Studying Diving Behavior of Whales and Dolphins Using Suction-Cup Attached Tags

by Robin Baird

Tagging whales with radio transmitters (either VHF or satellite-linked) or sensors which record depth, swimming speed, or other parameters can provide details on the movement patterns and behavior of a species. Methods for putting such tags on whales and dolphins have typically involved capturing the animals and pinning the tags onto the dorsal fin or dorsal ridge, or using tags which can be put on free-living animals but which penetrate the skin to anchor into the blubber. While these methods are necessary in many studies, especially for those in which long-term or long-distance information is required, there is an alternate method for short-term attachments which does not require capturing the animals or penetrating the skin. This approach uses remotely-attached suction-cup tags. Here I give information on the history of this technique, some details about methods, and talk about some of the limitations. Despite the potential situations where suction-cup tags may be valuable or even the most "appropriate" method for attaching instruments on cetaceans, many limitations to this method exist.

In 1981, Jeff Goodyear developed a method of putting radio tags on free-swimming whales without penetrating the skin. He used suction-cups to put VHF radio tags on humpback, minke, and fin whales which were released from fishing gear off Newfoundland. Later uses of suction-cup attached VHF tags to study short-term movements and nighttime behavior were conducted with humpback whales off Newfoundland and off Massachusetts, fin whales off Mexico (Goodyear 1986), and right whales in the Bay of Fundy. Despite the early promise of this technique, over the next 10 years only Goodyear and a few others used suction-cup attached tags. Many cetaceans were radio-tagged in the 1980s, but scientists continued to use traditional methods, using tags which penetrated the skin and remained attached for longer periods. It has only been in the last few years that a number of other researchers have picked up on Goodyear's pioneering work and have demonstrated its true value as a technique in the study of diving behavior, habitat use, and nighttime behavior of a variety of species. These studies have involved deployments of VHF tags on free-swimming Hector's dolphins in New Zealand (Stone et. al. 1994), and beluga whales in Alaska (Lerczak et. al. in preparation), as well as time-depth recorder (TDR)/VHF tags on killer whales and Dall's porpoise in British Columbia and Washington State (Baird 1994, Baird and Hanson 1996, Baird et al. 1998), northern bottlenose whales off Nova Scotia (S.K. Hooker, unpublished), fin and blue whales in the Gulf of St. Lawrence (Giard 1996, Giard and Michaud 1997), gray whales in Mexico and off British Columbia (Harvey and Sumich 1993, Malcolm et al. 1996), short-finned pilot whales off Japan (R.W. Baird and M. Amano, unpublished), and bottlenose dolphins in New Zealand (Schneider et al. 1998).

Suction-cups used for these studies are easily available and inexpensive (I use automobile roof rack suction cups available for about $2 each from a major tire chain store in Canada). After a few minor modifica-

A juvenile "transient" killer whale (M9) with a prototype suction-cup VHF tag off Victoria, October 8, 1991. This was the first time a radio tag was remotely applied to a wild dolphin. Photo by Robin Baird.

tions, a cup is attached to a tag body with either a flexible (plastic tubing) or inflexible (wire) connection. The stock of the suction cup has a pre-formed hole which conveniently fits a crossbow arrow, so they can be put onto animals up to five meters or more away using a crossbow (I use a 150-pound pull bow). The tags are also held firmly against the crossbow arrow with a small wire clip. Crossbow-deployed tags frequently bounce off when hitting an animal, so with this technique, many attempts are needed for each successful tagging. For species which bowride or which can be easily approached closer than five meters, it is easier to attach the tag onto the end of a pole and apply it simply by hitting the suction-cup against the body of the animal. The tags I currently use contain off-the-shelf components, including a TDR with a velocity sensor and a VHF radio transmitter. These components are housed in a block of syntactic foam, which remains buoyant at depths of 1000 meters or more. The foam can either be mixed into a custom-shaped mold, or a pre-made block can be carved to fit the components and weighted so that when it falls off an animal it floats with the antenna clear of the water. I have used tags of a number of different shapes (following the original concept and designs of Goodyear), and currently use an oval-shaped tag which seems to fly through the air fairly well. Once a tag falls off, the VHF signals can be picked up from several miles away, and the tag is recovered. To speed up tag release I have used a timed-release mechanism on the suction cup (designed by Goodyear), which involves a magnesium cap on the end of a tube which fits through the cup. This cap corrodes in salt water and causes the cup (and the attached tag) to release after a period of time. Many of these tags stay on longer than expected, since the rate at which the magnesium corrodes varies according to temperature, salinity, and the amount of movement through the water. However, some tags fall off much sooner than the mechanism is designed for, often prompted by long-term high speed movements of the tagged animal. On many recent deployments I have done away with the release mechanism completely, and waited until the cups fell off on their own.

