# Investigation of Dall's porpoise (Phocoenoides dalli)

# Responses to a Survey Vessel

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## INTRODUCTION

The Dall's porpoise (*Phocoenoides dalli*) is subject to an annual incidental take of 2-8,000 porpoise in the Japanese high seas salmon gillnet fishery (Jones, 1982). To assess the impact of this fishery on the population, an accurate estimate of its size is essential. Current estimates, based on shipboard sighting surveys, range from 740,000-1,700,000 (Bouchet, 1982) to 4,600,000-13,000,000 (Kato, 1982). One factor influencing the estimates is that some Dall's porpoise have been reported to actively seek the wake of moving vessels. Others may avoid moving vessels. Shipboard sighting surveys will obviously be affected if animals avoid or are attracted to the census vessels. To address this question of relative movement, a survey was conducted in August 1982 in southwest Prince William Sound, Alaska, to document avoidance/attraction of Dall's porpoise. A charter vessel and a helicopter were used as platforms from which to observe and describe the behavior of the porpoise and quantify these movements relative to the vessel. The purpose of this paper is to present the results of that survey and to provide recommendations for further research.

The captain and crew of the VIVIENNE II, John Cross, Terry Backen, and Doug Brock, are commended for their generous cooperation and assistance, without which this study could not have been undertaken. Special appreciation is directed to Mr. Bill Murphy, the helicopter pilot, whose extensive piloting expertise, safety consciousness, and assistance contributed to the successful completion of the study, and to Mr. Ron Sonntag for his enthusiasm and assistance in data collection and analysis.

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## METHODS

The vessel chartered for this survey was the M/V VIVIENNE II, an 86 ft former tuna fishing vessel outfitted with a helicopter landing pad and Bell 206 B3 ("Jet Ranger") helicopter. The VIVIENNE's cruising speed during the survey was approximately 10 kts and that of the helicopter approximately 60 kts. (Neither of these speeds was adhered to strictly.) Aerial surveys were not flown when the wind force exceeded a Beaufort 4 (>17 kts). Five hundred feet (152 m) was the standard helicopter survey altitude.

Flight paths were designed to cover a large area and yet remain within visual range of the VIVIENNE. For each flight, the helicopter flew directly:

1) over the vessel to calibrate position;
2) out along the ship's track line for one to six nautical miles;
3) executed a 90° turn to either port or starboard;
4) flew perpendicular to the ships track for one to four nautical miles;
5) again executed a 90° turn to fly parallel to the ship until abeam of the vessel; and
6) finally turned to fly over the vessel.

The surveys consisted of a number of these legs determined by the amount of fuel, visibility/sea state, and observer fatigue. During good weather, we flew three surveys per day, each of approximately 2 hr duration. A Loran fix from the helicopter was logged at the beginning and ending points of each leg or segment. The helicopter crew consisted of the pilot and two observers--the primary observer was seated next to the pilot and the secondary observer (principal data recorder) was seated in back of the pilot. When porpoises were encountered, the species, number, direction of travel, position (Loran), and behavior were recorded. Location, direction of travel of the porpoises, and behavior were then logged every 2 min while the helicopter circled the group. A total of 10 min was spent on each encounter, after which the survey trackline and altitude were resumed at the approximate point of departure.

Watches were conducted onboard the ship while the helicopter was in flight. These watches were conducted by two observers: one on the bridge responsible for recording ship position (Loran) and helicopter position (range and bearing) and the second in the "crow's nest" (35 ft (10m) above the water level) acting as the primary shipboard observer. The relative location of the helicopter with respect to the ship (distance and angle) was determined by radar onboard the VIVIENNE. Communication between the crow's nest and bridge was effected via a hand-held marine VHF radio, and between the bridge and helicopter with an aerial VHF radio. Time and position of the VIVIENNE (Loran) was noted whenever the helicopter completed a leg and arrived at the bow prior to commencing the next leg.

