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An Unexpected Benefit from Drone-Assisted Fecal Sample Collection: Picking Up Subsurface Poop After It Floats to the Surface

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Discovering how established methodologies can be applied in a new way can be quite exciting. We experienced this on 5 November 2021 while testing the use of an unoccupied aerial system (UAS, aka drone) as part of an effort to collect fecal samples from odontocetes in Hawai'i.

In the past, fecal samples from cetaceans have been collected (1) using scat-detecting dogs (e.g., Rolland et al., 2006; Ayres et al., 2012), (2) by simply following behind animals and watching for fecal plumes (i.e., the reddish-brown diffuse and spreading cloud of feces as the animal defecates) or looking for fecal material in the fluke prints (e.g., Hanson et al., 2010; Ford et al., 2016), or (3) opportunistically when defecations were observed while working with cetaceans for other reasons. While trying to collect both fecal and prey samples from fish-eating killer whales (*Orcinus orca*) in the murky waters of the Salish Sea, Washington, one of us (RWB) followed directly behind the whales while the sampler, positioned on a bow pulpit, would scan the fluke prints in case samples were welling up to the surface (see Hanson et al., 2010). Since the whales were typically traveling at speeds of 5 to 7 km/h, this required slowing the vessel down prior to reaching a fluke print in case a sample was available, and then increasing speed again if nothing was visible. While this approach was quite successful in the Salish Sea, with much better water clarity in Hawai'i and after having experienced the benefits of using a drone to observe and track a difficult-to-follow species (Baird et al., 2021), we thought that using a drone to visually monitor for the presence of fecal plumes from surfacing or near-surface whales would help increase fecal sample collection rates (e.g., Lemos et al., 2020). This would allow the research vessel to remain farther behind the animals, minimizing the potential for disturbance, as well as potentially increasing the number of individuals that could be simultaneously monitored for defecations, and, thus, sample collections. In November 2021, we undertook a 13-d field effort off the island of Hawai'i as part of a long-term study of Hawaiian odontocetes (Baird, 2016). One project goal was to test the approach of using a drone to aid in fecal sample collection with one or more of the odontocetes that we typically encounter (Baird et al., 2013).

Field operations were undertaken with a 7.3-m rigid-hulled Zodiac with a custom-made bow pulpit, providing an elevated platform for the sampler. Fecal samples were collected with a swimming pool leaf net on a ~4 m pole. On 5 November 2021, from 1152 to 1242 h (Hawai'i Standard Time), we worked with a group of approximately 25 short-finned pilot whales (*Globicephala macrorhynchus*) in approximately 950 m water depth off the west side of Hawai'i Island (19.557° N, 156.021° W). The group was dispersed over an estimated area of 750 × 450 m in small subgroups of one to five individuals. Individuals were generally traveling slowly to the south, interspersed with periods of surface logging and occasional milling. These behaviors are typical for pilot whales during midday in Hawaiian waters (Baird, 2016). We maneuvered the research vessel to generally remain 20 to 60 m behind a subgroup of whales. We launched and retrieved a DJI Mavic 2 Pro twice, with the drone in the air for a total of 39 min. A live video feed (1,080 p) from the drone was monitored using a DJI CrystalSky high brightness display. This display is brighter than other tablets, allowing for better monitoring of the darker areas in the image and tracking animals while subsurface in full sun. If whales visible to the drone pilot dove out of sight, the drone was maneuvered to find a new subgroup to observe, and the research vessel moved to the new subgroup. The drone was flying above or to the side of animals at altitudes ranging from 15 to 50 m and was positioned to minimize glare and to maximize the likelihood of detecting a fecal plume (which in slowly moving pilot whales can be up to 2 m long and half a meter wide) or floating fecal material. While the drone pilot was monitoring the video feed for fecal plumes or fecal material, we were set up for sample collection and were monitoring the water in front of and beside the boat for fecal material for ~30 min (Figure 1; see supplemental video; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). During that time, we collected three fecal samples (at 1211 h, 1213 h, and 1231 h), at distances of ~30 m, ~20 m, and ~7 m, respectively, from the closest whale that we were following. Based on the relative positioning of whales and the boat, we believe all three fecal samples likely came from different individuals, although we were not able to identify which individuals the samples came from given the defecations were subsurface. After collection, samples were stored in a cooler with ice packs and were archived for later analysis at the Health and Stranding Lab at the University of Hawai'i.

No fecal plumes were observed, and none of the fecal samples we collected were noted by the

Figure 1. (A) Collection of a floating fecal sample from short-finned pilot whales (*Globicephala macrorhynchus*) on 5 November 2021—although not visible from the drone, the sample is next to the boat in this image; and (B) collecting floating reddish-brown fecal material from a short-finned pilot whale.

drone pilot at the surface prior to their detection from the boat. While this may have been due in part to the altitude of the drone, it appeared that all three samples we collected originated from whales defecating far enough below the surface that fecal plumes were not visible to the drone pilot, and the fecal material took some time to float to the surface. During all three sample collections, fecal material was observed coming up to the surface next to and in front of the boat as sample collection was underway. These observations were insightful. Despite the fact that the drone pilot did not spot the fecal plumes, the mere use of the drone to visually monitor for fecal plumes led us to remain farther back from the animals than we would have otherwise, thus revealing an unexpected benefit of drone-assisted fecal sample collection.

Obviously, not all pilot whale (or other cetacean) fecal material will float, but collection of fecal material that sinks would require positioning the boat very close to a defecating whale or require sampling by a snorkeler in the water (e.g., Parsons et al., 2003). This approach of drone-assisted fecal sample collection has the benefit of allowing the research vessel to generally remain farther away from the whales, minimizing the potential for disturbance to the animals. The ideal distance for following for collecting samples is likely to depend on many factors, including species, travel speed, sea conditions, and group size, among other factors. There are downsides, however. When multiple whales are present in a subgroup, or if individuals are regularly changing their positions relative to one another, collecting samples farther away from the animals reduces the likelihood of being able to match the sample to the individual whale that defecated. Importantly, as well as allowing for simultaneous monitoring of multiple individuals for defecations, positioning the vessel farther behind the animals provides more time for subsurface poop to float to the surface, allowing for collection of samples that would otherwise be missed if following closer to the individuals.

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