

**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 2021**



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 Space Force
Space Launch Delta 30
30 CES/CEIEA
1028 Iceland Avenue
Vandenberg Air Force Base, CA 93437

16 February 2022

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Executive Summary

This report is prepared in accordance with a National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS; also called NOAA Fisheries) five-year Letter 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, 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.

In May 2021, Vandenberg Air Force Base was officially designated Vandenberg Space Force Base (VSFB) and the 30th Space Wing was redesignated 30th Space Launch Delta (or 30 SLD). "Historic" references to VAFB are still found within this document.

This report summarizes results of monthly pinniped surveys in addition to describing pinniped monitoring conducted in association with space vehicle (rocket) and missile launches, together with fixed-wing aircraft, helicopter and unmanned aerial vehicle operations. Species of interest at VSFB included in the LOA are 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 VSFB.

During the reporting period (1 January to 31 December 2021), VSFB launched six rockets and four missiles. One rocket, Firefly Alpha on September 2 2021, suffered a catastrophic failure and was intentionally destroyed about 2 minutes after lift-off. No known impacts of debris into the Pacific Ocean occurred. VSFB avoided launches 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. On-base pinniped monitoring was required for one rocket launch (April 26), no missile launches. Northern Channel Islands pinniped monitoring was required for two Falcon 9 rocket launches on 13 September and 23 November (the latter event was cancelled after the monitoring team deployed to the NCI; they then curtailed their visit and returned to the mainland). There were no first stage recoveries ("boost back") of the Falcon 9 requiring monitoring at VSFB; all three Falcon 9 first stage recoveries landed on an offshore, autonomous barge, west of Baja California, Mexico. During the reporting period, 7,914 operations were conducted from the VSFB airfield. No indications of significant disturbances, abnormal pinniped behavior, injury or mortality were reported as a result of these operations (R. Evans, pers. comm., 2021).

LOA monitoring requirements were followed during 2021 and no incidents of injury or mortality of a pinniped caused by VSFB operations were documented.

1.0 Introduction

This report presents information to satisfy the requirements of the LOA (NOAA 2019a) issued to VSF by NMFS. 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," VSF has agreed to send quarterly advisories and updates to NOAA. These quarterly advisories were submitted in January, April, July and October 2021 (R. Evans, pers. comm., 2021).

Historically, Pacific harbor seals (*Phoca vitulina*; hereafter harbor seal) have been the most abundant pinnipeds on VSF, at least during most months. In recent years, northern elephant seals (*Mirounga angustirostris*; hereafter elephant seal) are present in higher numbers than harbor seals in most months and California sea lions (*Zalophus californianus*) are often present in large numbers in the early summer. Steller sea lions (*Eumetopias jubatus*) are also present, albeit rarely; all species except Steller sea lions increasing in recent years (MSRS 2014, CEMML 2016a, CEMML 2016b). For about 4 years, between 2016 and 2019, very large numbers of juvenile California sea lions were observed near South Rocky Point (Figure 1) in the early summer months, however this did not occur in 2020 or 2021 for unknown reasons. During the latter half of 2016 and throughout 2019, elephant seal numbers had a marked increase and in 2017 established a rookery at Amphitheater Cove. Elephant seal pups were first documented in January 2017, again observed in January-March, all years 2018-2021. The revised 2017 LOA (NOAA 2017), required launch monitoring of the elephant seal rookery beginning 01 January 2018. 2021 is the first year where a second, small rookery was established at "Boathouse Beach" on South VSF; two pups were born and weaned, whereas more than 40 were born and weaned at "Amphitheater," which is located approximately 2 miles northwest.

Potential impacts to pinnipeds on VSF include harassment from noise, particularly sonic booms, generated from rocket or missile launches, SpaceX Falcon 9 boostback to land (return of the first stage of the rocket for later re-use, which did not occur in 2021), or aircraft noise, 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, though this has not been observed at VSF. 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 2021 reporting period, monitoring on the Northern Channel Islands (NCI) was required for one launch (SpaceX Falcon 9 in September). Monitoring on VSF was required for one rocket (Delta IV-Heavy in April). This report describes the methods and results of the marine mammal monitoring efforts and discusses the impacts of Air Force/Space Force operations. A new commercial launch entity, Firefly Space, began operations at Space Launch Complex 2 (SLC-2) in calendar year 2021. Other new entities plan to initiate operations at facilities to include SLC-8, SLC-11 and SLC-5 in 2022 or early 2023.