Behavior and movement of animals were recorded by both the helicopter and the shipboard observers. Most sightings from the VIVIENNE were independent of those from the helicopter, but when possible the sightings of an individual group of porpoises were pooled in order to compare and evaluate the difference (or similarity) between the observations from these two sources.

Movements and behavior of the porpoises were recorded relative to the ship's trackline by fixing the position of the sighting to the vessel (both distance and angle as well as exact position by Loran). When possible, multiple position fixes were recorded to allow later evaluation of relative "movement". Subjective information such as "movement toward vessel" ("+"), "movement away from vessel" ("-"), or "no net movement" ("0") of the pod/or individual porpoise was also recorded for later evaluation of movement to the VIVIENNE. Although the movements were "quantified" (+1 to -1, with 0 = no movement), they were subjective determinations standardized among observers. Generally, the net movement of an individual and/or a group was obvious and thus their behavioral response to the vessels was considered appropriately illustrated by our method of recording observations.

The survey included four areas of Prince William Sound--especially west, east and north of Montague Island, and Knights Passage, and adjacent waters. The survey dates were 24-28 August 1982.

## RESULTS AND DISCUSSION

Five distinct Dall's porpoise behavioral patterns were noted. The first two were observed by both the shipboard and helicopter personnel while the last three were observed only by the helicopter personnel.

a. Slow roll - a portion of the porpoise's upper body surface was visible briefly as the animal quietly broke the water surface, arched its back, and submerged while maintaining forward momentum. The entire sequence created only a slight disturbance at the water surface.

b. Rooster tail - this characteristic V-shaped spray was created on the water surface as fast swimming porpoise rapidly surfaced and submerged. Helicopter observers noted that intermittent "rooster tail" splashes were associated with a normally sustained, fast, subsurface swimming mode ("fast swimming").

c. Fast swimming - this sustained, rapid rate of swimming just beneath the water surface left no visible disturbance at the surface and was observed in free-ranging Dall's porpoise that apparently were not reacting to the presence of the survey vessel.

d. Surface splash - these "rooster tail" type splashes, generally directed over a short distance, were coupled with sharp changes of direction of travel at and just below the water surface, and subsurface rolls about the body axis (up to 90° left and/or right). This behavioral pattern, believed to be associated with feeding, always occurred in pods of several to many animals (up to 20) and in a surface area seldom exceeding several hundred square meters. (In the Platforms of Opportunity Program database, this behavior has been recorded as "milling".)

e. Deep dive - the activity was regularly observed as a continuation of the "slow roll" followed by 1.5 - 3.0 min dive times. When a pod or individual porpoise proceeded from "fast swimming" directly into "deep dive", they arrested their forward momentum by executing a sharp left or right turn ("hockey stop"), took several breaths while remaining still at the water surface, and then initiated the dive. Once the dive commenced, visual contact with the animal from the helicopter was almost immediately lost and not regained until the animal surfaced, normally near the location that the dive was initiated. Following the "deep dive", porpoise(s) surfaced slowly and took several breaths while remaining still at the water surface. On occasion, the first and sometimes the second exhalations were plainly visible from the helicopter which was hovering at 500 ft (152 m).

During extended observation periods of up to 10 min, helicopter observers noted that several of these outlined behavior patterns were often linked. For example, one group of six Dall's porpoises, initially sighted in the "rooster tail" mode, displayed the following sequence: "rooster tail", "slow roll", "deep dive", and finally, "rooster tail".

Summary data on pod sizes are presented in Table 1. We assume that the data include resightings of some individuals and groups made during the days that two of the four (general) areas were resurveyed (i.e. east and north of Montague Island). Although weather and sea state varied among days (27 and 28 August were rated "poor", and 24-26 August were considered "excellent") pod size did not vary. The modal pod size was three animals, a figure which is similar to that calculated from observations on the Japanese salmon mothership fishing ground. The biological significance of these results is unknown.

