulate scientific guidelines which will govern the incidental taking of marine mammals after 1 October

1993. NMFS will also use these data, in conjunction with population stock assessments, to determine the extent to which incidental mortality affects the marine mammal species involved in fishery conflicts.

DESCRIPTION OF THE FISHERIES

In Alaska three salmon gillnet fisheries were classified as Category I under the MMPA amendments: the Prince William Sound (PWS) driftnet fishery, the Prince William Sound setnet fishery, and South Unimak (SU) driftnet fishery. Figure 1 shows the relative location of these fisheries in Alaska.

The PWS driftnet fishery is a terminal salmon fishery spread out over five Alaska Department of Fish and Game (ADF&G) statistical districts included in Area E (Figure 2). The Eshamy (ES), Unakwik (UN), and Coghill (CG) districts are within the relatively deep, calm, and protected waters of Prince William Sound. The Copper River (CR) and Bering River (BR) districts are south and east of the Sound in the nearshore and offshore waters of the Copper River "Flats." Typically, fishing in the Copper and Bering River districts begins in mid-May and lasts until late September. Fishing in the three districts inside Prince William Sound usually begins in late June and continues through August. Targeted salmon species include:

sockeye	or	"red"	(*Oncorhynchus nerka*)
chinook	or	"King"	(*O. tschawytscha*)
pink	or	"humpy"	(*O. gorbuscha*)
coho	or	"silver"	(*O. kisutch*)
chum	or	"dog"	(*O. keta*)

The salmon fisheries in Alaska are managed with a limited entry system, and fishermen must have a permit to fish. Over 500 permit holders fish in the PWS driftnet fishery using relatively small boats (6-10m in length) and 273m (150 fathom) drift gillnets. Each fisherman deploys one gillnet which drifts attached to the vessel and is retrieved after a 15-minute to four-hour "soak" period. The net hangs (4-18m) from a corkline at the surface, and salmon swimming through the polyfilament net are caught by their gills.

The PWS setnet fishery takes place only in the Eshamy district, primarily in and near Main Bay (Figure 3). Approximately 25 setnetters each fish up to a

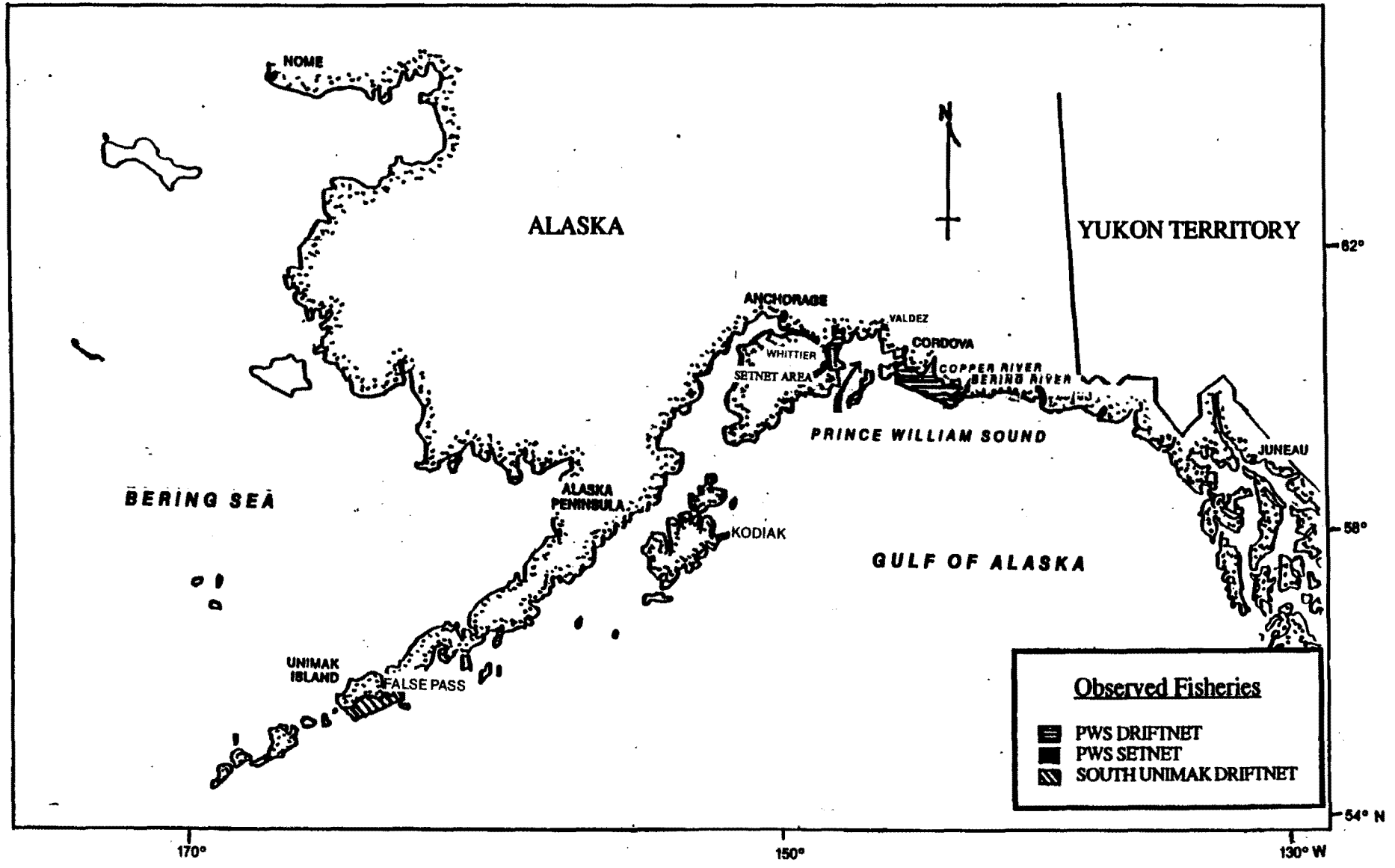

Figure 1. Approximate location of the South Unimak drift gillnet and Prince William Sound drift and set gillnet fisheries monitored by MMPA observers in 1990.

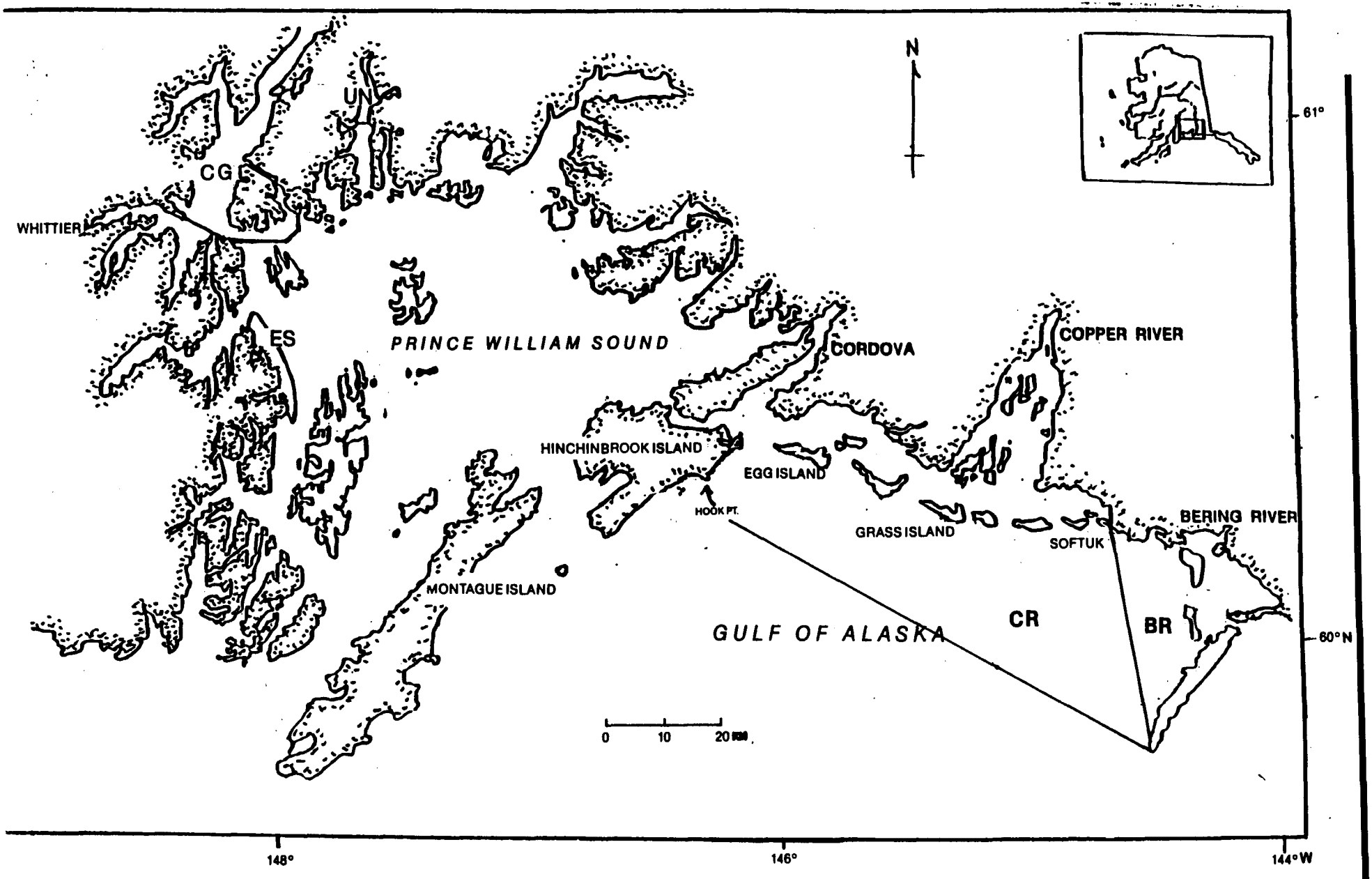

Figure 2. Relative location of the Bering River (BR), Copper River (CR), Coghill (CG), Unakwik (UN), and Eshamy (ES) districts open to PWS drift gillnet fishing in 1990.

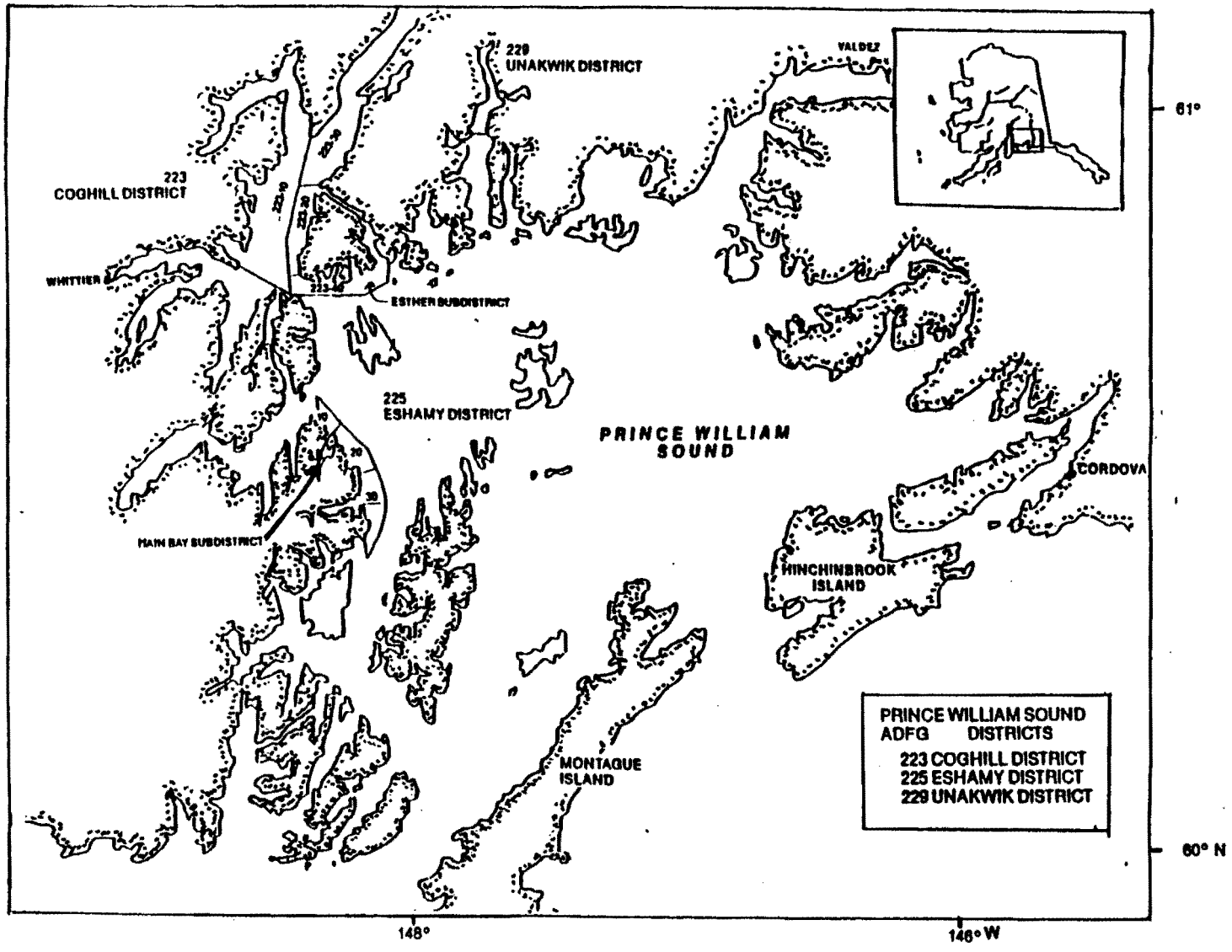

Figure 3. Location of ADF&G districts open to PWS drift gillnet operations (Coghill, Unakwik, Eshamy) and PWS set gillnet operations within Prince William Sound, 1990.

maximum of three gillnets totalling 273m (150 fathoms) which are anchored to shore at one end and allowed to fish through all tides. Setnetters use skiffs to retrieve fish from portions of the net, while the remainder of the net continues fishing. The setnet fishery typically lasts from mid-June to mid-July.

The SU driftnet fishery is an intercept salmon fishery which takes place in the open, offshore waters of Area M near False Pass, Alaska (Figure 4). Over 150 permit holders fish the SU driftnet fishery using relatively small boats (10-12m in length) and 364m (200 fathom) gillnets. As with PWS driftnets, SU driftnets hang in the water (approximately 20m) from a surface corkline and are allowed to "soak" prior to retrieval. The fishery generally lasts from June through July and is managed on a "quota" system to assure desired salmon escapement to the terminal fisheries in Bristol Bay and the Kuskokwim River. The timing and duration of legal fishing periods ("openings") are determined by ADF&G emergency order based on comparison of salmon landings to harvest guidelines and caps. Targeted species include sockeye and coho salmon.

