PAPER

Dall's Porpoise Reactions To Tagging Attempts Using A Remotely-Deployed Suction-Cup Tag

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ABSTRACT

Remotely-deployable non-invasive (suction-cup attached) tags to record underwater behavior of cetaceans have recently been developed. How useful these tags are for applications on a broad range of species has yet to be documented. However, we attempted to use such tags to study the diving behavior of Dall's porpoise (Phocoenoides dalli) *in the trans-boundary area of British Columbia and Washington state, and report here on the feasibility of the technique, including the reactions of Dall's porpoise to tagging attempts. Tagging activities were undertaken in August 1996, while porpoises were bow-riding on a small vessel. We made 15 tagging attempts and 13 resulted in tag contact with a porpoise. No reactions were observed for the 2 misses, nor for 2 of the 13 hits. Of the 11 cases when tag reactions were observed, porpoises returned to continue bow-riding almost immediately in 7 cases, suggesting no long-term effect. Short-term reactions observed included a flinch (9 of 13 hits), tail-slap (1 of 13 hits) and high speed swimming away from the vessel (4 of 13 hits), with some hits resulting in more than one type of reaction. Three of 13 hits resulted in successful tag attachment. One tag remained attached for 41 minutes, providing the first diving behavior data for this species. Rates of descent and ascent, as well as swimming velocity, were relatively high only for the first 6-8 minutes after tag attachment, suggesting a reaction to tagging that lasted approximately 8 minutes.*

INTRODUCTION

Time-depth recorders (TDRs) have been used with several species of small cetaceans to study habitat use and sub-surface behavior (e.g., Martin and Smith, 1992; Scott *et al.*, 1993; Baird, 1994; Martin *et al.*, 1994; Westgate *et al.*, 1995; Davis *et al.*, 1996). The incorporation of time-depth recorders into radio tags allows for detailed collection of data on sub-surface activities, specifically depth of dives, dive "shape" or profile, and rates of ascent and descent. On small cetaceans, such tags have been deployed either by using captured or stranded animals and surgically attaching tags, or by remotely attaching tags to free-ranging animals using suction-cups. Capture operations can be both difficult and expensive, and they run a risk of injuring or killing animals. Deploying tags by remote methods can also be difficult. Crossbow deployed suction-cup tags often bounce off (Baird, 1994), and their large size necessitates a short firing range. Deployments by pole also have a limited range and are essentially restricted to species that bow-ride, or to larger, slower moving species that can be approached closely. On small cetaceans, remotely-deployed suction-cup tags have only been applied to killer whales, *Orcinus orca* (Baird, 1994), belugas, *Delphinapterus leucas* (Lerczak, 1995), Hector's dolphins, *Cephalorhynchus hectori* (Stone *et al., 1994*), short-finned pilot whales, *Globicephala macrorhynchus* (Baird and Amano, unpublished), and bottlenose dolphins, *Tursiops* sp (Schneider et al., 1998). Attempts with the first four of the aforementioned species were successful, and the technique of suction-cup tagging appears to be feasible for those species. Bottlenose dolphins, however, seem to react strongly to these tags (Schneider et al., 1998), so much so that Schneider et al. (1998) concluded that this form of tagging was unfeasible (at least with the population they worked with in Doubtful Sound, New Zealand).

Dall's porpoise (*Phocoenoides dalli*) seem to be numerous in the trans-boundary waters of British Columbia and Washington state (Baird and Guenther, 1994), and regularly approach vessels to bow-ride. Virtually nothing is known of the biology of this species in that area. We were interested in applying suction-cup TDR tags to Dall's porpoise for three main reasons: 1) To determine whether this technique was feasible for this species; 2) to record the reactions of Dall's porpoise to tagging and tagging attempts; and 3) to learn about their diving behavior. This report documents the reactions of Dall's porpoise to tagging attempts using a suction-cup tag, and discusses the feasibility of this technique with Dall's porpoise. Details on the diving behavior of this species, based both on one tag deployed remotely as well as five tags deployed on captured animals, are discussed by Baird and Hanson (in prep.).