In 2021, Space Exploration Technologies (SpaceX) continued conducting their "boost-back" action, however all such actions in 2021 landed on an offshore, autonomous barge; this action

results in no noise impacts to the mainland or the Channel Islands. The first stage of the rocket is then refurbished and re-used. Starting in 2022 or 2023, significant modifications will be initiated at SLC’s 3 and 6 for new rocket types and perhaps new launch proponents. Test Pad 01 (TP-01) was used for one launch of a very small rocket in 2020 and a missile test in 2021. At least three other existing facilities (TP-01, LF-576E and SLC-8) are also planned for new programs and launch proponents in the next few years, as forecasts for more satellite and micro-satellite “constellations” are now commonplace. The formerly dormant SLC-5 will be reconfigured for a new program in the next 1-3 years, and the construction of two new SLC’s, tentatively named SLC-9 and SLC-11 are under consideration.

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 which occurred in 2021 are detailed below. The locations of launch sites in relation to pinniped haul-out areas on VAFB are shown in Figures 1 and 2.

2.1 Rocket Launches

Six rocket launches occurred during the reporting period (Table 1).

Table 1. Rocket Launches in 2021

Vehicle Type	Facility	Launch Date
Delta IV-Heavy	SLC 6	26 April
Firefly Alpha ¹	SLC-2	3 September
Falcon 9 ²	SLC-4	14 September
Atlas V	SLC-3	27 September
Falcon 9 ²	SLC-4	24 November
Falcon 9 ²	SLC-4	18 December

¹ Catastrophic failure, refer to text

² Included “boost back” and landing to an off-shore autonomous barge

2.2 Missile Launches

Four missile launches occurred during the reporting period from Launch Facilities LF-09, LF-10, LF-24 and TP-01 (Table 2); all of these facilities are on north VAFB. The locations of these sites in relation to pinniped haul-out areas on VAFB are shown in Figure 2. Two launches were unarmed Minuteman III (MM-III) Intercontinental Ballistic Missile (ICBM) test launches, one was a Missile Defense Agency Ground-Based Midcourse Defense Test and one was a test of the new Precision Strike Missile.

Table 2. Missile Launches in 2021

Missile Type	Facility	Launch Date
MM III GT-237GM	LF-10	24 February
MMIII GT-239GM	LF-09	11 August
GM BVT-03	LF-24	12 September
EDT-2	TP-01	13 October

2.3 Fixed-wing Aircraft and Helicopter Operations

Various types of fixed-wing aircraft fly from VSF. 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.