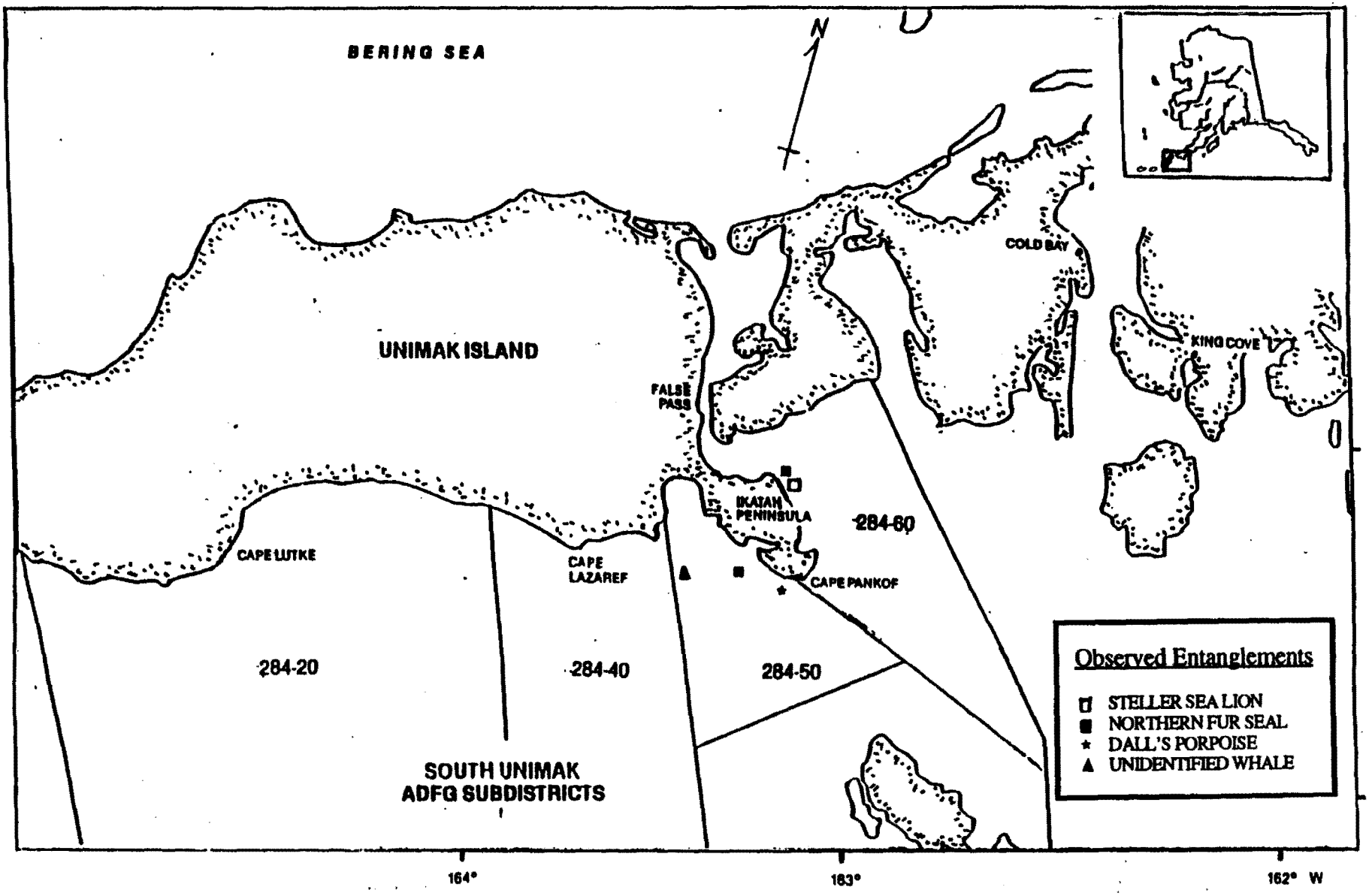

Figure 4. Location of the South Unimak drift gillnet district and sites of marine mammal entanglements reported by MMPA observers, 1990.

II. Data Collection Methods

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The MMPA amendments require the Secretary of Commerce to provide observer coverage for 20-35% of fishing operations in Category I fisheries wherever possible. In Category I fisheries where 20-35% observer coverage is precluded, the Secretary of Commerce is required to establish an alternative monitoring program which will provide statistically reliable information on the species and number of marine mammals taken in the observed fisheries.

The observer programs for the Alaska salmon gillnet fisheries fall into the "alternative program" category due to safety concerns and the large number of small boats involved in the fisheries. After considering the characteristics of these fisheries NMFS concluded that it was not safe or feasible to place observers on vessels to provide 20-35% observer coverage. Based on analyses by NMFS biologists, NMFS concluded that statistically reliable estimates of incidental take levels could be expected with 5% coverage.

FISHING EFFORT

In the PWS and SU driftnet fisheries, fishing operations consist of a net set, soak, and retrieval. To quantify fishing effort or operations, the PWS-SU project team defined a driftnet "set" as the complete retrieval of a net. In the PWS setnet fishery, nets fish continuously, and the project team quantified fishing operations in hours, with an "observation" defined as a minimum of two hours of monitoring.

ADF&G closely monitors the salmon harvest in these three fisheries, but does not directly measure fishing effort. With each delivery, processors fill out ADF&G fish tickets for fishermen which record the date, district, weight by species, and permit holder's name. ADF&G maintains a daily record of the number of salmon landed, the number of vessels landing salmon, and the maximum number of hours available to fish in each district.

With these variables the catch and available fishing opportunity can be quantified, but not fishing effort. Assumptions and biases associated with conversion of "catch" to "effort" are addressed in the Discussion section of this report. The actual number of hours fished, the duration of each set, and,

consequently, the number of sets made per available fishing hour vary seasonally and regionally throughout the fishery. These variations depend on run strength, the length of openings, the availability of daylight, fishing strategies, and other factors. To quantify fleet effort in terms of "sets," it is necessary to calculate a mean for the number of sets made per available fishing hour. Available fishing hours are used as the denominator rather than actual fishing hours to account for the variability in the percentage of time fished between individuals, districts, and weeks.

To account for this seasonal and regional variability, the team calculated weekly means of set duration for each district from observer observations of the number of sets made per available fishing hour. The team multiplied the weekly mean set duration by the weekly sum of fishing vessel hours (FV-Hours) available in each district. A FV-Hour is equal to the actual number of vessels landing salmon multiplied by the maximum number of hours available to fish on a daily basis (see Appendix, Form 5). Thus:

the estimated number of sets in each statistical week equals:

observed # of sets made ÷ available fishing hrs observed * sum(daily FV-Hrs)

Daily FV-Hrs equals:

maximum available fishing hours * actual # FV/day

Weekly estimates of the total number of sets made in each district are summed to estimate total driftnet fleet effort. Daily rather than weekly FV-Hour estimates are used to minimize the error associated with duplicate reports of vessel landings as detailed in the Discussion section.

Setnet effort is estimated in terms of "Setnet Hours," and assumes that all setnets fish continuously during openings.

OBSERVER EFFORT

The team used three observer platforms to monitor driftnet and setnet operations in 1990: fishing vessels, research vessels, and processor tender vessels. Observers onboard active fishing vessels provided the majority of coverage. Observers boarded fishing vessels opportunistically from town prior to openings, or from tender vessels and research vessels during openings after a

brief explanation of the program's goals. Although the observer program is mandatory, not all vessels are suitable for observer boarding which precludes a systematic or random deployment strategy. After project coordinators arranged initial boardings in town, observers were responsible for facilitating their own transfers to subsequent fishing vessels while on the fishing grounds.

Observers monitored, whenever possible, both the soak and retrieval of sets, and recorded the circumstances associated with all entanglement, injury, or death of marine birds and mammals. When a marine bird or mammal encountered a net (approached within 10m), observers noted the animal's behavior and recorded the consequences of the encounter including damage to fish and gear, and the use of deterrents. Observers recorded locational and environmental data for each set observed (see Appendix, Form 1).

Active fishing vessels were the preferred observer platform, but were not always available due to size and safety limitations. Therefore, fishing vessel-based coverage was augmented with observations made from research vessels and tender vessels adjacent to active driftnets. When possible, fishing vessel-based observers monitored nets (drift and set) adjacent to the fishing vessel they boarded. During these remote observations observers collected an abbreviated set of data using a separate data form (see Appendix, Form 2). Observers monitored setnet operations from research vessels, fishing vessels, and shore.

Prior estimates of fishing effort in terms of "sets" were not available on which to base observer coverage. Therefore, anticipated observer needs were based on the number and distribution of fishing vessels expected in each fishery. The project team anticipated that 25 observers would be able to monitor 5% of the 500 fishing vessels expected in PWS from mid-May to 1 September, and eight observers would be able to monitor the 160 fishing vessels expected to fish in September. The project team anticipated that two observers based out of a field camp in Main Bay would be able to monitor 5% of the PWS setnet operations. The team anticipated that eight observers would be able to monitor 5% of the 150 fishing vessels anticipated in the South Unimak June fishery, and three observers would be able to cover the anticipated 50 fishing vessels in the South Unimak July fishery.

The project team deployed driftnet observer effort between districts on a weekly basis based on the anticipated openings and fleet distribution, as determined from discussions with fishermen, processors, and ADF&G biologists. In South Unimak, Peter Pan Seafoods provided opportunistic reports of real-time fleet distribution assessed from aerial surveys of the fishing grounds.

INTERACTIONS

Observers recorded the number, species, time, and location of all marine birds and mammals which approached within 10m of monitored nets ("net encounter"). Observers recorded the result of these encounters including details of the behavior, harassment, entanglement, live-release, or incidental mortality of the animal encountered. When possible, the observers recorded and classified mammal behavior associated with net avoidance as "avoided" (voluntarily changed approach direction or behavior), "missed" (missed gear without apparent change in approach direction or behavior), or "harassed" (actively deterred by fisherman). Observers also recorded information on any deterrents used to harass approaching mammals and the apparent effectiveness of the deterrents (see Appendix, Forms 1 and 2).

Observers recorded the condition of entangled animals as dead, released alive, or unknown. Animals were considered "entangled" if they contacted the net and were detained or ensnared at least momentarily. Observers determined the degree of entanglement by whether the animal was able to release itself or required assistance from the vessel captain. All entanglements resulting in mortality or serious injury were summarized as "Incidental Mortality." The number of animals and sets involved in encounters, entanglements, and incidental mortality were summarized in each fishery for each marine bird and mammal species involved.

The number of birds and mammals observed dead and seriously injured was summarized separately each week for each district. A weekly take rate per district was derived for marine mammals and birds as a ratio of the number taken per observed set. The team applied this observed rate to the estimated weekly fishing effort (number of sets) in each district to obtain an estimate (mean $\pm$ SD) of weekly take in each district (straight ratio) (Hanan, et al., 1986). A 95%

confidence interval [$1.96(s_x)$] was generated for each estimate. The team summed weekly estimates of take per district over the season to obtain fleet-wide incidental take estimates (species-specific for mammals, combined for marine birds). To allow comparison with NOAA's definition of "frequent take," the team estimated take rates per fishing vessel day by considering each day an observer monitored a vessel as one FV-Day.

For each net retrieval, observers recorded the number and species of salmon, any non-target species (fish and shellfish bycatch) landed, and the number of each that were apparently damaged by marine mammals. The team assessed the level of fish damage experienced in the PWS and SU driftnet fisheries as the ratio of damaged to total catch, by species. Observed landings of non-salmon species were compared to total salmon landings to derive an observed "bycatch ratio."

BEACHCAST CARCASS SURVEYS

The project team conducted weekly surveys of barrier island beaches of the Copper River Delta to locate beachcast marine mammal carcasses. The surveys were conducted systematically in a manner comparable to those conducted in 1988 and 1989 (Wynne 1990). A Cessna 180 on wheels was flown at an altitude of 10-50m along the high-tide line to locate carcasses. Whenever possible, the plane was landed and the carcass examined to determine species, sex, and cause of death, to take standard measurements, and to collect teeth and other tissue samples. A survey was flown prior to the driftnet season to identify pre-existing carcasses. The location of these and all other carcasses was mapped to prevent recounting. Aerial surveys were groundtruthed twice. Paired observers, walking abreast along a stretch of beach immediately following its aerial survey, searched through clumps of eelgrass and debris for undetected carcasses.

III. RESULTS

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FISHING EFFORT

PWS Driftnet Fishery

A total of 524 permit holders fished during the 1990 PWS driftnet season. The season opened on the Flats (Copper River and Bering River districts) on 14 May and continued through 14 October 1990. The Coghill and Eshamy districts opened 24 June and closed 22 September 1990. The Unakwik district was open briefly in 1990, but was never fished by more than three driftnetters so ADF&G could not release harvest statistics.

The number and duration of fishing periods varied weekly between districts (Table 1). The Copper River district was open 27 periods ranging from 24- to 48-hours each, while the Bering River district was open 11 periods of 24- to 48-hours each. The Sound districts were generally open for longer periods to allow harvest of returning hatchery stock. The Coghill district was open for 19 periods ranging from 24 to 168 hours and Eshamy was open 10 periods, each for continuous fishing (168 hours).

The average number of sets made per available fishing hour varied weekly, and between districts, as a result of changes in soak duration and number of sets made per day (Table 2). The number of sets made per day fluctuated in response to salmon run strength, area fished, weather, number of daylight hours, fishermen's motivation, and fish prices. The team derived weekly estimates of the number of sets made in each district by multiplying the average sets per available hour by the number of hours available to fish in each district. These were summed to estimate total PWS driftnet fishing effort during the 1990 observer program (Table 1).

PWS Setnet Fishery

Twenty-nine PWS setnet permit holders fished during the 11-week season from 11 June to 2 September 1990 (Table 3). Most of the district was open continuously for 10 weeks, but the small "Alternative Gear Zone" (AGZ) at the head of Main Bay (Figure 5) was open only on alternating days for part of the

TABLE 1

Summary of weekly obs effort (# of sets observed) and fishing effort (est. # of sets made and available hrs/wk) by district in the PWS driftnet fishery, 10 June to 30 September 1990.

PRINCE WILLIAM SOUND DRIFTNET FISHERY

Week[a]		Observer Effort (sets)[b]					Estimated Fishing Effort[c]				
No.	Dates	BR	CR	CG	ES	PWS Total Sets	BR s (hr)	CR s (hr)	CG s (hr)	ES s (hr)	PWS Total Sets
24	6/10-16	-	11	0	0	11	-	7,251 (48)	1,807 (24)	3,666(160)	12,724
25	17-23	0	31	0	0	31	682 (48)	7,033 (48)	3,860 (48)	4,044(168)	15,619
26	24-30	*d	13	7	14	34	* (60)	8,613 (60)	6,083 (48)	4,834(168)	19,530
27	7/01-07	*	219	65	84	368	* (60)	5,122 (60)	1,874 (24)	5,760(168)	12,756
28	08-14	-	89	-	54	143	-	2,077 (60)	-	3,488(168)	5,565
29	15-21	-	393	-	11	404	-	2,952 (60)	-	65 (48)	3,017
30	22-28	-	128	89	-	217	-	1,461 (60)	1,944 (24)	-	3,405
31	29-8/4	-	190	205	16	411	-	1,264 (60)	5,149 (60)	866(168)	7,279
32	8/05-11	*	72	257	25	354	* (60)	1,960 (60)	7,772(108)	720(168)	10,452
33	12-18	*	170	143	41	354	* (48)	2,029 (48)	3,434 (60)	438(168)	5,901
34	19-25	0	91	139	0	230	524 (48)	3,870 (48)	5,058(168)	216(168)	9,668
35	26-9/1	15	115	158	0	288	351 (48)	3,858 (48)	4,044(168)	48(168)	8,301
36	9/02-08	30	65	154	*	249	1,022 (36)	1,935 (36)	3,974(168)	-	6,931
37	09-15	16	11	2	*	29	453 (48)	789 (48)	2,103(168)	-	3,345
38	16-22	0	0	28	*	28	29 (48)	1,046 (48)	855(168)	-	1,930
39	23-29	-	15	*	-	15	-	276 (48)	*(168)	-	276
CR+BR (>7/01)		1,619						31,018			
CG+ES (>7/01)				1,471					47,808		
01 July-30 Sept						3,090					78,826
10 June-30 Sept						3,166					126,699

% estimated sets observed > 7/01: CR + BR = 5.2%, CG + ES = 3.1%, all districts combined= 3.9%

a Week= calendar week and ADF&G Statistical week number

b districts: BR= Bering River, CR= Copper River, CG= Coghill, ES= Eshamy; no data reported for Unakwik (UN) district since never >3 fishermen present

c fishing effort: s= estimated total sets made based on weekly mean sets/available hr as observed in each district and assumes maximum available hrs/d were fished by each vessel present (hr)

d (*) indicates district with <3 fishermen present; no ADFG data released; (-) indicates district closed by ADFG emergency order

TABLE 2

Weekly summary of fishing intensity (%T) and set frequency (mean sets made per available fishing hour) used to estimate fishing effort in PWS and SU driftnet fisheries, 1990.