METHODS

Tagging activities were based out of Victoria, British Columbia, Canada, and were undertaken in both Canadian and U.S. waters (primarily Haro Strait, but also Juan de Fuca Strait). The tag used was a modified version of one designed by J. Goodyear, which has been previously used with humpback (*Megaptera novaeangliae*), northern right (*Eubalaena glacialis*), fin *(Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*) (Goodyear, 1981, 1989, personal communication), and gray (*Eschrichtius robustus*) whales (Malcolm *et al.*, 1996), as well as killer whales (Baird, 1994), bottlenose dolphins (Schneider et al., 1998), and northern bottlenose whales (*Hyperoodon ampullatus*; S. Hooker and Baird, unpublished). The tag (total weight of about 340 grams) was composed of a 7.5 cm diameter black rubber suction-cup (available from Canadian Tire, Canada—used for automobile roof racks and removing dents from automobile fenders) attached with flexible plastic tubing (allowing the tag to swivel) to a flattened, oval tag body (which was covered with a thin layer of plastic).

For the purposes of reactions to tagging attempts, several details on the tag construction are relevant and presented below. Additional details on the tag construction and components can be found in Baird and Hanson (1996). The tag body was constructed of syntactic foam and contained a Wildlife Computers Mk6 TDR (500 m depth data collection capacity, 2 m depth resolution), and a VHF transmitter with a 44 cm custom built wire antennae. A custom-built magnesium release system (designed by J. Goodyear) was incorporated into the suction-cup, limiting the maximum duration the tag would remain attached. The inner surface of the suction-cup was coated with silicone grease (Dow Corning 111 Valve Lubricant and Sealant) prior to tagging attempts. The tag was designed so as to float upright, with the antennae clear of the water's surface, after detaching from an animal.

The TDR had three sensors which were activated, a pressure (depth) sensor, a velocity sensor, and a salt-water switch. The accuracy of the pressure sensor was previously tested by subjecting the TDR to known pressures using a pressure chamber, and comparing the depth readings measured by the TDR. The sampling rates for the sensors were set at once per second. The velocity sensor on this tag calculates velocity based on the number of turns of a turbine, such that with a one second sampling rate the resolution of the sensor is 0.1 m/sec (M. Braun, Wildlife Computers, personal communication). However, given that flow characteristics should differ depending on the precise position of the tag on the body, accurately calibrating velocity meters is difficult. As such, we have used our velocity readings as an index of speed, rather than a precise measure (a similar approach to that taken in some other studies of diving mammals—McConnell *et al.*, 1992). Upon retrieval from a tagged animal, data were downloaded to a PC in two ways, as a straight ASCII file, and as a hexadecimal file (to be used with Dive Analysis software, provided by Wildlife Computers, Redmond, WA).

When weather conditions permitted, we traveled through the study area using a 7 m boat, looking for Dall's porpoise in areas of known abundance (see Baird and Guenther, 1994). When porpoise were sighted, the vessel was slowed and maneuvered in the direction of the animals. Tagging attempts were made while positioned on the bow of the vessel, with the tag attached to the end of an extension (2–4 m) pole. When porpoises approached the vessel to bowride, the pole (with tag attached) was held over the front of the boat. When a porpoise surfaced directly in front of or beside the bow of the research vessel, an attempt to tag could be made by bringing the suction-cup quickly in contact with the dorsal surface of the porpoise between the blow hole and the dorsal fin.

