

**Pinniped Monitoring Report
Missile Launches on San Nicolas Island, California,
June 2021 – June 2022**

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ACRONYMS AND ABBREVIATIONS

3-D	3-dimensional
ASL	above sea level
ATAR	Autonomous Terrestrial Acoustic Recorder
B807	Building 807
B809	Building 809
CFR	Code of Federal Regulations
cm	centimeter
dB	decibel
dBA	decibel, A-weighted, to emphasize mid-frequencies and to de-emphasize low and high frequencies to which human (and pinniped) ears are less sensitive
F	Fahrenheit
FOV	field of view
ft	feet
FLIR	Forward Looking Infrared
hr	hour
Hz	Hertz
IHA	Incidental Harassment Authorization
in	inches
kg	kilogram
kHz	kilohertz
km	kilometer (1 km = 3281 ft, 0.62 mi, or 0.54 n.mi)
kts	knots or nautical miles per hour
lb	pounds
LOA	Letter of Authorization
m	meter
mi	mile
min	minute
mm	millimeter
MMPA	Marine Mammal Protection Act
M _{pa}	Frequency weighting appropriate for pinnipeds in air (see Gentry et al. 2004; Southall et al. 2007)
NAWCWD	Naval Air Warfare Center Weapons Division
nm	nautical miles
NMFS	National Marine Fisheries Service
PTS	Permanent Threshold Shift
rms	root mean square (a type of average)
s	second
SEL	sound exposure level
SEL-A	A-weighted sound exposure level
SEL-M	M _{pa} -weighted sound exposure level
SNI	San Nicolas Island
SPL	sound pressure level
SPL-f	flat-weighted sound pressure level
TTS	Temporary Threshold Shift
μPa	micropascal

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EXECUTIVE SUMMARY

The U.S. Navy's Point Mugu Sea Range held an Incidental Harassment Authorization (IHA) issued by the National Marine Fisheries Service (NMFS) for the period of June 12, 2021 through June 11, 2022 (Appendix A, 86 FR 32372). The IHA allowed for the 'take by harassment' of California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina*) and northern elephant seals (*Mirounga angustirostris*) resulting from missile launches on San Nicolas Island (SNI), California, an island owned and managed by the Navy. Past IHAs and Letters of Authorizations (LOAs) allowed for disturbance of seals and sea lions (pinnipeds) for missile launches from SNI from July 2001 through June 2021 (66 FR 41834, 67 FR 56271, 68 FR 52132, 74 FR 26580, 79 FR 32678, 84 FR 28462, 85 FR 38863). This report summarizes activities and observations under the IHA (86 FR 32372, renewal) valid from June 2021 through June 2022.

Missiles Launched

From June 2021 through June 2022, seventeen (17) missiles (aerial targets) were launched from SNI representing fourteen (14) launch events¹. All seventeen (17) of these missiles crossed over SNI's shoreline on the western end of the island.

Monitoring Equipment deployed during Missile Launches

Up to three unattended video cameras were set up to monitor pinnipeds at different sites near the missile launch trajectory. Autonomous Terrestrial Acoustic Recorders (ATARs) were deployed next to the video cameras. An additional ATAR was deployed near the launch site for each missile. Beaches monitored during each launch varied based on presence of hauled-out pinnipeds and proximity to the launch site.

Estimated Numbers of Pinnipeds Affected

For each launch, the species and number of pinnipeds affected was estimated using the video recordings. When appropriate, extrapolations of the number of pinnipeds affected were made when the field of view of the camera did not include the entire beach being monitored.

All pinnipeds became alert when a missile launch sound was audible on the video recordings. When quantifying effects, only pinnipeds that moved more than 10 meters or entered the water were counted as being "taken" for the purposes of this permit. There was no evidence of pinniped injuries, fatalities or pup abandonment related to the monitored launches during this or any other monitoring period since 2001.

Approximately 2,107 California sea lions, 66 Pacific harbor seals and 4 northern elephant seals were estimated to be "taken" at monitoring sites during the June 2021 through June 2022 monitoring period. These figures are approximate and may include instances where the same individuals were counted more than once at different times and/or different days. These estimates correspond to an average rate of 150.7 sea lions, 4.7 harbor seals and 0.28 elephant seals affected per launch event at all monitored reference sites.

The data collected during this monitoring period and pinniped monitoring data collected at SNI since 2001 suggest that any effects of the launch operations were minor, short-term, and localized. It is not likely that any of the pinnipeds on SNI were adversely affected by behavioral reactions to missile launches from the island.

A detailed analysis of sound data from the ATARs is included in Appendix B of this report. The types of missiles launched during this monitoring period were the same as those launched in previous years.

¹ Multiple missiles fired in rapid succession (e.g. 3-5 seconds apart) are considered one launch event.

Only one launch site was used during this reporting period, which has been used in all previous reporting periods since 2001. Additionally, the missile launch sounds recorded during this monitoring period were similar to recordings from previous SNI launches (U.S. Navy 2020, Burke 2017, Ugoretz 2015, Ugoretz 2014, Ugoretz 2013, Holst et al. 2011). During this monitoring period, temporary threshold shift (TTS) for Phocids in air was exceeded during four launches and permanent threshold shift (PTS) for Phocids in air was exceeded during two launches. The ATAR device for all six of these locations was placed on a bluff or cliff high above the haul-out location. The bluff or cliff likely masked the missile sound, making it unlikely for either TTS or PTS to occur (U.S. Navy 2020, Burke 2017, Ugoretz 2015, Ugoretz 2014, Ugoretz 2013, Holst et al. 2011). Based on these data and past data analyses, it is unlikely that any pinnipeds incurred any TTS or PTS during launches at SNI. If TTS were to occur, hearing loss would have presumably been mild and recoverable and thus not have caused permanent damage.

1. MONITORING PROGRAM AND MISSILE LAUNCHES

1.1 Monitoring Program

San Nicolas Island (SNI) is located approximately 65 miles (m) (~100 kilometers (km)) from the mainland coast of southern California (Fig. 1.1). Missiles were launched from one of two land-based launch complexes on the western part of SNI. Building 807 (B807) Launch Complex is located on the west end of SNI, approximately 35 feet (ft) (11 meters [m]) Above Sea Level (ASL), and the Alpha Launch Complex is located approximately 625 ft (190.5 m) ASL on the west-central part of SNI (Fig. 1.2). The missiles pass over or near pinniped haul-out sites located around the northwestern periphery of SNI. The pinniped species that commonly occur on SNI include California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina*) and northern elephant seals (*Mirounga angustirostris*).

The U.S. Navy held an Incidental Harassment Authorization (IHA) issued by the National Marine Fisheries Service (NMFS) for the period of June 12, 2021 through June 11, 2022 (Appendix A, 86 FR 32372). The IHA allowed for the ‘take by harassment’ of California sea lions, Pacific harbor seals and northern elephant seals, resulting from missile launches on San Nicolas Island (SNI), California, an island owned and managed by the Navy. Past IHAs and Letters of Authorizations (LOAs) allowed for disturbance of seals and sea lions (pinnipeds) for missile launches from SNI from July 2001 through June 2021 (66 FR 41834, 67 FR 56271, 68 FR 52132, 74 FR 26580, 79 FR 32678, 84 FR 28462, 85 FR 38863). This report summarizes activities and observations under the IHA valid from June 2021 through June 2022.

The Navy’s application for the 2021-2022 IHA included provisions to monitor effects of missile launch activities on pinnipeds hauled-out at SNI in a manner similar to pinniped monitoring that took place during Navy launch activities from 2001–2021. Pinniped species monitored on SNI included the California sea lion, Pacific harbor seal and northern elephant seal.

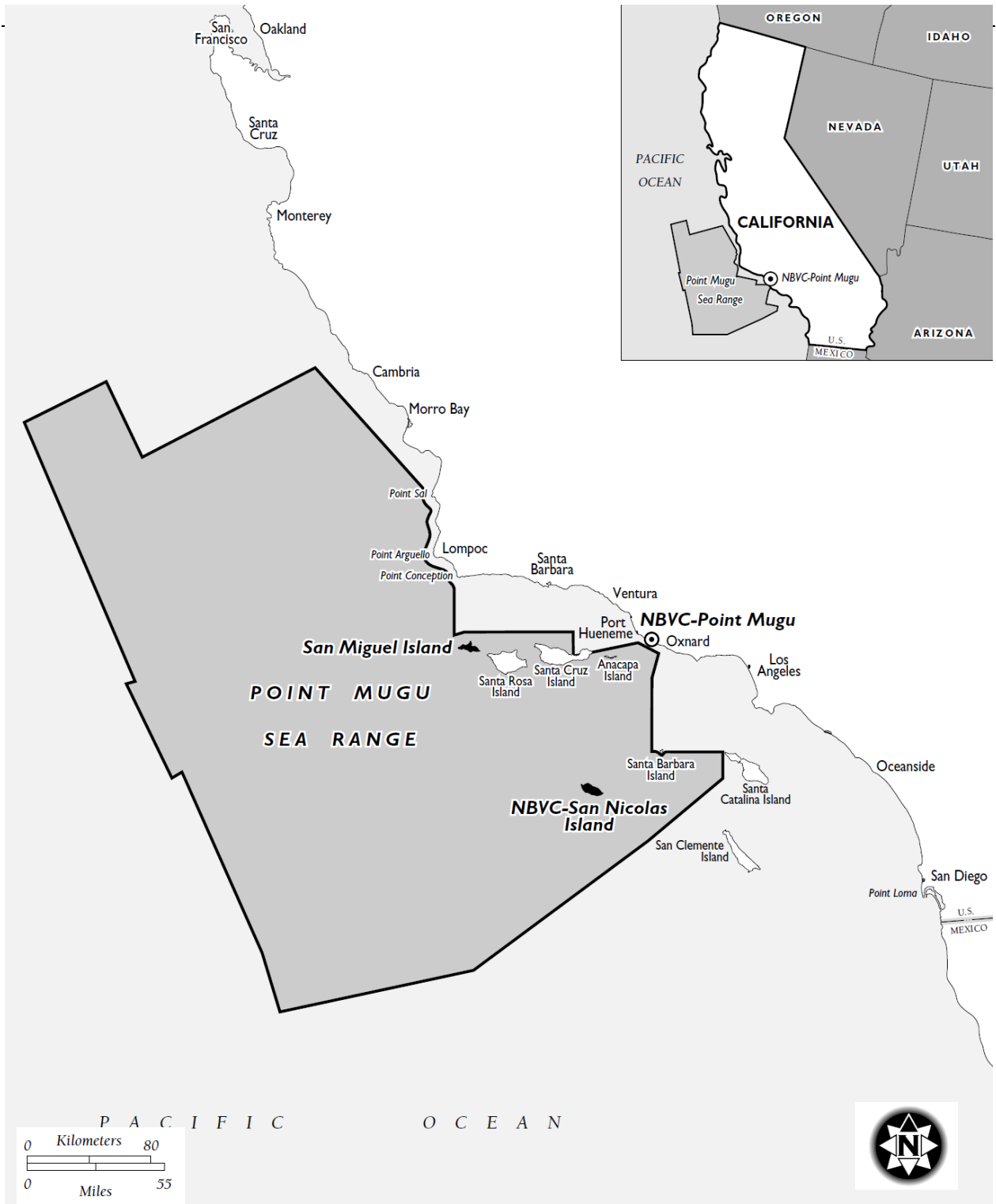


FIGURE 1.1. Regional site map of the Point Mugu Sea Range and San Nicolas Island, California

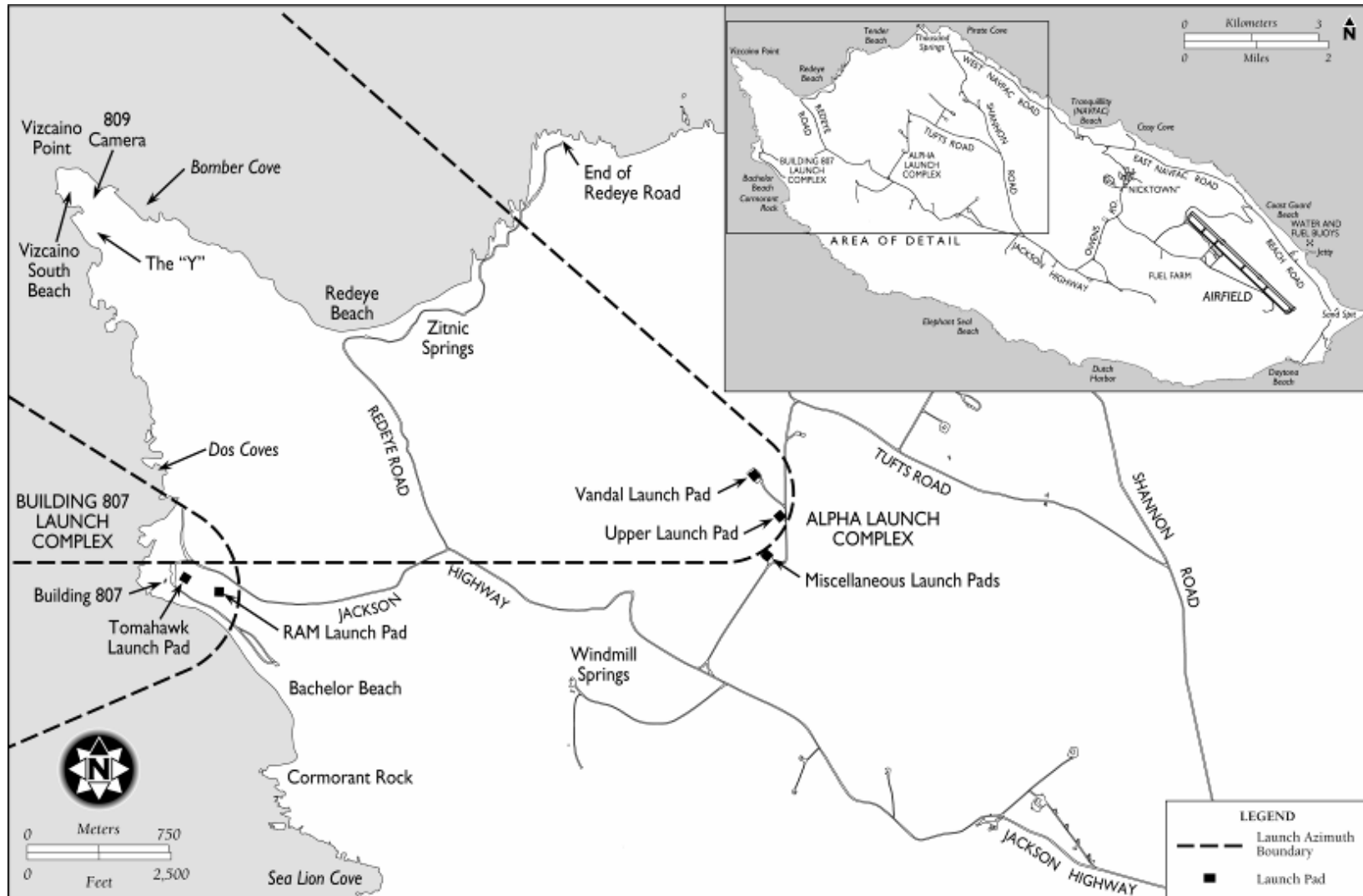


FIGURE 1.2. Map of San Nicolas Island, California, and the general launch azimuths (dashed lines) for each launch complex. These launch azimuths are typical, although occasionally launch paths could pass outside these boundaries.

The 2021-2022 monitoring plan required that, for each missile event at SNI, simultaneous autonomous audio recording of launch sounds and video recording of pinniped behavior occur. Generally monitoring occurred at three haul-out sites during each launch. Monitoring site locations changed throughout the monitoring period as they were selected based on the presence of pinnipeds due to seasonality and their proximity to the launch site. Certain monitoring sites were selected more frequently than others due to these factors as well. This monitoring provided data used to characterize the extent and nature of “taking.” Specifically, it provided information used to document the nature, frequency, occurrence, and duration of any changes in pinniped behavior resulting from missile launches.

1.1.1 Acoustic Monitoring

For all launches conducted during this monitoring period, Autonomous Terrestrial Acoustic Recorders (ATARs) were placed in the same location as video cameras documenting pinniped reactions, allowing for paired acoustic and pinniped-response data to be collected. In addition to recording launch sound, these audio recordings recorded ambient noise levels prior to and following the launches.