		PWS districts[a]								SU district	
		BR		CR		CG		ES			
Week	Date	%T	s/h[b]	%T	s/h	%T	s/h	%T	s/h	%T	s/h
24	6/10-16	-		-	0.67	-	0.64	-	0.27	63.2	0.26
25	17-23	-		-	0.96	-	0.64 *	-	0.27 *	52.5	0.22
26	24-30	-		-	1.40	-	0.64 *	-	0.27 *	44.7	0.17
27	7/01-07	-		-	0.73	-	0.61	-	0.6	-	
28	08-14	-		59.3	0.36	-		62.3	0.45*	-	
29	15-21	-		59.3	0.36 *	-		62.3	0.45	74.4	0.25
30	22-28	-		46.8	0.40	82.9	0.50	-		64.6	0.21
31	29-8/4	-		66.4	0.45	74.0	0.42	69.8	0.38	76.4	0.29
32	8/05-11	-		67.6	0.58	75.3	0.32	54.4	0.30	72.7	0.26
33	12-18	-		58.3	0.35	85.8	0.35	65.2	0.21		
34	19-25	-		86.5	0.58	62.7	0.25	-			
35	26-9/1	43.5	0.25	74.1	0.46	56.7	0.25	-			
36	9/02-08	84.4	0.59	62.2	0.28	59.6	0.24	-			
37	09-15	37.1	0.34	33.1	0.17	59.7	0.28	-			
38	16-22	-		-		68.2	0.27	-			
39	23-29	-		12.4	0.13	-					

[a] PWS districts: BR= Bering River, CR= Copper River, CG= Coghill, ES= Eshamy

[b] Estimated fishing intensity: %T= percent of maximum available hours fishermen actively fished their gear, estimated from FV observations; s/h= mean sets made per available hour of fishing, estimated from FV observations; (-) indicates no fishing effort; (*) indicates previous estimate used in week with inadequate estimator

TABLE 3

Summary of weekly observer effort (number of sets and hours observed) and fishing effort (number of permitholders and maximum available fishing time) in the PWS setnet fishery, 1990.

PWS SETNET FISHERY

Week[b]	Dates	Observer effort sets	Observer effort hrs	Setnet Effort[a] Max. hrs/wk	Setnet Effort[a] Daily Max setnets/hr	Setnet Effort[a] Sum daily setnet-hr
24	6/10-6/16	0	0	160	24	2,928
25	6/17-6/23	0	0	168	24	3,456
26	6/24-6/30	1	16.0	168	25	3,264
27	7/01-7/07	0	0	168	23	3,336
28	7/08-7/14	11	5.5	168	23	3,048
29	7/15-7/21	0	0	48	14	432
30	7/22-7/28	-	-	0	-	-
31	7/29-8/04	30	56.0	160	19	2,432
32	8/05-8/11	32	61.0	168	18	2,832
33	8/12-8/18	29	56.5	168	16	2,424
34	8/19-8/25	39	75.5	168	15	2,112
35	8/26-9/01	17	31.0	36	12	768
		159	301.5	1,580		27,032
	after 7/28:	147	280	700		10,568

% setnet-hrs observed: 2.7%

a setnet-hr= daily maximum available fishing time x actual number of setnetters fishing

b Week= calendar week and ADF&G Statistical week number

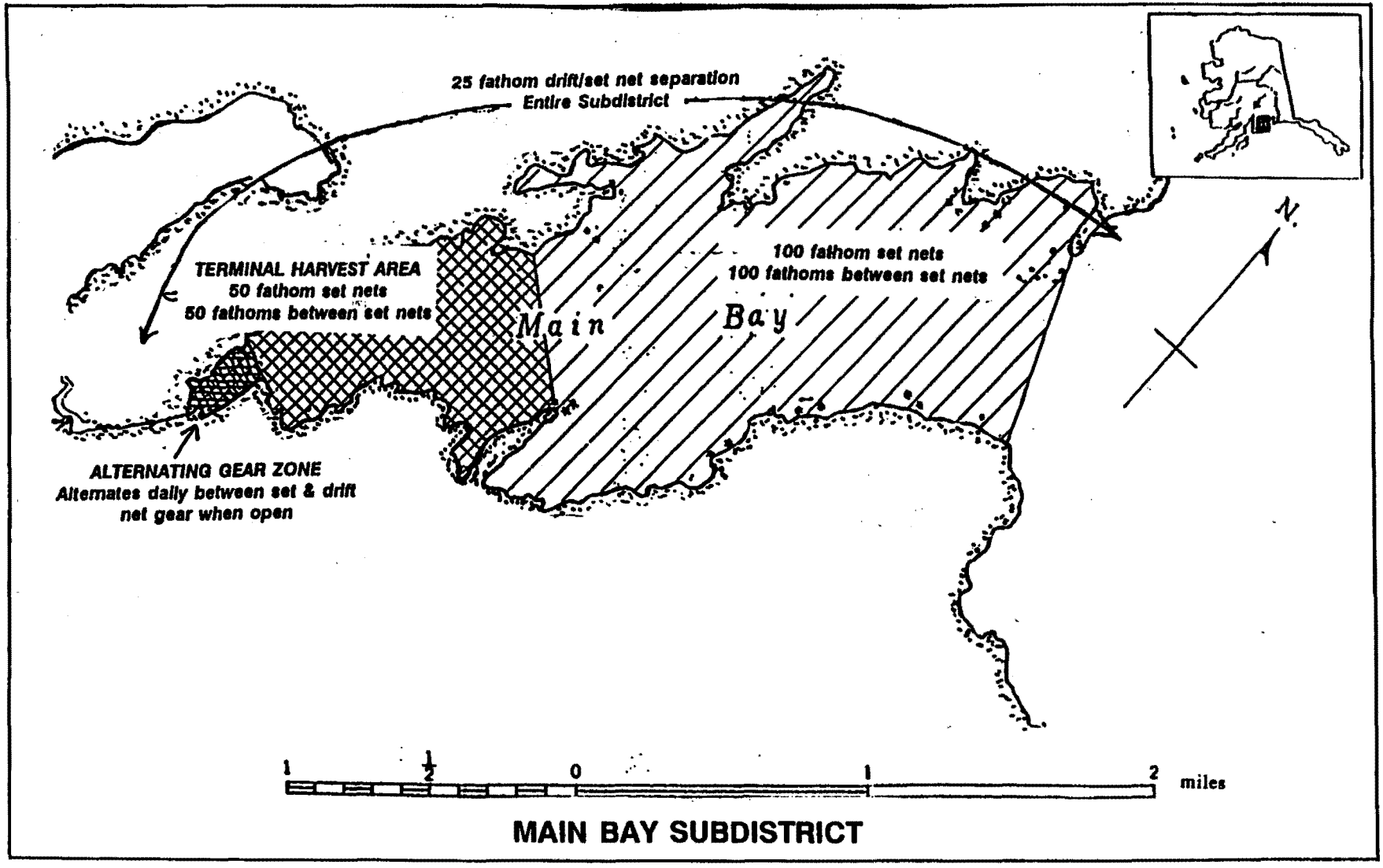

Figure 5. ADF&G partitioning of the Main Bay subdistrict (within Eshamy District) which affected the timing and net length of local setnet operations.

season. The estimate of total setnet effort assumes all setnetters fished outside the AGZ and that their gear fished continuously. This means that the estimate of total setnet effort is a maximum estimate.

SU Driftnet Fishery

A total of 154 permit holders fished the South Unimak district during the 1990 season from 13 June to 11 August. Fishing periods ranged from 5 to 184 hours in length. The team derived weekly estimates of the number of sets made by the fleet, and summed them to estimate seasonal fleet effort (Table 4).

OBSERVER EFFORT

The contract was awarded on 16 May and the first group of observers was trained and deployed to South Unimak for the season's first opening on 13 June 1990 (ADF&G statistical week 24). Due to the program's late start, observers were not fully deployed in the PWS driftnet fishery until 1 July 1990 (statistical week 27). The PWS driftnet fishery began 14 May in the Copper River and Bering River districts, and opened 14 June 1990 in the Prince William Sound districts. The PWS setnet fishery opened 11 June, but setnet observers were not able to commence operations in the Eshamy district until 29 July.

Observers boarded 300 of the 524 vessels (57.3%) that fished in the PWS driftnet fishery, and monitored a total of 3,166 sets between 10 June and 25 September (Table 1). Using the subtotal of 3,090 sets observed after 1 July when full effort began, observers monitored 3.9% of the estimated number of sets made by the fleet in the same period of time. During that period observers monitored 5.2% of the driftnet sets made on the Flats (BR and CR districts), and 3.1% of the PWS (CG and ES districts) sets (Table 1). Observers monitored 726 FV-Days and nearly 5000 hours of actual fishing time during 16 weeks of effort (Table 5).

Observers monitored 301.5 hours of setnet fishing in Prince William Sound during 159 observation periods in 1990 (Table 3). This represented 2.7% of the estimated maximum setnet hours occurring during five weeks of full setnet observer effort (statistical weeks 31-35).

TABLE 4

Summary of weekly observer effort (number of sets observed) and fishing effort (estimated number of sets made and available fishing hrs/wk) in the SU driftnet fishery, 1990.

SOUTH UNIMAK DRIFTNET FISHERY

Week[b]	Dates	Observer effort (obs. sets)	Fleet effort[a] Max hrs/week	Estim. sets
24	6/10-6/16	60	58	1,625
25	6/17-6/23	117	168	4,256
26	6/24-6/30	28	43	635
27	7/01-7/07	0	17	129
28	7/08-7/14	0	82	240
29	7/15-7/21	31	41	247
30	7/22-7/28	17	113	859
31	7/29-8/04	62	65	590
32	8/05-8/11	58	82	473
10 June-12 August total=		373	669	9,054

% estimated sets observed= 4.1%

[a] fishing effort: Max hrs/wk= available fishing hours; estim. sets= number of sets made by fleet, estimated based on observed weekly mean sets/available hr and assumes maximum available hrs/d were fished by each vessel present

[b] Week= calendar week and ADF&G Statistical week number

TABLE 5

Weekly summary of vessels, hours, sets, and percent of landings monitored by observers in PWS and SU driftnet fisheries, 1990.

OBSERVER EFFORT[a]

		PWS districts combined				SU district			
Week	Date	#FV	#Hr	#Sets	% Fleet Landings	#FV	#Hr	#Sets	% Fleet Landings
24	6/10-16	1	13.2	11	-	14	141.2	60	2.9%
25	17-23	4	30.9	31	-	28	251.5	117	2.1
26	24-30	10	78.1	34	-	14	71.3	28	1.1
27	7/01-07	55	500.0	368	4.0%	0	0	0	0
28	08-14	23	185.3	143	2.5	0	0	0	0
29	15-21	57	556.6	404	7.9	6	81.4	31	13.2
30	22-28	40	283.3	217	3.6	4	51.0	17	1.4
31	29-8/4	75	591.6	411	4.3	10	137.8	62	10.6
32	8/05-11	74	612.3	354	3.6	11	142.2	58	11.2
33	12-18	113	660.0	354	5.1				
34	19-25	60	422.3	230	2.4				
35	26-9/1	88	518.9	288	2.7				
36	9/02-08	91	404.5	249	2.1				
37	09-15	8	45.7	29	0.8				
38	16-22	17	68.0	28	2.1				
39	23-29	10	21.8	15	1.2				
	Total:	726	4992.5	3166	3.5%	87	876.4	373	3.2%

[a] observer effort: #FV= number of fishing vessels monitored by observers, #Hr= number of hours of actual fishing operations monitored by observers, #Sets= number of sets monitored by observers, % fleet landings= percent of weekly salmon harvest landed by vessels with observers onboard

South Unimak observers boarded 59 of the 154 vessels (38.3%) that fished in the SU driftnet fishery, and monitored a total of 373 sets in 1990 (Table 4). This represents 4.1% of the estimated number of sets made by the fleet in the same period of time. Observers monitored 87 FV-Days and 876 hours of actual fishing time during seven weeks of effort (Table 5).

INTERACTIONS

Marine Mammal Encounters, Entanglements, and Mortality

In the Prince William Sound fisheries observers recorded a total of 585 marine mammals approaching within 10m of 492 of the 3,166 (15.5%) driftnet sets, and 27 of 159 (17%) PWS setnets monitored in 1990 (Table 6). Harbor seals (*Phoca vitulina*) were the most frequently encountered mammal in the PWS driftnet fishery, and were seen near 360 (11.4%) of the sets. Harbor seals were also the most frequently encountered mammal in the PWS setnet fishery, and were seen within 10m of 12 of the 159 (7.6%) sets observed (Table 6).

In South Unimak, 64 marine mammals were observed within 10m of 57 monitored sets (15.3%). Northern fur seals (*Callorhinus ursinus*) were the most frequently encountered marine mammal, occurring near 34 of the 373 (9.1%) sets monitored (Table 6).

While marine mammals were common in all three fishing areas, they entangled in only 0.5% and 1.3% of the sets observed in the PWS and SU driftnet fisheries respectively. No entanglements were observed in PWS setnets (Table 7). Incidental mortality was observed in fewer than 0.3% of observed sets in each fishery (Table 7). Approximately 3% of the marine mammals that approached within 10m of observed driftnets became entangled in them: 15 of the 580 PWS encounters and 5 of the 64 SU encounters (Table 7). All PWS driftnet marine mammal entanglements occurred on the Flats (CR and BR districts). Species-specific rates of entanglement and encounter were determined for the PWS and SU driftnet fishery (Table 7).

Only 20% of entanglements resulted in death or injury to the mammal in observed PWS and SU driftnets (Table 8). Eight of the 15 (53.3%) mammals entangled in PWS driftnets were able to break through the net or untangle

TABLE 6

Summary of marine mammal encounters (mammal within 10m of net)
recorded by MMPA observers in the PWS and SU set and drift salmon gillnet fisheries, Alaska 1990.

(N= number sets observed, n= number of animals encountered, s= number of sets with encounters)

MARINE MAMMAL ENCOUNTERS

		HS[a]		SO		SL		NFS		Pin		HP		DP		UnWhl		Species Combined	
Fishery	N	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s	n	s
PWS drift	3166	433	360	92	75	48	45	0	0	7	7	5	5	0	0	0	0	585	492
PWS set	159	12	12	10	10	5	5	0	0	0	0	0	0	0	0	0	0	27	27
SU drift	373	0	0	8	8	13	8	34	34	3	3	1	1	3	1	2	2	64	57
	3698																	676	576

[a] species: HS= harbor seal, SO= sea otter, SL= Steller sea lion, NFS= northern fur seal, Pin= unidentified pinniped, HP= harbor porpoise, DP= Dall's porpoise, UnWhl= unidentified whale

TABLE 7

Species-specific outcome of net encounters and entanglement of marine mammals (MM) observed in PWS and SU driftnets, 1990.

