PROGRESS REPORT ON DALL'S PORPOISE RESEARCH, 1980

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MARINE MAMMAL RESEARCH ACTIVITIES, 1980

The studies of the incidental take of marine mammals in the gillnets of the Japanese high seas salmon mothership fishery were initiated during the 1978 salmon fishing season. The objectives of the three year cooperative Japan-U.S. research program are to determine the effects of the incidental take by the salmon mothership fishery on marine mammals and to work to reduce or eliminate the incidental catch of marine mammals in the fishery. The project includes collection of marine mammal sighting data aboard Japanese salmon research vessels and U.S. Platforms of Opportunity Program vessels for determination of distribution, movements and abundance of Dall's porpoise; collection of biological samples and information from all incidentally taken Dall's porpoise (Phocoenoides dalli) returned to the Japanese salmon motherships; and cooperative studies of behavior and entanglement aboard a vessel chartered by the Fisheries Agency of Japan dedicated to Dall's porpoise research.

A. Research aboard Japanese salmon research vessels.

In 1980, U.S. marine mammal biologists conducted marine mammal sighting surveys aboard the dedicated research vessel, Hoyo Maru No. 81, 16 May to 23 June, and two Japanese salmon research vessels, the Oshuro Maru from 5 June to 14 August and the Hokushin Maru from 29 June to 29 July. These latter two cruises emphasized data collection in the Gulf of Alaska, and in the mothership salmon fishery area, respectively. During these cruises, data were also collected on marine mammal entanglements during salmon gillnet operations.

The total number of Dall's porpoise sightings during the three cruises was 592 consisting of 2,738 individuals. This includes sightings of all

Phocoenoides, including True's type and unidentified Phocoenoides spp.

During gillnet operations of the salmon research vessels, a total of 13 northern fur seals (Callorhinus ursinus) were incidentally taken in 5,272 tans, a catch rate of 2.4 seals per 1000 tan. Seven of the fur seals were alive and released; the remainder were dead and necropsied. Three Lissodelphis borealis and one Dall's porpoise were also incidentally taken during these gillnet operations.

Marine mammal sightings were also collected aboard U.S. Platforms of Opportunity Program vessels from October through March. During five cruises a total of 360 Dall's porpoise were sighted (53 sightings). In addition, there was one sighting of several thousand Dall's porpoise reported in March in Stephens Passage in southeast Alaska. This is the largest sighting of Dall's porpoise reported to date.

B. Research aboard Japanese Salmon Motherships

A marine mammal biologist was aboard each of the four Japanese salmon motherships to collect biological samples and data from all incidentally taken Dall's porpoise that were returned to the mothership by the catcherboats while operating inside the U.S. Fishery Conservation Zone (FCZ). In addition, 10-12 Dall's porpoise collected prior to 10 June, outside the FCZ, were frozen aboard each mothership for dissection by the U.S. marine mammal biologists after their arrival onboard.

When the mothership fleets moved out of the FCZ into the Bering Sea in July, biological samples and data were also collected from Dall's porpoise by Japanese nationals, following the procedures described and depicted in dissection manuals provided to them. Approximately 40 of these animals were frozen whole for dissection at the National Marine Mammal Laboratory (Seattle).

The skeletal material from these specimens will be used for studies of possible stock differences.

The time periods during which U.S. marine mammal biologists were on board each mothership were:

Jinyo Maru: 10 June - 8 July, and 19-30 July (41 days)

Kizan Maru: 9 June - 1 July, and 14-31 July (38 days)

Meiyo Maru: 9 - 29 June, and 9 - 30 July (41 days)

Nojima Maru: 9 June - 8 July, and 20-29 July (37 days)

Samples were collected from 929 Dall's porpoises, including 5 True's-type and 1 black variant, and 4 harbor porpoises. The samples are being analyzed to determine the life history parameters and food habits of Dall's porpoise.

