Submitted in Support of the U.S. Navy's 2025 Annual Marine Species Monitoring Report for the Pacific

Naval Information Warfare Center

PACIFIC

TECHNICAL REPORT 0000
JUNE 2026

Odontocete Exposure and Response to Mid-Frequency Active Sonar off Kaua'i in February 2025

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EXECUTIVE SUMMARY

OBJECTIVE

Ten odontocetes were tagged with satellite-transmitting tags in February 2025 on the Pacific Missile Range Facility (PMRF) off the island of Kauaʻi before and during a Submarine Command Course (SCC) training event. These included four short-finned pilot whales, three rough-toothed dolphins, two false killer whales, and one dense-beaked whale. All four of the pilot whales, all three of the rough-toothed dolphins, and both false killer whales were matched to Cascadia Research Collective's (CRC's) long term photo identification catalogs. Two of the pilot whales and all three rough-toothed dolphins were identified as part of their respective Kauaʻi/Niʻihau resident populations, and both false killer whales were identified as part of the Northwestern Hawaiian Islands population.

Some of the animals remained on or near the range during periods of mid-frequency sonar activity, while others began moving out of the area or moved to the far side of the island prior to the onset of mid-frequency active sonar (MFAS). Therefore, modeled received levels varied; estimated received levels from surface ships were between 124 and 164 dB re 1 μPa (including two degrees of standard deviation around the median) at distances of 17–71 km, while estimated received levels from active sonobuoys and helicopter dips were much lower, 66–105 dB re 1 μPa and 91–128 dB re 1 μPa, respectively.

Daytime, dusk, and nighttime median dive depths and median dive durations differed significantly for three pilot whales and for one rough-toothed dolphin between multiple phases of the SCC. However, the patterns differed among individuals; for example, during the daytime, two of the pilot whales had deeper and longer dives during Phase B than during Phase A. One of these whales also had deeper dives during Phase B than After, while the third whale had shallower dives during Phase B than After. These data contribute to an ongoing long-term study of odontocete occurrence in the Kauaʻi/Niʻihau region and the potential for repeated exposures and behavioral responses to MFAS.

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ACRONYMS

BARSTUR	Barking Sands Tactical Underwater Range
BSURE	Barking Sands Underwater Range Expansion
CRC	Cascadia Research Collective
HST	Hawaii Standard Time
LIMPET	Low Impact Minimally Percutaneous Electronic Transmitter
MFAS	mid-frequency active sonar
NIWC	Naval Information Warfare Center
NUWC	Naval Undersea Warfare Center
PMRF	Pacific Missile Range Facility
SCC	Submarine Command Course
SWTR	Shallow Water Training Range
SD	standard deviation

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1. INTRODUCTION

This report provides a summary of the movement behavior before, during, and after the February 2025 Submarine Command Course (SCC) conducted at the Pacific Missile Range Facility (PMRF). It also provides received level estimates during periods of mid-frequency active sonar (MFAS) for the tagged animals. This work is part of an ongoing longitudinal study of odontocete occurrence off the islands of Kauaʻi and Niʻihau in the Hawaiian archipelago and a continuation of an analysis of the potential behavioral responses of these resident animals to MFAS used in Navy testing and training activities.

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2. METHODS

In February 2025, Cascadia Research Collective (CRC) conducted satellite tagging of odontocete species prior to and concurrent with an SCC training event conducted at PMRF (Figure 1; see Baird et al. 2025 for details). They were supported by personnel from Naval Undersea Warfare Center (NUWC) Newport and Naval Information Warfare Center (NIWC) Pacific who monitored the acoustic range and directed the small boat to acoustically active species of interest on the range. Odontocetes were also encountered and tagged off the range when the conditions on the range prevented working in that area. The tags deployed were SPLASH10-F tags (Wildlife Computers, Redmond, Washington) in the Low Impact Minimally Percutaneous Electronic Transmitter (LIMPET) configuration, which transmit both Argos satellite and Fastloc® GPS locations for increased granularity in positional data. Methods for tagging, data processing, detection and propagation modeling of MFAS, and the diel and behavioral response analysis have been described in detail in Henderson et al. (2021, 2025b) and Kratofil et al. (2023) and are not included here.

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3. RESULTS AND DISCUSSION

The satellite tagging was conducted from 9–18 February 2025. Ten tags were deployed on four species, including short-finned pilot whales (*Globicephala macrorhynchus*) (4), dense-beaked whales (*Mesoplodon densirostris*) (1), rough-toothed dolphins (*Steno bredanensis*) (3), and false killer whales (*Pseudorca crassidens*) (2) (Table 1). All four tagged pilot whales matched to known IDs in CRC's long-term photo-identification catalog. One individual, GmTag262, was identified as a member of the western community of short-finned pilot whales (cf. Van Cise et al. 2017), and GmTag259 was also identified as a likely member of this community. GmTag262 had been previously seen off O‘ahu three times in 2009 and five times off Kaua‘i: once in 2011, twice in 2012, and twice in 2021. GmTag259 had been previously seen three times off Kaua‘i, once in 2012 and twice in 2024. GmTag260 had been previously considered a member of the central community based on a previous sighting off O‘ahu in 2009, but community assignment for this individual is currently being reconsidered based on the associates this animal was sighted with when tagged. GmTag261 had also been previously seen off O‘ahu (in 2014), but community assignment for this individual is currently unknown.

All three tagged rough-toothed dolphins also matched to known IDs in CRC's catalog linked with the main component of the Kaua‘i/Ni‘ihau social network; they are therefore considered members of the resident Kaua‘i-Ni‘ihau population of rough-toothed dolphins (cf., Baird et al. 2008; Corsi et al. submitted). SbTag026 was previously identified off Kaua‘i in 2015 and 2018. SbTag027 was previously identified off Kaua‘i in 2005 and SbTag028 was previously identified off Kaua‘i in 2011, 2012, 2014, 2015, 2016, and 2019. The lone tagged dense-beaked whale (MdTag024), an adult male, did not match to any known IDs in CRC's catalog, nor did the other two individuals photo-identified in that encounter, and it is thus not known whether it was part of a resident, island-associated population. Both tagged false killer whales had been previously photo-identified and were known to be members of the Northwestern Hawaiian Islands population of false killer whales (cf. Baird et al. 2013). PcTag096 was previously seen off O‘ahu in 2013 and off Kaua‘i in 2012 and 2020, while PcTag097 was previously seen off Kaua‘i only once in 2012.

Tags transmitted for durations ranging from 6.5 to 25.6 days, transmitting between 13 and 19 Douglas Filtered Argos positions per day and 2 to 23 filtered FastLoc®-GPS positions per day (Table 1). Deployments had varying degrees of overlap with SCC phases, owing to the timing of deployments and when tags stopped transmitting (Table 2 and Table 3). After the training event was completed and the tags stopped transmitting, received levels were estimated for 9 of the 10 individuals from three sources, including helicopter-dipping sonar, active sonobuoys, and hull-mounted sonar from two source types (AN/SQS-53C and a source modeled as AN/SQS-56) (see Henderson et al. 2021, 2025b for details on the methods). Due to security concerns, modeled MFAS exposure metrics in Table 4 were limited to the highest median received level (in root-mean-square sound pressure level, SPL rms) and ± two standard deviations (SD) from a single modeled transmission in a 5-minute bin during a track.

The four tagged pilot whales were from three different groups, with received levels varying between groups (Tables 1 and 4). GmTag259 was tagged on the range and was present on the range during all phases with the exception of the Interphase (Figures 2 and 3). GmTag260 and GmTag261 were tagged within the same group on the range and showed almost identical movement patterns (Figures 4 and 6). Both tagged whales were present on the range during all phases and experienced the highest median received levels for ships (152 ± 5 dB re 1 μPa), helicopter-dipping sonar (~122 ± 5 dB re 1 μPa), and sonobuoys (~100 ± 3 dB re 1 μPa) of all the pilot whales (Table 4; Figures 5 and 7). GmTag262 was tagged on the range but moved far to the northwest of the range during the latter part of the Interphase and all of Phase B, only returning to the range afterwards (Figure 8). GmTag262 only had received levels for ship and sonobuoy sonar, with helicopter dipping sonar falling below ambient levels (Table 4, Figure 9).

MdTag024 was also tagged on the range during the Interphase, but quickly moved away from the range, ending up on the east side of Kaua‘i during Phase B (Figure 10). MdTag024 received exposures of ship and helicopter dipping sonar at low to moderate median received levels (130 ± 6 and 99 ± 8 dB re 1 µPa, respectively), but sonobuoy received levels were below ambient levels (Table 4, Figure 11). PcTag096 and PcTag097 were tagged within the same group on the range during Phase B, but both individuals soon moved far northwest of the range (Figures 12 and 14). Both individuals were exposed to sonar from ship (~143 ± 5 dB re 1 µPa) and sonobuoy (~ 74 ± 8 dB re 1 µPa) sources, but not from helicopter dipping sonars (Table 4; Figures 13 and 15). The three rough-toothed dolphins were tagged in three different groups, but only two of the dolphins were exposed to MFAS (Table 4; Figures 17 and 20).

SbTag026 was tagged on the range before Phase A, and was present on the range for all phases, and stopped transmitting during Phase B (Figure 16). SbTag027 was tagged on the range during Phase A, moved off the range before briefly returning during the Interphase, and eventually ended up east of Kaua'i during Phase B (Figure 18). There were no MFAS exposures for this individual (Table 4). SbTag28 was tagged on the range during Phase A and remained on the range for all subsequent phases (Figure 19). Received levels for SbTag028 were the highest among the rough-toothed dolphins and indeed all the animals this year, with maximum median received levels of 159 ± 5 dB re 1 µPa from ship MFAS, 101 ± 7 dB re 1 µPa from helicopter-dipping sonar, and 91 ± 6 dB re 1 µPa from sonobuoys (Table 4, Figure 20).

Dive behavior data was transmitted for a total of 3.6–14.3 days out of the full tag deployment periods. Three tags successfully transmitted behavior log data during all SCC phases, two tags transmitted for four out of the five SCC phases, two tags transmitted for three out of the five SCC phases, and the remaining two tags transmitted for two out of the five SCC phases (Tables 2 and 3). However, when broken down by time of day and phase, not every time of day and phase met the required coverage (relative to the phase duration) for inclusion in the dive behavior analyses (see Henderson et al. 2025a, 2025b for details on the methods).

Dive rates and surface time percentages varied across SCC phases, species, individual, and time of day, with no apparent consistent relationships across tagged individuals with SCC phase (Tables 5-8). Differences in dive rates and surface time across SCC phases were not statistically tested for, due to the nature of how these values were calculated (i.e., with only single values available for each SCC phase). No statistically significant differences in dive depth or duration were detected among dawn dive behavior records for any tagged individual (Table 5). During the daytime, statistically significant differences in dive depth and duration were detected for three of the tagged pilot whales, GmTag260, GmTag261, and GmTag262 (Table 6; Figures 21-23). The nature of the differences in daytime dive depth and duration between SCC phases were not always consistent between the three individuals, an effect likely driven by differences in movement patterns relative to PMRF, as well as group behavior. For example, both GmTag260 and GmTag261, who were tagged in the same group, had significantly deeper and longer dives during Phase B compared to Phase A (Table 6; Figures 21 and 22). In contrast, GmTag261 had significantly deeper dives during Phase B compared to After, while GmTag262 (tagged in a different group) had significantly shallower dives during Phase B compared to After (Table 6; Figures 22 and 23).

During the dusk period, statistically significant differences in dive depth were noted for only GmTag261, whose dusk dives during Phase B were significantly shallower compared to After, and statistically significant differences in dive duration were noted for only GmTag262, whose dusk dives during Phase B were significantly shorter compared to After (Table 7; Figures 22 and 23). Statistically significant differences in nighttime dive depth and duration were noted for GmTag260 and SbTag028, statistically significant differences in nighttime dive depth alone were noted for GmTag262, and statistically significant differences in nighttime dive duration alone were noted for GmTag261 (Table 8; Figures 21 and 24).

Similar to the differences detected among daytime dives, differences in dive depth and duration between SCC phases were not always consistent between tags deployed on the same species. For example, among the pilot whale tags, nighttime dives for GmTag260 were significantly shallower during Phase B compared to After, while nighttime dives for GmTag262 were significantly deeper during Phase B compared to After (Table 8;

Figures 21 and 23). However, for both GmTag260 and GmTag261, dives during the Interphase were significantly shorter compared to After (Table 8; Figures 21 and 22).

These data contribute to ongoing, long-term efforts to understand the general behavior and habitat use of resident species of odontocetes off Kaua‘i and their potential response to or habituation of MFAS use and other training activity on the PMRF range.

Table 1. Summary of satellite tag deployment data from February 2025.