SPS[d]	MM-net Encounters[a] No.	% obs sets	MM Entanglement[b] No.	% obs sets	Incid. Injury or Death[c] No.	% obs sets
PWS driftnet (N= 3,166 observed sets)						
HS	433	13.7%	4	0.13%	2	0.06%
SO	92	2.9	8	0.25	0	0
SL	48	1.5	1	0.03	0	0
HP	7	0.2	2	0.06	1	0.03
	580	18.3%	15	0.47%	3	0.09%
PWS setnet (N=159 observed sets)						
HS	12	7.5%	0			0
SO	10	6.3	0			0
SL	5	3.1	0			0
	27	17.0%	0			0
SU driftnet (N= 373 observed sets)						
NFS	34	9.1%	2	0.54%	0	0
SL	13	3.5	1	0.27	0	0
SO	8	2.1	0	0	0	0
DP	3	0.8	1	0.27	1	0.27%
UnPin	3	0.8	0	0	0	0
Whale	2	0.5	1	0.27	0	0
HP	1	0.3	0	0	0	0
	64	17.2%	5	1.34%	1	0.27%

a Net encounter= mammal observed within 10m of active driftnet, includes entanglements

b Entanglement= mammal contacted net, was released with or without assistance, includes incid. injury and death

c Incid. injury or death= incidental injury or death resulting from entanglement

d SPS= species: HS= harbor seal, SO= sea otter, SL= Steller sea lion, HP= harbor porpoise, NFS= Northern fur seal, UnPin= unidentified pinniped, Whale= unidentified whale species

TABLE 8

Number and disposition of marine mammals entangled in salmon gillnets observed by MMPA observers in Prince William Sound and South Unimak, Alaska, 1990.

NUMBER OF ENTANGLED MARINE MAMMALS

Fishery	No. Entangled	Released Alive[a] HS a	HS u	SO a	SO u	NFS a	NFS u	HP a	HP u	SL a	SL u	UnWhl[b] a	UnWhl[b] u	Incidental Injury or Death HS	DP	HP
PWS drift	15	1	1	2	6	0	0	1	0	0	1	0	0	2	0	1
PWS set	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SU drift	5	0	0	0	0	0	2	0	0	0	1	0	1	0	1	0

a number and species released alive after entanglement; a= assisted by vessel captain, u= unassisted release or momentary entanglement

b species: HS= harbor seal, SO= sea otter, NFS= northern fur seal, HP= harbor porpoise, SL= Steller sea lion, UnWhl= unidentified whale, DP= Dall's porpoise

themselves, and another four (26.7%) were released alive by the fisherman (Table 9). Of the three mammals incidentally killed or seriously injured in this fishery, two were young harbor seals that drowned, and one was a harbor porpoise (*Phocoena phocoena*) which was released alive but had sustained serious injury from the net.

In South Unimak four of the five (80%) mammals that entangled in driftnets either swam through or broke free from the net unassisted (Table 10). The only observed incidental death was one of three Dall's porpoise (*Phocoenoides dalli*) which had been bowriding off the project's research vessel. As the research vessel approached several fishing vessels, one porpoise swam off in the direction of a driftnet and apparently entangled in the leadline.

Point estimates with a 95% confidence interval of incidental marine mammal take were derived for each district based on the observed take rate (number of mammals taken per observed set) and the estimated number of sets made by the fleet per district (straight ratio). In all cases weekly take estimates were derived from low observed take rates with high variance and are consequently bounded by large confidence intervals. Extrapolated weekly take estimates of incidental mortality suggest 0-23 harbor porpoise (mean estimate=8) and 0-74 harbor seals (mean estimate=36) were incidentally injured or killed in the PWS driftnet fishery in 1990 (Table 11). Extrapolation from the singular entanglement observed suggests an estimated 0-81 (mean estimate=28) Dall's porpoise were incidentally killed in the SU driftnet fishery in 1990 (Table 12).

Rates for take per observed FV-Day were derived for the driftnet fisheries by defining an observed FV-Day as each day a vessel's operations were monitored by an observer. Incidental entanglement, injury, or death was recorded during 15 of 726 (1:48.4) observed FV-Days in the PWS and 5 of 87 (1:17.4) observed FV-Days in the SU driftnet fishery.

Marine Bird Encounters and Entanglements

A total of 631 marine birds, representing at least 20 species, were observed within 10m of active drift and set gillnets in Prince William Sound and driftnets in South Unimak in 1990 (Table 13). Of the 336 marine birds that were observed to encounter PWS driftnets, 41 became entangled (in 1.0% of observed

TABLE 9

Summary of date, location, and circumstance of marine mammal entanglements observed in the PWS driftnet fisheries, 1990.

PWS — MARINE MAMMAL ENTANGLEMENTS

Sps[a]	Date	Time	District[b]	Area[c]	Lat/Long		Cond[d]	Comments
SO	7-02	14:45	212-15	N	60°22.0'	146°05.0'	RA	released itself
	7-06	18:18	212-15	N	60°22.3'	146°04.3'	RA	rel.self during haul;in>4min
	7-13	14:25	212-25	S	60°14.0'	145°15.0'	RA	rel.self when FV capt. ran gear
	7-23	10:00	212-11	C	60°23.7'	146°03.9'	RA	untangled and released itself
	8-21	10:05	212-15	N	60°20.0'	145°50.0'	RA	untangled and released itself
	8-21	10:30	212-25	N	60°20.0'	145°50.0'	RA	pup, capt.rolled it out of net
	8-21	10:30	212-25	N	60°20.0'	145°50.0'	RA	pup's mother; capt.cut mesh to free
	9-06	20:56	212-15	C	60°22.5'	145°37.0'	RA	rel.self by lifting corkline
HS	7-16	13:20	212-35	S	60°12.9'	145°00.1'	RA	capt. rolled it out of net
	7-20	09:55	212-25	N	60°15.5'	145°26.7'	RA	rel.self when capt.approached
	8-03	10:34	212-21	C	60°15.0'	145°15.1'	DEAD	drowned, caught snout in mesh
	8-29	11:53	200-20	N	60°05.5'	144°24.0'	DEAD	drowned, caught snout in mesh
SL	8-13	22:24	212-15	N	60°22.0'	146°06.1'	RA	swam through net but not caught
HP	7-30	22:05	212-15	O	60°17.4'	145°43.8'	RA	capt.rolled it out; minor injury
	7-20	00:15	212-25	N	60°16.0'	145°20.0'	SI	capt.cut mesh to free;ser.injury

a Sps= species: SO= sea otter, HS= harbor seal, SL= Steller sea lion, HP= harbor porpoise
b Dist= ADFG finfish statistical district; 212- =Copper River dist., 200- = Bering River dist.
c Area: C= channel, S= surf, N= nearshore (<10 fa depth), O= offshore (>10 fa depth)
d Condition: RA= released from net alive, DEAD= dead when recovered, SI= serious injury

TABLE 10

Summary of date, location, and circumstance of marine mammal entanglements observed in the South Unimak driftnet fishery, 1990.

SU — MARINE MAMMAL ENTANGLEMENTS

Sps[a]	Date	Time	District[b]	Area[c]	Lat/Long		Cond[d]	Comments
SL	6-16	14:30	284-50	O	54°45.9'	163°07.6'	RA	rolled in net but not caught
NFS	6-16	20:25	284-60	O	54°46.0'	163°09.0'	RA	rel. self as net was retrieved
	6-28	19:00	284-50	O	54°37.6'	163°14.4'	RA	rel. self, tore through net
DP	6-14	15:40	284-50	O	54°36.5'	163°11.0'	DEAD	drowned in net;was RV bowrider
UnWhl	8-01	23:00	284-50	O	54°35.9'	163°24.5'	RA	swam through net, not caught

a Sps= species: SO= sea otter, HS= harbor seal, SL= Steller sea lion, HP= harbor porpoise
b Dist= ADFG finfish statistical district; 284- = South Unimak district
c Area: C= channel, S= surf, N= nearshore (<10 fa depth), O= offshore (>10 fa depth)
d Condition: RA= released from net alive, DEAD= dead when recovered, Unk= fate unknown

TABLE 11

Number (No.) weekly rates (mean ±SD) and mean estimates (±95% C.I.) of incidental marine mammal take (serious injury or death) observed in the PWS driftnet fishery, 1990.

PWS — ESTIMATED MARINE MAMMAL TAKE

Week	Date	SPS[c]	No.	Mean Obs Take rate (±SD)[a] BR	CR	CG	ES	Estim # sets/wk BR	CR	CG	ES	Mean estimate (±95% C.I.)[b] Marine Mammal Take BR	CR	CG	ES
24	6/10-16														
25	17-23														
26	24-30														
27	7/01-07														
28	08-14														
29	15-21	HP	1	0.0025 (±0.05)				2,952				7.5 (±14.6)			
30	22-28														
31	29-8/4	HS	1	0.0052 (±0.07)				1,264				12.6 (±12.6)			
32	8/05-11														
33	12-18														
34	19-25														
35	26-9/1	HS	1	0.0667 (±0.26)				351				23.3 (±24)			
36	9/02-08														
37	09-15														
38	16-22														
39	23-29														

All PWS districts combined: estimated take and 95% C.I. range:

HP = 8 (0-23)
HS = 36 (0-74)

a observed take rate= number marine mammals seriously injured or killed per observed set(±SD)
b estimated weekly take= mean take per observed set X estimated sets made in district
c species: HP= harbor porpoise (serious injury), HS= harbor seal (deaths)

TABLE 12

Number (No.) weekly rate (mean ±SD) and mean estimate (±95% C.I.) of incidental marine mammal take (serious injury or death) observed in the SU driftnet fishery, 1990.

SU — ESTIMATED MARINE MAMMAL TAKE

Week	Dates	SPS[b]	No.	Mean Obs take rate (±SD)[c]	Estim # sets/wk	Mean estimated take[a] (±95% C.I.)
24	6/10-16	DP	1	0.017 (±0.129)	1,625	27.6 (±53)
25	17-23					
26	24-30					
27	7/01-07					
28	08-14					
29	15-21					
30	22-28					
31	29-8/4					
32	8/05-11					
				Mean Estimated take (95% C.I. range)		DP = 28 (0-81)

a estimated weekly take= mean take per observed set X estimated sets made in district (±95% C.I.)

b species: DP= Dall's porpoise (death)

c observed take rate= number marine mammals seriously injured or killed per observed set (±SD)

TABLE 13

Number and species of marine birds
observed within 10m of active set and drift gillnets
in Prince William Sound and South Unimak, 10 June- 28 Sept 1990.

Species	Species Code	Number birds encountered or entangled[a] PWS drift n	(s)	PWS set n	(s)	SU drift n	(s)
Unid bird	400	55	(22)			1	(1)
Common loon	407	1	(1)				
Unid grebe	410	3	(1)				
Northern fulmar	431					3	(1)
Sooty shearwater	456					1	(1)
Short-tailed shearwater	457					1	(1)
Unid storm-petrel	470	1	(1)				
Fork-tailed storm-petrel	475					100	(3)
Unid phalarope	520	3	(3)				
Red phalarope	521	1	(1)				
Northern Phalarope	522	21	(8)				
Parasitic jaeger	527	1	(1)				
Unid gull	530	64	(24)			110	(9)
Herring gull	534	13	(4)	1	(1)		
Slaty-backed gull	538	1	(1)				
Glaucous-winged gull	539	13	(6)			1	(1)
Glaucous gull	540	8	(3)			14	(3)
Black-legged kittiwake	545	68	(20)	14	(3)	12	(3)
Arctic tern	558	12	(2)				
Unid alcid	570	2	(2)				
Unid murre	571	1	(1)			2	(1)
Common murre	573					10	(7)
Unid guillemot	574	2	(2)			1	(1)
Pigeon guillemot	576	3	(2)				
Unid murrelet	578	16	(8)				
Marbled murrelet	579	45	(33)	1	(1)	1	(1)
Kittlitz murrelet	580	2	(1)				
Horned puffin	591					4	(3)
Tufted puffin	592					18	(11)
		336	(147)	16	(5)	279	(47)

[a] n= number of birds observed, (s)= number of sets with bird encounters or entanglement

sets). Of the 41 birds that entangled, 37 died (in 0.9% of observed sets), and four were released alive (Table 14). The majority of birds (83.8%) that died in PWS driftnets were marbled murrelets (*Brachyramphus marmoratus*) (Table 15). Only one of 16 (6.2%) marine birds observed approaching PWS setnets became entangled, and it was released alive.

In South Unimak 19 of the 279 marine birds that encountered driftnets became entangled (in 4.0% of observed sets). Of the 19 entangled birds, 16 died (in 3.5% of observed sets) and three were released alive (Table 14). Half were common murres (*Uria aalge*) (Table 15).

Estimates of marine bird mortality, based on extrapolation of observed weekly rates, ranged (95% C.I.) from 836 to 2100 in PWS (Table 16) and 158 to 516 in SU (Table 17).

Other Interactions

Observers aboard driftnet vessels recorded the number of salmon landed in each retrieval, and also the number of salmon that bore injuries attributed to marine mammals. Of the 93,007 salmon landed during PWS driftnet observations, 268 (0.3%) bore "marine mammal damage." The percent of salmon damaged in observed SU driftnet retrievals was only slightly higher at 0.7% (Table 18). It was not possible to count or estimate the number of salmon that were removed entirely from nets without evidence.

Non-target species landings and marine mammal damage were also recorded. The percent of bycatch (non-salmon / salmon) was 1.9% for PWS and 0.9% for SU driftnets (Table 18). Primary PWS driftnet bycatch species were Starry flounder (*Platichthys stellatus*) and Dungeness crabs (*Cancer magister*). In South Unimak the primary non-target species were cod (*Gadus spp.*) and Pacific herring (*Clupea harengus*). Although the majority of bycatch was landed alive, an unquantified number (particularly crabs) died subsequent to capture during removal from the net.

Observers recorded the occurrence but not the extent of net damage attributed to marine mammals. Gear damage was recorded for 0.9% of PWS driftnets and 2.0% of SU driftnets observed. No effort was made to quantify the

TABLE 14

Frequency of marine bird (MB) encounters and consequences of entanglement in gillnets observed in Prince William Sound and South Unimak, 1990.

ALL BIRD SPECIES COMBINED

Fishery	Obs sets	MB-net Encounters[a] n	s	% obs sets	Entanglement n	s	% obs sets	Incid. mortality n	s	% obs sets
PWS drift	3,166	336	147	4.6%	41	32	1.0%	37	28	0.9%
PWS set	159	16	5	3.1	1	1	0.6	0	0	0
SU drift	373	279	47	12.6	19	15	4.0	16	13	3.5

[a] all encounters, including those that result in entanglement; n= number of birds involved, s= number of sets involved

TABLE 15

Number and species of marine birds retrieved dead from gillnets observed in Prince William Sound and South Unimak, 1990.
(n= number of dead birds, s= number of sets with incidental kills)

		FISHERY					
		PWS driftnet		PWS setnet		SU driftnet	
Species	Code	n	s	n	s	n	s
Marbled murrelet	579	31	23	0	0	1	1
Unid. murrelet	578	3	3	0	0	0	0
Kittlitz murrelet	580	2	1	0	0	0	0
Common loon	407	1	1	0	0	0	0
Common murre	573					8	6
Unid. murre	571					2	1
Sooty shearwater	456					1	1
Short-tailed shearwater	457					1	1
Horned puffin	591					1	1
Tufted puffin	592					1	1
Unid bird	400					1	1
Total by fishery		37	28	0	0	16	13
N and % of observed sets:		3,166	0.9%	159	0%	373	3.5%

TABLE 16

Number (No.), weekly rates (mean ±SD), and mean estimates (±95% C.I.) of incidental marine bird mortality (all species combined) observed in the PWS driftnet fishery, 1990.

