

**ANNUAL REPORT
LETTERS OF AUTHORIZATION:
TAKING MARINE MAMMALS INCIDENTAL TO SPACE VEHICLE AND MISSILE
LAUNCHES AND AIRCRAFT TEST FLIGHT AND HELICOPTER OPERATIONS AT
VANDENBERG AIR FORCE BASE, CALIFORNIA
1 JANUARY TO 31 DECEMBER 2019**



Photo Credit: Tiffany Whitsitt-Odell

Submitted to:
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Permits, Conservation and Education Division
Office of Protected Resources
1315 East-West Highway
Silver Spring, MD 20910

Submitted by:
United States Air Force
30th Space Wing
30 CES/CEIA
1028 Iceland Avenue
Vandenberg Air Force Base, CA 93437

20 February 2020

Table of Contents

Executive Summary.....	iii
1.0 Introduction	1
2.0 Operations	2
2.1 Rocket Launches	2
2.2 Missile Launches	2
2.3 Fixed-wing Aircraft and Helicopter Operations	2
3.0 Methods.....	5
3.1 Sonic Boom Modeling.....	5
3.2 Acoustic Monitoring.....	5
3.3 Launch Monitoring.....	5
3.4 Fixed-wing Aircraft and Helicopter Operations	6
3.5 Monthly Surveys	Error! Bookmark not defined.
4.0 Results.....	7
4.1 Sonic Boom Modeling.....	7
4.2 Acoustic Measurements	Error! Bookmark not defined.
4.3 Launch Monitoring.....	7
4.3.1 Falcon 9 (two launches)	Error! Bookmark not defined.
4.4 Monthly Marine Mammal Surveys	10
4.4.1 Harbor Seals	10
4.4.2 Northern Elephant Seal.....	14
4.4.3 California Sea Lion.....	15
4.4.4 Steller Sea Lion.....	16
4.4.5 Incidental Sightings	17
5.0 Discussion.....	18
5.1 Effects of Natural Factors	18
5.2 Effects of VAFB Operations.....	18
6.0 Conclusion.....	19
7.0 Literature Cited	20

Tables

Table 1. Rocket Launches in 2019.....	2
Table 2. Missile Launches in 2019.....	2
Table 3. Launch Mitigation Requirements in 2019.....	7
Table 4. 2019 Monthly Harbor Seal Survey Results.....	11
Table 5. Historic Harbor Seal and Elephant Seal Survey Results at Amphitheatre Cove.....	12
Table 6. 2019 Monthly Harbor Seal Results by Haul Out (North to South).....	13
Table 7. 2019 Monthly Elephant Seal Results.....	14
Table 8. 2019 Monthly California Sea Lion Results.....	15
Table 9. Historic and Current Summary of California Sea Lion Survey Results.	15
Table 10. 2019 Monthly Steller Sea Lion Results.....	17

Figures

Figure 1. Launch Sites and Pinniped Haul-out Areas on South VAFB.....	3
Figure 2. Launch Sites (many inactive) and Pinniped Haul-out Areas on North VAFB.....	4
Figure 3. Steller Sea Lion Range and Rookeries (Alaska Fisheries Science Center 2015).....	17

Executive Summary

This report is prepared in accordance with two National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS; also called NOAA Fisheries) five-year Letters of Authorization (LOA) to the U.S. Air Force, Vandenberg Air Force Base (VAFB), 30th Space Wing (30 SW) for the incidental harassment of marine mammals related to U.S. Air Force Launches and Operations at Vandenberg Air Force Base (NOAA 2019a). The current LOA was issued on 10 April 2019 (a separate LOA was valid through and including 26 March 2019; NOAA 2014a) after publication of the Federal Register Final Rule on 12 April 2019 (NOAA 2019b) related to VAFB's request for unintentional take of marine mammals pursuant to the Marine Mammal Protection Act (MMPA) regulation.

This report summarizes results of monthly pinniped surveys in addition to describing pinniped monitoring conducted in association with space vehicle (rocket) and missile launches, first stage recovery ("boostback") of the SpaceX Falcon 9, together with fixed-wing aircraft, helicopter and unmanned aerial vehicle operations. Species of interest at VAFB included in the LOA include Pacific harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), Northern elephant seals (*Mirounga angustirostris*) and Steller sea lions (*Eumetopias jubatus*). At San Miguel Island (SMI), which is occasionally impacted by sonic booms from rockets, the northern fur seal (*Callorhinus ursinus*) and Guadalupe fur seal (*Arctocephalus townsendi*) are considered species of interest in addition to the four species mentioned for VAFB.

During the reporting period (1 January to 31 December 2019) there were four rockets and five missile or related vehicles launched from VAFB. Launches were avoided when possible during the Pacific harbor seal pupping season (1 March through 30 June) or if they would produce a sonic boom over the Northern Channel Islands (NCI) during the Pacific harbor seal pupping season. For three launches, avoidance was not possible and pinniped monitoring was required. One launch from Space Launch Complex 6 was scheduled for December 2018, but was postponed to January 2019, thus it is included in this report. No Auditory Brainstem Response (ABR) studies were required for any rocket launches because such testing had already been performed for these vehicles (SRS 1999). During the reporting period, 1,201 operations were conducted from the VAFB airfield. No indications of significant disturbances, abnormal pinniped behavior, injury or mortality were reported as a result of these operations (R. Evans, pers. comm., 2019). Though unrelated to launch and other Air Force actions, a significant die-off of California sea lions, presumed to be caused by domoic acid toxicity, was noted in 2019 – this mortality event included most of Southern and Central California.

LOA monitoring requirements were followed during 2019 and no incidents of injury or mortality of a pinniped caused by VAFB operations were documented (Leidos 2019, MSRS 2019a-b).

1.0 Introduction

This report presents information to satisfy the requirements of the LOA (NOAA 2019a) issued to VAFB by NMFS (a prior LOA, NOAA 2014a, was in effect prior to the current LOA). In accordance with a condition in the 2014 LOA (NOAA 2014, page 1, item #4), instead of notifying NMFS "at least two (2) weeks prior to conducting any launch activities that may result in taking marine mammals by harassment," VAFB has agreed to send quarterly advisories and updates to NOAA. These quarterly advisories were submitted in January, April, July and October 2019 (R. Evans, pers. comm., 2019).

Historically, Pacific harbor seals (*Phoca vitulina*; hereafter harbor seal) have been the most abundant pinnipeds on VAFB, at least during most months. California sea lions (*Zalophus californianus*), Northern elephant seals (*Mirounga angustirostris*; hereafter elephant seal) and Steller sea lions (*Eumetopias jubatus*) are also present, with all species except Steller sea lions increasing in recent years (MSRS 2014b, CEMML 2016a, CEMML 2016b, CEMML 2018). In the last 3-4 years, very large numbers of juvenile California sea lions have been observed near South Rocky Point in the early summer months. During the latter half of 2016 and throughout 2019, elephant seal numbers had a marked increase and they established a rookery at Amphitheatre Cove. Elephant seal pups were first documented in January 2017, again observed in January-March 2018 and the same months in 2019. The revised 2017 LOA (NOAA 2017), required launch monitoring of the elephant seal rookery beginning 01 January 2018.