Species	Date tagged	Encounter #	Tag ID	Deployment duration (days)
Short-finned pilot whale	9-Feb-25	1	GmTag259	25.1
Short-finned pilot whale	10-Feb-25	5	GmTag260	22.0
Short-finned pilot whale	10-Feb-25	5	GmTag261	20.0
Short-finned pilot whale	15-Feb-25	4	GmTag262	22.5
Dense-beaked whale	15-Feb-25	1	MdTag024	6.5
False killer whale	17-Feb-25	3	PcTag096	12.4
False killer whale	17-Feb-25	3	PcTag097	25.6
Rough-toothed dolphin	09-Feb-25	8	SbTag026	8.3
Rough-toothed dolphin	11-Feb-25	3	SbTag027	6.5
Rough-toothed dolphin	11-Feb-25	10	SbTag028	14.4

Table 2. February 2025 SCC Phases, with times in Hawaii Standard Time (HST). The Before phase represents the recording effort before the start of the SCC, and the After phase represents the recording effort after the end of the SCC, both of which are truncated to three days for analysis.

Phase	Start Date/Time	End Date/Time	Duration (days)	# Tags Active
Before	2/8/2025 7:13	2/11/2025 7:13	3.00	4
Phase A	2/11/2025 7:14	2/14/2025 16:48	3.40	8
Interphase	2/14/2025 16:49	2/17/2025 7:44	2.62	8
Phase B	2/17/2025 7:45	2/19/2025 14:31	2.28	10
After	2/19/2025 14:32	2/22/2025 14:31	3.00	7

Table 3. Summary of data availability by SCC phase for February 2025 satellite-linked tags. The percentage of behavioral coverage is defined as the proportion of the duration of behavior log data relative to the duration of the tag within each phase.

	Percentage of dive/surfacing data				
Individual	Before	Phase A	Interphase	Phase B	After
GmTag259					
Duration overall (days)	1.86	3.40	2.62	2.28	14.93
Days behavior log data	1.86	2.06	1.21	2.27	4.91
Percentage behavioral coverage	100.00	60.59	46.18	99.56	32.89
GmTag260					
Duration overall (days)	0.78	3.40	2.62	2.28	12.92
Days behavior log data	0.78	3.40	2.62	2.28	5.16
Percentage behavioral coverage	100.00	100.00	100.00	100.00	39.94
GmTag261					
Duration overall (days)	0.77	3.40	2.62	2.28	10.92
Days behavior log data	0.77	3.40	2.62	2.28	4.98
Percentage behavioral coverage	100.00	100.00	100.00	100.00	45.60
GmTag262					
Duration overall (days)	0.00	0.00	1.85	2.28	18.36
Days behavior log data	0.00	0.00	1.85	2.28	5.00
Percentage behavioral coverage	NA	NA	100.00	100.00	27.23
MdTag024					
Duration overall (days)	0.00	0.00	1.97	2.28	2.20
Days behavior log data	0.00	0.00	1.96	1.86	0.65
Percentage behavioral coverage	NA	NA	99.49	81.58	29.55
PcTag096					
Duration overall (days)	0.00	0.00	0.00	2.20	10.17
Days behavior log data	0.00	0.00	0.00	1.25	2.21
Percentage behavioral coverage	NA	NA	NA	56.82	21.73
PcTag097					
Duration overall (days)	0.00	0.00	0.00	2.19	23.39
Days behavior log data	0.00	0.00	0.00	1.89	4.87
Percentage behavioral coverage	NA	NA	NA	86.30	20.82
SbTag026					
Duration overall (days)	1.68	3.40	2.62	0.63	0.00
Days behavior log data	1.43	1.19	1.13	0.07	0.00
Percentage behavioral coverage	85.12	35.00	43.13	11.11	NA
SbTag027					
Duration overall (days)	0.00	3.25	2.62	0.66	0.00
Days behavior log data	0.00	3.05	0.37	0.00	0.00
Percentage behavioral coverage	NA	93.85	14.12	0.00	NA
SbTag028					
Duration overall (days)	0.00	3.17	2.62	2.28	6.32
Days behavior log data	0.00	2.90	2.62	1.77	4.35
Percentage behavioral coverage	NA	91.48	100.00	77.63	68.83

Table 4. Received levels for all tagged individuals. SbTag027 had no exposures and is therefore excluded.

Individual	Highest median RL (± 2 SD) dB re 1 μPa	CPA (km)
GmTag259		
Surface ship	151.5 ± 5.3	16.7
Helicopter dipping	106.1 ± 6.0	69.6
Sonobuoy	99.4 ± 5.8	31.7
GmTag260		
Surface ship	151.8 ± 5.0	29.4
Helicopter dipping	123.4 ± 4.7	31.6
Sonobuoy	101.1 ± 3.6	30.1
GmTag261		
Surface ship	151.6 ± 4.7	17.4
Helicopter dipping	122.1 ± 5.6	32.4
Sonobuoy	99.0 ± 3.2	28.9
GmTag262		
Surface ship	142.3 ± 3.3	48.4
Helicopter dipping	Below ambient	98.7
Sonobuoy	85.3 ± 4.7	51.1
MdTag024		
Surface ship	130.0 ± 6.1	70.9
Helicopter dipping	98.7 ± 8.0	93.0
Sonobuoy	Below ambient	72.9
PcTag096		
Surface ship	142.4 ± 4.2	45.0
Helicopter dipping	--	--
Sonobuoy	74.3 ± 8.0	52.5
PcTag097		
Surface ship	143.0 ± 5.8	44.2
Helicopter dipping	--	--
Sonobuoy	74.6 ± 8.6	52.6
SbTag026		
Surface ship	142.7 ± 5.9	47.4
Helicopter dipping	--	--
Sonobuoy	77.2 ± 12.0	50.4
SbTag028		
Surface ship	158.6 ± 4.8	12.2
Helicopter dipping	100.7 ± 6.6	62.6
Sonobuoy	90.7 ± 6.4	37.3

Table 5. A comparison of dawn diving parameters by SCC phase for February 2025 satellite tags with behavior log data that meet the required coverage cutoff.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Dawn dive rate (dives/hr)							
GmTag259	NA	NA	NA	1.13	1.15		
GmTag260	NA	1.55	1.10	0.00	1.13		
GmTag261	NA	1.33	1.06	1.04	0.38		
GmTag262	NA	NA	NA	0.00	0.76		
PcTag097	NA	NA	NA	2.23	0.79		
SbTag027	NA	0.00	NA	NA	NA		
SbTag028	NA	0.00	0.00	NA	0.76		
% time in surface periods during dawn							
GmTag259	NA	NA	NA	82.04	74.69		
GmTag260	NA	64.70	87.70	100.00	88.87		
GmTag261	NA	69.83	77.85	74.25	95.87		
GmTag262	NA	NA	NA	100.00	75.50		
PcTag097	NA	NA	NA	84.42	91.37		
SbTag027	NA	100.00	NA	NA	NA		
SbTag028	NA	NA	100.00	NA	86.58		
Median dive depth during dawn (m)							
GmTag259	NA	NA	NA	117.50	799.50	0.083	
GmTag260	NA	799.50	77.50	NA	271.50	0.139	
GmTag261	NA	615.50	671.50	767.50	211.50	0.513	
GmTag262	NA	NA	NA	NA	775.50	NA	
PcTag097	NA	NA	NA	85.50	371.50	0.060	
SbTag028	NA	NA	NA	NA	122.50	NA	
Median dive duration during dawn (min)							
GmTag259	NA	NA	NA	9.53	14.70	0.248	
GmTag260	NA	16.67	7.10	NA	6.20	0.228	
GmTag261	NA	13.08	15.23	14.87	6.50	0.613	
GmTag262	NA	NA	NA	NA	19.47	NA	
PcTag097	NA	NA	NA	4.37	6.57	0.064	
SbTag028	NA	NA	NA	NA	2.72	NA	

Table 6. A comparison of daytime diving parameters by SCC phase for February 2025 satellite tags with behavior log data that meet the required coverage cutoff.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Daytime dive rate (dives/hr)							
GmTag259	1.00	1.04	NA	0.51	0.24		
GmTag260	NA	1.79	1.07	0.83	0.68		
GmTag261	NA	1.32	0.99	0.97	1.06		
GmTag262	NA	NA	0.75	0.97	0.94		
MdTag024	NA	NA	2.04	1.95	NA		
PcTag096	NA	NA	NA	NA	1.16		
PcTag097	NA	NA	NA	0.92	0.70		
SbTag027	NA	0.34	NA	NA	NA		
SbTag028	NA	0.07	0.31	0.34	0.46		
% time in surface periods during daytime							
GmTag259	81.79	80.23	NA	89.43	95.76		
GmTag260	NA	67.33	78.93	76.63	84.25		
GmTag261	NA	70.38	77.22	74.75	77.30		
GmTag262	NA	NA	85.81	79.04	71.40		
MdTag024	NA	NA	17.85	30.73	NA		
PcTag096	NA	NA	NA	NA	89.35		
PcTag097	NA	NA	NA	92.48	94.08		
SbTag027	NA	98.78	NA	NA	NA		
SbTag028	NA	99.59	97.89	98.58	97.19		
Median dive depth during daytime (m)							
GmTag259	623.50	671.50	NA	711.50	247.50	0.3766	
GmTag260	NA	213.50	751.50	767.50	687.50	<0.001*	A-B; A-Inter
GmTag261	NA	639.50	743.50	735.50	687.50	<0.001*	A-B; A-Inter; B-After
GmTag262	NA	NA	263.50	511.50	751.50	<0.001*	Inter-After; B-After
MdTag024	NA	NA	163.50	127.50	NA	0.073	
PcTag096	NA	NA	NA	NA	131.50	NA	
PcTag097	NA	NA	NA	115.50	88.50	0.130	
SbTag027	NA	46.75	NA	NA	NA	NA	
SbTag028	NA	135.50	127.50	123.50	175.50	0.151	

Table 6 continued.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Median dive duration during daytime (min)							
GmTag259	12.10	14.03	NA	14.23	10.17	0.235	
GmTag260	NA	8.57	14.87	18.13	17.00	<0.001*	A-B; A-After; Inter-B
GmTag261	NA	13.77	15.60	16.50	16.20	0.021*	A-B
GmTag262	NA	NA	13.10	13.13	19.05	<0.001*	Inter-After; B-After
MdTag024	NA	NA	17.43	15.60	NA	0.151	
PcTag096	NA	NA	NA	NA	5.53	NA	
PcTag097	NA	NA	NA	3.87	4.07	0.755	
SbTag027	NA	2.10	NA	NA	NA	NA	
SbTag028	NA	3.67	4.07	2.20	3.70	0.163	

Table 7. A comparison of dusk diving parameters by SCC phase for February 2025 satellite tags with behavior log data that meet the required coverage cutoff.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Dusk dive rate (dives/hr)							
GmTag259	NA	NA	NA	0.57	NA		
GmTag260	NA	1.86	2.83	2.21	2.26		
GmTag261	NA	3.50	1.80	2.80	2.30		
GmTag262	NA	NA	NA	2.41	2.67		
PcTag097	NA	NA	NA	0.57	0.37		
SbTag027	NA	0.00	NA	NA	NA		
SbTag028	NA	NA	1.14	0.55	0.42		
% time in surface periods during dusk							
GmTag259	NA	NA	NA	93.15	NA		
GmTag260	NA	51.63	51.57	42.91	41.22		
GmTag261	NA	27.26	59.57	43.81	43.02		
GmTag262	NA	NA	NA	49.31	24.85		
PcTag097	NA	NA	NA	95.48	94.03		
SbTag027	NA	100.00	NA	NA	NA		
SbTag028	NA	NA	92.26	94.78	98.48		
Median dive depth during dusk (m)							
GmTag259	NA	NA	NA	105.50	NA	NA	
GmTag260	NA	463.50	327.50	687.50	735.50	0.081	
GmTag261	NA	475.50	511.50	423.50	727.50	0.019*	B-After
GmTag262	NA	NA	NA	475.50	607.50	0.129	
PcTag097	NA	NA	NA	247.50	559.50	0.317	
SbTag028	NA	NA	223.50	187.50	87.50	0.766	

Table 7 continued.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Median dive duration during dusk (min)							
GmTag259	NA	NA	NA	7.27	NA	NA	
GmTag260	NA	15.10	10.22	15.60	17.53	0.081	
GmTag261	NA	12.42	13.57	12.87	15.20	0.128	
GmTag262	NA	NA	NA	14.50	16.97	0.037*	B-After
PcTag097	NA	NA	NA	4.77	9.57	0.317	
SbTag028	NA	NA	4.97	5.73	2.17	0.202	

Table 8. A comparison of nighttime diving parameters by SCC phase for February 2025 satellite tags with behavior log data that meet the required coverage cutoff.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
Nighttime dive rate (dives/hr)							
GmTag259	3.41	2.90	3.37	3.53	4.60		
GmTag260	NA	2.76	3.29	3.33	3.44		
GmTag261	NA	3.57	3.51	3.91	3.90		
GmTag262	NA	NA	2.85	2.47	3.38		
MdTag024	NA	NA	0.90	1.04	NA		
PcTag096	NA	NA	NA	0.51	0.55		
PcTag097	NA	NA	NA	0.26	0.26		
SbTag026	1.89	NA	NA	NA	NA		
SbTag027	NA	0.25	NA	NA	NA		
SbTag028	NA	2.87	2.91	5.88	2.17		
% time in surface periods during nighttime							
GmTag259	50.92	56.77	50.22	46.37	26.64		
GmTag260	NA	44.93	40.27	42.80	28.64		
GmTag261	NA	41.87	46.12	36.19	30.64		
GmTag262	NA	NA	40.65	46.96	32.91		
MdTag024	NA	NA	53.53	49.74	NA		
PcTag096	NA	NA	NA	96.26	95.77		
PcTag097	NA	NA	NA	97.14	97.76		
SbTag026	92.51	NA	NA	NA	NA		
SbTag027	NA	99.22	NA	NA	NA		
SbTag028	NA	78.64	79.48	60.37	86.48		
Median dive depth during nighttime (m)							
GmTag259	175.50	163.50	121.50	171.50	167.50	0.871	
GmTag260	NA	439.50	165.50	351.50	387.50	<0.001*	A-B; Inter-A; B-After
GmTag261	NA	137.50	131.50	163.50	131.50	0.108	

Table 8 continued.