Several conditions were required before tagging attempts could be made, including relatively calm seas, suitable light conditions, slowly swimming porpoises, and no other boats in the immediate area. Relatively calm seas (Beaufort 0 or 1) were necessary in order to see the animals prior to surfacing and allow for proper pole placement. Extremely rapid movement of the pole would sometimes result in dislodging of the tag from the pole end; thus some prior warning of where a particular porpoise was going to surface was necessary for an attempt. Suitable light conditions were also important. Seeing animals below the surface was facilitated by having the sun behind the vessel and fairly high in the sky, again allowing for proper placement of the pole prior to an attempt. Porpoise swimming speed also affected our ability to tag; if porpoises were traveling quickly, surfacing occurred too fast for tagging attempts to be made.

We did not attempt to tag when other boats were within the immediate vicinity. The area where tagging operations were taking place is a region of high vessel traffic, including commercial whale watching operations which focus some of their attention on Dall's porpoise. To minimize any negative public reactions resulting from observations of tagging activities (without being able to explain the nature and goals of the project and the potential reactions of the animals), we discontinued tagging attempts when other vessels approached within a few hundred meters (this occurred quite frequently). Porpoise group size was recorded as the maximum number of individuals present at the time of a tagging attempt using a 5 m "chain" rule (ie., a porpoise was a member of the group if it was within 5 m of any other member, cf. Smolker et al. 1992). As much as was possible (limited mainly by our ability to keep track of targeted animals), the behavior of the targeted animals (always bowriding at the time of a tagging attempt) and other animals in the group were recorded after tagging attempts. Monitoring of a VHF receiver was undertaken for the entire period when an individual was tagged.

RESULTS AND DISCUSSION

Dall's porpoise were encountered on 7 days over a 10 day period in August 1996. There were a total of 15 tagging attempts (of which 13 were hits). Reactions of Dall's porpoise to tagging attempts was varied (Table 1). Not all attempts resulted in a visible reaction. No reaction was observed in either case when the tag did not make contact with a porpoise, and 2 of 13 hits resulted in no visible reaction by the animal. Three other "types" of immediate reactions were noted: a flinch (9 of 13 hits), a tailslap (1 of 13 hits), and high speed swimming away from the vessel (4 of 13 hits) (though on some occasions two of these reactions were seen by the same animal). For the 11 cases where an immediate reaction was seen, individuals either continued bowriding or returned to the boat to bowride in 7 cases, suggesting no long-term impact, despite the short-term reaction. Three of the 13 hits were successful in attaching, though only one remained attached for an extended period (41 minutes). The short durations of the other two attachments (less than 2 minutes each) may have resulted from an air leak in the suction-cup (discovered later). For all three attachments, the porpoise swam quickly away from the boat. It was not possible, however, to determine whether the animals would have returned to bowride, as the boat was also stopped at that time to try to track the tagged animal.

We were able to obtain the first data on diving behavior of this species—for one individual tagged for 41 minutes on 9 August 1996, in the U.S. waters of northern Haro Strait. The tag was attached at 1203 hrs (local time), and came off the animal at 1244 hrs. Strong VHF signals were received on 5 occasions during the first few minutes after the tag was attached, and two signals were received about 33 minutes after tag attachment. The time of tag detachment was clearly indicated by the reception of strong, continuous VHF signals (as the tag floated at the water's surface with the antennae clear of the water). Very few signals were received during the period the tag was attached because the tag probably slid down along the side of the body of the animal, and the antennae was not above the water's surface. Sliding of suction-cup tags has been previously observed on killer whales (Baird unpublished).

The porpoise was not visually re-sighted during the period when the tag was attached, though no effort was made to follow the individual due to the lack of VHF signals. The tag was recovered within 2 kilometers of where the animal was originally tagged—evidence that it stayed in the general vicinity of where it was tagged. The sex of this individual was not known. Body size was estimated in the field to be about that of a sub-adult (approximately 50 kg), thus relative tag weight was estimated to be about 0.7 percent of body weight.