Potential impacts to pinnipeds on VAFB include harassment from rocket or missile launch, Falcon 9 boostback or aircraft noise, particularly sonic booms, which may result in a startle response. In rare cases, sudden disturbances from a variety of causes have resulted in the trampling of pups by adult animals, resulting in injuries or mortalities. Other potential noise impacts could result in temporary threshold shift (TTS), in which an animal's hearing is temporarily diminished over part or all of its hearing range. Severe cases can involve permanent threshold shift (PTS), in which the animal's hearing is permanently diminished over part or all of its hearing range.

During the 2019 reporting period, monitoring on the Northern Channel Islands (NCI) was not required for any launch. Monitoring on VAFB was required for three launches (two Falcon 9 launches, January and June; and a Delta IV in January; see Table 1). This report describes the methods and results of the marine mammal monitoring efforts and discusses the impacts of Air Force operations. The final Delta II launch from Space Launch Complex 2 occurred 15 September 2018 during the previous reporting period; a new commercial launch entity plans to begin operations at this facility, potentially in early calendar year 2020. In June, Space Exploration Technologies conducted their second successful terrestrial "boost-back," wherein the first stage of the rocket launched from Space Launch Complex (SLC) 4-East returned to SLC-4 West about 8 minutes later; the first stage of the rocket will be refurbished and re-used. Starting in 2020 or 2021, significant modifications will be initiated at Space Launch Complexes 3 and 6 for new rocket types and perhaps new launch proponents.

In July of 2016, VAFB concluded informal Section 7 consultation under the Endangered Species Act with NMFS. NMFS concurred that VAFB rocket launches are "not likely to adversely affect" the Guadalupe fur seal on the NCI.

2.0 Operations

Operations that occur on VAFB covered by the LOA include rocket and missile launches as well as fixed-wing aircraft and occasional helicopter activities. Operations activities occurring in 2019 are detailed below.

2.1 Rocket Launches

Four rocket launches occurred during the reporting period from Space Launch Complexes (SLC) 4 and 6 on south VAFB and Test Pad-01 on North VAFB (Table 1). The locations of launch sites in relation to pinniped haul-out areas on VAFB are shown in Figures 1 and 2.

Table 1. Rocket Launches in 2019

Vehicle Type	Facility	Launch Date
Falcon 9 – Iridium 7 ¹	SLC 4E	11 January
Delta IV – NROL 71	SLC 6	19 January
Falcon 9 CommSat ²	SLC 4E	6 June
Buzzard	TP-01	12 December

¹Included “boost back” and landing to an offshore barge

²Included “boost back” and landing to the pad at SLC-4W

2.2 Missile Launches

Five missile (and similar) launches occurred during the reporting period from Launch Facilities (LF) on north VAFB from LF-04, LF-09, LF-10 and LF-23 (Table 2). There was one Ground-based Midcourse Defense (GMD) launch test during the reporting period. The locations of these sites in relation to pinniped haul-out areas on VAFB are shown in Figure 2. Four of the five launches were unarmed Minuteman III (MM-III) Intercontinental Ballistic Missile (ICBM) test launches.

Table 2. Missile Launches in 2019

Missile Type	Facility	Launch Date
MM III FTU-1	LF-04	6 February
MDA GMD-FTG-1	LF-23	25 March
MM III GT-230GM	LF-10	1 May
MM III GT-229GM	LF-09	9 May
MM III GT-232GM	LF-10	2 October

2.3 Fixed-wing Aircraft and Helicopter Operations

Various types of fixed-wing aircraft fly from VAFB. In accordance with the LOA, all aircraft and helicopter flight paths maintain a minimum distance of 1,000 feet from recognized pinniped haul outs and rookeries, except during emergencies or security incidents. Class 0-2 unmanned aerial systems may be flown within 300 feet of recognized pinniped haul outs and rookeries.

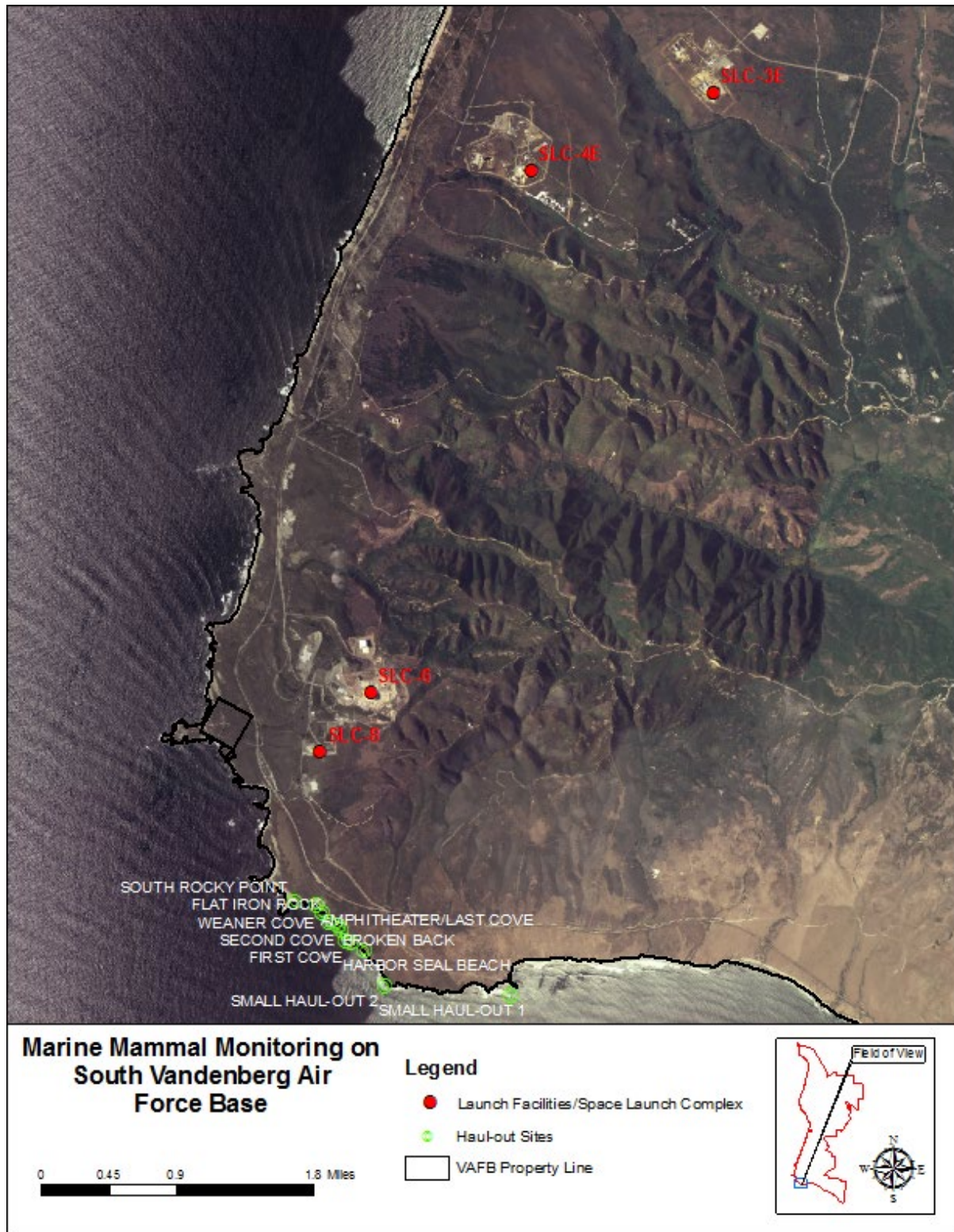


Figure 1. Launch Sites and Pinniped Haul-out Areas on South VAFB.

