Top Photo: A location-only LIMPET satellite tag on the dorsal fin of HIPc181, an adult male from Cluster 1 of the endangered main Hawaiian Islands population. HIPc181 has been photographed 39 times over a 25-year span, with sightings ranging from O'ahu east to Hawai'i Island. This tag remained attached for 57 days, during which time HIPc181 traveled as far west as the island of Ni'ihau and as far east as Hilo, spanning the entire main Hawaiian Islands. *Photo by Deron S. Verbeck/NMFS Permit 26596.*

THE RECENT HISTORY OF TAGGING FALSE KILLER WHALES IN THE WILD

ROBIN W. BAIRD

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When I first started working in Hawai'i in 1999, I brought VHF radio tracking gear and a number of suction-cup attached time-depth recorder (TDR)/VHF tags with me. These tags were re-usable and recoverable, and I had previously used them as part of my work with killer whales in the Salish Sea, studying their diving behavior. The tags, much simpler and much less expensive than the Dtags developed by Woods Hole Oceanographic Institution, recorded an animal's depth once per second, and some of the tags also recorded their swimming speed. At the time, nothing was known about false killer whale diving behavior, so when the opportunity arose on March 29, 1999, during only my second encounter with false killer whales in Hawai'i, we tagged an individual with a suction-cup TDR/VHF tag. The results, admittedly, were not very exciting. The tag stayed on just over an hour, and the whale dove to only 22 m (72 feet). The most interesting part of the whole thing was that the tag was removed by a companion, who grabbed onto the antenna and pulled it off. The tag floated to the surface right next to our boat, with the antenna bent as a result of the pull. Later on, after building up our photo-identification catalog, the tagged individual was designated as HIPc187, an adult from Cluster 3 of what is now recognized as the main Hawaiian Islands (MHI) insular population.

Our suction-cup tagging project continued, with a longer (and more interesting) deployment in November 1999, also on an individual from the insular population. This tag lasted for just over 13 hours, including almost six hours after sunset, and revealed for the first time that foraging seems to occur both during the day and at night (Ligon and Baird 2001). On September 30, 2002, working with Mike Heithaus from National Geographic, we had the opportunity to deploy a suction-cup attached Crittercam, and we obtained video footage for just over an hour (along with accompanying audio, albeit just audio from the camera system, not one designed for research on underwater acoustics). We had hoped to record prey captures and document what they were feeding on at depth, but over the hour-long deployment the tagged juvenile, HIPc555 from Cluster 2 from the insular population, primarily traveled and socialized. Regardless, it was amazing to see the underwater world from their perspective[5], rather than our own topside one. We deployed a couple more suction-cup attached time-depth recorder tags on false killer whales from the main Hawaiian Islands population, a 28.9-hour deployment in October 2004, and a 7.3-hour deployment in July 2008, but the need to recover the tags, potentially well outside our normal working area, limited how often we were inclined to deploy them. The individual tagged in October 2004, a sub-adult male that we designated as HIPc508, maxed out the depth sensor at 234 m (767') on six different dives, the longest of which was 12 minutes long.

> "How far offshore did they go? How much time did they spend on the windward sides of the islands, where we were usually unable to survey?"

Based on the rates of ascent and descent documented, the whale could have easily dove to 1,000 m (3,280'). One recoverable datalogging tag, similar to the time-depth recorders we were using but attached with a titanium arrowhead, was deployed on a false killer whale off Northern Japan in 2005 and remained attached for almost three days (Minamikawa et al. 2013). That whale dove over 600 m deep (almost 2,000') on three occasions.

In 2006, Russ Andrews, then at the Alaska SeaLife Center, developed a new type of satellite tag that could be deployed onto the dorsal fin of small- and medium-sized cetaceans and became known as a LIMPET tag. These tags are produced by Wildlife Computers, are remotely deployed using an air rifle or crossbow, and are attached with two surgical grade titanium darts to the animal's dorsal fin. The electronics of the tag remain *external* to the fin (the *E* in LIMPET). Currently available LIMPET tags weigh about the same as three AA batteries and have a similar footprint. Russ had deployed them on killer whales in the Antarctic (Andrews et al. 2008) and Alaska in the past, and in 2006, with Russ' help, we began to use these tags in Hawai'i.