A new research project was initiated aboard the salmon catcherboats this season. The marine mammal biologist aboard each mothership boarded the salmon catcherboats on four or five occasions to study entanglement of Dall's porpoise and the associated factors during the commercial operations. A total of 18 gillnet operations were observed on the following dates:

Mothership Fleet	Dates aboard catcherboats
Jinyo Maru:	23 June; 2, 5, and 25 July
Kizan Maru:	22, 28 June; 20, 24, and 27 July
Meiyo Maru:	21 June; 19, 21, 23, and 25 July
Nojima Maru:	16, 23 June; 1, and 23 July

The total number of Dall's porpoise entangled was 17, a catch rate of 0.94 porpoise per set. The number per set ranged from 0 (9 sets)

to 5 (1 set). The number reported by the remaining 36 catcherboats in the associated fleet during these 18 operations totaling 648 sets, was 89. The mean number of porpoise per gillnet set was 0.14. The daily range for the fleet for these sets was 0 to 14 porpoise. This incidental take rate is significantly lower than the rate observed by U.S. scientists aboard the 18 catcherboats ($t<.05$, 16 D.F.).

Figure 1 shows the position and incidental take for the 18 catcher-boat gillnet operations. The numbers above each location are, on the left, the number of Dall's porpoise incidentally taken by the catcherboat on which our biologist was aboard and, on the right, the number reported for the associated catcherboat fleet.

The total incidental take by the mothership fishery for the 1980 season was estimated using the observed rate of 0.94 porpoise per set. Assuming that 148 catcherboats fished inside the FCZ for 32 days (4,736 boat-days), the estimated incidental take would be 4,452 Dall's porpoise. The salmon motherships also fished approximately 20 days (2,960 boat-days), outside the FCZ in 1980; ten days in early June south of the FCZ and ten days in July in the Bering Sea. Assuming the same incidental take rate the estimated incidental take outside the FCZ would be 2,782. The total incidental take for the mothership fishery would thus be 7,234.

Applying a uniform rate of incidental take over the entire fishing area and season may not be an appropriate method for estimating the total incidental take for 1980. For example, the dedicated vessel made four sets with the Nojima Maru in the Bering Sea in 1979. One porpoise entangled, a rate of 0.25 per set compared to 0.94. Areal difference as well as differences in environmental conditions and fishing effort are

likely to have had some effect on the number of animals captured. It should also be noted that much less than 1% of the 1980 gillnet sets were observed by U.S. personnel, and this sample size may be inadequate to predict incidental take levels with certainty.

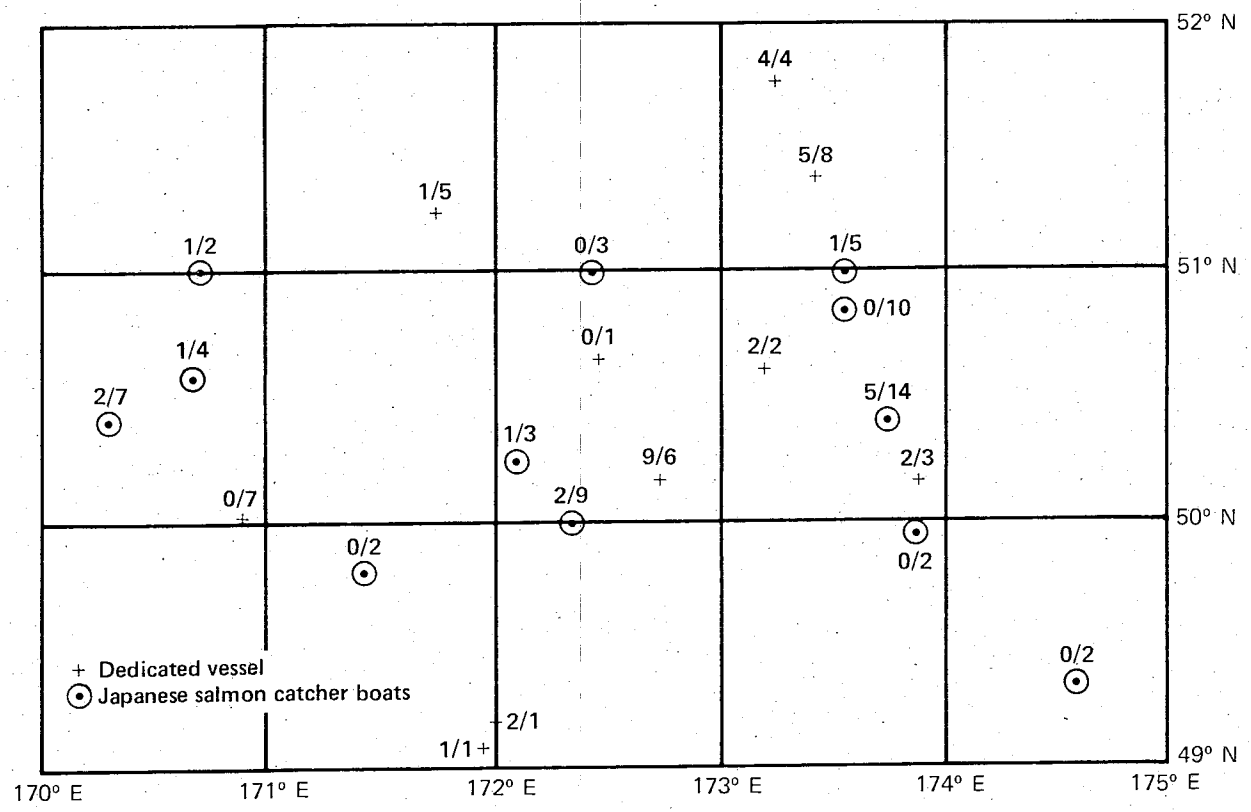
In addition, the selection of catcherboats for these studies was non-random. In seven of the eighteen cases (39%), the U.S. biologists selected catcherboats with the highest incidental take. This could have biased the estimate of the incidental take per set upwards. However, the rate observed aboard the dedicated research vessel (see below) was significantly higher than that observed aboard these catcherboats.

