Beaked Whale Science Coming of Age

Progress From Hawai‘i

By Robin W. Baird

Not so long ago many authors, myself included, regularly started talks and papers on beaked whales with a common phrase, something along the lines of “beaked whales are perhaps the least known group of large mammals.” In a very short period of time that has changed. A couple of the 21 species of beaked whales recognized today are now among the most-well known species of cetaceans world-wide. This change for these species has been driven by the recognition that beaked whales, as a group, appear to be more susceptible to the impacts of navy mid-frequency sonars than any other group of cetaceans, followed by the investment of a tremendous amount of resources – money from the U.S. Navy and others, and time, patience, and ingenuity by a number of different research groups. Prior to this recent surge in research activity, knowledge of non-stranded (living) beaked whales was only slowly accumulating. Hal Whitehead and his graduate students were studying northern bottlenose whales far offshore of Nova Scotia, in the “Gully,” Diane Claridge and others were studying Blainville’s beaked whales in the Bahamas, and other researchers scattered around the world were occasionally collecting photographs and observations, incidental to other projects. But encounters were limited, by the deep-water (typically offshore) habits of the species, their long dive times, and the difficulty in finding or approaching them in anything other than ideal conditions.

I saw my first beaked whale in 1987, a dead Hubbs’ beaked whale on the outer Washington coast, and had the opportunity to collect the skeletons from a couple other dead beaked whales in British Columbia. I was very lucky to be able to participate in working with live northern bottlenose whales off Nova Scotia for three summers in the mid-1990s, but there are few other opportunities for working with beaked whales in the wild. In 1999 when I started working off Maui, Hawai‘i, I called Jim Watt, a professional photographer living in Hawai‘i who had taken amazing underwater photographs of Blainville’s beaked whales off the west coast of the island of Hawai‘i. I asked him whether he thought there were particular places that beaked whales could be reliably found, and thus presumably studied, in Hawai‘i. He laughed, and explained that his few good underwater photos were taken in one or two encounters spread over many years of boating off the island.

It wasn’t until April 2002 that I started working off the island of Hawai‘i, in deep-water areas where beaked whales could be found. At first our work was not focused on beaked whales – the funding we had in April 2002 was to study bottlenose dolphins. On our 10th and last day on the water for that trip, just 18 minutes after leaving the harbor, we came across our first beaked whale, a lone female *Mesoplodon*. We were incredibly excited just at being able to get photos, expecting to lose the whale at any moment. But it continued to surface and we decided to try to collect a skin biopsy sample. We were successful - I think this was the first biopsy sample

Adult female Cuvier’s beaked whale in Hawai‘i. Photo © Robin Baird www.cascadiaresearch.org

collected from a free-ranging *Mesoplodon*. From the sample, the genetics lab at the Southwest Fisheries Science Center was later able to confirm that it was a Blainville's beaked whale. Ten minutes after the biopsy we were able to approach closely again and get more photos – certainly encouraging in terms of being able to work with this species in the future, despite how infrequently they might be encountered. Two years later when we had accumulated enough photos to set up our own photo-identification catalog, this individual became HIMd007 in the catalog, first seen by Dan McSweeney in 2000, and an individual we would see repeatedly in the future.

Juvenile Blainville's beaked whale with a suction-cup attached time-depth recorder, used to document the extremely long (up to 83 minutes) and deep (to 1,599 m.) dives of this species, and to model gas exchange to help understand the susceptibility they have to decompression sickness. Photo © Robin Baird/www.cascadiaresearch.org

Several mass strandings of beaked whales have been documented around the world associated with navy exercises, including Greece, the Bahamas, and the Canary Islands. The exact cause or causes of the strandings remain unclear, but the leading contender is that high-intensity mid-frequency sonar causes a behavioral reaction by the whales, which leads to decompression sickness. Since so little was known of the behavior of beaked whales until recently, much of the recent work has been funded, primarily by the U.S. Navy (but also supported by the National Marine Fisheries Service and several non-profit foundations), to try to understand more about their natural diving behavior and the implications it may have for sonar impacts.

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Over the years our beaked whale sighting rate has improved a bit – we've now worked off the island of Hawai'i in each of the last eight years, spending 303 days on the water and covering over 35,000 kilometers of trackline. On average we've encountered beaked whales a little bit more often than once every four days of field effort, although that has varied tremendously. We've had two field efforts each lasting 12 days with no beaked whale sightings in either, and another lasting 12 days with five different sightings. I think there were just as many beaked whales in the area during the 12 day periods with no sightings as the 12 day period with five sightings, but with dives of over an hour and their low surfacing profile, beaked whales are easy to miss. Despite our relatively low encounter rate, eight years later more is now known about the Hawaiian populations of both Blainville's and Cuvier's beaked whales than most populations of whales and dolphins anywhere in the world. A collaboration with Dan McSweeney, a researcher working off the island since the mid-1980s, has played a large role in this – while working with other species Dan has been taking beaked whale photographs opportunistically since the mid-1980s, and combined with our photos this has resulted in the longest-term photo-identification catalogs available for either species world-wide, allowing us to examine social organization and long-term site fidelity.