Individual	Before	Phase A	Interphase	Phase B	After	Kruskal-Wallis Test p-value	Post-hoc Dunn's test significant pairs
GmTag262	NA	NA	447.50	383.50	229.50	<0.001*	Inter-After; B-After
MdTag024	NA	NA	497.50	543.50	NA	0.972	
PcTag096	NA	NA	NA	135.50	167.50	0.202	
PcTag097	NA	NA	NA	275.50	163.50	0.480	
SbTag026	86.50	NA	NA	NA	NA	NA	
SbTag027	NA	38.75	NA	NA	NA	NA	
SbTag028	NA	127.50	99.50	81.50	78.50	<0.001*	A-B; A-After; Inter-A; Inter-B; Inter-After
Median dive duration during nighttime (min)							
GmTag259	8.50	8.83	8.75	9.30	9.68	0.192	
GmTag260	NA	12.83	11.27	11.48	12.78	<0.001*	A-B; Inter-A; Inter-After; B-After
GmTag261	NA	9.50	9.20	10.17	10.70	<0.001*	A-After; Inter-After
GmTag262	NA	NA	12.00	13.02	12.43	0.226	
MdTag024	NA	NA	31.25	25.53	NA	0.707	
PcTag096	NA	NA	NA	3.67	4.10	0.622	
PcTag097	NA	NA	NA	7.00	5.50	0.556	
SbTag026	2.43	NA	NA	NA	NA	NA	
SbTag027	NA	1.73	NA	NA	NA	NA	
SbTag028	NA	4.53	4.20	4.10	3.78	<0.001*	A-B; A-After; Inter-A; Inter-After

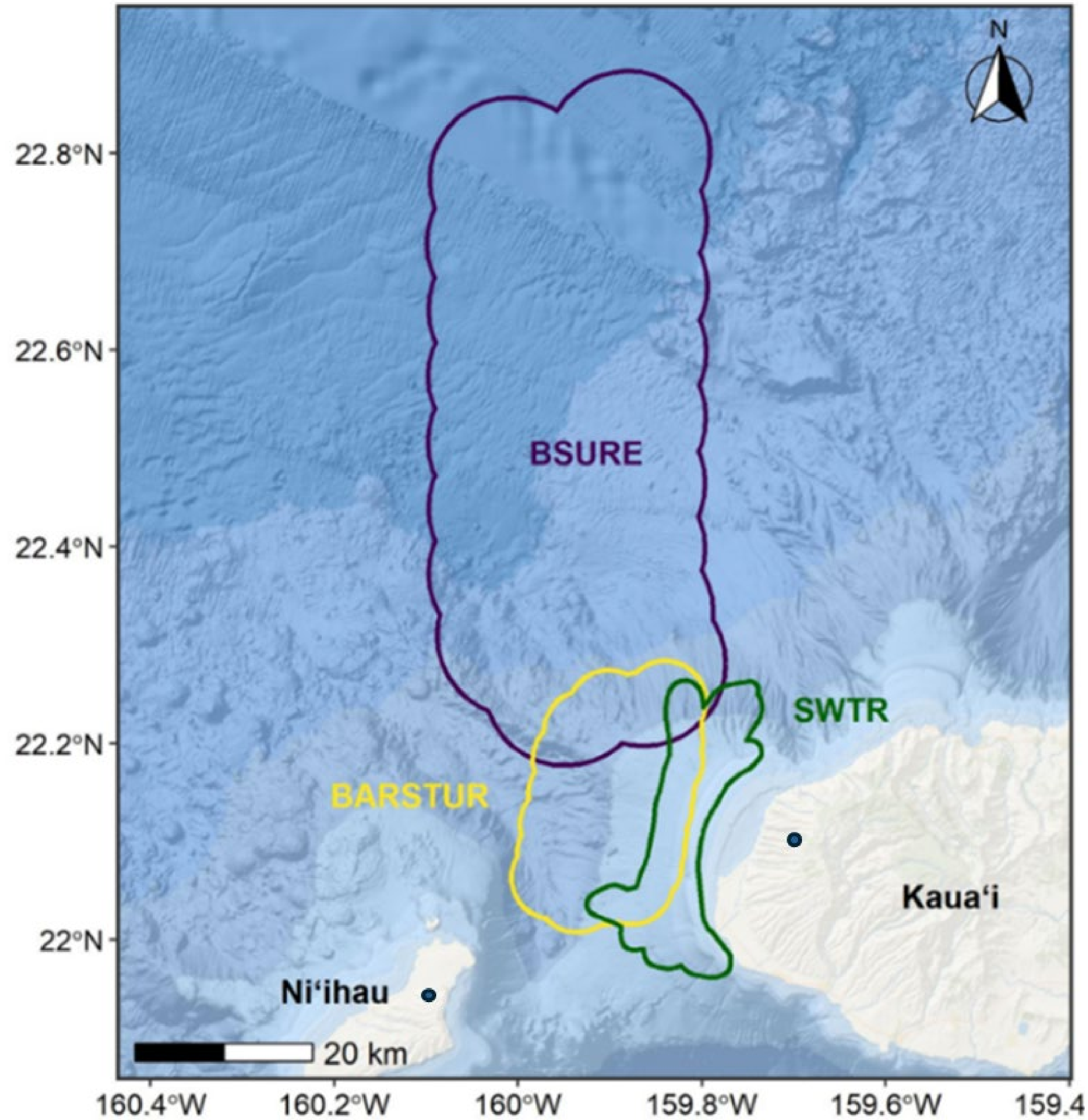


Figure 1. The Barking Sands Underwater Range at the Pacific Missile Range Facility (PMRF). The three areas are the Shallow Water Training Range (SWTR), Barking Sands Underwater Range Expansion (BSURE), and Barking Sands Tactical Underwater Range (BARSTUR). The two blue dots indicate the locations of the Mote antennas on the islands of Kaua'i and Ni'ihau.

Short-Finned Pilot Whales

GmTag259

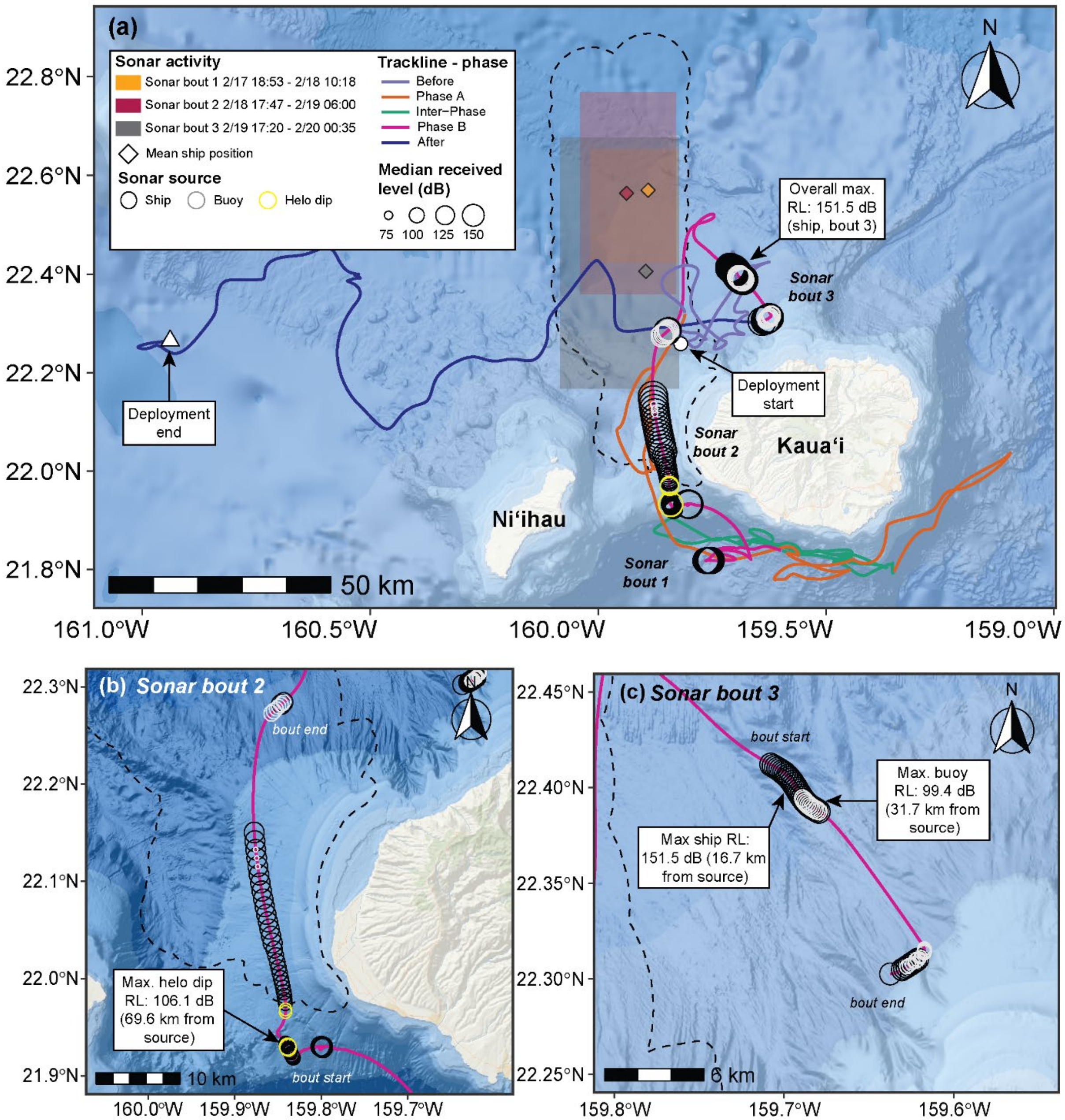
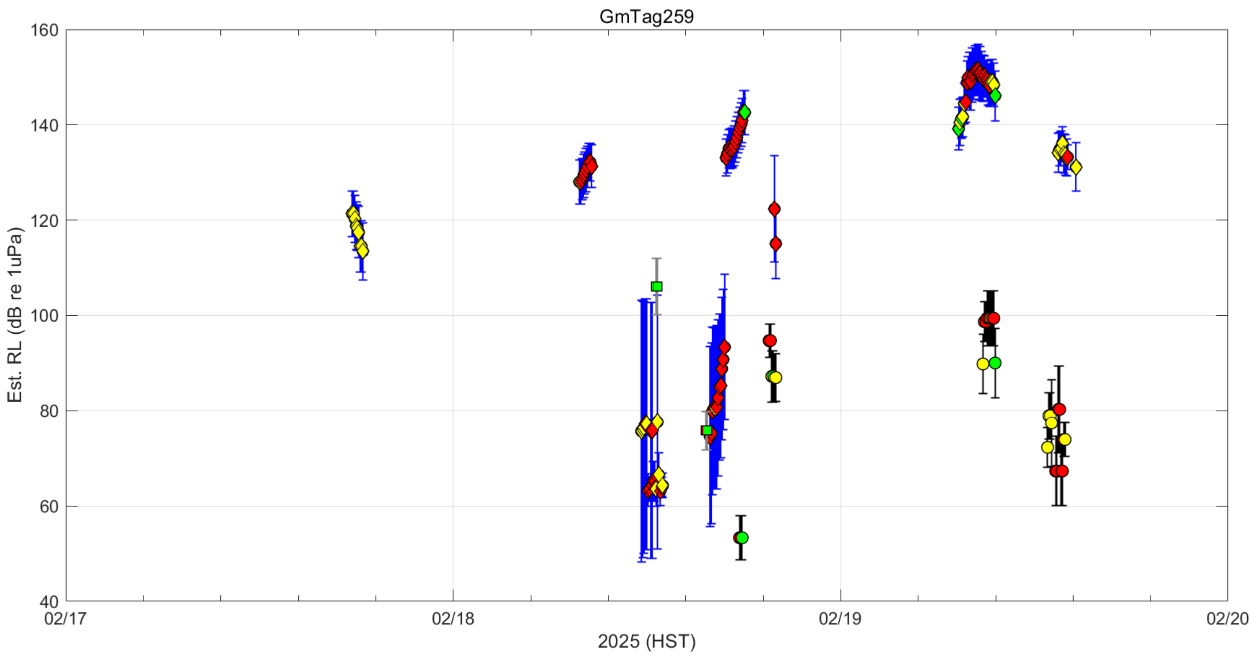


Figure 2. Movements and exposures for GmTag259 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC. Panel A shows movements throughout the SCC, while Panels B and C show two of three individual sonar bouts in detail.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 3. Stoplight plot for the received levels for GmTag259 from surface ships (diamond shape, blue error bars), helicopter-dipping sonar (squares, gray error bars), and active sonobuoys (circles, black error bars).