PWS DRIFTNET FISHERY — Estimated Marine Bird Mortality

Wk	Dates	(No.) Obs mean take rate ±SD[a] BR	CR	CG	Estim # sets/wk BR	CR	CG	Mean Estim MB take (±95% C.I.)[b] BR	CR	CG
24	6/10-16									
25	17-23		(1) 0.032±0.18			7033			225.1(±452)	
26	24-30		(1) 0.077±0.28			8613			663.2(±1298.6)	
27	7/01-07									
28	08-14									
29	15-21		(5) 0.013±0.21			2952			37.6(±60.7)	
30	22-28		(15) 0.117±0.74			1461			171.2(±187.5)	
31	29-8/4		(2) 0.011±0.10	(1) 0.005±0.07		1264	5149		12.6(±18.4)	27.1(±49.1)
32	8/05-11			(1) 0.004±0.06			7772			30.2(±59.2)
33	12-18		(1) 0.006±0.06	(1) 0.007±0.08		2029	3434		12.2(±23.4)	24.0(±47.1)
34	19-25			(1) 0.007±0.08			5058			36.4(±71.3)
35	26-9/1	(3) 0.200±0.56	(4) 0.035±0.92	(1) 0.006±0.08	351	3858	4044	70.2(±99.6)	134.2(±64.9)	24.3(±50.1)
36	9/02-08									
37	09-15									
38	16-22									
39	23-29									
		PWS driftnet districts combined = 37			53,018			70.2	1,256.1	142.0
		Mean estimate of take and 95% C.I. range:							1,468 (836-2,100)	

a observed rate= # dead birds per observed set (±SD)

b Estim # sets/wk: estimated weekly take= observed mean take per set X estimated sets made in district (±95% C.I)

TABLE 17

Number (No.) weekly rates (mean ±SD) and mean estimates (±95% C.I.) of incidental marine bird mortality (all species combined) observed in the SU driftnet fishery, 1990.

SU DRIFTNET FISHERY — Estimated Marine Bird Mortality

Week	Dates	Observed (No.) take rate ±SD[a]	Estim # sets/wk[b]	Mean estim take (±95% C.I.)[c]
24	6/10-16	(3) 0.050 ±0.22	1,625	81.2 (±90.4)
25	17-23	(3) 0.026 ±0.16	4,256	110.7 (±122.4)
26	24-30	(1) 0.036 ±0.19	635	22.9 (±44.5)
27	7/01-07			
28	08-14			
29	15-21	(1) 0.032 ±0.18	247	7.4 (±15.6)
30	22-28	(1) 0.059 ±0.24	859	50.4 (±99)
31	29-8/4	(5) 0.081 ±0.27	590	47.8 (±40.3)
32	8/05-11	(2) 0.034 ±0.18	473	16.1 (±22.4)
SU estimated take and 95% C.I. range:			8,685	336.5 (158-516)

a observed take rate= # dead birds per observed set (±SD)

b estim # sets/wk= estimated weekly take= observed mean take per set X estimated sets made in district (±95%C.I)

TABLE 18

Summary of landings (n), marine mammal-damaged fish (d), and percent of observed fish damaged (%) as observed in driftnet retrievals in Prince William Sound and South Unimak, Alaska, 1990.

OBSERVED TOTAL AND DAMAGED SALMON LANDINGS

	Sockeye			Chinook			Pink			Chum			Coho		
	d	n	%	d	n	%	d	n	%	d	n	%	d	n	%
PWS	144	6,283	2.3	1	20	5.0	34	73,320	0.05	5	3,256	0.15	84	10,128	0.8
SU	102	14,703	0.7	1	53	1.9	25	3,022	0.8	27	5,927	0.5	19	2,402	0.8

	SALMON			NON-TARGET SPECIES[a]					
	All species combined			Dead			Alive		
	d	n	%	d	n	%	d	n	%
PWS	268	93,007	0.3	2	558	0.4	0	1192	-
SU	174	26,107	0.7	2	168	1.2	14	60	23.3

a non-target fish and shellfish species; SU primarily cod and herring, PWS primarily Starry flounder and Dungeness crabs

extent of damage because it is difficult to distinguish holes caused by backlash or other operational sources from those caused by mammals scavenging fish or tearing through nets. Although difficult to quantify, gear losses during marine mammal entanglement and scavenging can be significant. A whale that entangled in SU tore a 13m hole in the net as it broke through.

Net Avoidance and Mammal Deterrents

Observers recorded the behavior of marine mammals as they approached gillnets to determine the animal's relative awareness of the net's presence. All species were able to detect and avoid net collision during a majority of the observed net approaches (Table 19) as evidenced by a change in the animal's course or behavior near the net. Marine mammals actively avoided 47.3% and missed 9.4% of observed PWS driftnet approaches without being harassed or deterred from the net. Mammals that avoided entanglement in SU driftnets appeared to actively avoid 41.8% and miss another 21.8% of the nets without being actively deterred (Table 19).

Pinnipeds that come within 10m of a driftnet are often seen or suspected of scavenging netted salmon and may damage nets while extracting fish. Commercial fishermen may legally defend their gear and catch with a variety of deterrents, many of which were observed in 1990. Fishermen used one or more deterrents to chase marine mammals from 43.3% of sets in PWS and 36.4% of sets observed in SU (Table 19). Harbor seals in PWS were the most frequently deterred marine mammal in these observations.

Fishermen used non-lethal deterrents in 179 of 213 harassment attempts (84%) observed in PWS and SU. Although a variety of deterrents were observed in PWS and SU, the most frequently used harbor seal deterrent was seal bombs (41.6% of deterrents). Northern fur seals were most frequently (58.3% of deterrents) deterred by "running the gear," physically chasing the animal away from the net with the vessel. Steller sea lions (*Eumatopias jubatus*) were equally harassed with seal bombs or by running the gear (each 39.5% of deterrents). In 20.2% of deterrent observations, the fisherman used more than one technique to harass persistent mammals. On four occasions fishermen were observed to throw seal bombs near sea otters (*Enhydra lutris*) in an effort to prevent their

TABLE 19

Species-specific behavior and harassment of marine mammals observed approaching SU and PWS driftnets, 1990.

Species[d]	No. Obs.	Avoided[a] n	(%obs)	Missed[b] n	(%obs)	Harassed[c] n	(%obs)	R	S	G	RS	RG	SG	C
PWS driftnet														
SO	80	61	(76.3)	13	(16.2)	6	(7.5)	2	4	0	0	0	0	0
HS	310	131	(42.2)	25	(8.1)	154	(49.7)	40	64	16	22	1	3	8
SL	47	15	(31.9)	2	(4.3)	30	(63.8)	13	10	0	6	0	0	1
Pin	5	2	(40.0)	0		3	(60.0)	1	1	0	0	0	0	1
HP	4	2	(50.0)	2	(50.0)	0		0	0	0	0	0	0	0
	446	211	(47.3)	42	(9.4)	193	(43.3)							
SU driftnet														
SO	8	3	(37.5)	5	(62.5)	0		0	0	0	0	0	0	0
NFS	29	13	(44.8)	4	(13.8)	12	(41.4)	7	2	0	0	0	0	3
HS	0	-		-		-								
SL	12	4	(33.3)	0		8	(66.7)	2	5	0	0	0	0	1
Pinn	3	1	(33.3)	2	(66.7)	0								
Porp	3	2	(66.7)	1	(33.3)	0								
	55	23	(41.8)	12	(21.8)	20	(36.4)							

a avoided= changed course of travel or modified behavior in active avoidance of the net

b missed= missed net by chance with no apparent modification of behavior or change in travel course

c harassed= captain used deterrent(s) in effort to chase mammal from vicinity of net; methods used: R= 'ran' gear, S= seal bomb, G= gunshot, RS= ran gear and seal bomb, RG= ran gear and gunshot, SG= seal bomb and gunshot, C= unspecified combination

d species: SO= sea otter, HS= harbor seal, SL=Steller sea lion, NFS= Northern fur seal, Pinn= unidentified pinniped, HP= harbor porpoise, Porp= harbor and/or Dall's porpoise

entanglement (Table 19). Fishermen used firearms to deter pinnipeds in 20 of 193 harassment attempts (9.3%) observed in PWS (Table 19).

BEACHCAST CARCASS SURVEYS

The barrier island beaches of the Copper River Delta were aerially surveyed 19 times between 13 May and 25 September 1990 to locate and identify beachcast marine mammal carcasses. No fresh carcasses were observed during the pre-season survey conducted just prior to the first driftnet fishing period. The remaining surveys were flown weekly, preferably between fishing periods. The species and location of carcasses were recorded during each flight (Table 20). Whenever possible, the plane was landed and each carcass was examined to determine its sex, approximate age, and apparent cause of death (Table 21).

A total of 58 carcasses representing four species were observed: 18 Steller sea lions, 16 harbor seals, 15 harbor porpoise, and 9 sea otters (Table 21). Males comprised the majority of each species examined (Table 22). A seasonal pattern of carcass deposition is evident for each species: sea lions were found primarily in May and June, sea otters primarily in August and September, and harbor seals and harbor porpoise throughout the summer (Table 21).

The cause of death was difficult to ascertain for the majority (63.8%) of carcasses observed due to advanced decomposition or inaccessibility of the carcass. Definite evidence of gunshot wounds were evident in six (33.3%) of the sea lions and one (6.2%) of the harbor seal carcasses. An additional six (33.3%) sea lion carcasses bore suspected gunshot wounds, but no bullets or slugs were recovered. Four harbor porpoise carcasses bore net marks around the flukes, flippers, or dorsal fin indicating entanglement and probable drowning as their cause of death. One sea otter had a fractured skull which probably resulted from a human-induced blow to the head. Three of the harbor seals were emaciated pups that had likely starved after abandonment by their mother.

Although beachcast carcasses were distributed throughout the study area, the majority were recovered from beaches in the western portion of the study

TABLE 20

Weekly summary of beachcast carcass surveys
conducted on the Copper River Delta 13 May-25 September, 1990.

Week	Date	Number of carcasses found[a] No. (r)	SL	HS	SO	HP	Location[b] SB	E	CS	G	K	EK	S	LS
20	5-13	pre-season survey to locate existing carcasses												
20	5-16	1	1	0	0	0	0	1	0	0	0	0	0	0
21	5-22	2	2	0	0	0	0	2	0	0	0	0	0	0
22	5-30	5 (1)	2	2	(1)	1	1	1	1	3	0	0	0	0
23	6-08	5 (10)	4(1)	(3)	0	1(6)	3	9	0	1	1	0	1	0
24	6-14	2	1	1	0	0	0	1	0	0	0	0	0	1
25	6-20	3	2	1	0	0	2	1	0	0	0	0	0	0
26	6-28	1	1	0	0	0	1	0	0	0	0	0	0	0
27	7-07	4	2	1	1	0	2	0	0	2	0	0	0	0
28	7-12	0	0	0	0	0	0	0	0	0	0	0	0	0
29	7-22	3	0	2	0	1	0	1	0	0	1	0	1	0
30	7-26	0	0	0	0	0	0	0	0	0	0	0	0	0
31	7-31	3	2	0	0	1	0	0	0	0	0	0	1	2
32	8-05	2	0	0	0	2	0	1	1	0	0	0	0	0
32	8-09	2	0	1	1	0	1	1	0	0	0	0	0	0
33	8-16	2 (2)	0	1(1)	0	1(1)	1	2	0	0	0	1	0	0
35	8-28	4	0	1	3	0	3	1	0	0	0	0	0	0
36	9-05	4 (1)	0	1	2(1)	1	3	2	0	0	0	0	0	0
39	9-25	(1)	0	(1)	0	0	0	0	0	0	0	1	0	0
	Total	43 (15)	17(1)	11(5)	7(2)	8(7)								

[a] No. of carcasses examined. (r)= carcasses observed but not examined. SL= Steller sea lion, HS= harbor seal, SO= sea otter, HP= harbor porpoise

[b] SB= Strawberry Beach, E= Egg I., CS= Copper Sands, G= Grass, K= Kokinhenik, EK= East Kokinhenik, S= Softuk, LS= Little Softuk (see Figure 9)

TABLE 21

Condition, location, and apparent cause of death of species found during surveys for beachcast carcasses on the Copper River Delta, 16 May-25 Sept 1990.

MARINE MAMMAL CARCASSES

Date	Spec No.	Sex	Aprx Age	Total Length	Apparent[a] COD	Location[b] Is.	Lat.	Long.	Condition
STELLER SEA LION									
5-16	SL90-001	F	Imm	165cm	def GS	E	60°20.4'	145°45.0'	fresh, scavenged
5-22	SL90-002	F	Ad(pg)	216	sus GS	E	60°21.8'	145°50.8'	nearterm fetus
5-22	SL90-003	M	Ad	295	sus GS	E	60°22.2'	145°52.9'	fresh
5-30	SL90-004	M	Ad	297	def GS	G	60°13.5'	145°16.5'	223cal rifle
5-30	SL90-005	F	Sub	203	def GS	G	60°15.8'	145°22.8'	chest wounds (3)
6-08	SL90-006	M	Ad	-	def GS	SB	60°20.7'	146°12.0'	mortally wounded-alive
6-08	SL90-007	U	Sub	-	U	SB	60°22.3'	146°10.4'	scavenged, skel. only
6-08	SL90-008	F	Ad	222	sus GS	SB	60°22.6'	146°09.1'	head, neck wound
6-08	SL90-009	M	Sub	151	def GS	E	60°21.6'	145°50.6'	buckshot recovered
6-08	SL90-010	F	-	-	U	S	60°12.8'	144°49.0'	could not land to exam
6-14	SL90-011	M	Sub	180	def GS	LS	60°12.9'	144°43.3'	enforcement obs shots
6-20	SL90-012	F	Sub	163	U	SB	60°20.3'	146°18.3'	badly decomposed
6-20	SL90-013	M	Ad	-	U	SB	60°21.3'	146°11.2'	alive,sick or injured
6-28	SL90-014	F	Sub	163	sus GS	SB	60°22.2'	146°10.5'	fresh,internal damage
7-07	SL90-015	M	Ad	283	sus GS	SB	60°20.5'	146°19.0'	partially decomposed
7-07	SL90-016	M	Sub	203	U	G	60°16.1'	145°23.6'	badly decomposed
7-31	SL90-017	M	Ad	277	sus GS	LS	60°11.4'	144°37.2'	fresh, head wound
7-31	SL90-018	M	Ad	273	U	LS	60°13.0'	144°42.8'	badly decomposed

(continued...)

