Response of Dall's Porpoise (*Phocoenoides dalli*) to Vessels in Both Offshore and Nearshore Waters: Results of 1984 Research

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INTRODUCTION

In 1982 and 1984, the National Marine Mammal Laboratory investigated the response of Dall's porpoise to survey vessels in Prince William Sound, Alaska (Bouchet et al. 1983 and 1984). The primary objectives of the 1984 study were to:

1) record the behavioral responses (especially attraction and avoidance) of Dall's porpoise to survey vessels in offshore and nearshore waters;
2) obtain information on where porpoises were found, how many, group size, and if possible, composition (particularly female-calf pairs);
3)obtain video recordings of porpoise behavior and survey methodology and make acoustic recordings of Dall's porpoise, helicopter, and vessel noise.

METHODS

The survey vessel used was the National Oceanic and Atmospheric Administration (NOAA) research ship Surveyor. The 88.5 m (292 ft) ship was equipped with a helicopter landing pad and a UHIH helicopter (the military version of a Bell 205). The Surveyor's cruising speed during the survey was approximately 90 rpm (10 kts) and that of the helicopter was 111 km/hr (60kts). Altitude of the helicopter was usually 212 meters (700 ft), but increased if there was disturbance. Aerial surveys were not flown when the wind force was greater than 30 km/hr (Beaufort 4), when visibility was reduced due to rain, or when ceiling was low (less than 151 meters). For each flight, the helicopter was flown in a search pattern as described previously (Figure 1; Bouchet et al. 1984). This flight path allowed the helicopter to scan an area 1-1.5 nm in front of the ship and 1.5 nm to either side of the ship's track line. These distances were shown (from the 2 previous years) to be optimal to maximize the likelihood of obtaining linked sightings between shipboard and helicopter observers.

Two surveys, each lasting about 2.5 hours, were flown daily when conditions permitted. The flight crew consisted of the pilot and two or three observers with the primary observer/data recorder seated next to the pilot. The video operator and other observers were seated behind the pilot. The helicopter's rear windows were removed to improve visibility. When a group of animals was initially sighted, the search pattern was suspended and the helicopter made a pass over the group to permit the shipboard observer to obtain distance and angle to the group by means of the ships radar and a transponder on the helicopter. The species, number, position (latitude and longitude), group composition (adults, immatures or young of the year) and direction of travel were recorded by the helicopter observers. The