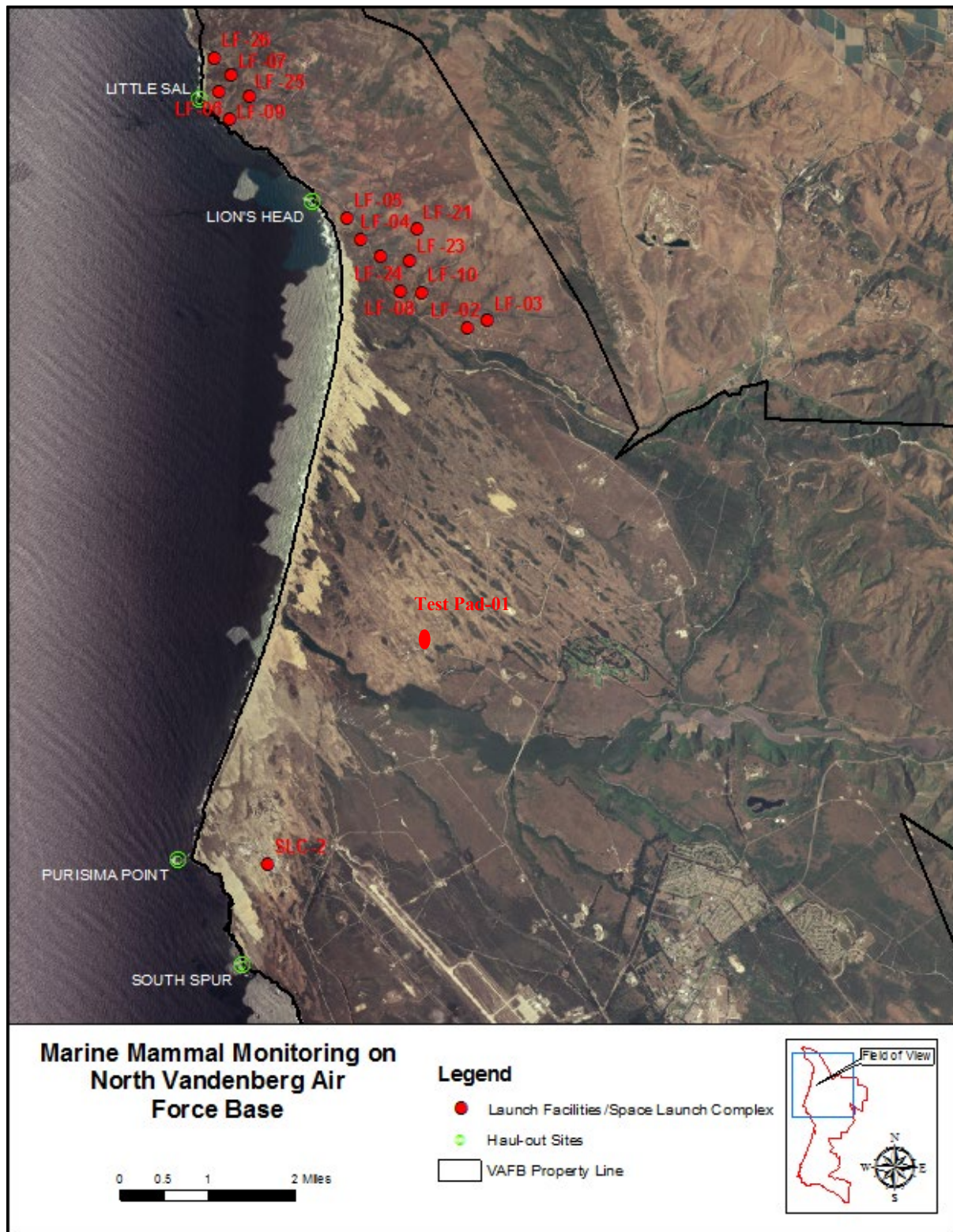


Figure 1. Launch Sites (many inactive) and Pinniped Haul-out Areas on North VAFB.

3.0 Methods

3.1 Sonic Boom Modeling

As required in the LOA, sonic boom modeling is performed prior to all rocket launches. Modeling is not necessary for the missile and MDA launches because these vehicles are launched with a westward trajectory and their sonic booms do not impact marine mammal haul-outs on VAFB or the NCI (NOAA 2014a). The modeling programs incorporate nominal flight trajectory information, rocket weight, length, engine thrust, engine plume drag, and meteorological conditions to predict the peak amplitude and impact location of potential booms. Among other factors, meteorological conditions include jet stream presence or absence, and if present, its direction, altitude, and velocity. Cloud type, altitude, and density are also considered. From these data, models predict peak amplitudes and impact locations.

3.2 Acoustic Monitoring

Acoustic monitoring is conducted on NCI when sonic boom modeling predicts impacts to the NCI in excess of the thresholds defined in the LOA. In order to record and analyze the level of the sonic boom that impacts the NCI as a result of the launch, monitors utilize a calibrated sound level meter with all the necessary accessories. Measurements could be downloaded to a laptop and analyzed. A separate system with a calibrated digital audio tracking (DAT) recorder, preamplifier, and specialized microphone is used to obtain sonic boom measurements. The microphone is mounted on a tripod and fitted with a windscreen. The DAT tapes are analyzed in the laboratory to determine various acoustic properties of the rocket noise and sonic boom.

3.3 Launch Monitoring

With the current LOA (NMFS 2019a), monitoring on the NCI is required if sonic boom modeling predicts a sonic boom greater than 2 psf is likely to impact one or more of the NCI between 1 March and 31 July, greater than 3.0 psf between 1 August and 30 September, and greater than 4 psf between 1 October and 28 February. Beginning 01 January 2018, pinniped monitoring was required on VAFB when launches occur during elephant seal pupping season (1 January through 28 February). A continuing requirement is pinniped monitoring during the harbor seal pupping season (1 March through 30 June). Note that elephant seal weaners are expected to still be present at their rookery for the first few weeks of March, therefore harbor seal monitoring will also incorporate this species. Starting in 2019, VAFB extended monitoring for launches until 31 July to account for recent increases in California sea lion numbers in the early summer months, though no successful pupping of this species has yet been documented.