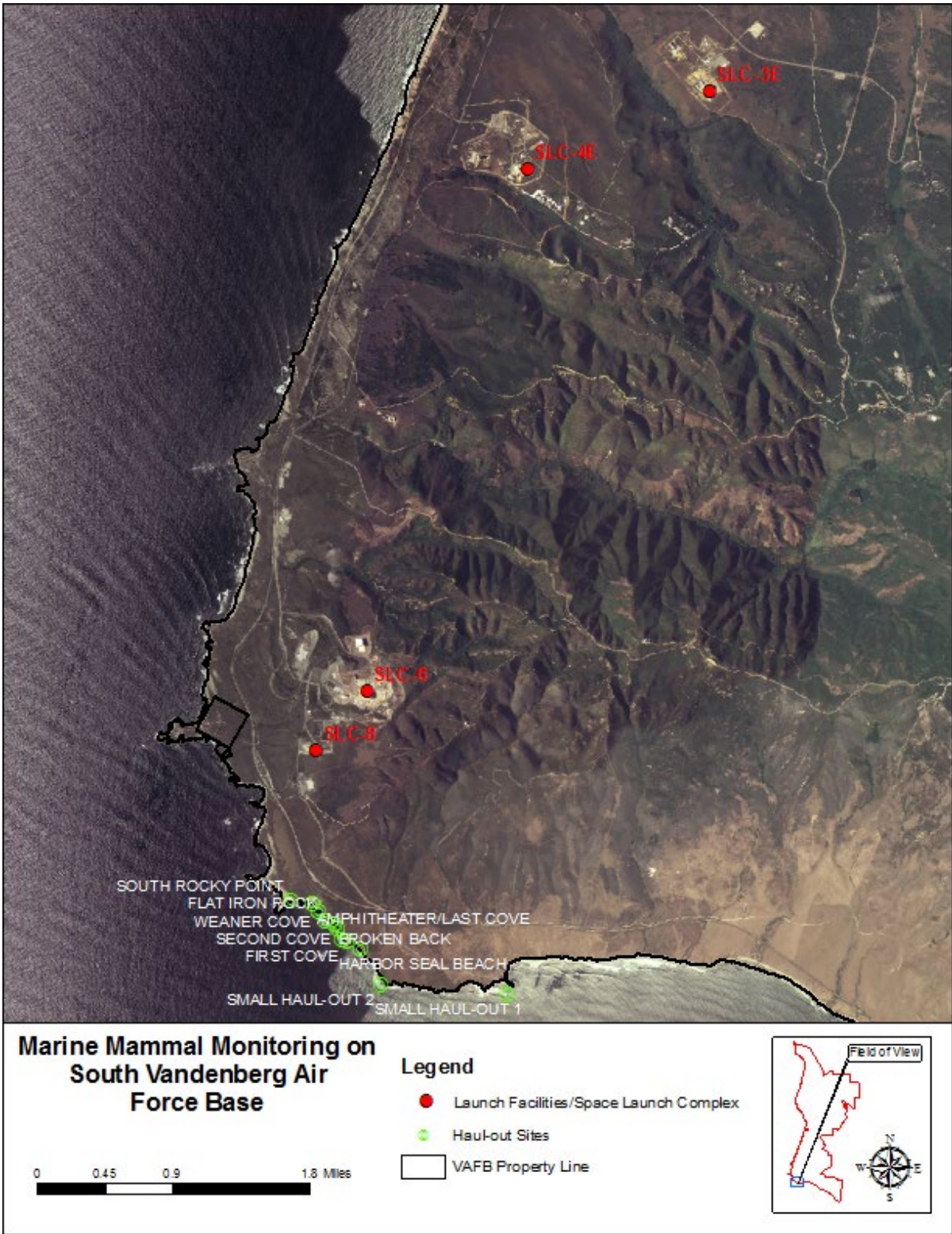


Figure 1. Launch Sites and Pinniped Haul-out Areas on South VSFB.