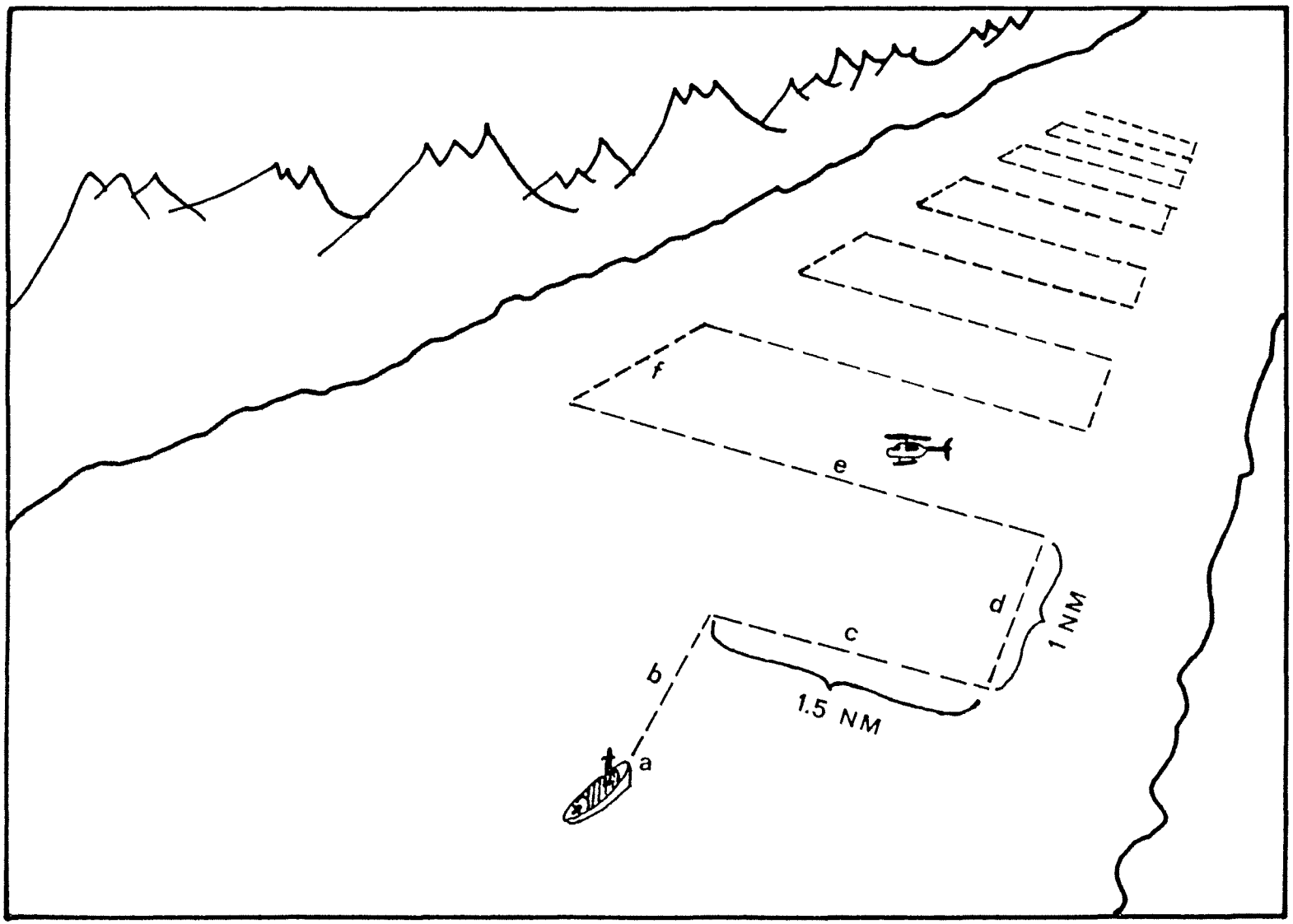

Figure 1. Experimental design, Dall's porpoise behavior study 1984. Dashed line indicates approximate helicopter flight path. See text for details. (Reprinted from Bouchet et al. 1984)

primary observer entered all data into a portable Epson HX-20 [1] computer in real time. A small cassette recorder was also used to record supplemental or detailed sighting and behavioral data. In accordance with procedures developed during the two previous studies, the helicopter was to continue observations with the porpoise groups for a maximum of 10 minutes until the animals were sighted by the shipboard observers or the porpoise passed abeam of the ship undetected. This procedure had to be modified, because the helicopter was affecting the behavior of the porpoise. The previous experimental protocol of spotting porpoise from the helicopter ahead of the vessel, following them until sighted or missed by the shipboard observers, could not be followed using the UH1H helicopter, because the animals were aware of the helicopter at all altitudes tested (up to 364 meters or 1200 feet). The porpoise dove, made erratic movements, and even rolled to their sides and looked up at the helicopter. At 364 m the animals still responded to the helicopter, however greater altitudes made the porpoise extremely difficult to observe. Therefore the helicopter made only one pass over the group recording as much information as the observers could gather in that pass. Range and bearings were also taken by the ship.

Concurrent with helicopter operations, shipboard watches were also conducted by at least three observers: one data recorder on the bridge and two on the flying bridge acting as primary observers. The shipboard observers followed standard sighting procedures, scanning with the unaided eye to make initial observations and using 8X binoculars and/or 25X binoculars "big eyes" to confirm species identifications. Species, number, behavior, distance and angle from the ship were transmitted to the bridge observer who recorded the information on the computer. The Epson HX-20 was also used by the bridge observer to enter (in real time) the range and bearings of the helicopter at every course modification and when directly ahead, and location of animals when encountered by the helicopter. After each flight, the records were compared to to determine whether any of the animals sighted from the helicopter were also seen from the ship. If so, the perpendicular distances and track lines were calculated to determine if attraction or avoidance had occurred.