The number of Dall's porpoise groups and their movements relative to the VIVIENNE are reported in Table 2. Greater numbers of Dall's porpoise were observed rooster tailing than slow rolling when a positive or negative net movement was observed relative to the vessel ($p<0.01$, Chi-square contingency test).

Of the total porpoise observed, 56.2% of the pods were roostertailing and/or splashing at the surface, and 43.8% were observed in a behavioral mode associated with slow rolling. Fully 71.3% of all pods made no apparent net movement towards or away from the vessel, while 28.7% did. Of those displaying a behavior possibly indicating a response to the vessel, 71.8% moved to the the vessel (not all rode the bow wave) and 28.2% moved away from the vessel.

Although more porpoise were seen rooster tailing than slow rolling from the vessel, the proportion seen as a function of distance from the vessel was not different (Table 3). Distance, then, was not significant, and observers on the vessel were thus not likely to see rooster tailing porpoises at greater distances than slow rolling porpoises.

Helicopter observers sighted more porpoises slow rolling away from the vessel at distances farther than 1 nm than less; however, rooster tailing porpoises were seen uniformly by distance (Table 4). Although proportionately more helicopter time was spent surveying areas greater than 0.5 nm from the vessel rather than less, these results suggest that rooster tail behavior is not solely associated with porpoise approaching the vessel. Data reported in Tables 2 and 5, however, suggest that once porpoise are within 0.5 nm of the vessel, they are more likely to rooster tail toward the vessel than when they are beyond that distance (e.g. certainly beyond 1 nm).

A total of 12 cow and calf pairs were seen (Table 6). This was 2% of all porpoises sighted. This is not an unbiased sample since some animals were undoubtedly seen more than once. However, the small sample of calves suggests that the study area may not be a primary calving ground, or that calf production within the population is much lower than previously reported (Newby 1982). The mean group size in which cows with calves were seen (3.58, SD = 1.93, n = 12) was not different from that for all groups reported in Table 1. The mean distance from the vessel at which cows and calves were seen was 1.3 nm (SD = 1.07, n = 9); however, all but one calf was seen by the helicopter observers. The one calf sighted by the vessel observers was detected at approximately 0.25 nm while the vessel was transiting through a narrow strait near Knights Passage; 8 of 11 sightings from the helicopter were made in more open water where the distance between either side of the vessel and the nearest shore exceeded 2 nm. Our impression was that cows with calves did not approach the vessel, because on at least three different occasions (= 3 groups), all animals in these groups except the cow and calf rooster tailed toward the vessel as it passed within 0.5 nm.

For purposes of discussion, we assumed that all animals within a specified viewing distance which were not reacting to the vessel were, in fact, observed by the vessel observers (not tested yet and perhaps not true). Of those animals reacting to the vessel (28.7% of the total), 20.6% moved to the vessel (+), whereas only 8.1% moved away (-). If animals react negatively to a vessel in the same manner observed (proportionately) when outside a specified viewing range (e.g. 1 nm), then an estimate of the number of animals present on first approximation would be the difference of 20.6%-8.1% or 12.5% overcounting. This would mean that estimates of abundance are too high. However, the above assumptions could not be tested.

To ensure that the observed behaviors were in response to the ship and not the helicopter, we experimented with varying the helicopter survey altitude. Beginning at 500 ft (152 m) the helicopter descended on three separate pods of porpoise. The animals only exhibited an obvious response to the helicopter at altitudes of less than 100 ft (31 m).

## CONCLUSIONS

A final conclusion cannot be reached yet as to whether a significant number of Dall's porpoise either moved to or away from our survey vessel and thus bias any population estimate. Also, we do not know if there is an equal chance of animals being seen whether rooster tailing or slow rolling. If too few animals are seen to be slow rolling than expected on the Japanese salmon mothership fishing ground, and assuming the behaviors observed in Prince William Sound are the same as on the fishing ground, then an underestimate of the current population may occur. However, if animals move toward the vessel in greater numbers, for example, when rooster tailing, then the abundance estimates may be too high.

