



Final

**Environmental Impact Statement
for Authorizing Changes to the
Falcon Launch Program at
Vandenberg Space Force Base, California
Appendices (Volume I)**

October 2025

Unique Identification Number: EISX-007-57-USF-1728547807

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for Authorizing Changes to the Falcon
Launch Program
at
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Appendices (Volume I)

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APPENDIX B: UNITED STATES FISH AND WILDLIFE SERVICE CONSULTATION (partial)

APPENDIX A
State Historic Preservation Office and Native American Tribal
Consultations



DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 30

Ms. Laura L. Miz
Deputy Base Civil Engineer
30th Civil Engineer Squadron
1172 Iceland Ave
Vandenberg SFB, CA 93437-6011

Ms. Julianne Polanco
State Historic Preservation Officer
Department of Parks and Recreation
Office of Historic Preservation
P.O. Box 942896
Sacramento CA 94296-0001

Dear Ms. Polanco

Space Launch Delta (SLD) 30 of the United States Space Force, Vandenberg Space Force Base (VSFB), in cooperation with SpaceX proposes to demolish several buildings and remove structures from Space Launch Complex (SLC)-6 in the South Base portion of VSFB in Santa Barbara County, California (Figures 1-3). The buildings and structures proposed for demolition include the mobile service tower (MST, Building 390A), mobile assembly shelter (MAS, Building 360), the fixed umbilical tower (FUT, Building 390C), and the launch crown (Building 391: Figure 4). The SLD 30 Range Safety Engineer determined that these structures pose a safety risk for personnel conducting engineering studies and analysis at the site due to the potential for loose debris to drop from fatal heights, stairway infrastructure failing while under personnel load, and overall building stability.

The purpose of the *SLC-6 Demolition Project* is to remove the safety risk to personnel at SLC-6 and is needed to meet the safety requirements for evaluation activities on VSFB, including AFSPCMAN 91-710, Occupational Safety and Health Administration (29 Code of Federal Regulations Part 1960 subpart 1910), and California Division of Occupational Safety and Health. The proposed project would reduce this risk by removing these structures.

Project activities will entail demolishing the buildings to the concrete slab. Concrete slabs would be left in-place. All work will take place on existing hardscaped surfaces and all material will be hauled offsite and disposed of or recycled in accordance with applicable Federal, state, interstate, and local laws.

The Department of the Air Force (DAF) carried out a reasonable and good-faith cultural resources investigation that fulfills federal agency responsibilities pursuant to 36 CFR 800.4(a)-(d) and 36 CFR 800.5(a)-(d). The Area of Potential Effects (APE) includes the Area of Direct Impact (ADI) plus any cultural resources that intersect the ADI. The ADI is confined to

previously graded, disturbed, and paved areas at SLC-6. The effort to identify historic properties included a review of previous surveys and cultural resources recorded within a 1,000-ft radius of the ADI.

Based on the results of the background research, no archaeological deposits exist within or immediately adjacent to the ADI. SLC-6 was first constructed in 1966 as a space launch site, but never finished. In 1979, it was redeveloped for the West Coast Space Shuttle Program. SLC-6, including the buildings this project intends to demolish, has been previously determined not eligible for the National Register of Historic Places (NRHP) with California State Historic Preservation Officer (SHPO) concurrence (SHPO File #USAF_2020_1109_001).

Given the results of background research, DAF concluded that demolishing the MST (Building 390A), MAS (Building 360), FUT (Building 390C), and launch crown (Building 391) will not affect any historic properties because none exist within the ADI. Archaeological sensitivity in the ADI is very low due to extensive ground disturbance which has occurred from decades of past development at SLC-6.

Per §800.3(c-f), the DAF is consulting with the SHPO on its findings. The DAF presents the following federal agency determinations for concurrence from the SHPO:

- a. The APE for the *SLC-6 Demolition Project* is adequately delineated; and
- b. The undertaking will have *no effect* on historic properties.

Pending concurrence with our above determinations, the DAF has reached a Section 106 finding of *no effect* for this undertaking. Excluding objection to this finding by the SHPO, the DAF has fulfilled its Section 106 responsibilities for this undertaking and no further consultation is required.

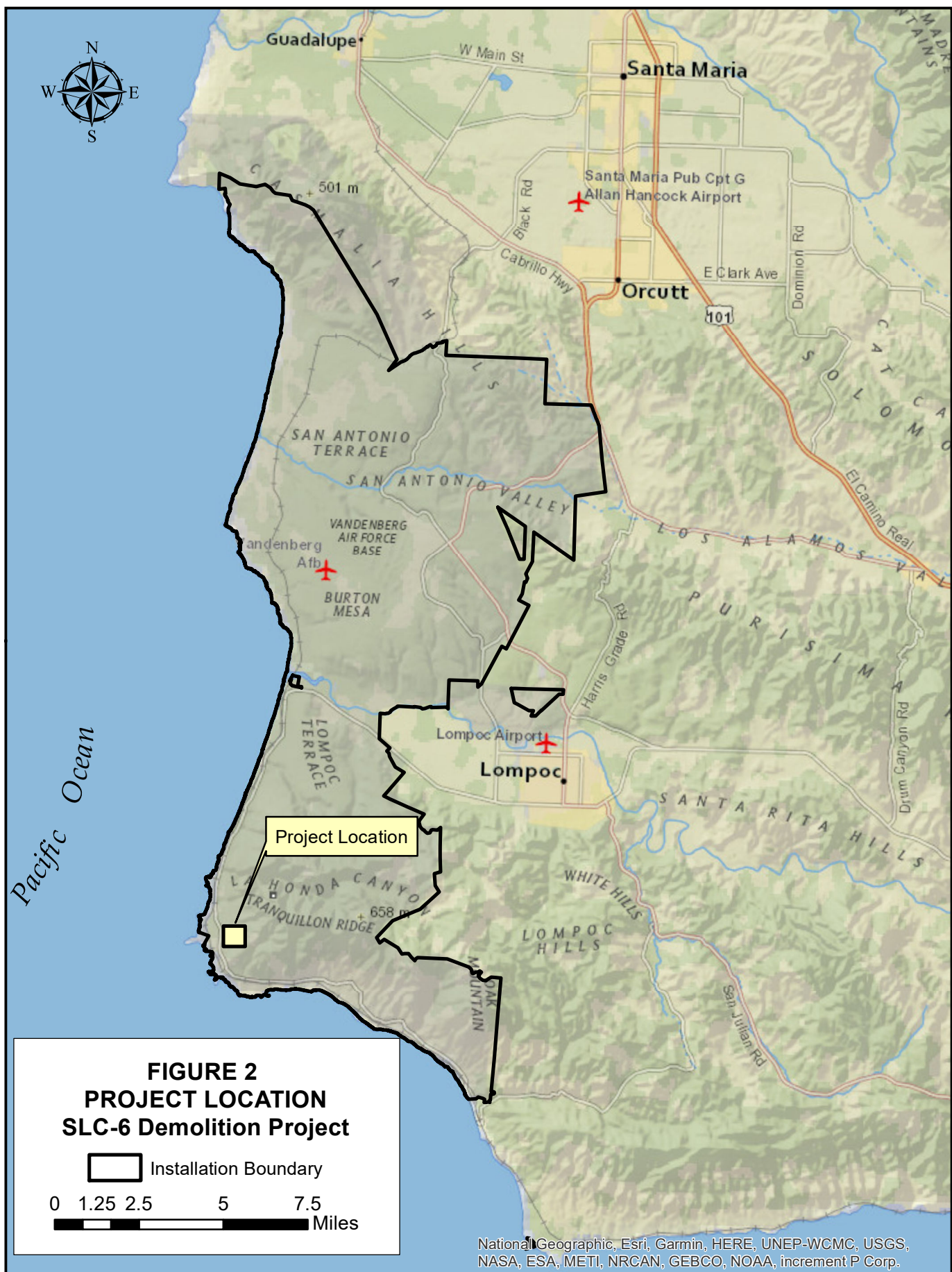
If you have any questions or require additional information, please contact Eric Nocerino, 30 CES/CEIEA, 1028 Iceland Avenue, Building 11146, Vandenberg SFB; phone: 720-883-6507; e-mail: eric.nocerino@spaceforce.mil. Thank you for your assistance with this undertaking.

Sincerely

LAURA L. MIZ
Deputy Base Civil Engineer

Attachment: Figures 1-4





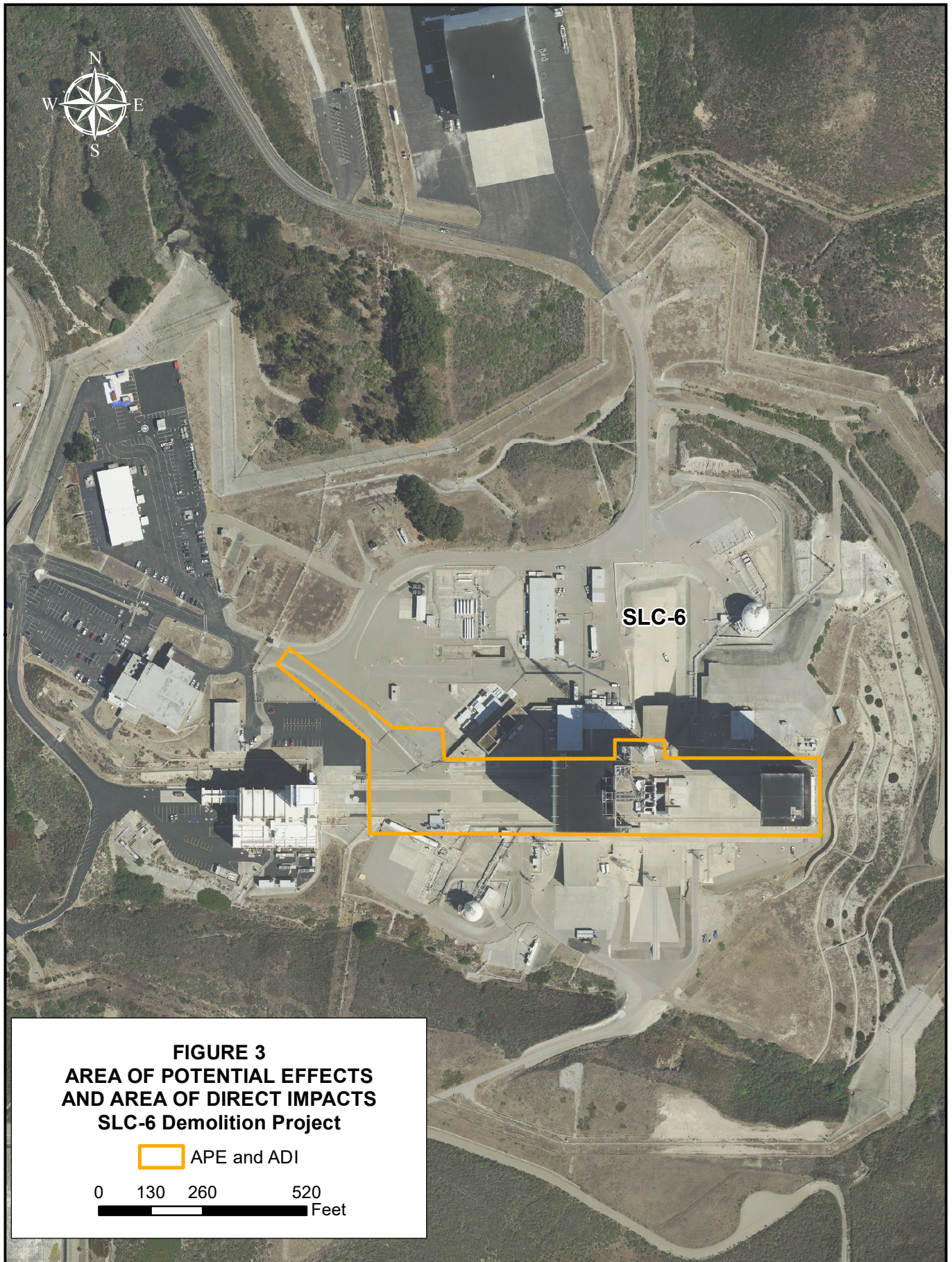
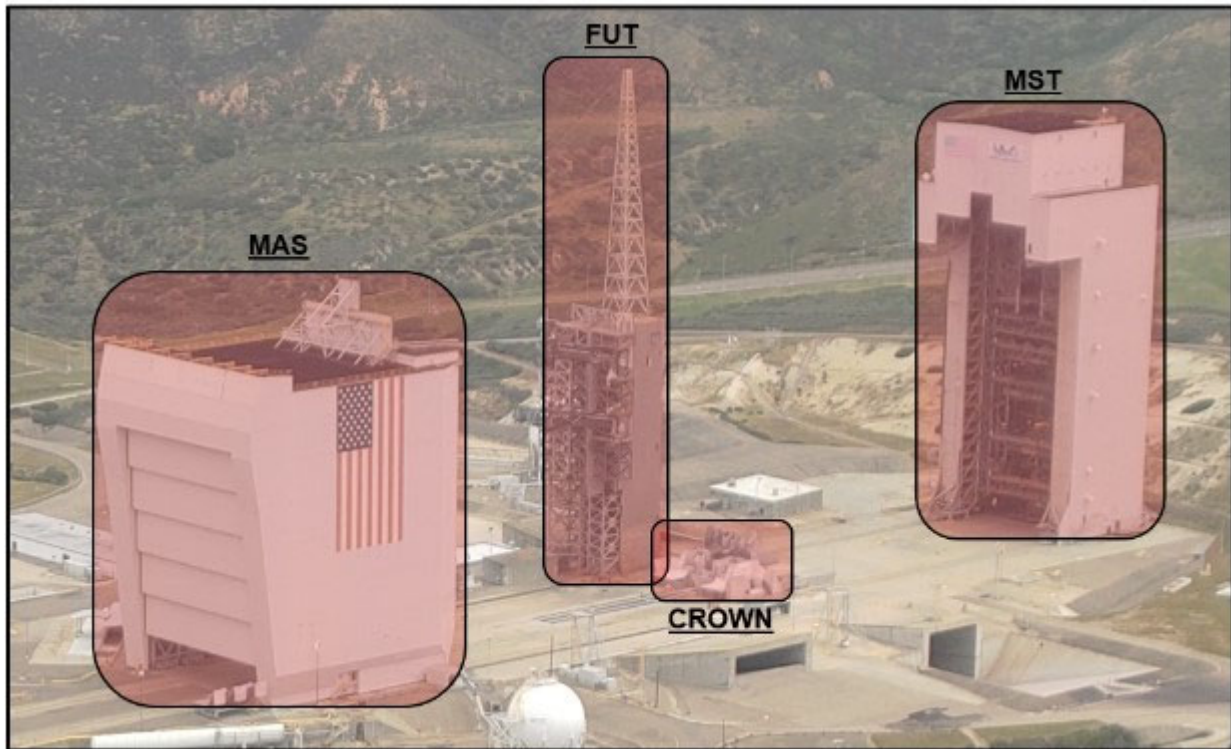


Figure 4: Buildings and Structures Proposed for Demolition





**DEPARTMENT OF PARKS AND RECREATION
OFFICE OF HISTORIC PRESERVATION**

Armando Quintero, Director

Julianne Polanco, State Historic Preservation Officer

1725 23rd Street, Suite 100, Sacramento, CA 95816-7100

Telephone: (916) 445-7000

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calshpo.ohp@parks.ca.gov

www.ohp.parks.ca.gov

October 16, 2024

Reply in Reference to: USAF_2024_0917_001

Ms. Laura L. Miz
Deputy Base Civil Engineer, 30th Civil Engineer Squadron
1172 Iceland Avenue
Vandenberg AFB, CA 93437-6011

VIA ELECTRONIC MAIL

Re: Section 106 Consultation for Space Launch Complex 6 Demolition, Vandenberg Space Force Base, Santa Barbara County

Dear Ms. Miz:

The United States Air Force (USAF) is initiating consultation with the State Historic Preservation Officer (SHPO) regarding its effort to comply with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. 306108), as amended, and its implementing regulation found at 36 CFR Part 800.

For safety purposes, the USAF are proposing to demolish and remove several buildings associated with the Space Launch Complex 6 at Vandenberg Space Force Base. All structures will be demolished to their concrete slabs, which will subsequently be left in place. A complete project description may be found in the USAF's supporting documentation.

In 2020, Space Launch Complex 6 was formally determined not eligible for NRHP inclusion and the project area is characterized as having low sensitivity for archeological resources.

The USAF are requesting concurrence with their APE definition and a finding of no historic properties affected. Upon review of the information provided, the SHPO has the following comments:

1. The SHPO has no objection to the USAF's area of potential effects definition.
2. The SHPO concurs with the USAF's finding of no historic properties affected. Be advised that under certain circumstances, such as an unanticipated discovery or a change in project description, the USAF may have future responsibilities for this undertaking under 36 CFR Part 800.

October 16, 2024

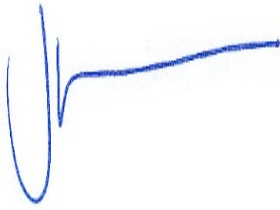
USAF_2024_0917_001

Ms. Miz

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This letter is being sent in electronic format only. Please confirm receipt of this letter and notify Ed Carroll, Historian II, at Ed.Carroll@parks.ca.gov or 916-503-8466 if there are any questions or to request a hard copy of this letter.

Sincerely,

A handwritten signature in blue ink, consisting of a large, stylized 'J' followed by a horizontal line that extends to the right.

Julianne Polanco
State Historic Preservation Officer

**DEPARTMENT OF PARKS AND RECREATION
OFFICE OF HISTORIC PRESERVATION**Armando Quintero, *Director*

Julianne Polanco, State Historic Preservation Officer

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calshpo.ohp@parks.ca.gov

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February 6, 2025

Reply in Reference to: USAF_2025_0116_002

Ms. Laura L. Miz

Deputy Base Civil Engineer, 30th Civil Engineer Squadron

1172 Iceland Avenue

Vandenberg AFB, CA 93437-6011

VIA ELECTRONIC MAIL

Re: Section 106 Consultation for SpaceX SLC-4 and SLC-6 Increased Launch Cadence and Modifications, Vandenberg Space Force Base, Santa Barbara County

Dear Ms. Miz:

The United States Air Force (USAF) is initiating consultation with the State Historic Preservation Officer (SHPO) regarding its effort to comply with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. 306108), as amended, and its implementing regulation found at 36 CFR Part 800.

According to their consultation letter, the USAF are proposing to “modify Space Launch Complex (SLC)-6 and increase launch cadence at both SLC-4 and SLC-6” at Vandenberg Space Force Base. The letter clarifies that no modifications or new construction is proposed at SLC-4. A complete project description may be found in the USAF’s supporting documentation.

In 2020, SLC- 6 was formally determined not eligible for NRHP inclusion. Archeological identification efforts revealed that Native American archaeological sites CA-SBA-1114 and CA-SBA-1941 are within the APE, however these sites were formally determined not eligible in 2021. Subsurface testing efforts at SLC-6’s landing zone were negative and no response from the Santa Ynez Band of Chumash Indians have been received to date

The USAF are requesting concurrence with their APE definition and a finding of no historic properties affected. Upon review of the information provided, the SHPO has the following comments:

1. The SHPO has no objection to the USAF’s area of potential effects definition.
2. The SHPO concurs with the USAF’s finding of no historic properties affected. Be advised that under certain circumstances, such as an unanticipated discovery or

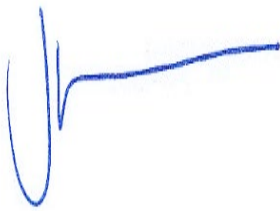
February 6, 2025
Ms. Miz
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USAF_2025_0116_002

a change in project description, the USAF may have future responsibilities for this undertaking under 36 CFR Part 800.

This letter is being sent in electronic format only. Please confirm receipt of this letter and notify Ed Carroll, Historian II, at Ed.Carroll@parks.ca.gov or 916-503-8466 if there are any questions or to request a hard copy of this letter.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Julianne Polanco', with a stylized flourish extending to the right.

Julianne Polanco
State Historic Preservation Officer

From: [SMALLWOOD, STACY J CIV USSF SSC 30 CES/CEIEA](#)
To: ["Wendy Teeter"](#)
Cc: [Crystal Mendoza](#); [Nakia Zavalla](#); [CRM Consultation](#); [Edgar Alvarez](#); [Samuel Cohen](#); [NOCERINO, ERIC CIV USAF SSC 30 CES/CEIEA](#); [KAISERSATT, SAMANTHA O CIV USSF SSC 30 CES/CEIEA](#); [Polanco, Julianne@Parks](#)
Subject: RE: [Non-DoD Source] RE: {EXTERNAL} 106 Vandenberg SpaceX SLC-4/SLC-6 Project (813-23-082)
Date: Friday, February 7, 2025 2:06:00 PM

Dear Wendy,

The SHPO responded yesterday with concurrence on our delineation of the APE and finding of *no historic properties affected* for the above-referenced SpaceX Project.

I still need to hear back from the Tribe. As I asked before, can the Tribe identify any effects resulting from the Project which could be considered adverse effects on a tribal cultural resource? What does the Tribe consider to be the cumulative effects?

Your help to clarify the Tribe's concerns is much appreciated.

Thank you,

-Josh

From: Wendy Teeter <wteeter@chumash.gov>
Sent: Wednesday, January 29, 2025 4:03 PM
To: SMALLWOOD, STACY J CIV USSF SSC 30 CES/CEIEA <stacy.smallwood.1@spaceforce.mil>
Cc: Crystal Mendoza <cmendoza@chumash.gov>; Nakia Zavalla <NZavalla@chumash.gov>; CRM Consultation <CRMConsultation@chumash.gov>; Edgar Alvarez <ealvarez@chumash.gov>; Samuel Cohen <scohen@chumash.gov>; NOCERINO, ERIC CIV USAF SSC 30 CES/CEIEA <eric.nocerino@spaceforce.mil>; KAISERSATT, SAMANTHA O CIV USSF SSC 30 CES/CEIEA <samantha.kaisersatt@spaceforce.mil>; Polanco, Julianne@Parks <Julianne.Polanco@parks.ca.gov>
Subject: RE: [Non-DoD Source] RE: {EXTERNAL} 106 Vandenberg SpaceX SLC-4/SLC-6 Project (813-23-082)

Dear Josh,

Thank you for your response to the Tribe's concerns. We will discuss internally and get back to you along with who would like to see the project area as quickly as possible. The SHPO is cc'd here for her records since the project information was sent to the Tribe and SHPO at the same time for consideration.

Sincerely,

Wendy

Wendy Giddens Teeter, PhD, RPA

Cultural Resources Archaeologist | Elders' Council and Culture Department

Santa Ynez Band of Chumash Indians

wteeter@chumash.gov

cell: 805-325-8630

Co-PI, Carrying our Ancestors Home, <https://coah-repat.com>

Co-Director, Pimu Catalina Island Archaeology Project

From: SMALLWOOD, STACY J CIV USSF SSC 30 CES/CEIA <stacy.smallwood.1@spaceforce.mil>
Sent: Wednesday, January 29, 2025 12:42 PM
To: Wendy Teeter <wteeter@chumash.gov>
Cc: Crystal Mendoza <cmendoza@chumash.gov>; Nakia Zavalla <NZavalla@chumash.gov>; CRM Consultation <CRMConsultation@chumash.gov>; Edgar Alvarez <ealvarez@chumash.gov>; Samuel Cohen <scohen@chumash.gov>; NOCERINO, ERIC CIV USAF SSC 30 CES/CEIA <eric.nocerino@spaceforce.mil>; KAISERSATT, SAMANTHA O CIV USSF SSC 30 CES/CEIA <samantha.kaisersatt@spaceforce.mil>
Subject: RE: [Non-DoD Source] RE: {EXTERNAL} 106 Vandenberg SpaceX SLC-4/SLC-6 Project (813-23-082)

Hi Wendy,

Jenni SciarappaShaw <jesciarappashaw@chumash.gov> reached out to schedule a large group field meeting on either February 26 or 27. I was hoping we could schedule something sooner, but I understand the difficulties of scheduling a large group of people.

To better understand and address the Tribe's concerns, I would like to discuss the concerns you stated below. You had mentioned below that "there are a number of lithic scatters" in the ADI (Area of Direct Impact). There are only two: CA-SBA-1114 and CA-SBA-1941, both of which have no potential to be affected by the project which will do minor improvements along the existing access road through these site polygons, and therefore, these two sites have been eliminated from the APE.

You mentioned a "trail and trade network that should be considered as potentially eligible", yet there is no physical evidence of a trail system or trade network at this location. Of course, the Chumash ancestors traveled all over this region, up and down every part of the coastline, ridges, and canyons to reach villages and resource areas on Vandenberg; hunted, fished, and gathered resources such as chert and other stone materials which are abundant on Base and throughout the region. Obsidian was obtained from as far away as northern California, and shell beads were traded to the Mojave at the Colorado River, but those trade networks are not evident within or adjacent to the Project area. There has been no substantial amount of, if any, trade items found at the lithic scatters in question, and identification of a trail and trade network in the Project vicinity would be speculation, at best.

While a Cultural Landscape Study would be a great opportunity to generate data on the local region, the effort and cost are way beyond the scope of a Project that will have no effect on cultural resources. A Cultural Landscape Study is more appropriate to a Project which will result in an adverse effect which requires mitigation, such as what occurred for the Sentinel Project at Lospe Village which our Cultural Resources Managers worked on together with the Tribe.

In summary, can the Tribe identify any effects resulting from the Project which could be considered adverse effects? What does the Tribe consider to be the cumulative effects? Your help to clarify the Tribe's concerns is much appreciated.

Thank you.

Respectfully,

-Josh

From: Wendy Teeter <wteeter@chumash.gov>

Sent: Tuesday, January 21, 2025 11:43 AM

To: SMALLWOOD, STACY J CIV USSF SSC 30 CES/CEIEA <stacy.smallwood.1@spaceforce.mil>

Cc: Crystal Mendoza <cmendoza@chumash.gov>; Nakia Zavalla <NZavalla@chumash.gov>; CRM Consultation <CRMConsultation@chumash.gov>; Edgar Alvarez <ealvarez@chumash.gov>; Samuel Cohen <scohen@chumash.gov>

Subject: [Non-DoD Source] RE: {EXTERNAL} 106 Vandenberg SpaceX SLC-4/SLC-6 Project (813-23-082)

Dear Josh,

There is a lot of modifications to SLC-6 that are of concern. We would like to schedule a site visit and discuss the cumulative effects from this work. While we understand there are a number of lithic scatters in the project ADI that by themselves don't seem eligible to the historic register, they are part of a trail and trade network that should be considered as potentially eligible and we would like to propose and partner in this study, evaluation and assessment of the effects to this important traditional cultural landscape before it is damaged by this work.

Thank you,

Wendy

Wendy Giddens Teeter, PhD, RPA

Cultural Resources Archaeologist | Elders' Council and Culture Department

Santa Ynez Band of Chumash Indians

wteeter@chumash.gov

cell: 805-325-8630

Co-PI, Carrying our Ancestors Home, <https://coah-repat.com>

Co-Director, Pimu Catalina Island Archaeology Project

From: SMALLWOOD, STACY J CIV USSF SSC 30 CES/CEIEA <stacy.smallwood.1@spaceforce.mil>

Sent: Tuesday, January 21, 2025 8:29 AM

To: Nakia Zavalla <NZavalla@chumash.gov>

Cc: Wendy Teeter <wteeter@chumash.gov>; Crystal Mendoza <cmendoza@chumash.gov>

Subject: {EXTERNAL} 106 Vandenberg SpaceX SLC-4/SLC-6 Project (813-23-082)

Dear Nakia,

This submittal is to initiate Section 106 consultation with the Santa Ynez Band of Chumash Indians regarding the SpaceX SLC-4/SLC-6 Project (813-23-082), Vandenberg Space Force Base, Santa Barbara County, California. The attachments are as follows:

- Signed transmittal letter;
- Section 106 report with appendices.

Please respond with comment within 30 calendar days. Please let me know if you require any additional information or if you require a site visit prior to making comment.