Objectives of the audio monitoring program included:

1. Document levels and characteristics of launch sound at several distances from the missile paths;
2. Document levels and characteristics of ambient sound to measure background noise against which the pinnipeds will (or will not) detect the launch sound; and
3. Determine if the sound levels from missile launches were high enough to have the potential to induce Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) in pinnipeds exposed to launch sound.

1.1.2 Visual Monitoring

Video monitoring provided data on behavioral changes of pinnipeds hauled-out on SNI. This information was used to document the nature, frequency, occurrence, and duration of any changes in pinniped behavior resulting from the missile launch events, including the occurrence of stampedes from haul-out sites if they occur.

Objectives of video monitoring included:

1. Identify and document any change in behavior or movements that occurred at the time of the launch event;
2. Quantify the interval required for pinniped numbers and behavior to return to normal if there was a change as a result of a launch event;
3. Ascertain periods or launch conditions when pinnipeds are most and least responsive to launch activities; and
4. Document numbers of pinnipeds disturbed by launch events and any evidence of injury or mortality associated with an event.

1.2 “Take” Estimates

The monitoring program for the missile launches on SNI was designed, in part, to provide data necessary to estimate the numbers of pinnipeds “taken” by launches and the manner in which they were affected. For military readiness activities, the MMPA defines harassment as:

“1) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild; or, (2) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered.” [10 USC Ch. 631§7235]

In this report, consistent with previous monitoring reports, the Navy and NMFS agreed that only those animals that met the following criteria count as “taken” by launches:

1. Pinnipeds injured or killed during launch events, if any² (e.g., by stampedes);
2. Pinnipeds exposed to launch sounds strong enough to cause TTS or PTS; or
3. Pinnipeds that left the haul-out site, or exhibited prolonged movement³ or behavioral changes (such as pups separated from mothers) relative to their behavior immediately prior to the launch.

No pinnipeds are known to have been injured or killed since the launch monitoring began in August 2001, and few, if any, are believed to have received sounds strong enough to elicit TTS or PTS (Holst, et al. 2011). Thus, the number of pinnipeds counted as potentially “taken” during the 2021-2022 monitoring period was based on criterion 3 above: The number that left the haul-out site, or exhibited prolonged movement or other behavioral changes relative to their behavior immediately prior to the launch.

1.3 Launch Dates and Information

From June 2021 through June 2022, seventeen (17) missiles (aerial targets), three of which were “dual launches”, were launched from SNI representing fourteen (14) launch events⁴ (Table 1.1). All seventeen (17) of these missiles crossed over SNI’s shoreline on the western end of the island.

² Note that the IHA issued to the Navy did not allow for injury or mortality. Any evidence of injury or mortality of pinnipeds associated with a launch event was to be reported to NMFS and conditions of the permit would be reevaluated.

³ Prolonged movement, for the purpose of the monitoring and this report, “prolonged movement” is defined as one or more animals moving in a directed manner either more than 10 m (33 ft) onshore or moving any distance from the shore and entering the ocean.

⁴ Multiple missiles fired in rapid succession (e.g. 3-5 seconds apart) are considered one launch event.

TABLE 1.1. Launch data for June 2021 through June 2022.

Launch Date	Launch Time (local)	Number of Missiles	Launch Complex	Pinniped Monitoring Locations		
07/21/2021	09:12	Single Launch (1)	Alpha	Dos Coves	Red Eye East	Phoca Reef
07/21/2021	11:33	Single Launch (1)	Alpha	Dos Coves	Red Eye East	Phoca Reef
08/16/2021	11:00	Dual Launch (2)	Alpha	Dos Coves	Red Eye West	Phoca Reef
08/18/2021	11:00	Dual Launch (2)	Alpha	Dos Coves	Red Eye West	Phoca Reef
09/20/2021	10:35	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
11/18/2021	11:16	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Red Eye East
12/07/2021	13:00	Dual Launch (2)	Alpha	Dos Coves	Red Eye West	Vizcaino Point
03/15/2022	15:00	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
03/16/2022	10:30	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
04/15/2022	11:53	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
04/16/2022	13:53	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
04/19/2022	13:43	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef

05/31/2022	12:00	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef
05/31/2022	13:47	Single Launch (1)	Alpha	Dos Coves	Red Eye West	Phoca Reef

2. PINNIPED BEHAVIOR DURING MISSILE LAUNCH EVENTS

2.1 Introduction

Three species of pinnipeds are common on SNI beaches – California sea lion, Pacific harbor seal, and northern elephant seal. No other pinniped species were observed at monitoring sites during this or previous monitoring periods since August 2001 (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011).

California sea lions often show startle responses to launches and movement along the beach. In most cases, sea lion behavior returns to pre-launch levels within seconds or minutes following the launches (Holst et al. 2011). Behavior as well as numbers of sea lions hauled-out several hours after a launch appears similar to the behavior and numbers observed before a launch.

In contrast, Pacific harbor seals often react strongly to launch sound. They commonly leave their haul-out sites to enter the water. Early monitoring reports suggested that harbor seals did not return to a haul-out site for several hours or the next tide cycle (Holst et al. 2011). Holst and Lawson (2002) noted that the behavior and numbers of Pacific harbor seals hauled-out on the day following a launch were similar to those on the day of the launch. Focused monitoring of Pacific harbor seals during the 2020-2021 monitoring period indicate that harbor seals can return to their haul-out site within minutes of a launch (U.S. Navy 2021). Distribution and abundance of harbor seals at the sites monitored were strongly influenced by the height of the tide.

Northern elephant seals are often startled by missile launch sounds but have otherwise shown little or no reaction to missile launches. During this monitoring period, elephant seals were present on many of the monitored haul-outs along with other species and were included in the camera's field of view. Elephant seal reactions were similar to those in the past (generally no movement or very minor movement down the beach) reconfirming their relative lack of reaction to missile launches.

2.2 Visual Field Methods

Navy personnel placed up to three Sony high definition digital video cameras (HDR-CX160) on tripods overlooking haul-out sites. Missile and other sounds detected by the microphones built into these cameras were also recorded. The audio data collected by the video cameras were used during behavioral analyses (e.g., to confirm the exact time when the missile was launched), but were not calibrated and not of sufficient quality to provide detailed launch sound information.

Video cameras were placed at locations overlooking haul-out sites prior to each launch in a manner that minimized disturbance to pinnipeds. When the entire haul-out aggregation at a given site could not be captured in the camera's field of view, a representative focal subgroup within the haul-out aggregation was selected. The number of animals "taken" at a given location was estimated based on the percentage of beach observed and percentage of the focal group affected with the assumption that animals were equally distributed along the beach. Video was recorded before, during, and after each launch event.

Time-lapse cameras were added to the monitoring effort during the 2020-2021 monitoring period and remained in use for the 2021-2022 monitoring period. When the video cameras either failed, due to technical difficulties, or lens fouling obstructed accurate take counts, the time-lapse cameras were used as an alternative method to measure pinniped disturbance. Up to six time-lapse cameras were deployed near haul-out locations on SNI beginning March 2020. The time-lapse camera systems included a Canon Rebel single lens reflex camera housed in a Pelican case and mounted onto a tripod. A solar panel and light sensor allowed for the cameras to be continuously deployed capturing photos during all daylight hours. Photos

were captured in intervals of one to five minutes. The time-lapse cameras documented environmental and seasonal changes in pinniped distribution and abundance and were used to supplement the data collected during video monitoring.

2.2.1 Video Analysis

Digital video recordings were reviewed by an experienced biologist on a high-resolution color monitor. The recordings before, during, and up to 60 min after each launch were reviewed to document the types and numbers of pinnipeds present, the nature of any overt responses to the launch, and the number of pinnipeds that overtly responded. The number, proportion and age class (adult or pup - where determinable) of the individuals that responded in various ways were estimated using the video recordings and supplemented with time-lapse imagery, when available. Following NMFS guidance [2002], subtle behavioral reactions persisting for only a few minutes are considered unlikely to have biologically significant consequences for the pinnipeds. Pinnipeds that move into the water or greater than 10 m (33 ft) along the beach are considered to have been “taken.”

2.3 Descriptions of Pinniped Behavior during Specific Launches

The following are brief summaries of the observations made from viewing the video and time-lapse data collected at monitoring sites during the 2021-2022 monitoring period.

2.3.1 Launch from Alpha: July 21, 2021 (0912hrs)

- Dos Coves – The entire beach was within the field of view of the camera with approximately 20 sea lions resting on the beach. The video lens had fouling and made it difficult to see. All sea lions on the beach startled when missile launch sound was audible on the video. The majority of the animals returned to pre-launch behavior within minutes of launch. An estimated 20 sea lions moved more than 10 meters or entered the water.
- Red Eye East – The entire beach was within the field of view of the camera with approximately 12 sea lions and 2 elephant seals on the beach. Majority of the sea lions and elephant seals were resting with little to no activity prior to the launch. Missile launch noise was audible on the video at the time of the launch. Approximately 6 sea lions startled and no observed movement from the elephant seals when launch noise was audible. An estimated 2 sea lions moved more than 10 meters or entered the water.
- Phoca Reef – This reef was used exclusively by harbor seals. At the time of the launch, the entire reef was exposed. Approximately 2 harbor seals were resting on the reef within the field of view of the camera. One (1) harbor seal startled at the time of the launch. Within 15 minutes after launch, 7 harbor seals were hauled out on the reef. No harbor seals moved more than 10 meters or entered the water as a result of the launch.

2.3.2 Launch from Alpha: July 21, 2021 (1133hrs)

- Dos Coves – The entire beach was within the field of view of the camera. Approximately 58 sea lions (approximately 70% pups and 30% adult females) were resting or had little to no movement on the beach prior to launch. No elephant seals hauled-out. All animals startled when launch noise was audible on the video. Approximately 32 sea lions at the monitoring site moved more than 10 meters or entered the water. All animals returned to pre-launch behavior within minutes after launch.

- Red Eye East – The entire beach was within view of the camera. Approximately 50 sea lions (80% adult males and 20% juveniles) and no elephant seals were resting on the beach prior to the launch. All animals startled at the time of the launch. Approximately 40 sea lions moved more than 10 meters or entered the water. Within 5 minutes animals started to return to the beach and began returning to pre-launch behavior.
- Phoca Reef – This reef was used exclusively by harbor seals. This reef was entirely exposed during the time of the launch. Approximately 51 harbor seals were hauled-out on the reef at the time of the launch. Launch sound was audible on video and all animals startled. Forty-one (41) harbor seals entered the water. Within 30 minutes 35 harbor seals had returned to the reef. The tide continued to increase throughout the day and eventually covered the reef.

2.3.3 Dual Launch from Alpha: August 16, 2021 (1100hrs)

- Dos Coves – Entire beach was within the field of view of the camera. Approximately 33 sea lions (50% pups and 50% adult females) on or above the beach immediately prior to launch. No elephant seals in field of view of the camera. All animals were resting prior to launch. Launch noise was audible on video camera. Approximately 15 sea lions either entered the water or moved towards the water in response to the launch. Fifteen (15) sea lions moved more than 10 meters or entered the water.
- Red Eye West – The entire beach was within the field of view of the camera. Approximately 61 sea lions (pups and adult females) resting either on the sand dune or near the water's edge were in view of the camera. There were also approximately 100 sea lions in the background of the camera. No elephant seals were hauled-out on the beach. All animals startled when launch was audible on video. Approximately 143 sea lions moved more than 10 meters, but then resumed pre-launch behaviors within minutes after the launch.
- Phoca Reef – This reef was used exclusively by harbor seals. This reef was entirely exposed during the time of the launch. Approximately 27 harbor seals were hauled-out on the reef at the time of the launch. Launch sound was audible on video and all animals startled. Twenty-five (25) harbor seals entered the water. Within 2 minutes after the launch, animals started returning to the reef and within 10 minutes 8 harbor seals were hauled-out on the reef.

2.3.4 Dual Launch from Alpha: August 18, 2021 (1100hrs)

- Dos Coves – It was raining this day and water droplets covered the view of the camera. The time-lapse camera was used to get accurate counts. Approximately 2 sea lions were interacting on the beach with approximately 34 sea lions resting on the bluffs in the field of view of the camera. No elephant seals hauled-out on the beach. All animals startled when launch noise was audible. Approximately 36 sea lions moved more than 10 meters towards the water or entered the water.
- Red Eye West – It was raining this day and water droplets covered the view of the camera. The time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 85 sea lions were hauled-out prior to launch. The majority were resting on the sand dune with a few walking down towards the water prior to the launch. No elephant seals were hauled-out on the beach. All of the sea lions startled when launch noise was audible on the video recording. Approximately 70 sea lions moved more than 10 meters or entered the water.
- Phoca Reef – This reef was used exclusively by harbor seals. This reef was entirely exposed during the time of the launch. Eight (8) harbor seals were hauled-out on reef at the time of the launch.

Launch sound was audible on video and all animals startled, but no animals entered the water. Within 1 minute after launch, the animals began to return to pre-launch behavior.

2.3.5 Launch from Alpha: September 20, 2021 (1035hrs)

- Dos Coves – The entire beach was within the field of view of the camera. Approximately 40 sea lions and 4 elephant seals were either resting or walking on the beach and bluff prior to the launch. Only the animals on the bluff had a startled response when launch noise was audible on video. Approximately 23 sea lions moved from the bluff towards the water in response to the launch noise. Approximately 23 sea lions, but no elephant seals, moved more than 10 meters or entered the water. Within minutes the animals returned to pre-launch behavior.
- Red Eye West – The entire beach was within the field of view of the camera. There were approximately 80 sea lions resting on the sand dune with an additional 50 sea lions surrounding the rocks near the water prior to the launch. No elephant seals were hauled-out on the beach. All animals startled when launch noise was audible on video. Birds began flying prior to launch noise. Approximately 80 sea lions moved more than 10 meters or entered the water.
- Phoca Reef – This reef is used exclusively by harbor seals. This reef was underwater during the time of the launch. No animals were hauled-out on the reef during time of launch.

2.3.6 Launch from Alpha: November 18, 2021 (1116hrs)

- Dos Coves – The entire beach was in view of the camera. There were approximately 109 sea lions (50% pups and 50% adult females) and 21 elephant seals. All animals were resting prior to launch. All animals startled when launch noise was audible on video. Approximately 74 sea lions and 1 elephant seal moved more than 10 meters or entered the water.
- Red Eye West – The entire beach was in view of the camera. Approximately 300 sea lions and 15 elephant seals were resting on the beach prior to the launch. All animals startled once launch noise was audible on video. Approximately 293 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye East – Entire beach was in view of camera. Approximately 50 elephant seals were resting on the beach prior to the launch noise. All animals startled when launch noise was audible on video. No animals moved more than 10 meters or entered the water. Within minutes all animals returned to pre-launch behavior.

2.3.7 Dual Launch from Alpha: December 07, 2021 (1300hrs)

- Dos Coves – Entire beach was within the field of view of the camera. Prior to launch, 60 sea lions and 11 elephant seals were resting on the beach. Launch noise was audible on video. Birds began to fly prior to launch noise causing some sea lion pups to run towards the water before launch noise was audible. Approximately 15 sea lions on the bluff had an initial startle response to the first launch pulse sound. The second pulse sound was audible on the video and caused approximately 40 sea lions to move more than 10 meters or enter the water.
- Red Eye West – The entire beach was within the field of view of the camera. Approximately 20 sea lions were resting on the sand dune, 40 sea lions were resting on the rocks near the water and an additional 100 sea lions were interacting in the background. There was also 1 additional elephant seal located near the water's edge. The launch noise was audible on video. Approximately 70 sea lions and 1 elephant seal moved more than 10 meters or entered the water.

- Vizcaino Point – The entire beach was in the field of view of the camera. Approximately 100 sea lions were resting on the beach prior to the launch. No elephant seals were hauled-out on the beach. All animals startled when launch noise was audible on video. Approximately 70 sea lions moved more than 10 meters or entered the water after the launch. Within minutes the animals returned to pre-launch behavior.