Monitoring must begin at least 72 hours prior to each launch and continue 48 hours after the launch. During pupping season, follow-up monitoring must be conducted on VAFB once approximately two weeks after each launch. Monitoring must be conducted as close to the launch window as possible, or at times with tides approximately equivalent to those expected during the launch window.

On VAFB, monitoring sites are selected based on proximity of the launch location to the nearest active haul-out sites. The haul outs that are monitored for rocket launches from South VAFB include Amphitheatre Cove and may include North and South Rocky Point (Figure 1).

Amphitheatre Cove has historically been utilized as a harbor seal rookery and is now also utilized as an elephant seal rookery. On the NCI, the monitoring location is selected based on the density and level of predicted sonic boom impacts and the nearest active haul-out of pupping pinnipeds.

Pinniped monitors used high quality binoculars and spotting scopes to make hourly counts and record species, number of individuals, sex, age class, and behavior within a predefined focal area. Several counts are conducted each day. Monitors may use night vision goggles (Exelis AN/PVS-7D or similar) if monitoring occurs during hours of darkness. Remarks are recorded, including the nature and cause of any natural or human-related disturbance, such as low-flying aircraft or boat traffic. Incidental information may be recorded for other wildlife species. Environmental data collected includes tide level and time, visibility, percentage and type of cloud cover, air temperature, wind direction and velocity, and swell direction and height. On VAFB, direct observations during launch events are usually not allowed due to safety concerns; therefore video is utilized during day time launches on VAFB to record the reactions of pinnipeds to the launch. Post-launch, the video equipment is collected and video reviewed with responses such as alert or flushing into the water noted. Alert is usually considered insignificant. When flushing is observed, the amount of time it takes for the number of hauled-out animals to return to the pre-launch count is determined if length of the recording allows.

3.4 Fixed-wing Aircraft and Helicopter Operations

The VAFB Airfield (30 OSS/OSAB) keeps records of number and nature of all fixed-wing aircraft and helicopter operations completed at VAFB.

3.5 Monthly Surveys

The Center for Environmental Management of Military Lands (CEMML) and U.S. Air Force personnel, 30th Civil Engineer Squadron (30 CES) biologists surveyed marine mammal haul-out sites on North and South VAFB (Figures 1 and 2) monthly from January to December 2019. For each survey, high quality binoculars and a spotting scope are utilized depending on conditions. Monthly surveys are timed to coincide with the lowest weekday late morning or afternoon low tides. The location, species, number of individuals, age class, and sex (when possible) were recorded for each site and ocean and weather conditions are documented. On VAFB, observations are made from cliffs overlooking haul-outs. Purisima Point has been omitted from all surveys throughout 2015-2019 because a permitted biologist must accompany anyone accessing Purisima Point during the California least tern and western snowy plover breeding season (1 March to 30 September). The site was not included in the remaining months (1 October to 28 February) in order to keep data consistent throughout the year.

Starting in 2017, several haul outs on South VAFB (Harbor Seal Beach, First Cove, First Ledge, Second Cove, Broken Back, and Weaner Cove) were omitted from almost all surveys. This was due to significant decreased use of these sites starting in 2016, likely linked to increased cliff erosion in the area. This allowed for adequate time to survey more heavily utilized haul outs (Amphitheatre Cove, South Rocky, and North Rocky). In 2019, these locations were surveyed via spotting scope from the apex of South Rocky Point, a vantage point that allows surveyors to see

most of the coast line. Additionally, three vantage points are now used to thoroughly survey North Rocky Point, which takes additional time.

4.0 Results

Based on modeling of launches and time of year, three monitoring efforts were required during 2019. Launch mitigation requirements are presented in Table 3 and discussed in detail in the following subsections.

Table 3. Launch Mitigation Requirements in 2019[^]

Vehicle or Missile	Launch Date	NCI	VAFB	Video	Video Result	Boom Model
Falcon 9-Iridium 7	11 January		Required	Required	Failure	Required
Delta IV NROL 71	19 January		Required	Required	Failure	Required
MMIII-FTU-1	6 February					
MDA GMD-FTG-11	25 March					
MM III GT-230-GM	1 May					
MM III GT-229-GM	9 May					
Falcon 9-RADARSat	12 June		Required	Required	Success	Required
MMIII GT-XXX-GM	2 October					
Buzzard	12 December					Required

[^] Blank Cell = action not required.

4.1 Sonic Boom Modeling

Sonic boom modeling was conducted for three of the rocket launches that occurred during the 2019 reporting period (Buzzard, like missiles, had a westward trajectory). No boom models predicted impacts that would require monitoring on the NCI.

4.2 Acoustic Monitoring

Modeling predicted no sonic booms would impact the NCI in the 2019 reporting period, therefore no acoustic monitoring was required.

4.3 Launch Monitoring

Three launches required monitoring on VAFB during the 2019 reporting period. No launches required monitoring on NCI. Full details of the monitoring for those launches can be found in launch monitoring reports sent to NMFS previously (summaries follow).

4.3.1 Falcon 9 – Iridium 7 (11 January)

Two separate launches of the Falcon 9 rocket occurred in the reporting period, both of these required pinniped monitoring on VAFB (MSRS 2019a-b). The second launch is described in Section 4.3.3. Sonic boom modeling of Iridium 7 determined that the launch would not generate a boom that would impact the NCI.

The Iridium 7 launch (MSRS 2019a) occurred at 0731 hours on 11 January, after several weather-related delays. The launch required elephant seal monitoring, other pinniped species were monitored opportunistically. This launch included “boost back” of the first stage to an off-shore, autonomous barge, downrange within the Iridium landing area. Video recording of the launch was attempted, but failed due to inclement weather (further described in Section 4.3.2).

Monitoring at VAFB was conducted at all haul-outs between North Rocky Point and Small Haul-Out 2, with a focus on South Rocky Point and Amphitheatre Cove. Pre-launch counts were recorded several times per day, from 8-13 January (accounting for weather and other launch delays). Post launch survey data was partially obtained from pre-launch surveys for the subsequent Delta IV launch described in Section 4.3.2. A two-week post-launch final count occurred on 26 January. Detailed counts are presented in MSRS 2019a.

Elephant seal pre-launch counts ranged from 21-37 adults, 17-25 juveniles and 2-8 pups. Post-launch counts ranged from 24-45 adults, 1-19 juveniles and 10-23 pups. Although harbor seal counts were not required, they ranged from 0-48 before and 0-40 after the launch.

During all monitoring, no pinnipeds were observed to have any injuries, mortality, or abnormal behavior.

4.3.2 Delta IV – NROL 71 (19 January)

This launch was originally scheduled for September 2018. Numerous delays resulted in it being postponed more than 7 times, it ultimately launched on 19 January 2019. Because the launch was delayed into January, it required pinniped monitoring on VAFB, focused on elephant seals. The sonic boom model indicated that a boom greater than 4 psf would *not* impact the NCI, monitoring at that location was not required.