Before we started LIMPET tagging, we knew that false killer whales around the main Hawaiian Islands exhibited long-term site fidelity, being seen over spans of many years (Baird et al. 2008) although sightings were infrequent, and many questions were unanswered. How far offshore did they go? How much time did they spend on the windward sides of the islands, where we were usually unable to survey? We successfully deployed a dozen LIMPET satellite tags on false killer whales in 2007 and 2008, and they provided the first answers to these questions. One of the individuals tagged in 2008 was part of an offshore population, recognized in the 2008 NOAA stock assessment report as the "Hawai'i pelagic stock", and it crossed from inside to outside of the longline fishing exclusion zone around the main Hawaiian Islands (Baird et al. 2010). In 2010, our partners with the NOAA Pacific Islands Fisheries Science Center (PIFSC) began using LIMPET tags, and they tagged two individuals in the northwestern Hawaiian Islands, in what is now the Papahānaumokuākea Marine National Monument. Combined with photo-identification results, these tags provided the first evidence of a second island-associated population in the Hawaiian Archipelago (Baird et al. 2013), and this population was recognized as the Northwestern Hawaiian Islands stock in the 2012 NOAA stock assessment reports.

Working with our partners at PIFSC, we've obtained data from 102 LIMPET tag deployments on false killer whales in Hawai'i, with deployments on individuals from all three populations, and the most recent tags being deployed in February 2025. More than three-quarters of the tag deployments (71) have been on individuals from the main Hawaiian Islands population, with an additional nine from the Northwestern Hawaiian Islands population and 22 from the Hawai'i pelagic stock. Michaela Kratofil of Cascadia Research is using data from all of these deployments, as part of her

[5] You can watch, and listen to, some of this footage at http://cascadiaresearch.org/Hawaii/fkwcrittercam/

MONITORING AND UNDERSTANDING TAGGING EFFECTS

ROBIN W. BAIRD

Our tagging work requires scientific research permits issued by the National Marine Fisheries Service (NMFS), and is also reviewed and approved by our Institutional Animal Care and Use Committee (IACUC). New NMFS permits are needed every five years, and applicants must review what is known about the potential effects of research activities, including tagging, and outline how they are going to monitor and minimize them. There is no doubt that individuals are startled when they are tagged—individuals typically exhibit a tail flick and fast dive, but they quickly return to normal behavior. For the main Hawaiian Islands insular population of false killer whales, re-sightings of individuals over time allow us to assess how the wounds at the tag site heal, and also assess long-term survival of tagged individuals. Of the 11 animals from the MHI population LIMPET tagged in 2007 and 2008, all were seen more than a year after the tags stopped transmitting, and five of the 11 have been re-sighted in the last five years. In 2017 we presented results of an analysis, led by Alex Zerbini, of survival rates of tagged and untagged individuals within the same social clusters. We found that survival of tagged individuals was similar to that of untagged individuals (Baird et al. 2017), suggesting no long-term health effects. Re-sightings after the tags have fallen off reveal that the two attachment darts typically migrate back out the holes they went in, and the tagging sites heal over and re-pigment back to the normal background color. We continue to monitor as photos are added to our catalogs, to better understand both short- and potential long-term effects of tagging. As one of the early adopters of LIMPET satellite tagging, we have helped with the development of best practice guidelines (Andrews et al. 2019) and work to ensure that we minimize the effect of our research activities on false killer whales and the other species of whales and dolphins we work with.