Another major factor in increasing our knowledge about beaked whales has come from using suction-cup attached time-depth recorders to study their diving and night-time behavior. Deploying and recovering such tags (we need to get them back in order to download the data) has only been possible through a team approach, and I've been lucky to work with Daniel Webster, Allan Ligon, and Greg Schorr on this endeavor. Over the years we've deployed suction-cup attached time-depth recorders on 11 individual Blainville's beaked whales and three Cuvier's beaked whales, and recovered all but one of them. The data from these tags have provide detailed looks into their sub-surface behavior and night-time activities on a minute-by-minute basis, with tags lasting an average of 24 hours, and one staying on almost 79 hours. From the suction-cup attached tags we know that both species feed very deep in the water column, regularly diving below 1,000 meters (as deep as 1,599 meters), for

dives that often last over an hour (as long as 94 minutes for one Cuvier's beaked whale). They do these deep and long foraging dives day and night.

Beaked whales have a reputation for being difficult to approach, and many people seem to think they are unpredictable in their behavior. But spending time tracking groups, often with the aid of VHF transmitters in the suction-cup attached tags, has shown the behavior of both Cuvier's and Blainville's beaked whales to be fairly predictable, as long as you know where, or when, in the dive cycle they are. The long and deep dives come with a cost – the whales, especially Blainville's beaked whales, both take a while to recover from the dives, and prepare for them ahead of time. So one 70 minute dive is followed by, and usually proceeded by, a series of 30 to 40 short dives each to just a few meters deep and with 5 to 10 seconds between each surfacing. So if your first observation of a beaked whale group involves such repeated surfacings, then you have to wonder whether they are preparing for a 60+ minute dive, and you are unlikely to ever see them again, or recovering from one, and their next "long" dive will be just 10 to 15 minutes long. Blainville's beaked whales at least move very slowly, often just a few hundred meters on a 15-minute dive, so you certainly have a reasonable chance of re-locating a group. One of the reasons why people consider beaked whales to be unpredictable is the lack of a clear relationship between the direction they are pointing when surfacing and where they are going to come up from their next dive. But when you are able to track groups over hours, rather than minutes, it becomes clear that they follow patterns, often traveling in a straight line for several hours, regardless of their surface orientation.

Learning such travel patterns, how far they move when on dives of 10 minutes or 60 minutes, has allowed us to make the most of the few encounters we have, in some cases deploying more than one time-depth recorder on individuals within the same group, to examine group coordination, or to deploy other types of tags. Starting in 2006 we've been using satellite tags to understand larger-scale and longer-term movements of beaked whales. Like other aspects of our study, this work has been a collaborative, effort: Greg Schorr from Cascadia, working with Russ Andrews of the Alaska SeaLife Center/University of Alaska Fairbanks, and Brad Hanson of the Northwest Fisheries Science Center, have refined deployment systems and remotely deployable satellite tags for use with beaked whales and other species. These tags were first used by Russ with killer whales, attaching with titanium darts to the dorsal fin. These we don't get back - they transmit to orbiting ARGOS satellites, and the locations of the tagged whales are determined from multiple "hits" to a satellite as it passes overhead. Since 2006 we've satellite tagged 10 Blainville's beaked whales and five Cuvier's beaked whales in the area, providing continuous movement and habitat use information over periods of days to months, rather than based only on sightings every four or so days on the water. We don't get all locations – a satellite has to be passing overhead during a period when a whale surfaces multiple times, and given the infrequency of satellite passes and the long dive times of beaked whales, these two do not always come together as often as we'd like.

Because of the large number of white scars caused by cookie-cutter sharks, we are able to recognize almost every individual we encounter using photographs. Unlike most other species, where photos need to be taken from a perpendicular angle to the dorsal fin, the scars create unique patterns that can be recognized from photos that are quite off angle, which is important since some times we are not able to get as close as we'd like, or at the right angle. These scars allow us to track individuals over time and determine that the scars re-pigment only very slowly, over periods of nine years or more. From these photographic records we've been able to determine that both the Blainville's and Cuvier's beaked whales exhibit long-term fidelity to the island of Hawai'i, with repeated sightings of individuals over spans of up to 17 years. Based on sighting frequency the density of both species in our study area is very low, much lower than off the Bahamas or the Canary Islands. We have evidence based on the photo-identification work that there are two

The tip of the jaw on the Blainville's beaked whale typically clears the water on surfacing. This adult male's two erupted teeth are not visible because they are covered with stalked barnacles. Photo © Robin Baird www.cascadiaresearch.org

populations of Blainville's beaked whales that we encounter, a small resident island-associated population, and an offshore population, presumably with individuals that just move through the area. Given where we work most of our encounters and most of the information we've collected on diving behavior and movement patterns are from individuals that are part of the island-associated population, but we have obtained some dive data (from a suction-cup attached time-depth recorder) and some movement information (from a satellite tag) from individuals we believe are part of the offshore population. Diving behavior of the island-associated and the one offshore individual Blainville's beaked whale were similar, although the offshore individuals was foraging in mid-water, while the island-associated individuals were likely foraging near the bottom, both with dives to 1,300 – 1,400 meters.