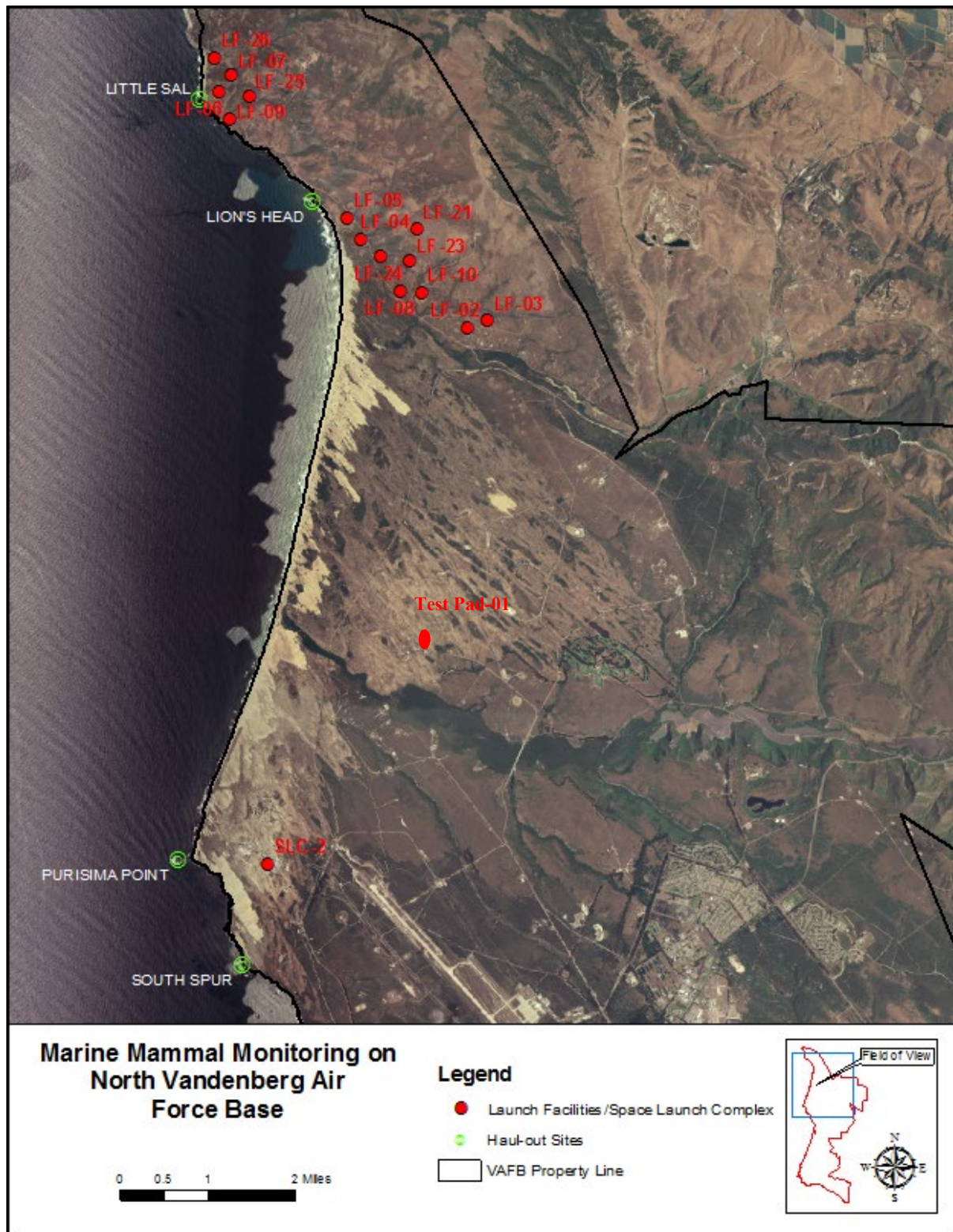


Figure 2. Launch Sites (many inactive) and Pinniped Haul-out Areas on North VSFB.

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 launches because these vehicles are launched with a westward trajectory and their sonic booms do not impact marine mammal haul-outs on VSF 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. Monitoring on NCI was not required in 2020.

Acoustic monitoring is also required on VSF for the landing of the Falcon 9 first stage (boostback) at SLC 4-W. Acoustic monitoring on south VSF was required for the November Falcon 9 launch.

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 pounds per square foot (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 VSF 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, VSF 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 on VSF.

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 VSF 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 VSF, 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 VSF include Amphitheater Cove and may include North and South Rocky Point (Figure 1). Amphitheater 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 VSF, direct observations during launch events are usually not allowed due to safety concerns; therefore video is utilized during daytime launches on VSF to record the reactions of pinnipeds to the launch. Post-launch, the video equipment is collected and video reviewed with responses noted such as alert or flushing into the water. 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 recording length allows.

3.4 Fixed-wing Aircraft and Helicopter Operations

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

3.5 Monthly Surveys

The Center for Environmental Management of Military Lands (CEMML) and U.S. Air Force / Space Force personnel, 30th Civil Engineer Squadron (30 CES) biologists surveyed marine mammal haul-out sites on North and South VSF (Figures 1 and 2) monthly from January to December 2021 (except in July, refer to “Results” in section 4.5). For each survey, high quality binoculars and/or a spotting scope are utilized depending on conditions. Monthly surveys are ideally 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 VSF, most observations are made from cliffs overlooking haul-outs. Purisima Point has been omitted from all surveys throughout 2015-2021 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 VSFB (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 (Amphitheater, South Rocky, and North Rocky). In 2021, 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, two monitoring efforts were required during 2021. Launch mitigation requirements are presented in Table 3 and discussed in detail in the following subsections.