Thank you,

-Josh

Josh Smallwood, M.A., RPA

Installation Tribal Liaison Officer/Cultural Resources Manager

SLD 30 CES/CEIEA

1028 Iceland Avenue, Building 11146

Vandenberg Space Force Base, CA 93437-6010

Mobile: 760-419-0092

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DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 30

Josh Smallwood
30 CES/CEIEA
1028 Iceland Avenue
Vandenberg SFB, CA 93437-6010

Ms. Nakia Zavalla
Santa Ynez Band of Chumash Indians
P.O. Box 517
Santa Ynez, CA 93460

Dear Ms. Zavalla

Space Exploration Technologies Corporation (SpaceX) proposes to modify Space Launch Complex (SLC)-6 and increase launch cadence at both SLC-4 and SLC-6 at Vandenberg Space Force Base (VSFB) in Santa Barbara County. The proposed *SpaceX SLC-4/SLC-6 Increased Launch Cadence and Modifications Project* would include increased cadence of Falcon 9 rockets from 50 to 100 launches per year, boost-back return landings at SLC-4 and SLC-6, and modifications to the SLC-6 campus to support Falcon Heavy rockets. No modifications or new construction is proposed at SLC-4.

The Department of the Air Force (DAF) determined the Project is an undertaking subject to compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and will comply with Section 106 using the implementing regulations [36 CFR Part 800]. The DAF has carried out a reasonable and good-faith cultural resources investigation that fulfills federal agency responsibilities pursuant to 36 CFR 800.4(a)-(d) and 36 CFR 800.5(a)-(d). With this letter and the accompanying report, the DAF is initiating consultation with the Tribe.

SpaceX contracted Langan, Inc. to conduct a cultural resources study of the Project area, and to prepare an analysis specifically addressing potential impacts on cultural resources from rocket engine noise and sonic boom vibrations associated with static tests, launches and booster return landings at SLC-4 and SLC-6. Data from the cultural resource noise vibration study has been used to show there is no potential for historic properties in the region to be affected by noise vibrations associated with launch activities at SLC-4 and SLC-6. Additionally, 20 years of site condition assessments on VSFB have indicated that rock art, historic buildings, and archaeological resources on VSFB, in close proximity to SLC-4 and SLC-6, are not affected by short-duration launch noise vibrations and sonic booms from boost-back return landings. Sand cone tests recently conducted by Smallwood within close proximity to SLC-4 confirm that short-duration launch noise of 150 decibels, and sonic booms above 5 pounds per square foot had no visible effect on the integrity of a sand cone with 45-degree slopes. Therefore, it is highly unlikely that any of the historic properties in the Lompoc vicinity or the Northern Channel

Islands has the potential to be affected by noise vibrations and sonic booms which last mere seconds at these thresholds.

It has been concluded that an increased cadence of launches and boost-back at SLC-4 and SLC-6 would not introduce any auditory elements which would have the potential to cause effects to historic properties under 36 CFR 800.3(a)(1). Thus, known historic properties in the region were considered in this study, but have been excluded from the Area of Potential Effects (APE) because there is no potential for them to be affected. No known historic properties have the potential to be affected by an increased cadence of launches and boost-back at SLC-4 and SLC-6, therefore, the noise polygons are not included as part of the APE.

Background research revealed that the boundaries of two Native American archaeological sites (CA-SBA-1114 and CA-SBA-1941) are intersected by the Project Area of Direct Impacts (ADI). CA-SBA-1114 is intersected by the western terminus of Cypress Ridge Road where it joins Coast Road. This site was tested and evaluated for National Register of Historic Places (NRHP) eligibility in 2021 and determined not eligible with SHPO concurrence (SHPO File Reference # USAF_2021_0408_001). The only activity proposed along this segment of Cypress Ridge Road is erosion control by adding a layer of crushed shale within the existing roadbed.

CA-SBA-1941 is intersected by the Project ADI along Cypress Ridge Road. However, CA-SBA-1941 was previously mapped as containing 14 artifacts spread out over a distance of more than 3,500 feet by 700 ft wide and encompassing an area measuring 181,700 square meters. The polygon drawn for the site includes large areas where no artifactual deposit exists. The segment of Cypress Ridge Road which traverses through the site boundaries measures 20 ft wide. Cypress Ridge Road has been previously surveyed with no artifacts being found in the roadway, and 57 shovel test pits (STPs) excavated along the edge of the roadway were completely sterile of cultural material. Furthermore, the only activity proposed along this segment of Cypress Ridge Road is erosion control by adding a layer of crushed shale within the existing roadbed. Based on previous investigation, the cultural materials recorded as CA-SBA-1941 are not situated within the ADI, and no buried deposits have been identified within the ADI, therefore, CA-SBA-1941 does not exist within the ADI and the proposed erosion control activity has no potential to affect the site. Therefore, CA-SBA-1941 is not included in the APE.

Due to the sensitive nature of the area south of SLC-6 for buried deposits, as evidenced by construction monitoring which occurred in the 1980s, a total of 52 STPs were excavated across the 23-acre proposed Landing Zone Improvement Area to establish the presence/absence of buried archaeological deposits. None of the 52 STPs excavated in the landing zone area encountered any cultural material. The balance of the Project area has been surveyed at an intensive level and while several archaeological sites have been recorded in the vicinity, no additional archaeological resources exist within or immediately adjacent to the ADI.

Finally, the entirety of the existing SLC-6 campus has been previously recorded as a Cold War era cultural resource (P-42-041202), evaluated for NRHP eligibility, and determined not eligible with SHPO concurrence (SHPO File Reference # USAF_2020_1109_001). Therefore, SLC-6 is not a historic property, and the demolition, modification, and new construction

activities proposed within the existing, developed portions of the SLC-6 campus will have no potential to affect a historic property.

Details of the investigation are provided in the attachment. Details of the investigation are provided in the attachment; however, briefly stated, the DAF has determined the following:

- a. The APE for the SLC-4/SLC-6 Increased Launch Cadence and Modifications Project is adequately delineated; and
- b. The undertaking will have *no effect* on any known historic properties.

In summary, the DAF has reached a Section 106 finding of *no historic properties affected* for this undertaking. The DAF recognizes that the Santa Ynez Band of Chumash Indians may have concerns beyond the purview of the National Historic Preservation Act. Therefore, I am seeking any additional comments or concerns you may have about cultural resources. I would appreciate receiving any feedback as part of this consultation within the next 30 calendar days. Please feel free to let me know if you require additional time. I can be reached at (760) 419-0092 or via email at stacy.smallwood.1@spaceforce.mil. Thank you for your assistance with this undertaking.

Sincerely

JOSH SMALLWOOD, M.A., RPA
Base Archaeologist
Asset Management Flight

Attachment:

Identification of Historic Properties and Finding of No Effect, SpaceX SLC-4 and SLC-6
Increased Launch Cadence and Modifications Project (813-23-082)

324 Anacapa Street, Suite 2X Santa Barbara, CA 93101 T: 805.957.6000 F: 805.957.6001

To: Brian Pownall - SpaceX

From: Heather McDaniel McDevitt, MA, RPA - Langan

Subject: Cultural Resources Assessment - Annual Falcon Launch Cadence Increase at SLC-4 and SLC-6 and Modification of SLC 6, Vandenberg Space Force Base, California (Langan Project No.: 781017001)

Date: January 13, 2025

Attachments: Appendix A – Figures

Space Exploration Technologies Corp. (SpaceX) retained Langan to conduct a cultural resources inventory, pedestrian survey and subsurface testing to support compliance with Section 106 of the National Historic Preservation Act (NHPA) for the proposed action of the Annual Falcon Launch Cadence Increase at SLC-4 and SLC-6 and Modification of SLC 6, Vandenberg Space Force Base (VSFB), California (Proposed Action). The intent of these assessments is to determine if resources exist within the study area that have potential to be adversely affected by the Proposed Action (Figure 1 Cultural Resources Study Area [CRSA]). In addition to a California Historical Information System (CHRIS) records search, a separate cultural resources records search for the on-Base portion of the Archaeological Study Area (ASA) for the Proposed Action was conducted by the 30th Civil Engineer Squadron, Installation Management Flight, Cultural Resources Office (30 CES/CEIEA) employing the VSFB database of cultural resources. This memo includes the following components: a brief project description for the Proposed Action; explanation of the CRSA and ASA; methods; summary of the VSFB and CHRIS database records search results for the CRSA; results of the pedestrian survey and the subsurface testing; and conclusions regarding whether the Proposed Action would result in an adverse effect to cultural resources located within the total ASA.

This investigation was performed by Langan's Cultural Resources Practice staff under the direction of Principal Investigator, Heather McDaniel McDevitt, RPA, who exceeds Secretary of Interior standards for prehistoric and historic archaeology. Each aspect of the study was conducted in consultation with the 30 CES/CEIEA and could not have been accomplished without their support as well as that of the SpaceX environmental team and the Santa Ynez Band of Chumash Indians (SYBCI).

Proposed Undertaking

SpaceX is proposing an increase in the annual Falcon launch cadence at VSFB through launch and landing operations at Space Launch Complex (SLC)-4 and SLC-6 and the modification of the SLC-6 facility for Falcon 9 and Falcon Heavy launch vehicles to support future U.S. Government and commercial launch service needs. The purpose of the Proposed Action is to provide greater

mission capability to the United States (US) government and commercial customers by increasing Falcon 9 and Falcon Heavy launch cadence capacity at both SLC-4 and SLC-6 from 50 to 100 launches per year. SpaceX developed the Falcon 9 and Falcon Heavy vertical orbital launch vehicles with the intent to launch commercial and government payloads from VSBF with reusable launch technology employing an in-air boost-back maneuver, return flight, and landing of the Falcon 9 first stage either downrange on a dronship in the Pacific Ocean or at the SLC-4 and the newly proposed SLC-6 pads at VSBF. The Proposed Action is needed to meet current and near-term U.S. Government space launch requirements from and return heavy-lift launch capability to the Western Range. Additionally, the Proposed Action would assist in fulfilling (in part) 10 USC Section 2276(a), "Commercial space launch cooperation" authorizing the Secretary of Defense to, with respect to its space transportation infrastructure: 1) maximize effectiveness and efficiency; 2) maximize use capacity by the private sector in the U.S.; 3) reduce its cost of services; and 4) encourage space activities by fostering cooperation with and enabling investment by covered entities.

This proposed action would include the annual landing of up to 12 boosters at SLC-4 for years 2024-2028 and up to 17 first stage boosters at SLC-6 for years 2025-2028. Therefore, the proposed launch increase includes an associated increase in boost-back landings of the first stage up to 100 times with no more than 12 of the first stage landings occurring at SLC-4 and no more than 17 of the first stage landings occurring at SLC-6 annually and the remainder occurring on the dronship located in the Pacific Ocean as described in the 2023 Supplemental Environmental Assessment (SEA). Additionally, there is potential for a static fire test of the engines, lasting a few seconds, to precede each launch by one to two days. Trajectories from SLC-4 would remain within the previously analyzed launch azimuth of between 140 and 325 degrees and trajectories from SLC-6 would fall within the same range. Fairing recovery and jettisoning of the Merlin Vacuum Engine skirt ring would occur as described in the 2023 SEA. SpaceX is proposing to expand its downrange recovery area by approximately 900 miles west and approximately 1,000 miles south to support Falcon Heavy missions. The dronship would then transport the booster to the Port of Long Beach as described in the 2023 SEA.

In order to support launches of the Falcon 9 and Falcon Heavy and landings of the first stage boosters at SLC-6, modifications of the SLC-6 facility would be required. A complete description of the Proposed Action can be provided upon request. SpaceX would modify SLC-6 to support Falcon 9 and Falcon Heavy launches. SpaceX would construct commodity storage tanks, a water tower, ground supporting equipment, and a rail system from the hangar to the launch pad. Where possible, existing infrastructure would be modified. This could include the liquid oxygen storage, launch pad apron and access road, and fence line. The existing flame trench would be retained and converted to a unidirectional water-cooled flame diverter, and a deluge/acoustic suppression system would be installed. Construction would generally occur in previously disturbed areas and on existing impervious surfaces, but some earthwork is anticipated. A new hangar or modification of an existing structure would be required for vehicle processing.

Approximately 143,000 square feet of commodity storage would be required. This includes storage tanks for liquid oxygen, rocket propellant-1, water, nitrogen, helium, and other launch commodities. A 200-foot water tower would be constructed on the east side of the launch

complex. Firebreaks would be incorporated as appropriate into the site design and final site layout is subject to Space Launch Delta (SLD) 30 review and approval.

SpaceX would construct two landing zones south of SLC-6 to support landing of first stage Falcon boosters launching from SLC-6. Each landing zone would be made up of a 280-foot diameter concrete pad surrounded by a 60-foot gravel apron, for a total diameter of 400 feet. SpaceX would construct a new nitrogen gas line from SLC-6 to a fluids bay at the landing zones. The fluids bay is used to send nitrogen to different systems of the booster after landing. A 30-foot by 30-foot pedestal, which sits flush with the ground, would be constructed at each landing pad to support post-landing operations. Crane storage, a cleared area to lay down cranes when not in operation, is proposed on the western site boundary. Each landing zone would have a connection to the existing road to support booster transport. Approximately 16 acres would be cleared to construct the landing zones and approximately 7 acres would be impervious.

A new approximately 50-foot wide firebreak is proposed south of the landing zones and would connect to the existing firebreak for SLC-8. Additionally, Cypress Ridge Road would be improved within its existing footprint to protect against potential erosion. An offset plan for any native Coastal Scrub shrubland alliance impacts would be developed in accordance with the VSNB Integrated Natural Resources Management Plan and approved prior to construction.

For ease of identification, the areas of ground disturbance are categorized as separate areas and are illustrated in Figure 12 – Areas of Potential Ground Disturbance. Following are the proposed Project components, listed north to south that will or have the potential to result in ground-disturbance or landscape-alterations:

Far Northern Improvement Area - Encompassing between approximately 3 to 9 acres (depending on whether modification of hanger is completed) and approximately 415 linear feet at an approximate width of 100 feet for rail system installation.

Construction:

- Installation of rail system from the hangar to the launch pad (approximately 415 linear feet within Far North Improvement Area at a width of approximately 100 feet); and

Modifications/improvements:

- Modification of existing hanger for vehicle processing (potential) (approximately 9 acres).

Near Northern Improvement Area (encompassing approximately 6 acres and 590 linear feet at an approximate width of 100 feet for rail system installation)

Construction:

- Installation of rail system from the potential new hangar to the launch pad (approximately 590 linear feet within Near North Improvement Area at a width of approximately 100 feet); and
- Construction of new hanger for vehicle processing (potential) (approximately 6 acres).

Modifications/improvements:

Relocation of fence line

Central SLC-6 Improvement Area - Encompassing approximately 34 acres including 680 linear feet at an approximate width of 100 feet for rail system installation.

Construction:

- Construction of commodity storage tanks (approximately 2 acres);
- Construction of aerospace ground supporting equipment (approximately 0.2 acre);
- Installation of rail system from the hangar to the launch pad (approximately 680 linear feet within Central SLC-6 Improvement Area at a width of approximately 100 feet);
- Construction of a 143,000 square feet space for commodity storage (approximately 3 acres)
 - storage tanks for liquid oxygen, rocket propellant-1, water, nitrogen, helium, and other launch commodities; and
- Installation of a 200-foot water tower (replacing former water tower previously demolished) (approximately 0.1 acre).

Modifications/improvements:

- Installation of liquid oxygen storage (approximately 1 acre); and
- Conversion of existing flame trench to a unidirectional water-cooled flame diverter (approximately 0.4 acre).

Landing Zone Improvement Area - Encompassing approximately 23 acres (landing zone area = 16 acres and potential additional grubbing/grading preparation = 7 acres) and 1,420 linear feet for nitrogen gas line installation. Depth of disturbance is estimated to not extend deeper than 5 feet below current ground surface (bcgs) within the 16 acres to establish the subgrade and no deeper than 3 feet bcgs for installation of the nitrogen gas line. All other disturbances are expected to occur within graded soils.

Construction:

- Construction of two landing zones including (approximately 16 acres):
 - Two 280-ft-diameter concrete pads;
 - 60-foot gravel apron surrounding each pad;
 - 50-foot access road from Road N to each landing pad (approximately 2 acres).
 - Two 30 x 30-foot pedestals to support post-landing operations (placed east of each landing pad);
 - The above areas total approximately 7 acres of impervious pavement;
- Installation of approximately 1,420 linear feet of new nitrogen gas line from SLC-6 to a 30 x 60-foot fluids bay; and

Cleared/Graded Areas:

- To construct the landing zones, preparation (grubbing, grading, etc.) within the area surrounding the landing zones, totaling approximately 7 additional acres, may be required; and
- Crane storage located west of the landing pads (approximately 1 acre).

Fire Breaks Improvement Area - Encompassing approximately 2,035 linear feet at an approximate width of 20 feet; 2,410 linear feet at an approximate width of 50 feet; and 6,340 linear feet at an approximate width of 17 feet. Depth of disturbance is estimated to not exceed one-foot bcgs for initial mechanical clearing of vegetation employing a bulldozer followed by periodic tilling at an approximate depth of six inches for firebreak maintenance.

Cleared Areas:

- 50-foot-wide firebreak east and south of the landing zones connecting to the existing firebreak for SLC-8 (approximately 2,410 linear feet along North Road at an approximate width of 50 feet and 2,035 linear feet from North Road to the SLC-8 firebreak at an approximate width of 20 feet); and
- Improvement of Cypress Ridge Road within its existing footprint to protect against potential erosion (approximately 6,340 linear feet at an approximate width of 17 feet).

Cultural Resources and Archaeological Study Areas

The area of potential effect (APE) of an undertaking is defined as “the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist” (36 CFR 800-16(d)). The APE considers any physical, visual, or auditory effects that the project may have on historic properties. The APE for the current project will be developed in consideration of ground-disturbing or landscape-altering actions and auditory effects predicated on vibratory impacts. In order to define the APE, an assessment of the CRSA (see Figure 1) and more specifically, the ASA (see Figure 12) has been conducted the results of which are provided in this report. The CRSA was determined based on data and thresholds relative to auditory effects provided in the noise study (KBR 2024) conducted to specifically address the Proposed Action and relevant literature. The ASA, located within the CRSA, was determined based on the extent of proposed ground disturbances relative to known resources.

AUDITORY EFFECTS PREDICATED ON VIBRATORY IMPACTS

KBR, Inc. (2024) conducted a noise study to support environmental studies for Federal Aviation Administration (FAA) launch licensing and the United States Space Force (USSF) 2024 environmental review under the National Environmental Policy Act (NEPA) of Falcon 9 and Falcon Heavy cadence increase and SLC-6 campus modifications at VSFB (KBR 2024). This noise modeling study was conducted to estimate the single event and cumulative noise levels within the vicinity of VSFB from future Falcon 9 and Heavy launches, landings and static fire tests proposed to occur as SLC-4 and SLC-6.

Based on previous studies that have determined at which levels structures and archaeological resources could potentially be affected by rocket noise and sonic booms; the focus of this study’s analysis was determined by the auditory effects threshold of noise exceeding 120 dB and sonic booms exceeding 2 psf. In 1972, Guest et al. conducted analysis to assess claims that rocket engine thrusts were potentially impacting areas adjacent to a test site located at Marshall Space Flight Center’s Mississippi Test Facility. The results of the study established that the potential to damage the most sensitive structural components such as windows and plaster on historic

buildings occurred as a result of prolonged noise thresholds greater than 120 dB. Furthermore, the FAA uses the 120 dB noise contour for engine noise to define areas that may experience structural damage resulting from space launch vehicle noise. A 2016 study by Richard Fenton and Rick Methold considered the long-term continuous measurement of airborne sound pressure levels, air over pressure and ground-born vibration caused by a series of activities undertaken on Military of Defense (MOD) facilities. Their study was conducted at the request of the MOD to analyze possible causal links between the studied activities and measured magnitudes to determine the likely risk of potential building damage. Fenton and Methold considered the influence of various factors that can affect acoustic impacts to structures and determined a 'safe' maximum threshold of 134 dB to be used for blast regime planning by the MOD but also recognized the scholarly consensus, including the authors, that damage becomes improbable below approximately 140 dB. The study by KBR, Inc. considers the range between 120 and 140 dB as well as the 'safe' maximum threshold of 134 dB.

ROCKET NOISE

The noise study identified where unweighted maximum noise levels (Lmax) were expected to occur employing the RNOISE model, that computes the far field noise levels, to estimate the impacts of rocket noise. Based on criteria described in their report, KBR Inc.'s (2024) study found that estimated contours from 130 dB and 140 dB resulting from all Falcon 9 flight and test operations are well within VSFB property. Since SLC-6 is located about 3.5 miles southwest of SLC-4 the noise exposure reach from rocket noise produced by Falcon launch and landing events occurring at SLC-6 is further southwest than the exposure reach of the same events occurring at SLC-4. Accordingly, noise exposure in Lompoc is estimated to be less from Falcon 9 launch and landing events at SLC-6 compared to Falcon 9 launch and landing events at SLC-4.

Falcon 9 orbital launch events are estimated to generate Lmax of 134 dB approximately 0.5 miles from the launch pad. Falcon Heavy launch events are estimated to generate Lmax of 134 dB approximately 1 mile from the launch pad with the 120 dB contour extending only slightly outside and east of the VSFB in an uninhabited area. The Lmax dB thresholds of 120, 140 and 145 dB contours estimated for Falcon 9 and Falcon Heavy orbital launch events at SLC-4 and SLC-6 are shown in Figures 2 and 3. Falcon 9 and Falcon Heavy orbital landing events occurring at SLC-4 and SLC-6 are estimated to generate Lmax of between the 120 and 140 dB contours entirely within VSFB property (see Figures 4 and 5).

Finally, Falcon 9 static fires tests occurring at both SLC-4 and SLC-6 and Falcon Heavy static fires tests occurring at SLC-6 are estimated to result in Lmax of between the 120 and 140 dB entirely within VSFB property (see Figures 6 and 7). Only levels less than an Lmax of 60 dB, which is well outside the threshold range of Lmax 120 and 140 dB, are anticipated to extend into the community outside VSFB when test events occur at night and/or when onshore wind conditions favor sound propagation to the east.

In consultation with the 30 CES/CEIEA concerning the Proposed Action and its potential for direct and indirect effects to cultural resources resulting from any related construction, static fire, launches, and boost-back landings, an area of direct impacts (ADI) and subsequent APE will be determined. The ADI for the Proposed Action relative to auditory effects predicted on vibratory

impacts will include the area within which noise vibrations reach levels above 120 dB, as well as sonic booms in excess of 2 psf.

SONIC BOOMS LEVELS

A study conducted to assess the effects of aircraft noise and sonic booms on structures (Haber et al. 1989) determined that potential damage resulting from sonic booms measuring at 2-4 pounds per square foot (psf) were nominal and categorized as failures that occurred due to the poor condition of the structures or elements of the structure. Additionally, in a study commissioned by NASA it was reported that only rare and minor damage may occur with overpressures between 2 and 5 psf and that experimental testing of sonic boom effects has shown structures in good condition remain undamaged by overpressures up to 11 psf (Gibbs 2017). The Proposed Action will not result in overpressures any greater than 5 psf. Accordingly, the threshold for potential damage resulting from sonic booms (overpressure) for this Proposed Action is established at 2 psf or greater.

KBR Inc. computed the sonic boom footprint for each launch and landing event associated with the Proposed Action employing PCBoom modeling. These efforts determined the launch azimuths that have the potential to produce a sonic boom that could impact land during all launch and landing events included in the Proposed Action and identify where overpressures of 2 psf or greater are expected to occur. Figures 8 through 11 show the sonic boom footprint, in the form of overpressure contours, for Falcon 9 launch and landing events at SLC-4 and SLC-6 and the Falcon Heavy launch and landing events at SLC-6.

According to KBR Inc.'s (2024) study findings, peak overpressures levels from Falcon 9 launch events occurring at SLC-4 are estimated at between 0.1 and 1.0 psf with the crescent-shaped contour located entirely over water (see Figure 8). Peak overpressure levels from Falcon 9 launch events occurring at SLC-6 are between 0.1 and 5.0 psf with the crescent-shaped contour located entirely over water (see Figure 9). Peak overpressure levels from Falcon Heavy launch events occurring at SLC-6 are estimated between 0.1 and 7.0 psf with the crescent-shaped contour located mostly over water (see Figure 9), except for the exposed land areas of the Northern Channel Islands as well as Oxnard, CA and areas just north of Los Angeles, CA. Only a limited area of the Northern Channel Islands is estimated to be exposed to overpressure levels between 5.0 and 7.0 psf.

KBR Inc.'s (2024) study found sonic boom levels resulting from landing events at SLC-4 range from 5.0 to 7.5 psf near the landing pad and 0.1 to 5.0 psf on VSFB in areas away from the SLC-4 landing pad (see Figure 10). The greatest psf of 7.5 is limited to a narrow 100-yard-wide area off shore and the boom levels within the NCI area are estimated to range between 0.1 to 2.0 psf. The sonic boom footprint and overpressure levels for the Falcon Heavy landing events at SLC-6 have a similar shape to the Falcon 9 (see Figure 11). The exception is that the Falcon Heavy landings are expected to have higher overpressure levels near the landing pad.

In short, sonic boom overpressure measurements of 2 psf or greater resulting from the Proposed Action are predicted to occur within portions of the Lompoc Valley and surrounding areas, including VSFB, and the three most northerly Channel Islands (NCI) of San Miguel Island, Santa

Rosa Island, and Santa Cruz Island with sonic booms reaching 5 psf primarily occurring on VSFB and over open ocean.

GROUND-DISTURBING OR LANDSCAPE-ALTERING ACTIONS

In consultation with the 30 CES/CEIEA and based on the description of the proposed action provided by SpaceX, boundaries of known cultural resources and findings of previously conducted studies, Langan investigated ASA for the SLC-6 Landing Zone Area, the Firebreak Area, and the Cypress Ridge and North Fire Access Roads as illustrated in Figure 12. The ASAs encompass the predicted development footprint for the ground disturbing or landscape altering activities including potential grading, launch pad construction and related infrastructure, improvement and maintenance of access roads and firebreaks. Langan conducted a cultural resource inventory, pedestrian survey and subsurface testing. No cultural material was identified within the ASA as a result of any of the investigative approaches.

Methods

RECORDS SEARCH

A cultural resource records search of the California Historical Resources Information System (CHRIS) for the cultural resource study area outside of the VSFB was conducted at the Central Coastal Information Center (CCIC) on February 10 and 24, 2023 in support of the 2023 SEA environmental review efforts. The results from the 2023 records search were reviewed and only one applicable, as defined below, additional resource was identified during a supplemental records search conducted in December 2023 in support of this study. The records search included a review of all recorded archaeological sites and built environment resources. Additionally, a review of the National Register of Historic Places (NRHP), the California Register of Historical Resources (CRHR), the California Historic Property Data File, and the lists of California State Historical Landmarks, California Points of Historical Interest, and Archaeological Determinations of Eligibility was conducted.

In consultation with the 30 CES/CEIEA, Ms. McDaniel McDevitt reviewed available literature to determine what types of resources located within the cultural resource study area have the potential to be impacted by the auditory effects of the Proposed Action predicated on vibratory impacts. Analysis specifically addressing potential impacts on built environment historic properties from rocket engine noise and sonic boom vibrations associated with static tests, launches and boost-back landings at SLC-4 and SLC-6 considered previously conducted studies. These studies include those by Fenton and Methold (2016), Guest and Sloane (1972) and Gibbs (2017) that establish the thresholds at which prolonged noise thresholds (static fires) and sonic booms have the potential to impact historic properties. Additionally, Ms. McDaniel McDevitt reviewed a previous study that considered potential impacts to archaeological sites (Norcerino et al. 2021) and consulted with Mr. Josh Smallwood of the 30 CES/CEIEA regarding the results of experimental analysis conducted by the 30 CES/CEIEA at VSFB (Smallwood personal communication 2023). The experimental analysis included the placement and observation of a 12-inch-tall, 45-degree slopes and cone and a 12x12x12-inch midden chunk on a concrete pad located 3,180 feet to the southwest of the SLC-4 SpaceX boost-back pad to determine if noise vibration

resulting from two SpaceX launches/boost-back landings would result in any visual change to the materials. No visual impacts were observed in either the midden chunk or sand cone after the launch/boost-back with the exception of a few fine grains of sand shifting down the cone likely resulting from the samples drying in the wind. Importantly, there was no cracking or crumbling observed, on the midden chunk or sand cones from launch vibrations/sonic boom overpressures (Smallwood personal communication 2023). Smallwood asserted that based on experimental analysis and observations of archaeological sites located on base, VSFB cultural resources staff have established that archaeological sites consisting of only surface artifacts and/or buried archaeological material do not have the potential to be affected by rocket engine noise. A sheer cliff-face midden deposit present within CA-SBA-530 located in the southern portion of the VSFB between SLC-4 and SLC-6 has been monitored for impacts resulting from noise vibrations. Despite the observation of significant impacts resulting from natural erosion due to rainfall, wind, and wave compression, no visible effect resulting from noise vibrations due to launch and boost-back events has been observed (Smallwood personal communication 2023).