Several counts were conducted daily from 12-13 January 2019, prior to a then-scheduled 14 January launch. A series of winter storms then delayed the launch and prevented additional pre-launch surveys until 18 January. Additional monitoring data was collected and shared from the previous launch (Section 4.3.1). The launch finally occurred at 1110 hours on 19 January. Post-launch monitoring occurred on 21 and 22 January following an additional day where site access by biologists was unsafe due to weather. A final day of monitoring took place on 3 February, approximately 2 weeks after the 19 January launch, once again delayed one day due to inclement weather.

Poor visibility, a series of winter storms and winds recorded in excess of 50 knots prevented effective video monitoring. Monitoring occurred pre- and post-launch at approximately the same tide cycle as what was expected to be present during the launch (again impacted by launch delays). Small numbers of harbor seals, California sea lions and Steller sea lions were observed hauled out (harbor seals 23-36 pre-launch, 10-29 post-launch; California sea lions, 7 before, 1 after; Steller sea lions 4 before, zero after); however the variation in these numbers was considered more closely related to the early seasonality, not effects from the launch. Harbor seal pupping monitored later in the year (refer to Section 4.5.1) was within normal to above-normal

numbers. We have never observed successful pupping of either California or Steller sea lions on VAFB.

Total pre-launch counts for elephant seal adults ranged from 18-53, including 11 pups. Total post-launch counts for adults ranged from 20-25, 0-7 juveniles and 20-25 pups. As pupping continued as expected, with ultimately 25-27 pups being counted in 2019 (reported separately), no impacts of the launch were observed.

Two weeks after the launch, two deceased elephant seal pups and one deceased adult female were observed; the adult female (observed from a distance through a spotting scope) appeared to have a prolapsed uterus and intestines, thus her death was attributed to complications during birth. One of the two deceased pups was perhaps offspring of the deceased adult female, with death assumed during birth, stillbirth or starvation shortly after birth due to the female's death. The second pup's death was within normal pup mortality figures of about 5-25% (J. Greenman, NMFS, 2019, Pers. Comm.). As these observations all occurred slightly more than two weeks after the launch, none of the deaths were attributed to the launch. Overall no abnormal behavior, injuries, or mortalities were reported as a result of the launch.

4.3.3 Falcon 9 – RADARSat (12 June)

The launch on 12 June (MSRS 2019b) occurred after several delays; it was initially scheduled for 6 June. It required harbor seal and sea lion monitoring. This launch included "boost back" of the first stage to a terrestrial landing pad at SLC-4 West, about 400 meters from the launch pad at SLC-4 East (the landing occurred about 7.5 minutes after the launch).

Sonic boom modeling determined that neither launch nor return flight and landing would generate a boom that would impact the NCI at a level requiring monitoring at that location. The model predicted a landing boom of 1.0 to 1.5 pounds per square foot (psf) impacting the mainland, however the actual boom was louder, recorded at 2.866 psf. The significant variation in the model and actual results was attributed to the boom model still being in development (it was designed to model sonic booms generated by aircraft, not spacecraft); predictive accuracy will likely improve in the future.

Numerous counts were conducted each day from 9 to 13 June (3 days before and 2 days after), in addition to a two-week follow-up count performed on 24 June. Harbor seal numbers ranged from 47-79 adults and 5-16 juveniles before, 49-113 adults and 9-10 juveniles after the launch. Elephant seal counts ranged from 2-107 before and 47-104 after the launch. California sea lion counts ranged from 0-9 adults and 146-1,362 juveniles before and 0-13 adults and 677-1,254 juveniles after the launch. No Steller sea lions were observed.

A sub-set of hauled out harbor seals was selected for video monitoring during and immediately following the launch. Review of the recordings showed that all harbor seals reacted to the launch by flushing into the ocean, they had not yet returned to their haul-out prior to the boostback (thus did not flush twice); the first seal returned to the site about 23 minutes after the launch and numbers were back to the pre-launch count at about 60 minutes post-launch.

A total of 6 deceased California sea lions were observed pre-launch and 2 additional dead were observed during the two-week follow-up count. Deaths of these animals were not attributed to the launch, but were likely due to domoic acid poisoning, as described in Section 4.5.3.

4.4 Fixed-wing Aircraft, Helicopter and Unmanned Aerial Vehicle Operations

During the reporting period, 1201 operations were conducted from the VAFB airfield. Most of these consisted of overflights or training and proficiency flights involving practice approaches and touch and goes. 304 operations were either Unmanned vehicles or helicopters, which are not allowed to fly lower than 1,000 feet over the coastline. Some were logistics flights involving the transfer of supplies, equipment and personnel. The Vice President of the United States visited VAFB in July 2019.

The total number of take-offs and landings (including touch and goes) was 1177; additionally, 16 overflights below 2,500 feet in altitude (but not above the coastline), and 254 Unmanned Aerial Systems (“drone”) operations were recorded. No indications of significant disturbances, abnormal pinniped behavior, injury or mortality were reported as a result of these operations (R. Evans, pers. comm. 2019).

4.5 Monthly Marine Mammal Surveys

Monthly surveys were conducted throughout 2019. None of the monthly surveys suggested any changes in haul-out patterns as a result of launches. Table 4 displays the monthly survey results of harbor seals and Table 5 indicates the monthly survey results of harbor seals and elephant seals at Amphitheater Cove on VAFB from 2014-2019.

4.5.1 Harbor Seals

Harbor seals regularly utilize Amphitheatre Cove as a rookery and give birth from 1 March to 30 June. Mating occurs in the water after pups are weaned. Because harbor seals are not all hauled out on shore at one time, a 1.54 correction factor is applied to the number of hauled out harbor seals observed to account for individuals in the water (Harvey and Goley 2011). All harbor seal counts in this document are calculated and reported based on this correction factor, unless otherwise stated.

Harbor seal totals in 2019 varied from a low of 48 in January to a high of 183 in June (Table 4), with an average monthly count of 104 for the survey period. Pups were observed in March, April, May and June, with a peak of 34 in April 2019.

On North VAFB, the Spur Road haul out had the most individuals observed with a peak of 35 in August 2019 (Table 6) and Lion’s Head had the least individuals observed. On South VAFB, the Small Haul Out 2 and Amphitheatre locations regularly had the most individuals observed. Amphitheatre had a peak of 57 in April 2019 and Small Haul Out 2 had a peak of 72 in December 2019 (Table 6). East Islet and South Arguello Ridge were not surveyed. North Rocky Point, South Rocky Point, Second Cove, and Harbor Seal Beach were surveyed locations with no harbor seals

recorded; First Ledge and First Cove only had harbor seals observed in one month each in 2019 (April and May, respectively).

Table 4. 2019 Monthly Pacific Harbor Seal Survey Results.