TABLE 21 (continued)

Date	Spec No.	Sex	Aprx Age	Total Length	Apparent[a] COD	Is.	Location[b] Lat.	Long.	Condition
SEA OTTER									
5-30	SO90-001	U	-	-	U	E	60°23.3'	145°57.2'	could not land to exam
7-07	SO90-002	M	Ad	134cm	U	SB	60°24.3'	146°05.0'	no head injury
8-09	SO90-003	M	Sub	109	U	E	60°22.6'	145°54.0'	badly decomposed
8-28	SO90-004	M	Sub	112	FS	SB	60°23.4'	146°05.0'	fractured skull
8-28	SO90-005	M	Pup	84	U	SB	60°23.5'	146°04.8'	fresh, no head injury
8-28	SO90-006	M	Ad	122	U	SB	60°24.0'	146°05.2'	fresh, no head injury
9-05	SO90-007	F	Pup	107	U	E	60°22.0'	145°43.9'	badly decomposed
9-05	SO90-008	U	Pup	-	U	E	60°22.3'	145°44.3'	could not land to exam
9-05	SO90-009	U	Pup	-	U	SB	60°23.3'	146°05.0'	skeleton only, bear-scavenged
HARBOR SEAL									
5-30	HS90-001	F	Pup	72cm	N	G	60°13.7'	145°17.0'	emaciated, abandoned
5-30	HS90-002	U	Pup	-	N	CS	60°19.1'	145°35.1'	emaciated, abandoned
6-08	HS90-003	U	-	-	U	E	60°20.3'	145°44.8'	could not land to exam
6-08	HS90-004	U	Sub	-	U	G	60°15.2'	145°21.0'	could not land to exam
6-08	HS90-005	U	Pup	-	N	K	60°13.3'	145°09.5'	emaciated, abandoned
6-14	HS90-006	U	Sub	-	U	SB	60°23.6'	146°00.5'	could not land
6-20	HS90-007	U	Pup	-	U	G	60°14.3'	145°18.9'	scavenged
7-07	HS90-008	M	Pup	-	U	G	60°13.8'	145°18.9'	hide/skeletal remains
7-22	HS90-009	M	Pup	-	U	EK	60°13.9'	145°11.8'	badly decomposed
7-22	HS90-010	U	Pup	-	U	E	60°21.8'	145°50.6'	decomposed, headless
8-09	HS90-011	M	Ad	127	U	SB	60°20.3'	146°18.0'	decomposed, head intact
8-16	HS90-012	U	Pup	-	U	SB	60°24.3'	146°05.6'	could not land to exam
8-16	HS90-013	M	Sub	122	def GS	EK	60°12.5'	144°57.7'	shattered skull
8-28	HS90-014	F	Ad	150	U	E	60°21.7'	145°49.5'	metal detector= 0
9-05	HS90-015	F	Ad	151	U	SB	60°23.4'	146°04.8'	floating in surf
9-05	HS90-016	U	-	-	U	EK	60°12.6'	144°55.2'	could not land to exam

(continued...)

TABLE 21 (continued)

Date	Spec No.	Sex	Aprx Age	Total Length	Apparent[a] COD	Is.	Location[b] Lat.	Long.	Condition
HARBOR PORPOISE									
5-30	HP90-001	M	Ad	147cm	PD	SB	60°20.2	146°18.5'	fresh, netmarks
6-08	HP90-002	U	Ad	160	U	E	60°22.7'	145°54.5'	skeleton w/flukes
6-08	HP90-003	U	U	-	U	E	60°22.2'	145°52.2'	} Could not land; all within 500m of next; all only skeletal remains
6-08	HP90-004	U	U	-	U	E	60°21.7'	145°49.2'	
6-08	HP90-005	U	U	-	U	E	60°21.6'	145°49.0'	
6-08	HP90-006	U	U	-	U	E	60°21.4'	145°48.8'	
6-08	HP90-007	U	U	-	U	E	60°21.2'	145°48.4'	
6-08	HP90-008	U	U	-	U	E	60°21.0'	145°48.0'	
7-22	HP90-009	U	U	-	U	S	60°13.2'	144°52.2'	skeletal remains only
7-31	HP90-010	M	U	-	U	S	60°12.7'	144°47.0'	skeleton, penis only
8-05	HP90-011	M	Ad	154	PD	CS	60°19.1'	145°35.1'	netmarks
8-05	HP90-012	M	Ad	132	PD	E	60°21.5'	145°48.5'	netmarks
8-16	HP90-013	M	Ad	180	PD	E	60°21.9'	145°51.0'	netmarks on flukes
8-16	HP90-014	U	Ad	-	U	E	60°21.0'	145°48.0'	could not land to exam
9-05	HP90-015	M	Ad	163	U	SB	60°23.0'	146°05.9'	scavenged by bear

a COD= Cause of death: GS= gunshot (definite, suspected), N= natural, SF= skull fracture; PD= probably drowned, U= unknown

b SB= Strawberry Beach, E= Egg Island, CS= Copper Sands, G= Grass Island, K= Kokinhenik Island, EK= East Kokinhenik Island, S= Softuk, LS= Little Softuk (see Figure 9)

TABLE 22

Summary of marine mammal carcasses found or examined during 18 weekly aerial surveys of barrier islands of the Copper River Delta, 16 May-25 Sept 1990.

Animal[a]		Sex[b]			Estimated Age Class[c]				Cause of death[d]					
Species	No.(r)	M	F (pg)	U	Y	S	A	U	U	dGS	sGS	D	F	N
SL	17 (1)	10	7 (1)	1	0	3M, 4F, 1U	7M, 2F	0	6	6	6	0	0	0
HS	11 (5)	5	1	3	2M, 1F, 5U	1M, 2U	2M, 1F	2U	12	1	0	0	0	3
SO	7 (2)	5	1	3	1M, 1F, 2U	3M	1M	1U	8	0	0	0	1	0
HP	8 (7)	6	0	9	0	0	5M, 2U	1M, 7U	11	0	0	4	0	0
Total	43 (15) = 58													

a No.= number necropsied, (r)= number observed but not examined; Species: SL= Steller sea lion, HS= harbor seal, SO= sea otter, HP= harbor porpoise

b M= male, F= female, U= undetermined; (pg)= number of pregnant females

c Y= young of the year, S= subadult, A= adult, U= undetermined

d U= undetermined, dGS= definite gunshot, sGS= suspected gunshot, D= drowned, F= fractured skull, N= natural, including abandonment

area (Figure 6). Distribution of carcasses in the area is likely both a function of the mammals' distribution and the effect of nearshore drift on carcass deposition. Although sea lions, seals, and porpoises are common throughout the area, sea otter densities are greatest west of Copper Sands. The distribution of beachcast carcasses observed in 1990 is compared to 1988 and 1989 reports (Wynne 1990) (Figure 6).

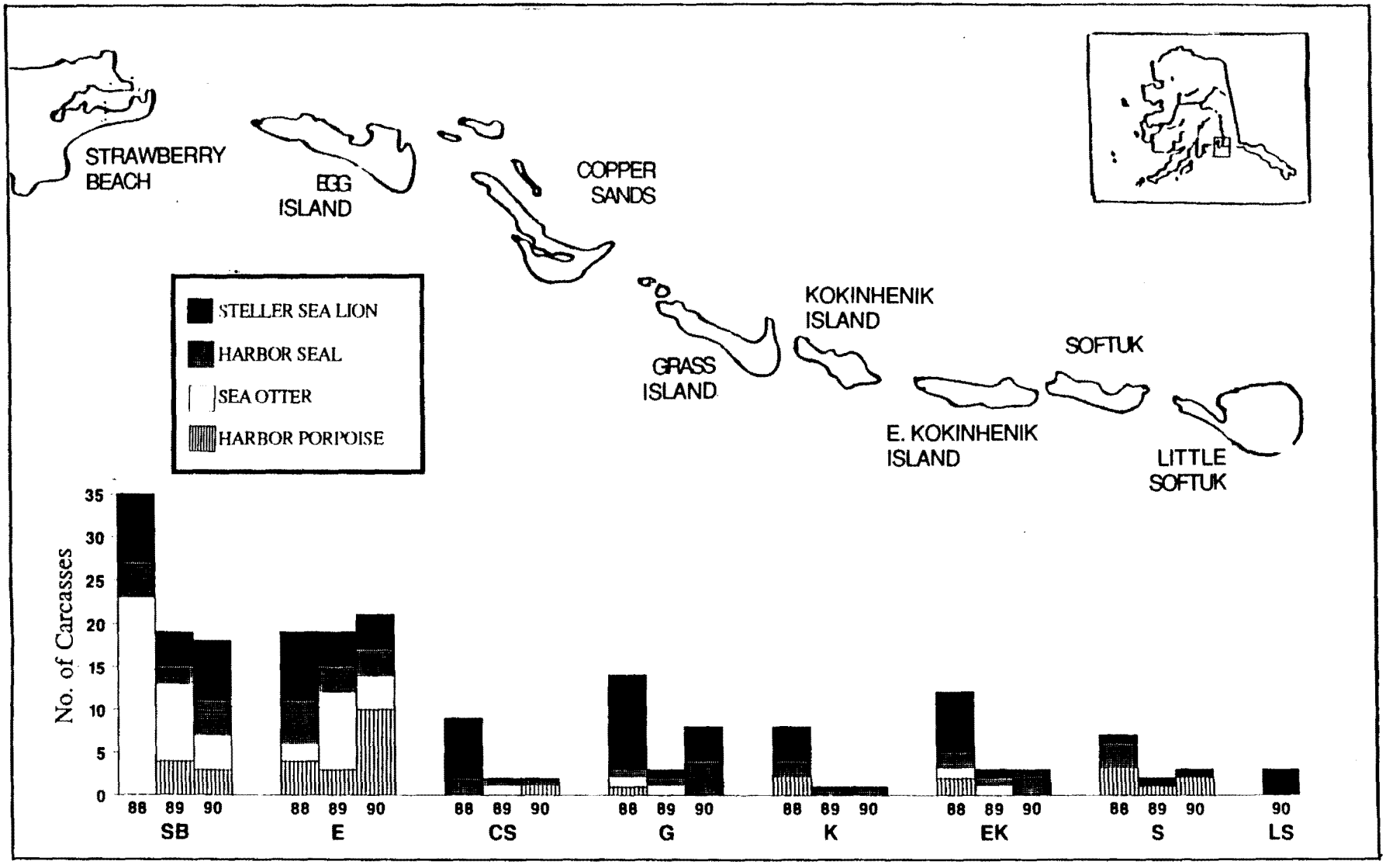

Figure 6. Frequency and distribution of marine mammal carcasses observed or necropsied during aerial surveys of beaches on the Copper River Delta, May to September, 1988-1990 (1988 total= 100, 1989 total= 50, 1990 total= 58) (adapted from Wynne, 1990).

IV. DISCUSSION

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OBSERVER COVERAGE

The design and implementation of viable observer programs in these fisheries presented numerous statistical, operational, and logistical challenges. As expected, the team encountered significant difficulty in deploying observers to dispersed fleets of small vessels with unpredictable, dangerous, and variable fishing patterns. Determining the level of observer coverage requires interpretation because fleet effort in these fisheries is not directly monitored by ADF&G and has to be estimated. These operational and interpretational factors contributed to the relatively low observer coverage reported in these fisheries. Although difficult to quantify, these factors should be considered when evaluating the overall observer coverage in these fisheries.

Operational Considerations - Observer Deployment

1. Safety. Safety concerns over weather conditions and vessel size affected observer deployment in both the Prince William Sound and South Unimak driftnet fisheries. Fishing in these areas in small vessels is notoriously dangerous due to extensive breakers, shoals, and rough weather and seas (Figure 7). Two PWS vessels boarded by observers in 1990 capsized by the season's end, resulting in the death of one captain and near death of the other. In response to these safety concerns, Saltwater Inc. did not deploy observers when Small Craft Advisories (winds greater than 25mph) were posted with a deteriorating forecast. This deployment limitation resulted in the loss of approximately 538 of 1737 (31%) potential observer days in the PWS and 45 of 153 (29.4%) potential observer days in the SU driftnet fisheries (Figure 8).

2. Vessel Size. Although the majority of the fleet cooperated with the program, observers were frequently denied boarding on fishing vessels due to vessel size. The primary reasons for boarding denials were lack of living and bunk space, lack of privacy, and safety or insurance concerns. Many of the smaller vessels in the fleet have only one bunk and approximately nine square meters of living space. Non-weather denials accounted for the loss of approximately 21 of 1737 (1.2%) potential observer days in PWS. This loss may

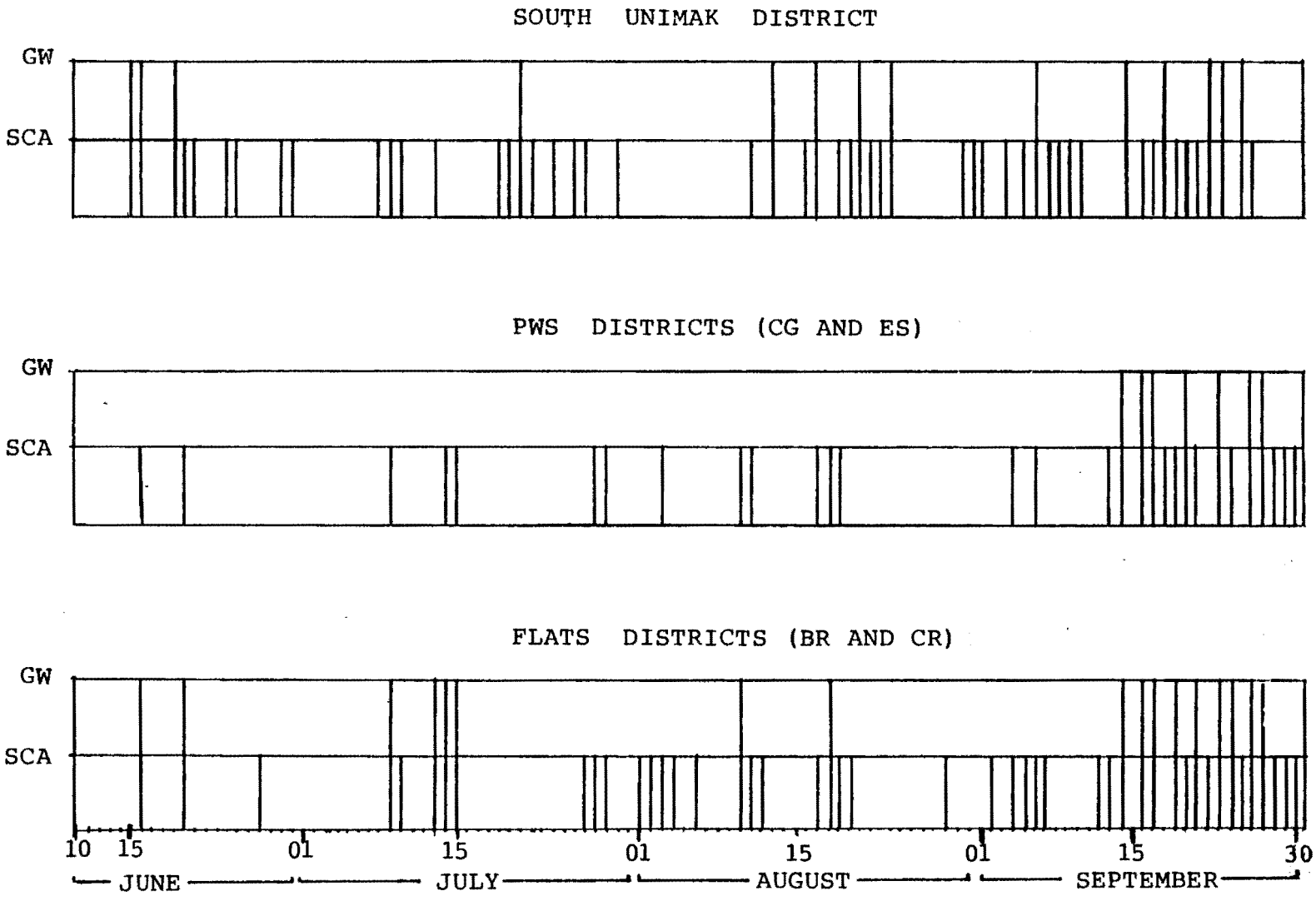

Figure 7. Daily summary of Small Craft Advisories (SCA) and Gale Warnings (GW) that were posted in the SU and PWS districts during the 1990 observer season (SCA= wind speeds 25-38mph or 40-61kph, GW= wind speeds 39-54mph or 63-87kph).