2.3.8 Launch from Alpha: March 15, 2022 (1500hrs)

- Dos Coves – Fouling on the lens made it was difficult to see the beach. The time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 90 sea lions and 8 elephant seals were resting on the beach prior to the launch. Approximately 60 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye West –Fouling on the lens made it was difficult to see the beach. The time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 50 sea lions and 70 elephant seals were resting or had little to no activity on the beach prior to the launch. All 50 sea lions moved more than 10 meters or entered the water in response to the launch noise.
- Phoca Reef – This reef is used exclusively by harbor seals. At the time of the launch, the reef was underwater. No harbor seals present.

2.3.9 Launch from Alpha: March 16, 2022 (1030hrs)

- Dos Coves –Due to technical difficulties on the video camera, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 46 sea lions and 5 elephant seals were resting on the beach or bluff prior to the launch. Many sea lions ran from the bluff towards the water in response to the launch noise. Approximately 46 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye West – Due to lens fouling, the beach was difficult to see. The entire beach was within the field of view of the camera. Approximately 100 sea lions and 17 elephant seals were resting on the beach prior to the launch. All 100 sea lions, but no elephant seals, moved more than 10 meters or entered the water in response to the launch noise.
- Phoca Reef – This reef is used exclusively by harbor seals. At the time of the launch, the reef was underwater. No harbor seals present.

2.3.10 Launch from Alpha: April 15, 2022 (1153hrs)

- Dos Coves – The entire beach was within the field of view of the camera. Approximately 70 sea lions and 21 elephant seals were resting on the beach prior to the launch. All animals startled when launch noise was audible on video. Approximately 41 sea lions, but no elephant seals, moved more than 10 meters or entered the water. Within minutes the animals returned to pre-launch behavior.
- Red Eye West – Due to fouling on the video lens, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 11 sea lions and 26 elephant seals were resting on the beach prior to the launch. Approximately 5 sea lions moved more than 10 meters or entered the water in response to the launch noise.
- Phoca Reef – This reef was used exclusively by harbor seals. This reef was entirely exposed during the time of the launch, but no animals were present.

2.3.11 Launch from Alpha: April 16, 2022 (1353hrs)

- Dos Coves – The entire beach was within the field of view of the camera. Approximately 119 sea lions and 38 elephant seals were resting or had little to no activity by the water’s edge prior to the launch. All animals startled when launch noise was audible on video. Approximately 70 sea lions and 2 elephant seals moved more than 10 meters or entered the water.
- Red Eye West – The entire beach was within the field of view of the camera. Approximately 200 sea lions and 31 elephant seals were all resting on the beach prior to the launch. The launch noise was audible on the video causing all animals to startle. All 200 sea lions, but no elephant seals, moved more than 10 meters or entered the water. Within 5 minutes the animals returned to pre-launch behavior.
- Phoca Reef – This reef is used exclusively by harbor seals. This reef was entirely exposed during the time of the launch, but no animals were present.

2.3.12 Launch from Alpha: April 19, 2022 (1343hrs)

- Dos Coves – The entire beach was within the field of view of the camera. Approximately 80 sea lions and 30 elephant seals were resting on the beach prior to the launch. All animals startled when launch noise was audible on video. Birds began to fly prior to launch noise causing some animals to startle prior to launch noise on video. Approximately 64 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye West – The entire beach was within the field of view. Approximately 96 sea lions and 40 elephant seals were all resting on the beach prior to the launch. The majority of the sea lions were resting on the sand dune prior to launch with a few resting near the water’s edge. The launch noise was audible on the video. All animals startled. Approximately 86 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Phoca Reef – This video camera experienced technical difficulties and the time-lapse camera was used to get accurate counts. This reef is used exclusively by harbor seals. The reef was entirely exposed during the time of the launch, with 1 harbor seal hauled-out. There was a startle response at time of launch, but the harbor seal remained hauled-out. No animal moved more than 10 meters or entered the water.

2.3.13 Launch from Alpha: May 31, 2022 (1200hrs)

- Dos Coves – Due to technical difficulties, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 102 sea lions and 65 elephant seals were resting on beach prior to the launch. Approximately 60% of the animals had a startle response during the time of the launch. Approximately 52 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye West – Due to fouling on the video camera lens, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 198 sea lions and 40 elephant seals were all resting on the beach prior to the launch. All animals startled at the time of the launch. Approximately 135 sea lions, but no elephant seals, moved more than 10 meters or entered the water. All animals returned to pre-launch behavior within 5 minutes.
- Phoca Reef – This reef is used exclusively by harbor seals. This reef was entirely exposed during the time of the launch, but no animals were present.

2.3.14 Launch from Alpha: May 31, 2022 (1347hrs)

- Dos Coves – Due to technical difficulties, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 85 sea lions and 53 elephant seals were resting or had little to no activity on the beach prior to the launch. Approximately 50% of the animals had a startle response during the time of the launch. Approximately 46 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Red Eye West – Due to fouling on the video camera lens, the time-lapse camera was used to get accurate counts. The entire beach was within the field of view of the camera. Approximately 180 sea lions and 40 elephant seals were all resting on the beach prior to the launch. All animals startled at the time of the launch. Approximately 144 sea lions, but no elephant seals, moved more than 10 meters or entered the water.
- Phoca Reef – This reef is used exclusively by harbor seals. This reef was entirely exposed during the time of the launch, but no animals were present.

3. ACOUSTIC MEASUREMENTS OF MISSILE LAUNCH EVENTS

3.1 Introduction

The acoustic measurement techniques for the 2021-2022 monitoring period were consistent in approach and methodology with those used in the preceding years (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011). Recordings of launch sound and ambient sound, were measured at up to three pinniped haul-out sites as well as near the launch pad for each missile event. ATARs were developed for this purpose by the Navy's acoustical contractor, Greeneridge Sciences Inc. of Santa Barbara, California. The specific design of the ATARs is described in earlier reports (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011).

3.2 Acoustic Analysis

Various federal, state, and other organizations recommend specific acoustic thresholds for the onset of TTS and PTS in marine mammals. The thresholds used in this report are for impulsive noise (noise with high peak sound pressure, short duration, fast rise-time, and broad frequency content) from the U.S. Navy technical report by J. Finneran, E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow, *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*, published by the Space and Naval Warfare Systems Center Pacific, San Diego, CA in June 2017.

As with Navy Phase II criteria (Finneran & Jenkins, 2012), auditory weighting functions were applied to acoustic data, prior to the calculation of acoustic metrics such as sound exposure level (SEL) and sound pressure level (SPL), to account for various species' frequency-dependent hearing sensitivity. However, unlike Navy auditory weighting functions for Phase II which were based on "M-weighting" curves for "functional hearing groups", Navy Phase III (Finneran et al., 2017) weighting functions are defined by a generic band-pass filter whose shape is determined by parameters specific to a slightly different classification of nine "marine species hearing groups".

In addition to differences in auditory weighting functions, TTS and PTS thresholds differ between Navy Phase II and Phase III. In Navy Phases II and III, pinnipeds were classified into two hearing groups based upon pinnipeds' two scientific families: Otariidae (eared seals: sea lions and fur seals) and Phocidae (earless seals, or true seals). However, in Navy Phase II, TTS thresholds were the same for both Otariids and Phocids in air, as were PTS thresholds. In Navy Phase III, different TTS and PTS thresholds are defined for Otariids in air (OA) and Phocids in air (PA). The Navy Phase III thresholds for pinnipeds in air are summarized in Table 3.1 below:

Table 3.1. Navy Phase III TTS and PTS thresholds for pinnipeds in air.

Group	Non-impulsive		Impulsive			
	TTS threshold SEL ^a (weighted)	PTS threshold SEL ^a (weighted)	TTS Threshold		PTS threshold	
			SEL ^a (weighted)	Peak SPL ^b (unweighted)	SEL ^b (weighted)	Peak SPL ^b (unweighted)
OA ^c	157	177	146	170	161	176
PA ^d	134	154	123	155	138	161

^a SEL thresholds are in dB re (20 μPa)²·s in air

^b SPL thresholds in dB re 20 μPa in air

^c OA-Otariid in air (includes California sea lion)

^d PA-Phocid in air (includes Pacific harbor seal)

The TTS and PTS thresholds relevant to San Nicolas Island missile launches and used in this report are those listed under “Impulsive” in Table 3.1.

3.3 Results Acoustic Analysis

Acoustic data collected during the June 2021 through June 2022 monitoring period were analyzed by Greeneridge Sciences Inc. The acoustic monitoring results for all seventeen (17) launches are presented in Table 3.2. Four parameters are reported for the missile flight sounds: peak pressure level, SPL, SEL, and duration. These values are similar to sound levels reported for previous launches from SNI (U.S. Navy 2020, Burke 2017, Ugoretz 2015, Ugoretz 2014, Ugoretz 2013, Holst et al. 2011).

TABLE 3.2. Pulse parameters for unweighted, OA-weighted, and PA-weighted sound from SNI missile launches, June 2021 – June 2022.

Values highlighted in green exceeded the level at which TTS onset might occur

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
21 July 2021 (1 of 2)											
Phoca Reef		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Redeye East		144.	120.1	119.5	0.9	110.5	108.6	0.6	113.7	112.2	0.7
Dos Coves		142.	130.5	118.9	0.1	97.8	95.5	0.6	102.0	99.9	0.6
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21 July 2021 (2 of 2)											
Phoca Reef		98.4	75.7	85.6	9.9	46.3	57.2	12.4	48.3	59.1	12.2
Redeye East		143.	121.2	120.5	0.9	111.1	109.8	0.8	115.4	114.3	0.8
Dos Coves		144.	133.4	120.2	0.0	104.4	98.4	0.3	108.0	102.7	0.3
Alpha		135.	118.8	122.0	2.1	92.1	95.6	2.2	97.5	101.0	2.2
16 August 2021											
Redeye West		140.	116.4	120.4	2.5	93.2	97.6	2.7	97.8	102.2	2.8
Dos Coves		155.	127.1	129.0	1.5	105.0	107.9	2.0	111.6	114.6	2.0
Phoca Reef		108.	90.9	100.9	9.8	59.4	69.4	10.1	64.0	73.9	9.8
Alpha Complex		160.	143.8	147.9	2.6	128.0	131.1	2.1	134.0	136.9	2.0
18 August 2021											
Redeye West		139.	116.8	120.3	2.2	92.4	96.2	2.4	97.5	101.3	2.4
Dos Coves		160.	136.7	138.6	1.5	127.1	128.7	1.4	131.4	132.9	1.4
Phoca Reef		102.	82.6	90.9	6.6	53.3	62.7	8.7	55.2	65.2	10.0

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
Alpha Complex		152.	139.2	143.0	2.4	121.4	125.0	2.3	126.4	129.9	2.2
20 September 2021											
Dos Coves		107.	90.9	101.5	11.6	67.5	76.1	7.3	74.1	82.0	6.1
Redeye West		109.	95.5	100.6	3.2	76.6	81.1	2.9	82.3	86.9	2.9
Phoca Reef		98.1	83.4	89.2	3.8	57.5	62.1	2.9	63.2	67.9	3.0
Alpha		137.	116.0	119.3	2.2	83.6	87.3	2.3	87.6	91.4	2.4
18 November 2021											
Dos Coves		137.	122.0	116.4	0.3	94.6	90.5	0.4	97.8	95.1	0.5
Redeye West		119.	103.7	107.6	2.5	84.3	87.8	2.3	90.2	93.8	2.3
Redeye East		113.	98.0	102.7	3.0	80.4	84.7	2.7	85.9	90.3	2.8
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7 December 2021											
Dos Coves		104.	87.1	95.1	6.3	62.9	70.9	6.4	69.2	77.3	6.4
Redeye West		123.	109.2	121.2	15.7	86.7	95.8	8.3	91.7	100.8	8.0
Vizcaino Point		97.4	80.9	90.9	10.0	51.9	62.5	11.4	55.0	65.6	11.5
Alpha Complex		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15 March 2022											
Dos Coves		146.	133.1	121.7	0.1	102.4	98.9	0.4	107.1	103.7	0.5
Redeye West		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phoca Reef		103.	82.6	91.4	7.6	52.8	61.4	7.1	59.2	67.9	7.5
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16 March 2022											
Dos Coves		164.	141.2	139.2	0.6	130.8	129.4	0.7	59.2	133.0	0.8
Redeye West		154.	132.9	133.4	1.1	118.2	118.2	1.0	59.2	121.9	1.0
Phoca Reef		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15 April 2022											
Dos Coves		160.	145.6	136.3	0.1	120.2	120.1	1.0	125.4	124.8	0.9
Redeye West		143.	121.1	121.6	1.1	101.2	102.3	1.3	105.0	106.2	1.3
Phoca Reef		96.9	79.2	88.9	9.4	52.4	60.0	5.7	57.8	66.2	7.0
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16 April 2022											
Dos Coves		146.	136.4	121.4	0.0	102.3	99.6	0.5	107.4	104.6	0.5
Redeye West		160.	134.2	135.8	1.5	119.8	121.5	1.5	126.5	128.1	1.5
Phoca Reef		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19 April 2022											
Dos Coves		145.	133.7	121.4	0.1	101.9	98.5	0.5	105.9	102.9	0.5
Redeye West		165.	134.2	134.4	1.0	118.5	117.0	0.7	124.8	123.4	0.7
Phoca Reef		104.	85.5	94.0	7.1	54.0	62.8	7.7	59.6	68.0	6.9
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31 May 2022 (1 of 2)											
Dos Coves		142.	134.1	119.2	0.0	99.5	96.7	0.5	102.5	100.6	0.6
Redeye West		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phoca Reef		99.3	79.5	87.0	5.7	50.4	57.0	4.6	54.0	62.1	6.5
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31 May 2022 (2 of 2)											
Dos Coves		142.	132.7	119.1	0.0	97.4	95.4	0.6	101.5	99.8	0.7
Redeye West		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
Phoca Reef		99.3	78.9	85.3	4.3	50.1	58.6	7.0	54.3	62.7	6.8
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: Peak levels (Pk) and SPLs are in dB relative to 20 μPa . SELs or energy levels are in dB re 20 $\mu\text{Pa}^2\cdot\text{s}$. Durations (Dur) are in seconds. N/A = data not available.

3.4 Discussion and Summary

During the June 2021-June 2022 monitoring period, the sound levels received from the seventeen launches were comparable to those recorded from previous launches at SNI.

- Four missile launches exceeded TTS for either unweighted peak SPL or weighted peak SEL for Phocids in air:
 - On August 16, 2021, the TTS threshold for Phocids in air was exceeded at Dos Coves. The sound was measured at 155.1 dB re 20 $\mu\text{Pa}^2\cdot\text{s}$ for unweighted peak SPL. There were no elephant seals or harbor seals in the field of view of the camera.
 - On August 18, 2021, the TTS threshold for Phocids in air was exceeded for both the weighted SEL and unweighted peak SPL at Dos Coves. The weighted SEL was recorded at 132.9 dB re 20 $\mu\text{Pa}^2\cdot\text{s}$ and the unweighted peak SPL was recorded at 160.7 dB re 20 μPa . There were no elephant seals or harbor seals in the field of view of the camera.
 - On April 15, 2022, there were 21 elephant seals and no harbor seals in the field of view of the camera located at Dos Coves. The TTS threshold for Phocids in air was exceeded for both the weighted SEL and unweighted peak SPL. The unweighted peak SPL was measured at 160.8 dB re 20 μPa and 124.8 dB re 20 $\mu\text{Pa}^2\cdot\text{s}$ for the weighted SEL. No elephant seals reacted to the launch sound other than an initial startle response. It is unlikely that the launch sound caused TTS as the recording device was placed on the cliff above the haul-out site. It is likely the cliff masked the launch sound.
 - On April 16, 2022, there were 31 elephant seals and no harbor seals in the field of view of the camera located at Red Eye West. The TTS threshold for Phocids in air was exceeded for both the weighted SEL and unweighted peak SPL. The unweighted peak SPL was measured at 160.9 dB re 20 μPa and 128.1 dB re 20 $\mu\text{Pa}^2\cdot\text{s}$ for the weighted SEL. The elephant seals had an initial startle response to the launch sound but none of the elephant seals moved more than 10 meters or entered the water. The recorder was placed on a bluff high above the haul-out location. It is unlikely that TTS was experienced as the bluff likely masked the launch sound.
- Two missile launches exceeded PTS for unweighted peak SPL thresholds for Phocids in air:
 - On March 16, 2022, there were 5 elephant seals and no harbor seals in the field of view of the camera located at Dos Coves. The PTS threshold for Phocids in air was exceeded for unweighted peak SPL. The unweighted peak SPL was measured at 164.4 dB re 20 μPa . The elephant seals had an initial startle response to the launch noise but none of them moved more than 10 meters or entered the water. The recorder at this location was placed on a cliff above the haul-out location. It is unlikely that TTS or PTS was experienced by the animals as the cliff likely masked the sound of the launch.
 - On April 19, 2022, there were 40 elephants seals and no harbor seals in the field of view of the camera located at Red Eye West. The PTS threshold for Phocids in air was exceeded for unweighted peak SPL. The unweighted peak SPL was measured at 165.4 dB re 20 μPa .