Month	Adult[^]	Juvenile[^]	Pup[^]	Total[^]
January	48	0	0	48
February	91	3	0	94
March	97	11	5	112
April	89	0	34	123
May	122	0	17	139
June	162	22	0	184
July	129	0	0	129
August	123	5	0	128
September	57	3	0	60
October	77	8	0	85
November	74	0	0	74
December	68	9	0	77

[^]Numbers reflect 1.54x correction factor

There has been significant variation in the number of harbor seals utilizing Amphitheatre Cove from 2014 through 2019 (Table 5). A drastic increase occurred from 2014 to 2015 and a drastic decrease occurred from 2016 to 2019. This is not a product of survey intensity as a survey was conducted nearly every month for all five years at Amphitheatre Cove. One explanation could be the increased use of Amphitheatre by elephant seals, discussed further in Section 4.5.2. When looking at the data presented in Tables 5 and 6, it is notable that from 2014 to 2015 when harbor seal numbers increased, the elephant seal numbers remained relatively similar. From 2015 to 2016 harbor seal numbers stayed relatively similar while elephant seal numbers significantly increased. From 2016 to 2019 the harbor seal numbers decreased dramatically and the elephant seal numbers dramatically increased. It is not directly known if use of Amphitheatre by elephant seals is affecting the number of harbor seals utilizing the site, or if another unknown factor is contributing to this affect. In 2017-2019, both harbor seals and elephant seals utilized the Amphitheatre haul out for giving birth and weaning pups.

Table 5. Historic Pacific Harbor Seal and Northern Elephant Seal Survey Results at Amphitheatre Cove.

Year	Pacific Harbor Seals			Northern Elephant Seals		
	Average [^]	Total [^]	Highest Count [^] (Month)	Average	Total	Highest Count (Month)
2014	4	37	23 (December)	3	31	24 (April)
2015	178	1962	590 (October)	1	12	10 (June)
2016	130	1428	339 (May)	19	213	84 (November)
2017	37	450	80 (February)	58	692	197 (October)
2018	35	414	131 (June)	77	919	209 (November)
2019	26	310	57 (April)	100	1202	300 (May)

[^]Numbers reflect 1.54x correction factor, rounded to nearest whole number

Table 6. 2019 Monthly Pacific Harbor Seal Results by Haul-Out (North to South).

Haul-Outs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Little Sal	0	0	0	0	0	1	10	10	4	4	0	0
Lion's Head	5	4	3	4	4	1	0	5	3	9	3	3
Purisima Point	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Spur Road	11	9	10	3	8	1	12	23	0	20	14	22
East Islet	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S. Arguello Ridge	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
North Rocky Point	0	0	0	0	0	0	0	0	0	0	0	0
South Rocky Point	0	0	0	0	0	0	0	0	0	0	0	0
Amphitheatre	10	17	20	37	35	32	17	0	8	15	6	6
Weaner Cove	0	0	0	0	0	3	0	4	0	0	0	0
Flat Iron Rock	0	0	0	0	0	64	26	22	4	0	0	0
Broken Back	0	0	0	16	9	0	0	0	0	0	0	0
Second Cove	0	0	0	0	0	0	0	0	0	0	0	0
First Ledge	0	0	0	1	0	0	0	0	0	0	0	0
First Cove	0	0	0	0	4	0	0	0	0	0	0	0
Harbor Seal Beach	0	0	0	0	0	0	0	0	0	0	0	0
Small Haul Out 2	5	30	27	19	28	17	20	24	23	16	25	72
Small Haul Out 1	0	1	3	0	5	0	0	0	0	0	0	0
Total	31	61	53	80	93	119	85	88	42	64	48	132

^aNumbers reflect 1.54x correction factor, rounded to nearest whole number

*NS = Not Surveyed

4.5.2 Northern Elephant Seal

Elephant seals historically have hauled out in low numbers on VAFB beaches, with a total of 10 elephant seals observed on monthly counts between 2007 and 2010. Beginning in 2013, greater than average numbers of elephant seals were observed at South Rocky Point with numbers peaking at 191 individuals, primarily of sub-adult males, in November 2013 (MSRS 2014). Greater than average numbers were again reported in 2014, with a total of 237 observations. There were smaller numbers in 2015 with a total of 41 individuals observed (likely due to South Rocky Point not being surveyed during the majority of months), and again, an increase in 2016 with a total of 288. A very significant increase began in 2017, with a total of 916 animals observed in 2017 and 919 in 2018. This trend has continued into 2019 with a total of 1,345 elephant seals detected during 2019 surveys (Table 7). These numbers peaked in May with more than 315 elephant seals counted. Five elephant seal mortalities (including two pups) were documented and reported to NMFS in January, February (2), March and April 2019 (R. Evans, pers. comm., 2019). No optimally-timed surveys occurred at Point Conception in 2019.

Table 7. 2019 Monthly Northern Elephant Seal Results.

Month	Adult	Juvenile	Pup	Total
January	28	8	25	61
February	21	4	18	43
March	0	0	31	31
April	0	204	0	204
May	0	315	0	315
June	0	98	0	98
July	19	3	0	22
August	0	4	0	4
September	0	115	0	115
October	0	229	0	229
November	4	118	0	122
December	19	82	0	101

Elephant seal pupping was first documented at Amphitheatre Cove in January 2017, with pups documented on 09 Jan 2017 during routine monthly surveys. In 2017, a maximum of 19 pups were observed. Twenty-five elephant seal pups were observed in 2018 and 31 in 2019. Since 2018, the Air Force has conducted additional surveys of Amphitheatre Cove in order to document elephant seal pupping in late December and early January with intent to record the first pupping each season, which we then compare to other regional pupping locations.

In early March 2019, VAFB and scientists affiliated with the California Polytechnic State University, San Luis Obispo (Cal Poly-SLO) flipper tagged 25 elephant seal pups under authority of permit 19108-01, issued to Dr. Daniel Costa (University of California at Santa Cruz). Dr. Heather

Liwanag (Cal Poly-SLO) has since obtained a permit under her name (#22187) for additional tagging now planned for March 2020.

4.5.3 California Sea Lion

During 2019, the highest number of California sea lion observations was 1,122 adults and juveniles in June, with high numbers continuing into July (Table 8). These are the highest documented numbers since at least 2011 (Table 9). Typically California sea lions haul out at North Rocky Point, recently with more frequent hauled-out individuals observed at Amphitheatre and South Rocky Point. In 2019, California sea lions used all three haul outs regularly during the early summer months.

Table 8. 2019 Monthly California Sea Lion Results.

Month	Adult	Juvenile	Pup	Total
January	5	1	0	6
February	11	0	0	11
March	1	0	1	1
April	13	0	0	13
May	0	680	0	680
June	7	1,115	0	1,122
July	0	1,083	0	1,083
August	0	161	0	161
September	8	2	0	10
October	11	0	0	11
November	8	0	0	8
December	4	1	0	5

Table 9. Historic and Current Summary of California Sea Lion Survey Results.

Year	Average	Total	Highest Count (Month)
2011	4	45	21 (Jul & Sep)
2012	33	398	150 (Aug)
2013	4	53	25 (Jan)
2014	136	1366	416 (May)
2015	18	201	156 (Jan)
2016	11	118	39 (Sep)
2017	21	255	68 (Sep)
2018	175	2103	980 (May)
2019	259	3111	1122 (June)

Historically, pups are irregularly detected at North Rocky Point and pregnant California sea lions observed were usually sick or in poor condition (MSRS 2015); therefore, North Rocky Point is not considered a rookery.