The animal's reaction to tagging was apparent in the TDR data (Fig. 1). During the first few minutes following attachment, the animal remained close to the water's surface (within the top 2–6 m), before beginning a series of deeper dives. Examining the rates of descent and ascent during the first few deeper dives (Table 2) suggests that the animal was diving faster during the first few minutes then for the remainder of the tag attachment. Velocity readings are also highest during the first eight minutes of the tag attachment (Fig. 2). These velocity readings, however, are not particularly high for this species. Law and Blake (1994) measured swimming velocity of free-swimming Dall's porpoise using video recordings of surfacing animals, obtaining velocities of 3.4 to 6.0 m/sec (mean of 4.3 m/sec) for "rooster-tailing" (ie., fast swimming) animals, and 1.6 to 2.1 m/sec (mean = 1.8 m/sec) for "slow rolling" animals. Readings from our tagged animal were only within the range which Law and Blake (1994) recorded for rooster-tailing animals during the first four minutes after tagging. As noted above, however, accurate calibration of the velocity meter is difficult, thus readings given probably differ from the actual speed of the animal.

Table 1. Tagging attempts where a reaction was observed. Each line represents a different tagging attempt

Date	No. Animals[1] Responding	Behaviour During Attempt[2]	Behaviour After Attempt	Tag Attachment (yes/no)
8 August	1	flinch	bowriding	no
8 August	1	flinch	bowriding	no
9 August	1	flinch	bowriding	no
9 August	1	flinch	bowriding	no
9 August	2	tailslap by 1, high speed swimming away by both	high speed swim away	yes (41 min)
10 August	4	flinch by 1, high speed swimming away by all	social	no
10 August	1	high speed swimming away	high speed swim away	yes
10 August	4	flinch by 1, high speed swim away by all	high speed swim away	yes
12 August	1	flinch	bowriding	no
12 August	1	flinch	bowriding	no
15 August	1	flinch	bowriding	no

[1]Only one tagging attempt was made in each case—when the number of individuals given is greater than one, reactions were also observed for nearby (always less than 5 m) individuals.
[2]Behaviour before tagging attempts in all cases was bowriding.

A closer examination of the velocity data in relation to depth sheds further light on the duration of disturbance. Swimming speed generally decreased with an increase in depth during the first six-minutes (from 1206 to 1212 hrs) after the animal began to dive below 4 m in depth (regression, $r = -0.675$, $n = 359$). We suggest this relationship may reflect the individual's avoidance of the surface waters, as a reaction to the tagging attempt. For the rest of the time the tag was attached the relationship was reversed; swimming speed generally increased with depth, although this relationship was not as strong (regression, $r = 0.295$, $n = 1924$). Combined with the decrease in the rates of ascent and descent after the first few minutes, this change in behavior over time leads us to believe the animal was no longer "disturbed" after the first 6 or 8 minutes of tag attachment.

In conclusion, we were able to demonstrate that it is possible to tag Dall's porpoise, at least for relatively short periods of time, using a remotely-deployed suction-cup attached tag. Dall's porpoises reacted much less to tagging attempts and tag attachment then did bottlenose dolphins, using virtually the same tag and methods. While Schneider *et al.* (1998) concluded that the population of bottlenose dolphins they were studying (in Doubtful Sound, New Zealand) did not appear to be taggable using this technique, our results indicate that this technique appears feasible to use with Dall's porpoise. Five tags deployed on captured Dall's porpoise by Baird and Hanson (in prep.) remained attached from 2.8 to 18.8 hours, thus longer-duration attachments using a pole system also seem possible. While using captured animals may result in more tags being deployed in equivalent amounts of time, both the costs and logistics involved in capture operations are greater, thus pole-deployment may be the preferred method under some circumstances. Further studies with this technique should lead to a greater understanding of the diving behavior and habitat use of this, and other species, of small cetaceans.

Figure 1. Profile of Dall's porpoise dive depth over the 41 minute tag attachment.