Future research of the behavior of Dall's porpoise is warranted. The following information is needed (a partial list):

1. Quantitative evidence of the frequency of the various sighting cues as a function of distance within a specified range from the census vessels, especially in the North Pacific Ocean.
2. Cross quantification of the above using an independent method -- for example, a helicopter, fixed-wing aircraft, or perhaps both, and a vessel with a high crow's nest.
3. Duplication of the August 1982 study should be made in Prince William Sound and/or on the Japanese salmon mothership fishing ground, and/or in other areas in the North Pacific Ocean.

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TABLE 1.--Summary by day of Dall's porpoise observed during the Prince William Sound behavior study.

| Date | No. Pods | Total Dall's | Mean pod size[1] | Standard deviation | 95% confidence interval |
|---|---|---|---|---|---|
| August 24 | 35 | 123 | 3.51 | 1.72 | 2.94-4.08 |
| 25 | 27 | 74 | 2.74 | 1.48 | 2.18-3.30 |
| 26 | 58 | 165 | 2.84 | 1.09 | 2.56-3.12 |
| 27 | 44 | 142 | 3.23 | 1.67 | 2.74-3.72 |
| 28 | 33 | 110 | 3.33 | 1.78 | 2.72-3.94 |
| $\Sigma$ $\overline{X}$ | 197 | 614 | 3.23 | 1.58 | 3.01-3.45 |

[1] Pod size was not different among days (P>0.05, Student's t-statistic).

TABLE 2.--Number of Dall's porpoise reacting to the vessel as a function of general sighting cue.

| Sighting cue or behavior | Movement to the vessel ( + ) | No net movement ( 0 ) | Moved away from vessel ( - ) |
|---|---|---|---|
| Slow rolling | 9 | 62 | 3 |
| Rooster tail | 28 | 55 | 12 |

TABLE 3.--Number of sightings of rooster tail versus slow roll made from the vessel by sighting intervals 0.5, 0.5-1.0, and beyond 1 nm. A Chi-square contingency test (adjusted for small samples) was not significant ($P>0.05$).

| Distance from vessel (nm) | Vessel | |
|---|---|---|
| | Slow roll | Rooster tail |
| >0.5 | 23 | 43 |
| 0.5-1.0 | 5 | 9 |
| >1.0 | 3 | 2 |
| | 31 | 55 |

TABLE 4.--Number of sightings of rooster tail versus slow roll made from the helicopter by sighting interval away from the vessel of 0.5, 0.5-1.0, and beyond 1 nm. A Chi-square contingency test was significant ($P<0.01$).

| Distance from vessel (nm) | Helicopter | |
|---|---|---|
| | Slow roll | Rooster tail |
| >0.5 | 9 | 10 |
| 0.5-1.0 | 4 | 9 |
| >1.0 | 29 | 7 |
| | 42 | 26 |

TABLE 5.--Number and movement of porpoise groups observed from the vessel versus distance intervals.

| Movement relative to vessel | Distance from the vessel (nm) | | |
|---|---|---|---|
| | <0.25 | <0.5 | >1.0 |
| 0 | 19 | 28 | 36 |
| + | 19 | 25 | 28 |
| - | 5 | 6 | 6 |

TABLE 6.--Information on the number and associated information on cow and calf pairs of Dall's porpoise.

| Cow and calf pairs (cows counted only) | | Summary of behavioral information | |
|---|---|---|---|
| Group size | No. of groups | Observed | Total Pairs |
| 2 | 5 | 0 | 11 |
| 3 | 2 | + | 0 |
| 4 | 2 | - | 0 |
| 5 | 1 | Slow roll | 7 |
| 6 | 1 | Rooster tail | 4 |
| 7 | 0 | Boat | 1 |
| 8 | 1 | Helicopter | 11 |
| Total | 12 | | |