A condition assessment program has occurred at the NRHP-eligible Honda Ridge Rock Art Site (CA-SBA-550), located 7,000 feet east of SLC-6, since the early 2000s (Nocerino et al. 2021; Smallwood personal communication 2023). The program has found no evidence of effects to the rock art surfaces from heavy- and medium-payload rocket launches and boost backs or sonic boom overpressure (Smallwood personal communication 2023). Therefore, all archaeological resources, including those with rock art, cairns, and rock shelters were excluded from further consideration because they are highly unlikely to be affected by short-duration launch noise from an increased cadence of SpaceX launches, static fires, and boost-back landings.

Finally, all but one building located on VSFB and within the cultural resource study area are associated with launch complexes and supporting infrastructure and are built to withstand concussive forces. The only historic building located on VSFB that is not associated with launch complexes or supporting infrastructure is the former U.S. Coast Guard Lifeboat Rescue Station (P-42-040495). The Colonial Revival architectural style, wood-frame structures were built in 1936 as administrative barracks with ancillary structures. The buildings have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6 with no reported and observed effect.

Based on these considerations, the off-Base cultural resources records search focused on resources identified by the CHRIS as NRHP listed or eligible for listing in accordance with the Office of Historic Preservation (OHP) attribute codes (OHP 1995). Those categories identified for consideration of the potential for effects resulting from the Proposed Action included built environment resources and archaeological features located above ground such as rock art, cairns and rock shelters.

HISTORIC AERIAL AND TOPOGRAPHIC MAP REVIEW

Historical topographic maps and aerial photographs were reviewed to better understand the nature of landscape change to the improvement areas proposed for potential ground-disturbing or landscape-altering activities and surrounding area over time. A review of all available historical aerial photographs was conducted and includes the following years: 1981, 1994, 2005, 2008,

2009, 2010, and 2012 (NETR 2024a). Through careful comparative review of historical aeriels, changes to the landscape of a study area may be revealed. Historic aeriels were also used to obtain approximate dates of construction and dates of alterations for buildings and structures within and surrounding the subject property. A review of available topographic maps was conducted and includes the following years: 1948, 1956, 1957, 1958, 1960, 1966, 1967, 1968, 1986, 1987, 2012, 2015, 2018, and 2021 (NETR 2024b). Topographic maps depict elevation of the study area as well as the areas surrounding it and illustrate the location of roads, structural features, community services and some buildings. Although topographic maps are not comprehensive and do vary from year to year in their inclusion of information, they are another tool in determining the presence of structures and the nature of land use.

The historic topographic maps were limited in illustrative data; however, they do demonstrate that the general area within which Central SLC-6, Near North and Far North improvement areas are located has been developed with roads, trails and structures since at least 1948 with no development illustrated in the proposed landing zones and firebreaks improvement areas. The historic photographic aeriels demonstrate that the Central SLC-6, Near North and Far North improvement areas have been substantially disturbed by grading and construction and demolition of structures roads and utility installation since at least 1981 (the earliest aerial photograph available) and the landing zones and firebreaks have only been slightly disturbed by limited grading. These disturbances coincide with the recording of the Cold-War historical built-environment resources documented by the first recordation of the site by Dames and Moore in 1994 and the West Coast Space Shuttle Orbiter and launch complex recordation by U.S. Army Construction Engineering Research Laboratory in 1996 and the most recent recordation by Smallwood in 2018. Based on these results and that a large portion of the areas are currently covered in pavement and structures, it was determined that the Central SLC-6, Near North and Far North improvement areas were highly disturbed to a degree greater than that which is being proposed for this undertaking and that a pedestrian survey of these areas would not provide any relevant information. Since the proposed landing zones and new firebreak have been only minimally disturbed, a pedestrian survey of the landings zones and both firebreaks were determined necessary as well as subsurface testing in a portion of the proposed Landing Zones improvement area.

PEDESTRIAN SURVEY

The intensive-level survey methods consisted of a pedestrian survey conducted in parallel transects, spaced no more than 3 meters apart (approximately 10 feet), where feasible. The ground surface was inspected for prehistoric artifacts (e.g., flaked stone tools, tool-making debris, groundstone tools, ceramics, fire-affected rock), soil discoloration that might indicate the presence of a cultural midden, soil depressions, features indicative of structures and/or buildings (e.g., standing exterior walls, post holes, foundations), and historical artifacts (e.g., metal, glass, ceramics, building materials). To overcome visibility issues, small shovel scrapes were conducted in 10-meter intervals, or subjectively as needed. Ground disturbances such as rodent burrows, ephemeral trails and areas of barren ground were given specific attention to provide the best opportunity to observe soils and any potential exposed subsurface materials. No artifacts were collected during the survey.

SUBSURFACE TESTING

The necessity for subsurface testing within the ASAs was determined in consultation with the 30 CES/CEIEA and was limited to the areas within the Landing Zone improvement area that had not already been subjected to subsurface testing. Subsurface testing was conducted employing shovel test pits (STPs) placed in a 50-meter (164-ft) staggered grid. All efforts were made to adhere to the prescribed grid placement; however, the chaparral within a majority of the ASA was very dense requiring minimal shifting of the locations (< one meter) in order to avoid mechanical vegetation clearing. The STPs measured 50 cm diameter and were excavated in 20-centimeter levels to a prescribed depth of 150 cm unless refusal was reached. Refusal was determined by encountering either groundwater or impenetrable rock. A sampling of no more than 0.3 liter (1 cup) of soils was removed from each level and dried to ensure a more accurate reading of soil color, texture and composition. All excavated soils were dry-screened through 1/8-inch mesh and placed back in the ground (backfilled) once the STP was completed and fully documented.

All fieldwork (pedestrian survey and subsurface testing) was documented using field notes and an Apple Generation 7 iPad (iPad) equipped with ESRI Field Maps software with close-scale georeferenced field maps of the proposed Project site, and aerial photographs. Location-specific photographs were taken using the iPad's 12-mega-pixel resolution camera. If any cultural resources had been identified during the fieldwork, they would have been recorded on standard field forms, consistent with the *Instructions for Recording Historical Resources* (Office of Historic Preservation 1995). All field practices met the Secretary of Interior's standards and guidelines for a cultural resources inventory and subsurface testing.

Fieldwork was conducted in the presence of a Tribal monitor provided by the Santa Ynez Band of Chumash Indians (SYBCI). Field notes, photographs, and records related to the current study are on file at Langan's Santa Barbara, California office. STP logs and a spreadsheet of soil descriptions and testing results can be found in appendices B and C.

Results

RECORDS SEARCH

Tables 1 and 2 provide both built environment and archaeological cultural resources that are listed on or determined eligible for listing on the NRHP and are, as previously mentioned, identified as including elements that may have the potential for effects resulting from the Proposed Action. Table 3 provides a list of cultural resources within 0.5-mile of the ASA (Far North, Near North, Central SLC-6, Landing Zones, Firebreaks improvement areas) none of which are listed on or determined eligible for listing on the NRHP but are important to understanding the general archaeological sensitivity of the areas proposed for ground-disturbing or landscape-altering actions. For the purpose of this assessment and since the San Miguel, Santa Rosa, and Santa Cruz Archaeological Districts encompass the entirety of their respective islands, all contributing resources within the districts are assumed eligible for the NRHP for the purposes of this Proposed Action. As such, individual archaeological resources on the NCI are captured in the respective island's archaeological district.

On-Base Resources Related to Auditory Effects. The records search of the VSFB cultural resources database conducted by the 30 CES/CEIEA revealed that large portions of the CRSA within the VSFB has been previously surveyed for cultural resources resulting in the identification of 350 previously recorded cultural resources within this portion of the CRSA. Of these resources, four archaeological sites and 103 historic-age buildings fit the criteria previously outlined as those with above-ground buildings, structures, or objects that are NRHP-listed or eligible and could potentially be affected by launch noise vibrations. The four archaeological resources are rock art sites, and the 103 historic-age buildings are associated with launch complexes and supporting infrastructure that have been built to withstand concussive forces. A total of 123 other archaeological sites on VSFB have been identified within the CRSA but do not include elements that could potentially be affected by launch noise vibrations and sonic boom overpressure. As previously explained, the only historic NRHP-listed structures located on VSFB that are not associated with launch complexes or supporting infrastructure is the former U.S. Coast Guard Lifeboat Rescue Station (P-42-040495). The Colonial Revival architectural style, wood-frame structures were built in 1936 as administrative barracks with ancillary structures. The buildings have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6 with no reported and observed effect.

Far North, Near North, Central SLC-6, Landing Zones, and Firebreaks Improvement Areas.

Areas where ground-disturbing or landscape-altering actions, ASA, are proposed were scrutinized specifically for the potential of unknown cultural resources to exist. The records search of the VSFB cultural resources database conducted by the 30 CES/CEIEA revealed that the areas proposed for ground-disturbing or landscape-altering actions have been partially addressed by previous studies resulting in the identification of 16 previously recorded cultural resources within this portion of the ASA. Of these resources one (1) is a multicomponent (consisting of both prehistoric and historic components); thirteen (13) are prehistoric-era archaeological sites; one (1) is a historic-era archaeological site; and one is a built environment historic district. Except for CA-SBA-1941, each of the sites have either been found ineligible or have unknown eligibility due to a lack of testing/evaluation. As explained further below, CA-SBA-1941 is assumed eligible for NRHP listing but the portion overlapping the ASA (Cypress Ridge Rd firebreak) has been found not contributing to the assumed eligibility of the site. The most recent studies addressing the ASA include *Archaeological Investigations in 2014–2015 for Firebreaks and Fire Access Roads, Vandenberg Air Force Base, Santa Barbara County, California* by Clayton G. Lebow, Rebecca L. McKim, Douglas R. Harro, and Michelle Newcomb; *Identification of Historic Properties and Assessment of Effects Vandenberg Operational Lightning Tracking System (VOLTS) Project, Vandenberg Air Force Base, Santa Barbara County, California (813-17-060)* by Josh Smallwood and Christopher Ryan; and *Cultural Resource Investigations at SLC-3W, SLC-5, SLC-8, Lompoc Terrace, and the Boat Dock Vandenberg Space Force Base, California (813-19-033CRV)* by Joyce Gerber, Eric S. Nocerino and Karin Pitts-Olemedo with contributions by Clayton G. Lebow.

Table 1. Cultural Resources Located within One-Half Mile of the ASA

Designation	Resource Description	Recorded By	NRHP Eligibility	Proximity to Proposed Project Site
CA-SBA-639	Prehistoric site consisting of a heavy density shell midden on sea cliff with moderate vertebrate faunal density and light density of chipped stone; radiocarbon testing dates site to Middle-Late Transitional Period; likely associated with CA-SBA-1783	Spanne 1970; Carbon and Mason 1994; McDowell 1994; Enright 2011; Cruz 2020; Coleman and Mirro 2004;	unknown	290 m (950 ft) west of Cypress Ridge Fire Access Road
CA-SBA-1114	Prehistoric site consisting of chipped stone flakes; potential chipping/production site. (summary provided following)	Sawyer 1974; Pitts-Olmedo et al. 2020;	Not eligible pursuant to 36 CFR 60.6 (a–d)	Immediately adjacent and east of Cypress Ridge Fire Access Road
CA-SBA-1148H	Historic archaeological site associated with Sudden Ranch, Red Roof Canyon,. Headquarters for the northern portion of Sudden Ranch in the late nineteenth and early twentieth century; site of Station B-30 during WWII. Site has been totally destroyed by construction of SLC-6. (summary provided following)	Spanne 1976; Enright et al. 2016	Not eligible pursuant to 36 CFR 60.6 (a–d)	505 m (1650 ft) north of Landing Zone
CA-SBA-1149	Multicomponent archaeological site. Large prehistoric with sparse lithic and shell scatter with discrete areas of higher density; Historic ranch house site.	Spanne 1974 and 1982; Gibson 1988; Marmor 1988; Gibson Hawley et al. 1998	unknown; not yet evaluated	250 m (825 ft) south of Cypress Ridge Fire Access Road
CA-SBA-1686	Prehistoric site consisting of groundstone and chipped stone artifacts; cultural deposit confirmed to over 140 cm in depth. (summary provided following)	Serena 1981;	unknown; appears ineligible due to destruction	19 m (64 ft) northeast of Cypress Ridge Fire Access Road
CA-SBA-1783	see CA-SBA-639			170 m (550 ft) southwest of Cypress Ridge Fire Access Road
CA-SBA-1941	Prehistoric site consisting of a low density of groundstone and chipped stone artifacts; cultural	Spanne 1985; Gibson 1988;	Assumed eligible; portion	Overlaps Cypress Ridge

Designation	Resource Description	Recorded By	NRHP Eligibility	Proximity to Proposed Project Site
	deposit confirmed to over 140 cm in depth. (summary provided following)	Lebow et al. 2016	overlapping Cypress Ridge Rd found not contributing to assumed eligibility	Fire Access Road
CA-SBA-2032	Prehistoric site consisting of a low density of groundstone and chipped stone artifacts; three loci within consisting of more abundant artifacts; typology of artifacts potentially dates site to Early Period. (summary provided following)	Spanne 1985; Gibson 1986; Harrow et al. 1998; Lebow et al. 2016	Unknown	730 m (2400 ft) north of Landing Zone
CA-SBA-2212	Prehistoric site consisting of a low density scatter of lithic flakes and one groundstone artifact; typology of artifacts potentially dates site to Early Period; possible association with CA-SBA-1941. (summary provided following)	Gibson 1988; Garza and James 2009;	unknown; not yet evaluated	290 m (950 ft) southeast of Cypress Ridge Fire Access Road
CA-SBA-2213	Prehistoric site consisting of three manos and one metate fragment on edge of small terrace overlooking unnamed drainage; typology of artifacts potentially dates site to Early Period. (summary provided following)	Gibson 1988; Garza and James 2009;	unknown; not yet evaluated	205 m (675 ft) southeast of Cypress Ridge Fire Access Road
CA-SBA-2214	Prehistoric site consisting of trace density of lithic flakes and one <i>Olivella biplicata</i> shell with chipped spire (likely bead); potentially Early Period site. (summary provided following)	Gibson 1988; Garza and James 2009;	unknown; not yet evaluated	215 m (700 ft) east of Cypress Ridge Fire Access Road
CA-SBA-2217	Prehistoric site consisting of groundstone artifacts; one of 3 loci previously recorded as one archaeological site. (summary provided following)	Gibson 1986 and 1996	Not eligible pursuant to 36 CFR 60.6 (a–d)	60 m (200 ft) northeast of Landing Zone
CA-SBA-2218	Prehistoric site consisting of groundstone artifacts; one of 3 loci previously recorded as one archaeological site. (summary provided following)	Gibson 1986 and 1996	Not eligible pursuant to 36 CFR 60.6 (a–d)	35 m (110 ft) west of Landing Zone

Designation	Resource Description	Recorded By	NRHP Eligibility	Proximity to Proposed Project Site
CA-SBA-2219	Prehistoric site consisting of groundstone and chipped-stone artifacts; one of 3 loci previously recorded as one archaeological site. (summary provided following)	Gibson 1986 and 1996	Not eligible pursuant to 36 CFR 60.6 (a–d)	275 m (900 ft) west of Landing Zone
CA-SBA-2797	Prehistoric site consisting of a low-density bone and lithic scatter.	Davis and Carrillo 1994	unknown; not yet evaluated	320 m (1050 ft) south of Cypress Ridge Fire Access Road
P-42-041209 included within is P-42-041202	Built Environment Historic District: Space Shuttle Orbiter Program District. District encompasses numerous buildings and structures on North and South Base including include SLC-6, Building 3000, the Shuttle airstrip, Building 398, Building 330, the South Base Harbor, and various segments of tow roads which interconnect these facilities. (summary provided following)	Smallwood 2018 (P-42-041209); Dames and Moore 1994, Nowlan et al. 1996, Smallwood 2018 (P-42-041202)	Not eligible pursuant to 36 CFR 60.6 (a–d)	Within the Central SLC-6 Improvement Area; partially within the Near Northern Improvement Area; north adjacent to the Far North Improvement area; and south adjacent to the Landing Zones
VAFB-ISO-318	Prehistoric isolate – well-shaped basalt hammerstone. (summary provided following)	Unknown	Not eligible	9 m (30 ft) east of Cypress Ridge Road firebreak
VAFB-ISO-319	Unknown origin isolate – six to ten shell fragments. (summary provided following)	Unknown	Not eligible	201 m (660 ft) southeast of Cypress Ridge Road firebreak
VAFB-ISO-320	Prehistoric isolate – light brown Monterey chert primary flake. (summary provided following)	Unknown	Not eligible	34 m (110 ft) east of Cypress Ridge Road firebreak

Central SLC-6, Near North, and Far North Improvement Areas. These Central SLC-6 improvement area has been previously subjected to a reconnaissance survey (Smallwood 2018) and portions of the Near North and the entirety of the Far North improvement areas have not been addressed by a pedestrian survey or subsurface testing. However, as demonstrated in the results of the historic topographic maps and aerial photographs and review of site records, all three improvement areas have been subject to significant ground disturbance and landscape altering

activities since at least the 1800s and are currently largely developed with structures and pavement. The 2018 reconnaissance survey recorded and evaluated numerous structures and associated facilities within the SLC-6 portion of the Space Shuttle Orbiter Program District. Although the SLC-6 complex and the Space Shuttle Orbiter Program District it is located within were associated with planned launch facilities developed in support of the Space Shuttle program, they were never used for that purpose. As such they do not meet the threshold of significance and therefore are considered ineligible for listing on the NRHP (see P-42-041202 summary below). Summaries for the resources within and nearest these improvement areas are included below to demonstrate the type of unknown resources that could potentially exist within this portion of the ASA.

CA-SBA-1148H

CA-SBA-1148H is a historic site, measuring approximately 295 meters (968 ft.) north to south by 213 meters (699 ft.) east to west, at an elevation of approximately 400 ft. amsl, and is located immediately adjacent and south of proposed Far North Improvement Area and approximately 39 meters (133 feet) west of proposed Near North Improvement Area the of the ASA. CA-SBA-1148H was originally documented as part of the 1800s Long Ranch; however, further research revealed that the area also served as the headquarter for the northern outpost of Sudden Ranch in the late nineteenth and early twentieth centuries. Additionally, the site was occupied by the WWII radar reporting station center (Station B-30); the associated structures were dismantled at the close of WWII. CA-SBA-1148H was originally formally recorded in 1974 by Larry Spanne, who described the site as "a historic ranch site with foundations and historic artifacts on the surface" and owned by George Long in 1800s. CA-SBA-1148H was revisited in 2012 by Vincent Parsick III who updated the site record to reflect the Sudden Ranch and Station B-30 components and to document remaining artifacts and features. Parsick also documented the condition of the early historic Long/Sudden Ranch site as completely destroyed by heavy earthworks resulting from the historic installation of Station B-30 and subsequently by the USAF SLC-6. CA-SBA-1148H has been documented as not eligible for NRHP listing pursuant to 36 CFR 60.6 (a-d).

CA-SBA-2032

CA-SBA-2032 is a prehistoric site, measuring approximately 284 meters (932 ft.) north to south by 62 meters (203 ft.) east to west, at an elevation of approximately 400 ft. amsl, and is located approximately 42 meters (136 feet) west of the proposed Far North Improvement Area of the ASA. CA-SBA-2032 was originally documented as consisting of a scatter of manos, chert biface fragments, thinning flakes and debitage, an anvil, cobble hammer and several modified cobbles. CA-SBA-2032 was originally formally recorded in 1986 by R.O. Gibson, who described the site as "a low-density artifact scatter largely buried on the flat to gently sloping terrace on the north side of Red Roof Canyon" and dated the site to be older than 3,000 years based on artifact typology. Gibson conducted sub surface testing employing shovel test pits and concluded that the site was 50-75 percent destroyed but since he did not conduct boundary testing, that portions of the site may remain intact. CA-SBA-2032 was revisited in 1998 by D.R. Harro during construction monitoring who updated the site record to document artifacts identified during construction and the level of disturbance. Harro states that construction of the lower "V-23" parking lot and North Access Road, trenching for the liquid nitrogen pipeline and installation of utility poles resulted in major impacts to the site. Therefore, Harro recommended CA-SBA-2032 as not eligible for listing

on the NRHP. The documented have impacts significantly disturbed the area between CA-SBA-2032 and the proposed Far North Improvement Area.

P-42-041202

P-42-041202 is a built environment resource identified as a military property (HP 34) containing numerous structures and ancillary facilities. Known as Space Launch Complex (SLC)-6, the resource was originally constructed in 1966 on the former Long Ranch of the 1800s and the Sudden Ranch of the late 19th and early 20th centuries. SLC-6 was originally built to support the Manned Orbiting Laboratory (MOL) Program initiated in 1963 that was cancelled in 1969. After a decade, the complex underwent a major reconstruction by the United States Air Force (USAF) in support of the Space Shuttle Orbiter Program. The complex was used to fit test the Program's prototype, Enterprise, but due to the Space Shuttle Challenger explosion at Cape Canaveral in 1986, no shuttle mission was ever conducted at the complex. P-42-041202 was first evaluated by Dames and Moore in 1994 as a Cold War historical built-environment resource and again in 1996 by Nowlan et al. SLC-6 currently contains a single concrete launch pad with launch mount and two exhaust ducts; a mobile service tower; an assembly building; a payload change-out building; a payload preparation room; a LO₂ tank; a LH₂ tank; a sound suppression water deluge system; ancillary buildings and structures; and a 1.5-mile-long railroad spur travels from the Union Pacific mainline to the Solid Rocket Motor Processing Facility immediately west of Lunar Road. As mentioned previously, although the SLC-6 complex and the Space Shuttle Orbiter Program District it is located within were associated with planned launch facilities developed in support of the Space Shuttle program, they were never officially used for that purpose. As such they do not meet the threshold of significance and therefore are considered ineligible for listing on the NRHP.

Landing Zones. The proposed landing zone area has been previously subjected to a pedestrian survey and partially addressed by subsurface testing (Gerber et al. 2023). As previously mentioned, no cultural resources have been identified within the Landing Zone portion of the ASA. The Gerber et al. 2023 study conducted a pedestrian survey of the entire Landing Zone portion of the ASA and nineteen shovel test pits within the southern and central portions of the Landing Zone portion of the ASA. Both the pedestrian survey and subsurface testing efforts did not result in the identification of cultural resources or materials. Following are summaries of resources identified nearest the Landing Zone portion of the ASA. Although all three sites have been determined ineligible for NRHP, summaries for the resources nearest this improvement area are included to demonstrate the type of unknown resources that could potentially exist within this portion of the ASA.

CA-SBA-2217

CA-SBA-2217 is a prehistoric site, measuring approximately 91 meters (300 ft.) north to south by 107 meters (350 ft.) east to west, at an elevation of approximately 475 ft. amsl, and is located approximately 30 meters (100 feet) northeast of the proposed landing zone portion of the ASA. CA-SBA-2217 was originally documented as part of a larger site consisting of three loci (A, B and C) with similar content including uniface, biface and triface manos, cobble chopper and hammer and potential anvil. Based on typology of artifacts, the site was interpreted as dating to pre 3,000 B.P. CA-SBA-2217 was originally formally recorded in 1986 by R.O. Gibson, who described the site as "contains at least 3 subsurface concentrations of ground stone artifacts occurring from 1

to 5 feet below the modern surface and unearthed during construction activity along the gently sloping terrace.” CA-SBA-2217 was revisited in 1996 by R.O. Gibson who updated the site record to reflect the separation of the three loci into three separate archaeological sites: Locus A as CA-SBA-2217, Locus B as CA-SBA-2218, and Locus C as CA-SBA-2219. All three sites were discovered and further observed as a result of pedestrian survey, limited subsurface testing and monitoring and all three were considered ineligible for NRHP.

CA-SBA-2218

CA-SBA-2218 is a prehistoric site, measuring approximately 350 meters (1,150 ft.) north to south by 107 meters (350 ft.) west, at an elevation of approximately 415 ft. amsl, and is located approximately 61 meters (200 feet) west of the proposed landing zone portion of the ASA. Please see summary of CA-SBA-2217 for additional information.

CA-SBA-2219

CA-SBA-2219 is a prehistoric site, measuring approximately 350 meters (1,125 ft.) north to south by 107 meters (675 ft.) east to west, at an elevation of approximately 380 ft. amsl, and is located approximately 274 meters (900 feet) west of the proposed landing zone portion of the ASA. Please see summary of CA-SBA-2217 for additional information. CA-SBA-2217 was originally documented as part of a larger site consisting of three loci (A, B and C) with similar content. Cultural material observed at this site during separate studies includes multiface and uniface manos, as well as utilized flake tools and a single crescent. Based on typology of artifacts, the site was interpreted as an Early Period dating to pre 3,000 B.P. CA-SBA-2217 was originally formally recorded in 1986 by R.O. Gibson with additional observations made in 1981 during construction of Coast Road; in 1990 by Environmental Solutions that reviewed Gibson’s data and concluded the site has retained little to no integrity and suggested large scale excavations to properly delineate the site boundary; Applied Earthworks conducted testing in 2011 to determine potential effects to the site resulting from a proposed undertaking. All three testing locations within and outside the northern portion of CA-SBA-2219 were negative for cultural resources (no resources found). Like CA-SBA-2217 and -2218, CA-SBA-2219 is considered ineligible for NRHP.

Firebreaks Improvement Area. The proposed north firebreak road improvement and maintenance area has been previously subjected to a pedestrian survey and partially addressed by subsurface testing (Gerber et al. 2023). As previously mentioned, no cultural resources have been identified within the north firebreak road improvement and maintenance area of the ASA. The Gerber et al. 2023 study conducted a pedestrian survey of the entire north firebreak road improvement and maintenance area of the ASA and six shovel test pits within the western portion of the north firebreak road improvement and maintenance area of the ASA. Both the pedestrian survey and subsurface testing efforts did not result in the identification of cultural resources or materials.

The proposed Cypress Ridge and North fire access roads improvement and maintenance area have been previously subjected to a pedestrian survey and partially addressed by subsurface testing (Lebow et al. 2016). Cypress Ridge Road overlaps CA-SBA-1941 for approximately 1.150 meters and the entirety of the site encompasses 181,700 square meters. Pedestrian survey efforts resulted in the identification of only fourteen artifacts including seven manos and seven

pieces of flaked stone. Applied Earthworks conducted 57 shovel test pits (STPs) placed outside but adjacent to the road at regular intervals along the entirety of the linear expanse where the road overlaps CA-SBA-1941. No cultural resources were observed within any of the STPs. Based on the findings, Applied Earthworks deduced integrity of CA-SBA-1941 had been lost within the firebreak road and as a result "this portion of the site does not contribute to the site's assumed National Register eligibility: (Lebow et al. 2016). Following are summaries of resources identified nearest the Firebreak improvement areas to demonstrate the type of unknown resources that could potentially exist within this portion of the ASA.

CA-SBA-1114

CA-SBA-1114 is a prehistoric site, measuring approximately 30 meters (98 ft.) north to south by 43 meters (141 ft.) east to west, at an elevation of approximately 110 m (360 ft.) amsl, and is located immediately adjacent and east of the western terminus of Cypress Ridge Fire Access Road firebreak portion of the ASA. CA-SBA-1114 is documented as containing lithic debitage and one utilized flake tool. CA-SBA-1114 was originally formally recorded in 1974 by W.B. Sawyer, who described the site as "no midden;/chert flakes; no shell" and "aboriginal; shipping site; occasional use". Sawyer noted that the site had been disturbed by previous road and railroad realignment activities. CA-SBA-1114 was revisited in 2020 by Pitts-Olmeda et al. who updated the site record to document excavations they had conducted to establish the site boundary and evaluate the site's eligibility for listing on the NRHP. Twenty-one shovel test pits and two 0.5 by 1 meter test units were conducted. Based on the results of the excavations, Pitts-Olmeda et al. determined that CA-SBA-1114 does not meet the criteria for listing eligibility on the NRHP.

CA-SBA-1686

CA-SBA-1686 is a prehistoric site, measuring approximately 100 meters (328 ft.) north to south by 70 meters (230 ft.) east to west, at an elevation of approximately 212 m (696 ft.) amsl, and is located approximately 19 m (64 ft) northeast of the western terminus of Cypress Ridge Fire Access Road firebreak portion of the ASA. CA-SBA-1686 is documented as containing Monterey chert and obsidian debitage, chert bifacial tools, hammerstones, manos, chert cores and andesite and shale flakes. CA-SBA-1686 was formally recorded in 1981 by J. Serena, who described the site as "deep deposit of chert debitage and tools, sandstone manos and hammerstones, obsidian and andesite and shale debitage". Serena conducted a "block" and four unit excavations; results and interpretation are not provided in site record. However, Serena does state that "all but the southeast corner of the site had been destroyed by construction", likely of the V-33 external tank processing and storage facility depicted on the site map. Although the site has been subjected to exploratory excavations, the results and interpretation are not available and therefore a formal evaluation results of the site's eligibility for NRHP listing is unknown. However, based on the information available in the site record and the level of disturbance, the site appears ineligible for listing eligibility on the NRHP.