Table 3. Launch Monitoring Requirements in 2021¹

Rocket or Missile	Launch Date	NCI	VSFB	Video	Video Result	Boom Model
Delta IV-Heavy	26 April		Required	Required	Success	Required
Falcon 9-Starlink	14 September	Required		Required	Success	Required

¹ Blank Cell = action not required.

4.1 Sonic Boom Modeling

Sonic boom modeling was conducted for all rocket launches that occurred during the 2021 reporting period. The boom model predicted impacts that would require monitoring on the NCI for only the 14 September Falcon 9-Starlink launch, and the launch scheduled for November, which was postponed to 2022.

4.2 Acoustic Monitoring

Modeling predicted sonic booms would impact the NCI as a result of one launch during the 2021 reporting period, however, as discussed in additional detail below, no boom was actually recorded (we surmise that a boom impacted the “broad ocean area” south of NCI).

4.3 Launch Monitoring

Two launches required monitoring during the 2021 reporting period. One launch required monitoring on VSFB, and one on NCI. Full details of the monitoring for those launches can be found in the respective launch and landing monitoring report sent to NMFS previously (AECOM 2021; MSRS, 2021), summaries follow.

4.3.1 Delta IV – Heavy (NROL-82)

One launch of the Delta IV-Heavy rocket occurred in the reporting period, carrying a National Reconnaissance Office satellite. Sonic boom modeling determined that the launch would not generate a boom in excess of 1.0 psf that would impact the NCI, therefore monitoring on NCI was

not required. However, because the launch occurred during VSFB pupping season, on-base monitoring was required.

The Delta IV-Heavy launch (AECOM, 2021) occurred at 1347 hours on 26 April. Video recording of the pinnipeds during the launch was successful.

Monitoring at VSFB was conducted at all haul-outs between North Rocky Point and Small Haul-Out 2, with a focus on South Rocky Point and Amphitheater Cove. Pre-launch counts were recorded several times per day, from 23-25 April. Post launch surveys were conducted 27-28 April. Detailed counts are presented in AECOM 2021.

Elephant seal pre-launch counts ranged from 165-171 adults and juveniles. Post-launch counts ranged from 158-175 adults. Harbor seal counts ranged from 1-59 before and 14-59 after the launch (an average of 67 percent of all harbor seals were adults).

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

4.3.2 Falcon 9 (Starlink 2-1)

A SpaceX Falcon 9 launch on 13 September required monitoring on the Northern Channel Islands. Because the launch occurred outside of all pinniped pupping seasons, no monitoring on VSFB was required. Because this launch included boost-back of the first stage to an autonomous barge located west of Baja California (Mexico), no monitoring of the boost-back and landing was required.

The launch occurred at 2055 Pacific Daylight Time (MSRS 2021a). Although the sonic boom model predicted a sonic boom greater than 4.0 psf could impact the NCI, no boom resulting from the actual launch was detected.

Pre-launch counts of California sea lions ranged from 581-826; post-launch counts ranged from 705 and 848. Northern elephant seal pre-launch counts ranged from 48-63 with post-launch counts ranging from 60-87. No reaction from either species was observed. No injury or mortality to any individual pinniped was observed.

4.3.3 Falcon 9

A SpaceX Falcon 9 launch was scheduled for 23 November 2021. A pinniped monitoring team was deployed to San Nicolas Island three days before the scheduled launch. The launch was then cancelled (rescheduled in calendar year 2022) and the team returned to the mainland. No formal data was collected or reported.

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

During the reporting period, 7,914 operations were conducted from the VSFB airfield. Most of these consisted of overflights or training and proficiency flights involving practice approaches

and touch and goes. VSFB had 520 operations that 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 total number of take-offs and landings (including touch and goes) was 3425; additionally, 4005 overflights below 2,500 feet in altitude (but not above the coastline), and 454 Unmanned Aerial Systems (“drone”) operations were recorded. Distinguished Visitor flights included the United States Space Force Commander. No indications of significant disturbances, abnormal pinniped behavior, injury, or mortality were reported as a result of these operations (R. Evans, pers. comm. 2021).