An observer was added to the catwalk in front of and along side the bridge, after it was determined that the helicopter was unable to track the porpoise undetected, and therefore confirmed linked sightings between shipboard and helicopter observers could not be obtained. This observer was able to receive helicopter and ship sighting transmissions using a portable walkie-talkie equipped with headphones. His duty was to locate the group reported by the helicopter, track the group and confirm whether or not the group sighted by the other ship observers was the same.

Once offshore and once in Prince William Sound, recordings of the Surveyor were made to determine the source level noise of the Surveyor. The recording instrumentation consisted of a NAGRA IV SJS tape recorder coupled to a KSP hydrophone with an on-line 2 db step attenuator. The frequency response at a speed of 7 1/2 ips was 40 hz to 20khz (+ or - 2 db). The hydrophone was at a depth of 4 meters (12 feet). Recordings were made with the Surveyor running at normal speed at distances of 1/4, 1/2, 3/4, and 1 mile from the whaleboat. Measurements were made from a beam aspect. Distances and bearings to the ship were voice recorded on the tape simultaneously. Similar recordings were made of the helicopter at various altitudes over Lake Washington (in Seattle, Washington) prior to the start of the cruise.

An attempt was made in Prince William Sound to record signals produced by Dall's porpoise. With the assistance of ship's personnel, a Panasonic 6500 video tape recorder was coupled to the KSP hydrophone. A 2db step attenuator and an oscilloscope were also in-line. This system provided a frequency response of 100 hz to 200 khz which allows recording of the high frequency signals produced by Dall's porpoise (up to 160 Khz).

Dates and Location:

Departure from Seattle, Washington was on 12 June 1984. After leaving the Strait of Juan de Fuca, the vessel headed northwest, beyond the continental shelf, to a distance of approximately 400 km (250 miles) offshore. The ship traveled north and entered Prince William Sound on 22 June. The inshore and nearshore waters were surveyed until 27 June after which seamounts 325 km (200 miles) off Kodiak Island were surveyed. We continued to survey offshore, past the Albatross Banks, terminating the study at Kodiak Island, Alaska on 3 July.

Personnel:

Linda Jones	National Marine Mammal Laboratory (NMML) NOAA, NMFS (Chief Scientist)
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Mamotu Kato	Japanese Fisheries Agency (JFA)
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RESULTS

The marine mammal most often encountered was the Dall's porpoise. A total of 182 sightings (544 individuals) were made from the Surveyor during effort watches. A total of 55 hours of helicopter observations were conducted during 15 days when weather permitted. During the period when the ship and helicopter observers were censusing simultaneously, 85 sightings of Dall's porpoise were made by the shipboard observers (N=221; mean group size = 2.6); and 65 sightings (N=176; mean group size = 2.9) were made from the helicopter. The number of porpoise schools sighted by both the ship and helicopter observers (i.e. "linked" sightings) was 22; twelve in offshore waters and ten in Prince William Sound (nearshore/ coastal waters).

Subsequently, to minimize animal disturbance, only one pass was made over each porpoise group with the helicopter. This allowed us to obtain a range and bearing and an approximate number in the group, but occasionally other information such as group composition was sacrificed. Ensuring group identification for linked sightings was not a problem offshore where the frequency of sightings was low. However, porpoise groups in Prince William Sound were numerous enough that we could not be certain whether the groups sighted from the helicopter was the same group sighted from the ship. Placing an additional observer on the bridge catwalk who monitored helo/ship transmissions and followed porpoise groups sighted from the helicopter until subsequent sighting from the ship increased the number of linked sightings.

Helicopter sightings occurred between 1500 and 3000 meters from the ship with the mean sighting distance equal to 2079 meters (Figure 2). Most sightings from the ship occurred from 100 to 600 meters with the mean sighting distance equal to 204 meters (Figure 3). Similar results were obtained in previous years (Bouchet et al. 1984).