CA-SBA-2212

CA-SBA-2212 is a prehistoric site, measuring approximately 80 meters (262 ft.) north to south by 63 meters (207 ft.) east to west, at an elevation of approximately 212 m (696 ft.) amsl, and is located approximately 290 m (950 ft) southeast of the Cypress Ridge Fire Access Road firebreak portion of the ASA. CA-SBA-2212 is documented as containing Monterey chert flakes, one

sandstone mano with pecking and polish and located along a long narrow ridge/terrace with a possible rock outcrop just below that may provide water. Based on typology of artifacts, the site was interpreted as dating to the Early Period potentially connected to CA-SBA-1941. CA-SBA-2212 was originally formally recorded in 1989 by R.O. Gibson, who described the site as "a trace to light density pf Monterey chert flakes and one mano..."; Gibson noted that the site was in excellent condition. CA-SBA-2212 was revisited in 2009 by S. Garza and S. James who updated the site record describing no change in the constituents of the site, but that the condition was disturbed by burrowing animals and game trails. CA-SBA-2212 has not been subjected to subsurface investigations to fully delineate the site boundary nor has it been evaluated for listing on the NRHP.

CA-SBA-2213

CA-SBA-2213 is a prehistoric site, measuring approximately 57 meters (187 ft.) north to south by 18 meters (59 ft.) east to west, at an elevation of approximately 216 m. (709 ft) amsl, and is located approximately 205 m (675 ft) southeast of Cypress Ridge Fire Access Road firebreak portion of the ASA. CA-SBA-2213 is documented as containing "3 tan sandstone manos, all completed with well used and polished surfaces, one is a biface with slight edge grinding, two are trifacial with canting on the edge," and one thin fragment of a basin metate. Based on typology of artifacts, the site was interpreted as dating to the Early Period. CA-SBA-2213 was originally formally recorded in 1988 by R.O. Gibson, who described the site as "a concentration of three mons and one metate fragment located at the southern edge of a small terrace bounded by very steep side overlooking an unnamed drainage"; Gibson noted that the site was in excellent condition with the exception of four small "blowouts" in the center of the site where the sandstone artifacts were identified suggesting that yet unidentified cultural deposits exist subsurface. CA-SBA-2213 was revisited in 2009 by S. Garza and S. James who updated the site record describing no change in the constituents or condition of the site. CA-SBA-2213 has not been subjected to subsurface investigations to fully delineate the site boundary nor has it been evaluated for listing on the NRHP.

CA-SBA-2214

CA-SBA-2214 is a prehistoric site, measuring approximately 155 meters (509 ft.) north to south by 101 meters (331 ft.) east to west, at an elevation of approximately 204 m (669 ft). amsl, and is located approximately 215 m (700 ft) east of Cypress Ridge Fire Access Road firebreak portion of the ASA. CA-SBA-2214 is documented as containing light brown/pink mottled chert flake (blade), one long primary Monterey chert flake, and a bluish color Olivella biplicate shell with a chipped spire, that could potentially be a bead. Based on initial observation, the site was interpreted as potentially dating to the Early Period. CA-SBA-2214 was originally formally recorded in 1988 by R.O. Gibson, who described the site as "a trace density concentration of chert flakes on a densely vegetated terrace overlooking the lower coastal terraces and the ocean to the south"; Gibson noted that the site appeared intact but had been subjected to fires that burned the surface. CA-SBA-2214 was revisited in 2009 by S. Garza and S. James who updated the site record describing no change in the constituents or condition of the site. CA-SBA-2213 has not been subjected to subsurface investigations to fully delineate the site boundary nor has it been evaluated for listing on the NRHP.

VAFB-ISO-318

VAFB-ISO-318 is a prehistoric isolate, found at an elevation of 230 ft. amsl, and is located approximately 9 m (30 ft) east of the Cypress Ridge Road firebreak portion of the ASA. VAFB-ISO-318 is documented as a well-shaped basalt hammerstone. It is standard practice that isolated artifacts are not eligible for listing in the NRHP or the CRHR; therefore, VAFB-ISO-318 has not been formally evaluated for listing on the NRHP or the CRHR.

VAFB-ISO-319

VAFB-ISO-319 is an isolate of unknown origin, found at an elevation of 200 ft. amsl, and is located approximately 201 m (660 ft) southeast of the Cypress Ridge Road firebreak portion of the ASA. VAFB-ISO-319 is documented as six to ten shell fragments. It is standard practice that isolated artifacts are not eligible for listing in the NRHP or the CRHR; therefore, VAFB-ISO-319 has not been formally evaluated for listing on the NRHP or the CRHR.

VAFB-ISO-320

VAFB-ISO-320 is an isolate of unknown origin, found at an elevation of 280 ft. amsl, and is located approximately 34 m (110 ft) east of the Cypress Ridge Road firebreak portion of the A8. VAFB-ISO-320 is documented as a light brown Monterey chert primary flake. It is standard practice that isolated artifacts are not eligible for listing in the NRHP or the CRHR; therefore, VAFB-ISO-320 has not been formally evaluated for listing on the NRHP or the CRHR.

Off-Base within Lompoc Valley. A cultural resource records search of the CHRIS revealed that large portions of the cultural resources study area located within off-base portion of the Lompoc Valley and surrounding areas have been previously surveyed for cultural resources resulting in the identification of at least 1,920 previously recorded cultural resources within this portion of the ASA. Of these resources, one archaeological site and eleven historic-age buildings fit the criteria previously outlined as those with above-ground buildings, structures, or objects that are NRHP-listed or eligible and could potentially be affected by launch noise vibrations and sonic boom overpressure.

Table 2. NRHP-listed or Eligible Cultural Resources Located - Lompoc Valley Area of CRSA

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
_70000147	Built Environment	La Purisima Mission	Adobe mission buildings	Listed
_78000891	Built Environment	Point Conception Lighthouse	Stucco, brick and wooden tower building	Listed
_90001818	Built Environment	Lompoc Public Library (Carnegie)	Masonry building	Listed
_16000664	Built Environment	Lompoc Veterans Memorial Building	Masonry building	Listed

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
_78000775	Built Environment	Mission de la Purisima Concepcion de Maria Santisima Site	Adobe mission buildings	Listed
OTIS ID: 488380	Built Environment	Artesia School	Wood-frame building	Eligible
P-42-003865	Built Environment	Well, Hill 4	Oil well	Eligible
OTIS ID: 565260	Built Environment	Spanne Building	Wood-frame building	Eligible
OTIS ID: 565254	Built Environment	105 H St Building	Wood-frame building	Eligible
OTIS ID: 689985	Built Environment	U.S. Army Disciplinary Barracks, U.S. Lompoc Prison	Masonry building	Eligible
OTIS ID: 533649	Built Environment	Lompoc Theater	Masonry building	Eligible
P-42-040480	Archaeological	Site of Original Mission and remaining ruins of buildings of Mission de la Purisima Concepcion de Maria Santisima	Adobe ruins	Eligible

Northern Channel Islands (San Miguel Island, Santa Rosa Island, and Santa Cruz Island). A cultural resource records search of the CHRIS conducted revealed that large portions of the cultural resources study area located within the NCI have been previously surveyed for cultural resources resulting in the identification of at least 2,204 cultural resources. All three islands, San Miguel, Santa Rosa, and Santa Cruz are NRHP-listed as archaeological districts encompassing the entirety of their respective islands. For the purposes of this study, all contributing resources within the districts are assumed eligible for the NRHP. Likewise, the historic buildings present on Santa Cruz Island are NRHP-listed as the Santa Cruz Island Ranching District. Historic properties on the NCI include historic ranches and archaeological deposits, and prehistoric Native American archaeological sites. Historic buildings and archaeological sites include wood-frame, masonry, adobe construction and adobe ruins. The prehistoric sites consist of Native American shell middens, burials, habitation sites, and lithic scatters.

Table 3. NRHP-listed/eligible Cultural Resources Located – Northern Channel Islands Area of CRSA

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
Santa Cruz Island				
_80000405 & _100007199	Archaeological	Santa Cruz Island Archeological District	Various types of archaeological sites	Listed
OTIS ID: 529803	Built Environment	Santa Cruz Island Ranching District	Various structure types: wood-frame, masonry, and adobe construction	Eligible

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
Santa Rosa Island				
_100007896	Archaeological	Santa Rosa Island Archaeological District	Various types of archaeological sites	Listed
OTIS ID: 529721	Built Environment	Santa Rosa Island Ranch – China Camp Cabin	Wood-frame building	Eligible
OTIS ID: 529722	Built Environment	Santa Rosa Island Ranch – Clapp Springs	Wood-frame building	Eligible
OTIS ID: 529725	Built Environment	Santa Rosa Island Ranch – Horse Barn	Wood-frame building	Eligible
OTIS ID: 529726	Built Environment	Santa Rosa Island Ranch – Main Ranch House	Wood-frame building	Eligible
OTIS ID: 529728	Built Environment	Santa Rosa Island Ranch – Old School House	Wood-frame building	Eligible
OTIS ID: 529738	Built Environment	Santa Rosa Island Ranch – Rope House	Wood-frame building	Eligible
OTIS ID: 529747	Built Environment	Santa Rosa Island Ranch – Army Camp Water System	Wood-frame building	Eligible
OTIS ID: 529748	Built Environment	Santa Rosa Island Ranch – South Point Lighthouse	Wood-frame building	Eligible
San Miguel Island				
_79000258	Archaeological	San Miguel Island Archaeological District	Various types of archaeological sites	Listed
4-SMI-456	Built Environment	Nidever Adobe	Adobe ruins	Eligible
Unknown	Built Environment	Waters Ranch House Site	Wood-frame building	Eligible

PEDESTRIAN SURVEY

An archaeological intensive pedestrian survey of the ASA (LZ/F) was completed by Langan's archaeological technician staff on March 1, 4, 5, 7, 20, and 21, 2024 under the direction of this study's Principal Investigator, Heather McDaniel McDevitt, RPA. Careful attention was given to barren ground including at the base of the chaparral, within ephemeral paths/trails, and any subsurface soils exposed by burrowing animals. Ground surface visibility within the proposed Project site was variable and as such, in areas of dense ground coverage, surface scrapes were occasionally implemented, when necessary, to enhance detection of archaeological materials that

may have been obscured on the surface. Four distinct visibility conditions were afforded: 1) within the northwestern portion of ASA (representing approximately 10 percent of the surveyed area) that was relatively clear of vegetation with general ground visibility of good to excellent (60-100 percent); 2) within the southeastern portion of the ASA (representing approximately 5 percent of the surveyed area) that was relatively clear of dense vegetation but possessed a meadow of annual grasses and poppies with general ground visibility of fair to good (40-80 percent); 3) within the areas of the ASA (representing approximately 20 percent of the surveyed area) that possessed dense chaparral but within the dense vegetation there were sporadic areas of barren ground and within areas that were minimally cleared by animal trails or with hand tools in order to access the prescribed STP locations, these areas provided general ground visibility of good to excellent (60-100 percent); and 4) within the remainder of the ASA (representing approximately 65 percent of the surveyed area) that possessed dense chaparral with general ground visibility of none to poor (0-20 percent).

No cultural resources or evidence of the potential for the existence of cultural resources were observed during the intensive pedestrian surveys.

SUBSURFACE TESTING

Subsurface testing of the ASA (LZ/F) was completed by Langan's archaeological technician staff on March 5, 7, 12, 13, 14, 15, 19, 20, and 21, 2024 under the direction of this study's Principal Investigator, Heather McDaniel McDevitt, RPA, to determine the absence/presence of cultural artifacts or materials. The locations of the STPs were determined in consultation with the 30 CES/CEIEA and in consideration of the previous subsurface testing conducted (Gerber et al. 2023) within and surrounding the ASA (LZ/F) and that no ground disturbance is proposed in the western portion of the ASA (LZ/F). All STPs were conducted consistent with the methods outlined in the "Methods" section of this report.

In total, fifty-two (52) STPs were attempted seven (7) (5, 6, 9, 10, 15, 16, and 17) of which were abandoned due to the presence of standing water at the ground surface in the central-western portion of the ASA (LZ/F). In addition to the seven STPs that were abandoned due to the presence of standing water, thirty-seven (37) STPs were prematurely terminated at depths between 20 and 140 cm (8 and 55 in) due to the presence of groundwater. The seven most westerly STPs (1, 2, 3, 4, 11, 12, and 13) encountered what appeared to be imported fill within the previously graded area to depths of approximately 40 cm (15 in). Three (3) STPs were prematurely terminated at depths between 100 and 120 cm (39 and 47 in) due to encountering impenetrable rock. Twenty-four (24) STPs were excavated to depths of at least 100 cm (39 in) and five (5) STPs were completed to the full prescribed depth of 150 cm (59 in).

No cultural resources were identified as a result of the subsurface testing which is consistent with the negative findings of the subsurface testing conducted by Gerber et al. in 2023. Table 4 provides the results and associated conditions of each STP and Figure 13 provides the locations of all STPs that have been conducted within the ASA (LZ/F) as a result of this investigation as well as those previously conducted in 2023. A detailed accounting of conditions observed during the excavation of each STP can be found in Appendix B and individual excavation can be provided upon request.

Table 4. Subsurface Testing Results

Soil Test Pit (STP)	Depth of Termination (cm)	Volume Excavated (m ³)	Reason for Termination	Cultural Material (Y/N)	Soil Type*
1	150	1.18	Completion of Prescribed Depth	N	GRLS, SL, C
2	150	1.18	Refusal - Groundwater	N	GRSL, SCL, C, SC, C
3	120	0.94	Refusal - Groundwater	N	VGRSL, SC, SCL, SC
4	20	0.16	Refusal - Groundwater	N	SC
5	0	0	Surface Water	N	
6	0	0	Surface Water	N	
7	150	1.18	Refusal - Groundwater	N	SICL, SIL, GRSIL
8	100	0.79	Refusal - Dense Mud (groundwater)	N	VGR/STSIL
9	0	0	Surface Water	N	
10	0	0	Surface Water	N	
11	120	0.94	Refusal - Groundwater	N	SL, GRSL
12	130	1.02	Refusal - Groundwater	N	GRSL, C, GRLS
13	150	1.18	Completion of Prescribed Depth	N	GRSL, SL, C, GRLS
14	140	1.1	Refusal - Impenetrable Rock	N	L, GRL, VGRSL, SL
15	0	0	Surface Water	N	
16	0	0	Surface Water	N	
17	0	0	Surface Water	N	
18	120	0.94	Refusal - Impenetrable Rock	N	GRL, GRSIL, GRSL
19	90	0.71	Refusal - Groundwater	N	GRL, L, C, GRSIL, S
20	120	0.94	Refusal - Groundwater	N	L, SICL, SC, S
21	140	1.1	Refusal - Groundwater	N	L, SICL, SC, S
22	150	1.18	Completion of Prescribed Depth	N	SL, GRSL, LS
23	120	0.94	Refusal - Groundwater	N	L, SICL, SC, S
24	80	0.63	Refusal - Groundwater	N	SIL, GR SICL, GRCL
25	110	0.86	Refusal - Groundwater	N	GRL
26	110	0.86	Refusal - Groundwater	N	VGRL, GRC, GRC
27	80	0.63	Refusal - Groundwater	N	GRL, GRCL, CL
28	80	0.63	Refusal - Groundwater	N	GRL, GRSICL, SICL
29	100	0.79	Refusal - Groundwater	N	GRSIL, SIL, SICL
30	80	0.63	Refusal - Groundwater	N	XGRL, GRSC, GRSC
31	60	0.47	Refusal - Groundwater	N	VGRL, GRSL, SC, GRSC
32	140	1.1	Refusal - Groundwater	N	GRL, GRSC
33	70	0.55	Refusal - Groundwater	N	L, GRL
34	80	0.63	Refusal - Groundwater	N	L
35	80	0.63	Refusal - Groundwater	N	SIL, C
36	150	1.18	Completion of Prescribed Depth	N	L

Soil Test Pit (STP)	Depth of Termination (cm)	Volume Excavated (m ³)	Reason for Termination	Cultural Material (Y/N)	Soil Type*
37	80	0.63	Refusal - Groundwater	N	SIL
38	80	0.63	Refusal - Groundwater	N	SIL
39	150	1.18	Completion of Prescribed Depth	N	L, GRL, SIL, GRSIL, SL
40	80	0.63	Refusal - Groundwater	N	L, SIL, GRSIL, SIL
41	80	0.63	Refusal - Groundwater	N	GRL, V/GRSIL, SICL
42	80	0.63	Refusal - Groundwater	N	GRL, SICL
43	80	0.63	Refusal - Groundwater	N	GRL, GRSIL, SIL, SICL
44	100	0.79	Refusal - Groundwater	N	L, GRSIL, SIL
45	140	1.1	Refusal - Groundwater	N	L, SIL
46	90	0.71	Refusal - Groundwater	N	L, SICL, SIL
47	80	0.63	Refusal - Groundwater	N	L, SIL
48	80	0.63	Refusal - Groundwater	N	SIL
49	130	1.02	Refusal - Groundwater	N	SIL, GRSIL
50	80	0.63	Refusal - Groundwater	N	GRSIL
51	80	0.63	Refusal - Groundwater	N	GRSIL, C
52	100	0.79	Refusal - Impenetrable Rock	N	GRSIL, SIL, GRSL

*Soil trait classifications based on United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) parameters C = clay; CL = clay loam; SIC = silty clay; SICL = silty clay loam; SIL = silt loam; SI = silt; L = loam; SC = sandy clay; SCL = sandy clay loam; SL = sandy loam; LS = loamy sand; S = sand; V = very; X = extremely; GR = gravelly; ST = stoney.

CONCLUSIONS

The Proposed Action is subject to NHPA Section 106 compliance and AFMAN 32-7003, Cultural Resources Management. Section 106 compliance also satisfies federal agencies' NEPA responsibilities to consider potential project-related effects on historic properties. The NHPA, Section 106, requires federal agencies to consider the effects of proposed federal undertakings on historic properties that are listed in or eligible for listing in the NRHP. If a cultural resource is listed in, or eligible for, the NRHP it is considered a "historic property" for purposes of Section 106 and is significant. Compliance with Section 106 requires the federal agency to determine either that the undertaking would have no effect, no adverse effect, or an adverse effect to historic properties (that is, to significant cultural resources). The Section 106 implementing regulations (36 CFR Part 800) prescribe the process for making these determinations.

In consultation with the 30 CES/CEIEA concerning the Proposed Action and its potential for direct and indirect effects to cultural resources resulting from any related construction, static fire, launches, and boost-back landings, an CRSA was determined relative to the auditory effects predicated on vibratory impacts. Based on standard thresholds for potential effects resulting from launch noise and sonic booms, this study was conducted to identify historic properties within areas where noise vibration levels exceed 120 dB and the sonic boom arc exceeds 2psf as a result of the Proposed Action. Additionally, and ASA was established to determine absence/presence of

NRHP eligible cultural resources within areas proposed for ground disturbing or landscape-altering activities.

The 120 dB launch noise contour would extend only slightly outside and east of the VSFB in an uninhabited area with no reported resources. All but one building located on VSFB are associated with launch complexes and supporting infrastructure and are built to withstand concussive forces. The only historic building located on VSFB that is not associated with launch complexes or supporting infrastructure is the former U.S. Coast Guard Lifeboat Rescue Station (P-42-040495). The Colonial Revival architectural style, wood-frame structure was built in 1936 as administrative barracks and ancillary structures. The structures have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6 with no reported and observed effect. Accordingly, there would be no effect to any NRHP eligible resources in the built environment at VSFB from launch noise exceeding 120 dB.

Built environment and archaeological resources located within the CRSA could be subject to sonic booms of up to 4 and 5 psf. Specifically, the 2 psf and greater sonic boom impact area encompasses all of Santa Cruz, Santa Rosa, and San Miguel islands and may reach an overpressure of as much as 5 psf over a very narrow portion of land on the NCI; however, a large portion of the NCI will be exposed to an overpressure no more than of 2–3 psf. Sonic booms are dependent on launch trajectory, inclination, and atmospheric conditions. The Proposed Action is not expected to result in a repeated alignment of the sonic boom overpressure footprint within specific areas of the CRSA and the duration of the overpressure effects are estimated to last less than one second per sonic boom (personal communication with SpaceX staff 2023). Previous studies, experimental analysis and observations of archaeological sites located on VSFB have provided good evidence that archaeological sites consisting of only surface artifacts and/or buried archaeological material do not have the potential to be affected by rocket engine noise exceeding 120 dB and sonic booms exceeding 2 psf. Furthermore, both archaeological and built environment resources within the CRSA have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at SLC-6 with no reported and observed effect.

A reasonable and good-faith effort to identify historic properties within the CRSA pursuant to 36 CFR 800.4(a)-(d) and 36 CFR 800.5(a)-(d) has been conducted by both the 30 CES/CEIEA and Langan. A desktop analysis of archaeological sites and historic-age buildings in the launch noise/sonic boom study area; fieldwork including intensive pedestrian surveys and subsurface testing was conducted within the ASA associated with proposed ground disturbing or landscape-altering activities; and identification of all NRHP eligible cultural resources in the CRSA was conducted and historic properties were assessed for their potential to be affected by the Proposed Action. Based on thresholds established by previous studies, the results of previous experiments and observational assessments (Fenton and Methold 20261; Gibbs 2017; Guest and Sloane 1972; Haber et al. 1989; NASA 2017; Nocerino et al. 2021; and Smallwood personal communication 2023), no NRHP eligible resources with the potential to be adversely effected by proposed actions were identified within the CRSA, and no eligible or NRHP-listed archaeological resources with the potential to be adversely effected proposed actions were identified within the ASA as a result of intensive pedestrian surveys and subsurface testing. Therefore, it is the conclusion of this investigation that it is highly unlikely that identified or yet unidentified historic properties located

MEMO

Cultural Resources Assessments - SLC-6 Modification and Falcon 9 Annual Cadence
Increase at Vandenberg Space Force Base, California and Offshore Landing Locations
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within the NRHP have the potential to be affected by the Proposed Action and the undertaking will have no effect on any known historic properties.

Please do not hesitate to contact Langan at any time with questions or concerns about this investigation. I can be reached at hmcdanielmcdevitt@langan.com or by calling 805-696-0957.



Heather McDaniel McDevitt, RPA
Principal Investigator
Langan Cultural Resources Practice Director

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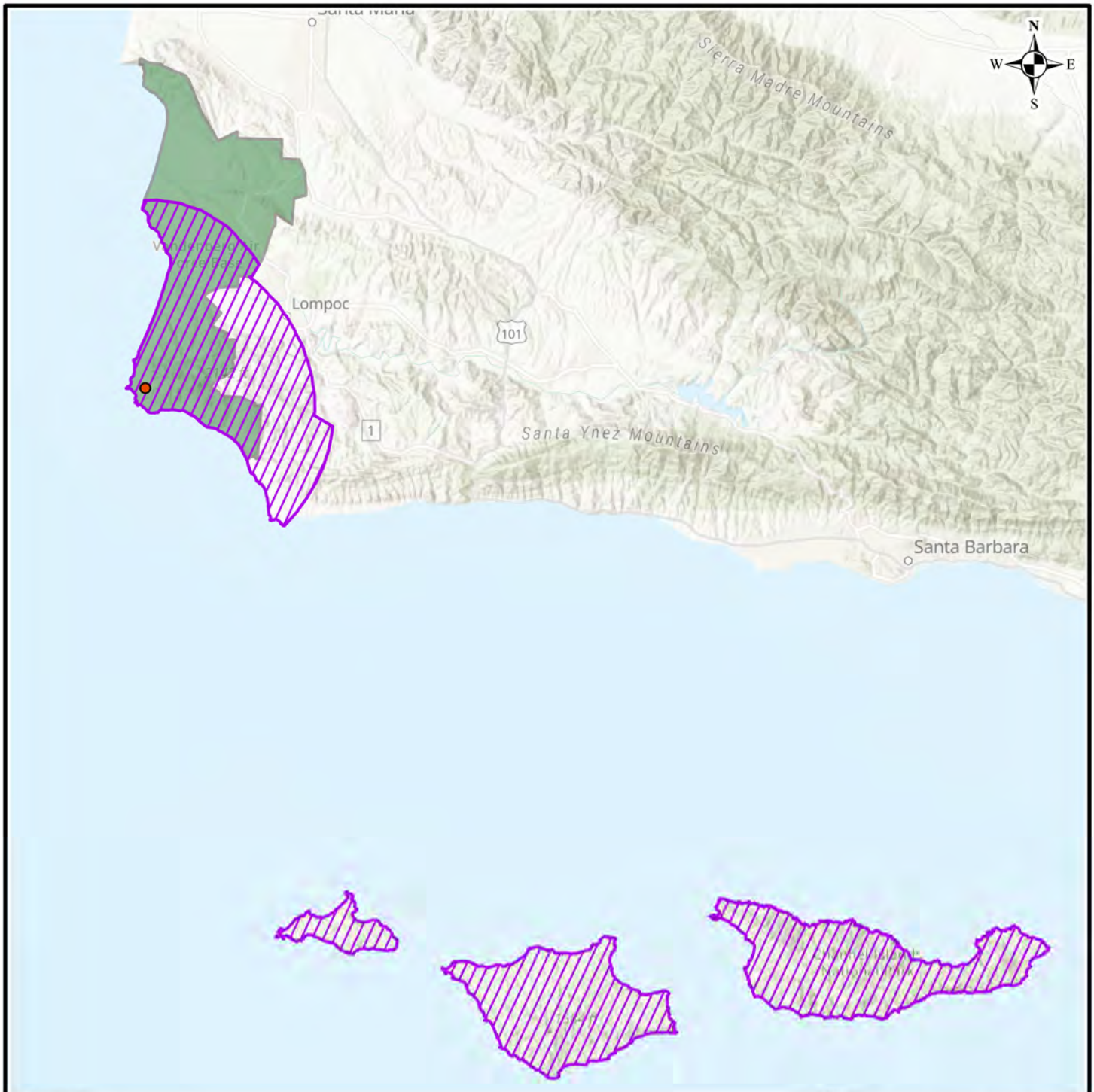
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Legend

- SLC-6 Launch Site
- Cultural Resources Study Area
- Vandenberg AFB

Notes:
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Project

**FALCON LAUNCH CADENCE
 INCREASE AT SLC-4/SLC-6
 & SLC-6 MODIFICATION**

LOMPOC

SANTA BARBARA
 COUNTY

CALIFORNIA

Figure Title

**CULTURAL
 RESOURCES
 STUDY AREA**

Project No.