4.5 Monthly Marine Mammal Surveys

Monthly surveys were conducted throughout 2021. No survey was completed in the month of July due to staffing availability, disadvantageous tides and the COVID 19 pandemic. 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 VSFB from 2014-2021.

4.5.1 Pacific Harbor Seal

Harbor seals use many of the locations along the VSFB coastline to haul out throughout the year. Harbor seals regularly utilize Amphitheater Cove as a rookery, give birth and nurse young 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 2021 varied from a low of 18 in August to a high of 149 in June (Table 4), with an average monthly count of 65 for the survey period. Pups were observed in March, April, May and June, with a peak of 23 in April 2021. No harbor seal mortalities were detected in 2021, however 2 “unknown pinniped” mortalities were reported to NMFS (unknown due to scavenging and advanced decomposition).

On North VSFB, the Spur Road haul out had the most individuals observed with a peak of 21 in February 2021 (Table 6) and Lion’s Head had the least individuals observed. On South VSFB, Amphitheater consistently had the most individuals observed. Amphitheater had a peak of 105 in June 2021 (Table 6). East Islet was not surveyed; South Arguello Ridge was occupied by harbor seals (6 animals) only one month (June 2021). North Rocky Point, South Rocky Point, First Cove and Harbor Seal Beach were among several surveyed locations with no harbor seals recorded.

Table 4. 2021 Monthly Pacific Harbor Seal Survey Results.

Month	Adult[^]	Juvenile[^]	Pup[^]	Total[^]
January	94	0	0	94
February	99	0	0	99
March	142	0	20	120
April	95	3	35	133
May	80	0	15	95
June	217	12	0	229
July¹				
August	28	0	0	28
September	39	15	0	54
October	62	8	0	70
November	99	2	0	101
December	34	0	0	34

[^]Numbers reflect 1.54x correction factor

1-Survey not completed in July, refer to text

There has been significant variation in the number of harbor seals utilizing Amphitheater Cove from 2014 through 2021 (Table 5). A drastic increase occurred from 2014 to 2015 and a decrease occurred from 2016 to 2021. This is not a product of survey intensity as a survey was conducted nearly every month for all 8 years at Amphitheater Cove. One explanation could be the increased use of Amphitheater 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 2020 the harbor seal numbers decreased dramatically and the elephant seal numbers dramatically increased, a significant increase was noted in 2021. It is not directly known if use of Amphitheater by elephant seals is affecting the number of harbor seals utilizing the site, or if another unknown factor is contributing to this affect. In 2017-2021, both harbor seals and elephant seals utilized the Amphitheater haul out for giving birth and weaning pups.

Table 5. Historic Pacific Harbor Seal and Northern Elephant Seal Survey Results at Amphitheater 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)
2020	32	382	77 (April)	78	930	302 (May)
2021	57	685	162 (June)	85	931	195 (May)

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

Table 6. 2021 Monthly Pacific Harbor Seal Results by Haul-Out (North to South).

Haul-Outs	Jan	Feb	Mar	Apr	May	Jun	Jul ¹	Aug	Sep	Oct	Nov	Dec
Little Sal	0	0	0	0	0	9	0	0	3	3	6	0
Lion's Head	6	8	0	0	0	8	0	0	0	0	0	6
Purisima Point	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Spur Road	23	32	14	9	9	5	0	26	12	0	28	12
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
Amphitheater	43	26	123	99	69	162	0	2	39	55	34	34
Weaner Cove	0	0	0	0	0	0	0	0	0	0	9	9
Flat Iron Rock	0	0	0	0	35	119	0	0	0	0	8	8
Broken Back	0	0	0	0	0	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	0	0	0	0	0	0	0	0	0
First Cove	0	0	0	0	0	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	17	17	14	18	14	6	0	0	0	11	14	72
Small Haul Out 1	5	15	11	8	3	5	0	0	0	0	2	8
Total	94	99	162	134	95	229	0	28	54	69	100	149

¹Numbers reflect 1.54x correction factor, rounded to nearest whole number

*NS = Not Surveyed

1-NO surveys conducted in July, refer to text.