During each gillnet operation, data were collected on the gillnet location and set direction, wind and swell direction, weather conditions and marine mammal activities. Data on entanglements were recorded during retrieval. Preliminary examination of these data has revealed that these factors may not affect entanglement of Dall's porpoise.

C. Research aboard the Vessel Dedicated to Marine Mammal Research

U.S. scientists conducted studies aboard a vessel, the Hoyo Maru No. 81, dedicated to marine mammal research during the interval from 16 May to 23 June. During the first two weeks, the vessel was involved in tagging Dall's porpoise in the high seas salmon mothership fishing area. The objectives of the tagging study were to obtain information on the movements of Dall's porpoise on the fishery grounds; on the frequency of resighting of individuals, particularly those that may repeatedly approach the vessel; and on school composition and integrity.

Figure 1. Location of gillnet operations for studies of Dall's porpoise entanglement, 1980. The numbers above each station are the number of incidentally taken Dall's porpoise by the catcherboat (left) and by the associated morthership fleet (right).



A series of transect lines was designed to cover the fishing area twice prior to the beginning of the fishing season. This would have facilitated the collection of Dall's porpoise sighting data and would have increased the likelihood of resighting of tagged animals, during the second transit through the area. Due to bad weather, other scheduled operations, and an emergency run to Adak for medical assistance, the designated track line had to be modified, and the area was covered only once.

Dall's porpoise were tagged from the bow of the vessel as the porpoise swam at the bow. A modified spaghetti tag with a 1 cm by 15 cm color-coded streamer was emplaced in the porpoise using either a cross bow, or a long telescoping pole. The porpoise were difficult to tag due to their rapid and eratic movements. In addition, the porpoise generally did not approach the bow of this vessel unless it slowed to 2 knots or less.

A total of 54 Dall's porpoise were tagged during the two weeks. One tag sighting was reported near Little Tanaga Island, Alaska, 16 days after tag emplacement near Adak, Alaska. No tagged porpoise were returned to the salmon mothership by the catcherboats. Tag loss rates remain unknown.

During the interval 8-19 June the dedicated vessel operated with the salmon mothership fleet conducting studies of the entanglement of Dall's porpoise in conjunction with commercial fishery operations. Using standard commercial gillnets (300 tans, 10 m depth), the vessel was deployed as part of the catcherboat fleet by the Fleet Commander of the mothership fleet. The Hoyo Maru No. 81 followed the following operation schedule:

Mothership	Dates	Areas of Operation
Nojima Maru	11-8 June	49° to 51°15'N; and 170°53' to 172° E
Jinyo Maru	12-14 June	51°N and 173°E (no operations on 13 June due to weather conditions)
Kizan Maru	15-17 June	50°N; and 170°27' to 173°51'E
Meiyo Maru	18 June	50°N; and 172°45'E

The position and orientation of the net for each of these fishing operations were determined by the Fleet Commander of the mothership with which the dedicated vessel was operating on that day (Figure 1). For each set, data were collected on the date, location and direction of the set, wind and swell parameters, water temperature and the catch composition.