As detailed above, since approximately 2017, the Air Force has observed enormous increases in early summer use of (primarily) the South Rocky Point haul-out by (mostly) juvenile and sub-adult California sea lions. It is possible that a majority of these animals are “displaced” as a result of increasingly high numbers of both California sea lions and elephant seals at the NCI.

As noted in Section 4.3.3, 8 deceased California sea lions were observed during launch monitoring, but they were not attributed to space or missile launch operations. In 2019, more than 80 California sea lions were found dead on VAFB beaches, and more than 1,600 were found dead between San Luis Obispo and Orange Counties (NMFS, J. Greenman, 2019, unpublished data). These were primarily attributed to domoic acid toxicity, though a smaller number were likely due to natural causes, predation by great white sharks and other factors.

4.5.4 Steller Sea Lion

Steller sea lions were first reported on VAFB at North Rocky Point in April 2012 during a monthly count (MMCG and SAIC 2013). Since May 2012 they have been observed regularly in low numbers on North Rocky Point (MMCG and SAIC 2013, MSRS 2014, 2015; prior year LOA reports). There are approximately 65 breeding rookeries and more than 300 haul-outs utilized by Steller sea lions across their range (Fisheries and Oceans Canada 2010) (Figure 3). The range of the Steller sea lion stretches from Japan to Alaska to southern California, and there are two distinct populations, the western population and the eastern population (separated at 144° W longitude (near Cape Suckling, just east of Prince William Sound, Alaska (Alaska Fisheries Science Center 2015; Figure 5).

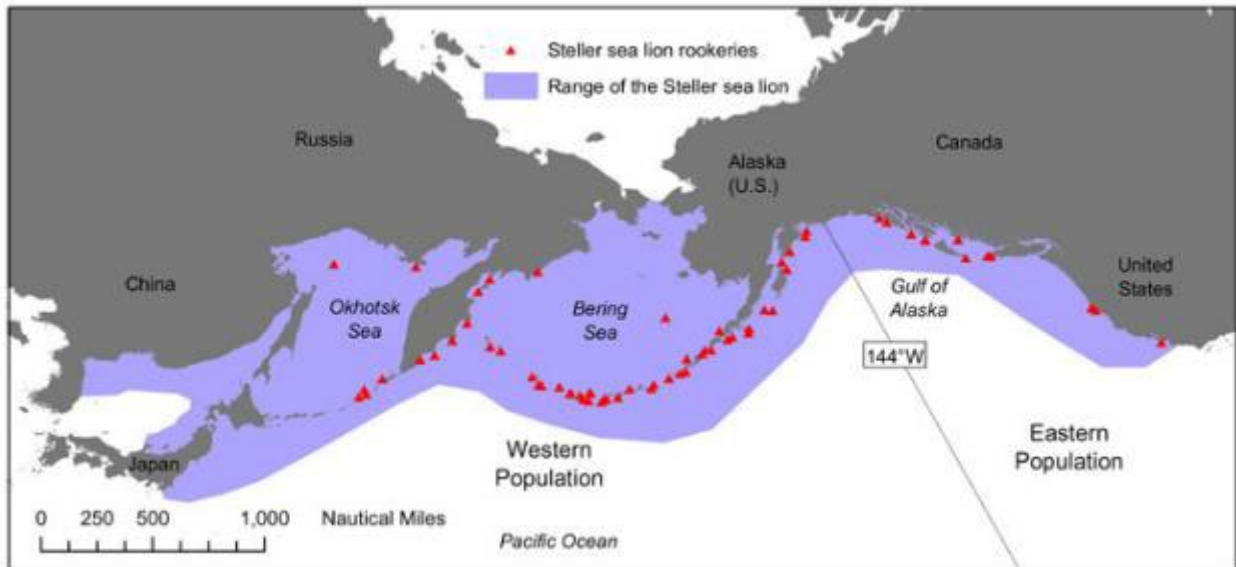


Figure 3. Steller Sea Lion Range and Rookeries (Alaska Fisheries Science Center 2015).

Table 10. 2019 Monthly Steller Sea Lion Results.

Month	Adult	Juvenile	Pup	Total
January	4 ¹	0	0	4
February	0	0	0	0
March	0	0	0	0
April	1	0	0	1
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0

¹ Observed prior to Delta IV rocket launch, see Section 4.3.2

Steller sea lions are non-migratory, but they will disperse long distances from natal rookeries throughout the year (Bigg 1985). Availability of forage fish is likely the primary factor driving Steller sea lion use of widely dispersed haul-outs like North Rocky Point (Fisheries and Oceans Canada 2010). Prior to May 2012, Steller sea lions had not been observed during VAFB monthly counts for 20 years). Studies in British Columbia document Steller sea lions returning to historical haul outs after decades of abandonment or extirpation (Bigg 1985).

Only one Steller sea lion was recorded during monthly surveys at North Rocky Point in 2019 (Table 10). However 4 additional animals were observed prior to the rocket launch described in Section 4.3.2. Between the monthly surveys and launch monitoring, the total number is only slightly lower than previous years. No Steller sea lion mortalities were documented in 2019 (R. Evans, pers. comm., 2019).

4.5.5 Incidental Sightings

Two deceased humpback whales (*Megaptera novaeangliae*) and one *Kogia spp.* (either *K. breviceps* or *K. sima*) were found on Vandenberg beaches in 2019. All of these were reported by the Air Force and/or the Channel Islands Cetacean Research Unit (CICRU) to NMFS and to the California Academy of Sciences. Unfortunately, personnel were not available to collect tissue samples from the *Kogia spp.*, thus speciation is uncertain. Tissue samples were collected by CICRU for one of the two humpback whales, though results of that tissue analysis have not yet been made available to VAFB. After obtaining a permit from NMFS, the Air Force is in the process of donating the skull and a few ribs of one humpback whale to the aquarium at nearby Cabrillo High School northwest of Lompoc.

Several incidental sightings of non-pinniped marine mammals or other notable observations occurred during 2019 surveys. One of the more common incidental observation is of southern sea otters (*Enhydra lutris nereis*) which are often detected using the boat harbor kelp bed area. Sea otters documented in this area include: one in February, one in July, one in August, and two in October. Three sea otters were seen near the Little Sal haul out in April.

Whales and dolphins are somewhat common, and if close enough, are recorded to species. In January eight gray whales (*Eschrichtius robustus*) were documented between the boat harbor and Rocky Point. In March seven unknown whale species were documented near the boat harbor area, this day was very windy and ocean conditions made it difficult to identify these animals to species. In April, one mother/calf pair and one additional adult was observed near the Amphitheater haul-out. In June, a total of eight dolphins (likely bottlenose dolphins [*Tursiops truncatus*]) were sighted; five were near Little Sal and three were near South Rocky Point. In July, two dolphins were sighted near South Rocky Point and in August, three dolphins were sighted near the boat harbor.