The elephant seals had an initial startle response to the launch sound but none of the elephant seals moved more than 10 meters or entered the water. The recorder was placed on a bluff high above the haul-out location. It is unlikely that TTS or PTS was experienced as the bluff likely masked the launch sound.

The highest measured, unweighted (flat weighting), peak SPL was measured at 165.4 dB re 20 μ Pa recorded on 19 April 2022 at Red Eye West. This measurement surpassed the PTS threshold for unweighted peak SPL Phocids in air. The recording for this location was taken from a bluff above the haul-out location. It is likely the cliff masked the sound of the launch. Therefore, it is unlikely that any pinnipeds experienced launch sounds that could have caused TTS or PTS.

The highest measured, weighted SEL was measured at the Alpha Complex on 16 August 2021. The measured sound levels were 131.1 dB re 20 μ Pa²-s for Otariids in air and 136.9 dB re 20 μ Pa²-s for Phocids in air. The Alpha Complex is a launch site and is not a haul-out location for pinnipeds.

The highest measured, weighted SEL was measured at Dos Coves on 16 March 2022. The 129.4 dB re 20 μ Pa²-s was below the TTS and PTS for Otariids in air. TTS was exceeded for Phocids in air, measuring at 133.0 dB re 20 μ Pa²-s. The recording for this location was taken from a bluff above the haul-out location. It is likely the cliff masked the sound of the launch. Therefore, it is unlikely that any pinnipeds experienced launch sounds that could have caused TTS.

Overall, the results to date indicate that there is little potential for appreciable TTS or PTS in pinnipeds hauled-out on SNI near the missile launch paths during launch operations. This conclusion is necessarily speculative given the limited TTS and PTS data for pinnipeds in air exposed to strong sounds for brief periods. In the event that levels are occasionally sufficiently high to cause TTS, these levels probably would be only slightly above the presumed thresholds for mild TTS. Thus, in the event that TTS did occur, it would typically be mild and reversible and thus PTS would necessarily not occur. Given the relatively infrequent launches from SNI, the low probability of TTS during any one launch, and the fact that a given pinniped is not always present on land, there appears to be no likelihood of PTS from the cumulative effects of multiple launches. Additionally, it is unlikely that the launch events observed during this monitoring period caused PTS as the launch sounds recorded were similar to those recorded in the past (U.S. Navy 2020, Burke 2017, Ugoretz 2015, Ugoretz 2014, Ugoretz 2013, Holst et al. 2011) and the pinnipeds that flushed the haul-out locations due to the launch sounds returned to the haul-out location within minutes.

- 4. IMPLEMENTATION OF MITIGATION MEASURES

Table 4.1 provides a summary of the mitigation measures that were specified by NMFS in the IHA, and how they were implemented during the June 2021 through June 2022 monitoring period.

TABLE 4.1. Implementation of mitigation measures.

Mitigation Measure	Implementation
Personnel must not enter pinniped haul-outs. Personnel may be adjacent to haul-outs prior to and following a launch for monitoring purposes.	Personnel on San Nicolas Island were prohibited from entering pinniped haul-out areas. Monitoring personnel set up video and audio equipment near haul-outs without disturbing pinnipeds.
Missile must not cross over pinniped haul-outs at [altitudes] less than 305 meters (m) (1000 feet).	No missiles crossed over pinniped haul-outs at less than 1000 feet.
The Navy may not conduct more than 10 launch events at night.	No launches were conducted at night during this period
Launches must not occur February through April, to the maximum extent practicable.	Five (5) launch events were conducted between February and April during this monitoring period. During all of these launch events, no harbor seals moved more than 10 meters or entered the water due to launch noise disturbance.
Launches must be limited January through February and June through July, to the maximum extent practicable.	No launch events were conducted January through February. There were 2 launch events conducted June through July. The female sea lions and pups reacted to launches but there was no indication of pup abandonment or mortality.
All aircraft and helicopter flight paths must maintain a minimum distance of 305 m from recognized seal haul-out and rookeries, to the maximum extent practicable.	All aircraft maintained a minimum distance of 305 meters from recognized seal haul-out and rookeries.
For a species for which authorization has not been granted, or for a species for which authorization has been granted but authorized takes are met, the Navy must consult with NMFS before the next launch event.	No species for which authorization was not granted (e.g. Guadalupe fur seal, Steller sea lion) was observed during this period. Authorized take for other species not met.
The Navy must review launch procedure and monitoring methods, in cooperation with NMFS, if any injuries or mortality of a pinniped are discovered during post-launch surveys, or if surveys indicate possible effects to the distribution, size or productivity of the affected pinniped populations as a result of the specified activities.	No injured or dead pinnipeds were observed in post launch observations during the monitoring period. No evidence of effects to the distribution, size or productivity of affected pinniped populations.

5. TOTAL ESTIMATED NUMBERS OF PINNIPEDS “TAKEN”

Table 5.1 summarizes the estimated “take” estimates for each launch event and monitoring location. Table 5.2 compares estimated “take” estimates with the estimated take allowed in the 2021-2022 IHA.

TABLE 5.1. Estimated number of pinnipeds affected by launches June 2021 - June 2022

Date/Time Location	Monitoring Locations	Species	Observed	Reacted ⁵	Percent Reacted	Multiple ⁶	Total
07/21/2021 0912hrs Alpha	Dos Coves	Sea Lion	20	20	100%	1	20
	Red Eye East	Sea Lion	12	2	17%	1	2
		Elephant Seal	2	0	0%	1	0
	Phoca Reef	Harbor Seals	2	0	0%	1	0
07/21/2021 1133hrs Alpha	Dos Coves	Sea Lion	58	32	55%	1	32
	Red Eye East	Sea Lion	50	40	80%	1	40
	Phoca Reef	Harbor Seal	51	41	80%	1	41
08/16/2021 1100hrs Alpha	Dos Coves	Sea Lion	33	15	45%	1	15
	Red Eye West	Sea Lion	161	143	89%	1	143
	Phoca Reef	Harbor Seal	27	25	93%	1	25
08/18/2021 1100hrs Alpha	Dos Coves	Sea Lion	36	36	100%	1	36
	Red Eye West	Sea Lion	85	70	82%	1	70
	Phoca Reef	Harbor Seal	8	0	0%	1	0
09/20/2021 1035hrs Alpha	Dos Coves	Sea Lion	40	23	58%	1	23
		Elephant Seal	4	0	0%	1	0
	Red Eye West	Sea Lion	130	80	62%	1	80
	Phoca Reef	Harbor Seal	0	0	0%	1	0
11/18/2021 1116hrs Alpha	Dos Coves	Sea Lion	109	74	68%	1	74
		Elephant Seal	21	1	5%	1	1
	Red Eye West	Sea Lion	300	293	98%	1	293
		Elephant Seal	15	0	0%	1	0
Red Eye East	Elephant Seal	50	0	0%	1	0	
12/07/2021 1300hrs Alpha	Dos Coves	Sea Lion	60	40	67%	1	40
		Elephant Seal	11	0	0%	1	0
	Red Eye West	Sea Lion	160	70	44%	1	70
		Elephant Seal	1	1	100%	1	1
	Vizcaino Point	Sea Lion	100	70	70%	1	70

⁵ “Reacted” defined as an animal moving more than 10 meters and/or entering the water.

⁶ A multiplier of greater than 1 was applied when the entire monitored area was not within the field of view of the camera. During this monitoring period, all monitoring sites had the entire monitored area within the field of view of the video camera.

03/15/2022 1500hrs Alpha	Dos Coves	Sea Lion	90	60	67%	1	60
		Elephant Seal	70	0	0%	1	0
	Red Eye West	Sea Lion	50	50	100%	1	50
		Elephant Seal	70	0	0%	1	0
Phoca Reef	Harbor Seal	0	0	0%	1	0	
03/16/2022 1030hrs Alpha	Dos Coves	Sea Lion	46	46	100%	1	46
		Elephant Seal	5	0	0%	1	0
	Red Eye West	Sea Lion	100	100	100%	1	100
		Elephant Seal	17	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0
04/15/2022 1153hrs Alpha	Dos Coves	Sea Lion	70	41	59%	1	41
		Elephant Seal	21	0	0%	1	0
	Red Eye West	Sea Lion	11	5	45%	1	5
		Elephant Seal	26	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0
04/16/2022 1353hrs Alpha	Dos Coves	Sea Lion	119	70	59%	1	70
		Elephant Seal	38	2	5%	1	2
	Red Eye West	Sea Lion	200	200	100%	1	200
		Elephant Seal	31	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0
04/19/2022 1343hrs Alpha	Dos Coves	Sea Lion	80	64	80%	1	64
		Elephant Seal	30	0	0%	1	0
	Red Eye West	Sea Lion	96	86	90%	1	86
		Elephant Seal	40	0	0%	1	0
	Phoca Reef	Harbor Seal	1	0	0%	1	0
05/31/2022 1200hrs Alpha	Dos Coves	Sea Lion	102	52	51%	1	52
		Elephant Seal	65	0	0%	1	0
	Red Eye West	Sea Lion	198	135	68%	1	135
		Elephant Seal	40	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0
05/31/2022 1347hrs Alpha	Dos Coves	Sea Lion	85	46	54%	1	46
		Elephant Seal	53	0	0%	1	0
	Red Eye West	Sea Lion	180	144	80%	1	144
		Elephant Seal	40	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0

TABLE 5.2. Comparison of June 2021 through June 2022 estimates with IHA allowances for pinniped disturbance

Species	Total Reactions observed	Average/event (14 events)	IHA Average/event	IHA Maximum/year (40 events)
CA Sea Lion	2,107	150.7	275	11,000
N. Elephant Seal	4	0.28	0.61 (1)	40
P. Harbor Seal	66	4.7	2.39 (3)	120

SUMMARY

No evidence of pinniped injuries or fatalities related to launch noises or other launch operations was evident, nor was it expected based on past measurements and observations. It is also unlikely that any pinnipeds were exposed to received levels of sound energy above levels at which TTS or PTS would occur.

In total, 2,107 California sea lions, 66 Pacific harbor seals and 4 northern elephant seals are estimated to have been “taken” during the June 2021 through June 2022 monitoring period. These figures are approximate, because they (a) may count some of the same individuals more than once, and (b) exclude pinnipeds on beaches that were not monitored. The pinnipeds included in these estimates entered the water in response to the launch or moved more than 10 meters immediately after a launch.

The results from the June 2021 through June 2022 monitoring period (and those from previous monitoring periods) suggest that any effects of the launch operations were minor, short-term, and localized. Some Pacific harbor seals left their haul-out site on offshore reefs, but numbers occupying haul-out sites shortly after a launch were comparable to pre-launch levels. It is not likely that any of the pinnipeds on SNI were adversely affected by such behavioral reactions.

These results are supported by continuing population increases of pinnipeds on SNI. Counts of all three species of pinnipeds have significantly increased on SNI over the past three decades (Barlow, et al., 1997; Fluharty, 1999; Le Boeuf, et al., 1978; Lowry 2002; Lowry and Maravilla, 2005; Lowry, et al., 1996, 2008, 2017, 2020). This includes increases in pinniped counts in the portions of the island closest to the missile launch trajectories.

ACKNOWLEDGEMENTS

United States Navy biologist, Elizabeth Seacord, identified monitoring sites, collected data, analyzed video and prepared this report.

Katherine H. Kim and Robert G. Norman, consultants to Greeneridge Science Inc., were largely responsible for the design of the ATARs, and continue to improve their operation.

We are grateful to all concerned.

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**APPENDIX A:
INCIDENTAL HARRASSMENT AUTHORIZATION
12 JUNE 2021 – 11 JUNE 2022**

Dated: June 8, 2021.

Delores Barber,

Director, Information Technology and Resources Management Division, Office of Program Support.

[FR Doc. 2021-13065 Filed 6-17-21; 4:15 am]

BILLING CODE 6560-50-P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648-XB160]

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to the U.S. Navy Target and Missile Launch Activities on San Nicolas Island

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; issuance of an incidental harassment authorization.

SUMMARY: In accordance with the regulations implementing the Marine Mammal Protection Act (MMPA) as amended, notification is hereby given that NMFS has issued an incidental harassment authorization (IHA) to the U.S. Navy (Navy) to incidentally harass, by Level B harassment only, marine mammals during target and missile launch activities on San Nicolas Island (SNI), California. The Navy's activities are considered military readiness activities pursuant to the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (NDAA).

DATES: This Authorization is effective from June 12, 2021 through June 11, 2022.

FOR FURTHER INFORMATION CONTACT: Stephanie Egger, Office of Protected Resources, NMFS, (301) 427-8401. Electronic copies of the original application and supporting documents (including NMFS **Federal Register** notices of the original proposed and final authorizations, and the previous IHA), as well as a list of the references cited in this document, may be obtained online at: <https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act>. In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the "take" of marine mammals, with certain

exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed incidental take authorization may be provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other "means of effecting the least practicable adverse impact" on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stocks for taking for certain subsistence uses (referred to in shorthand as "mitigation"); and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

The NDAA (Pub. L. 108-136) removed the "small numbers" and "specified geographical region" limitations indicated above and amended the definition of "harassment" as it applies to a "military readiness activity." The activity for which incidental take of marine mammals is being requested addressed here qualifies as a military readiness activity.

History of Request

On March 1, 2021, NMFS received an adequate and complete application from the Navy, requesting the take of marine mammals incidental to target and missile launch activities on SNI. NMFS previously issued an IHA for this activity on June 12, 2019 (84 FR 28462; June 19, 2019) as well as a renewal IHA on June 19, 2020 (85 FR 38863; June 29, 2020). The activities for which incidental take is authorized are identical to those covered under the previous IHAs.

Navy complied with all the requirements (*e.g.*, mitigation, monitoring, and reporting) of the previous authorizations and information regarding their monitoring results may be found in the Potential Effects of Specified Activity on Marine Mammals

and their Habitat and Estimated Take section of the previous authorization (84 FR 28462; June 19, 2019) as well <https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities#active-authorizations>. This IHA would cover 1 year of an on-going activity for which Navy obtained prior authorizations, specifically continuation of target and missile launches on SNI. Of note, the Navy also submitted a revised and complete application on August 28, 2020 for a 7-year rulemaking and Letter of Authorization (LOA) for the same target and missile launch activities on SNI, as well as other Navy testing and training activities in the same area. On September 4, 2020, NMFS published a notice of receipt of application in the **Federal Register** (85 FR 55257) requesting comments and information related to the Navy's request. However, NMFS is unable to make determinations regarding the requested LOA prior to the expiration of the currently active renewal IHA, which would leave a lapse in coverage for the Navy for target and missile launch activities on SNI after it expires on June 11, 2021. This IHA is intended to provide coverage during this period and is valid for one year from June 12, 2021 through June 11, 2022.

Description of the Planned Activity and Anticipated Impacts

The Navy plans to continue a target and missile launch program on SNI, located in Southern California and part of the Channel Islands, which is identical to the program covered under the previous authorizations. The Navy has been conducting this program since 2001, which supports testing and training activities associated with operations on the Point Mugu Sea Range (PMSR). The PMSR is used by the U.S. and allied military services to test and evaluate sea, land, and air weapon systems; to provide realistic training opportunities; and to maintain operational readiness of these forces. Missiles vary from tactical and developmental weapons to target missiles used to test defensive strategies and other weapons systems. Some launch events involve a single missile, while others involve the launch of multiple missiles in quick succession and are launched from two launch sites on SNI. As before, the Navy proposes to conduct up to 40 missile launch events from SNI, but the total may be less than 40 depending on operational requirements. Launch timing will be determined by operational, meteorological, and logistical factors. Up to 10 of the 40 launches may occur

at night, but this is also dependent on operational requirements and only conducted when required by test objectives. The specified activities are expected to result in the take of three marine mammal species: California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and northern elephant seals (*Mirounga angustirostris*) by Level B harassment only, primarily in the form of behavioral disturbance, as a result of the airborne noise produced during launch activities.