The total incidental take by the dedicated vessel for these ten sets was 26 Dall's porpoise, or 2.6 porpoise per set. The number of porpoise entangled per set ranged from 0 (in 2 sets) to 9 (1 set). The total number of Dall's porpoise reported by the associated mothership fleet for the same 10 sets (37 catcherboats per fleet, a total of 370 sets) was 33. The mean number per set was 0.089. Thus the incidental take reported aboard the catcherboats was significantly lower than that observed aboard the dedicated vessel ($t < .05$, 9 DF).

Of the animals entangled in the gillnets of the dedicated vessel, approximately 19% (5 out of 26) were alive, and released. The majority (73%) entangled in the upper half of the gillnet; half entangled near the ends of one of the net sections.

D. Life History Studies

Table 1 lists the composition of the incidental take during the three years. Biological samples collected during 1978 and 1979 have been examined and analysis of life history parameters is in progress.

Sexually mature males comprized only 13% of the total sample examined in 1978-1979, whereas mature females accounted for approximately 34%. Immature males and females represented about 53% of the total. Of the mature females, 90% or more were pregnant with near term fetuses at the time of capture.

Teeth collected from 409 porpoise have been prepared and examined for age determinations. The number of growth layers counted per tooth were 0 to 24. Most individuals had ten or fewer growth layers.

A total of 185 Dall's porpoise stomachs collected in 1978 and 87 collected in 1979 were analyzed to determine vertebrate prey species. All stomaches contained at least a trace of food and most were judged to be approximately half full. Fish otoliths were collected from the stomachs, sorted and identified (John Fitch, California Fish and Game, retired). The mean number per stomach was about 630 otoliths. Twenty-nine fish species were identified, consisting of epi- and meso-pelagic species. The most abundant species (70-80%) was Protomyctophum tompsoni. No salmon species were identified as as prey of Dall's porpoise.

The other major prey component in the stomachs was squid, which were the major component volumetrically. Species identification and numeration of the squid are in progress.

D. Population Abundance

Information concerning the distribution and abundance of marine mammals,

TABLE 1. Composition of the Incidental Take of Dall's Porpoise by the Japanese High Seas Salmon Mothership Fishery, 1978-1980.

	Total Take	Inside US FCZ	Total Sampled	Males			Females				
				Total	Immature	Mature[2] (%)	Total	Immature	Mature[3] (%)	Pregnant	(% of Mature)
1978	499	353	349	157	106	51 (32)	192	101	91 (47)	83	(91)
1979	682	595	590	222	150	72 (32)	368	143	225 (62)	215	(96)
1980	976[1]	806[1]	929	326	205	121 (37)	603	167	436[4] (72)	392	(90)
	2,157	1,754	1,868	705	461	244 (35)	1,163	411	752 (65)	690	(92)

1 Estimated from field data.
2 Maturity was based upon a body length of $\geq$ 181 cm.
3 Female maturity was determined by the presence of at least one corpus luteum or albicans in the ovaries.
4 Estimate based on body length of $\geq$175 cm, the approximate mean length of sexually mature females of the 1978 and 1979 samples.

particularly Dall's porpoise (Phocoenoides dalli), was collected aboard Japanese research vessels and U.S. Platforms of Opportunity Program vessels during 1978, 1979, and 1980, by the Dall's Porpoise Task, National Marine Mammal Laboratory. The results of our analyses of the density and abundance of Dall's porpoise in the northern North Pacific Ocean and the Bering Sea based on the data collected during 1978 and 1979 are briefly summarized. The methods used and results of the 1978-1979 sighting surveys are described in Boucher et al (1980). The data were stratified by area and year (Figures 2 and 3). Data collected during adverse weather conditions (Beaufort 4 or greater) were not used in the analysis.

The strip transect model developed by Estes and Gilbert (1978) for analysis of aerial survey data for marine mammals was used for one set of estimates of population density and abundance, and a general line transect model (Burhman et al. 1980) was used for comparative estimates.

The estimates for the abundance and density of Dall's porpoise based on the strip censuses are presented in Tables 2 and 3 (from Boucher et al 1980, Tables 4 and 5). The abundance estimates range from a low of 837,000 to a high of 1,821,000 for the northern North Pacific and Bering Sea portions of the range of the species (3.3 million square nautical miles). Two strip widths were used, 200 m and 400 m. In general, the densities and abundance based on the 200 m strip width data were larger by approximately 50% than the estimates based on the 400 m strip width. Variances are high and the confidence limits are large due to the small percentage of area surveyed (<1%).