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PhD research at Oregon State University (see the article by Michaela in this issue). Such tags have also been used in northern Australia to study the movements and spatial usage of false killer whales there (Palmer et al. 2017). In November 2021, Filipe Alves of MARE tagged a false killer whale off Madeira with a LIMPET tag. This was the first deployment of these tags on a false killer whale in the Atlantic, and the tag transmitted for 22 days, with the individual remaining in the area around Madeira[6]. Reactions to tagging appear to be short-term, and part of our efforts involve monitoring and understanding the effects of tagging **(see sidebar on the left)**.

LIMPET tags can remain attached for extended periods – our longest duration on a false killer whale has been 236 days, and the mean attachment duration of location-only tags is about 54 days. Fourteen of our LIMPET tags have been depth-transmitting tags that, in addition to location data, transmit information on the durations and maximum depths of dives. Since the tags are not recovered and all the data need to be transmitted to polar-orbiting ARGOS satellites in the brief time that whales come to the surface between dives, only coarse-resolution dive data can be obtained. We now have 175 days of dive data from depth-transmitting LIMPET tags around the Hawaiian archipelago, and these data are also being analyzed as part of Michaela Kratofil's PhD research. Diving behavior is highly variable among individuals and populations, but false killer whales in Hawai'i often dive very deep, far exceeding 1,000 m.

The tags are expensive – including the attachment darts, location-only tags cost $2550 US, and depth-transmitting tags that include a Fastloc®-GPS system cost $5800 US (five of our deployments have been these Fastloc®-GPS tags). Not all tagging attempts are successful, and while most of the time we recover the tag on a missed shot, sometimes we lose them since the tags have no flotation, as both weight and size is minimized in order to allow them to be deployed remotely.

Deployment of recoverable suction-cup attached tags has continued, primarily because of the value of high-resolution data that these tags provide, such as acoustic and video data, as well as the details of

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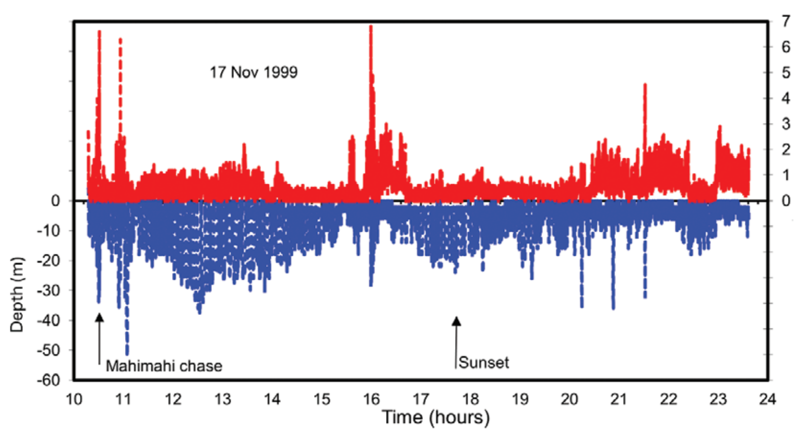
[6] You can see the locations from this tag at https://tinyurl.com/mrxrshxz

dives (e.g., pitch, roll, and heading). In 2008, two Dtags were deployed on false killer whales in the Bahamas, as part of a study to examine responses to simulated mid-frequency active sonar (MFAS), and that study found that the tagged whales appeared to modify their whistles to imitate the MFAS (DeRuiter et al. 2013). In 2011, working with Aran Mooney of the Woods Hole Oceanographic Institution, we deployed a Dtag on an individual from Cluster 3 of the main Hawaiian Islands population, and acoustic data from that tag are being used by Brijonnay Madrigal of the University of Hawaiʻi as part of her PhD research. Camera tags have also been deployed subsequent to our 2002 Crittercam deployment—in March 2022, Jochen Zaeschmar tagged two false killer whales in New Zealand with camera tags (**see sidebar on next page**). In 2023 and 2024, a team from the Pacific Whale Foundation and the University of Hawaiʻi also deployed camera tags on individuals from Cluster 4, and these are being used by Brijonnay Madrigal as well as by Jens Currie from the Pacific Whale Foundation (also a PhD student at the University of Hawaiʻi) for studies of acoustics and behavior (see both of their articles in this issue).