We refer the reader to the documents related to the previously issued IHAs (84 FR 28462; June 19, 2019 and 85 FR 38863; June 29, 2020) as a detailed description of the planned target and missile launch activities can be found in these documents. We also refer the reader to the Navy’s current and previous applications and monitoring reports which can be found at <https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities#active-authorizations>. The location, timing, and nature of the activities, including the types of missiles planned for use, are identical to

those described in the previous notifications.

Comments and Responses

A notice of NMFS’s proposal to issue an IHA to the Navy was published in the **Federal Register** on May 4, 2021 (86 FR 23690). That notice described the Navy’s activity, the marine mammal species that may be affected by the activity, and the anticipated effects on marine mammals. No comments were received during the public comment period.

Description of Marine Mammals

A description of the marine mammals in the area of the activities is found in these previous documents, which remains applicable to this IHA as well. In addition, NMFS has reviewed recent draft Stock Assessment Reports, information on relevant Unusual Mortality Events, and recent scientific literature, and determined that no new information affects our original analysis of impacts under the previous authorizations. NMFS has also reviewed the Navy’s monitoring reports and they support the current take estimates and our findings. Therefore, no change in the take estimates was warranted.

Potential Effects on Marine Mammals and Their Habitat

A description of the potential effects of the specified activities on marine mammals and their habitat may be found in the documents supporting the previous IHAs, which remains applicable to the issuance of this IHA. There is no new information on potential effects.

Estimated Take

A detailed description of the methods and inputs used to estimate authorized take is found in these previous documents. The methods of estimating take for this IHA are identical to those used in the previous IHAs. The source levels, number of launches, and the marine mammal abundance on SNI used to calculate take remain unchanged from the previously issued IHAs. The authorized stocks taken, types of take, and methods of taking remain unchanged from the previously issued IHAs. The same is true for the number of takes, which are indicated below in Table 1. As before, no serious injury or mortality is anticipated or authorized for the Navy’s activity.

TABLE 1—REQUESTED TAKE AMOUNT, PER SPECIES, RELATIVE TO POPULATION SIZE

Species	Authorized level B harassment	Stock abundance (percent taken by level B harassment)
California sea lion	11,000	257,606 (4.27 percent).
Harbor seal	480	30,968 (less than 2 percent).
Northern elephant seal	40	179,000 (less than 1 percent).

Description of Mitigation, Monitoring and Reporting Measures

The mitigation, monitoring, and reporting measures here are identical to those included in the previous IHAs. The discussion of the least practicable adverse impact included in that document remains accurate. All mitigation, monitoring, and reporting measures in the previous IHA are carried over to this IHA and summarized below:

- *Personnel Mitigation*—Personnel will not enter pinniped haulouts. Personnel will be adjacent to pinniped haulouts below the predicted missile path for two hours prior to a launch only for monitoring purposes.
- *Launch Mitigation*—Missiles will not cross over pinniped haulouts at elevations less than 305 m (1,000 ft). Launches at night will be limited. Launches will be avoided during harbor seal pupping season (February through April) unless constrained by mission

objectives. Launches will be limited during the pupping season for northern elephant seal (January through February) and California sea lion (June through July) unless constrained by mission objectives or certain other factors. It is vital that the Navy effectively executes readiness activities to ensure naval forces can effectively execute military operations.

- *Aircraft Operation Mitigation*—All aircraft and helicopter flight paths must maintain a minimum distance of 1,000 ft (305 m) from recognized seal haulouts and rookeries, except in emergencies.
- *Non-authorized Take Prohibited*—If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, the Navy must consult with NMFS before the next launch event.
- *Visual and Video Camera Monitoring*—The Navy proposes to conduct marine mammal monitoring during launches from SNI, using visual

monitoring as well as simultaneous autonomous audio recording of launch sounds and video recording of pinniped behavior. Visual monitoring, before and after launches, is a scan of the haulout beaches to count pinnipeds over a wider field of view than can be captured by a stationary video camera. This is typically done over a 15–30 minute period. Visual monitoring is conducted while the equipment is being set up and broken down for video and acoustic monitoring. Video monitoring is conducted by recording continuously from a minimum of two hours before the event to approximately one hour after the event. These video and audio records will be used to document pinniped responses to the launches.

- *Acoustic Monitoring*—Acoustical recordings will be obtained during each monitored launch. These recordings will be suitable for quantitative analysis of the levels and characteristics of the received launch sounds.

▪ *Reporting*—A technical report will be submitted to the NMFS' Office of Protected Resources within 90 days from the date the IHA expires. This report will provide full documentation of methods, results, and interpretation pertaining to all monitoring tasks for launches activities at SNI that are covered under this IHA.

Determinations

The Navy planned target and missile launch activities identical to those covered in the previous IHAs. The methods of taking and effects of the action resulting in Level B harassment only remains the same as what was previously analyzed. When issuing the previous IHAs, NMFS found the Navy's target and missile launch activities would have a negligible impact to species or stocks' rates of recruitment and survival. This IHA also carries over identical mitigation, monitoring, and reporting measures as required under the previous IHAs. NMFS has concluded that there is no new information suggesting that our analysis or findings should change from those reached for the previous IHAs. Based on the analysis in the previous IHAs, the likely effects of the specified activity on marine mammals and their habitat, as well as the previous monitoring results at SNI, NMFS likewise finds that the total marine mammal take from this planned activity will have a negligible impact on all affected marine mammal species or stocks.

Based on the information contained here and in the referenced documents, NMFS has determined the following: (1) The required mitigation measures will effect the least practicable impact on marine mammal species or stocks and their habitat; (2) the authorized takes will have a negligible impact on the affected marine mammal species or stocks; and (3) the Navy's activities will not have an unmitigable adverse impact on taking for subsistence purposes as no relevant subsistence uses of marine mammals are implicated by this action, and (4) appropriate monitoring and reporting requirements are included.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216-6A, NMFS must review our action (*i.e.*, the issuance of an incidental harassment authorization) with respect to potential impacts on the human environment. This action is consistent with categories of activities identified in Categorical Exclusion B4 (incidental harassment authorizations with no anticipated serious injury or mortality) of the Companion Manual for NOAA Administrative Order 216-6A, which do not individually or cumulatively have the potential for significant impacts on the quality of the human environment and for which we have not identified any extraordinary circumstances that would preclude this categorical

exclusion. Accordingly, NMFS has determined that the issuance of the IHA qualifies to be categorically excluded from further NEPA review.

Endangered Species Act (ESA)

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA: 16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. No incidental take of ESA-listed species is authorized or expected to result from this activity. Therefore, formal consultation under section 7 of the ESA was not required for this action.

Authorization

As a result of these determinations, NMFS authorizes an IHA to the Navy for conducting target and missile launches on SNI, effective from June 12, 2021 through June 11, 2022, with the previously mentioned mitigation, monitoring, and reporting requirements incorporated.

Dated: June 16, 2021.

Catherine Marzin,

*Acting Director, Office of Protected Resources,
National Marine Fisheries Service.*

[FR Doc. 2021-13075 Filed 6-17-21; 4:15 am]

BILLING CODE 3510-22-P

APPENDIX B:

Acoustic Measurements of SNI Missile Launches: July 2021-May2022

Greeneridge Sciences, Inc.

GSI Technical Memorandum 546-2



GREENERIDGE SCIENCES, INC.

5142 HOLLISTER AVE, STE 283 • SANTA BARBARA, CA 93111 • T 805-967-7720 • F 805-683-8577

TECHNICAL MEMORANDUM

To: Elizabeth Seacord, NAVAIR Sustainability Office
From: Katherine H. Kim, Robert G. Norman
Date: 14 November 2022
Re: Acoustic Measurements of SNI Missile Launches: July 2021 – May 2022
[GSI Technical Memorandum 546-3]

Introduction

The material in this technical memorandum has been provided for inclusion in the report stipulated by NAVAIR’s 2021–2022 Incidental Harassment Authorization under the Marine Mammal Protection Act. The material presents the results of sound measurements of fourteen missile launch events over pinniped haul-outs on San Nicolas Island on 21 July 2021 (two events), 16 August 2021, 18 August 2021, 20 September 2021, 18 November 2021, 7 December 2021, 15 March 2022, 16 March 2022, 16 April 2022, 16 April 2022, 19 April 2022, and 31 May 2022 (two events).

Methods

Various federal, state, and other organizations recommend specific acoustic thresholds for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in marine mammals. The thresholds cited in the *Results* section below are for impulsive noise (noise with high peak sound pressure, short duration, fast rise-time, and broad frequency content) from the U.S. Navy technical report by J. Finneran, E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow, *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*, published by the Space and Naval Warfare Systems Center Pacific, San Diego, CA in June 2017.

As with Navy Phase II criteria (Finneran & Jenkins, 2012), auditory weighting functions were applied to acoustic data, prior to the calculation of acoustic metrics such as sound exposure level (SEL) and sound pressure level (SPL), to account for various species’ frequency-dependent hearing sensitivity. However, unlike Navy auditory weighting functions for Phase II which were based on “M-weighting” curves for “functional hearing groups”, Navy Phase III weighting functions are defined by a generic band-pass filter whose shape is determined by parameters specific to a slightly different classification of nine “marine species hearing groups”.

In addition to differences in auditory weighting functions, TTS and PTS thresholds differ between Navy Phase II and Phase III. In Navy Phases II and III, pinnipeds were classified into two hearing groups based upon pinnipeds’ two scientific families: Otariidae (eared seals: sea

lions and fur seals) and Phocidae (earless seals, or true seals). However, in Navy Phase II, TTS thresholds were the same for both Otariids and Phocids in air, as were PTS thresholds. In Navy Phase III, different TTS and PTS thresholds are defined for Otariids in air (OA) and Phocids in air (PA). The Navy Phase III thresholds for pinnipeds in air are summarized in the table below:

TABLE 1. Navy Phase III TTS and PTS thresholds for pinnipeds in air.

Group	Non-impulsive		Impulsive			
	TTS threshold SEL ^a (weighted)	PTS threshold SEL ^a (weighted)	TTS Threshold		PTS threshold	
			SEL ^a (weighted)	Peak SPL ^b (unweighted)	SEL ^b (weighted)	Peak SPL ^b (unweighted)
OA ^c	157	177	146	170	161	176
PA ^d	134	154	123	155	138	161

^a SEL thresholds are in dB re (20 μPa)²·s in air

^b SPL thresholds in dB re 20 μPa in air

^c OA-Otariid in air (includes California sea lion)

^d PA-Phocid in air (includes Pacific harbor seal)

The TTS and PTS thresholds relevant to San Nicolas Island missile launches and utilized in this report are those listed under “Impulsive” in Table 1.

Results

Measured missile sounds exceeding the level considered sufficient to cause temporary threshold shift (TTS) in Otariids in air, specifically, weighted sound exposure level (SEL) of 146 dB re 20 μPa²·s or unweighted peak sound pressure level (SPL) of 170 dB re 20 μPa:

No measured sound levels exceeded the weighted SEL threshold nor unweighted peak SPL for TTS for Otariids in air.

Measured missile sounds exceeding the level considered sufficient to cause permanent threshold shift (PTS) in Otariids in air, specifically, weighted SEL of 161 dB re 20 μPa²·s or unweighted peak SPL of 176 dB re 20 μPa:

Similarly, no measured sound levels exceeded the weighted SEL threshold nor unweighted peak SPL thresholds for PTS for Otariids in air.

Measured missile sounds exceeding the level considered sufficient to cause TTS in Phocids in air, specifically, weighted SEL of 123 dB re 20 μPa²·s or unweighted peak SPL of 155 dB re 20 μPa:

On 16 August 2021, a dual missile launch occurred at the Alpha Complex launch site, located between two pads. At the launch site, only one missile was heard on the recording, with an unweighted peak SPL of 160.1 dB re 20 μPa and weighted (for Phocids in air) SEL of 136.9 dB re 20 μPa²·s. This resulted in a measured unweighted peak SPL of 155.1 dB re 20 μPa at the Dos Coves pinniped monitoring site, just exceeding the TTS threshold for Phocids in air.

Weighted SELs measured at all three pinniped monitoring sites ranged from 73.9 to 114.6 dB re 20 $\mu\text{Pa}^2\text{-s}$, far below weighted SEL threshold levels.

On 18 August 2021, another dual missile launch occurred at the Alpha Complex launch site. Again, only one missile was heard on the recording from the launch site, with an unweighted peak SPL of 152.2 dB re 20 μPa and weighted SEL of 129.9 dB re 20 $\mu\text{Pa}^2\text{-s}$. At the Dos Coves pinniped monitoring site, the TTS threshold for Phocids in air was exceeded by both weighted SEL and unweighted peak SPL metrics, measured at 132.9 dB re 20 $\mu\text{Pa}^2\text{-s}$ and 160.7 dB re 20 μPa , respectively. The lower sound levels at the launch site yet higher sound levels at the Dos Coves monitoring site compared to 16 August suggest differences in missile sound signature and/or in acoustic propagation characteristics on the two days.

On 16 March 2022, a single missile launch from the Alpha launch site resulted in a measured unweighted peak SPL of 164.4 dB re 20 μPa and weighted SEL of 133.0 dB re 20 $\mu\text{Pa}^2\text{-s}$ at the Dos Coves monitoring site. Both peak SPL and SEL metrics exceeded TTS thresholds for Phocids in air.

On 15 April 2022, another single missile launch from the Alpha launch site resulted in a measured unweighted peak SPL of 160.8 dB re 20 μPa and weighted SEL of 124.8 dB re 20 $\mu\text{Pa}^2\text{-s}$ at the Dos Coves monitoring site. Again, both metrics exceeded TTS thresholds for Phocids in air.

On 16 April 2022, a single missile launch from the Alpha launch site resulted in a measured unweighted peak SPL of 160.9 dB re 20 μPa and weighted SEL of 128.1 dB re 20 $\mu\text{Pa}^2\text{-s}$ at the Redeye West monitoring site. Both metrics exceeded TTS thresholds for Phocids in air.

On 19 April 2022, a single missile launch from the Alpha launch site resulted in a measured unweighted peak SPL of 165.4 dB re 20 μPa and weighted SEL of 123.4 dB re 20 $\mu\text{Pa}^2\text{-s}$ at the Redeye West monitoring site. Again, both metrics exceeded TTS thresholds for Phocids in air.

Measured missile sounds exceeding the level considered sufficient to cause PTS in Phocids in air, specifically, weighted SEL of 138 dB re 20 $\mu\text{Pa}^2\text{-s}$ or unweighted peak SPL of 161 dB re 20 μPa :

Two of the aforementioned measurements at pinniped monitoring sites exceeded unweighted peak SPL thresholds for PTS for Phocids in air, specifically, at the Dos Coves site on 16 March 2022 (164.4. dB re 20 μPa) and at the Redeye West site on 19 April 2022 (165.4 dB re 20 μPa). In both cases, weighted SEL thresholds for PTS for Phocids in air were not exceeded.

The highest levels measured for the fourteen days of missile launches:

The **highest measured, unweighted (flat weighting), peak SPL** was measured at monitoring site Redeye West for the missile launch which took place on 19 April 2022. That unweighted peak SPL of 165.4 dB re 20 μPa was close to the saturation level of the recording equipment and exceeded the PTS threshold for Phocids in air. (Sound levels at the Alpha launch site are unknown for this date due to recorder equipment failure. Details are described in the section “Atypical processing of missile flights” below.)

The **highest measured, weighted, SEL** was 131.1 dB re 20 $\mu\text{Pa}^2\text{-s}$ (for Otariids) and 136.9 dB re 20 $\mu\text{Pa}^2\text{-s}$ (for Phocids), both recorded at the Alpha Complex *launch site* on 16 August 2021.

The **highest measured, weighted, SEL** recorded at a *pinniped monitoring site* was 129.4 dB re 20 $\mu\text{Pa}^2\text{-s}$ (for Otariids; below TTS and PTS thresholds) and 133.0 dB re 20 $\mu\text{Pa}^2\text{-s}$ (for Phocids; above TTS but below PTS thresholds), both at the Dos Coves monitoring site on 16 March 2022.