The major difference between line and trip transect analyses is that in line transect analysis, a correction is made for the probability of missing some sightings away from the track line rather than a truncation of the data beyond the strip width as in the strip transect method (for more

Figure 2. Areas used for estimates of abundance of Dall's porpoise, 1978. Lines inside areas are the survey track lines. Area D was not surveyed this year.

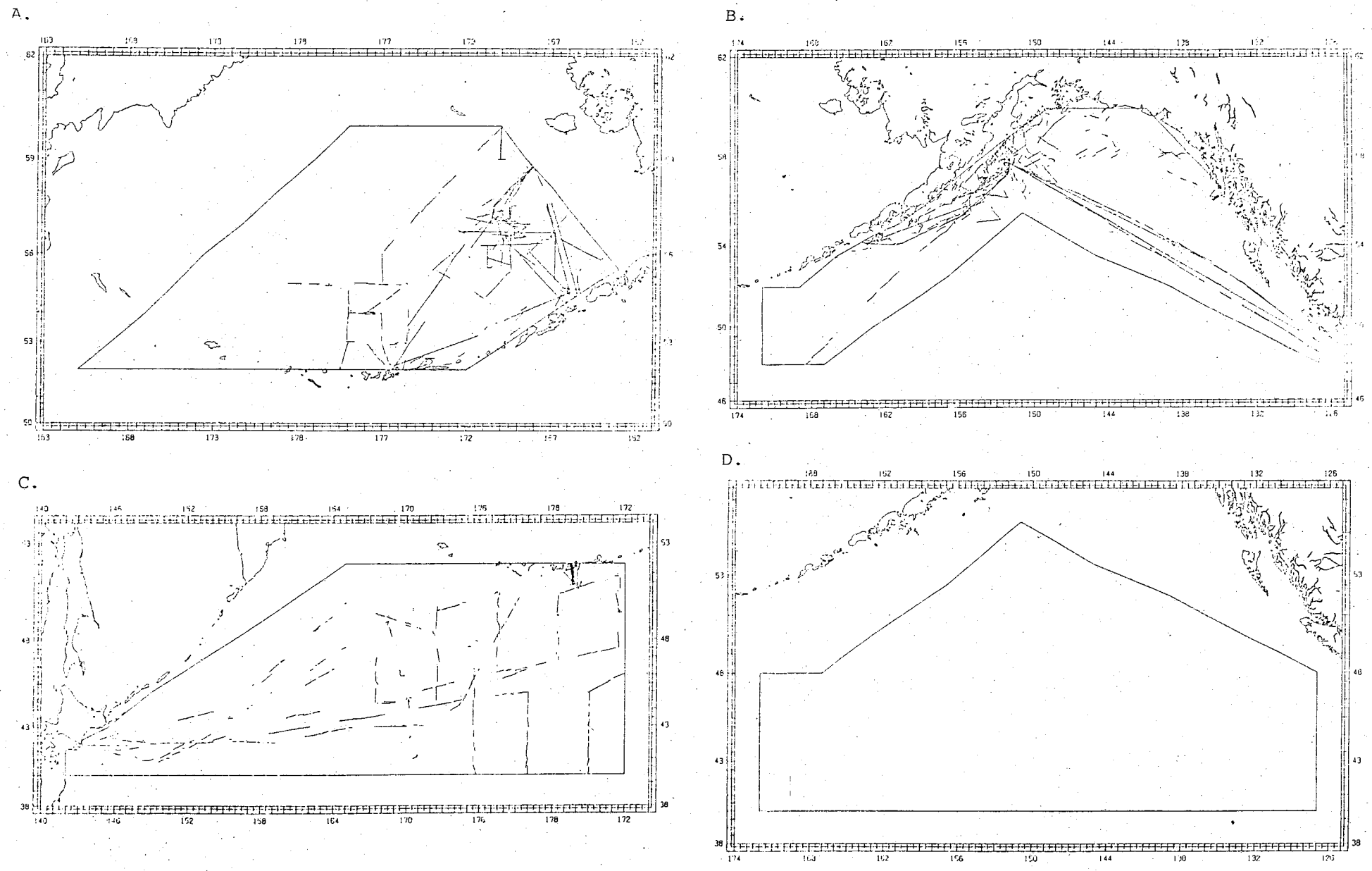
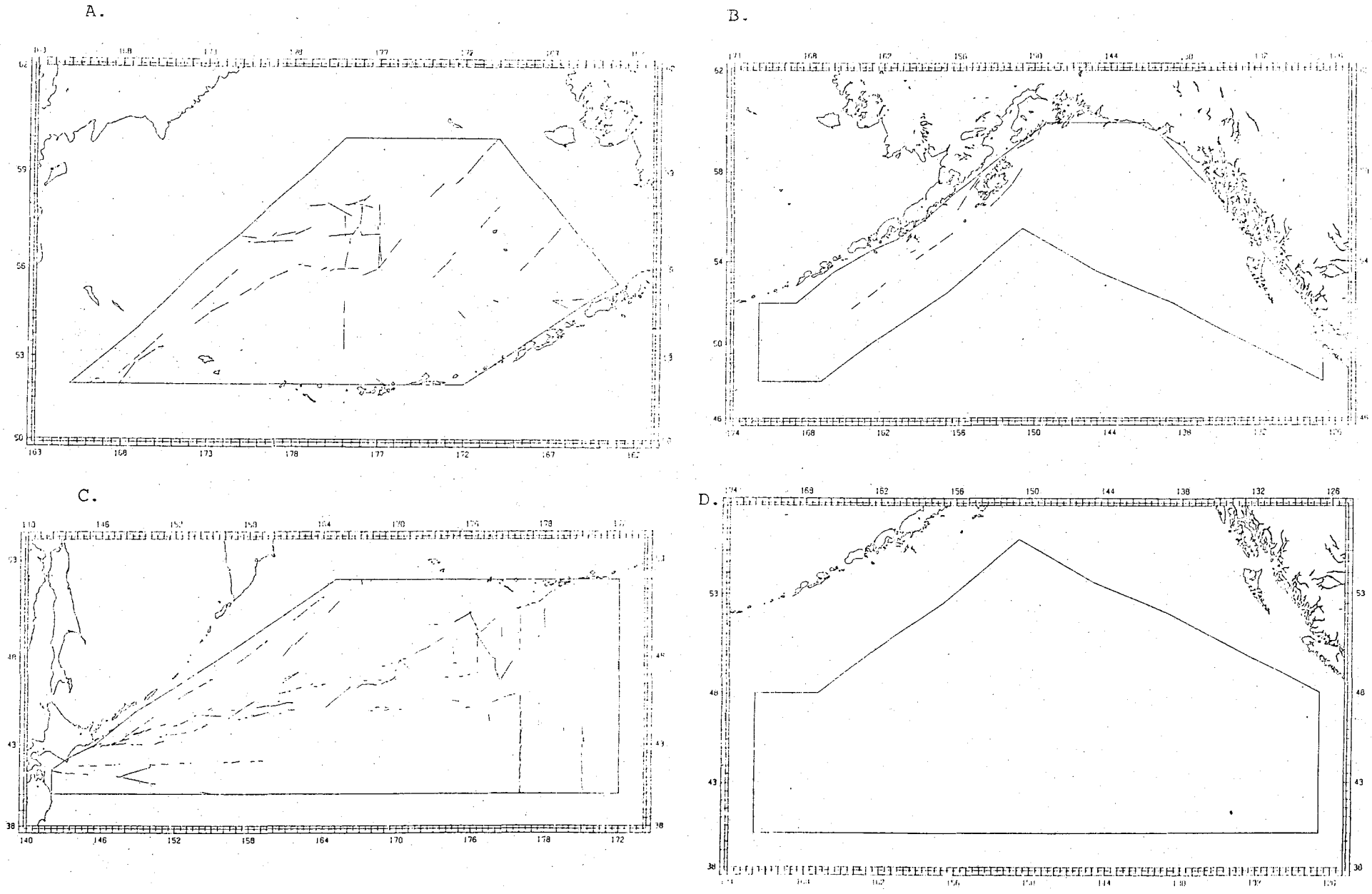


Figure 3. Areas used for estimates of abundance of Dall's porpoise, 1979. Lines inside areas are the survey track lines. Area D was not surveyed this year.



details see Burnham et al 1980). This analysis is discussed further in Bouchet (in prep.).