GmTag260

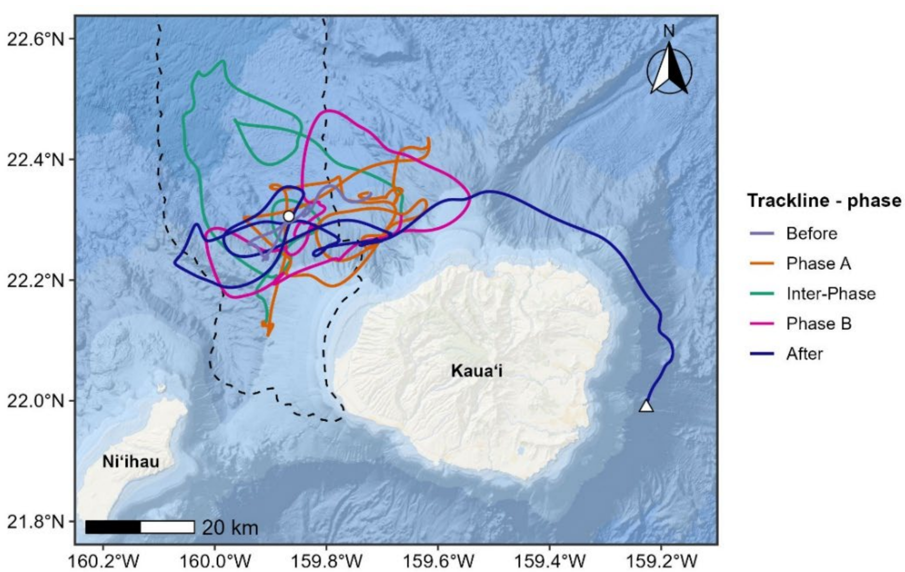
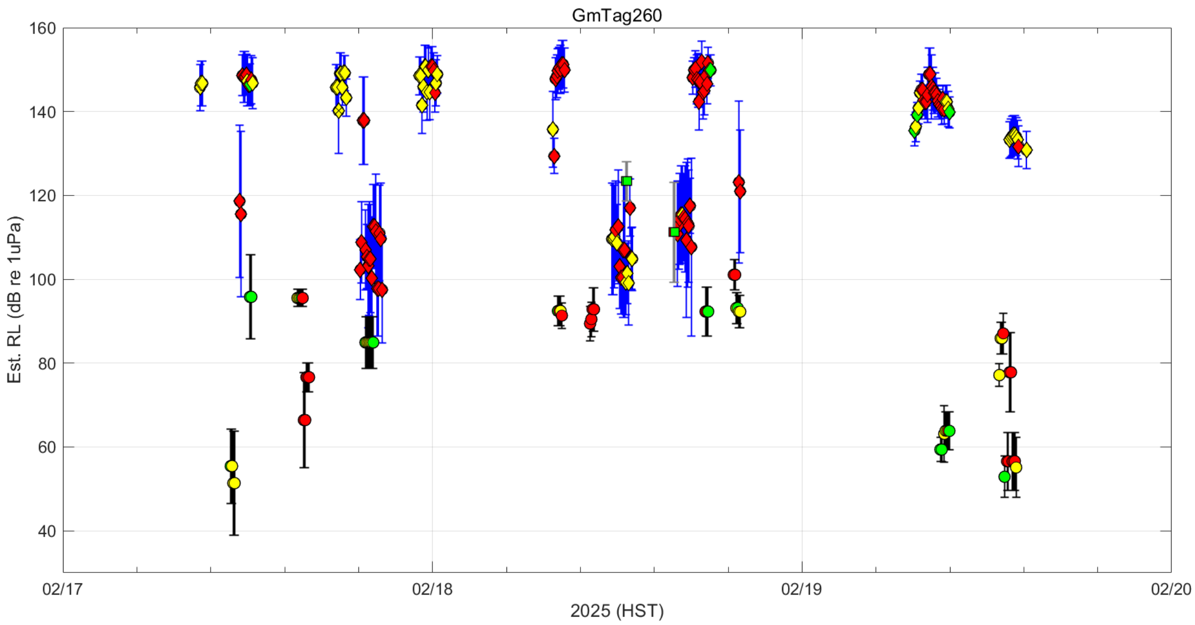


Figure 4. Movements of GmTag260 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 5. Stoplight plot for the received levels for GmTag260 from surface ships (diamond shape, blue error bars), helicopter-dipping sonar (squares, gray error bars), and active sonobuoys (circles, black error bars).

GmTag261

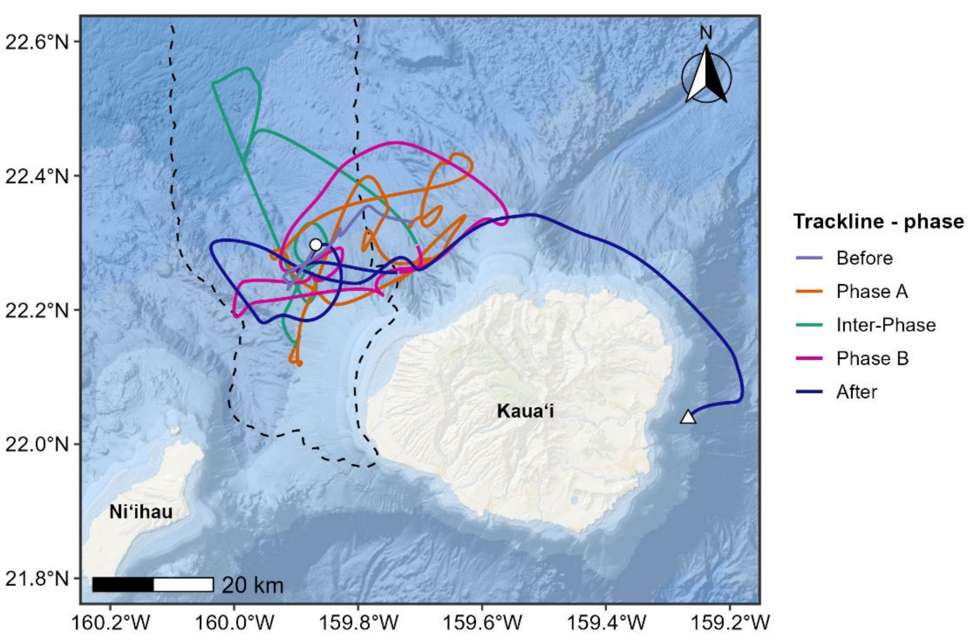
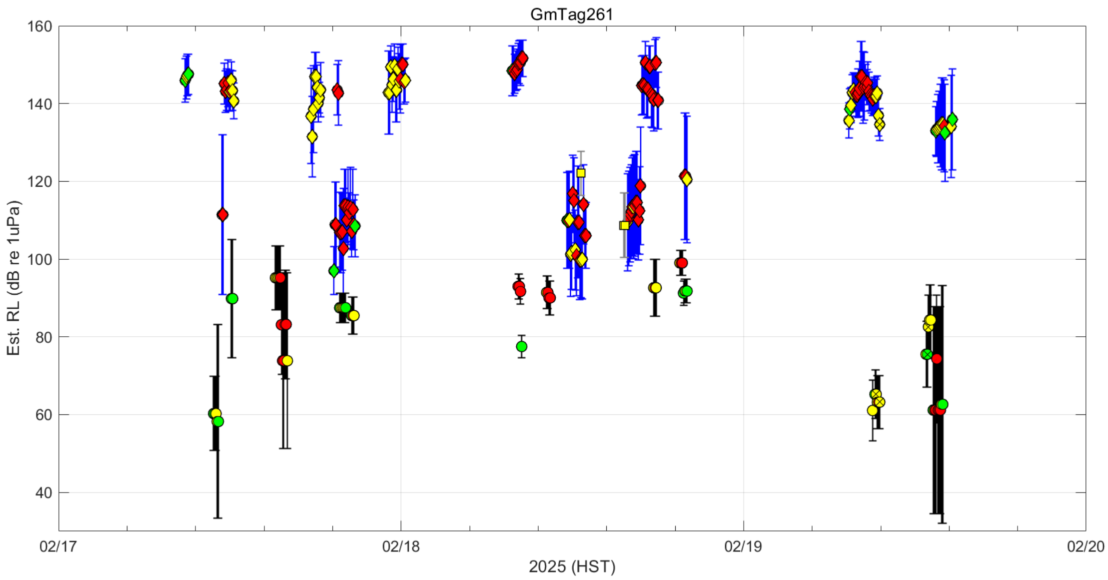


Figure 6. Movements of GmTag261 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high. The "x" within colored symbols indicates the probability of exposure was < 100%.

Figure 7. Stoplight plot for the received levels for GmTag261 from surface ships (diamond shape, blue error bars), helicopter-dipping sonar (squares, gray error bars), and active sonobuoys (circles, black error bars).

GmTag262

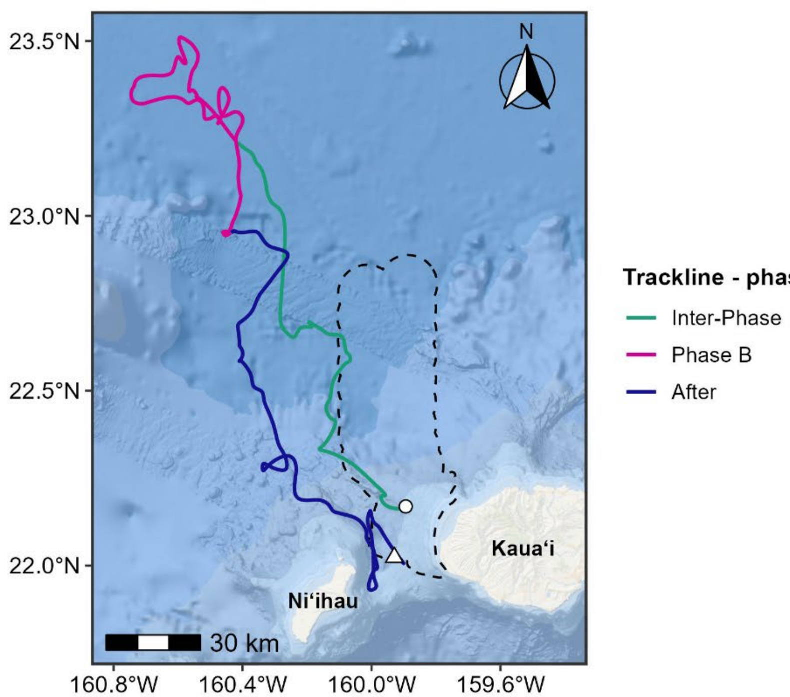
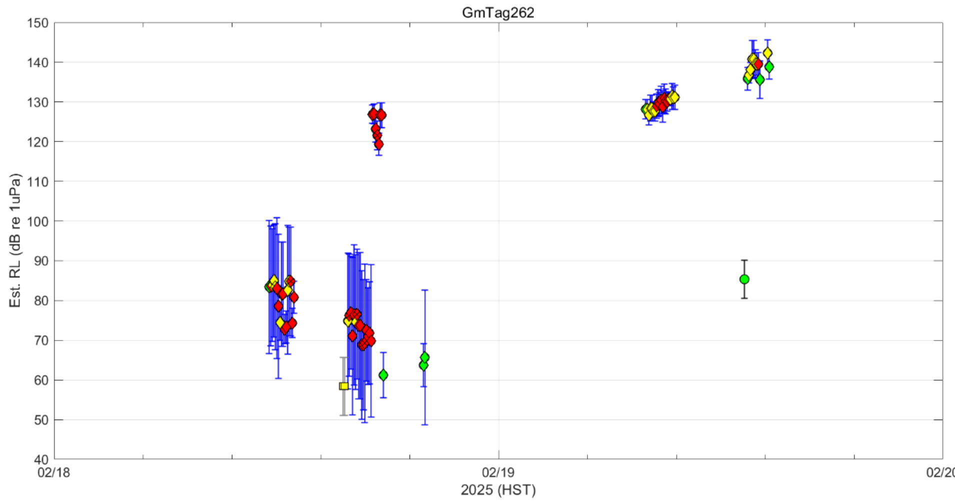


Figure 8. Movements of GmTag262 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high. The "x" within colored symbols indicates the probability of exposure was < 100%.