Atypical processing of missile flights:

During the first of two launch events on 21 July 2021, two of the recordings from the four recorders were not analyzed. In one recording, the missile sounds were barely audible on the “sensitive” recording channel and were below the noise floor of the “insensitive” recording channel. In the other recording, the signals on both channels were clipped (i.e., exceeded the maximum recording levels of the equipment, thus, distorting the signal) during the launch and, when the “insensitive” channel was not clipped, its signal was nevertheless severely distorted.

For launch events from 18 November 2021 to 31 May 2022 inclusive, the recorder typically deployed at the launch site detected missile sounds on the recorder’s “insensitive” channel (although with increasingly lower amplitude in successive launch events) and detected little to no signal on the “sensitive” channel. These recordings were not analyzed.

On 15 March 2022 at the Redeye West site and on 16 March 2022 at the Phoca Reef site, missile sounds were barely or not discernable in their respective recordings and, thus, not analyzed.

On 16 April 2022, the recorder deployed at the Phoca Reef monitoring site exhibited very low signal levels (± 3 counts) on the “insensitive” channel and clipping on the “sensitive” channel. These data were not analyzed.

For the two launch events on 31 May 2022, the recorder deployed at the Redeye West monitoring site was found powered off upon equipment collection and lacked sound files.

To address hardware issues, in July–August 2022, all four recorders were calibrated, underwent diagnostic tests, and were repaired if needed.

In summary, 40 out of 54 total available recordings of missile events/monitoring sites were analyzed and are presented in this memorandum.

TABLE 2. Pulse parameters for unweighted, OA-weighted, and PA-weighted sound from SNI missile launches, July 2021 – May 2022. [CPA data to be provided by NAVAIR.]

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
21 July 2021 (1 of 2)											
Phoca Reef	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Redeye East	144.2	120.1	119.5	0.9	110.5	108.6	0.6	113.7	112.2	0.7	
Dos Coves	142.5	130.5	118.9	0.1	97.8	95.5	0.6	102.0	99.9	0.6	
Alpha	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
21 July 2021 (2 of 2)											
Phoca Reef	98.4	75.7	85.6	9.9	46.3	57.2	12.4	48.3	59.1	12.2	
Redeye East	143.4	121.2	120.5	0.9	111.1	109.8	0.8	115.4	114.3	0.8	
Dos Coves	144.4	133.4	120.2	0.0	104.4	98.4	0.3	108.0	102.7	0.3	
Alpha	135.8	118.8	122.0	2.1	92.1	95.6	2.2	97.5	101.0	2.2	
16 August 2021											
Redeye West	140.2	116.4	120.4	2.5	93.2	97.6	2.7	97.8	102.2	2.8	
Dos Coves	155.1	127.1	129.0	1.5	105.0	107.9	2.0	111.6	114.6	2.0	
Phoca Reef	108.6	90.9	100.9	9.8	59.4	69.4	10.1	64.0	73.9	9.8	
Alpha Complex	160.1	143.8	147.9	2.6	128.0	131.1	2.1	134.0	136.9	2.0	
18 August 2021											
Redeye West	139.7	116.8	120.3	2.2	92.4	96.2	2.4	97.5	101.3	2.4	
Dos Coves	160.7	136.7	138.6	1.5	127.1	128.7	1.4	131.4	132.9	1.4	
Phoca Reef	102.2	82.6	90.9	6.6	53.3	62.7	8.7	55.2	65.2	10.0	
Alpha Complex	152.2	139.2	143.0	2.4	121.4	125.0	2.3	126.4	129.9	2.2	
20 September 2021											
Dos Coves	107.8	90.9	101.5	11.6	67.5	76.1	7.3	74.1	82.0	6.1	
Redeye West	109.5	95.5	100.6	3.2	76.6	81.1	2.9	82.3	86.9	2.9	
Phoca Reef	98.1	83.4	89.2	3.8	57.5	62.1	2.9	63.2	67.9	3.0	
Alpha	137.6	116.0	119.3	2.2	83.6	87.3	2.3	87.6	91.4	2.4	
18 November 2021											
Dos Coves	137.4	122.0	116.4	0.3	94.6	90.5	0.4	97.8	95.1	0.5	
Redeye West	119.3	103.7	107.6	2.5	84.3	87.8	2.3	90.2	93.8	2.3	
Redeye East	113.3	98.0	102.7	3.0	80.4	84.7	2.7	85.9	90.3	2.8	
Alpha	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
7 December 2021											
Dos Coves	104.4	87.1	95.1	6.3	62.9	70.9	6.4	69.2	77.3	6.4	
Redeye West	123.4	109.2	121.2	15.7	86.7	95.8	8.3	91.7	100.8	8.0	
Vizcaino Point	97.4	80.9	90.9	10.0	51.9	62.5	11.4	55.0	65.6	11.5	
Alpha Complex	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
15 March 2022											
Dos Coves	146.2	133.1	121.7	0.1	102.4	98.9	0.4	107.1	103.7	0.5	
Redeye West	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Phoca Reef	103.0	82.6	91.4	7.6	52.8	61.4	7.1	59.2	67.9	7.5	
Alpha	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
16 March 2022											
Dos Coves	164.4	141.2	139.2	0.6	130.8	129.4	0.7	59.2	133.0	0.8	
Redeye West	154.8	132.9	133.4	1.1	118.2	118.2	1.0	59.2	121.9	1.0	
Phoca Reef	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Acoustic Measurements of SNI Missile Launches: July 2021 – May 2022

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15 April 2022											
Dos Coves		160.8	145.6	136.3	0.1	120.2	120.1	1.0	125.4	124.8	0.9
Redeye West		143.1	121.1	121.6	1.1	101.2	102.3	1.3	105.0	106.2	1.3
Phoca Reef		96.9	79.2	88.9	9.4	52.4	60.0	5.7	57.8	66.2	7.0
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16 April 2022											
Dos Coves		146.3	136.4	121.4	0.0	102.3	99.6	0.5	107.4	104.6	0.5
Redeye West		160.9	134.2	135.8	1.5	119.8	121.5	1.5	126.5	128.1	1.5
Phoca Reef		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19 April 2022											
Dos Coves		145.3	133.7	121.4	0.1	101.9	98.5	0.5	105.9	102.9	0.5
Redeye West		165.4	134.2	134.4	1.0	118.5	117.0	0.7	124.8	123.4	0.7
Phoca Reef		104.3	85.5	94.0	7.1	54.0	62.8	7.7	59.6	68.0	6.9
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31 May 2022 (1 of 2)											
Dos Coves		142.1	134.1	119.2	0.0	99.5	96.7	0.5	102.5	100.6	0.6
Redeye West		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phoca Reef		99.3	79.5	87.0	5.7	50.4	57.0	4.6	54.0	62.1	6.5
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31 May 2022 (2 of 2)											
Dos Coves		142.7	132.7	119.1	0.0	97.4	95.4	0.6	101.5	99.8	0.7
Redeye West		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phoca Reef		99.3	78.9	85.3	4.3	50.1	58.6	7.0	54.3	62.7	6.8
Alpha		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: Peak levels (Pk) and SPLs are in dB relative to 20 μ Pa. SELs or energy levels are in dB re 20 μ Pa²·s. Durations (Dur) are in seconds. N/A = data not available.

TABLE 3. Ambient broadband (10–20,000 Hz) sound levels (in dB re 20 μ Pa) as recorded before launches.

Date	Vehicle Class	Site	Unweighted	OA-weighted	PA-weighted
21 July 2021 (1 of 2)	5	Phoca Reef	N/A	N/A	N/A
		Redeye East	79.1	49.2	53.6
		Dos Coves	68.8	48.1	54.8
		Alpha	N/A	N/A	N/A
21 July 2021 (2 of 2)	5	Phoca Reef	51.6	31.4	36.8
		Redeye East	65.2	43.5	49.3
		Dos Coves	68.1	47.8	54.0
		Alpha	53.5	22.8	25.5
16 August 2021	5	Redeye West	62.3	35.9	41.9
		Dos Coves	65.3	34.7	39.7
		Phoca Reef	51.3	30.2	35.4
		Alpha Complex	45.0	19.8	20.5
18 August 2021	5	Redeye West	58.3	30.2	35.9
		Dos Coves	68.8	45.8	51.4
		Phoca Reef	56.0	36.3	41.3
		Alpha Complex	47.8	20.2	20.9
20 September 2021	5	Dos Coves	63.8	38.8	44.9
		Redeye West	72.0	41.6	46.8
		Phoca Reef	53.9	33.5	38.5
		Alpha	59.2	27.0	30.2
18 November 2021	5	Dos Coves	58.5	35.7	41.4
		Redeye West	55.4	32.9	39.1
		Redeye East	60.0	44.4	49.0
		Alpha	N/A	N/A	N/A
7 December 2021	5	Dos Coves	73.9	46.0	51.8
		Redeye West	61.3	34.9	40.9
		Vizcaino Point	57.4	27.9	32.7
		Alpha Complex	N/A	N/A	N/A
15 March 2022	5	Dos Coves	69.0	44.5	49.9
		Redeye West	N/A	N/A	N/A
		Phoca Reef	66.9	39.0	43.7
		Alpha	N/A	N/A	N/A
16 March 2022	5	Dos Coves	88.5	56.5	60.4
		Redeye West	75.3	44.4	49.1
		Phoca Reef	N/A	N/A	N/A
		Alpha	N/A	N/A	N/A
15 April 2022	5	Dos Coves	90.6	62.1	67.3
		Redeye West	73.7	41.9	46.3
		Phoca Reef	60.2	35.1	40.0
		Alpha	N/A	N/A	N/A
16 April 2022	5	Dos Coves	53.4	30.3	35.8

Acoustic Measurements of SNI Missile Launches: July 2021 – May 2022

Date	Vehicle Class	Site	Unweighted	OA-weighted	PA-weighted
19 April 2022	5	Redeye West	71.0	38.3	41.9
		Phoca Reef	N/A	N/A	N/A
		Alpha	N/A	N/A	N/A
		Dos Coves	80.6	48.7	53.0
		Redeye West	73.9	42.2	46.5
		Phoca Reef	71.6	39.9	43.8
		Alpha	N/A	N/A	N/A
31 May 2022 (1 of 2)	5	Dos Coves	50.2	22.5	27.4
		Redeye West	N/A	N/A	N/A
		Phoca Reef	60.7	34.1	39.1
		Alpha	N/A	N/A	N/A
31 May 2022 (2 of 2)	5	Dos Coves	51.5	23.2	28.3
		Redeye West	N/A	N/A	N/A
		Phoca Reef	70.6	38.8	42.9
		Alpha	N/A	N/A	N/A

N/A = data not available.

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

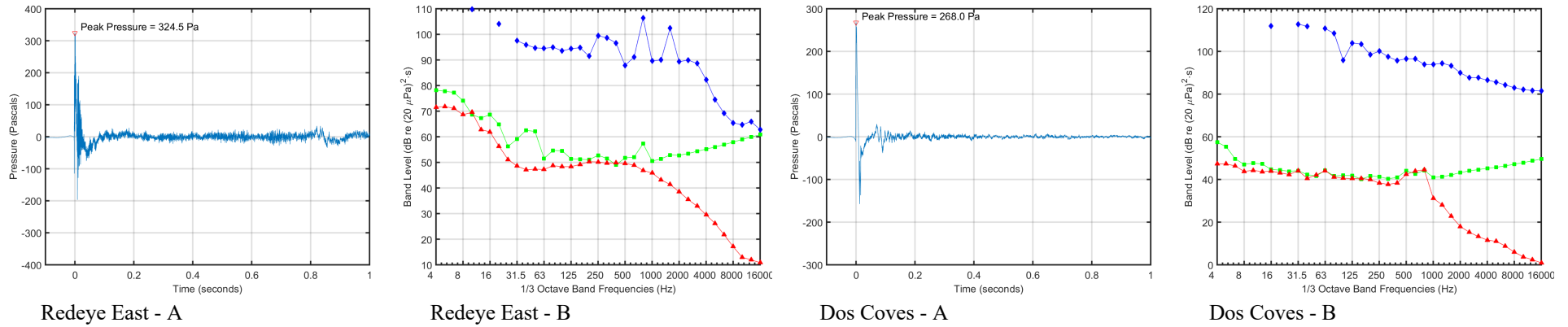


FIGURE 1. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 09:12:00 Local Time on 21 July 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; \triangle = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

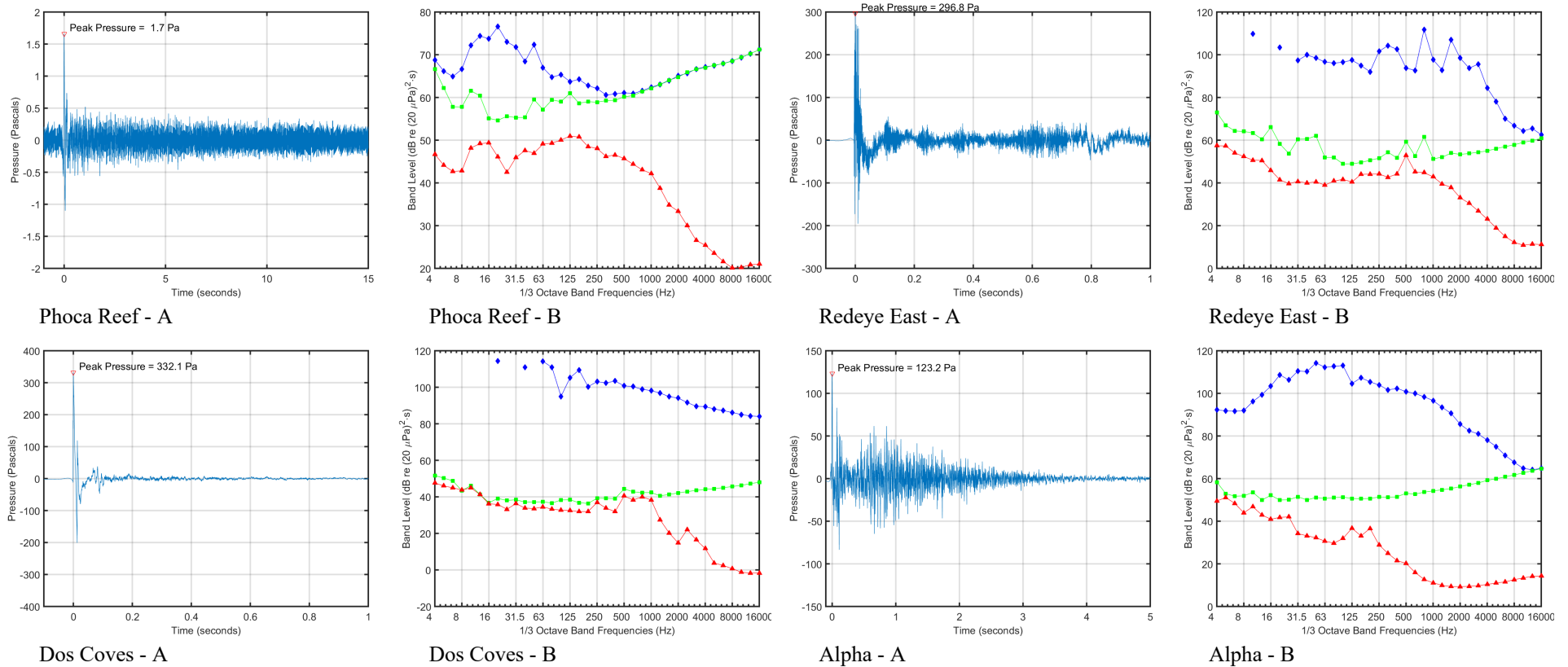


FIGURE 2. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 11:33:00 Local Time on 21 July 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