The estimates for density and abundance based on the line transect analysis are sumarized in Table 4. The abundance estimates based on the 1978 and 1979 data were 920,000 and 2,327,000 respectively.

Three different analyses (200 and 400 m strip width and line transect) based on two different years' sighting effort has resulted in six estimates of Dall's porpoise abundance ranging from 840,000 to 2.3 million animals in the North Pacific and Bering Sea. The problems associated with the use of strip transect analysis have been discussed in Boucher et al (1980). Summarizing, they are related to choosing a strip width sufficiently narrow such that (1) no animals are missed within the chosen strip area, and (2) no animals move into the strip before being seen. The movement of Dall's porpoise, particularly towards the vessel over unknown distance, makes the choice of effective strip width difficult.

The problems associated with the application of line transect methodology to shipboard sighting surveys of Dall's porpoise involve violation of some basic assumptions of the theory. These relevant assumptions (Burnham et al 1980) and their relation to our data are as follows:

(1) Points (= animals) are fixed at the initial sighting position, (a) they do not move before being detected and (b) none are counted twice.

Dall's porpoise are fast swimming animals, capable of overtaking vessels such as the survey vessels cruising at 10 knots. Depending on whether the animals are attracted to the vessel (the predominate behavior observed in the field) or repelled, the estimates of distance will be biased high or low, with an inverse effect on the density estimate.

TABLE 2 --Abundance and density estimates for Dall's porpoise based on data collected during shipboard sighting surveys. Results obtained by using 200 meter strip width.

Stratum	Stratum area (NM^2) 1/	Percent of area sampled	Transects in stratum =N	Dall's porpoise counted	Density ($\hat{R}$) individuals/ NM^2	Variance $S^2_{\hat{R}}$	Abundance $\hat{T}$	Variance $V(\hat{T})$ (in millions)	95% confidence interval around $\hat{T}$
1978									
Western-central North Pacific	1,029,633	.151	526	583	.376	.00675	386,831	7,149.6	(220,723 - 552,940)
Bering Sea	309,874	.227	307	159	.226	.00326	70,108	312.2	(35,339 - 104,877)
Gulf of Alaska	493,958	.303	567	769	.514	.00811	253,865	1,973.9	(166,601- 341,130)
Totals:									
Surveyed area	1,833,465						710,804		
Eastern North Pacific (unsurveyed)	1,429,218				.442 2/		(631,714)		
Total surveyed and unsurveyed	3,262,683						1,342,518		
1979									
Western-central North Pacific	1,029,633	.081	207	362	.432	.00754	445,230	7,982.7	(269,080 - 621,380)
Bering Sea	309,874	.123	73	214	.562	.01116	173,995	1,070.4	(108,775 - 239,215)
Gulf of Alaska	493,958	.020	16	101	1.007	.12474	497,451	30,429.6	(125,639 - 869,263)
Totals:									
Surveyed area	1,833,465						1,116,676		
Eastern North Pacific (unsurveyed)	1,429,218				.493 2/		(704,604)		
Total surveyed and unsurveyed	3,262,683						1,821,280		

1/ Stratum areas are approximated by straight line integration.

2/ Density was obtained from weighted mean of western-central North Pacific and Gulf of Alaska.

TABLE 3.--Abundance and density estimates for Dall's porpoise based on data collected using shipboard sighting surveys. Results obtained by using 400 meter strip width.

Stratum	Stratum area (NM^2) 1/	Percent of area sampled	Transects in stratum =N	Dall's porpoise counted	Density ($\hat{R}$) individuals/ NM^2	Variance $S^2_{\hat{R}}$	Abundance $\hat{T}$	Variance $V(\hat{T})$ ($\times 10^6$)	95% confidence interval around $\hat{T}$	Mean group size
1978										
Western-central North Pacific	1,029,633	.301	526	777	.250	.00191	257,777	2021.5	(169,452 - 346,102)	4.466
Bering Sea	309,874	.454	307	298	.212	.00191	65,699	182.9	(39,084 - 92,314)	4.448
Gulf of Alaska	493,958	.606	567	828	.277	.00204	136,671	495.8	(92,935 - 180,407)	6.900
Totals:										
Surveyed area	1,833,465						460,147			5.476
Eastern North Pacific (unsurveyed)	1,429,218				.264 2/		(373,313)			
Total surveyed and unsurveyed	3,262,683						837,460			
1979										
Western-central North Pacific	1,029,633	.163	207	433	.259	.00237	266,277	2510.0	(167,502 - 365,052)	4.047
Bering Sea	309,874	.246	73	303	.398	.00572	123,179	548.3	(76,499 - 169,858)	3.523
Gulf of Alaska	493,958	.041	16	151	.753	.09266	371,857	22,598.5	(51,440 - 692,274)	5.808
Totals:										
Surveyed area	1,833,465						761,313			4.402
Eastern North Pacific (unsurveyed)	1,429,218				.312 2/		(445,916)			
Total surveyed and unsurveyed	3,262,683						1,207,229			