Figure 9. Stoplight plot for the received levels for GmTag262 from surface ships (diamond shape, blue error bars), helicopter-dipping sonar (squares, gray error bars), and active sonobuoys (circles, black error bars).

Dense-Beaked Whale

MdTag024

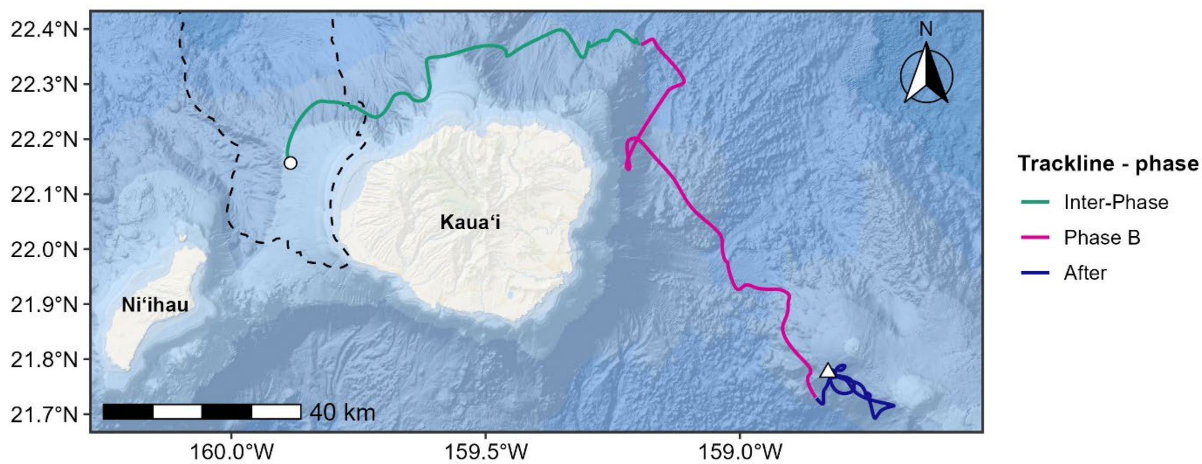
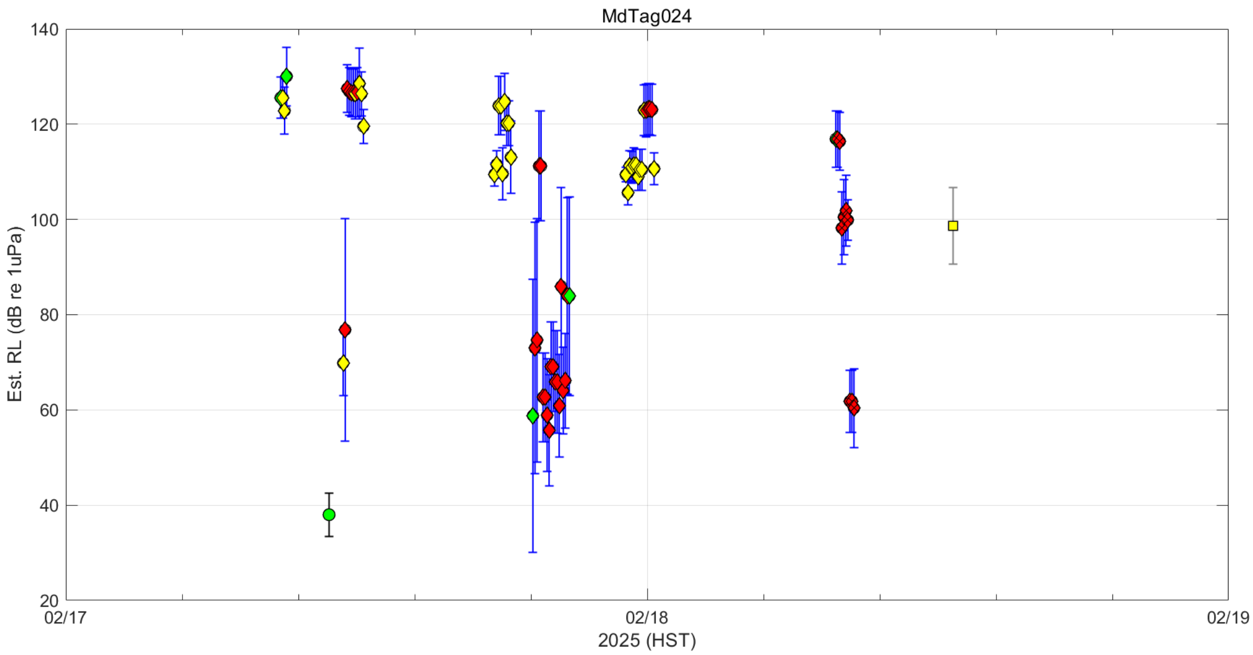


Figure 10. Movements of MdTag024 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high. The "x" within colored symbols indicates the probability of exposure was < 100%.

Figure 11. Stoplight plot for the received levels for Md024 from surface ships (diamond shape, blue error bars) and active sonobuoys (circles, black error bars).

False Killer Whales

PcTag096

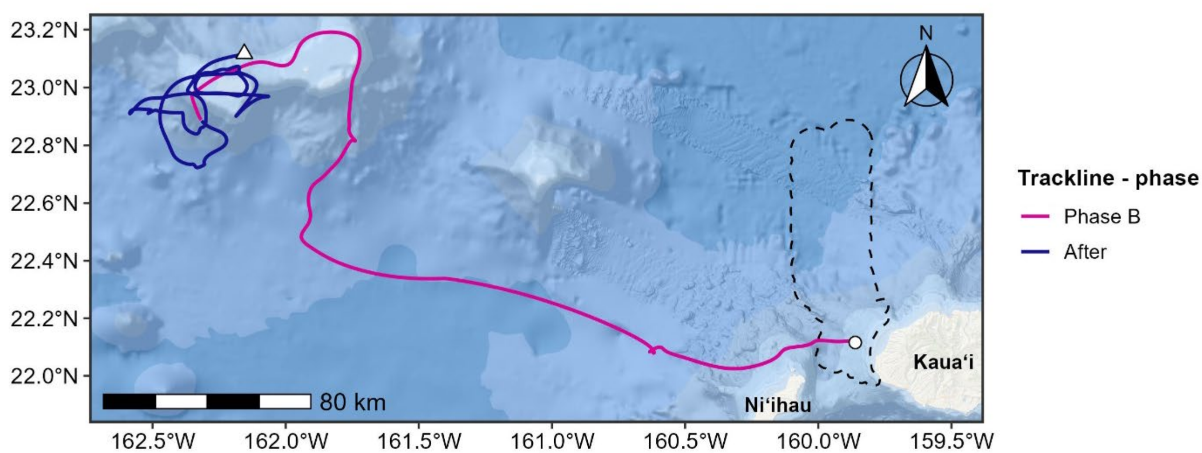
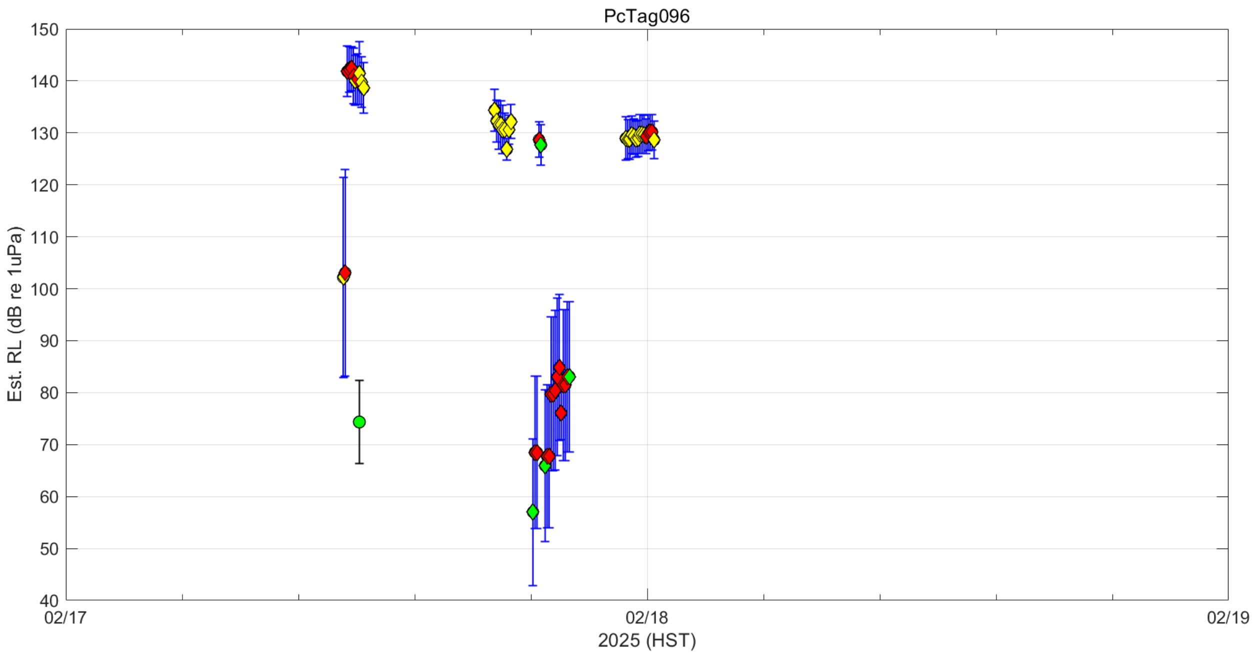


Figure 12. Movements of PcTag096 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 13. Stoplight plot for the received levels for Pc096 from surface ships (diamond shape, blue error bars) and active sonobuoys (circles, black error bars).

PcTag097

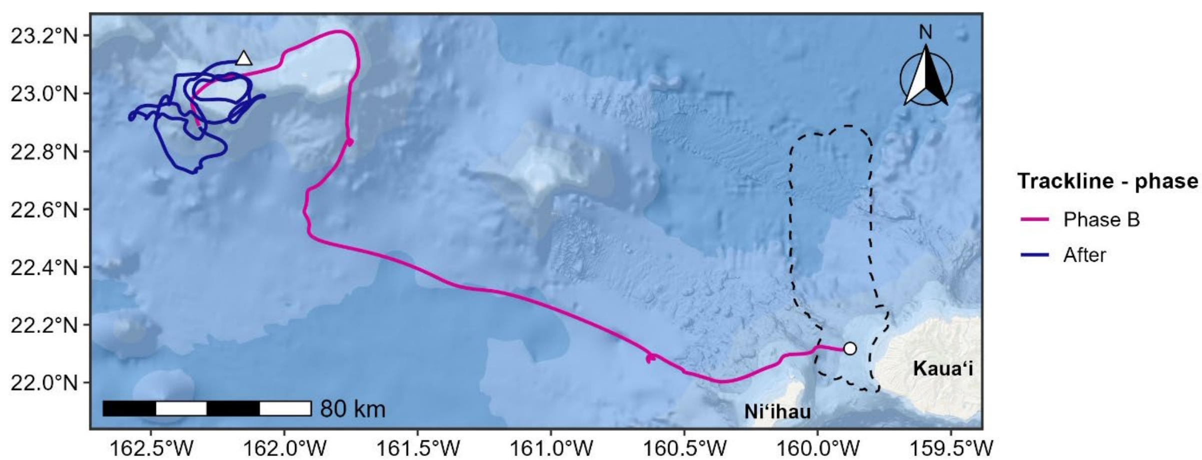
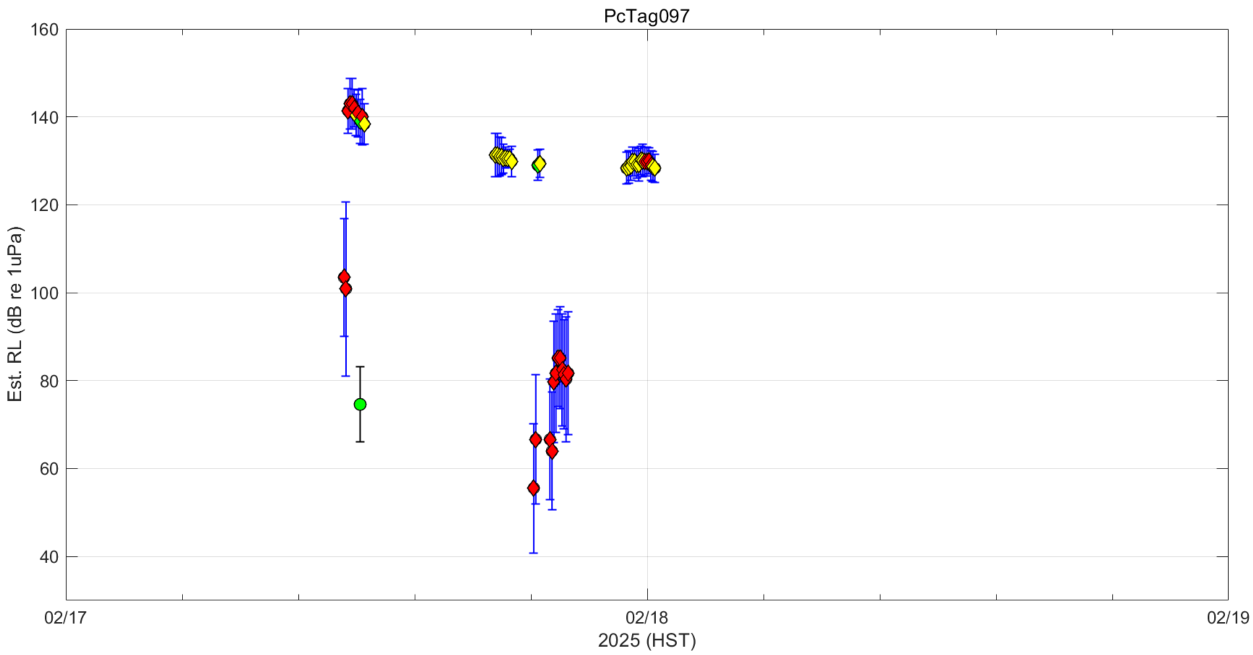