Top Photo: A suction-cup attached time-depth recorder on HIPc0320 in July 2008, a male from Cluster 1 of the endangered main Hawaiian Islands population. This tag remained attached for just over seven hours, and HIPc0320, a juvenile, dove to a maximum depth of 180 m.
Photo by Annie B. Douglas/Cascadia Research.

Bottom Graph: Fourteen hours of dive data from HIPc122, an adult female false killer whale from Cluster 4 of the endangered main Hawaiian Islands population. This was only the second suction-cup tag we deployed, and the first tag providing night-time dive data for a false killer whale. The top half of the graph, in red, shows swim speed, while the bottom, in blue, shows dive depth (in meters). During the time we were following HIPc0122 we observed one chase of a mahimahi, which involved both a spike in swim speed and a rapid descent to about 35 m (~115'). Swim speed and dive depths were roughly similar before and after sunset, suggesting that foraging likely occurs both during the day and at night.

DEPLOYING CAMERA TAGS ON NEW ZEALAND FALSE KILLER WHALES

JOCHEN ZAESCHMAR

In 2022 we had the opportunity to deploy suction-cup attached camera tags on false killer whales from one of the two well-known social clusters that enter the coastal waters of New Zealand during the warm season. The work was a collaboration between the University of Auckland, our NGO, the Far Out Ocean Research Collective, and the BBC's Natural History Unit for their landmark series Mammals[1]. The tags had a custom-built camera in a CEIIA custom-built housing, and a Cefas G-5 long-life data logger for recording dive profiles. There were many challenges involved. Despite being considered 'local', false killer whales are typically very hard to find due to their low natural abundance and fast movements over large areas. Once located, weather conditions need to be suitable to work from a small craft to deploy the tags from the end of a long pole. Then, the whales need to be approachable and tolerate the tag. Lastly, the tag needs to function properly. One of these factors would usually be our undoing, but we learned a lot in the process. For one, false killer whales in New Zealand are very good at dislodging suction cup tags, seemingly with ease, by simply twisting and arching their backs. If this technique doesn't work, other group members will assist in removing the tag only to inspect the device with much interest afterwards. However, after countless unsuccessful attempts, we managed to deploy two tags on two adult males who seemed to tolerate them better than females, possibly due to their larger body size in relation to the tag. In total, we recorded eight hours of dive profiles and five hours of video footage. Despite the overall disappointment of the relatively small amount of data collected, the results were fascinating. One of the whales dove straight to the bottom at 122 meters, with descent speeds reaching up to 6 meters per second. He then swam sideways just above the seafloor, presumably to better enable the capture of prey at the bottom and he dispatched his unidentified prey quickly. On the ascent, the individual (now named 'Sticky') encountered another male at around 50 meters who offered him his kingfish, which the two shared repeatedly, and at around 30 meters several bottlenose dolphins interacted with this individual in a playful manner. The dive profile of the other male, tagged on a different day, aligned more with our surface observations, with many short dives of 3-5 minutes and dive depths of 20-50 meters. Sadly, the project did not yield enough data to determine if differences in dive profiles were linked to factors including sex, age, occurrence of prey or individual preferences. Nevertheless, we gained valuable new insights about New Zealand false killer whales that show that feeding at the bottom, so-called benthic foraging, is a strategy that is employed at least by some individuals, and that whales may be actively feeding even when surface observations don't suggest much foraging activity, such as visible prey sharing, the carrying of prey, or the presence of seabirds. Given these results we are keen to deploy more tags in the future to gain more in-depth knowledge of false killer whale behavior below the surface.

[1] 'Mammals' is available to watch on BBC America and AMC+ in North America and on BBC I-player in Europe

Tagging has been an integral part of our research on false killer whales since the beginning, providing incredible insights into movements and behavior, population structure, and fisheries interactions, among other things. However, it is the combination of tagging with photo-identification (Mahaffy et al. 2023) and genetic analyses (see Karen Martien's article in this issue) that provides the most powerful approach to understanding false killer whales, along with other species of whales and dolphins.