1/ Stratum areas are approximated by straight line integration.

2/ Density was obtained by treating western-central North Pacific and Gulf of Alaska as one area.

TABLE 4. Density and Abundance estimates for Dall's Porpoise based on data collected during shipboard sighting surveys. Estimates based on line transect using exponential polynomial fall off curve.

Stratum	Stratum area (NM^2) 1/	Transect Length NM	Dall's Porpoise Groups Counted	Density (Dg) Groups/NM^2	Coefficient of variation CV (Dg)	Mean Group Size ($\bar{G}$)	Coefficient of variation CV ($\bar{G}$)	Density (Di) Individuals/ NM^2	Variance Var Di	Abundance $\hat{T}$	Variance Var (T) (millions)	95% confidence interval around $\hat{T}$
1978												
West-Central North Pacific	1,029,633	7046	243	.07962	.064	4.0247	.001313	.3205	.0004208	329,942	446.1	288,546-371,339
Bering Sea	309,874	4590	83	.03647	.243	4.0723	.02328	.1485	.001314	46,021	126.2	24,002-68,040
Gulf of Alaska	493,958	9396	121	.04054	.092	7.0413	.0004011	.2855	.0006897	141,002	168.3	115,577-166,428
Totals:												
Surveyed area	1,833,465									516,965		
Eastern North Pacific (unsurveyed) 2/	1,429,218			(.05605)		(5.0275)		(.2818)		(402,741)		
Total surveyed and unsurveyed	3,262,683									919,706		
1979												
West-Central North Pacific	1,029,633	3732	115	.1465	.093	4.0696	.003195	.5962	.003078	613,863	3,263.0	501,002-725,824
Bering Sea	309,874	1623	112	.1532	.025	3.4911	.004433	.5348	.002567	165,732	246.4	134,539-196,625
Gulf of Alaska	493,958	432	19	.2263	.320	5.4211	.009420	1.2268	.1542	605,985	37,635.7	225,746-986,223
Totals:												
Surveyed area	1,833,465									1,385,579		
Eastern North Pacific (unsurveyed) 2/	1,429,218			(.1546)		(4.2612)		(.6588)		(941,542)		
Total surveyed and unsurveyed	3,262,683									2,327,121		

1/ Stratum areas were approximated by straight line integration.
2/ Density and mean group size obtained as the weighted mean of Western-Central North Pacific and Gulf of Alaska.

Burnham et al (1980) discuss the problem of animal movement away from the transect line. They indicate that use of the exponential polynomial estimator results in a less biased estimate of abundance under this condition. We assumed this estimator would be equally useful in the case where porpoise are attracted to the transect line and therefore used this estimator for our analysis. If we further assume that the percent relative bias caused by movement movement toward the transect line is of the same magnitude as that caused by animal animal movement away from the line, these estimates of density and abundance could be overestimated by as much as 60% (Burnham et al. 1980).

(2) Distances and angles are measured exactly and thus are not subject to measurement nor rounding errors.

Due to the Dall's propoise speed and the inaccuracy of rangefinders for distance movements greater than a few hundred meters, distances and angles are estimated by observers. As a result, there are grouping of distances at 100 m intervals at distances greater than 200 m and grouping of angles at 40° and 90°. Both of these types of errors will tend to increase the variance of the estimate without necessarily changing the magnitude. The strip transect method probably minimizes these problems since it is only necessary to determine whether an animal is within the chosen strip.

The estimates of Dall's propoise abundance range from 840,000 to 2.3 million. The estimates are biased due to violations of some of the assumptions of the methods used and by the small amount of the area actually surveyed ($< 1\%$). The estimates may be high as a result of these biases. The 1978 estimates may be somewhat more reliable because there was greater survey effort that year.

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