Figure 14. Movements of PcTag097 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 15. Stoplight plot for the received levels for Pc097 from surface ships (diamond shape, blue error bars) and active sonobuoys (circles, black error bars).

Rough-toothed Dolphins

SbTag026

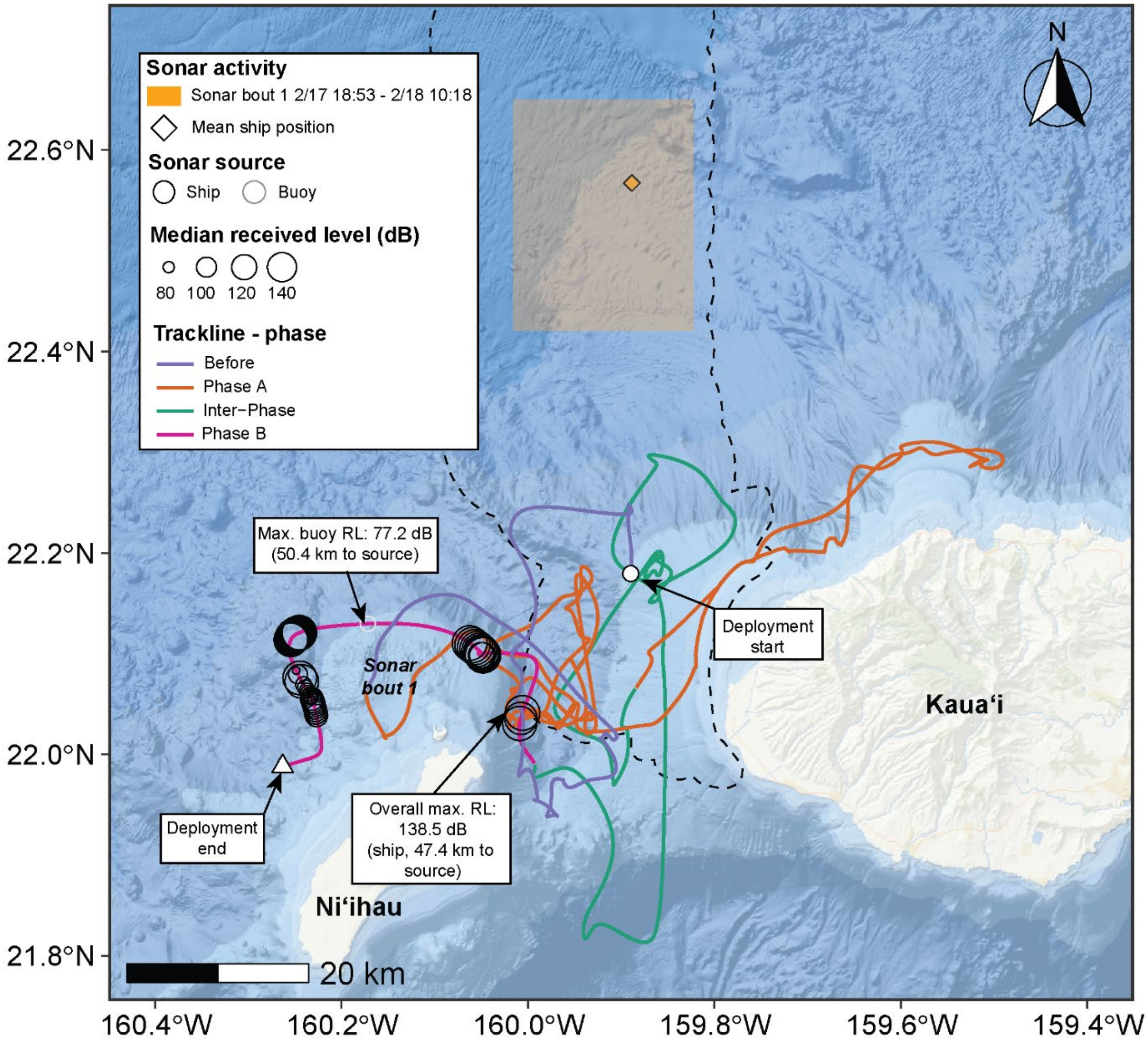
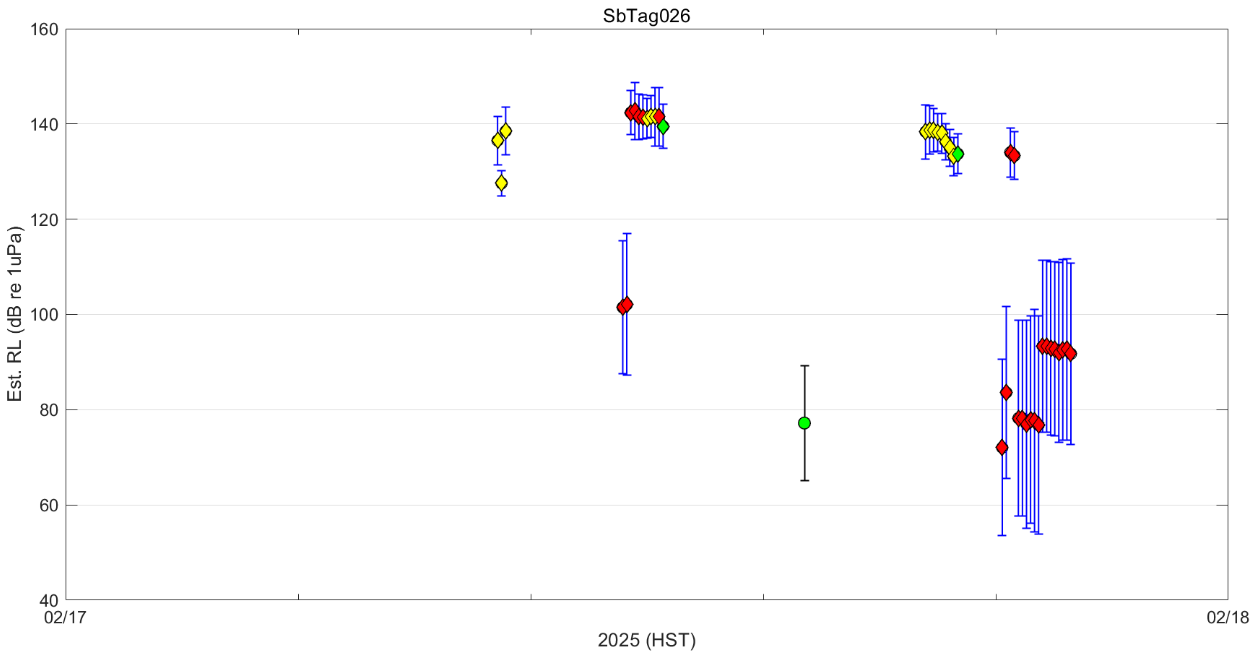


Figure 16. Movements and exposures for SbTag026 during the February 2025 SCC event.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 17. Stoplight plot for the received levels for Sb026 from surface ships (diamond shape, blue error bars) and active sonobuoys (circles, black error bars).

SbTag027

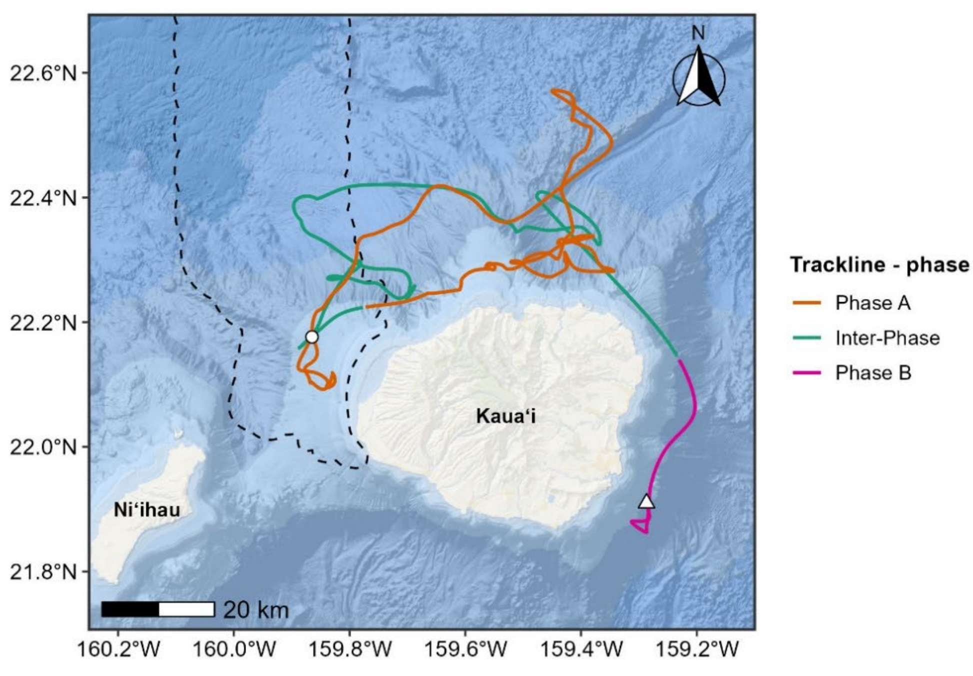


Figure 18. Movements of SbTag027 during the February 2025 SCC event.