Porpoise sighting distance and angle measurements were transformed into perpendicular distances from the ship's track line prior to analysis. Vessel attraction.as defined by Bouchet et al. 1984, is a decrease in perpendicular distance over the period of observation. If the net movement was less than 100 meters in either direction, this was termed no reaction. Table 1 shows these perpendicular distances and other information for the 22 linked sightings in 1984. The net changes in perpendicular distance for 1984 and 1983 are illustrated in Figures 4 and 5 respectively. From the 22 linked sightings in 1984, we observed 19 cases (86.4%) of vessel attraction, no cases of vessel avoidance, and 3 cases (13.6%) of no reaction (Tables 1 & 2 and Figure 4). The mean net change in perpendicular distance was -723 meters. For the 21 linked sightings in 1983 (Prince William Sound) we found 13 cases (61.9%) of attraction, 5 cases

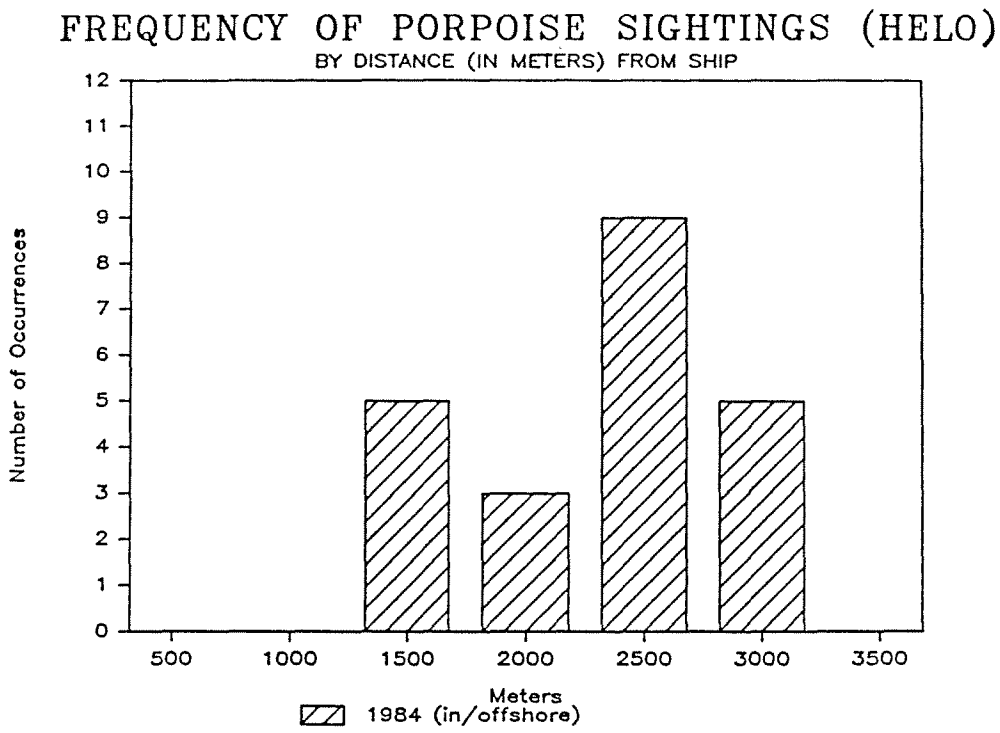

FIGURE 2.