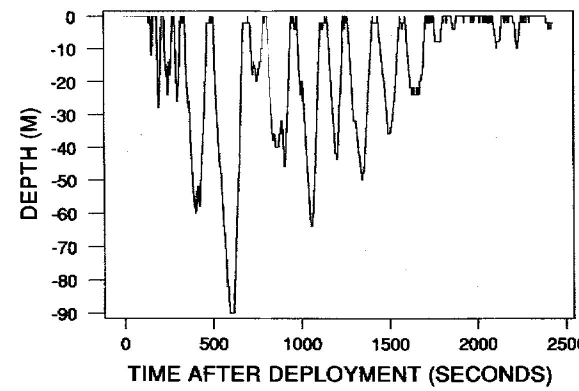
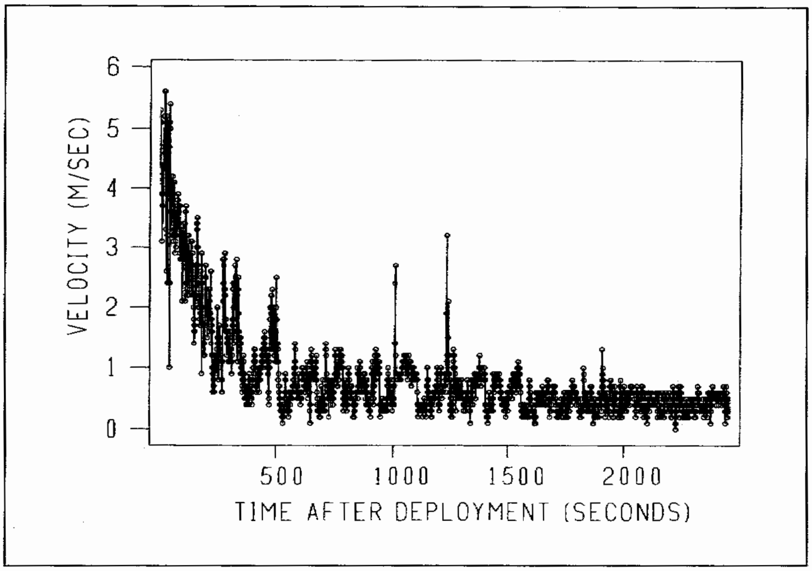


Table 2. Characteristics for all dives at least 4 m in depth[1].

Dive No.	Start Time of Dive	Maximum Depth (m)	Duration (min)	Bottom Time[2] (min)	Average Rate of Descent[3] (m/sec)	Average Rate of Ascent[3] (m/sec)
1	12:06:04	14	0.2	0.08	3.43	3.43
2	12:06:39	30	0.45	0.13	3.47	2.26
3	12:07:21	26	0.75	0.1	1.45	1.07
4	12:08:19	28	0.57	0.15	2.09	1.78
5	12:09:18	60	2.12	0.73	1.17	1.35
6	12:12:02	94	2.78	0.75	1.09	1.65
7	12:15:29	20	1.2	0.55	1.44	0.68
8	12:17:07	46	2.18	1	0.94	1.4
9	12:19:57	64	2.15	0.4	0.85	1.42
10	12:22:50	44	1.4	0.35	1.07	1.38
11	12:24:45	50	2.28	0.48	0.7	0.97
12	12:27:38	36	1.97	0.52	0.69	0.79
13	12:30:14	24	1.82	0.92	0.98	0.7
14	12:32:55	8	0.72	0.53	1.78	1.23
15	12:34:41	4	0.22	0.2	—	—
16	12:38:32	10	0.7	0.02	0.61	0.39
17	12:40:31	10	0.47	0.12	1.05	0.87
Mean (SD)		33.4 (23.9)	1.29 (0.84)	0.41 (0.31)	1.43 (0.88)	1.34 (0.73)

[1]With a 2-m depth resolution of the TDR, 4 m was the minimum depth that could be considered a "dive".
[2]Bottom Time was calculated as the amount of time spent below 85% of the maximum depth.
[3]Average rates of descent and ascent calculated using depth versus time data, not using the velocity sensor.

Figure 2. Profile of Dall's porpoise velocity over the 41 minute tag attachment.



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