NOTE: The track of SbTag027 did not overlap with any active MFAS

SbTag028

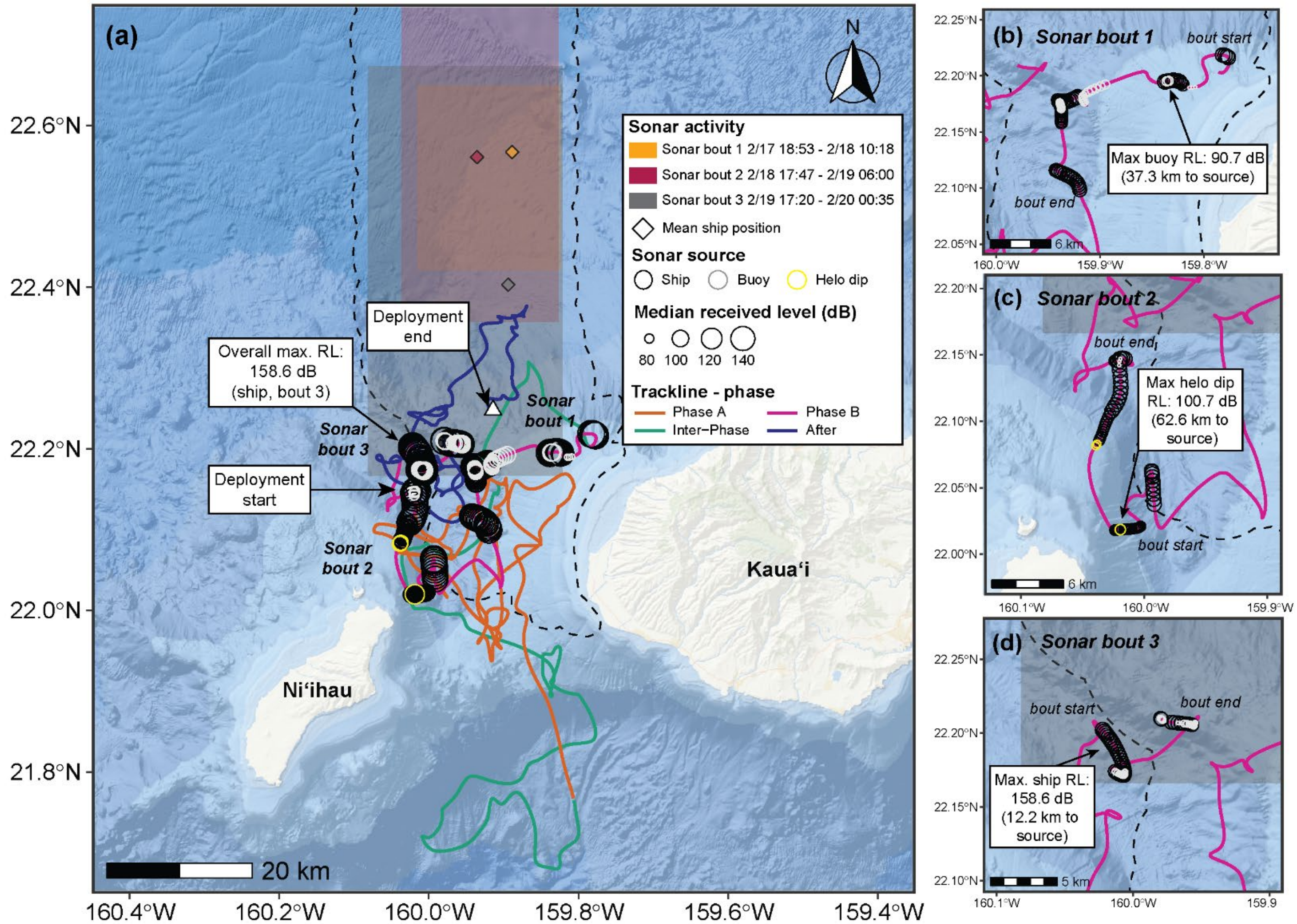
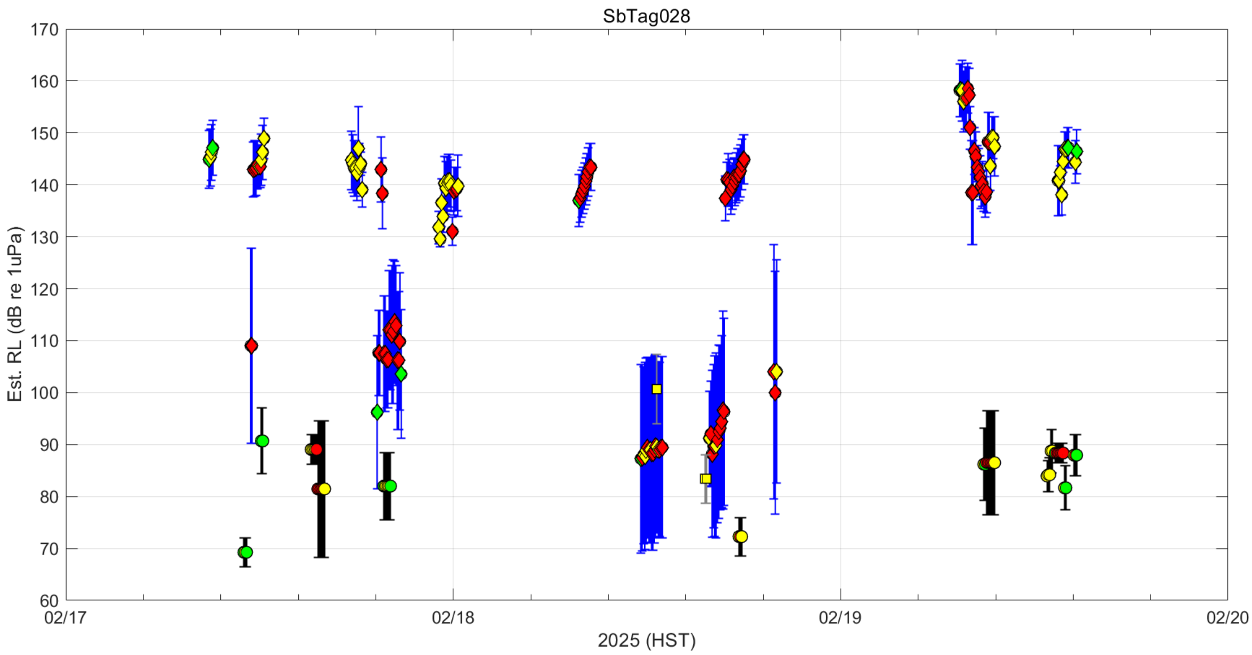


Figure 19. Movements and exposures for SbTag028 during the February 2025 SCC event. The trackline is restricted to 3 days following the end of the SCC. Panel A shows movements throughout the SCC, while Panels B-D show individual sonar bouts in detail, including maximum received levels from each source.



- The symbol indicates the median RL for each 5-min bin, while the error bars indicate ± 2 standard deviations around the median. The color indicates the relative number of pings that occurred in that 5-min bin, with green being few, yellow being moderate, and red being high.

Figure 20. Stoplight plot for the received levels for Sb028 from surface ships (diamond shape, blue error bars), helicopter-dipping sonar (squares, gray error bars), and active sonobuoys (circles, black error bars).

Diel Analysis

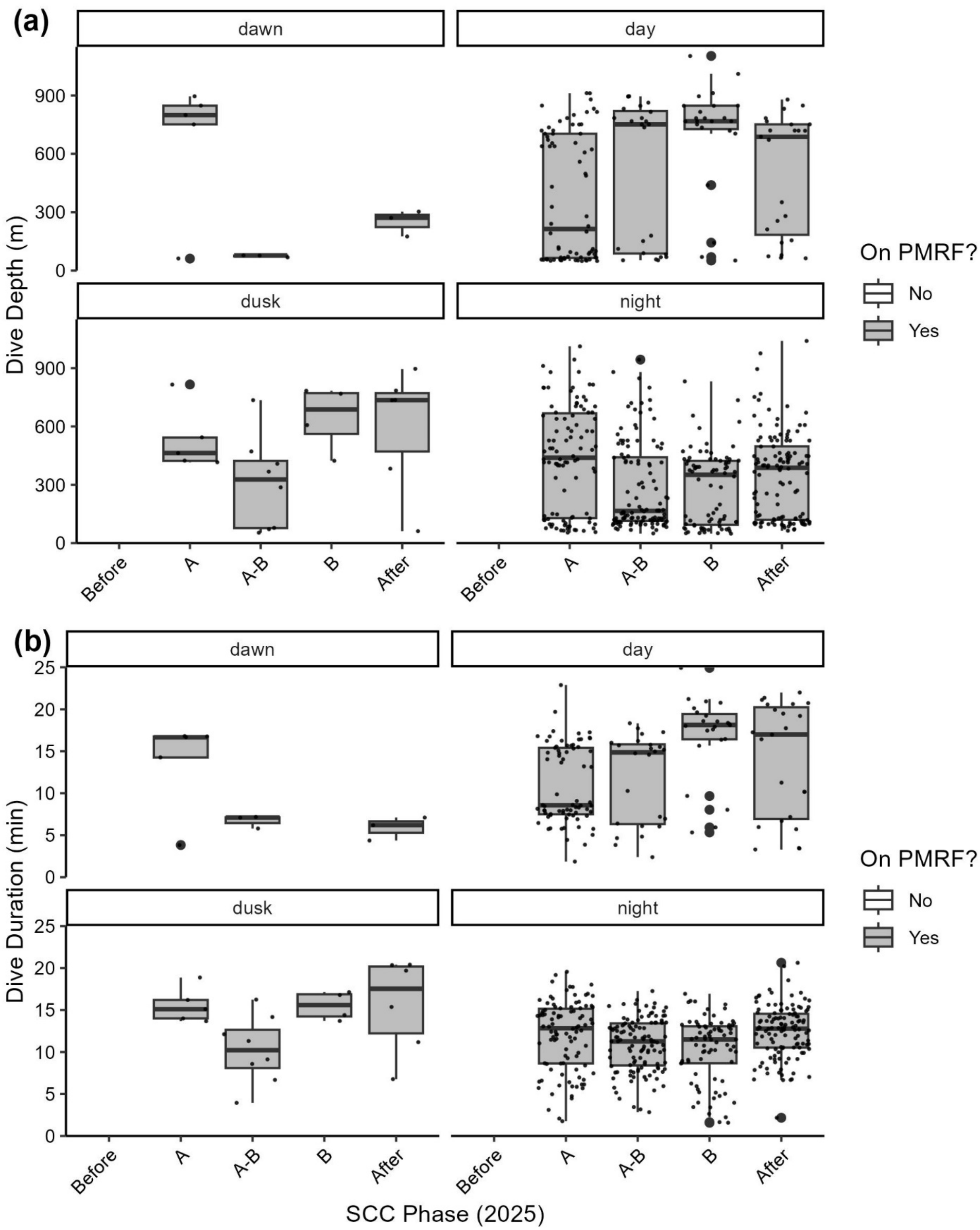


Figure 21. Boxplot showing A) dive depths and B) dive durations of GmTag260 by SCC phase and time of day with Interphase shown as A-B. GmTag260 had 100.00% behavioral coverage for all phases except After, which had 39.94% behavioral coverage.

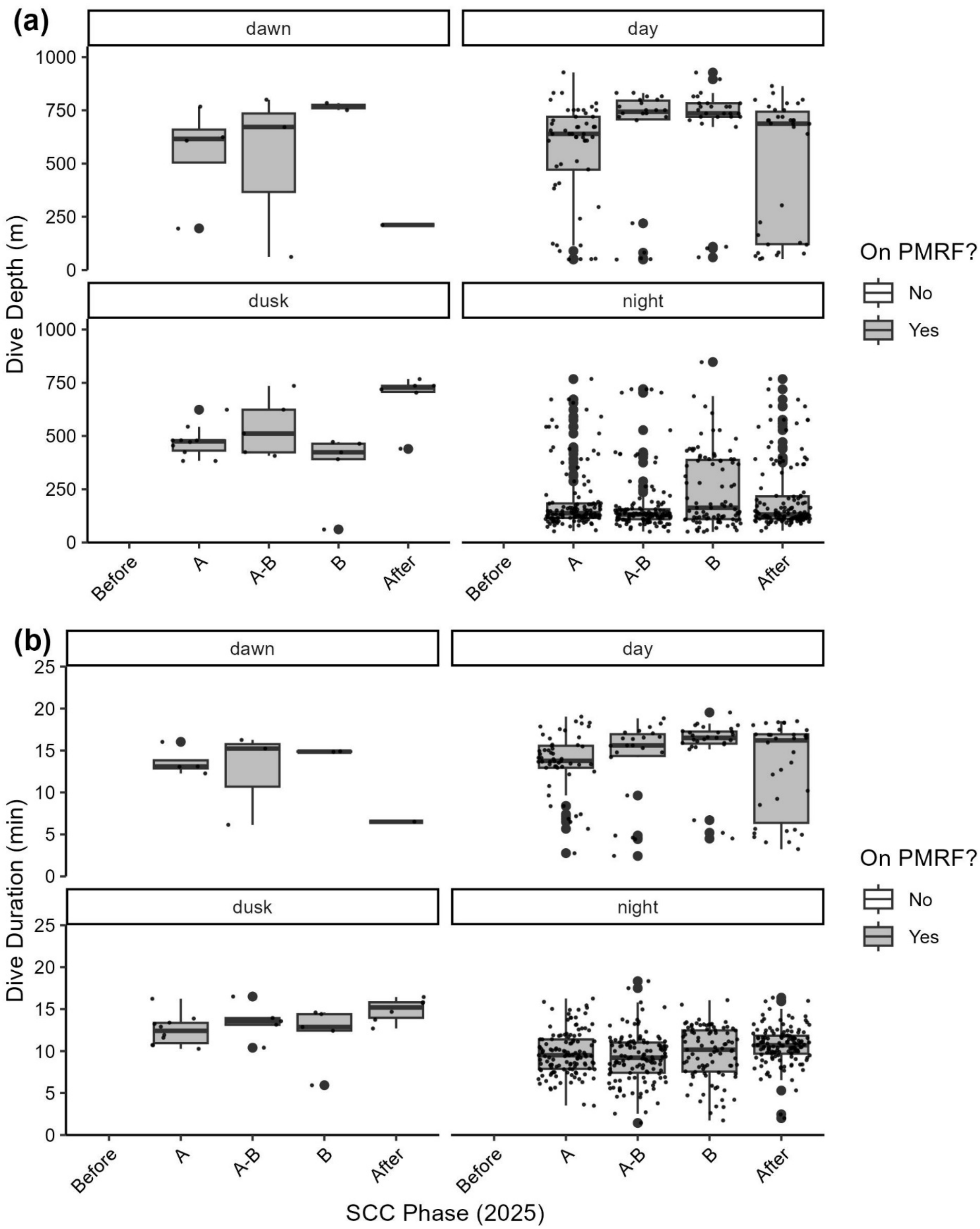


Figure 22. Boxplot showing A) dive depths and B) dive durations of GmTag261 by SCC phase and time of day with Interphase shown as A-B. GmTag261 had 100.00% behavioral coverage for all phases except After, which had 45.60% behavioral coverage.