Such tags can provide extremely detailed information on diving behavior, habitat use, and nighttime behavior, sampling such parameters as depth, velocity, light levels, and water temperature at rates up to once per second. The short-term attachments generally mean that memory limitations in the TDR are not important. Perhaps the most convincing demonstration of their potential is the work of Janie Giard and Robert Michaud of GREMM (Groupe de Recherche et d'Education sur le Milieu Marin) in Tadoussac, Quebec. This team has deployed and recovered 24 data-logging tags in the last few years on fin whales, with attachment durations ranging from 23 minutes to 78 hours (averaging just over 15 hours), collecting a total of 382 hours of subsurface behavioral information (Giard 1996, Giard and Michaud 1997). Twelve of their tags remained

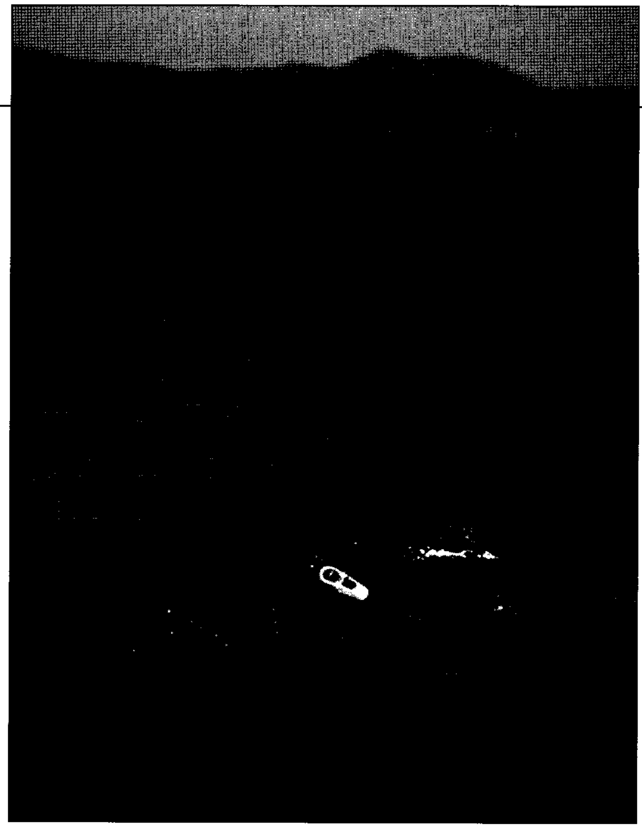
A suction-cup TDR/VHF tag attached to a crossbow arrow, ready for deployment. Photo by Robin Baird.

attached for complete 24-hour cycles. The tags were positioned using the pole method, and the whales showed reactions that could best be described as "low-level" or non-existent.

The animals I have worked with the most, killer whales, show little or no reaction to tagging attempts or tag attachment (Baird 1994). As of April 1998, I have deployed 22 suction-cup tags (21 of which included a TDR) on killer whales, for periods ranging from 15 minutes to 31 hours (an average of about 10 hours per attachment). The tag I currently use weighs about 330 grams, and is deployed using a crossbow. The typical reaction of a killer whale to crossbow-deployed tags involves a slight flinch and/or a faster dive; many individuals have shown no visible reaction. However, one species for which this technique has been tried has shown strong-level reactions to remote suction-cup tagging. A study by Schneider et al. (1998) of bottlenose dolphin reactions to suction-cup tagging attempts in the deep water fjords of southwestern New Zealand suggests that individuals in this population (and possibly other populations of bottlenose dolphins) may not be 'taggable' using this technique. In 17 attempts using either a pole- or crossbow-deployed tag on bowriding dolphins, five successful attempts resulted in only short-duration attachments (less than a few minutes). The tagged dolphins swam at speed and made spectacular leaps, in an apparent attempt — always successful — to dislodge the tags. Reactions were both prolonged and of high intensity, and other dolphins nearby also reacted to these attempts.

It is not surprising, however, that there is considerable variability between species or populations in how they react to suction-cup tagging. In 1996 we attempted to apply suction-cup tags to bowriding Dall's porpoise (a very fast swimming species) with considerably more success and much less reaction (Baird and Hanson 1996). Then, in May 1997, as part of an ongoing project to VHF radio tag Dall's porpoise which involved capturing the animals, Brad Hanson and I applied suction-cup tags to three captured individuals. This project demonstrated one potential use of suction-cup attached tags — as a method of monitoring post-release behavior for studies which involve capturing animals. One of our tags on a Dall's porpoise remained attached for 13 hours (the others remained attached for three and seven hours), collecting information on dive depth and swim speed continuously for the entire period.