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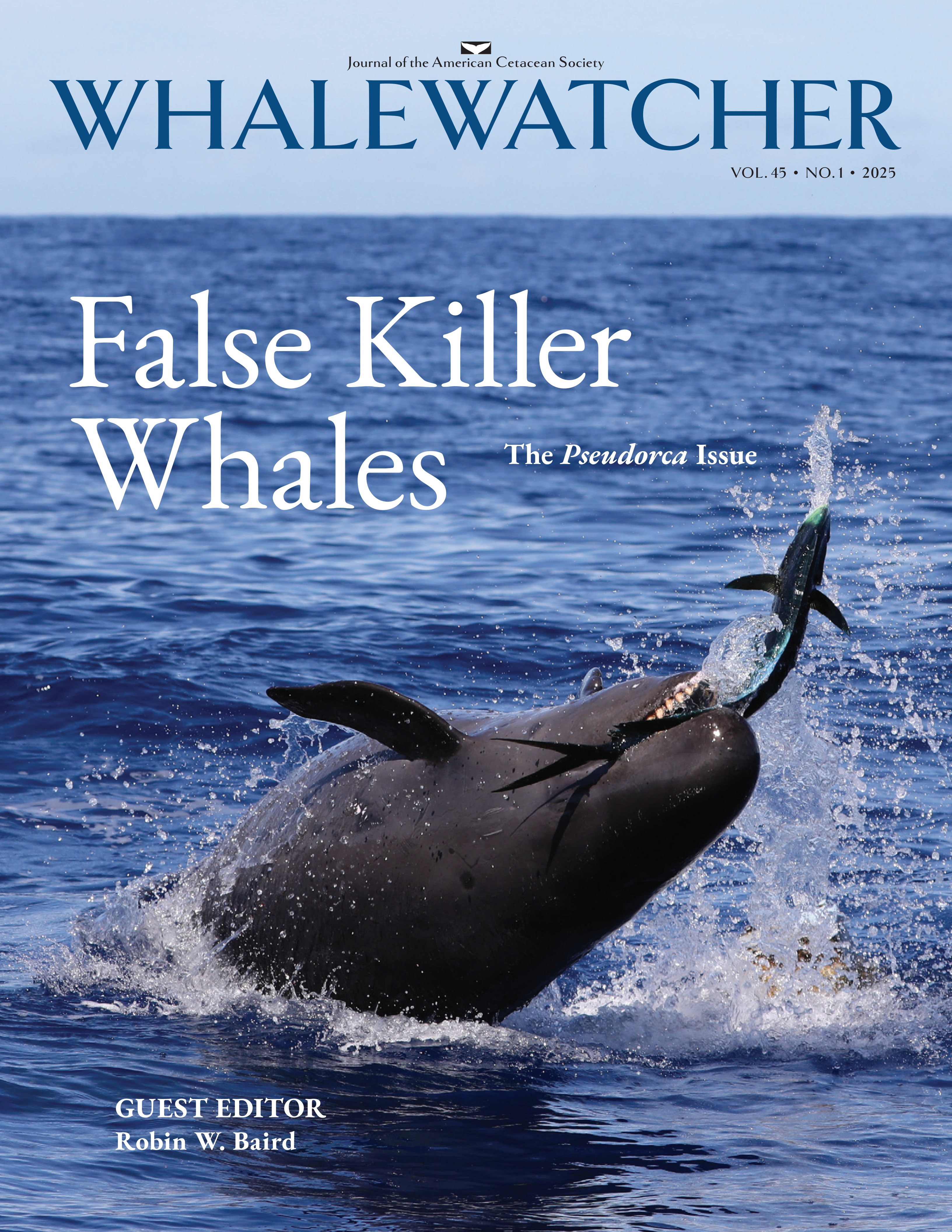

False Killer Whales

The *Pseudorca* Issue

GUEST EDITOR
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