4.5.2 Northern Elephant Seal

Elephant seals historically hauled out in low numbers on VSFB 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 for the decade at 191 individuals, primarily 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, 919 in 2018, 1,345 in 2019 and 1,396 in 2020. This trend showed a minor decrease in 2021 (no surveys were completed in July, refer to section 4.5), with a total of 1,015 elephant seals detected during 2021 surveys (Table 7). These numbers peaked in May with 280 elephant seals counted. One confirmed elephant seal mortality (May) and one suspected elephant seal mortality (April) were documented and reported to NMFS (R. Evans, pers. comm., 2021). No formal surveys occurred at Point Conception in 2021, primarily due to access restrictions deemed necessary by The Nature Conservancy, land managers for the Jack and Laura Dangermond Preserve (which is located between VSFB and Point Conception).

Table 7. 2021 Monthly Northern Elephant Seal Results.

Month	Adult	Juvenile	Pup	Total
January	50	0	26	76
February	10	0	33	43
March	0	10	28	38
April	0	66	0	66
May	0	237	0	237
June	0	51	0	51
July ¹	0	0	0	0
August	5	6	0	11
September	65	16	0	81
October	190	10	0	200
November	118	0	0	118
December	94	0	0	94

1- No surveys completed in July, see text

Elephant seal pupping was first documented at Amphitheater 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, 31 in 2019, 34 in 2020 33 in 2021. Since 2018, the Air Force has conducted additional surveys of Amphitheater Cove in order to document pupping in late December and early January with intent to record the first pup each season, which we then compare to other regional pupping locations. As of early 2021, we have not observed elephant seal pups on any Vandenberg rookery earlier than 3 January.

In early March 2019, VSFB 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) obtained a permit under her name (#22187); her team tagged 34 elephant seal pups on 29 February 2020; and 35 tagged in late Feb 2021. A fourth year of tagging is planned for late February 2022, and VSFB has secured funding for a three-year satellite telemetry tagging project in cooperation with Dr. Liwanag, which will start in 2022.

4.5.3 California Sea Lion

During 2021, the highest number of California sea lion observations was 72 adults and juveniles in June (Table 8). This is a very significant decrease from 2019, for unknown reasons (Table 9). Typically California sea lions haul out at North Rocky Point, recently with more frequent hauled-out individuals observed at Amphitheater and South Rocky Point. The large increase in sub-adult California sea lion counts, as seen in 2018 and 2019 (Table 9) did not occur in 2021, for reasons unknown (but not believed to be in any way related to Vandenberg operations).

Table 8. 2021 Monthly California Sea Lion Results.

Month	Adult	Juvenile	Pup	Total
January	11	0	0	11
February	9	0	0	9
March	1	0	0	1
April	2	0	0	2
May	9	0	0	9
June	72	0	0	72
July ¹	0	0	0	0
August	1	0	0	1
September	2	0	0	2
October	2	0	0	2
November	17	0	0	17
December	2	0	0	2

1-Surveys were not completed in July, refer to text

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)
2020	14	167	62 (July)
2021	12	126	72 (June)

Historically, stillborn pups have been 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, from 2017-2019, the Air Force 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. Also as noted above, this phenomenon did NOT reoccur in 2020 or 2021.

In 2021, 7 California sea lion mortalities were confirmed and reported, and four additional “unknown pinniped, likely California sea lion” mortality reports were submitted, when either decomposition or distance (e.g. only viewed through binoculars) prevented certain identification. This contrasts greatly with 2019, in which more than 80 California sea lions were found dead on VSFb beaches, and more than 1,600 were found dead between San Luis Obispo and Orange Counties (NMFS, J. Greenman, 2019, unpublished data). These deaths 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 VSFb at North Rocky Point in April 2012 during a monthly count (MMCG and SAIC 2013). Since May 2012 they have been observed irregularly 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).

