Beneath the surface: Diving behavior of false killer whales from two populations across diel and lunar cycles in Hawaiian waters

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WHY IS THIS IMPORTANT?

- There are two genetically distinct island-associated populations of false killer whales (*Pseudorca crassidens*) in Hawaiian waters: the main Hawaiian Islands (MHI) stock and the Northwestern Hawaiian Islands (NWHI) stock. The MHI population was listed as "endangered" under the Endangered Species Act in 2012.
- Observational studies indicate this species forages during the day on epipelagic and reef-associated game fish[1], while stomach contents from stranded individuals from the MHI population also suggest they feed on mesopelagic cephalopods[2].
- Previous movement ecology studies focused on horizontal movements and habitat use[3,4]. There has been little work on the diving behavior of false killer whales.

WHAT WE DID

- To characterize diving behavior, we analyzed **depth-transmitting satellite tag (Wildlife Computers SPLASH 10 and SPLASH10-F) data** from six individuals from the MHI population and three individuals from the NWHI population.
- We used a **correlated random walk model** to estimate locations of **dive records** to determine distance from shore and bathymetric depths.
- We ran **Analysis of variance (ANOVA)** and **generalized additive mixed models (GAMMs)** to examine the effects of solar and lunar cycles on vertical movements.

MAIN FINDINGS

1 Diving varies between populations

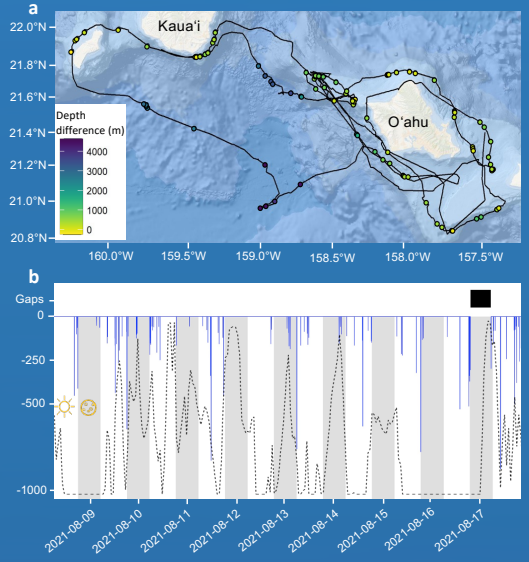
The NWHI population dove, on average, 90 meters deeper (39.5%) and 4.7 km further from shore (17.7%).

Tag ID	Total dives	Time at surface (%)	Dive depth (m) median/ maximum	Dive duration (min) median/ maximum	Distance to shroe (km) median/ maximum
MHI Stock					
PcTag026	141	93.2	49.8 / 1271.8	4.0 / 14.7	39.5 / 113.9
PcTag028	540	87.4	50.8 / 727.8	4.8 / 12.5	16.9 / 97.0
PcTag030	358	93.9	171.5 / 991.5	4.4 / 11.2	13.3 / 40.8
PcTag032	239	95.0	171.5 / 1263.5	5.7 / 18.7	19.2 / 38.8
PcTag055	207	91.5	39.0 / 815.5	3.2 / 12.0	14.9 / 29.5
PcTag074	92	97.0	147.5 /863.5	3.5 / 11.8	15.5 / 97.2
NWHI Stock					
PcTag035	55	96.4	351.5 / 1039.5	5.9 / 16.7	22.1 / 145.5
PcTag037	118	95.6	177.5 / 927.5	4.3 / 15.2	8.9 / 18.8
PcTag049	228	92.3	143.5 / 1103.5	5.7 / 18.2	10.6 / 104.3

2 Deep dive rates highest during dawn and day

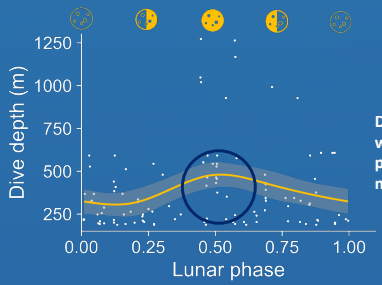
a) Dives are sometimes close to the bottom but are often to mid-water. Map shows dive locations by 'depth difference' (dive depth – bathymetric depth) for PcTag074 (a SPLASH10-F tag), with values close to zero indicating a dive near the sea floor.

b) Dive rates are higher during the day and dawn than during the night and dusk. Example of dive profile in meters (blue lines) of PcTag074 in relation to day/night with bathymetric depth, shown by dashed lines (shown on x axis when bathymetric depth >1000 m).



3 Lunar phase indirectly influenced dive behavior

Relationship between deep dive (greater than 184 m) depths and lunar phase at night. Lunar influence on dive depth was only found during night-time dives. Dive durations followed similar patterns.



Deep dives at night were deeper during periods of greatest moon illumination.

CONCLUSIONS & NEXT STEPS

- Diving patterns likely shift based on **distribution of prey across populations and light cycles**.
- In addition to **foraging on epipelagic species during the day**, individuals **feed at night** and dive to depths where they can **target mesopelagic prey**.
- Individuals appear to occasionally **forage at or near the sea floor**. However, some dive locations are along the slope where bathymetric depth varies over small scales, and higher resolution animal locations (e.g., from Fastloc-GPS tags) are needed to assess diving in relation to bottom depth.

REFERENCES:
[1]Baird (2016). *The lives of Hawai'i's dolphins and whales: Natural history and conservation*. University of Hawai'i Press.; [2]West et al. unpublished data.; [3]Baird et al. (2010). *Endangered Species Research, 10*, 107-121.; [4]Baird et al. (2012). Endangered Species Research 18:47–61.

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For more information on false killer whales, see cascadiaresearch.org/hawaii-species/false-killer-whales-hawaii/