5 Discussion

5.1 Effects of Natural Factors

Both seasonal and cyclic effects have been discussed in previous documents with haul-out numbers being affected by high tides, strong surf, pupping, breeding, and molting seasons (MMCG & SAIC 2012a and 2012b). Landslides also affect available haul-out locations, such as the continued landslide at Weaner Cove (MMCG & SAIC 2012b), which continues to be monitored (MSRS 2014a, 2015a, CEMML 2016a, 2018). Predation risk from coyotes (*Canis latrans*) can make harbor seals wary of hauling out (Gearin *et al.* 1990; MMCG & SAIC 2012a), causing them to haul out in fewer numbers and quickly reacting to any movement from shore or from the bluffs. Some evidence suggests that there may be an increase in white shark (*Carcharodon carcharias*) predation on harbor and elephant seals in the region, which may be a contributing factor in the declining number of harbor seals observed on VAFB (MMCG & SAIC 2011 and 2012b); however, more study would be required to determine if sharks are having a significant impact on this population. Additionally, elephant seals have become more prevalent at Amphitheatre Cove as they have established rookery (2019 is the third consecutive year with confirmed elephant seal pupping). It is unknown what effect this is having or may have on harbor seals' use of Amphitheatre Cove in the future. Harbor seals are still using this site as a rookery.

5.2 Effects of VAFB Operations

The second SpaceX "boost back" and terrestrial landing occurred at VAFB in 2019. These are likely to become much more frequent in the near future (one Falcon 9 rocket boosted back to an autonomous barge offshore). There was no evidence of injury, mortality, or abnormal behavior as a result of missile launches or of multiple rocket launches including one terrestrial landing. No abnormal activity or mortalities were observed during the active monitoring of three launches this year or during monthly marine mammal surveys. No observations indicated that activities

associated with airfield operations caused any significant effects on pinniped counts, or have caused injury, mortality, or significant abnormal behavior.

6 Conclusion

Three launches required monitoring; all concluded that no abnormal behavior, injuries, or mortalities resulted from launches, the single terrestrial boost-back of a Falcon 9, and associated sonic booms. In prior years, consistent results have been obtained showing no indications of significant disturbances, abnormal behavior, injury, or mortality as a result of launch or aircraft operations. Responses to launches, when they did occur, were short-lived and insignificant. VAFB recommends that we continue to discuss reduction of future monitoring requirements.

Monthly surveys provided routine assessment of potential effects of launch operations on pinniped populations at VAFB. Fluctuations in monthly counts were mostly due to environmental conditions, such as natural landslides and changing tides, rather than the disturbances associated with the launches. Monthly pinniped counts across VAFB show a cyclical, but stable population of harbor seals hauled out on VAFB and an unusually high number of California sea lions hauled out on VAFB during the summer months. Elephant seal pupping continued for a third year in 2019.

7 Literature Cited

- Bigg, M.A. 1985. Status of Steller sea lion (*Eumetopias jubatus*) and California sea lion (*Zalophus californianus*) in British Columbia. Canadian Special Publication of Fisheries Aquatic Sciences 77: 1-20.
- Center for Environmental Management of Military Lands (CEMML). 2019. Marine Mammal Surveys 2019 Annual Report, Vandenberg Air Force Base, California. 14 pp.
- 2016a. Marine Mammal Surveys 2015 Annual Report, Vandenberg Air Force Base, California. 19 pp.
- 2016b. Marine Mammal Surveys 2016 Annual Report, Vandenberg Air Force Base, California. 22 pp.
- Fisheries and Oceans Canada. 2010. Management Plan for the Steller Sea Lion (*Eumetopia jubatus*) in Canada [Final]. Species at Risk Act Management Plan Series. Fisheries and Oceans Canada. vi + 69 pp.
- Gearin, P., M. Johnson, J. Calambokidis, and G. Steiger. 1990. Coyote (*Canis latrans*) Predation and scavenging on Harbor Seal (*Phoca vitulina*) pups. Cascadia Research Collective, Olympia, Washington. Unpublished manuscript.
- Harvey, J.T. and D. Goley. 2011. Determining a correction factor for aerial surveys of harbor seals in California. Marine mammal Science 27(4):719-735.
- Leidos, Inc. 2019. Natural Resources Report: Sonic Boom Modeling and Pinniped Monitoring (of the) 19 January 2019, Delta IV Medium NROL-71 Launch; Space Launch Complex 6 Vandenberg Air Force Base, California. 17 pp.
- MMCG and SAIC. 2011. Annual Report, Monthly Marine Mammal Surveys Vandenberg Air Force Base, California. 1 February 2011 through 31 January 2012.
- MMCG and SAIC. 2012a. Annual Report, Monthly Marine Mammal Surveys Vandenberg Air Force Base, California. 1 February 2012 through 31 January 2013.
- MMCG and SAIC. 2012b. Technical Report: Population Trends and Current Population Status of Harbor Seals at Vandenberg Air Force Base, California. 1993-2012. September 2012. MMCG and SAIC.
- MSRS. 2014a. Marine Mammal Surveys 2013 Annual Report Vandenberg Air Force Base California. 1 March 2013 through 28 February 2014. 17 pp.
- 2014b. Biological Marine Mammal Surveys, September 2014 – October 2014 Quarterly Report, Vandenberg Air Force Base, California. 17 November 2014.
- 2015a. Marine Mammal Surveys 2014 Annual Report, Vandenberg Air Force Base, California. 17 pp. NOTE: See also Annual LOA Reports for 2016-2018.
- 2019a. Pinniped Monitoring for the 11 January 2019 SpaceX Falcon 9 Iridium Next 66-75 Launch from Vandenberg Air Force Base, California. 11 pp.

- 2019b. Biological Monitoring of Pinnipeds for the 12 June 2019 SpaceX Falcon 9 RADARSAT Constellation Mission at Vandenberg Air Force Base, California. 18 pp.
- NOAA, NMFS. 2014. Letter of Authorization issued to U.S. Air Force, VAFB, 30th Space Wing, 26 March 2014. (Expired during the reporting period, but replaced by NMFS 2019a, below)
- NOAA, NMFS. 2017. Letter of Authorization issued to U.S. Air Force, VAFB, 30th Space Wing, 1 February 2017. 7 pp. Note: no longer directly applicable, but “historically relevant” (and cited historically).
- NOAA, NMFS. 2019a. Letter of Authorization issued to U.S. Air Force, VAFB, 30th Space Wing, 10 April 2019. 8 pp.
- NOAA, NMFS. 2019b. Taking Marine Mammals; Taking Marine Mammals Incidental to U.S. Air Force Launches and Operations at Vandenberg Air Force Base, California; Federal Register
- SRS Technologies. 1999. Acoustic Measurement of the 16 September 1997 Peacekeeper and 13 November 1999 Minuteman III Ballistic Missile launches from Vandenberg Air Force Base. SRS Technologies System Development Division, Manhattan Beach, California. 34pp.