781017001

Date

4/18/2024

Scale

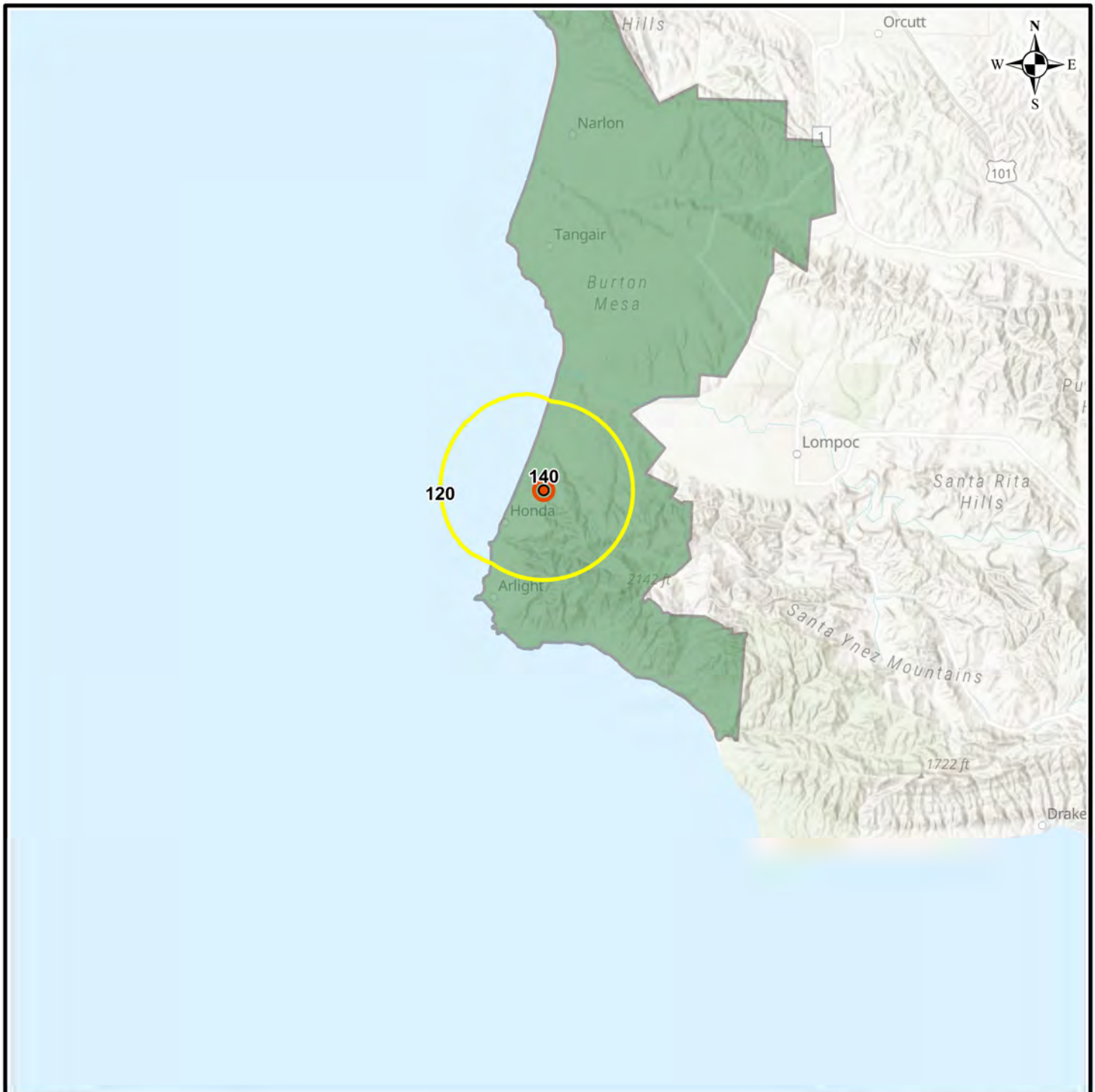
1" = 10 miles

Drawn By

AC

Figure

1



Legend

- SLC-4 Launch Site
- 120 dB
- 140 dB
- Vandenberg AFB

Notes:

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Project

**FALCON LAUNCH CADENCE
INCREASE AT SLC-4/SLC-6
& SLC-6 MODIFICATION**

LOMPOC

SANTA BARBARA
COUNTY

CALIFORNIA

Figure Title

**FALCON 9 ORBITAL
LAUNCH FROM SLC-4:
MAXIMUM UNWEIGHTED
SOUND LEVELS**

Project No.

781017001

Date

4/23/2024

Scale

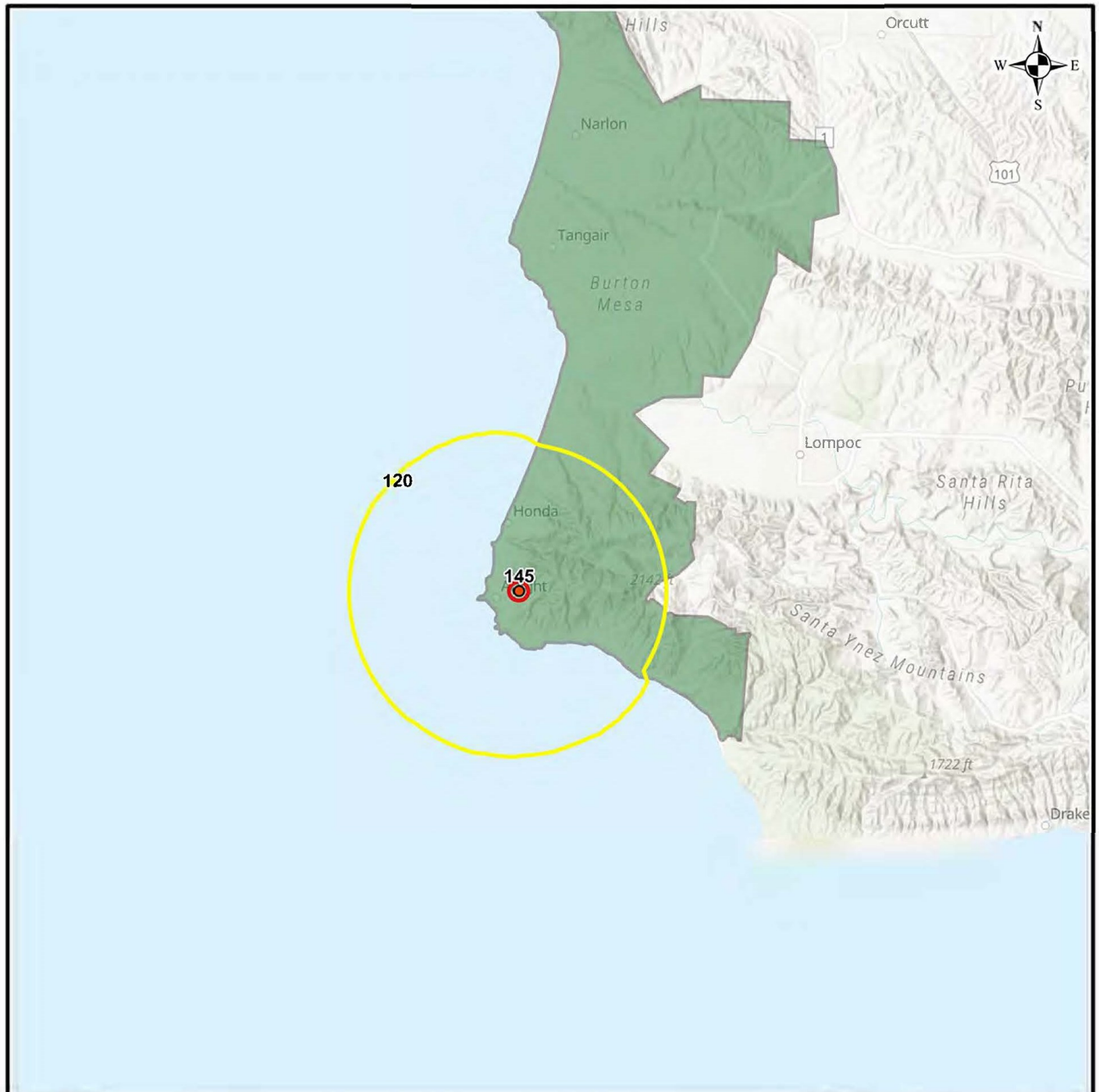
1" = 5 miles

Drawn By

AC

Figure

2

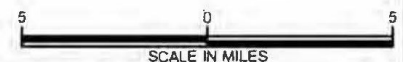


Legend

- SLC-6 Launch Site
- 120 dB
- 145 dB
- Vandenberg AFB

Notes

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Project

**FALCON LAUNCH CADENCE
INCREASE AT SLC-4/SLC-6
& SLC-6 MODIFICATION**

LOMPOC

SANTA BARBARA
COUNTY

CALIFORNIA

Figure Title

**FALCON 9 & FALCON
HEAVY ORBITAL
LAUNCH FROM SLC-6:
MAXIMUM UNWEIGHTED
SOUND LEVELS**

Project No.

781017001

Date

4/23/2024

Scale

1" = 5 miles

Drawn By

AC

Figure

3

APPENDIX B

United States Fish and Wildlife Service Consultation



IN REPLY REFER TO:
2022-0013990-S7-001-R003

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE

Ecological Services
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003



August 21, 2025

Gretchen Swinehart
30 CES/CEI
1028 Iceland Avenue
Vandenberg Space Force Base, California 93437

Subject: Biological Opinion on the Launch, Boost-Back, and Landing of Falcon 9 First Stage cadence increase at Space Launch Complex (SLC) 4 and 6, with introduction of Falcon Heavy vehicle and modifications of SLC-6, Vandenberg Space Force Base, Santa Barbara County, California.

Dear Gretchen Swinehart:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the U.S. Space Force's (Space Force) proposed authorization of the Space Exploration Technologies Corporation (SpaceX; the Applicant) to increase launch cadence from SLC-4 as well as to modify SLC-6 to support Falcon 9 and Falcon Heavy vehicle operations, to increase collective launch cadence to 100 times annually with 24 associated terrestrial landings and 50 static test fires on Vandenberg Space Force Base (VSFB), and its effects on the federally endangered California least tern (*Sterna antillarum browni*) as well as the federally threatened California red-legged frog (*Rana draytonii*), southern sea otter (*Enhydra lutris nereis*), and western snowy plover (*Charadrius nivosus nivosus*), in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 et seq.). We received your April 9, 2025, amended biological assessment and communicated request to initiate formal consultation on April 10, 2025.

We have based this biological opinion on information that followed your April 9, 2025 request for consultation including the revised 2025 biological assessment (SLD 30 2025), 2024 biological assessment (MSRS 2024a), 2022 biological assessment (MSRS 2022a) and associated information obtained during previous reinitiations, and further coordination in 2025 between Space Force and Service staff. Electronic documents related to the consultation are stored at the Ventura Fish and Wildlife Office.

Definitions Related to Launch Noise and Overpressure Disturbance

The Service includes brief descriptions on launch noise and overpressure disturbance that will be referenced in the following 'Not Likely to Adversely Affect Determination' sections. More

specific detail on this modeling can be located under ‘Project Description’ found later in this document.

Rocket Noise

Rockets generate different noise events during operation – the noise from rocket engines during launch and landing, and then the sonic boom noise from the vehicle reaching supersonic speeds during ascent and descent.

The intensity of sound is measured on a logarithmic scale in decibels (dB). The highest sound level measure during a single event is called the $L_{\max}$. For the project description and our analysis, we will refer to the intensity of sound in unweighted dB and thus $L_{\max}$. Converting dB to dBA, an adjusted scale corresponding to the frequency range of human hearing [approximately 20 Hertz (Hz) to 20,000 Hz], requires additional information from the noise source that is not always available or documented. As such, we will only refer dBA in our analysis when the existing relevant scientific literature uses this scale.

Sonic booms produce disturbance in the form of overpressure, which is a high energy impulsive noise disturbance (BRRC 2020, p. 32). Throughout the document, sonic booms are represented in units of pounds per square feet (psf) and have an associated noise event represented in unweighted dB. We have included Table 1 that provides conversions of psf to dB.

Table 1. Noise metric conversion table.

Sonic Boom Overpressure (psf)	Unweighted Sound Pressure Level (dB)
0.1	107.58
0.3	117.12
0.5	121.56
1	127.6
2	133.6
4	139.6
6	143.1
10	147.6
11	148.4
15	151.1
21	154

The Federal Aviation Administration (FAA) provides that in humans, acute exposure to 120 dB noise may cause ear discomfort, 130 dB may cause ear pain, and 140 dB may cause eardrum rupture (FAA 2025, p. 2). The Service will also include the FAA’s sound level comparison chart (Appendix A, Figure 1A) that describes lower realized noise levels to help contextualize the proposed project’s levels of noise disturbance (FAA 2022).

The Space Force provided modeling outputs of rocket noise and sonic boom levels from the Falcon 9 and Falcon Heavy launches overlapping with species locality and habitat. These figures can be found in the Appendix A, Figures 2A–X, 3A–P, and 4A–N.

Launching, Static Test Fire, and Landings

Up to 100 launches of the Falcon 9 and Falcon Heavy vehicles would occur from a combination of SLC-4 and SLC-6. Each of the 100 launches generate noise disturbance from the ignition of the rocket fuel and would attenuate outward in all directions. Noise disturbances from Falcon Heavy would be greater than Falcon 9 due to vehicle size and additional booster engine.

A total of 50 static test fires could occur one to three days before a full launch and are considered separate from launch disturbance. Static test fires would impact a smaller portion of a full launch disturbance footprint and last for approximately 7 seconds. This is a separate and distinct disturbance event that is not comparable or substitutable to a full launch event. A static test fire noise event would attenuate at shorter distances and does not create associated sonic booms.

Lastly, all launches would have a vehicle landing (boost-back) event. Up to 24 of these vehicle landings could occur at VSFB (terrestrial boost-back) or up to 100 landings could occur on a barge located in the ocean. Each event, regardless of land location, would generate a sonic boom. The landings would occur approximately between 6 and 10 minutes following a launch ascent. During the 24 Falcon-9 and Falcon Heavy boost-backs, overpressure levels would be up to 9.5 psf at SLC-4 and 13 psf at SLC-6. The Space Force determined that sonic booms on barges would be directed at the ocean surface without impacting any land.

Launch Ascent Sonic Boom Modeling (Mainland California)

The Space Force has included specific sonic boom modeling for the proposed project's launch ascent easterly trajectories that will be referenced in the following 'Not Likely to Adversely Affect Determination' sections. More specific detail on this modeling can be found in 'Project Description; Launch Sonic Boom (Overpressure Disturbance); Mainland California (Southeastern Santa Barbara, Ventura, and Los Angeles Counties) – Launch Ascent'.

To briefly summarize, the Space Force indicated that although 100 launches could occur annually, it is unreasonable to assume that all of them would have an easterly trajectory, producing a sonic boom on mainland California. Since the Space Force was unable to forecast how many easterly trajectories would occur in any year, for our analysis we assume approximately 75 percent of launches that occur annually could utilize the easterly trajectory based off information provided in past analyses (Service 2024a, p. 3)

When sonic booms will occur in certain areas is not fully understood. Mainland sonic booms caused by launch ascents are most likely to occur during winter months with colder atmospheric conditions. The modeling provided by Space Force indicates that the launch ascent sonic booms that would impact mainland California areas would be reasonably certain to be less than 1 psf (Table 2) (SLD 30 2025, p. 18). Referencing the above noise tables (Table 1), 1 psf is equivalent

to approximately 127 dB, a non-discountable acute noise event. Further, coordination with NASA indicates that the Applicant produced sonic boom modeling may underpredict the impacted region (NASA pers. comm., 2024a). Until more information becomes available, we will only analyze the available sonic boom modeling provided as part of the proposed action (Appendix A, Figures 4A–N, Overpressure Effect Area). Any changes to the described proposed project and action area could warrant reinitiation as described at the end of this document.

Table 2. Proportion of sonic boom ranges (psf) provided by the Space Force overlapping eastern Santa Barbara, Ventura, and Los Angeles Counties (SLD 30 2025, p. 18).

County	Percentage of Sonic Boom Levels Overlapping			
	0–1 psf	1–2 psf	2–3 psf	3+ psf
Santa Barbara	12.0%	7.8%	1.3%	0.3% (3.7 psf)
Ventura	84.7%	19.5%	2.9% (2.3 psf)	0%
Los Angeles	100% (0.8 psf)	0%	0%	0%

Biologist Definitions

Avoidance and minimization measures included in this biological opinion require various levels of biological competency from personnel completing specific tasks, as defined below:

- **Permitted Biologist**: Biologist with a valid and current Section 10(a)(1)(A) Recovery Permit issued by the Service or specifically named as a Service Approved Biologist in a project-specific biological opinion. The Space Force will coordinate with the Service prior to assigning Permitted Biologists to a specific project.
- **Service Approved Biologist**: Biologist with the expertise to identify listed species and species with similar appearance. The Space Force will review and approve the resumes for each individual and then submit them to the Service for review and approval no less than 30 days prior to the start of the project. A Service Approved Biologist could train other biologists and personnel during surveys and project work; in some cases, a Service Approved Biologist could also provide on-site supervision of other biologists.
- **Qualified Biologist**: Biologist trained to accurately identify specific federally listed species and their habitats by either a Permitted or Service Approved Biologist. This person could perform basic project monitoring but would need to have oversight from a Permitted or Service Approved Biologist. Oversight will require a Permitted or Service Approved Biologist to be available for phone/electronic mail consultation during the surveys and to have the ability to visit during monitoring/survey activities if needed.

NOT LIKELY TO ADVERSELY AFFECT DETERMINATION

The Space Force’s request for consultation also included the determination that the proposed action may affect but is not likely to adversely affect the federally threatened marbled murrelet (*Brachyramphus marmoratus*), light-footed Ridgway’s rail (*Rallus obsoletus levipes*), and coastal California gnatcatcher (*Poliophtila californica californica*), as well as the federally endangered short-tailed albatross (*Phoebastria albatrus*), southwestern willow flycatcher

(*Empidonax traillii extimus*), least Bell's vireo (*Vireo bellii pusillus*), Hawaiian petrel (*Pterodroma sandwichensis*), California tiger salamander (*Ambystoma californiense*), California condor (*Gymnogyps californianus*), unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), tidewater goby (*Eucyclogobius newberryi*), and arroyo toad (*Anaxyrus californicus*). The Space Force also requested concurrence with their determination that the proposed project may affect but is not likely to adversely affect critical habitat for the western snowy plover.

Conservation Measures Implemented Under the Programmatic Biological Opinion

The Space Force will continue to implement the following measures as required under the Programmatic Biological Opinion (PBO; 8-8-12-F-49R) or as part of the ongoing reinitiation of the PBO that are also relevant to this proposed action. Until the final reinitiated PBO is complete, the Space Force will ensure these measures are completed as part of this consultation:

- PBO-1 The Space Force will have a Qualified Biologist conduct marbled murrelet population surveys at the current levels to monitor the frequency and distribution of marbled murrelets within the action area.

- PBO-2 The Space Force will determine if California condors are present by coordinating with the Service and Ventana Wildlife Society personnel on a quarterly basis and/or via direct access to Condor tracking platforms utilized by the Service. The Space Force will contact the Service if California condors appear to be near or within the area affected by a launch from SLC-4 or SLC-6. In the unlikely event that a California condor is nearby, Qualified or Permitted Biologists will monitor California condor movements in the vicinity of VSFB and coordinate with the Service to analyze data before, during, and after launch events to determine whether any changes in movement occur. The Space Force will coordinate with the Service, California Condor Recovery Program, and Ventana Wildlife Society to keep updated on recent California condor movement patterns and observations.

- PBO-3 The Space Force will require that project-related boats that utilize the harbor during hours of darkness operate under a lighting management plan to reduce potential impacts to rafting southern sea otter and other marine mammals from visual disturbance.

- PBO-4 As depicted in the 2022 Programmatic Biological Assessment, the Space Force will require the project proponent to adhere to the following measures in regard to watercraft speed within and adjacent to the VSFB Harbor: a) Within the harbor during hours of daylight, personnel will maintain a speed of less than 11.5 miles per hour (10 knots) if southern sea otter are present and maintain a minimum of 80 feet of separation from rafting southern sea otter; b) Within the harbor during hours of darkness, personnel will maintain a speed of less than 11.5 miles per hour (10 knots) at all times; c) Outside the harbor, personnel will maintain speeds

of less than 17 miles per hour (15 knots) within depths of less than approximately 80 feet which correlates to approximately 5.5 miles from shore; d) Outside the harbor during hours of daylight, personnel will maintain a minimum of 325 feet of separation from rafting southern sea otter and 30 feet of separation from kelp. If this separation distance is determined to be infeasible in coordination with the Qualified Biologist, personnel will maintain a 'no wake' speed (5 miles per hour/4.3 knots) when within 30 feet of kelp.

PBO-5 The Space Force will have a Qualified Biologist conduct point count surveys for least Bell's vireos on VSFB and at potential breeding habitats at the Santa Ynez River adjacent to Buellton, California during the breeding season (May 15 through August 15) concurrent with routine riparian bird surveys on VSFB.

PBO-6 The Space Force will have a Qualified Biologist conduct point count surveys for southwestern willow flycatchers on VSFB and at potential breeding habitats at the Santa Ynez River adjacent to Buellton, California during the breeding season (May 15 through August 15) concurrent with routine riparian bird surveys on VSFB.

Least Bell's Vireo

Least Bell's Vireo Occurrence on VSFB

There are no records of, or suitable habitat for, least Bell's vireo within the proposed construction and demolition area of SLC-6. However, there is potential habitat for least Bell's vireo within the launch noise and overpressure effects area on VSFB.

Over 20 years ago, there were two documented non-breeding occurrences of least Bell's vireo recorded east of the 13th Street Bridge and Santa Ynez River crossing, approximately 7.6 miles northeast of SLC-6 (See Appendix A; Holmgren and Collins 1999, as seen in Tetra Tech 2020, p. 30). The least Bell's vireo was not detected in riparian point count surveys conducted on VSFB in 1998, annually from 2000 to 2005, 2008, or 2010 (SLD 30 2025, p. 79). In addition, least Bell's vireos were not observed during biological surveys in 2018 and 2019 (Service 2020a, p. 2). However, one lone male was detected on VSFB in June 2023 on the Santa Ynez River near the 13th Street Bridge (SLD 30 2025, p. 78). The lone male was not detected on follow-up surveys and was presumed to be a transient unpaired male (SLD 30 2025, p. 78).

Near the 13th Street Bridge, suitable least Bell's vireo breeding and non-breeding transitory habitat would experience variable noise disturbance exposure between 100 to 120 dB (considered across 50 static test fires, 100 full launch ascents, and 24 terrestrial landings) lasting between 7 seconds to up to one minute. During the 24 terrestrial landings, least Bell's vireo would also experience sonic boom overpressure exposure of 2 to 4 psf (133 to 139 dB), each lasting a fraction of a second. Annually, the various disturbance events would be separated by 1 to 2 days for both SLC-4 and SLC-6 operations.

Least Bell's Vireo Occurrence Outside of VSFB

Buellton and Santa Maria

Within the proposed project launch noise and overpressure effects areas located off base, the least Bell's vireo has been recorded at the Santa Ynez River adjacent to Buellton, approximately 24.5 miles east of SLC-6, and along the Sisquoc River in the Santa Maria Valley at locations approximately 28 to 30.1 miles northeast of SLC-6 (See Appendix A, Figures 2A–C, 3A–B, and 4A).

At the Santa Ynez River adjacent to Buellton, one territorial male was detected in 2016 and presumed to be unpaired based on behavior (CNDDDB 2023). At this location, a single male was detected again in 2020, a transient male in 2021, and a territorial male in 2022 (Griffith Wildlife Biology 2022, p. 2). Breeding attempts and behavior were documented at this location in 2020 but failed due to predation and incomplete nest building (Griffith 2020). Occupied least Bell's vireo breeding habitat located off VSFB along the Santa Ynez River adjacent to Buellton would experience noise exposure from Falcon 9 engine noise between approximately 100 to 107 dB up to a minute 100 times annually during the proposed project (Table 3) (SLD 30 2025, p. 147). Breeding least Bell's vireo in this area could also experience overpressure exposure between 1 to 1.5 psf (127.6 to 131.1 dB) from Falcon 9 and Falcon Heavy landing events (Table 4) (SLD 30 2025, p. 147).

Along the Sisquoc River in the Santa Maria Valley, four singing males were detected in 2021 (Griffith Wildlife Biology 2021). In 2022, four paired males were detected and three of those pairs successfully raised young (Griffith Wildlife Biology 2022). The least Bell's vireo was again detected in this area in 2023 (Griffith 2024). Occupied least Bell's vireo breeding habitat located off VSFB along the Sisquoc River in the Santa Maria Valley would experience noise exposure from launch noise by Falcon Heavy between 100 to 110 dB for up to a minute, once a day up to five times a year (SLD 30 2025, p. 147). The models provided by the Space Force indicated that launch noise from Falcon 9 would not overlap with occupied breeding habitat along the Sisquoc River in the Santa Maria Valley (Appendix A, Figures 2A–B).

Mainland California (Los Angeles, Santa Barbara, and Ventura Counties)

The least Bell's vireo occupies riparian habitats across Los Angeles, Santa Barbara, and Ventura Counties within the action area. Namely, breeding least Bell's vireos have been reported within the Upper Santa Ynez River, Ventura River, Santa Clara River, and Piru Creek within the last 5 years (SLD 30 2025, p. 79). Within 6.2 miles of their modeled localities, least Bell's vireos are predicted to be exposed to up to 3 psf (139 dB) whenever the launches occur with an easterly trajectory (SLD 30 2025, p. 149).

Effects to the Least Bell's Vireo on VSFB

Construction and Demolition at SLC-6

Least Bell's vireos are not expected to occur within the project's construction and demolition

area due to lack of suitable habitat and documented occurrences. As a result, we do not anticipate any effects to least Bell's vireo from construction or demolition activities.

Operations

For up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires per year, the potential project effects would be limited to the proposed project's noise and overpressure effects area (Table 3 and Table 4). No breeding records for the least Bell's vireo have been documented on VSFB, and so we assume only infrequent transitory unpaired males could be affected if their presence overlapped with proposed project disturbance area. In the unlikely event a transitory individual was present during a launch, we anticipate that overpressure and noise exposure events could briefly affect behavior and cause a startle response. Since there has been no documented breeding on VSFB, our records are limited to infrequent transitory males, and the expectation that any effect would be limited to a temporary startle, we anticipate that effects from the proposed action would be insignificant.

Effects to the Least Bell's Vireo Outside of VSFB

Construction and Demolition at SLC-6

The project's construction and demolition effects do not extend off VSFB, therefore we do not anticipate any effects to least Bell's vireo from construction activities.

Operations

Buellton and Santa Maria

Sonic boom overpressure and noise exposure events may affect historic and extant nesting habitat of least Bell's vireo at the Sisquoc River in the Santa Maria Valley and along the Santa Ynez River adjacent to Buellton by disturbing birds frequently (2 to 3 times a week) during the breeding season (Table 3 and 4).

Table 3. Estimated engine noise (dB L_{max}) from Falcon 9 and Falcon Heavy historic and extant Bell's vireo localities (SLD 30 2025, p. 147).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Santa Ynez River	110	105	118	118	108	112	112	106	116
Buellton	<100	<100	102	<100	<100	102	100	<100	107

Table 4. Estimated sonic boom levels (psf) and equivalent noise event (dB) from Falcon 9 and Falcon Heavy landings at historic and extant least Bell's vireo localities (SLD 30 2025, p. 147).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
13th Street Bridge	4–5	139.6–141.6	2.5	135.5	2.5	135.5
Buellton	1–1.5	127.6–131.1	1–1.5	127.6–131.1	1–1.5	127.6–131.1

We anticipate this level of novel, acute disturbance may cause a startle and stress response, which could potentially result in individuals flushing from the nest. However, the overpressure event produced by the sonic boom will be very brief in duration, lasting a fraction of a second (BRRC 2020, p. 32). Least Bell's vireos exhibit a high degree of nest site fidelity (Kus 2002, entire) and have demonstrated successful territory establishment in routinely noisy environments, including other routine military air operations (Tetra Tech 2020, p. 44). Therefore, we anticipate that least Bell's vireos would likely exhibit a high degree of nest tenacity and continue to be able to successfully breed within these areas. We expect that any response to sonic boom and engine noise would be temporary, the number of individuals that may be impacted is likely small, and existing monitoring indicates that effects would be overall insignificant.

Noise and overpressure modeling for the proposed action did not incorporate adjacent topography. Surrounding topographic features may serve to attenuate both noise and overpressure levels produced from the proposed project (Bermingham 2013, pp. 19–21). This may result in overall lower levels of overpressure and noise reaching any potential least Bell's vireo breeding territories than originally predicted. The Space Force indicates that consequently, the provided modeling is a conservative estimate.

Mainland California (Los Angeles, Santa Barbara, and Ventura Counties)

Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 88 percent could create sonic booms with the potential to impact least Bell's vireos within the identified occupied localities (SLD 30 2025, p. 148). Although least Bell's vireos that occur in Santa Barbara, Ventura, and Los Angeles Counties could experience ascent sonic booms up to 3.7 psf (139 dB), the Space Force has indicated this is extremely unlikely to occur. The majority of potential sonic booms would be between 0 to 2 psf (133 dB) (SLD 30 2025, p. 149). However, recent information indicates that 0.1 to 1 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review Space Force's produced audiograms with subject matter experts. These experts have consistently provided opposing conclusions and have recommended that until additional information is provided, it is unclear if the species can perceive the sonic boom (J. Tennesen, pers. comm., 2022; R. Dooling, pers. comm., 2024)

As discussed above, we expect that any response to the proposed project's sonic boom would be temporary, and existing monitoring indicates that effects would be overall insignificant. We also understand that realized sonic booms produced on the mainland from launch ascent (easterly trajectory) occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of realized mainland disturbance events annually. Least Bell's vireo breeding season begins in mid-March and ends in August, which is likely to further limit overall disturbance. We expect disturbance to mainland areas would occur relatively infrequently (we assume approximately once a week during winter months) and that sufficient recovery time would occur between disturbance to likely preclude observable effects.