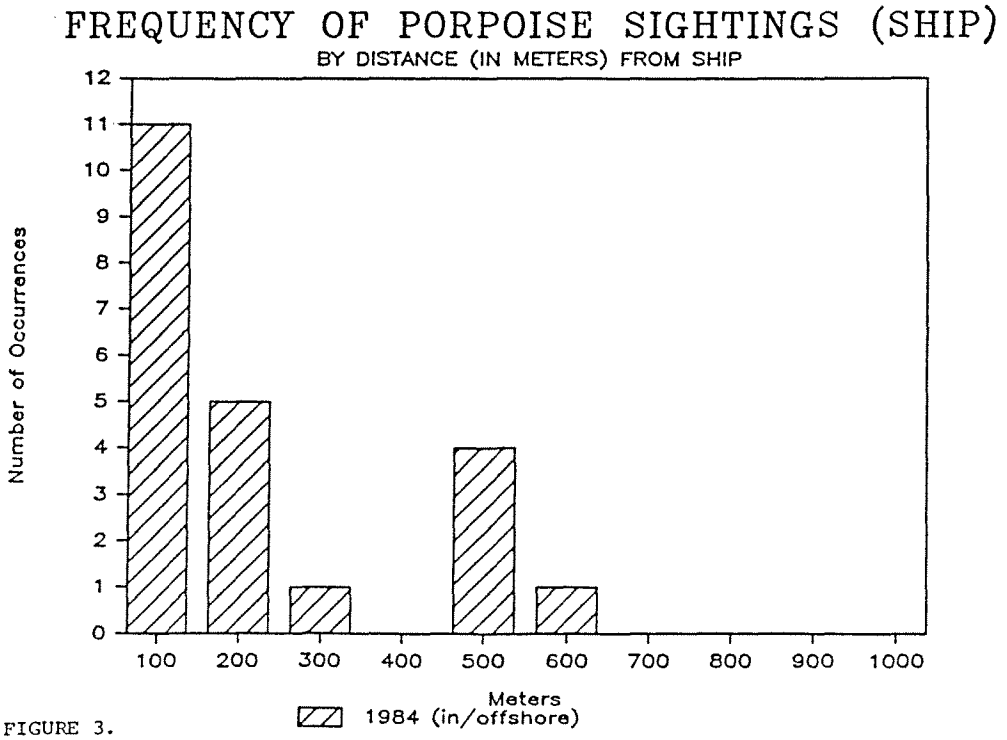

FIGURE 3.

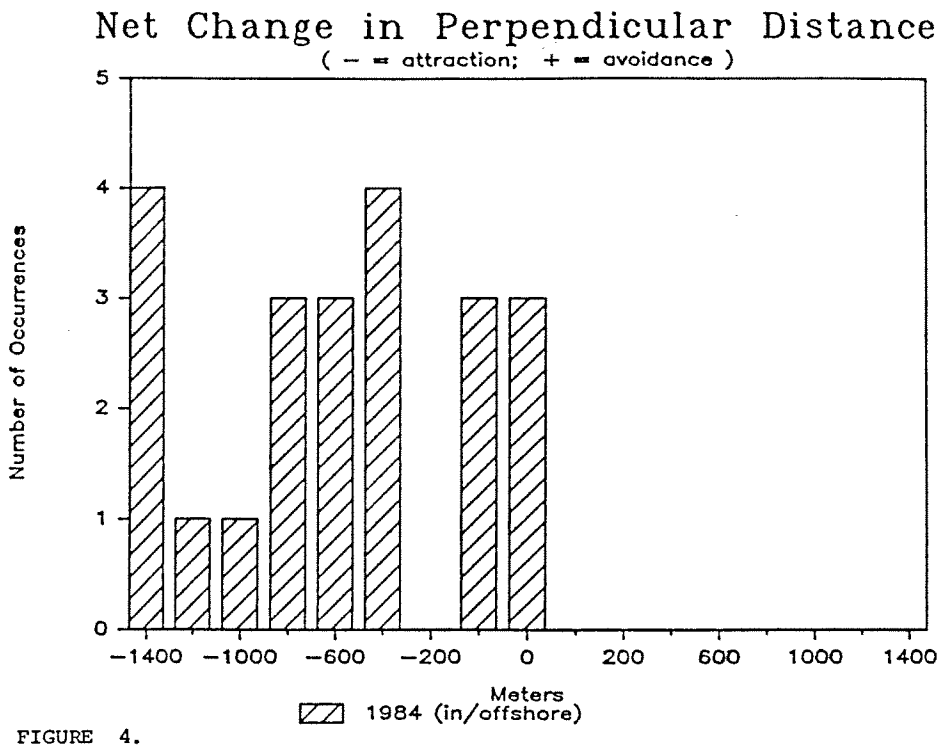

FIGURE 4.