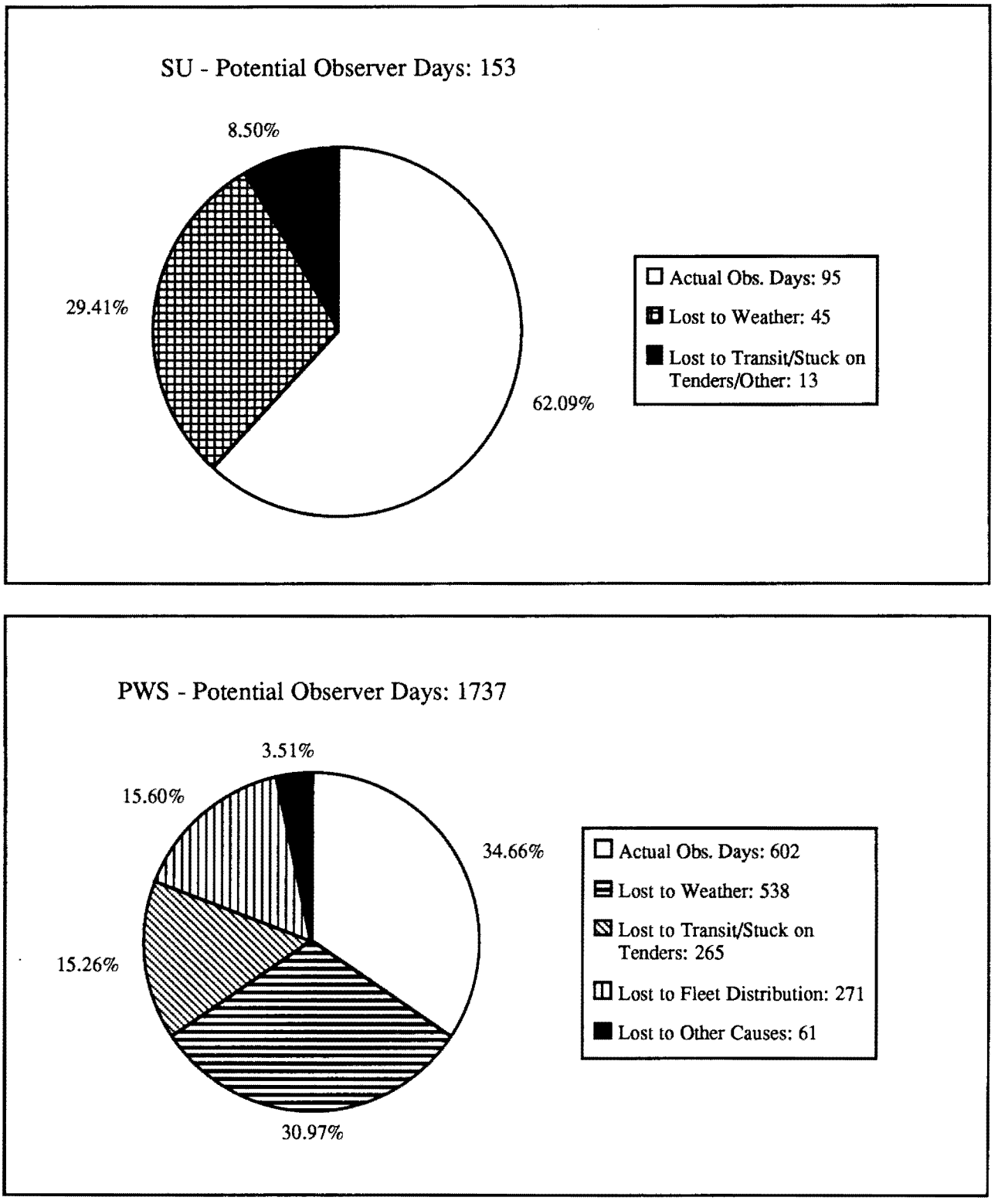

Figure 8. Relative success and sources of loss of potential observer days in the SU and PWS gillnet fishery observer programs, 1990.

be minimized in the future by limiting the time an observer is aboard and providing the observer with independent transportation and housing.

3. Dependence on Fleet Vessels. Observer dependence on fishing and tender vessels for shelter and transport proved a limiting factor. Observers were often stuck on tenders due to unpredictable fishing vessel delivery schedules. In addition, cooperative captains with larger vessels were overburdened by observer coverage while others were undersampled. Because the majority of observer transport and coverage was from fishing vessels, the sample distribution could not be prearranged or closely controlled. Approximately 265 of 1737 (15.3%) and 13 of 153 (8.5%) potential observer days were lost in PWS and SU, respectively, while observers were stranded on tender vessels or en route to the fishing grounds. Shuttling of observers to the grounds and between vessels by project vessels could reduce these losses in the future.

4. Unpredictable Fishing Schedules. The variability in fleet effort and distribution in these fisheries decreased the efficiency of observer deployments. Low fishing success resulted in fewer fishing vessel deliveries to tenders (which reduced the opportunity to board from tender vessels). Fishing success also resulted in unpredictable shifts in fishing vessel distribution throughout the fishing areas. Vessels often moved significant distances (up to 150 miles (241km) from Flats to PWS districts) spontaneously, reducing their willingness to accept an observer and complicating observer deployment strategies. In addition, the timing and duration of fishing openings varied between PWS districts which resulted in unavoidable "downtime" for observers assigned to short openings on the Flats while the PWS districts were open continuously. Observers committed to deployment in one area could not easily be "reallocated" in response to fleet redistribution. This contributed to the differential observer coverage between the Flats and other PWS districts. Approximately 271 of 1737 (15.6%) potential observer days were lost for these reasons. Decreased dependence on fishing vessels for observer deployment could reduce this inefficiency in the future.

5. Fleet Distribution. The opportunistic nature of observer deployment in 1990 made it difficult to correlate observer distribution with fleet distribution. Fleet distribution is a nebulous function of many unpredictable variables including weather, run strength, market values, ADF&G time/area closures,

fishermen's personal preferences and fishing success. Fleet distribution is difficult to predict and constantly changing. In 1990 the project's ability to adjust observer distribution to fleet distribution was limited since observers were placed on fishing vessels opportunistically. In addition, the lag time of over two weeks between an actual fishing period and the ADF&G preliminary estimate of fishing effort for that period, made real-time determination of observer coverage impossible. Future observer deployment efforts would benefit from real-time aerial assessment of vessel distribution throughout the districts.

Interpretational Considerations - Coverage Assessment

Observer coverage represents a percentage of fishing effort or operations, defined here in terms of "sets." Because no direct measure of fleet effort is recorded in these fisheries, the team derived estimates of fleet effort using ADF&G landings data. Conversion from landings data to effort estimates introduced a number of biases which tended to overestimate fleet effort and consequently reduce relative observer coverage. Although it is difficult to quantify the effects these biases have on coverage, it is important to acknowledge them and their potential effect on coverage assessment.

1. Catch vs Effort. ADF&G monitors the salmon harvest through landing records. These records indicate how many fishermen harvested fish, where, and when they were sold. They do not accurately indicate how long, where, or when the fishermen fished. Lacking better data, the team assumed that all fishermen landing fish in a district had fished there for the entire day in which they landed their catch. To estimate total fishing effort the team multiplied the number of vessels landing salmon in each district by the maximum available fishing hours in each district.

The team recognizes this as an inflated but unavoidable assumption that results in overestimation of fishing effort. For instance, Russian Orthodox fishermen do not fish on Sundays but may deliver fish on Sundays, which inflates estimates of Sundays' effort (Table 23). In addition, individual fishermen often land salmon in more than one district in a day. Thus, the daily sum of vessels fishing in each PWS district exceeds the actual number of vessels fishing throughout Area E (Table 24). The team estimates effort as if each vessel that landed fish in a district had fished in that district full time. Thus, district-wide

TABLE 23

Sample discrepancies between daily reports of driftnet vessels landing salmon (ADF&G data) and the actual number of driftnet vessels (effort) observed during aerial surveys of the SU driftnet area in June, 1990.

Date	# FVs Landing Salmon (ADF&G Data)	Actual # FVs[a] (aerial count)	Discrepancy difference	Discrepancy % of actual	Comments
Sunday 6-17	112	67	45	67.2%	~30 Russian FV not fishing
6-18	129	95	34	35.8	
6-19	101	-	-		
6-20	107	-	-		
6-21	123	95	28	29.5	
6-22	125	-	-		
6-23	109	90	19	21.1	
Sunday 6-24	82	50	32	64	~30 Russian FV not fishing

[a] aerial counts of driftnet vessels (FVs) present made by helicopter and provided compliments of Peter Pan Seafood.

TABLE 24

Example of disparity between the daily sum of driftnetters landing salmon in each PWS district and the actual number of driftnetters fishing throughout Area E resulting from daily shifts in vessel distribution.

Sample Date	Number of Vessels Landing Salmon by district BR	CR	CG	ES	sum	Actual Area E total	Overestimate[a] diff.	% of actual
6-18	24	123	144	68	359	352	7	1.99%
6-25	4	93	263	47	407	402	5	1.24
7-02	0	90	132	61	283	280	3	1.07
8-13	0	145	108	8	261	242	19	7.85
8-22	23	171	109	8	311	304	7	2.30
9-07	59	233	53	0	345	339	6	1.77
9-13	33	139	45	0	217	212	5	2.36
9-19	9	16	11	0	36	36	0	0
Daily sample total					2,514	2,457	57	2.32%

[a] difference and % by which sum of individual district values exceeds the Area E total

calculations of effort (FV-Hours) overestimate total fleet effort and underestimate observer coverage by a variable degree each week. A sample comparison of daily landings between Area E and summed districts showed an overestimate of 0-7.9% of the actual number of vessels landing fish (Table 24). An overestimate of the number of vessels landing results in an overestimate of FV-Hours and, consequently, the estimated number of sets made in each district.

2. Available vs Actual Fishing Time. PWS setnets are capable of fishing continuously when deployed because the net remains set when fish are extracted and transported to tender vessels. Driftnets, however, are attached to driftnet vessels and are removed from the water when the vessels retrieve fish, transport catch to tenders, or are in transit. Consequently, no driftnetter fishes 100% of the time available to them. The percentage of available time that is actually fished is dependent on a number of variables including weather, run strength, area fished, personal preference, length of opening, amount of daylight, etc. (Table 2). To account for this variability and minimize associated bias, the team calculated effort estimates using the weekly mean number of sets made per (maximum) available hour recorded by observers aboard fishing vessels. This was then readily multiplied by maximum available hours of fishing in each district to estimate overall fishing effort.

INTERACTIONS

PWS Driftnet

Both sea lions and harbor seals were observed scavenging netted salmon from active driftnets. In addition, cetaceans and sea otters inadvertently encountered nets while in fishing areas. Approximately 2.6% of the marine mammals that were observed within 10m of active driftnets became entangled in the gear, and only half of those entangled died or were seriously injured (0.09% of observed sets). All marine mammal entanglements observed in the PWS driftnet fishery occurred on the Flats (Copper River and Bering River districts) (Figure 9). Historically, sea lion conflicts with the PWS driftnet fishery are most frequent during the May-June sockeye season on the Flats (Matkin and Fay 1980, Wynne 1990). The 1990 observer season was not initiated in the PWS driftnet fishery until late June, effectively missing the "sea lion season." While

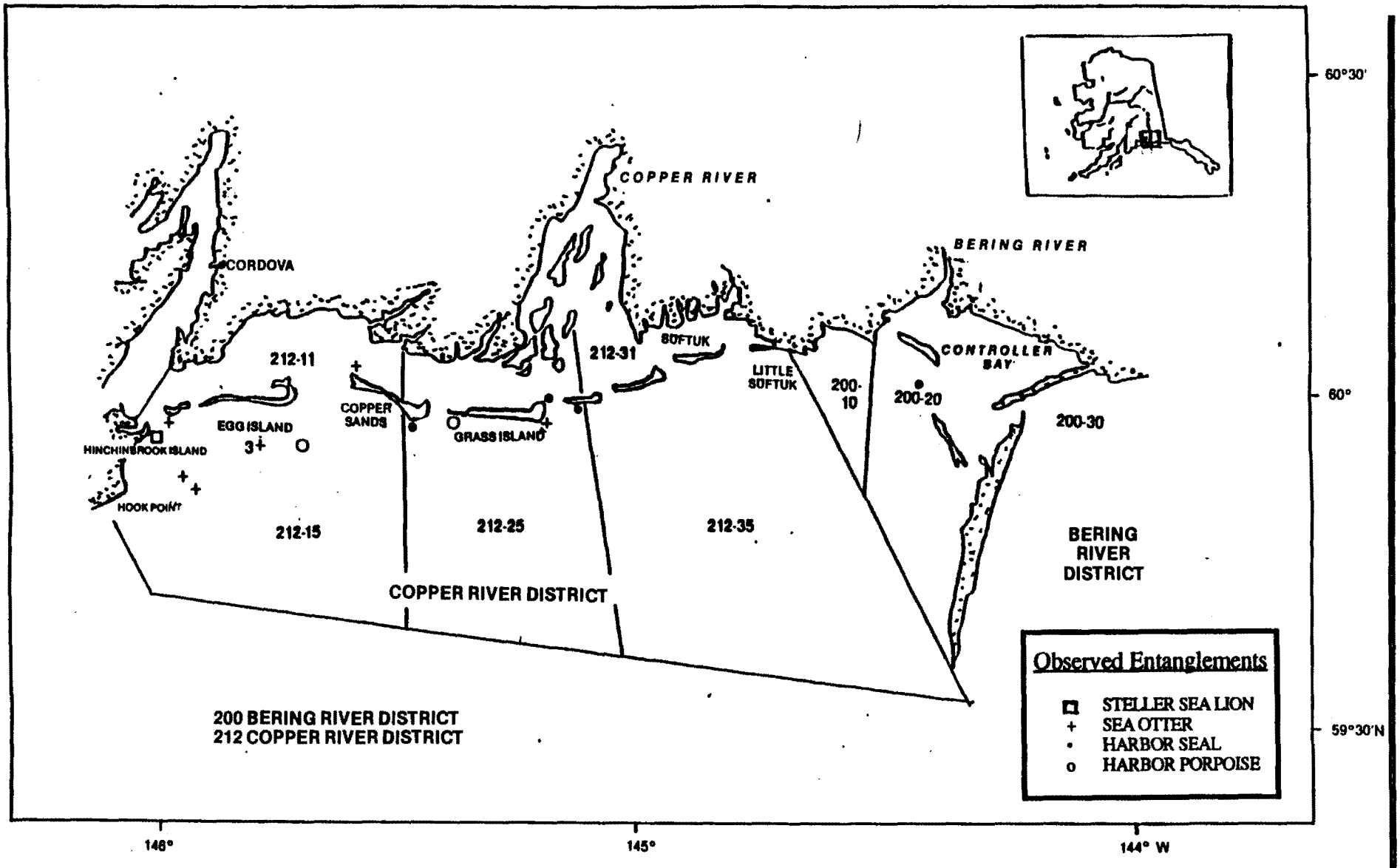

Figure 9. Location of the Copper River and Bering River districts and sites of marine mammal entanglements reported by MMPA observers in 1990.

not representative of total marine mammal interactions occurring in the fishery, observed July-September results are similar to previous findings (Matkin and Fay 1980, Wynne 1990). Although incidental sea lion mortality was minimal on the Flats in 1988 and 1989 (Wynne 1990), more net encounters, gear fish damage, and temporary entanglements of Steller sea lions could be expected in May and early June driftnet activities.