Previous nest failure along the Santa Ynez River adjacent to Buellton has been attributed to identifiable causes (e.g., egg predation and incomplete nests) (Griffith Wildlife Biology 2020). We anticipate that the Space Force's future survey efforts described in the avoidance and minimization measure below would help ensure consistency with the on VSFB portion of this analysis. We also expect that the Space Force, in coordination with the Service, will continue to review and communicate available long-term population data from off VSFB sites over the next ten years annually to ensure no unanticipated or unexplained effects (e.g., decreases in nesting success or abundance in known off VSFB occupied breeding areas) to reasonably continue to support our concurrence.

Avoidance and Minimization Measures

PBO-5. The Space Force will ensure that a Qualified Biologist will conduct point count surveys for least Bell's vireos on VSFB and at potential breeding habitats at the Santa Ynez River adjacent to Buellton, California during the breeding season (May 15 through August 15) concurrent with routine riparian bird surveys on VSFB.

After reviewing the information provided, we concur with your determination that the proposed action may affect, but is not likely to adversely affect, the least Bell's vireo. Our concurrence is based on the following:

1. The least Bell's vireo is not expected to occur within the demolition and construction areas on VSFB because of a lack of suitable habitat.
2. The least Bell's vireo has not been documented to utilize suitable habitat located on VSFB for breeding at this time and occurrences are limited to infrequent transitory unpaired males.
3. We expect that any response to sonic boom and engine noise would be temporary, and the number of individuals that may be impacted is likely small.

Southwestern Willow Flycatcher

Southwestern Willow Flycatcher Occurrence on VSFB

Southwestern willow flycatchers were last documented to be present on VSFB in 2003 at the 13th Street Bridge over the Santa Ynez River and the Wildlife Natural Resources Area (Farmer et al. 2003; See Appendix A). In targeted surveys until 2017, southwestern willow flycatchers were not detected on VSFB (Stanek and Whitfield 2017; SRS Technologies, Inc. 2023; DiGaudio et al. 2011, and Ball et al. 2012, as seen in SLD 30 2025). One migrant willow flycatcher was observed on VSFB in 2023, but the individual was not confirmed to be a southwestern willow flycatcher (Whitfield and Meyer, 2023, p. 10).

The modifications to the Santa Ynez River and deterioration of the floodplain on VSFB have contributed to the absence of southwestern willow flycatchers. The base has concluded that

southwestern willow flycatcher breeding on VSFB is unlikely and if any individuals are found that they are likely to be migrants or transitory individuals (DAF, as seen in SLD 30 2025, p. 70).

Southwestern Willow Flycatcher Occurrence Outside of VSFB

Buellton

In 2022, one territorial male was detected at the Santa Ynez River adjacent to Buellton, approximately 24.5 miles east of SLC-6 (Griffith Wildlife Biology 2022). In the following year, two southwestern willow flycatcher males were found, one a transitory male and the other was a territorial male but likely unmated (Whitfield and Meyer 2023, p. 20).

Mainland California (Los Angeles, Santa Barbara, and Ventura Counties)

Southwestern willow flycatchers occupy the upper Santa Ynez River and the Santa Clara River within Santa Barbara, Ventura and Los Angeles Counties during breeding season (May through August). Southwestern willow flycatchers occur in the Santa Clara River drainages within Ventura and Los Angeles Counties (CDFW 2025). Within 6.2 miles of their modeled localities across Los Angeles, Santa Barbara, and Ventura Counties, southwestern willow flycatchers are predicted to be exposed to up to 1.7 psf (132 dB) whenever the launches occur with an easterly trajectory (SLD 30 2025, p. 146).

Effects to the Southwestern Willow Flycatcher on VSFB

Construction and Demolition at SLC-6

Southwestern willow flycatchers are not expected to occur within the project's construction and demolition area due to lack of suitable habitat and documented occurrences. As a result, we do not anticipate any effects to southwestern willow flycatchers from construction or demolition activities.

Operation

For up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires per year, the potential project effects would be limited to the proposed project's noise and overpressure effects area (Table 5 and Table 6). No breeding records for southwestern willow flycatchers have been documented on VSFB, and so we assume only infrequent transitory unpaired males could be affected if their presence overlapped with proposed project disturbance that would occur throughout the year. In the unlikely event that a transitory individual was present during a launch, we anticipate that overpressure and noise exposure events could briefly affect behavior and cause a startle response. Since there has been no documented breeding on VSFB, our records are limited to infrequent transitory males, and the expectation that any effect would be limited to a temporary startle, we anticipate effects would be insignificant.

Effects to the Southwestern Willow Flycatcher Outside of VSFB

Construction and Demolition at SLC-6

The project's construction area does not extend off VSFB, therefore we do not anticipate any effects to southwestern willow flycatcher from construction activities.

Operation

Buellton

Sonic boom overpressure and noise exposure events may affect historic and extant of southwestern willow flycatchers outside of VSFB at the Santa Ynez River adjacent to Buellton by disturbing birds frequently (2 to 3 times a week) during the breeding season (Table 5 and Table 6).

Table 5. Estimated engine noise (dB Lmax) from Falcon 9 and Falcon Heavy at historic and extant southwestern willow flycatcher localities (SLD 30 2025, p. 145).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
13th Street Bridge	110	105	118	118	108	112	112	106	116
Buellton	<100	<100	102	<100	<100	102	100	<100	107

Table 6. Estimated sonic boom levels (psf) and equivalent noise event (dB) from Falcon 9 and Falcon Heavy landings at historic and extant southwestern willow flycatcher localities (SLD 30 2025, p. 145).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
13th Street Bridge	4–5	139.6–141.6	2.5	135.5	2.5	135.5
Buellton	1–1.5	127.6–131.1	1–1.5	127.6–131.1	1–1.5	127.6–131.1

Noise and overpressure modeling for the proposed action did not incorporate adjacent topography. Surrounding topographic features may serve to attenuate both noise and overpressure levels produced from the proposed project (Birmingham 2013, pp. 19–21). This may serve to result in overall lower levels of overpressure and noise reaching any potential southwestern willow flycatcher breeding territories than originally predicted. The Space Force indicates that consequently, the provided modeling is a conservative estimate.

Mainland California (Los Angeles, Santa Barbara, and Ventura Counties)

Out of the 100 launches, only 75 percent are expected to take an easterly trajectory. Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 48 percent could create sonic booms with the potential to impact southwestern willow flycatchers within the identified occupied localities

(SLD 30 2025, p. 146). Although southwestern willow flycatchers that occur in Santa Barbara, Ventura, and Los Angeles Counties could experience ascent sonic booms up to 1.7 psf (132 dB), the Space Force has indicated this is extremely unlikely to occur. The majority of potential sonic booms would be between 0 to 1 psf (127 dB) (SLD 30 2025, p. 146). However, recent information indicates that 0.1 to 1 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review Space Force's produced audiograms with subject matter experts. These experts have consistently provided opposing conclusions and have recommended that until additional information is provided, it is unclear if the species can perceive the sonic boom (J. Tennesen, pers. comm., 2022; R. Dooling, pers. comm., 2024).

As discussed above, we expect that any response to the proposed project's sonic boom would be temporary and existing monitoring indicates that effects would be insignificant overall. We also understand that realized sonic booms produced on the mainland from launch ascent (easterly trajectory) occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of realized mainland disturbance events annually. Southwestern willow flycatchers spend time migrating from April to June and from July to September, which is likely to further limit overall disturbance. We expect disturbance to mainland areas would occur relatively infrequently (we assume approximately once a week during winter months) and that sufficient recovery time would occur between disturbance to likely preclude observable effects.

Avoidance and Minimization Measures

PBO-6. The Space Force will ensure that a Qualified Biologist will conduct point count surveys for southwestern willow flycatchers on VSFB and at potential breeding habitats at the Santa Ynez River adjacent to Buellton, California during the breeding season (May 15 through August 15) concurrent with routine riparian bird surveys on VSFB.

After reviewing the information provided, we concur with your determination that the proposed action may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Our concurrence is based on the following:

1. The southwestern willow flycatcher is not expected to occur within the demolition and construction areas on VSFB because of a lack of suitable habitat.
2. The southwestern willow flycatcher has not been documented utilizing suitable habitat located on VSFB for breeding at this time and occurrences are limited to a potential transitory individual.
3. We expect that any response to sonic boom and engine noise would be temporary, and the number of individuals that may be impacted is likely small.

Marbled Murrelet

Marbled Murrelet Occurrence

There are 25 total observations of marbled murrelets offshore of VSFB between 1995 and 2023 (eBird 2025a). In 2023, one observation recorded two marbled murrelets near Brown's Beach south of Lion's Head on VSFB. In 2011, one observation recorded approximately 0.5 mile west of SLC-4 and SLC-6 indicated presence of a marbled murrelet at an unreported distance offshore. Two additional 1995 observations (each of one individual) taken from approximately 7.5 miles north of SLC-4 and SLC-6 indicated presence offshore from Purisima Point. The remaining observations occurred north of Minuteman Beach. Marbled murrelets do not breed on VSFB due to lack of breeding habitat; project activities would only impact foraging adults which observers document infrequently. Marbled murrelet observations in this area have occurred at a range of 984 to 6,561 feet from the shore (Strachan et al. 1995, p. 247)

Effects to Marbled Murrelet

Noise and overpressure produced by the proposed project activities have the potential to affect marbled murrelets should they be present in the vicinity of SLC-4 and SLC-6 during the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires per year. Immediately off the coast, potential project effects would be limited to the proposed project's noise and overpressure effects area (Table 7 and Table 8). However, marbled murrelets typically inhabit areas further off the coast (984 to 6,561 feet from shore), which would experience much lower noise levels. It is unknown how noise and overpressure levels would affect marbled murrelets, but we expect any nearby individuals to exhibit a temporary startle response (i.e., dive and resurface) during launch, landing, or static test fire events and quickly return to normal behavior post-event. It is unlikely marbled murrelets would be present at the exact moment of a launch, landing, or static test fire event because of their transitory nature and overall scarcity within the action area. Therefore, the probability of noise-related impacts to marbled murrelets from project activities would be extremely low if they occur (Appendix A, Figures 2G–I and 3E–3F).

Table 7. Estimated maximum engine noise levels (dB L_{max}) from Falcon 9 and Falcon Heavy vehicles at the nearest coastline to each launch facility (SLD 30 2025, p. 143).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landin g	Launch	Static Fire	Landin g	Launch	Static Fire	Landin g	Launch
Nearest Coastline	122	130	140	130	120	140	130	120	130

Table 8. Estimated maximum sonic boom levels (psf) and the equivalent noise event (dB) from Falcon 9 and Falcon Heavy vehicles at the nearest coastline to each launch facility (SLD 30 2025, p. 143).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Nearest Coastline	7–8	144.5–145.6	10	147.6	10	147.6

The Space Force has determined that there would be no effect to marbled murrelet populations located off VSFB from launch ascents with easterly trajectories (SLD 30 2025, p. 144).

Avoidance and Minimization Measures

PBO-1. The Space Force will ensure that a Qualified Biologist will conduct marbled murrelet population surveys at the current levels to monitor the frequency and distribution of marbled murrelets within the action area.

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the marbled murrelet based on discountable effects. Our concurrence is based on the following:

1. Within the project vicinity, marbled murrelets occur irregularly and only as adults foraging offshore; they do not breed at VSFB.
2. Available monitoring data suggest that maximum noise levels produced from launch operations are unlikely to have a significant effect on marbled murrelets.

California Condor

California Condor Occurrence on VSFB

There have been two separate occurrences of California condors on VSFB based on GPS transmitter data: one individual in 2017 (studbook number 760) and another in 2022 (studbook number 1031). In both instances, it was a single condor that spent a short period of time (one to three days) at VSFB. These data indicate that while California condors can occur on VSFB, the current frequency of occurrence is very low.

California Condor Occurrence Outside of VSFB

California condors occupy many of the foothills and mountains within Santa Barbara, Ventura, and Los Angeles Counties. These areas are occupied by both the Southern California Flock managed by Hopper Mountain National Wildlife Refuge Complex and the Central California Flock managed by Ventana Wildlife Society and Pinnacles National Park. Both flocks overlap in distribution within the mainland California sonic boom overpressure effect area. The majority of California condor activity relative to VSFB is east of Interstate 101 in Santa Barbara County, greater than 20 miles from SLC-4 and 25 miles from SLC-6.

Effects to California Condor on VSFB

Sound pressure and overpressure produced by the proposed project activities have the potential to affect California condors should the birds be present in the vicinity of SLC-4 and SLC-6 during the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires per year. The maximum anticipated noise levels during proposed activities at SLC-4 would be up to 150 dB L_{max} during Falcon 9 launches (MSRS 2024a, p. 104). This area would also experience sonic booms with overpressure levels up to 9.5 psf during each vehicle landing at SLC-4 (USSF 2024a). If California condors were present in the on VSFB portions of the proposed project area, they would likely be foraging or roosting.

The Service anticipates that in the unlikely event that California condor was present within the immediate area of SLC-4 and SLC-6 during the time of a launch, the potential magnitude of noise from launch, landing, or static test fire events, sonic booms, physical flame and steam, and visual disturbances could result in physical harm and other behavioral shifts to the species. However, GPS transmitter data indicate that California condor occurrences on VSFB are very rare or infrequent and it is unlikely that California condors would be on VSFB during project activities. Therefore, the probability of project-related impacts to California condors are very low. Additionally, the Space Force will coordinate with the Service and Ventana Wildlife Society in the event that a California condor is present on base near SLC-4 or SLC-6 during the day of a launch (See Avoidance and Minimization Measure PBO-2 below).

Effects to California Condor Outside of VSFB

California condors occur within the region potentially impacted by sonic booms during missions with easterly trajectories. Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 31.5 percent could create sonic booms with the potential to impact California condors within the identified occupied localities (SLD 30 2025, p. 168). Although California condors that occur in Santa Barbara, Ventura, and Los Angeles Counties could experience ascent sonic booms up to 3.5 psf (138 dB), the Space Force has indicated this is extremely unlikely to occur. The majority of potential sonic booms would be between 0 to 1 psf (127 dB) (SLD 30 2025, p. 168). Sonic boom overpressure levels are dependent on atmospheric conditions, with sonic booms not likely to happen during the warmer seasons. For the purposes of this analysis, these sonic boom levels are not coupled with any visual stimuli, would occur relatively infrequently, and each last only a fraction of a second.

It is unknown how noise and overpressure levels affect California condors, but we expect individuals within this region to exhibit a temporary startle response or other minor and temporary behavioral shifts in response to noise from sonic booms. California condors are remarkably tolerant of human disturbance as indicated by the variety of hands-on management. Additionally, helicopter noise has not caused California condors to abandon nests (J. Brandt, USFWS, pers. comm. 2025). Therefore, the likelihood of noise-related impacts to California condors from project activities off VSFB would be low and insignificant if they occur.

Avoidance and Minimization Measures

PBO-2. The Space Force will determine if California condors are present by coordinating with the Service and Ventana Wildlife Society personnel on a quarterly basis and/or via direct access to California condor tracking platforms utilized by the Service. The Space Force will contact the Service if California condors appear to be near or within the area affected by a launch from SLC-4 or SLC-6. In the unlikely event that a California condor is nearby, Qualified or Permitted Biologists will monitor California condor movements in the vicinity of VSFB and coordinate with the Service to analyze data before, during, and after launch events to determine whether any changes in movement occur. The Space Force will coordinate with the Service, California Condor Recovery Program, and Ventana Wildlife Society to keep updated on recent California condor movement patterns and observations.

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the California condor based on both discountable and insignificant effects. Our concurrence is based on the following:

1. The probability of a California condor being present on VSFB during project activities is extremely low, making associated effects discountable.
2. We anticipate that effects that would occur off VSFB would be insignificant due to California condors being very tolerant of human disturbance and projected noise levels.

Tidewater Goby

Tidewater Goby Occurrence on VSFB

Tidewater gobies have been documented in all major drainages on VSFB up to 7.5 miles upstream from the Pacific Ocean (Swift 1999). The project area consists of suitable habitat for the species within Honda Creek, San Antonio Creek, Shuman Creek, Jalama Creek, and the Santa Ynez River. The tidewater goby has not been documented in Honda Creek since 2008, potentially because of changing habitat suitability conditions precluding the occupancy of and persistence of tidewater gobies and other fish species. Tidewater gobies occur in the Santa Ynez River from the estuary to the 13th Street bridge and San Antonio Creek. In San Antonio Creek, tidewater gobies primarily inhabit the lagoon.

Tidewater Goby Occurrence Outside of VSFB

The closest tidewater goby occurrence outside of VSFB is approximately 20 miles southeast of SLC-6 at Gaviota Creek (Goldsmith, et al. 2014). Continuing southeast, in the region potentially impacted by sonic booms from easterly trajectories, tidewater gobies currently occur in most coastal streams, bays, and estuaries in southeastern Santa Barbara, Ventura, and southwestern Los Angeles Counties (SLD 30 2025, p. 34).

Effects to the Tidewater Goby on VSFB

Noise and overpressure produced by the proposed project activities (launch, landing, and static test fire events) have the potential to affect tidewater gobies that occur on VSFB. Project-related engine noise and vibrations (Table 9 and 10 and Figure 4D) could cause a temporary disruption to individuals within San Antonio Creek and Santa Ynez River (SLD 30 2025, p. 122) during the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires per year. It is unknown how various noise and overpressure levels could affect tidewater gobies, but we currently expect individuals to only exhibit minor and temporary behavioral shifts, if any, because of understood noise attenuation in water.

Maximum anticipated noise and overpressure levels within potential habitat for the species in Honda Creek are presented in Table 9 and 10. However, using the best available information, we anticipate that disturbance would overall be unlikely given that the species has not occupied Honda Creek since 2008, potentially as a result of changing habitat suitability conditions. We currently anticipate that disturbance to other occupied localities further distance away from SLC-4 and SLC-6 would likely be temporary and minor, if any.

Table 9. Estimated maximum engine noise levels (dB L_{max}) from Falcon 9 and Falcon Heavy at tidewater goby habitat and extant localities (SLD 30 2025, p. 123).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Honda Creek	118	120	125	122	119	125	129	120	130
Santa Ynez River	110	105	118	118	108	112	112	106	116
Jalama Creek	<100	<100	108	108	105	112	108	<100	110
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 10. Estimated maximum sonic boom levels (psf) and equivalent noise events (dB) from Falcon 9 and Falcon Heavy at tidewater goby habitat and extant localities (SLD 30 2025, p. 123).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Honda Creek	6	143	9.5	147	9.5	147
Santa Ynez River	4–5	139.6–141.6	2.5	135.5	2.5	135.5
Jalama Creek	2–3	133.6–137	3	137	3	137
San Antonio Creek	2.2	134.4	1–2	127–133.6	1–2	127–133.6

For most of the proposed project, the Space Force would source water from an existing connection between State Water and the VSFB water supply system. However, during annual maintenance that lasts approximately two to three weeks, the Space Force utilizes four water wells in the San Antonio Creek Basin. During those two to three weeks, the Space Force would utilize approximately 5.3 million gallons (16.4 acre-feet) from the groundwater basin annually. Increasing water extraction could reduce flow rates, hydration periods, or water levels in San Antonio Creek and negatively impact tidewater gobies. However, the Space Force indicates that

the proposed project's water usage would be negligible and would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek (SLD 30 2025, p. 123–124). Similarly, referencing previous analysis (USGS 2019, p. 5) and associated discussion with hydrologists involved with the associated hydrological modeling (Faunt and Cromwell 2021, USGS pers. comm.), the proposed project's 16.4 acre-feet extraction amount would not be anticipated to result in measurable decline of streamflow or associated aquatic habitat.

Effects to the Tidewater Goby Outside of VSFB

The Space Force has determined tidewater goby populations would not be affected in off VSFB locations from launch ascents with easterly trajectories creating low level (less than 1 psf) sonic booms (SLD 30 2025, p. 123).

Avoidance and Minimization Measures

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the tidewater goby based on insignificant effects. Our concurrence is based on the following:

1. Any effects to tidewater gobies that would occur would be insignificant as a result of anticipated noise attenuation. If any effects occur, we expect only temporary and minor behavioral reactions to infrequent noise disturbance.
2. The tidewater goby does not currently occur in Honda Creek, and we understand there is currently low likelihood for recolonization due to a change in habitat suitability conditions precluding their occupancy and persistence.
3. VSFB is connected to State Water. Increased water extraction from the San Antonio Creek basin during the annual maintenance period (2 to 3 weeks) from proposed project activities is expected to be negligible.

Unarmored Threespine Stickleback

Unarmored Threespine Stickleback Occurrence on VSFB

The unarmored threespine stickleback occupies San Antonio Creek from Barka Slough to the lagoon (Swift 1999). The project area consists of unoccupied suitable habitat for the species within Honda Creek, Shuman Creek, Jalama Creek, and the Santa Ynez River. In 1984, attempts to reintroduce unarmored threespine sticklebacks were made, but determined to be unsuccessful. The lack of success was potentially from changing habitat suitability conditions precluding the occupancy of and persistence of unarmored threespine sticklebacks and other fish species. Therefore, the presence of the unarmored threespine stickleback in Honda Creek is unlikely.

Unarmored Threespine Stickleback Occurrence Outside of VSFB

The closest unarmored threespine stickleback occurrence outside of VSFB is in Los Angeles County within the upper Santa Clara River. However, that population of the unarmored threespine stickleback occurs outside of noise effects from easterly trajectory launches.

Effects to the Unarmored Threespine Stickleback on VSFB

Noise and overpressure produced by the proposed project activities (launch, landing, and static fire events) have the potential to affect unarmored threespine sticklebacks that occur on VSFB. Project-related engine noise and vibrations could cause a temporary disruption to individuals within San Antonio Creek where they would experience variable noise levels from the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires from Falcon 9 and Falcon Heavy at SLC-4 and SLC-6 (Table 11 and Table 12). We do not know how noise and overpressure levels could affect unarmored threespine sticklebacks, but we expect individuals to only exhibit minor and temporary behavioral shifts, if any, because of understood noise attenuation in water.

Table 11. Estimated maximum engine noise levels (dB L_{max}) from Falcon 9 and Falcon Heavy at unarmored threespine stickleback habitat (SLD 30 2025, p. 126).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 12. Estimated maximum sonic boom levels (psf) and the equivalent noise events (dB) from Falcon 9 and Falcon Heavy at unarmored threespine stickleback habitat (SLD 30 2025, p. 126).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
San Antonio Creek	2.2	134.4	1–2	127.6–133.6	1–2	127.6–133.6

Honda Creek could provide potential habitat for the unarmored threespine stickleback despite the failure of past reintroduction for efforts. If unarmored threespine sticklebacks were to occur in Honda Creek, the launch, static fire, and boost-back noise and sonic boom events from SLC-4 and SLC-6 would be more intense. However, we anticipate that any disturbance would be unlikely since unarmored threespine sticklebacks do not currently occupy Honda Creek and we do not anticipate the species to recolonize in the future due to the changing habitat conditions described above.

For most of the proposed project, the Space Force would source water from an existing connection between State Water and the VSFB water supply system. However, during annual maintenance that lasts approximately two to three weeks, the Space Force utilizes four water wells in the San Antonio Creek Basin. During those two to three weeks, the Space Force could utilize approximately 5.3 million gallons (16.4 acre-feet) from the groundwater basin annually. Increasing water extraction could reduce flow rates, hydration periods, or water levels in San Antonio Creek and negatively impact unarmored threespine sticklebacks. However, the Space Force indicates that the proposed project's water usage would be negligible and would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek.

(SLD 30 2025, pp. 123–124). Similarly, referencing previous analysis (USGS 2019, p. 5) and associated discussion with hydrologists involved with the associated hydrological modeling (Faunt and Cromwell 2021, USGS, pers. comm.), the proposed project's proposed 16.4 acre-feet extraction amount would not be anticipated to result in measurable decline of streamflow or associated aquatic habitat.

Effects to the Unarmored Threespine Stickleback Outside of VSFB

The Space Force has determined unarmored threespine stickleback populations would not be affected in off VSFB locations from launch ascents with easterly trajectories creating low level (less than 1 psf) sonic booms (SLD 30 2025, p. 126). Therefore, the Service will not comment on effects to unarmored threespine stickleback outside of VSFB.

Avoidance and Minimization Measures

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the unarmored threespine stickleback based on insignificant effects. Our concurrence is based on the following:

1. Any effects that would occur to the unarmored threespine stickleback are anticipated to be insignificant, as a result of expected noise attenuation. If any effects should occur, we expect only temporary and minor behavioral reactions to infrequent noise disturbance.
2. Unarmored threespine sticklebacks do not currently occur in Honda Creek, and there is low likelihood for recolonization due to changes in habitat suitability.
3. Increased water extraction from the San Antonio Creek basin due to proposed project activities would be negligible to unarmored threespine sticklebacks and not reduce unarmored threespine stickleback habitat.

Arroyo Toad

Arroyo Toad Occurrence

Arroyo toads are not known to occur on VSFB. Arroyo toads occur within the region potentially impacted by sonic booms during missions with easterly trajectories. Specifically, these areas include the upper Santa Ynez River, Sespe Creek, Piru Creek, Castaic Creek, and the upper Santa Clara River. Only select launches with easterly trajectories are expected to create sonic booms that have the potential to reach these species. We do not expect sonic booms to reach these species from the other launch trajectories.

Arroyo Toad Effects

Arroyo toads are not expected to occur on VSFB; therefore, we do not anticipate any effects to these species from project activities on VSFB.

Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 45 percent could create sonic booms with the potential to impact arroyo toad within the identified occupied localities (SLD 30 2025, p. 142).

Sonic booms would last a fraction of a second, would not be coupled with visual disturbance, and consist of levels reasonably expected to be under 1 psf (SLD 30 2025, p. 142). In our 2024 analysis (Service 2024a), clear psf to dB noise conversion levels were not available (MSRS 2024a, p. 113; SLD 30 2025, p. 142; SpaceX 2025). However, recent information indicates that 0.1 to 1 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review Space Force's produced audiograms with subject matter experts. These experts have consistently provided opposing conclusions and have recommended that until additional information is provided, the Service should reasonably expect that species likely perceive project noise (J. Tennessen, pers. comm., 2022; R. Dooling, pers. comm., 2024).

As discussed above, we expect that any response to the proposed project's sonic boom would be temporary and existing monitoring indicates that effects would be overall insignificant. We also understand that realized sonic booms produced on the mainland from launch ascent (easterly trajectory) occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of realized mainland disturbance events annually.

It is unknown how noise and overpressure levels would affect arroyo toads, but we expect individuals may exhibit a temporary startle and/or stress response and that species are likely to resume normal behavior shortly thereafter. We also understand that realized sonic booms on the mainland appear to occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of realized disturbance events annually. Depending on seasonal rainfall, arroyo toads may be inactive and aestivating underground during a portion of this winter period, generally between October to January, which is likely to further limit overall disturbance annually. During their active periods they also remain underground during the daytime. Arroyo toads typically breed between March to July (Nafis 2025), usually warmer months when we expect sonic booms are unlikely to occur. We expect disturbance would occur relatively infrequently (we assume approximately once a week during winter months) and that sufficient recovery time would occur between disturbance to preclude observable effects in populations over time.

After reviewing the information provided, we concur with your determination that the proposed project may affect but is not likely to adversely affect the arroyo toad based on insignificant effects. Our concurrence is based on the following:

1. Arroyo toads may exhibit a startle or stress response, but we anticipate any reaction would be temporary and the species would quickly resume normal behavior and thus be insignificant.
2. We anticipate that the overall likelihood of disturbance from sonic booms would be overall infrequent and limited to winter months when arroyo toad may be underground and less susceptible to effects.

Coastal California Gnatcatcher

Coastal California Gnatcatcher Occurrence

Coastal California gnatcatcher is not known to occur on VSFB. Within the region potentially impacted by sonic booms during missions with easterly trajectories, coastal California gnatcatchers occur across southern Ventura and western Los Angeles Counties.

Coastal California Gnatcatcher Effects

Coastal California gnatcatcher are not expected to occur on VSFB; therefore, we do not anticipate any effects to these species from project activities on VSFB.

Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 84 percent could create sonic booms with the potential to impact coastal California gnatcatcher within the identified occupied localities (SLD 30 2025, p. 170).