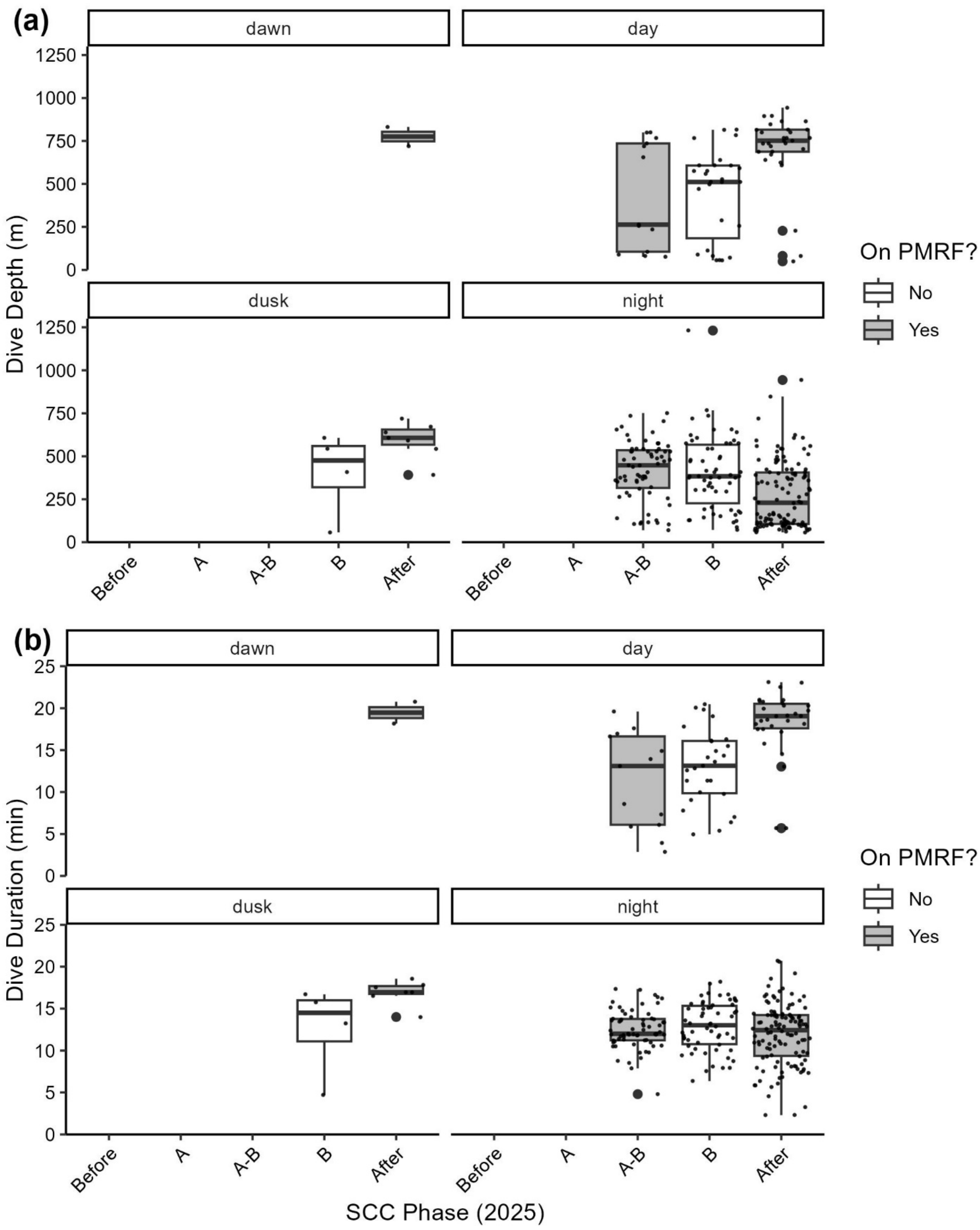


Figure 23. Boxplot showing A) dive depths and B) dive durations of GmTag262 by SCC phase and time of day with Interphase shown as A-B. GmTag262 had 100.00% behavioral coverage for Interphase and Phase B, and 27.23% behavioral coverage for After.

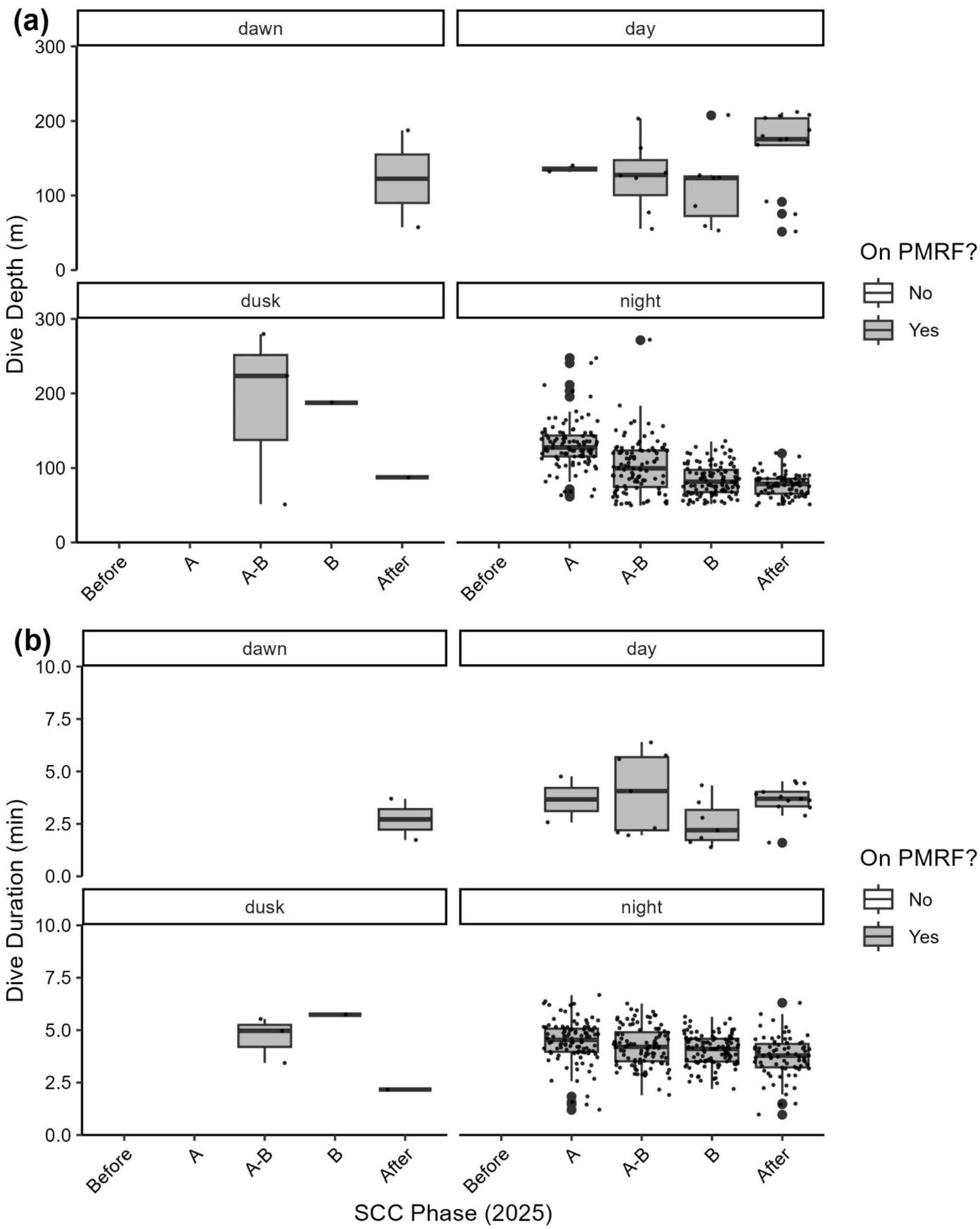


Figure 24. Boxplot showing A) dive depths and B) dive durations of SbTag028 by SCC phase and time of day with Interphase shown as A-B. SbTag028 had 100.00% behavioral coverage during Interphase, 91.48% behavioral coverage during Phase A, 77.63% behavioral coverage during Phase B, and 68.83% behavioral coverage during After.

REFERENCES

Baird, R.W., D.L. Webster, S.D. Mahaffy, D.J. McSweeney, G.S. Schorr and A.D. Ligon. 2008. Site fidelity and association patterns in a deep-water dolphin: rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. Marine Mammal Science 24(3):535-553. https://doi.org/10.1111/j.1748-7692.2008.00201.x

Baird, R.W., E.M. Oleson, J. Barlow, A.D. Ligon, A.M. Gorgone, and S.D. Mahaffy. 2013. Evidence of an island-associated population of false killer whales (*Pseudorca crassidens*) in the Northwestern Hawaiian Islands. Pacific Science 67(4):513-521. https://doi.org/10.2984/67.4.2

Baird, R.W., A.E. Harnish, C.J. Cornforth, M.A. Mohler, D.M. Barrios, J.A. Fahlbusch, L.D. Hutcheson, S.D. Mahaffy, and M.A. Kratofil. 2025. Small-boat surveys and satellite tagging of cetaceans on the Pacific Missile Range Facility, Kaua‘i, in February 2025. Field survey report to U.S. Pacific Fleet by HDR, under Federal contract number N62470-20-D-0016, Task Order No. 24F0225. August 2025.

Corsi, E., R.W. Baird, S.D. Mahaffy, and J.J. Kiszka. Submitted. Social life in the deep: variation in network structure and association patterns of rough-toothed dolphins (*Steno bredanensis*) around the main Hawaiian Islands.

Henderson, E.E., C.R. Martin, R.W. Baird, M.A. Kratofil, S.W. Martin, and B.L. Southall. 2021. FY20 summary report on the received level analysis of satellite tagged odontocetes at the Pacific Missile Range Facility. Naval Information Warfare Center Pacific.

Henderson, E.E., M.A. Kratofil, R.W. Baird, C.R. Martin, A.E. Harnish, G. Alongi, S.W. Martin, and B.L. Southall. 2025a. Exposure and response of satellite-tagged Blainville’s beaked whales to mid-frequency active sonar off Kaua‘i, Hawai‘i. Movement Ecology 13:29. https://doi.org/10.1186/s40462-025-00550-9.

Henderson, E.E., R.W. Baird, C. Martin, A.E. Harnish, M.A. Kratofil, S. Martin, C.J. Cornforth, and R.D. Andrews. 2025b. Received Levels of Odontocetes Tagged During Submarine Command Courses at the Pacific Missile Range Facility in 2023 and 2024. Technical Report 3386, NIWC Pacific, San Diego CA.

Kratofil, M.A., Harnish, A.E., Mahaffy, S.D., Henderson, E.E., Bradford, A.L., Martin, S.W., Lagerquist, B.A., Palacios, D.M., Oleson, E.M. and Baird, R.W., 2023. Biologically Important Areas II for cetaceans within US and adjacent waters–Hawai‘i Region. Frontiers in Marine Science, 10, p.1053581.

Van Cise, A. M., K. K. Martien, S. D. Mahaffy, R. W. Baird, D. L. Webster, J. H. Fowler, E. M. Oleson, P. A. Morin. 2017. Familial social structure and socially driven genetic differentiation in Hawaiian short-finned pilot whales. Molecular Ecology 26(23):6730-6741. https://doi.org/10.1111/mec.14397.

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14. ABSTRACT

This report provides a summary of the movement behavior before, during, and after the February 2025 Submarine Command Course (SCC) conducted at the Pacific Missile Range Facility (PMRF). It also provides received level estimates during periods of mid-frequency active sonar (MFAS) for the tagged animals. This work is part of an ongoing longitudinal study of odontocete occurrence off the islands of Kaua‘i and Ni‘ihau in the Hawaiian archipelago and a continuation of an analysis of the potential behavioral responses of these resident animals to MFAS used in Navy testing and training activities.

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