We've also used the photographic identifications to get an idea of how large the populations are, using mark-recapture methods. For Cuvier's beaked whales, the population that used the west side of the island of Hawai'i from 2003-2006 was estimated to be just 56 individuals. For Blainville's beaked whales, the estimate is higher (140 individuals), although this number includes both the island-associated population and some unknown number of individuals from the offshore population.

Adult female Cuvier's beaked whale high-speed surfacing. This individual is missing the rostrum, either through congenital defect or injury. Photo © Robin Baird/www.cascadiaresearch.org

From the tagging and photo-identification work we've determine that the populations are small and individuals show strong site fidelity, both over periods of weeks to months (based on the satellite tag data) and years (based on the photo-identification). Hawai'i is home to a major U.S. Naval base, and is regularly the site of naval exercises involving mid-frequency active sonar, the same sonar that has been implicated in a number of atypical mass stranding events of beaked whales elsewhere. The small population size and their susceptibility to impacts puts both populations at risk. We do not yet have enough information to monitor trends in either population, but this will be necessary in order to assess what types of impacts sonar associated with navy exercises may be having on these populations.

Opportunity, perseverance and some high tech tags have greatly expanded our knowledge of both of these species in Hawai'i. Combined with work on these same species, by Natacha Aguilar, Mark Johnson and others in the Canary Islands, and Diane Claridge, John Durban and others in the Bahamas, and by Eletta Revelli, Massimiliano Rosso and others in the Mediterranean, more is now known about Cuvier's and Blainville's beaked whales than the majority of species of whales and dolphins. This information has helped us understand why these species are susceptible to impacts from naval sonars, and helps direct efforts for conserving their populations.

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For many years his research focused on marine mammals in British Columbia. His current research interests focus on the biology and behavior of killer whales, cetacean diving behavior, and population assessment of Hawaiian odontocetes.
Robin has authored numerous research papers and publications, as well as a popular book on killer whales (Voyageur Press, 2002). More information on his research in Hawai'i can be found at www.cascadiaresearch.org/robin/hawaii.htm.

Additional photos and a variety of references on beaked whales in Hawai‘i and elsewhere are available at www.cascadiaresearch.org/robin/beakedwhales.htm including:

Baird, R.W., D.L. Webster, G.S. Schorr, D.J. McSweeney and J. Barlow. 2008. Diel variation in beaked whale diving behavior. Marine Mammal Science 24:630-642.

Baird, R.W., D.L. Webster, D.J. McSweeney, A.D. Ligon, G.S. Schorr, and J. Barlow. 2006. Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris)* beaked whales in Hawai‘i. Canadian Journal of Zoology 84:1120-1128.

Faerber, M.M., and R.W. Baird. 2007. Does a lack of beaked whale strandings in relation to military exercises mean no impacts have occurred? A comparison of stranding and detection probabilities in the Canary and Hawaiian Islands. Talk presented at the 17th Biennial Conference on the Biology of Marine Mammals, Cape Town, South Africa, November-December 2007.

Hooker, S.K., R.W. Baird, and A. Fahlman. 2009. Could beaked whales get the bends? Effects of diving behaviour and physiology on modelled gas exchange for three species: *Ziphius cavirostris, Mesoplodon densirostris* and *Hyperoodon ampullatus.* Respiratory Physiology & Neurobiology doi:10.1016/j.resp.2009.04.023.

McSweeney, D.J., R.W. Baird and S.D. Mahaffy. 2007. Site fidelity, associations and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris)* beaked whales off the island of Hawai‘i. Marine Mammal Science 23:666-687.

Schorr, G.S., R.W. Baird, M.B. Hanson, D.L. Webster, D.J. McSweeney and R.D. Andrews. In press. Movements of satellite-tagged Blainville's beaked whales off the island of Hawai‘i. Endangered Species Research.

Beaked Whales On the Web

Although no popular publications exist that specifically deal with beaked whales, the Web provides two valuable and interesting resources completely devoted to this enigmatic family.

Beaked Whale Identification Guide
Smithsonian's National Museum of Natural History Marine Mammal Program

http://vertebrates.si.edu/mammals/beaked_whales/pages/main_menu.htm

Features two ID guides, a Skull Morphology Guide and an External Morphology Guide, as well as a Species Menu and many interesting and helpful photos.

The Beaked Whale Resource
Organisation Cetacea (ORCA) in the U.K..

http://www.beakedwhaleresource.com

Provides species information, recent sightings, exciting photos, and plenty of general information on the biology and ecology of beaked whales.