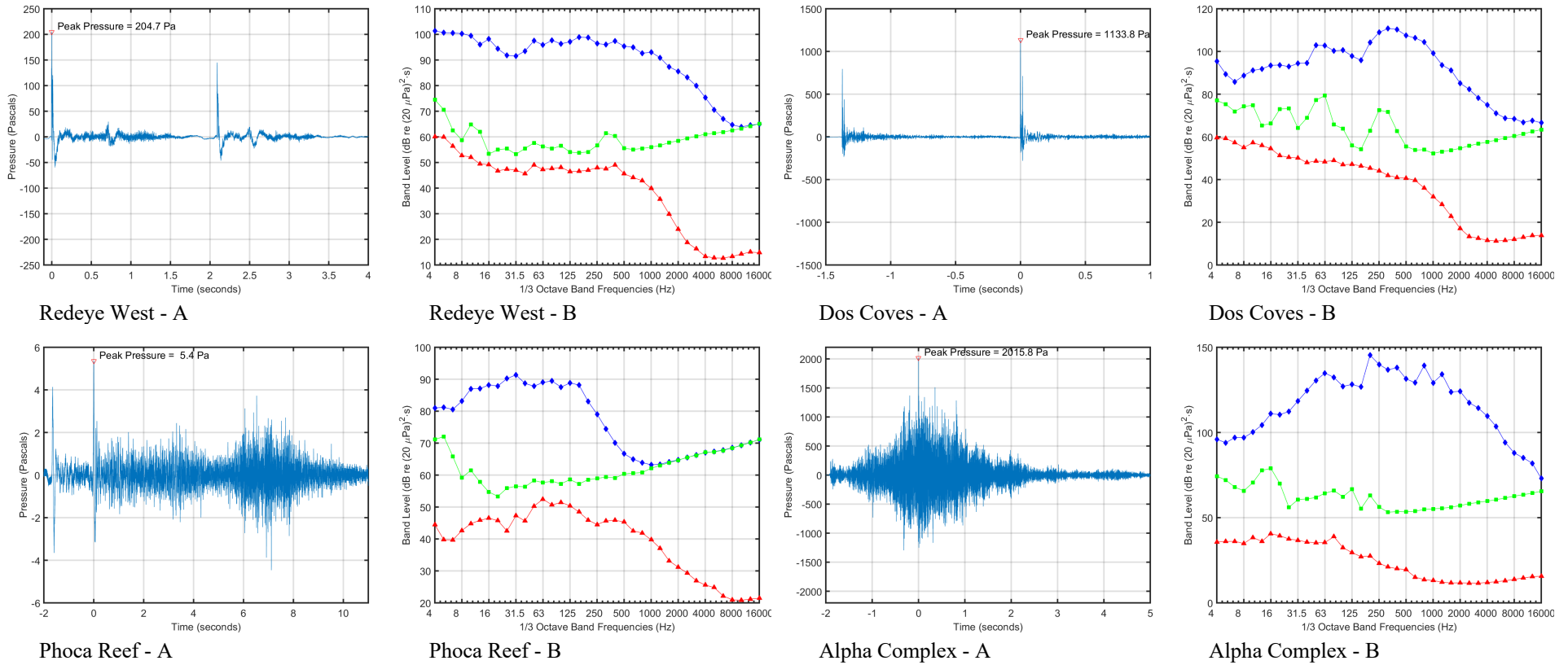


FIGURE 3. (A) Pressure waveform and (B) one-third octave band levels for a dual missile flight at 11:00:00 Local Time on 16 August 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

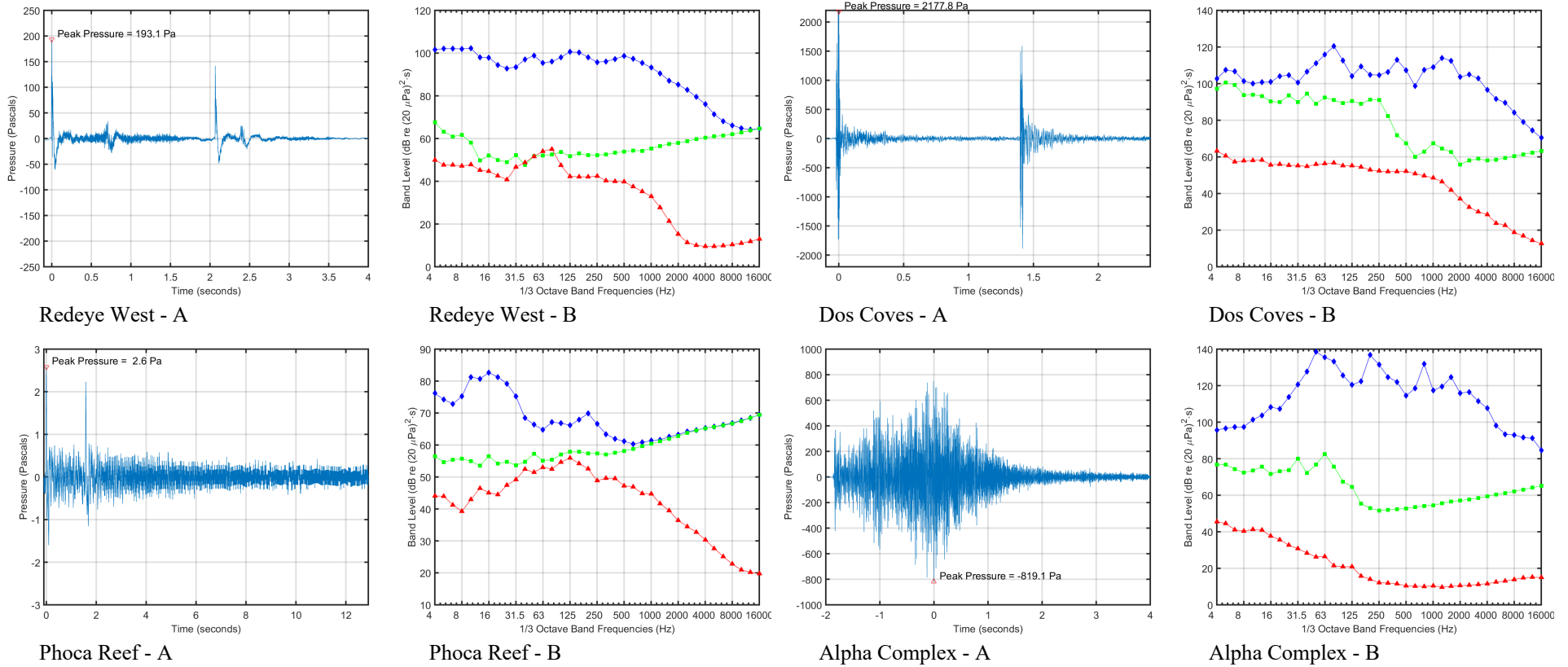


FIGURE 4. (A) Pressure waveform and (B) one-third octave band levels for a dual missile flight at 11:00:00 Local Time on 18 August 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

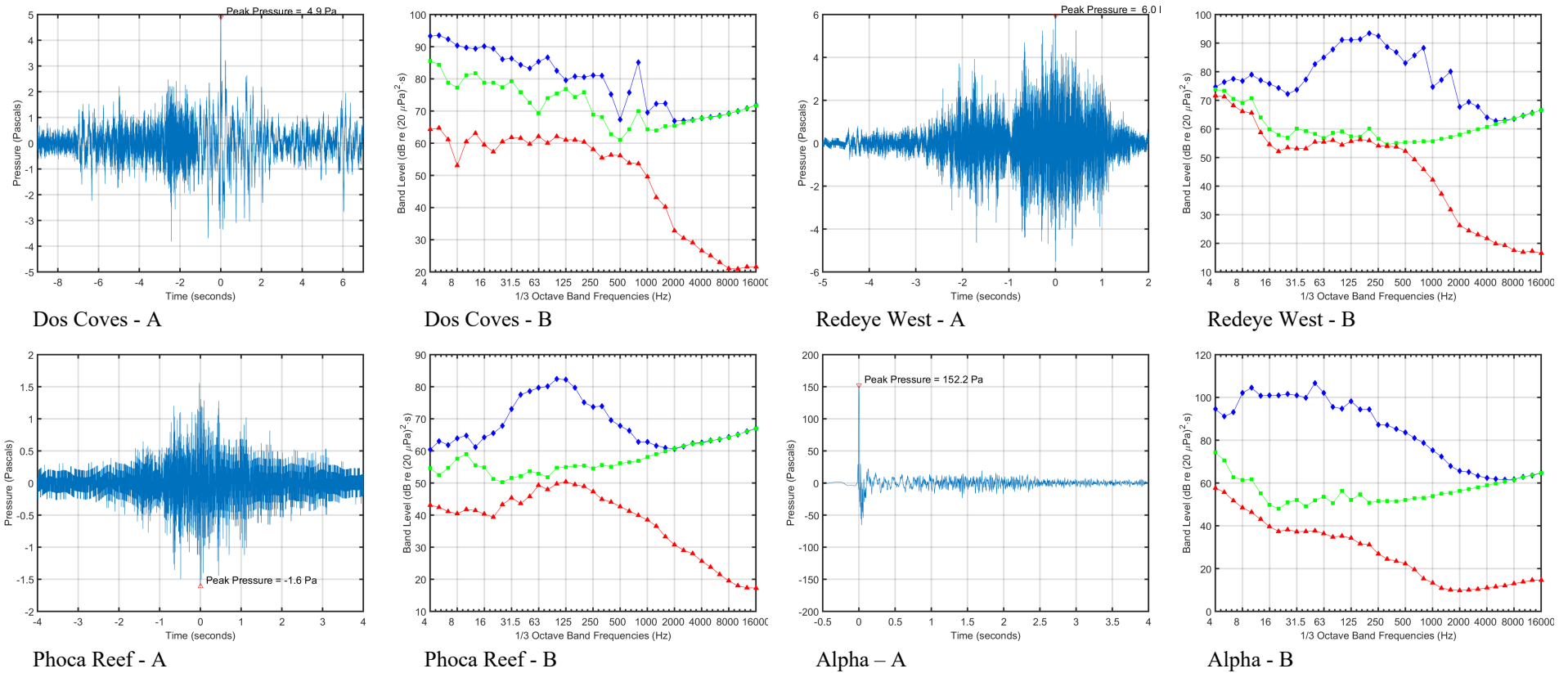
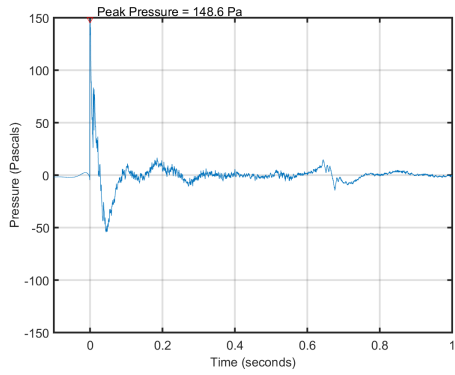
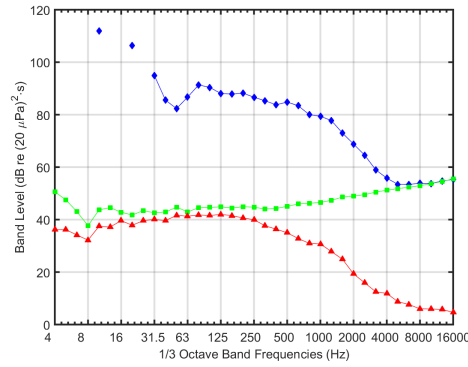


FIGURE 5. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 10:35:00 Local Time on 20 September 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; \triangle = ambient noise power. Band frequencies in Hertz (Hz).

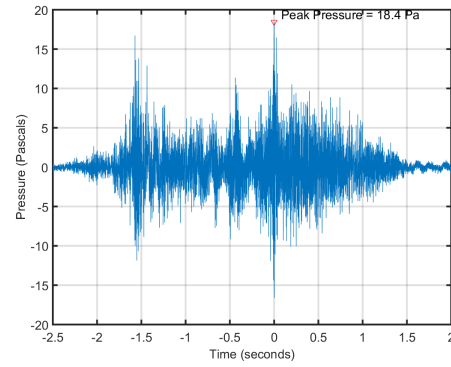
Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022



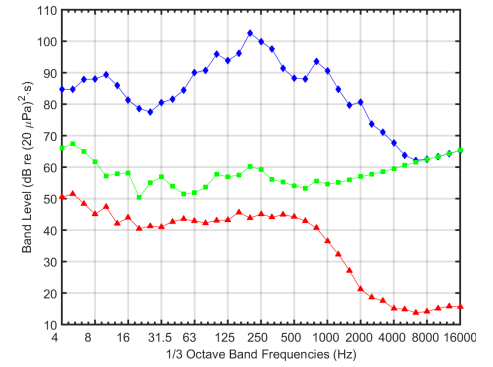
Dos Coves - A



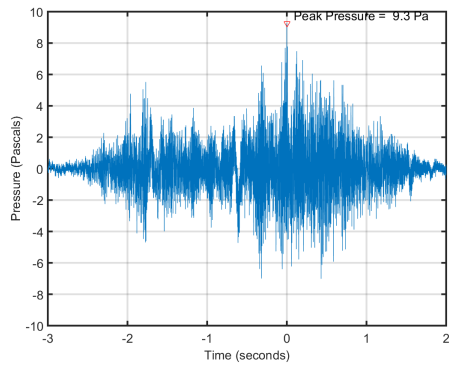
Dos Coves - B



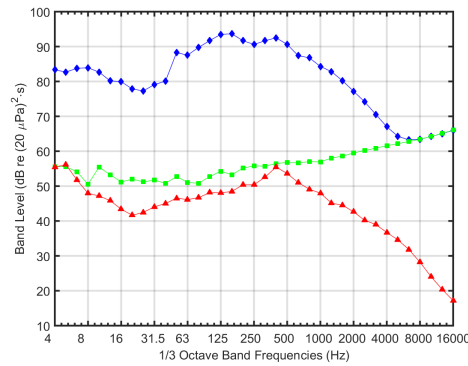
Redeye West - A



Redeye West - B



Redeye East - A



Redeye East - B

FIGURE 6. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 11:20:00 Local Time on 18 November 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

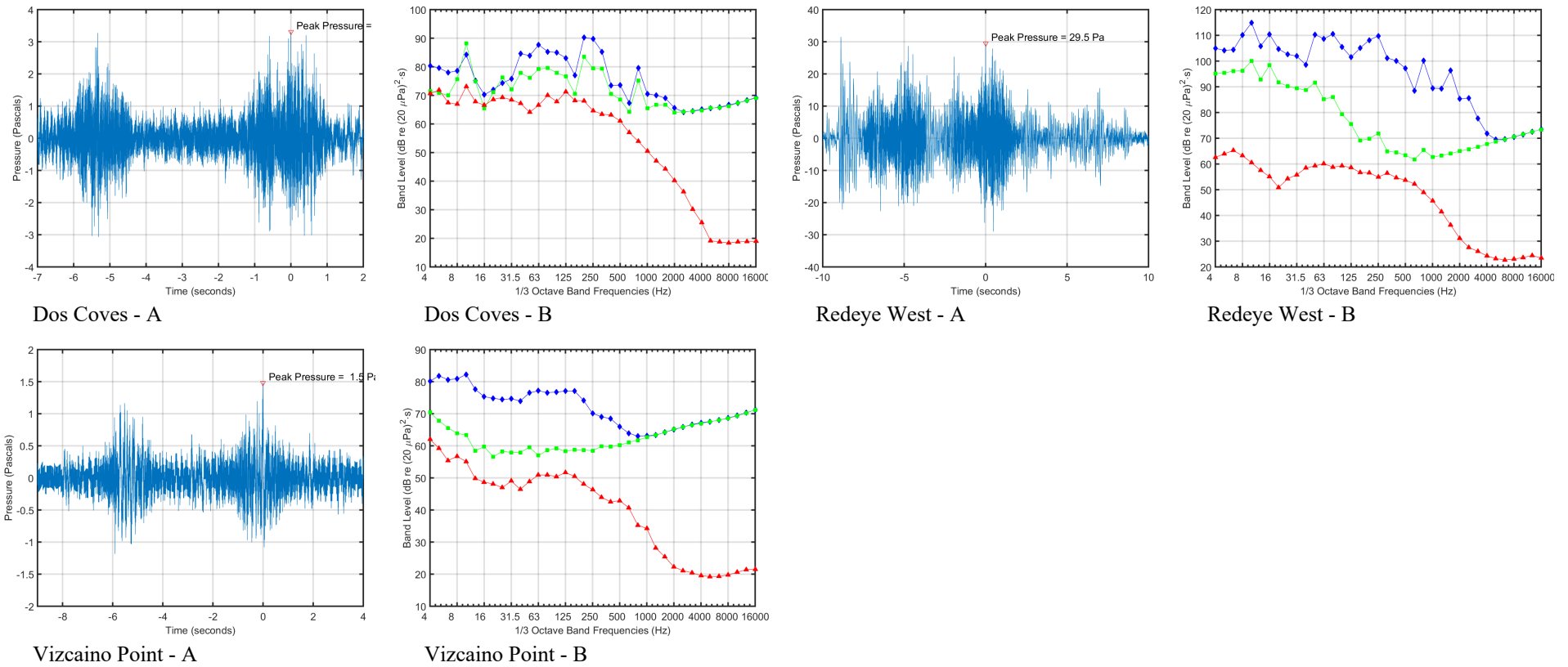


FIGURE 7. (A) Pressure waveform and (B) one-third octave band levels for a dual missile flight at 13:00:00 Local Time on 7 December 2021. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