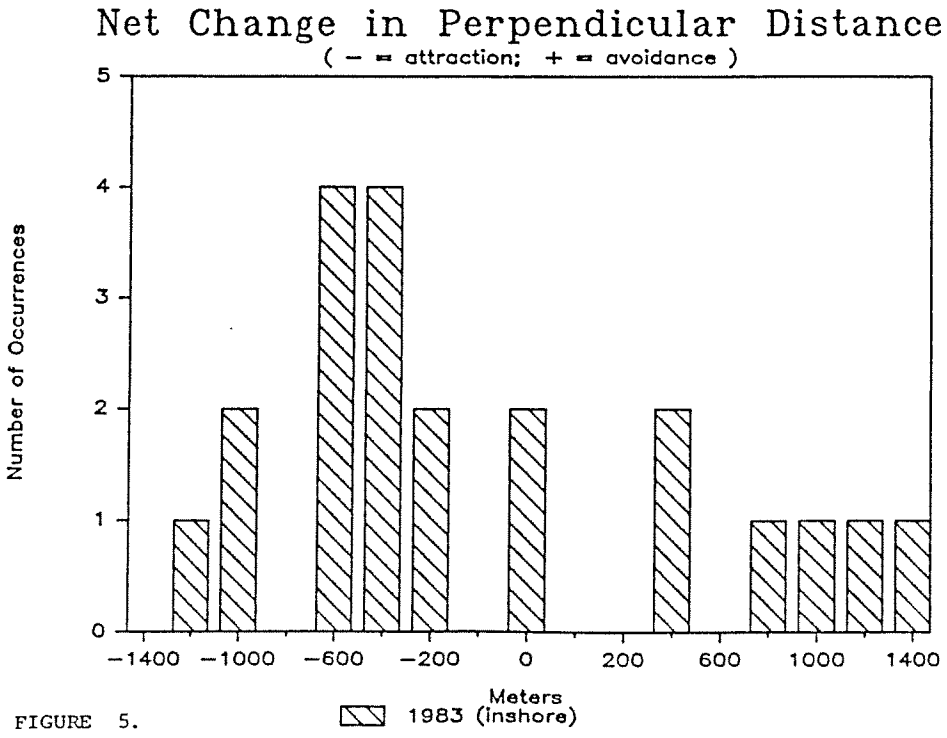

FIGURE 5.

TABLE 1. COMPARISON BETWEEN SHIP AND HELO SIGHTINGS; NET CHANGE IN PERPENDICULAR DISTANCE

SHIP TIME	NUMBER PORPOISE	DISTANCE METERS	ANGLE	PERP. DISTANCE	HELO TIME	NUMBER PORPOISE	ANGLE	RANGE R(NM)	DISTANCE METERS	PERP. DISTANCE	NET DIFF.	DATE 1984
951	2	200	90	200	943	5	22	2	2778	1041	-841	20 JUNE
1422	3	50	30	25	1413	2	25	2	2963	1252	-1227	20 JUNE
1552	1	50	30	25	1547	2	328	2	2778	1472	-1447	22 JUNE
1134	5	100	300	87	1125	5	5	1	1482	129	-43	24 JUNE
1322	11	100	350	17	1319	4	351	1	1296	203	-186	24 JUNE
1335	3	7	50	5	1330	3	18	1	1667	515	-510	24 JUNE
1417	3	150	330	75	1415	2	330	1	1482	741	-666	26 JUNE
1422	2	550	270	550	1420	2	318	1	2037	1363	-813	26 JUNE
1427	2	150	280	148	1424	2	300	1	1852	1604	-1456	26 JUNE
143?	3	500	340	171	1430	1	328	1	2037	1080	-909	26 JUNE
1436	2	500	270	500	1433	2	297	1	2222	1980	-1480	26 JUNE
14??	3	500	340	171	1438	2	324	1	2222	1306	-1135	26 JUNE
1445	2	250	270	250	1443	2	302	1	2593	2199	-1949	26 JUNE
1057	1	200	50	153	1054	6	15	1	2222	575	-422	27 JUNE
1445	1	100	270	100	1440	3	353	1	2408	294	-194	27 JUNE
1456	1	200	50	153	1450	1	40	1	1482	952	-799	27 JUNE
1644	7	500	0	0	1641	5	21	1	1667	597	-597	1 JULY
1059	2	100	80	98	1053	3	12	1	2593	539	-441	2 JULY
1101	4	30	20	10	1057	2	4	1	2037	142	-132	2 JULY
1213	5	100	350	17	1207	1	0	1	2222	0	17	2 JULY
1530	3	50	40	32	1526	5	0	1	1482	0	32	2 JULY
1607	2	100	330	50	1603	1	340	1	2222	760	-710	2 JULY