Sonic booms would last a fraction of a second, would not be coupled with visual disturbance, and consist of levels reasonably expected to be under 1 psf (SLD 30 2025, p. 142). In the 2024 analysis (Service 2024a), clear psf to decibel noise conversion levels were not available and that associated sonic boom noise disturbance would be ‘low’ or ‘discountable’ (MSRS 2024a, p. 113; SLD 30 2025, p. 142; SpaceX 2025). However, recent information indicates that 0.1 to 1.0 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review Space Force’s produced audiograms with subject matter experts. These experts have consistently provided opposing conclusions and have recommended that until additional information is provided, the Service should reasonably expect that species likely perceive project noise (J. Tennessen, pers. comm., 2022; R. Dooling, pers. comm., 2024).

It is unknown how noise and overpressure levels would affect coastal California gnatcatchers, but we expect individuals may exhibit a temporary startle and/or stress response and that species are likely to resume normal behavior shortly thereafter. Coastal California gnatcatchers exhibit strong site tenacity (Atwood 1993, p. 152) and would be expected to return quickly in the event they startle/flush from a sonic boom (expected to be less than 1 psf (127.5 dB) Realized sonic booms on mainland California appear to occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of disturbance events annually. These events would generally be outside of the California gnatcatcher’s breeding season, expected between February to August, which is likely to further limit overall disturbance

annually. We expect disturbance would occur relatively infrequently and that sufficient recovery time would occur between disturbance to preclude observable effects in populations over time.

After reviewing the information provided, we concur with your determination that the proposed project may affect but is not likely to adversely affect the coastal California gnatcatcher based on insignificant effects. Our concurrence is based on the following:

1. Coastal California gnatcatchers may exhibit a startle or stress response, but we anticipate any reaction would be temporary and species would quickly resume normal behavior and thus be insignificant.
2. We anticipate that overall likelihood of disturbance from sonic booms would be overall infrequent and limited to winter months generally outside of coastal California gnatcatcher's breeding season.

Light-Footed Ridgway's Rail

Light-Footed Ridgway's Rail Occurrence

Light-footed Ridgway's rail is not known to occur on VSFB. Within the region potentially impacted by sonic booms during missions with easterly trajectories, light-footed Ridgway's rails occur at the Carpinteria Salt Marsh and the marshes at Naval Base Ventura County Point Mugu.

Light-Footed Ridgway's Rail Effects

Light-footed Ridgway's rail are not expected to occur on VSFB; therefore, we do not anticipate any effects to these species from project activities on VSFB.

Of the estimated 75 percent of launches that occur annually that could utilize the easterly trajectory, the Space Force has indicated that approximately 98 percent could create sonic booms with the potential to impact light-footed Ridgway's rail within the identified occupied localities (SLD 30 2025, p. 171).

Sonic booms would last a fraction of a second, would not be coupled with visual disturbance, and consist of levels reasonably expected to be under 1 psf (SLD 30 2025, p. 142). In the 2024 analysis (Service 2024a), clear psf to dB noise conversion levels were not available and that associated sonic boom noise disturbance would be 'low' or 'discountable' (MSRS 2024a, p. 113; SLD 30 2025, p. 142; SpaceX 2025). However, recent information indicates that 0.1 to 1 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review Space Force's produced audiograms with subject matter experts. These experts have consistently provided opposing conclusions and have recommended that until additional information is provided, the Service should reasonably expect that species likely both perceive project noise (J. Tennessen, pers. comm., 2022; R. Dooling pers. comm., 2024).

It is unknown how noise and overpressure levels would affect light-footed Ridgway's rails, but we expect individuals may exhibit a temporary startle and/or stress response and that species are

likely to resume normal behavior shortly thereafter. Light-footed Ridgway's rails have exhibited successful territory establishment at Naval Base Ventura County Point Mugu (Zemba et al. 2016, p. 4), another military base where the species is subject to routine aircraft noise disturbance that is likely more frequent than noise from project-related sonic booms. Therefore, the probability of noise-related impacts to light-footed Ridgway's rails from project activities would be low, if they occur. We also understand that realized sonic booms on mainland California appear to occur predominantly during the winter months under colder atmospheric conditions which would reduce the overall number of realized disturbance events annually. These events would generally be outside of the light-footed Ridgway's rail's breeding season, expected between March to August, which is likely to further limit overall disturbance annually. We expect disturbance would occur relatively infrequently and that sufficient recovery time would occur between disturbance to preclude observable effects in populations over time.

After reviewing the information provided, we concur with your determination that the proposed project may affect but is not likely to adversely affect the light-footed Ridgway's rail based on insignificant effects. Our concurrence is based on the following:

1. Light-footed Ridgway's rails may exhibit a startle or stress response, but we anticipate any reaction would be temporary and species would quickly resume normal behavior and thus be insignificant.
2. Light-footed Ridgway's rails are known to occur in other areas with routine noise disturbance from military aircraft operations.
3. We anticipate that overall likelihood of disturbance from sonic booms would be infrequent and limited to winter months generally outside of light-footed Ridgway's rail's breeding season.

California Tiger Salamander

California Tiger Salamander Occurrence on VSFB

Santa Barbara County Distinct Population Segment (DPS) of California tiger salamanders have not been detected on VSFB during regular protocol surveys of suitable habitat from 2006 to 2022 (MSRS 2024a, p. 45).

California Tiger Salamander Occurrence Outside of VSFB

The closest occurrences of California tiger salamander to the proposed project are approximately 14 miles east of SLC-4 within the Santa Rita Hills and 18 miles south of within Santa Maria Valley. California tiger salamanders occur approximately 18 miles east of SLC-6 within the Santa Rita Hills and approximately 20 miles south of the Santa Maria Valley (See Appendix A, Figures 2J–L and 3G–H).

Effects to the California Tiger Salamander on VSFB

California tiger salamanders are not expected to occur on VSFB as evident by a lack of recorded observations during regular protocol surveys of suitable habitat until 2022. Therefore, we do not anticipate any effects to California tiger salamanders on VSFB from the proposed project activities.

Effects to the California Tiger Salamander Outside of VSFB

Sound pressure and overpressure produced by the proposed project activities (launch, landing, and static test fire events) have the potential to affect California tiger salamanders that occur off VSFB within the Santa Rita Hills where they would experience variable noise levels expected to exceed 116 dB L_{max} and variable overpressure levels up to 1.5 psf (131 dB) during the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires from SLC-4 and SLC-6 (Table 13 and 14).

Table 13. Estimated maximum engine noise levels (dB L_{max}) from Falcon 9 and Falcon Heavy vehicles at California tiger salamander localities (SLD 30 2025, p. 127).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Santa Rita Hills	<100	<100	105	100	<100	106	110	106	116
Santa Maria Valley	<100	<100	100	<100	<100	105	103	<100	108

Table 14. Estimated maximum sonic boom levels (psf) and their equivalent estimated noise events (dB) from the boost-backs at California tiger salamander localities (SLD 30 2025, p. 127).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Santa Rita Hills	1–2	127.6–133.6	1.5	131	1.5	131
Santa Maria Valley	1–1.5	127.6–131	1	127.6	1	127.6

During the dry season, California tiger salamanders will likely be underground and aestivating. California tiger salamanders live in burrows for majority of their lives and temporarily emerge from burrows following rainfall to migrate to breeding pools. Potential effects to California tiger salamanders could include launch related vibration of burrows. If vibration mimics characteristics of rainfall, this could induce early emergence and associated injury or mortality from desiccation if this is improperly timed. Potential launch related vibration may be of low frequency which attenuates less readily than high frequency (Norton et al. 2011, p. 658) and may travel further. However, the biological assessment indicated that project-related terrestrial vibration should attenuate based on the distance and depth from SLC-4 and SLC-6 to the extant populations of California tiger salamanders (SLD 30 2025, p. 128). Given that approximately 30 percent of sound energy attenuates for every centimeter of depth (Oelze et al. 2002) and that California tiger salamanders typically burrow deeper underground than surface noise is anticipated to reach (Barry and Shaffer 1994), it is unlikely that aestivating California tiger salamanders would be impacted by launch vibration or associated noise.

California tiger salamanders are aboveground infrequently and for a short period (i.e., only a few rainy nights a year). If California tiger salamanders are above ground during a launch ascent or landing, the Service anticipates that the species could have a temporary behavioral reaction in response and would return to normal behavior shortly thereafter. In the event that California tiger salamander adults or larvae are underwater during rainy season while a launch or boost-back occurs, the Service anticipates no effect to California tiger salamander behavior since very little sound is transmitted from air to water (Godin 2008). A study on the hearing sensitivity of *Ambystoma mexicanum* demonstrated that exposure to noise at 170 dB for 48 hours can cause auditory harm underwater (Fehrenbach 2015). Since the noise from launch, static fire, and boost-back events do not generate that level of noise and do not last longer than a minute, the Service anticipates that the project activities do not rise to the level of auditory harm for California tiger salamanders.

We do not have specific data on the response of California tiger salamander larvae and eggs to varying levels or duration of exposure to vibration from launch operations. Although no studies on California tiger salamanders exists, there are comparable studies in other amphibians. For example, in a laboratory study, researchers investigated the effects of low frequency vibrations on early embryonic development of African clawed frog (*Xenopus laevis*). The study demonstrated that vibrating embryos in petri dishes overnight during the embryo development process at three low frequency levels (7, 15, and 100 hertz) induced significant levels of physiological effects (heterotaxia defined by the abnormal position of the heart, gall bladder, and/or gut loop), with some treatments inducing neural tube defects as well as bent tail morphology (Vandenberg et al. 2012a, pp. 3–5). The Space Force monitored the vibrations of Falcon 9 launch and boost-back from SLC-4 in 2024, and found that the vibration intensity at Oxbow restoration site (10.84 miles from the launch pad) was approximately 5 hertz and intensity reduced by 99 percent on the surface and 90 percent underground from SLC-4 (Bunyan 2025, p. 10). There has been no vibration monitoring of Falcon Heavy, but SLC-6 is further from California tiger salamander occurrences. We assume vibration from Falcon Heavy launches and boost-backs at SLC-6 would be comparably similar at the vibration monitoring sites as Falcon 9 launches at SLC-4. We expect vibration would attenuate by the time it reaches Santa Rita Hills and Santa Maria Valley to the level that does not cause harm to California tiger salamander embryo and larvae. Therefore, any vibration effects would be discountable to the California tiger salamander.

Avoidance and Minimization Measures

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the California tiger salamander based on discountable effects. Our concurrence is based on the following:

1. We anticipate that aestivating California tiger salamanders would not be disturbed by routine launch effects. Associated launch noise and vibration would attenuate entirely based on distance and depth of extant populations of California tiger salamander.
2. Any effects to any California tiger salamander would likely occur very infrequently and are expected to be overall discountable. We expect any potential effects to only include

temporary minor behavioral reactions, and that species would return to normal behavior shortly thereafter.

Hawaiian Petrel and Short-Tailed Albatross

Hawaiian Petrel and Short-Tailed Albatross Occurrence

The Hawaiian petrel and short-tailed albatross are not known to occur on VSFB. Hawaiian petrels and short-tailed albatrosses are pelagic species which occur off the coast of California within the region potentially impacted by vehicle barge landings and associated sonic booms.

Hawaiian Petrel

The Hawaiian petrel does not breed on VSFB due to lack of breeding habitat; however, project activities (barge landings) would have the potential to impact migrating adults. A GIS analysis was conducted using existing eBird records and the proposed landing areas. We incorporated a 55-mile buffer from the proposed landing area boundary, which is the likely extent of the offshore sonic boom potential impacts of greater than 0.5 psf (121.5 dB) associated with the barge landings, constituting the understood Vehicle Landing Action Area (Appendix A, Figure 5A). This analysis indicated there are 211 total unique observations of Hawaiian petrels between 1992 to 2024 with a high of 42 records and average of 10 records annually (eBird 2025b; Service, unpublished data 2025a). Most records are located between San Diego and Fortuna, California with 75 percent of all records occurring during the months of April and May. Consequently, the species is generally expected to be an infrequent migrant across the proposed landing areas throughout the year.

Short-tailed Albatross

The short-tailed albatross does not breed on VSFB due to lack of breeding habitat; however, project activities (barge landings) would have the potential to impact migrating adults. A GIS analysis was conducted using existing eBird records and the proposed landing areas as described above for the Hawaiian petrel (Appendix A, Figure 5A). This analysis indicates that there are 21 total unique observations of the short-tailed albatross between 1983 to 2024 with a high of four records and average of two records annually (eBird 2025c; Service, unpublished data 2025b). Most records are located north of Santa Barbara, California and are scattered throughout the year with higher numbers in November. Consequently, the species is generally expected to be a very infrequent migrant across the proposed landing areas throughout the year.

Effects to the Hawaiian Petrel and Short-Tailed Albatross

The Hawaiian petrel and short-tailed albatross are not known or expected to occur on VSFB; therefore, we do not anticipate any effects from project activities on VSFB. Potential project effects would be limited to infrequent migrating populations located within the proposed

project's offshore barge landing area (Pacific Ocean) from vehicle landing noise and associated sonic booms.

Offshore Landings (Pacific Ocean)

Noise and overpressure produced by the proposed project's offshore landing activities have the potential to impact Hawaiian petrels and short-tailed albatrosses for up to 100 barge landing events annually. In the event that either species was migrating within the vicinity of the area at the time of a barge landing, they could be exposed up to approximate landing noise of 150 dB for a minute and associated sonic boom levels of up to 5 psf (133 dB).

It is unknown how noise and overpressure levels would specifically affect the Hawaiian petrel and short-tailed albatross, but similar to the marbled murrelet, we expect any nearby individuals would exhibit a startle response (i.e., dive and resurface) during barge landing events and would likely return to normal behavior quickly post-event (Bellefleur et al. 2009, p. 535). However, it is unlikely that either of these species would be present at the exact moment of a barge landing event because of their transitory nature and overall scarcity in any given year within the action area. In addition, data that indicate the vast majority of barge landings are concentrated to the south near Isla Guadalupe off the coast of Baja California (USSF 2025a), located over 150 miles from the nearest known records for either species. Therefore, the probability of noise-related impacts to the Hawaiian petrel and short-tailed albatross from project activities would be very low if they were to occur.

Avoidance and Minimization Measures

After reviewing the information provided, we concur with your determination that the proposed action may affect but is not likely to adversely affect the Hawaiian petrel and short-tailed albatross based on discountable effects. Our concurrence is based on the following:

1. Within the offshore landing areas, the Hawaiian petrel and short-tailed albatross occur irregularly as migrating adults and they do not breed at VSFB.
2. Most offshore landing locations have been and would continue to be concentrated around Isla Guadalupe off the coast of Baja California, a far distance from existing species records which further reduces the potential for effect.
3. Available monitoring data suggest that in the unlikely event either species were present in the near vicinity of an offshore landing location, the noise levels produced from launch operations would likely trigger a temporary startle response with species resuming normal behavior shortly thereafter.

Western Snowy Plover Critical Habitat

The Service designated critical habitat for the western snowy plover in 1999 and revised this designation on September 29, 2005 (70 FR 56969–57119) and on June 19, 2012 (77 FR 36727). VSFB was exempted from critical habitat designation under Section 4(a)(3) of the ESA. In the region potentially impacted by ascent sonic booms during missions with easterly trajectories,

critical habitat has been designated at various sandy beaches along the coast of eastern Santa Barbara, Ventura, and Los Angeles Counties (Appendix A, Figure 4K).

The Service listed the following Primary Constituent Elements (PCEs) for the western snowy plover:

Sandy beaches, dune systems immediately inland of an active beach face, salt flats, mud flats, seasonally exposed gravel bars, artificial salt ponds and adjoining levees, and dredge spoil sites, with:

- 1) Areas that are below heavily vegetated areas or developed areas and above the daily high tides;
- 2) Shoreline habitat areas for feeding, with no or very sparse vegetation, that are between the annual low tide or low-water flow and annual high tide or high-water flow, subject to inundation but not constantly under water, that support small invertebrates, such as crabs, worms, flies, beetles, spiders, sand hoppers, clams, and ostracods, that are essential food sources;
- 3) Surf or water-deposited organic debris, such as seaweed (including kelp and eelgrass) or driftwood located on open substrates that supports and attracts small invertebrates described in PCE 2 for food, and provides cover or shelter from predators and weather, and assists in avoidance of detection (crypsis) for nests, chicks, and incubating adults; and.
- 4) Minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators, which provide relatively undisturbed areas for individual and population growth and for normal behavior.

Critical Habitat Occurrence within Santa Rosa Island

Santa Rosa Island has a total of 585.75 acres of designated western snowy plover critical habitat across 11 polygons.

Critical Habitat Occurrence within Mainland California

Between Point Conception in western Santa Barbara County and Point Mugu in Ventura County, there are a total of 1176.23 acres of designated western snowy plover critical habitat across five polygons.

Effects to Western Snowy Plover Critical Habitat

Santa Rosa Island

The proposed project's launch ascent would create sonic booms with linear trajectories that cross portions of Santa Rosa Island (Appendix A, Figures 4L–M). Three separate polygons of designated western snowy plover critical habitat on Santa Rosa Island could be impacted by the up to 100 launch ascent booms between 0.5 to 8 psf annually. During previous analyses, it was expected that 30 percent of launch ascents could impact the northern Channel Islands, with the vast majority constituting overpressure of under 2 psf (Kaisersatt, pers. comm. 2023a, p. 1).

However, recently provided information suggests that 50 percent of past launches have created sonic boom impacts on Santa Rosa Island and that variation in atmospheric conditions and trajectories would continue to influence the magnitude and frequency of realized impacts across these areas (SLD 30 2025, p. 160). Even with the increase in realized sonic booms, it is not reasonably likely that sonic boom impacts to Santa Rosa Island would occur during every launch.

In the unlikely event that 100 sonic booms occurred annually across a large portion of the island, the Service expects that this would impact western snowy plover PCE-4. PCE-4 states: minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators, which provide relatively undisturbed areas for individual and population growth and for normal behavior. Frequent sonic booms could affect PCE-4 by creating disturbance in a relatively undisturbed area (Santa Rosa Island backcountry) and impact normal behavior of western snowy plovers. Launch noise would not be present, but we consider that 100 sonic booms between 0.5 to 8 psf would still be reasonably likely to impact normal behavior (SLD 30 2025, p. 160). However, the Space Force provided launch ascent sonic boom shapefiles (USSF 2025b) and visual mapping (Appendix A, Figures 4L–M) that depict that the area of impact is limited to very narrow trajectories across three polygons of critical habitat on the island, all of which do not currently support occupied populations. Our analysis of this information indicates that the area of potential disturbance across three separate polygons would be limited to 0.6 acre of the 585.75 acres of designated critical habitat available on Santa Rosa Island, which overall constitutes 0.001 percent. Consequently, because the proposed project would impact a very small area of often unoccupied portions of critical habitat, we consider this to be overall insignificant.

Western Snowy Plover Critical Habitat on Mainland California

The proposed project's launch ascent would create sonic booms with linear trajectories that cross portions of mainland California. Designated critical habitat could be impacted by the proposed project within East Beach in Santa Barbara County, and within Hollywood Beach to McGrath State Park in Ventura County. As discussed above, due to variations in atmospheric condition and trajectories, although 100 sonic booms could occur across these areas, it is not reasonably likely that they would occur during every launch.

In the unlikely event 100 sonic booms occurred annually across mainland California, this disturbance would impact identified PCE 4. However, based on information from the Space Force (USSF 2025b) (Appendix A, Figures 4J–K), the area of impact is likely to be limited to very narrow trajectories across two polygons of critical habitat on the mainland. Therefore, the area of potential disturbance across two separate polygons would be limited collectively to 1.5 acres of the 1176.23 available acres on the mainland which constitutes 0.001 percent. Consequently, because the proposed project would temporarily impact a small area of the designated critical habitat available on the mainland, we consider this to be overall insignificant and concur that this may affect but is unlikely to adversely affect PCE 4.

Additionally, designated western snowy plover critical habitat between Santa Barbara County and Los Angeles County is located in the region potentially impacted by sonic booms up to 2 psf

during missions with easterly trajectories (Appendix A, Figure K). Using information provided in past analyses (Service 2024a, p. 3), approximately 75 percent of launches that occur across the year could utilize the easterly trajectory. Realized sonic booms on the mainland appear to occur predominantly during the winter months under colder atmospheric conditions which would further reduce the overall number of realized disturbance events annually with the majority occurring outside of western snowy plover breeding season in these areas. We therefore expect disturbance would occur relatively infrequently and that sufficient recovery time would occur between disturbance events to allow for individual and population growth and for normal behavior. Consequently, because the proposed project's easterly trajectories are anticipated to infrequently impact designated critical habitat predominantly outside of breeding season, we consider this to be overall insignificant.

Avoidance and Minimization Measures

After reviewing the information provided, we concur with your determination that the proposed project may affect but is not likely to adversely affect western snowy plover critical habitat based on insignificant effects. Our concurrence is based on the following:

1. We anticipate that overall extent of disturbance from sonic booms would be small compared with available critical habitat and thus would still provide relatively undisturbed areas that allow for individual and population growth and for normal behavior.
2. We anticipate that overall frequency of realized sonic booms associated with the proposed project's easterly trajectories would be low enough to still provide for individual and population growth and for normal behavior.

The Space Force, in coordination with the Service, will review any new available information and available long term population data over the next ten years annually to ensure no unanticipated, unexplained effects occur to reasonably continue to support these conclusions for consistency with this analysis. In reference to the above 'Not Likely to Adversely Affect' analysis, further consultation pursuant to section 7(a)(2) of the ESA is not required. If new information becomes available or the proposed action changes in any manner that may affect a listed species or critical habitat in a manner not previously considered, you must contact us immediately to determine whether additional consultation is required.

Consultation History

We have previously completed six biological opinions (Service 2010a, Service 2011, Service 2014a), two concurrence letters (Service 2014b, Service 2015a), and associated electronic mail transmittals (C. Diel, pers. comm., 2022a, C. Diel, pers. comm., b) regarding the effects of operations performed to support the Falcon Launch Vehicle program at SLC-4.

In our biological opinion dated December 10, 2010 (Service 2010a), we consulted on the modification and operation of SLC-4 East (4E) for the new Falcon 9 and Falcon 9 Heavy Space Vehicle Program. We concurred that launch noise and visual disturbance from space vehicle

launches from this facility may affect, but were not likely to adversely affect the California least tern, western snowy plover, or southern sea otter. We authorized incidental take of El Segundo blue butterflies resulting from landscape maintenance actions and launch-related fires.

On May 25, 2011, the U.S. Air Force (Air Force) requested reinitiation of that consultation due to a change in the effects determination for the California red-legged frog from “no effect” to “may affect, not likely to adversely affect.” In our biological opinion dated June 24, 2011, we concurred that launch noise and visual disturbance from space vehicle launches from this facility may affect, but were not likely to adversely affect the California red-legged frog, the California least tern, western snowy plover, and southern sea otter, and re-authorized incidental take of El Segundo blue butterflies resulting from landscape maintenance actions and launch-related fires (Service 2011).

On October 10, 2013, the Air Force informed us of potential unauthorized impacts to El Segundo blue butterflies and California red-legged frogs resulting from the discharge of water into Spring Canyon during the launch of a Falcon 9 rocket on September 29, 2013. Personnel placed approximately 125,000 gallons of water in the flame bucket, resulting in approximately 25,000 to 50,000 gallons entering Spring Canyon during the launch. Completed mitigation for the unanticipated impacts consisted of habitat restoration (planting of seacliff buckwheat, treatment of invasive plants) and removal of bullfrogs (*Lithobates catesbeianus*) in San Antonio Creek. The Air Force stated that personnel would conduct all future launches from SLC-4E with a dry flame duct to prevent discharge into Spring Canyon. In a letter dated August 29, 2014, we concurred that launch activities at SLC-4E may affect, but were not likely to adversely affect California red-legged frogs that may occur in suitable habitat in Spring Canyon (Service 2014b).

In our biological opinion dated December 22, 2014 (Service 2014a), we consulted on the proposed in-flight abort test and improvements at SLC-4W which included construction of a 300-foot diameter concrete pad to accommodate future landings of Falcon 9 first stage, two new access roads, and a new “FireX” fire control system. We concurred that the proposed activities may affect but were not likely to adversely affect the California least tern, western snowy plover, and southern sea otter. We authorized incidental take of El Segundo blue butterflies and California red-legged frogs resulting from site improvements and, for California red-legged frogs capture and relocation.

On July 2, 2015, we consulted on Falcon 9 boost-back landing operations, which would occur up to 10 times per year at SLC-4W or at sea. The anticipated engine noise at landing would be less than the noise generated during launch, and the anticipated sonic boom overpressure would be up to a maximum of 2 psf. We concurred that boost-back landings of the Falcon 9 first stage as described at SLC-4W may affect, but were not likely to adversely affect the California red-legged frog, the California least tern, western snowy plover, and southern sea otter (Service 2015a).

On June 14, 2017, we received the Air Force’s initial request for formal consultation, including a biological assessment, for proposed launch, boost-back, and landing of the Falcon 9 first stage, not including the use of flame duct water during launch. This request included determinations for

the species named above, except for El Segundo blue butterfly. We requested additional information in a letter dated July 14, 2017. We received a revised biological assessment (MSRS 2017a) on August 14, 2017, with the Air Force's August 8, 2017, request, which included a new project scope regarding SLC-4E flame duct water and impacts to Spring Canyon. As a result of this change, the Air Force made revised determinations that the proposed project may affect and is likely to adversely affect the El Segundo blue butterfly and the California red-legged frog. The determinations that the proposed project was likely to adversely affect the California least tern and western snowy plover and may affect, but was likely to adversely affect the California condor, marbled murrelet, and southern sea otter were not changed from the initial request submitted on June 14, 2017. The Air Force provided additional and clarifying information, including GIS data, on species and habitat occurrence data and impacts to California red-legged frogs and western snowy plovers via electronic mail. On November 20, 2017, the Service received the Air Force's revisions to the project description consisting of the Spring Canyon Riparian Mitigation Plan (mitigation required by the Central Coast Water Control Board; MSRS 2017b) and the project's Monitoring and Minimization Plan (MSRS 2017b) for federally listed species. Where monitoring or minimization measures differ between the biological assessment and the Monitoring and Minimization Plan, the Air Force has confirmed that the latter represents the most up-to-date information, and we incorporated into the Description of the Proposed Action. The Air Force provided additional clarifications of monitoring measures on November 28, 2017, at which time the Air Force also removed a minimization measure for California least terns from the project description. We sent the Air Force a final biological opinion for the project on December 12, 2017 (Service 2017; 2017-F-0480). In this biological opinion, we consulted on the launch of the Falcon 9 from SLC-4E. This included a first stage boost-back and landing at SLC-4W up to 12 times per year, use of up to 200,000 gallons of water in the flame duct, construction of a civil structure and retention basin to divert and retain a portion of the water expelled from the flame duct, removal of vegetation in Spring Canyon to minimize potential effects to nesting birds, and habitat enhancement within Spring Canyon to mitigate for impacts on riparian vegetation.

The Service sent a letter to the Air Force on March 9, 2020 (Service 2020b, entire; 2020-TA-0285), to address a change in status of the *Euphilotes* butterflies on Vandenberg Air Force Base (VAFB) based on the results of a recent study (Dupuis et al. 2020) that determined that they are not the federally endangered El Segundo blue butterfly (*Euphilotes battoides allyni*). We consequently did not consult on the species during subsequent reinitiations.

On May 14, 2021, VAFB changed its name to Vandenberg Space Force Base (VSFB).

In an electronic mail communication dated February 17, 2022, the Service agreed that the effects from modifying two avoidance and minimization measures (CRLF 1 and 2) would maintain the original intention analyzed in the 2017 biological opinion. This concurrence was based on new information that included that no suitable California red-legged frog breeding habitat is present within the effects area of Spring Canyon and that biologists encountered no individual California red-legged frogs following 11 survey efforts, indicating that California red-legged frogs most likely only use the feature for transitory habitat (Diel, pers. comm., 2022a).

In an electronic mail communication dated October 13, 2022, the Service agreed that the effects from increasing the number of Falcon 9 launches from 12 to 14 in 2022 was consistent with existing analyses and did not warrant reinitiation (C. Diel, pers. comm., 2022b).