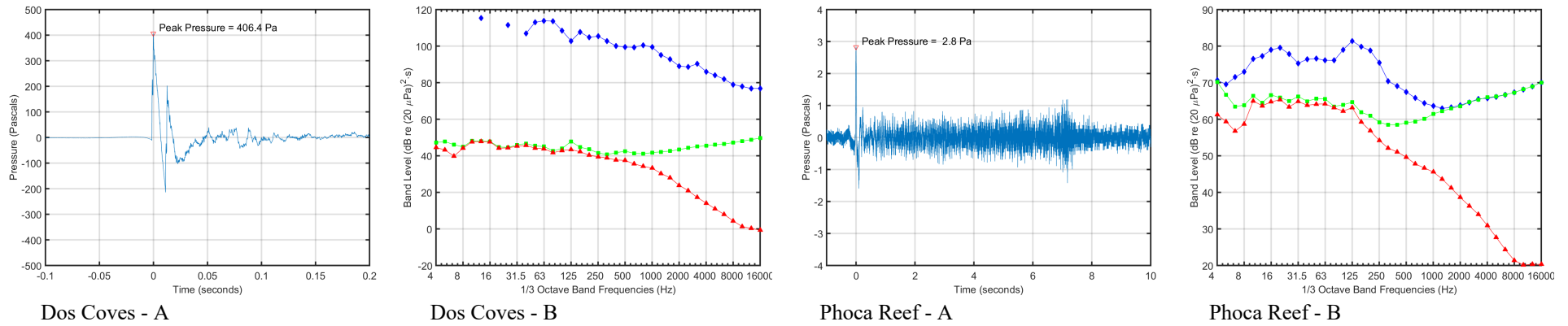


FIGURE 8. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 15:00:00 Local Time on 15 March 2022. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

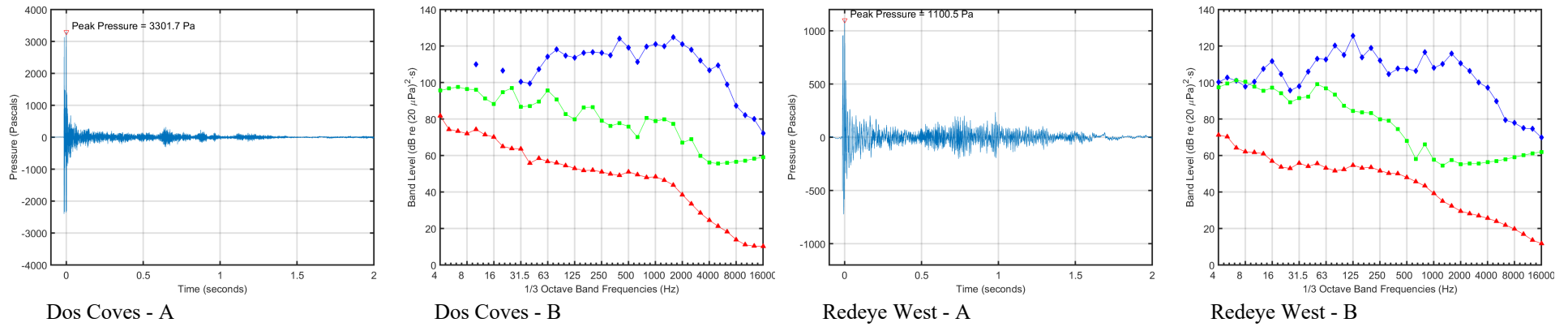


FIGURE 9. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 10:30:00 Local Time on 16 March 2022.
 In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

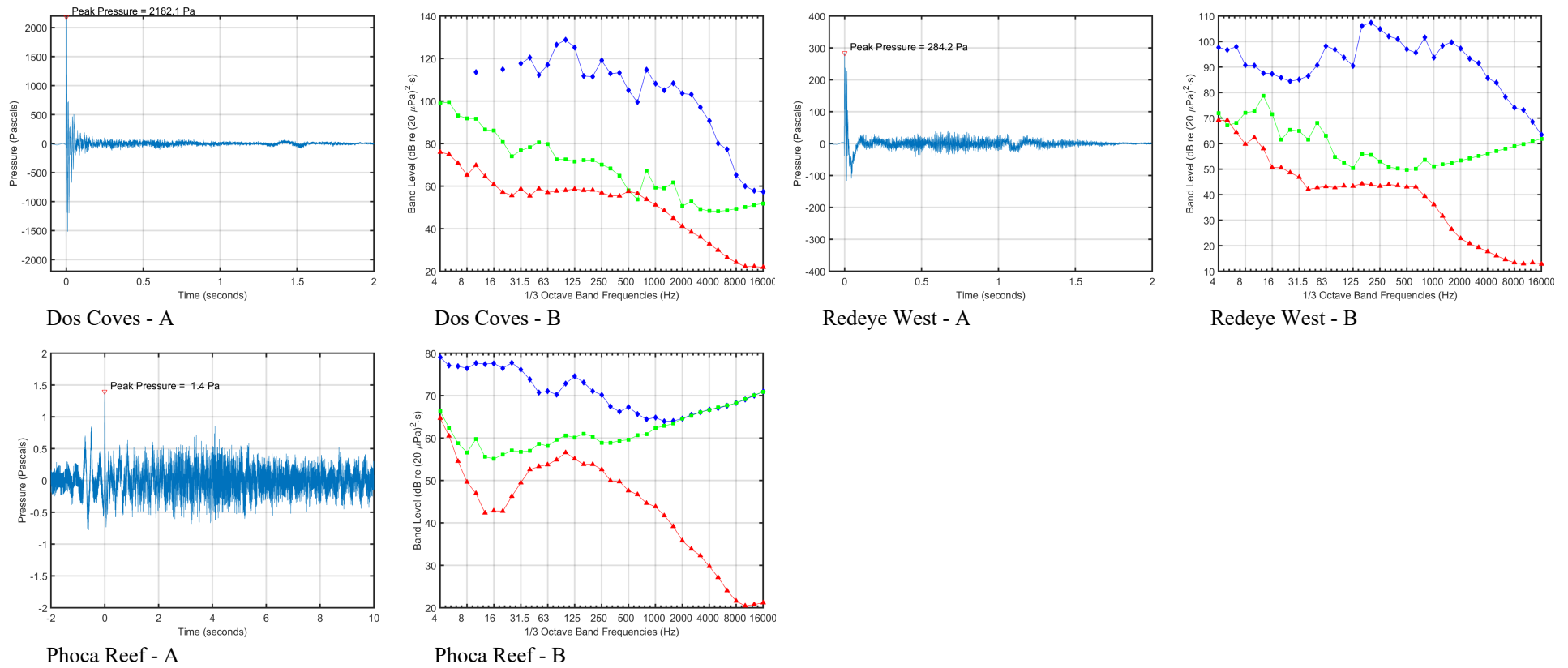


FIGURE 10. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 11:53:00 Local Time on 15 April 2022. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

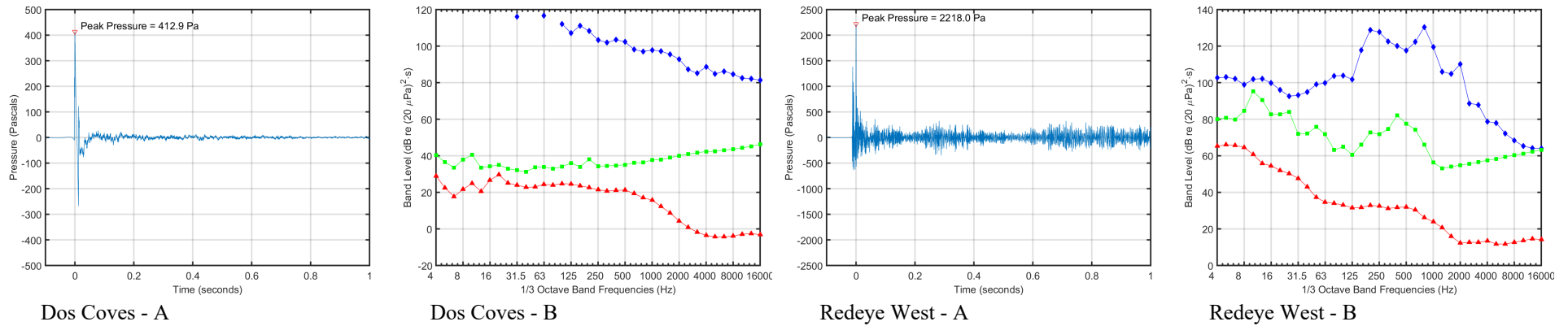


FIGURE 11. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 13:53:00 Local Time on 16 April 2022. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

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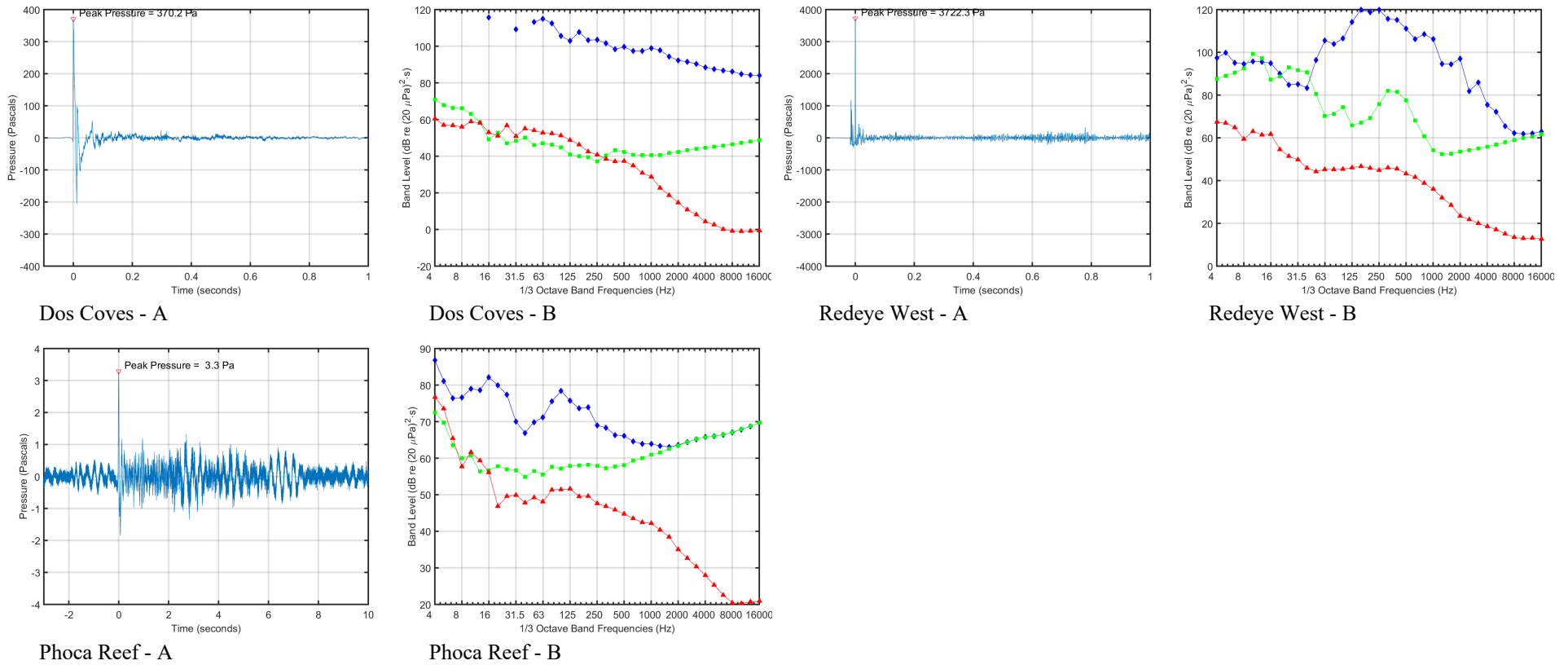


FIGURE 12. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 13:43:00 Local Time on 19 April 2022. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

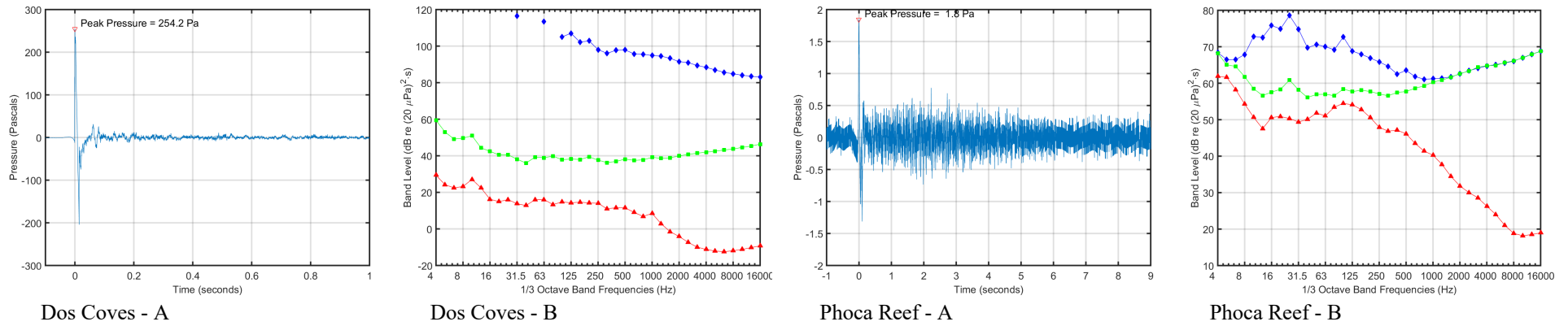


FIGURE 13. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 12:00:00 Local Time on 31 May 2022.
 In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

Acoustical Measurements of SNI Missile Launches: July 2021 – May 2022

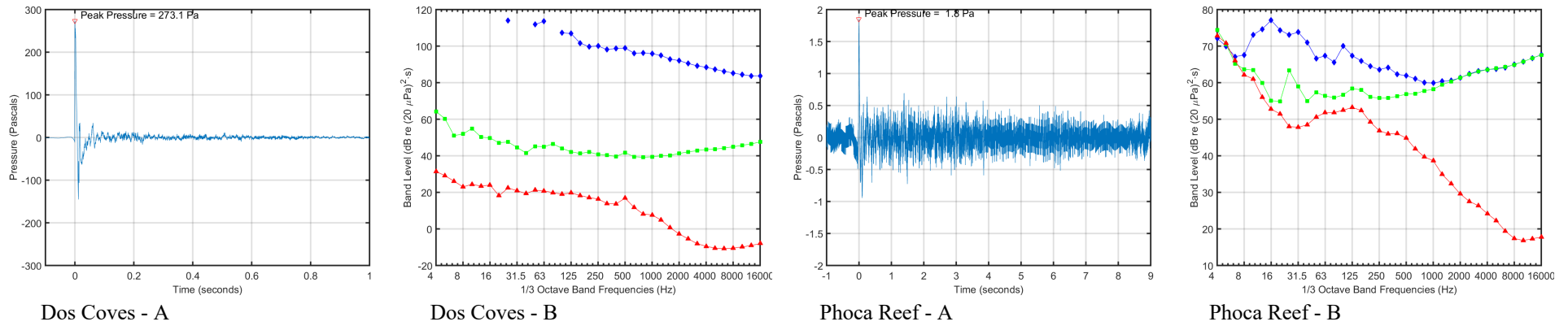


FIGURE 14. (A) Pressure waveform and (B) one-third octave band levels for a missile flight at 13:47:00 Local Time on 31 May 2022. In (B), \diamond = missile sound energy; \square = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).