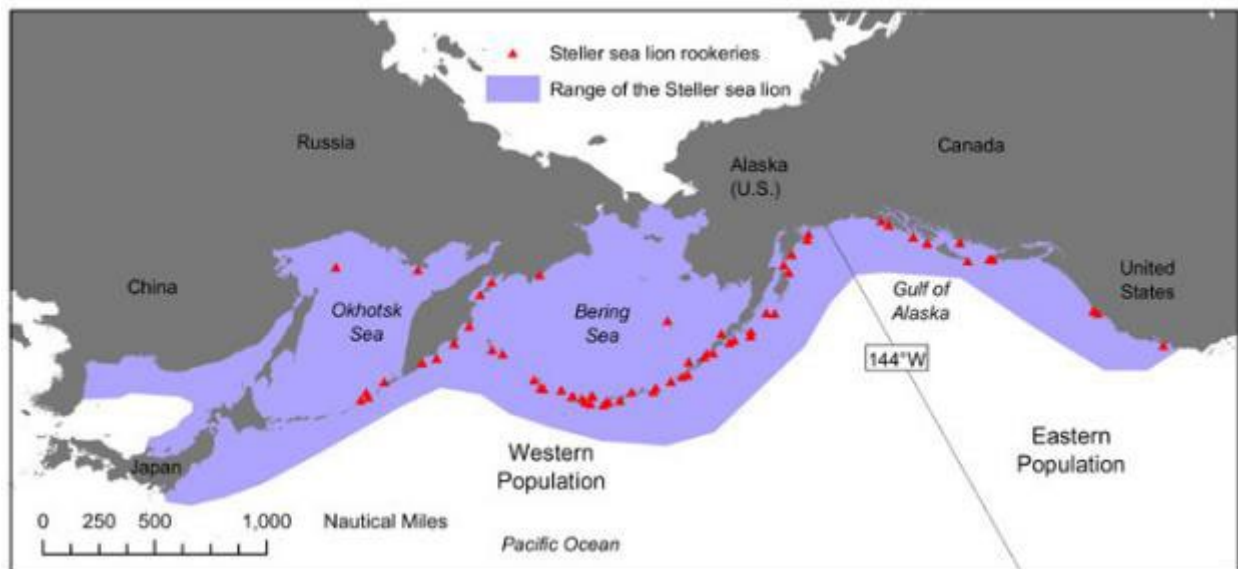


Figure 3. Steller Sea Lion Range and Rookeries (Alaska Fisheries Science Center 2015).

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 VSFB 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).

No Steller sea lions were observed during 2021 monthly surveys on VSFB. No Steller sea lion mortalities were documented in 2021 (R. Evans, pers. comm., 2021).

4.5.5 Incidental Sightings

Two deceased delphinids, one believed to be a white sided-dolphin (April) and 1 (presumed) bottlenose dolphin (October), were found on Vandenberg beaches in 2021. Also, one humpback whale was found near Jalama Beach in late September; this carcass was apparently washed out to sea by tides and then was most likely washed up again on south Minuteman Beach, about 20 miles upcoast, as in November, a “badly decomposed” humpback was found at the second location. Vandenberg reported all of these mortalities to NMFS.

Several incidental sightings of non-pinniped marine mammals or other notable observations occurred during 2021 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: two in April (during Delta IV-Heavy monitoring).

5.0 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 2014, 2015, 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 VSFB (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 Amphitheater Cove as they have established rookery. It is unknown what effect this is having or may have on harbor seals' use of Amphitheater Cove in the future; they continue to use this site as a rookery.

5.2 Effects of VSFB Operations

No SpaceX “boost back” and terrestrial landings occurred at VSFB in 2021. These are likely to become more frequent in the near future, with at least four planned for 2022. There was no evidence of injury, mortality, or abnormal behavior as a result of missile or any rocket launches. No abnormal activity or mortalities were observed during the active monitoring of **one** rocket launch 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.

6.0 Conclusion

Two rocket launches required monitoring; both concluded that no abnormal behavior, injuries, or mortalities resulted from the launch of the Delta IV-Heavy or the Falcon 9-Starlink, and their 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. VSFb 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 VSFb. 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 VSFb show a cyclical, but stable population of harbor seals hauled out on VSFb and an unusually high number of California sea lions hauled out on VSFb during early summer months, however not in 2021. Elephant seal pupping continued for a fifth year

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