Table 2. Percentage of porpoise attraction and avoidance

Source	Platform	Nearshore	Offshore	Percent (N) Attraction	Percent (N) Avoidance	Percent (N) No Reaction
Bouchet et al. 1983	ship/helo	X		21.9% (37)	8.9% (15)	69.2% (117)
Withrow 1982 in Bouchet et al. 1984	ship		X	52.2% (47)	26.7% (24)	21.1% (19)
Bouchet et al. 1984	ship/helo	X		61.9% (13)	28.6% (6)	9.5% (2)
Withrow 1983 in Bouchet et al. 1984	ship		X	48.4% (15)	9.7% (3)	41.9% (13)
Withrow et al. 1985	ship/helo	X	X	86.4% (19)	0 (0)	13.6% (3)
(All studies to date which showed either attraction or avoidance) in Bouchet et al. 1984	ship/helo	X	X	70.0% (112)	30.0% (48)	
Withrow et al. 1985 (this study)	ship/helo	X*		66.7% (2)	33.3% (1)	
Withrow et al. 1985 (this study)	ship/helo		X*	66.7% (4)	33.3% (2)	
********** AVERAGE FOR ALL STUDIES **********				66.7%	33.3%	

* Assuming the porpoise the vessel observers had an opportunity to see (within 400 m), but did not, were recorded as avoidance.

Table 3. Linked and non-linked sightings of Dall's porpoise.

number porpoise	angle	range (NM)	distance meters	perp. distance	location	linked sighting
3	353	1.3	2407.6	293.66	offshore	yes
2	352	1.1	2037.2	283.73	offshore	no
4	351	0.7	1296.4	202.93	inshore	yes
2	359	1	1852	32.52	inshore	no
1	0	1.2	2222.4	0	offshore	yes
5	0	0.8	1481.6	0	offshore	yes
2	0	1.2	2222.4	0	offshore	no
5	5	0.8	1481.6	129.13	inshore	yes
2	4	1.1	2037.2	142.11	offshore	yes

Table 4. Marine Mammal Sightings

CETACEANS	COMMON NAME	NUMBER OF ANIMALS	NUMBER OF GROUPS
Phocoenoides dalli	Dall's porpoise	544	182
Lagenorhnychus obliquidens	Pacific white sided dolphin	28	5
Orcinus orca	Killer whale	45	3
Megaptera novaeangliae	Humpback whale	32	14
Balaenoptera physalus	Fin whale	2	2
Balaenoptera acuterostrata	Minke whale	3	3
Physeter macrocephalus	Sperm whale	29	9
Ziphius cavirostris	Goosebeak or Cuvier's whale	11	7
Mesoplodon (species unknown)	probably Stejnegeri beaked whale	3	1
Unidentified whales		3	3
PINNIPEDS			
Callorhinus ursinus	Northern fur seal	26	23
Eumetopias jubatus	Northern or Steller sea lion (not including Middleton Is.)	7	4

Table 5. Reaction of various marine mammal species to the helicopter (UH1H) at 212 meters (700 feet) in altitude