Two young harbor seals apparently entangled and drowned in the billowing mesh of nets set in shallow waters. Similar incidental mortality of inexperienced harbor seal pups was observed in 1988 (Wynne 1990). One of two entangled harbor porpoise was released alive from an observed salmon driftnet in 1990, an unusual event also documented in 1988 (Wynne 1990). Although incidental porpoise mortality is evident in this fishery, to our knowledge this is one of few gillnet fisheries where live-release of entangled porpoise has been documented. This is possibly due to the surface-hanging design of these nets which allows the animal to surface for air while entangled. Wynne (1990) witnessed the live-release of a harbor porpoise in 1988 which had continued to surface for at least 20 minutes while entangled in a driftnet.

Sea otter driftnet encounters are most frequent in the western portion of the Copper River district where large aggregations of sea otters (primarily female:pup pairs) commonly occur behind Egg Island (Simon-Jackson 1986, Wynne 1989). The majority (76.3%) were observed to detect and actively avoid contact with driftnets encountered. Eight sea otter entanglements were observed in 1990 but all were able to untangle themselves or were released alive by fishermen. Three otters were ensnared in a single set, suggesting sea otter entanglement is not uniform but "contagious," as previously reported by Wynne (1989). The beachcast sea otter carcass found with a fractured skull was likely injured during release from a net by a fisherman who attempted to stun the animal prior to release (a technique reported in 1988 and 1989 to Wynne [1990]). Further education of the fleet regarding proper otter release techniques may help reduce the frequency of inadvertent mortality.

Although sea otter interactions observed in the Egg Island area from 1988 to 1990 involved primarily females and pups, only one of the seven beachcast otters of known sex was female. This pattern was also seen in 1988 and 1989 (Wynne 1990), and suggests non-driftnet mortality of sea otters occurs in this

area. This is supported by four beachcast sea otter carcasses collected in the study area in 1989 and necropsied by U.S. Fish and Wildlife Service pathologists which exhibited signs of gastric enteritis, a non-specific terminal symptom common in emaciated otters. The frequency of sea otter driftnet encounters may increase as the otter population continues to expand eastward into the fishing area, but the incidental mortality rate is not expected to change.

The distribution of beachcast carcasses in 1990 did not differ appreciably from that documented in 1989 (Wynne 1990) (Figure 6). The total and number of each species found in 1990 fell between counts made in 1988 (higher) and 1989 (lower), with the exception of sea otter counts which were appreciably lower in 1990 than previous years.

Past studies of marine mammal/fishery interactions in the PWS driftnet fishery have shown that interactions are not evenly distributed but exhibit species-specific spatial and temporal patterns (Matkin and Fay 1980, Wynne 1990). The frequency of interaction varies between districts throughout the season in response to the presence and relative abundance of marine mammals in the fishing area. Realistic extrapolation of fishery-wide take rates, therefore, should incorporate knowledge of these patterns into the analysis of observed take rates. The project team acknowledged these patterns in the incidental take assessment by deriving weekly take rate estimates for each PWS district based on observed take and local fishing effort. The observed rates are only applied to fishing effort in the districts where the take was observed, and are then summed across the fishery. This reduces overestimation of take throughout Area E. The breadth of the 95% confidence range on mortality estimates demonstrates the difficulties associated with accurately extrapolating incidental take rates when the observed frequency of occurrence is low.

The 1990 observer sample suggests that marine mammal encounters are common events (>18% of observed sets) in the PWS driftnet fishery, but that incidental mortality is infrequent (<0.1% of observed sets). "Frequent" incidental take is defined by Congress as "highly likely that more than one marine mammal will be incidentally taken (entangled, seriously injured, or killed) by a randomly selected vessel in the fishery during a 20-day period" (U.S. Senate Rept 100-592, 1988). Considering each day an observer monitored a fishing vessel as one FV-Day, incidental marine mammal entanglement, injury, or death was

observed during 15 of 726 FV-Days throughout all PWS districts. This overall PWS average frequency of incidental take (1:48.4 FV-Days) is less than the 1:20 FV-Day rate used by Congress to define "frequent" take. Although the level of incidental take in the PWS fisheries was low in 1990, re-evaluation of this fishery's Category I status would be premature since the first six weeks of the 1990 season were not monitored.

PWS Setnet

Although marine mammals occur in the PWS setnet districts and the observed rate of net encounters in 1990 was comparable to that for the monitored driftnet fisheries, no incidental marine mammal entanglements, injuries, or deaths were observed in the 1990 setnet fishery. The 1990 observer data suggests this fishery experiences infrequent incidental take, and should be considered for re-classification to Category II.

SU Driftnet

Most marine mammal interactions with SU driftnets involved pinnipeds and occurred in the waters surrounding the Ikatan Peninsula (Figure 4). Northern fur seals were the most frequently encountered and entangled marine mammal. Both Northern fur seals and Steller sea lions were observed scavenging salmon from driftnets and were incidentally entangled as a result. Fishermen attempted to defend their gear and catch by throwing "seal bombs" and physically chasing mammals from the net ("running gear").

Cetaceans encountered SU driftnets incidentally and were not apparently attracted to the gear. Most SU driftnets are set in relatively deep, offshore waters and may occupy waters frequented by migrating gray whales (*Eschrichtius robustus*) and other large cetaceans. Although Dall's porpoise are common in the area, it is unclear whether the animals' affinity for bowriding contributed to the observed entanglement in a SU driftnet.

The observer data suggests that incidental marine mammal mortality in the SU driftnet fishery is infrequent. Only one incidental death was observed during 87 observed FV-Days. If momentary entanglements (2 of 5 observed entanglements) are included, however, the rate of incidental entanglement, injury,

or death observed in SU driftnets is 1:17.4 FV-Days. This rate exceeds Congressional standards for "frequent" take and qualifies this fishery for Category I status.

NOAA fisheries considers all definitions of "take" when categorizing fisheries [FR 54(96):21915]. If the original MMPA definition of incidental take (which includes harassment as well as entanglement, injury, and death) is used to categorize fisheries, both the PWS and SU driftnet fisheries would qualify for Category I status. Observers documented harassment, entanglement, injury, or death in an average of 1:3.5 FV-Days observed in each fishery in 1990.

The vast majority (84%) of harassment observed in these fisheries in 1990, however, involved non-lethal deterrents (seal bombs and running gear). Therefore, inclusion of harassment in "take" estimates for these fisheries may exceed Congressional intent (U.S. Senate Rept 100-592, 1988) and the immediate goal of the MMPA as amended "to reduce the incidental kill or serious injury of marine mammals in the course of commercial fishing operations to insignificant levels approaching a zero mortality and serious injury rate" [FR 54(96):21915]. The use of non-lethal deterrents by commercial fishermen experiencing gear and catch damage complies with this MMPA goal. If included in incidental take assessments, frequent non-lethal harassment would overstate the probability of serious injury or death in these fisheries.

Marine Birds

Marine birds encountered fewer than 5% of the observed sets and entangled in fewer than 2% of the observed sets in the SU and PWS driftnet fisheries. Although the entanglement rate was low, most birds that entangled drowned. Fishermen informally reported that the abundance of marbled murrelets in the Copper River district and the number of net entanglements was far higher than normal. This is supported by 1988 and 1989 observations (Wynne, unpublished data) of no marine bird entanglements in 387 sets observed on the Flats. Future monitoring of Copper River and Bering River driftnets would facilitate documentation of differences in incidental bird take between years. The distribution of marine birds and incidental take is clumped. One Copper River set was responsible for 6 of the 28 marbled murrelet deaths and both of the Kittlitz murrelet (*Brachyramphus brevirostris*) deaths. Although

some species were observed scavenging netted salmon, most marine birds apparently encountered nets inadvertently while in the area. The majority of bird species that entangled are not considered scavengers.

Beachcast Carcass Surveys

Surveys for beachcast carcasses provide a valuable supplement to observer data. These standardized, systematic surveys allow monitoring of unobserved intentional and incidental take, and can be used as an index to monitor mortality trends between years. Unfortunately, a number of variables and uncertainties preclude the use of these surveys to derive absolute estimates of fishery-related mortality. For example, the cause of death is often indeterminable due to advanced decomposition of the carcass, and carcass deposition patterns are not well enough understood to identify the carcass' origin. Despite these limitations carcass surveys provide valuable information on unobserved take and identify trends in mortality between years.

V. CONCLUSIONS/RECOMMENDATIONS

V. CONCLUSIONS/RECOMMENDATIONS

1. Marine mammal encounters with these three salmon gillnet fisheries is frequent (15.6% of observed sets) but rarely fatal (0.1% of observed sets).

2. The observer data suggests that incidental marine mammal take in the PWS setnet fishery is not "frequent" by Congressional standards, and the fisheries may be appropriately reclassified into Category II. Although incidental take in the PWS driftnet fishery appears not "frequent" based on 1990 observer data, more complete observer coverage of the fishing season is needed to assess the appropriateness of this fishery's Category I classification. The inclusion of momentary entanglements as incidental take contributed to a take rate that qualifies the SU driftnet fishery as a Category I fishery.

3. A second year of observation will be needed in the PWS driftnet fishery to document May and June sea lion interactions on the Flats, and to further monitor the incidental take of marine birds. Future PWS observer effort may be most effectively deployed on the Flats rather than in the PWS districts. All entanglements observed in 1990 and the majority of previously documented sea lion interactions occurred in the Copper River and Bering River districts.

4. It appears pinnipeds are attracted to gillnets where they scavenge netted salmon. Sea otters and cetaceans encounter nets inadvertently as they pass through a driftnet area. Marine mammal encounters with these salmon driftnets are frequent but rarely fatal. The majority of entangled mammals were able either to release themselves unharmed or to be released with fishermen's assistance. Large cetaceans and pinnipeds may tear through these nets undetained. Porpoises and small (young) pinnipeds may drown as a result of entanglement in salmon driftnets if unassisted. No entanglements were observed in PWS setnets.

5. Legal means of harassment were observed in these fisheries. Although apparently infrequent, lethal deterrence of Steller sea lions on the Flats was evident by examining beachcast gunshot carcasses. Weekly monitoring of the Copper River Delta barrier island beaches should be continued to

provide an index of overall marine mammal mortality and a minimal estimate of lethal intentional take levels in this fishery. More frequent surveys may improve the probability of finding fresh carcasses and determining the animals' cause of death.

6. In 1990, the project depended on active fishing vessels and processing tender vessels for observer coverage and transportation. Although most of the fleet was cooperative, this dependence limited observer coverage. Observer coverage may be increased in the future by contracting research vessels to transport and house observers. This would allow greater control of observer distribution and coverage.

VI. ACKNOWLEDGEMENTS

VI. ACKNOWLEDGEMENTS

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VIII. APPENDIX - SAMPLE OBSERVER FORMS

Form 1 - Alaska Salmon Gillnet Data Summary

Gear and Set Data

FisheryCode	Obs.Code (Initials)	Date YY MM DD	WK #	Vessel Name	Exemption Number	Set #

Tide: S = slack, E = ebb, F = flood, M = mid, H = high, L = low

Seas: F = flat, S = swells, C = chop, R = rough

Wind: kn

Visibility: C = clear, O = overcast, P = pt. cloudy, R = rain, D = dusk/dawn, F = fog/haze

Net Depth (ft)

Mesh Size(ins)

Position:

District		Latitude	Longitude
Number Code	Initials	Degs Mins.	Degs Mins.

Max Distance to Shore (Meters)

Avg. Depth (Fathoms)

Fishing Area: S = surf, C = channel, N = nearshore, O = offshore, F = fiord

Platform: F = fishing vessel, R = research vessel, T = tender, O = other

Observed Other Vessel? Y, N

Complete Set Obs.?	Set Time:	Drift Net		HH:MM
Y, N	Soak Total	+ Haul Total	=	Total Time
	Obs Soak	+ Obs Haul	=	Obs Total

Observation Time: **Set Net**

Begin Obs.	to	End Obs.	=	Total Obs. HH:MM	Tended? Y, N

All times use 24 hour clock

Fish Catch Data

Salmon:	Red	King	Pink	Chum	Silver	Bycatch Dead	Bycatch Alive
Total # Caught							
# Damaged by MM							

Marine Mammal / Bird Encounter Data

Animal Name and Characteristics							Net Encounter <10 m from net			Intentional Harassment/Take		Loss Due to Mammal	
Species	Code	#	Photo y,n	Sex m,f,u	Age a,s,p,u	Length Est. (ft) Bill Length (mm)	Entan-gled? Y, N	If Y Cond. D, A, U	If N Behavior M, A	Cond. H, I, K	Method Used G, R, S, O, C	Fish Damage Y, N	Gear Damage Y, N

Comments (Continue on back):

Form 2 – Alaska Salmon Gillnet Data Summary

Observing From Other Vessel

Fishery Code	Obs. Code (Initials)	Date YY MM DD	WK #

Tide: S = slack, E = ebb, F = flood; M = mid, H = high, L = low

Seas: F = flat, S = swells, C = chop, R = rough

Wind: kn

Visibility: C = clear, O = overcast, P = pt. cloudy, R = rain, D = dusk/dawn, F = fog/haze

Platform: F = fishing vessel, R = research vessel, T = tender, O = other

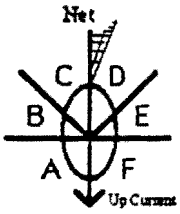
Position:

District Number Code	Initials

Latitude	Longitude
Degs Mins.	Degs Mins.

Distance to Shore	Avg. Depth
Meters	Fathoms

Fishing Area: S = surf, C = channel, N = nearshore, O = offshore, F = fiord



Relative Position to Net

Vessel Identification and Observation Effort Data

Vessel	Relative Pos. A–F	Vessel Name	Exemption Number	Time Begin Obs.	Time End Obs.	Observed Soak Time (total mins)	Observed Haul Time (total mins)
Vessel 1							
Vessel 2							
Vessel 3							

Marine Mammal / Bird Encounter Data

Mammal / Bird Observation	Vessel 1				Vessel 2				Vessel 3			
	Species 1	Number	Species 2	Number	Species 1	Number	Species 2	Number	Species 1	Number	Species 2	Number
<10m – Not Entangled												
Released												
Drowned												
Harassed												
Injured												
Killed												
Fisherman Response	Method 1		Method 2		Method 1		Method 2		Method 1		Method 2	
Method(s) Used												
Effective? (Y, N)												

Comments (Use back if necessary):

** Record all hours in tenths **

Form 4 - Time and Sets

Week#

Observer:

Date	Vessel Name	Time Opener/ Board	Time Depart	Dist.	A Prior to boarding (day boarded) #hr fish	A # sets	B Observed #hr fish	B # sets	C Unobserved #hr fish	C # sets	T Total avail fish time	Obs # salmon landed	Incidental Deaths Mammals Code	Mammals #	Birds Code	Birds #

	Dist.	A		B		C		T	# Salmon	incidental deaths mm	#	bird	#
Weekly Total (sum) by District													
1													
2													
3													

Comments

Form 5 - Weekly Summary of Fishing and Observer Effort by District

Wk#

Dist.	From Form 4 Sum of A+B+C #Hr Fish	# Sets	Total T Avail Hr	F/V Effort Modifiers %T fish	avg. sets/hr	Observer Effort #FV	#HR	#Sets	#fish	Indidental Deaths Marine mammals SP	#	#/set	Marine Birds SP	#	#/set
BR															
CR															
CG															
ES															
UN															
SU															

Dist.	ADFG Statistics # Salmon Landed	Max. # Hr	Max. # FV	Max. #FV-Hr	Estim Actual F/V Effort #FV-Hr	est. # Sets	% Sets Observed	Indidental Deaths Marine mammals SP	Obs. #/Set	Extrap #/Dist	Marine Birds SP	Obs. #/Set	Extrap #/Dist
BR													
CR													
CG													
ES													
UN													
SU													