The results this technique can produce can be found in my ongoing study of the diving behavior of killer whales. Like virtually all other behavioral research with cetaceans, studies of killer whales have focused almost exclusively on those behaviors visible at the water's surface. Such studies have concluded



An adult male "resident" killer whale (L44) with a suction-cup attached TDR/VHF radio tag, swimming off Saturna Island, British Columbia, June 14, 1997. Photo by Robin Baird.

that salmon (particularly chinook salmon, the largest species) are the primary prey of the so-called "resident" killer whales when they utilize the calm, inshore waters on the coast of British Columbia and Washington State each summer (Bigg et al. 1990). TDR attachments on foraging animals in 1993, 1996, and 1997 all show occasional dives down to 100 meters (328 feet) or more (Baird 1994, Baird et al. 1998). However, salmon are concentrated in the top 20 or so meters (65 feet) of the water column, thus these deep dives probably represent regular feeding on bottom or mid-water fish. Similarly, the general consensus was that nighttime activities of killer whales were similar to activities during the day. One overnight deployment in 1996 cast the first doubt on this assumption, as the whale basically spent the entire night swimming slower, shallower, and more regularly than have all previous animals in daylight (including that particular individual during the seven or so hours of daylight immediately following attachment of the tag). Nine tag deployments which include nighttime data from 1997 also support the hypothesis that killer whales show a distinct diurnal pattern, with much less activity at night than during the day. Continued work planned for 1998 should shed further light on these questions. To date, I have deployed only one TDR on a "transient" killer whale, but the dive characteristics differed from all "residents" for which I have TDR data (Baird 1994,

A suction-cup TDR/VHF tag about to hit a short-finned pilot whale off Hokkaido, Japan. Two tags were attached to pilot whales in this study, a collaborative project between Drs. Masao Amano and Robin Baird. Photo by Seiji Yoshida.

unpublished). If further deployments on "transients" support such differences, this will be another example of the extreme behavioral and ecological differences between these two types of killer whales (e.g., Baird and Dill 1995, 1996).

I believe these non-invasive, remotely-deployed tags may be the best way of studying diving behavior, habitat use or nighttime behavior of cetaceans in at least four different situations: (1) in many studies the logistics or costs associated with capturing animals are prohibitive, and some penetrating tags which transmit dive information (i.e., satellite-linked tags) are relatively expensive. Suction-cup attached TDRs are less expensive, and recoverable (I have yet to lose one); (2) in some areas, politics (e.g., pressure from animal rights groups or scientists who disagree with such methods) make using penetrating tags or capturing animals undesirable or impossible. Suction-cup attached tags are often perceived as a much less intrusive method for collecting similar data; (3) some researchers may feel that it is ethically inappropriate to use penetrating tags or to capture animals. On the majority of species on which they have been used, suction-cup attached tags appear to cause only low-levels of short-term disturbance; and (4) for some specific research projects, the questions being asked warrant large numbers of animals tagged for short periods of time, rather than small numbers of animals tagged for long periods. Since suction-cup tags are less expensive (at least less so than satellite-linked tags), recoverable, and reusable, multiple deployments may be a more feasible goal with these tags, considering the limited budgets of many researchers. Also, the information they collect can be of extremely high resolution (e.g., depth and velocity sampled once per second), giving a much less biased picture of the real underwater behavior of these animals than can be obtained with satellite-linked TDRs. When the technique is adopted by researchers working on additional species and in broader geographic areas, and when detailed analyses of the current studies are published, I suspect data collected from tags attached to free-swimming animals using suction-cups will begin to play a more important role in our understanding of the behavior of whales and dolphins beneath the water's surface and at night.

Robin Baird is currently working as a post-doctoral fellow supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) in Hal Whitehead's lab at Dalhousie University in Halifax, Nova Scotia, Canada. His research focuses on the sub-surface and nighttime behavior of "resident" and "transient" killer whales. Robin Baird can be reached by e-mail at: rwbaird@is.dal.ca or by snail mail at: Biology Department, Dalhousie University, Halifax, Nova Scotia, B3H 4J1 Canada. More information on this technique and results of some of these studies can be found at: http://is.dal.ca/~whitelab/labrwb.htm.

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A northern bottlenose whale with suction-cup attached tag, in the Gully, off Nova Scotia, July 9, 1997. Photo by Robin Baird.

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