Species	Number in group	Comments
Fin whale	1	No apparent reaction
Goosebeak whale	1 cow/calf pair	No apparent reaction
Goosebeak whale	2	Rolled on side and dove
Mesoplodon sp.	3	Rolled on side; changed direction
Minke whale	1	Swam just below surface; hesitated to blow
Humpback whale	2	Swam tight circles and dove
Killer whale	25-30	Regrouped into linear formation from 7 groups into 4 groups
Sperm whale	10	No apparent response
Steller sea lion	1	Confused by helo; turned and dove
Steller sea lion	1	Rolled on side and dove
Steller sea lion	1000+	Stampeded off beach into water when helicopter was 1+ miles away (Middleton Is., Alaska)

(28.6%) of avoidance, and 2 cases (9.5%) of no reaction. The 1983 mean net change in perpendicular distance was -90.0 meters. The higher net change in perpendicular distance for 1984 is expected since no avoidance (positive net change) was observed and the helicopter was searching slightly farther ahead of the vessel than in previous years.

There were no examples of avoidance observed in 1984 and the helicopter was unable to track the porpoise schools without adversely affecting their behavior. Therefore, to further explore the question of avoidance, all helicopter sightings were examined, whether seen by the shipboard observers or not. Withrow and Bouchet, using sighting data from the POP database, determined that all sightings where the perpendicular distance of the porpoise group was within 400 meters of the ship, ought to be seen by the shipboard observers. If they were not, then the animals must have moved away, possibly in response to the vessel. Of the 65 helicopter sightings, nine sightings met the above criteria (Table 3), and of these, six were subsequently seen by the shipboard observers (2 nearshore, n=3 and 4 offshore, n=6 : Table 2). Therefore, in 33% of the cases, porpoise may have avoided the vessel.

Four cow/calf pairs were sighted from the helicopter on 19 June and one pair from the ship on 20 June. Little information on calving exists for the eastern North Pacific Ocean. In the western North Pacific, calves have been observed entangled in salmon gillnets as early as 11 June (Jones et al., 1984). Based on the five sightings during this project, calving occurs in both areas at about the same time period.

In addition to Dall's porpoise, eight species of cetaceans and two of pinnipeds were observed from the ship and/or helicopter (Table 4). Of special interest were sightings of beaked whales (*Ziphius cavirostris* and *Mesoplodon* sp.) which are infrequently seen during cruises in this area. Calves were seen on two occasions during sightings of beaked whales, in three groups of killer whales and in one group of sperm whales.

DISCUSSION

If Dall's porpoise responds to the presence of ships that are the primary census platform, then the magnitude of their response must be included in any population estimate. Results from previous studies (Bouchet et al. 1983 and 1984) indicate that porpoise are attracted to vessels, at least in the inshore waters of Prince William Sound. Although the database is quite small, porpoise offshore, like the nearshore animals, are apparently attracted to vessels.

Clearly, Dall's porpoise are attracted to vessels and we consistently find the attraction/avoidance ratio in the range of 2/3 (66.6%) attraction and 1/3 (33.3%) avoidance for both nearshore and offshore animals (Table 2). Sample sizes for the database are still low and should be increased to insure statistical reliability and to narrow confidence limits.

The actual effect of this level of attraction on the abundance estimates has not yet been determined. Before this can be quantified, more information must be obtained. Specifically, the fraction of animals showing no reaction is quite variable, ranging from 10-70% (Table 2). It must be determined whether this variability is a result of time, area, or vessel used in the survey. For example, Kasuya and Jones (1984) reported variability in behavior by area. The average frequency of non attraction will have to be included in analyses. The effect of movement will have to be simulated to determine its impact on abundance estimates using both strip and line transect methods. The question is how to apply these corrections. We plan to do these analyses using computer simulations.

The goosebeak or Cuvier's whale is infrequently seen during sighting surveys. We encountered 11 animals in seven groups during our trip (Table 4). Twice we saw cow/calf pairs, once on 19 June and once on 20 June. These are the first known recorded sightings of calves in the North Pacific.

The UHlH helicopter is not the preferred helicopter for this study. It was extremely loud, easily detectable by the animals, and altered their behavior in most cases (Table 5). A Bell 206 jet ranger (which did not affect the porpoise's behavior in previous studies) and an observer who tracks sightings from the helicopter, are recommend for future studies.

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