On November 29, 2022, the Space Force requested expedited reinitiation of the formal consultation (Service 2017; 2017-F-0480) due to a change in the project description to increase launch cadence from 12 to 36 launches annually (Kephart, in litt., 2022). The Service responded with a request for additional information to clarify the project description in relation to the proposed launch frequency, impacts on the northern Channel Islands, and water extraction details for the proposed project. The Space Force clarified the effects determination in their original request's and provided supplemental information to the Service on January 17, 2023 (Kaisersatt, pers. comm., 2023a). The Space Force included that the proposed project is likely to adversely affect the California least tern, western snowy plover, and California red-legged frog and may affect, but is not likely to adversely affect the marbled murrelet, southern sea otter, California condor, unarmored threespine stickleback, and tidewater goby. Project effects outside of VSFB, specifically the northern Channel Islands or Los Angeles, Ventura, and Santa Barbara Counties (referred from here on as mainland California) were not considered during this period. The Service provided the Space Force a draft biological opinion for review on March 3, 2023. The Space Force provided comments on March 9, 2023 (Kaisersatt pers. comm., 2023) and the Service signed the reinitiated final biological opinion on March 21, 2023.

On June 27, 2024, the Space Force requested reinitiation with an updated biological assessment for 50 Falcon 9 launches from SLC-4, including the development of SLC-6 to support future Falcon 9 and Falcon Heavy operations. However, through conversation with the Service's Ventura Fish and Wildlife office and Pacific Southwest Regional Office, the project description was revised to include only 14 launches, 2 static tests and 1 boost-back from SLC-4 between October 1 to December 31, 2024 (SpaceX, meeting communication, July 2, 2024). The Space Force requested expedited formal consultation (by August 15, 2024) for this stand-alone consultation. The Space Force included that the proposed project was likely to adversely affect the California least tern, western snowy plover, California red-legged frog and requested the Service conference on the southwestern pond turtle (*Actinemys pallida*), which was proposed for listing as threatened. Project impacts to off VSFB, mainland California were newly considered in this consultation, which led to the Space Force's additional determinations of may affect, but not likely to adversely affect for the marbled murrelet, southern sea otter, California condor, unarmored threespine stickleback, tidewater goby, coastal California gnatcatcher, light-footed Ridgeway's rail, arroyo toad, California tiger salamander, and conference on the western spadefoot (*Spea hammondi*), which was proposed for listing as threatened. Project effects to the northern Channel Islands or off VSFB, mainland California were not considered during this period. The Service provided the Space Force sections of the draft biological opinion for review between July 15 and August 15, 2024, and the Space Force provided comments during this period. The Service reviewed and incorporated changes to the project description as appropriate, including a communicated request for 16 launches (updated from the original 14 launches proposed). Following a phone call and then additional comments on the draft biological opinion's effects analysis and relevant terms and conditions provided by Space Force on August 13, 2024, the Service and Space Force agreed to revise the biological opinion's due date to

August 28, 2024, to provide necessary time to address comments. The Service and Space Force continued to coordinate on comment resolution until August 20, 2024, and the Service provided the signed final opinion on August 28, 2024. During this consultation period, the Space Force indicated they would request reinitiation for 100 launches in 2025. On December 17, 2025, after coordination with the Space Force, the Service extended the consultation for 16 additional launches from January 1 through February 28, 2025 (not to exceed 50 annual launches total).

On April 10, 2025, the Space Force provided the request for reinitiation with an updated biological assessment for up to 100 collective launches of Falcon-9 (95 to 100 launches) and the Falcon Heavy vehicle (up to 5 launches from SLC-6) annually between SLC-4 and SLC-6, including redevelopment of SLC-6 to support future Falcon-9 and Falcon Heavy operations.

On July 22, 2025, the Service issued the draft biological opinion to the Space Force. On August 6, 2025, the Service, Space Force, Federal Aviation Administration, and the Applicant conducted a conference call to discuss comments on the draft. On August 13, 2025, the Space Force sent written comments to the Service.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The implementing regulations for section 7(a)(2) of the ESA define “action” as “all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. Examples include but are not limited to: (a) actions intended to conserve listed species or their habitat; (b) the promulgation of regulations; (c) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants-in-aid; or (d) actions directly or indirectly causing modifications to the land, water, or air” (50 CFR 402.02).

The Service and Space Force have agreed that this biological opinion is effective for a period of ten calendar years from the date of its issuance and can be extended if deemed appropriate by both agencies. During preparation of each annual report, both agencies will review this consultation to ensure consistency with the analysis and discuss any new information obtained.

Project Overview

The proposed project would increase annual Falcon 9 launch cadence at SLC-4 and modify SLC-6 to support two Falcon launch vehicles, the existing Falcon 9 as well as the Falcon Heavy vehicle. Collectively between SLC-4 and SLC-6, the Space Force would authorize up to 100 launches annually as further detailed below. A total of up to 12 first stage boost-back landings would occur at SLC-4 per year and up to 12 mission landings would occur at SLC-6. All other boost-back landing events would occur offshore. A total of no more than 50 separate associated static test fires per year would also occur.

Demolition/Construction*SLC-4*

Previous components of the project's construction features described in the 2017 consultation remain unchanged. This construction is complete and this reinitiation will not discuss these features further.

SLC-6

The existing SLC-6 footprint was developed during the 1980's to support the previous Space Shuttle program and has existing infrastructure that was utilized by various launch operators until 2022.

Demolition and New Construction

The Applicant would modify SLC-6 to support Falcon 9 and Falcon Heavy launches and landings. Construction is expected to take approximately 18 months and would start in late 2025, depending on acquisition of the lease by the Applicant. However, construction could occur more quickly than this timeline. Initial demolition of large structures that cannot support Falcon vehicles would occur concurrently with construction of Falcon-specific infrastructure. The major construction and demolition activities would occur during approximately the first 12 months of construction. The remaining construction time would primarily involve construction and activation of infrastructure such as fluid systems.

Proposed infrastructure includes commodity storage tanks, a vehicle erector, water tower(s), ground supporting equipment, and a rail system from the hangar to the launch pad (Appendix A, Figure 6A). Existing infrastructure would be modified, including the liquid oxygen storage, launch pad apron, access road between the launch pad and a new hangar, and fence line. The existing flame trench would be retained and converted to a unidirectional water-cooled flame diverter, and a deluge/acoustic suppression system would be installed. A water reclamation system would be used that could pump residual deluge water back into the water storage tanks. The majority of this work would occur in previously disturbed areas and on existing impervious surfaces, but some earthwork is anticipated. Construction may occur at any time of the day or night.

A new hangar would be required for vehicle processing. The Applicant would construct a new approximately 62,000 ft² hangar north of the launch pad to support Falcon 9 and Falcon Heavy integration and processing. Areas around the hangar would be filled and graded to provide rear access to the hangar. Approximately 40,000 cubic yards of fill would be required and would be sourced locally. Approximately 244,000 ft² of additional impervious area would be added to construct this hangar. Existing stormwater infrastructure is expected to be adequate to support this additional impervious area but would be confirmed during final design of the site. The Applicant would modify the existing access road by widening the road and adding a rail system between the launch pad and the existing Horizontal Integration Facility (HIF) for transport of the

Falcon vehicle between a new hangar to the launch pad. The exiting SLC-6 fence would be relocated and vehicular access from Luner Road to N Road would be removed.

The existing mobile service tower, mobile assembly shelter, fixed umbilical tower, and launch crown would be demolished. Mechanical shears would be used to cut the building sections into manageable sizes. Cranes would be utilized to assist with any heavy lifts of the structure and an excavator with a thumb attachment would be used to move the pieces to a dump truck to haul out the material. Staging and temporary storage of materials would occur in the areas of disturbance. Demolition work would occur during daylight hours. The duration of demolition activities may last up to 6 months.

Daily sound levels from construction and demolition would vary depending on the type of activity occurring that day and equipment used, but generally sound would remain within the vicinity of SLC-6. Explosives would be used in one instance to remove one structure, during which four approximately 50-pound explosive charges would be detonated simultaneously. This will cause a short impulsive sound, similar to that experienced during first stage landing events at SLC-4, but over a much smaller area. The distance at which the impulsive noise caused by the explosion would attenuate to 140 dB $L_{\max}$ (4.17 psf) is estimated to be approximately 0.57 miles from SLC-6, 130 dB $L_{\max}$ (1.32 psf) at approximately 1.19 miles, and 120 dB $L_{\max}$ (0.42 psf) at approximately 3.79 miles.

SLC-6 New Landing Zones, Utilities, and Firebreaks

The Applicant would construct two landing zones south of SLC-6 to support landing of first stage Falcon boosters launching from SLC-6. Each landing zone would be made up of a 280-foot diameter concrete pad surrounded by a 60-foot gravel apron, for a total diameter of 400 feet. The Applicant would construct a new nitrogen gas line from SLC-6 to a fluids bay at the landing zones. The fluids bay is used to send nitrogen to different systems of the booster after landing. A 15-foot tall 30- by 30-foot pedestal, would be constructed at each landing pad. The first stage booster is lifted onto the pedestal during post-flight processing to remove the landing legs prior to transport. Crane storage, a cleared area to lay down cranes when not in operation, is proposed on the western site boundary. Each landing zone would have a connection to the existing road to support booster transport. Approximately 16 acres would be cleared to construct the landing zones and approximately 7 acres would be impervious upon completion of construction. Any fill would be purchased from local existing off base suppliers, and/or if using any sources on VSFB, the fill would be obtained from preexisting, established borrow pits, which are covered under an existing biological opinion (8-8-10-F-5) and related regulatory permitting. Proposed landing zones at SLC-6 would take approximately 2 to 4 months to construct, including the length of time for the concrete to cure.

A new firebreak is proposed south of the landing zones. Cypress Ridge Road and N Road would also be improved to ensure suitable access for fire defense. These improvements are anticipated to be within the existing roadway footprints. The proposed firebreak is approximately 50 feet wide and would connect to the existing firebreak for SLC-8. Cypress Ridge Road, an existing

fire access road, would be improved within its existing footprint to protect against potential erosion. Vegetation maintenance would occur within the vegetation maintenance area.

Launch Operations

SLC-4

Based on estimated future launch frequency, the Applicant anticipates launching the Falcon 9 vehicle up to 70 times per year from SLC-4E. A static test fire of engines may precede 30 launches. Following each launch ascent, the Applicant would perform a boost-back and landing descent of the first stage either downrange on a droneship in the Pacific Ocean or at SLC-4W at VSFB (up to 12 times).

The proposed action includes launch azimuths between 140 and 325 degrees.

SLC-6

The Applicant anticipates launching the Falcon vehicles up to 30 times per year, specifically with the Falcon Heavy Vehicle launching up to 5 times per year and remaining launches being Falcon 9. A static test fire of engines may precede 20 launches. Following each launch ascent, the Applicant would perform a boost-back and landing descent of the first stage either downrange on a droneship in the Pacific Ocean up to 25 to 30 or at SLC-6 at VSFB (up to 12 times).

The proposed action includes launch azimuths between 140 and 325 degrees.

Launch Schedule and Frequency

Each of the 100 launches would be separated by a calculated average of twice per week. Launches could occur as frequently as three days apart but this would not occur regularly as depicted in the provided estimated launch schedule that the Service considered for purposes of this analysis (USSF 2024a). Although rare, it is possible that a launch could occur from SLC-4 and SLC-6 on the same day.

Launch operations would occur day or night under all but extreme weather conditions (i.e., would not occur during gale force winds, high wind shear, or extreme thunder and lightning conditions). Individual launch ascent noise disturbance would last up to 1 minute. Launch ascent may result in a separate instantaneous sonic boom that impacts portions of the Channel Islands and mainland California discussed below. Individual launch landing disturbance (boost-back) would last up to 17 seconds. Launch landing would also create a separate instantaneous sonic boom that impacts the vicinity of VSFB. The total time from launch to landing would be 6 to 10 minutes (Kaisersatt, pers. comm., 2024).

A static test fire could occur one to three days before a full launch and is considered a separate form of launch disturbance. Static test fires would impact a smaller portion of a full launch's

disturbance footprint over a substantially shorter duration (7 seconds) and are consequently a separate distinct disturbance event that is not comparable or substitutable for a full launch.

Table 16. Proposed launch disturbance type with details.

Launch Disturbance Type	Duration/Frequency	Frequency	Number Proposed Annually
Static Test Fire	7 seconds	One to three days before full launch	50
Launch (Ascent)	1 minute ascent	Once every 5 days on average (up to 3 days infrequently)	100
Terrestrial landing (boost-back)	17 seconds landing coupled with instantaneous sonic boom	6 to 10 minutes following launch ascent, up to once every 5 days	24

Vehicle Terrestrial Landing at VSFB (Boost-back) and Offshore Landings

For missions launching from SLC-4, the Applicant would land the first stage, either downrange on a droneship in the booster recovery area (Appendix A, Figure 7A) or at the existing landing zone at SLC-4 or at the proposed landing zones at SLC-6 (Appendix A, Figure 7B). The Applicant would continue to land up to 12 first stages at SLC-4 each year. In addition, up to 12 missions each year would utilize the proposed landing zones at SLC-6, including 10 boosters landing simultaneously during a maximum of five Falcon Heavy missions per year, which would land the two side boosters at the same time at SLC-6. The Falcon Heavy center core first stage booster is typically expended each launch but may land on an offshore droneship. Up to 10 launches per year may include expendable first stages that would be deposited anywhere within the booster recovery area.

When first stages and fairings land in the downrange recovery area, the droneship would continue to transport first stage boosters and fairings from the Port of Long Beach to the VSFB harbor via a “roll-on-roll-off” (RORO) barge, as described in the 2023 BO (Service 2023a), or over roads if ocean conditions are too rough to support barge operations. The Proposed Action would include up to 100 events per year utilizing RORO operations.

Launch Noise

The Space Force provided modeling of individual launches and associated static test fire events for the purposes of this analysis using the $L_{\max}$ noise metric. $L_{\max}$ is the unweighted peak sound level, the highest sound pressure level measure during a single launch event. Although it provides some measure of the event, $L_{\max}$ does not fully describe the noise disturbance because it

does not account for the duration of the sound. Sound exposure level (SEL) considers the length of time a noise occurs and provides a measure of the net impact of the entire acoustic event.

Launch Sonic Boom (Overpressure Disturbance)

Each proposed launch ascent and landing descent would generate a sonic boom resulting in overpressures of high energy impulsive sound. Sonic booms are low frequency, impulsive noise events with durations lasting a fraction of a second (BRRC 2020, p. 32). Sonic boom impact areas will depend on the launch trajectory. The Space Force used PCBoom to model sonic booms produced by the proposed project.

Rockets create two different types of noises during ascent and descent: 1) noise generated from the rocket engines (rocket engine noise) during launch and landing; and 2) sonic boom noise caused by the overpressure (i.e., shock wave) that is generated as the vehicle reaches supersonic speeds during its ascent and descent. The potential levels and impact locations of these different types of noises must be modeled by different methods because the physics and mathematical calculations in predicting their attributes are also very different. Sonic boom levels are typically presented in psf values; however, they can be directly translated into dB as well.

Falcon rocket engine noise was modeled using a software package called RNoise (KBR, et. al, 2025). This model incorporates numerous components, including the acoustic power of the rocket engine source, forward flight effects, the angle from the source to the receiver (directivity), Doppler effect, propagation between the source and receiver (ray path), atmospheric absorption, and ground interference to estimate received noise levels. RNoise assumes the surface of the earth is flat and therefore does not account for attenuation due to landforms. Therefore, the estimates of engine noise levels below are conservative for areas shielded by hills, bluffs, or other features, such as buildings or dense vegetation.

During Falcon 9 launches from SLC-4 and SLC-6, engine noise produced during launches would be audible across VSFB and the surrounding areas. Engine noise during Falcon 9 first stage landings at SLC-4 and SLC-6 would impact a smaller area, between Purisima Point and Point Conception along the coast and inland to Lompoc. During the 5 annual projected Falcon Heavy launches from SLC-6, a larger area would receive engine noise since there are 3 first stages on the launch vehicle. Noise during Falcon Heavy launches would reach the Santa Maria Valley and the Gaviota Coast. When landing at SLC-4 or SLC-6, landing engine noise follows the associated launch engine noise by approximately 5 to 7 minutes and typically occurs slightly before or simultaneous with the sonic boom that impacts land. Static fire engine tests at SLC-4 and SLC-6, which typically occur 1 to 3 days prior to launch and last up to 7 seconds per event, would also generate engine noise across VSFB and off base areas, including the Santa Rita Hills and Gaviota Coast.

Falcon Heavy sonic boom impacts were modeled using PCBoom software (KBR, et. al., 2025). During ascent, a sonic boom (overpressure of impulsive sound) typically with a peak of approximately 3 to 5 psf, but up to approximately 8 psf, would be generated. Depending on the launch trajectory, the sonic boom may or may not impact the surface of the earth. Since 2017,

approximately 10 percent of the ascent sonic booms generated during Falcon 9 launches from SLC-4 did not impact the surface of the earth because the ascent of the rocket was too steep. When ascent sonic booms do impact the earth's surface, they primarily impact the Pacific Ocean but often overlap the northern Channel Islands. From 2017 through October 20, 2024, of the launches that produced ascent sonic booms that impacted the surface of the earth, approximately 67 percent have impacted the northern Channel Islands. As discussed in the 2023 section 7 consultation (Service 2023a), modeling determined that sonic booms generated during ascent for missions with northerly mission profiles (launch azimuth between 305 and 325 degrees) are expected to only impact the ocean's surface with no impacts to land.

During launch ascent, a sonic boom with overpressure up to 5 psf could impact various linear pathways across the northern Channel Islands (Santa Rosa and Santa Cruz Islands) (Appendix A, Figure 4L). The Space Force has previously indicated that 30 percent of launches could impact the northern Channel Islands, with the vast majority constituting overpressure of under 2 psf (Kaisersatt pers. comm., 2023, p. 1). For this analysis, the Space Force has conservatively provided that 100 launches could impact the northern Channel Islands with associated sonic booms over 1 psf. Areas impacted would be limited to narrow trajectories as indicated in provided mapping (Appendix A, Figure 4L–M).

For easterly trajectories (launch azimuth between 140 and approximately 150 degrees), ascent sonic booms may impact eastern Santa Barbara County, Ventura County, and Los Angeles County on the mainland. The majority of the ascent sonic booms that would overlap these areas are predicted to be less than 1 psf. Even with identical trajectories, atmospheric conditions create considerable variation in where ascent sonic booms impact and the level at which they impact. To account for this variation, PCBoom can utilize meteorological parameters in the model that affect where and at what level a sonic boom may impact the surface of the Earth. In the late 1990's, SRS Technologies, Inc. assembled a series of daily meteorological profiles across 10 years (1984–1994, one per day for 10 years) from radiosonde data for weather balloons released by the SLD 30 weather squadron. These data include pressure, temperature, wind speed, and wind direction along an elevational profile from ground, every 1,000 ft, to 110,000 ft. Each trajectory was run between 29 and 40 times, with each run representing 1 of between 29 and 40 randomly selected meteorological profiles that capture potential weather conditions throughout the year (308 model outputs total). Only 13 percent of model runs resulted in sonic booms that overlapped eastern Santa Barbara County, 85 percent of model runs resulted in sonic booms that overlapped Ventura County and 58 percent of model runs resulted in sonic booms that overlapped western Los Angeles County.

During first stage landings at SLC-4, PCBoom modeling has predicted that landing (i.e., descent) sonic booms may reach up to approximately 7 psf in the area around SLC-4. Areas impacted by 1 psf contour extend as much as approximately 27 miles north of SLC-4 and up to approximately 38 miles to the east.

Falcon 9 first stage landings at SLC-6 would have similar extents and levels as landings at SLC-4, although shifted to the south. For Falcon Heavy missions at SLC-6, two boosters would land nearly simultaneously at SLC-6. Modeling predicted that the boosters would produce sonic

booms up to 13 psf in the immediate area surrounding SLC-6 and the 1 psf contour would extend approximately 17 miles north and 40 miles to the east of SLC-4. Focal booms (relatively small areas where high sonic boom levels may occur) are predicted to reach up to an estimated 5 psf approximately 40 miles to the east.

Although unlikely, sonic booms up to 3.1 psf may also impact the northern Channel Islands during landing events at SLC-4, SLC-6, or on droneships in offshore areas if near VSFB, depending on the landing trajectory and weather conditions. However, during the majority of downrange droneship landings in the proposed landing areas, sonic booms would be directed entirely at the ocean surface without impacting any land. Landing sonic booms can vary substantially depending on mission requirements and the associated landing trajectories.

Overpressure to decibel conversion

Overpressure can be expressed as instantaneous noise disturbance ($L_{\max}$) by using a mathematical conversion from psf to decibel levels. The biological assessment did not include conversions of overpressure into instantaneous noise disturbance ($L_{\max}$).

The Service reviewed past Falcon 9 monitoring reports to reference these conversions for purposes of facilitating comparison. Previous realized monitoring, prior to observed changes in past provided overpressure modeling for the same vehicle, indicates that the realized sonic boom at south Surf Beach was 3.6 psf, which produced experienced noise levels of 138 dB $L_{\max}$; 1.1 psf produced experienced noise of 129 dB $L_{\max}$ at Purisima Point; and 2.4 psf produced experienced noise of 135 dB $L_{\max}$ at Honda Creek (Robinette and Rice 2019a, p. 14; MSRS 2022a, p. 4; D. Robinette and Rice 2022, p. 13). Therefore, the proposed project overpressure levels in natural habitat outside of SLC-4 (e.g. 5 psf) would equate to maximum received noise levels between 140 to 150 dB produced from sonic booms.

Launch Fueling and Combustion

During launch operations, mobile fuel trailers would supply fuel (rocket propellant-1 (RP-1) and liquid oxygen (LOX) rocket propellant) to on-site ground support equipment. Black carbon (soot) can be a byproduct of rocket launches and is largely a factor of running a fuel-rich mixture, such as a fuel-rich gas generator rocket engine. The Space Force has included that the proposed project uses oxidizer-rich staged combustion engines that produce a diminutive amount of terrestrial soot. The primary emission products from the Falcon liquid engines are carbon dioxide (CO₂), carbon monoxide (CO), water vapor, oxides of nitrogen, and carbon particulates. Although the exhaust is fuel-rich and contains high concentrations of CO, subsequent entrainment of ambient air results in complete conversion of the CO into CO₂ and oxidation of the soot from the gas generator exhaust. Referencing previously produced environmental assessments for other Falcon 9 launch operations, the Space Force specified that the proposed project's exhaust process results in the complete conversion of produced carbon monoxide into carbon dioxide as well as the oxidation of soot from the gas generation exhaust. The Space Force consequently expects that the produced soot would burn up in the exhaust plume (Kaisersatt, pers. comm., 2023b, p. 7).

No additional information detailing amounts of atmospheric emissions or an associated effects analysis from the proposed rocket launching were provided within the biological assessment.

Water Usage, Flame Duct, and Deluge Water System

The proposed action would use up to 21.1 million gallons (65.6 acre-feet) of water per year. At SLC-4, the Applicant would utilize an existing water-filled flame duct to reduce vibration impacts from noise on payloads. During Falcon 9 launches, approximately 70,000 gallons of water would be utilized per launch with approximately 40,000 gallons per landing. Using these estimates, for 70 launches and 12 terrestrial landing this would amount to approximately 5.38 million gallons (approximately 16.5 acre-feet) annually to support personnel and operational activities at SLC-4.

At SLC-6, the Applicant would utilize an existing water-filled flame duct, but more water would be required at this site since the existing feature is substantially larger than the infrastructure at SLC-4. Each Falcon 9 launch from SLC-6 would require 200,000 gallons per launch and Falcon Heavy would use up to 1.5 million gallons of water per launch. In addition, a maximum of 1.19 million gallons (3.64 acre-feet) per year to support personnel at Buildings 398 and 520, and 1.10 million gallons (3.36 acre-feet) per year would be required to support the personnel and operational activities at SLC-6.

The Space Force has recently clarified that the current water source for VSFB, including SLC-4, comes from an existing connection between State Water and the VSFB water supply system. For the majority of the proposed project, the Space Force would source water from this connection. However, during annual maintenance that lasts approximately two weeks and may occur once annually, VSFB utilizes four water wells in the San Antonio Creek Basin. Consequently, conservative estimates across this period (14 days), up to 184,615 gallons (0.57 acre-feet) could be extracted from these wells in San Antonio Creek Basin in support of the proposed project.

Launches would eject flame duct water. Based on prior Falcon 9 missions, approximately half of the volume of water remains in the flame duct and half is expelled as water and water vapor. Of the expelled water, approximately half is in the form of hot steam (17,500 gallons) with the remaining half being liquid (17,500 gallons). The proposed project would not create any overland flow of water into Spring Canyon as v-ditches divert and collect the water before it leaves the SLC-4 fence line. The containment features (e.g. v-ditch, etc.) within SLC-4 hold all water for a short duration until it dissipates. A minimal quantity of water reaches Spring Canyon in the form of steam and water droplets and is expected to dissipate quickly.

At SLC-6, approximately half of the volume of water is expected to remain in the flame duct and half is expelled as water and water vapor. There would be no overland flow of any water outside of the SLC-6 feature into the southern identified ephemeral drainage. The v-ditch feature within SLC-6 would hold all water for a short duration until it dissipates.

The Space Force would maintain vegetation within the v-ditch feature on a periodic basis (Kaisersatt pers. comm. 2023). A minimal quantity of water that reaches the southern ephemeral drainage in the form of steam and water droplets and would be expected to dissipate quickly.

The Applicant would remove any accumulated standing water within 24 hours any storm event that have the potential to fill features like the flame trench.

AVOIDANCE AND MINIMIZATION MEASURES

This consultation supersedes all previous Falcon 9 consultations at Vandenberg Space Force Base. The following measures are inclusive of all that will be implemented for the Falcon 9 and Falcon Heavy program as proposed in the 2025 BA (SLD 30 2025). The Space Force will ensure all measures will be implemented as described.

General Project Avoidance and Minimization Measures

The following protection and monitoring measures would apply to all aspects of the Proposed Action to protect and minimize effects on biological resources:

- GM-1 A Service Approved Biologist will brief all construction personnel prior to participating in construction and demolition activities at SLC-6. At a minimum, the training would include a description of the listed species and sensitive biological resources occurring in the area, the general and specific measures and restrictions to protect these resources during project implementation, applicable provisions of the ESA and the necessity of adhering to those provisions, and the penalties associated with violations of the ESA.
- GM-2 The Applicant will develop a lighting management plan to incorporate into the construction of SLC-6 and will be provided to the Service.
- GM-3 The Applicant will limit construction and demolition activities to areas and durations necessary, as verified by the Space Force, to accomplish project objectives.
- GM-4 The Applicant will place all human-generated trash and food waste in concealed containers. Trash will be transferred to a secure on-site dumpster or equivalent at the end of each workday and removed from the work area weekly throughout construction and demolition at SLC-6.
- GM-5 The Applicant will ensure that a Qualified Biologist inspects any construction equipment left overnight prior to the start of work the following day. The Qualified Biologist will check equipment for presence of special-status species in the vicinity and for fluid leaks and immediately let 30 CES/CEIEA know to coordinate subsequent actions prior to the start of work.

- GM-6 The Space Force will ensure that the Applicant implements the following measures at SLC-4 and SLC-6: (1) the site-specific Stormwater Pollution Prevention Plan; (2) the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; (3) collect any rocket propellant seen floating in the retention basin using absorbent pads prior to discharge to the spray field; and (4) the procedures in VSFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill.

Southern Sea Otter

- SSO-1 The Space Force will continue to conduct southern sea otter population surveys at the current levels to monitor the densities and distribution of southern sea otters along VSFB's coastline.

California Red-legged Frog

- CRLF-1 Service-Approved Biologists, approved by Service and 30 CES/CEIEA, including personnel who are familiar with and possess necessary qualifications to be approved for capture, handle, and release of California red-legged frogs, will be present to monitor construction and demolition activities at SLC-6 when deemed necessary by the Space Force throughout the length of the project to minimize impacts on this species. The biological monitors will be responsible for delineating areas where special-status species are located or concentrated, relocating special-status species in jeopardy of being killed or injured by construction, and inspecting equipment and equipment staging areas for fluid leaks. Prior to the onset of construction activities, qualification submittals of biologist(s), who would conduct the monitoring, surveying, species relocation, and other biological field activities will be submitted by 30 CES/CEIEA to the Service for approval.
- CRLF-2 Prior to construction activities at SLC-6, any California red-legged frogs will be removed by a Service Approved Biologist from an exclusion area within the project site and relocated, to the nearest suitable habitat location at least 500 feet away to decrease the likelihood of recapture through the process described below.
- CRLF-3 The Applicant, under direction from a Qualified Biologist, will establish an exclusion area (or potentially multiple separate exclusion areas) around previously undisturbed areas where construction activities occur and require vegetation removal, fill placement, and California red-legged frog removal/exclusion to avoid impacts to this species.
- CRLF-4 The applicant, under direction of a Qualified Biologist, will ensure the exclusion area is encircled with a minimum 3-foot-high silt fencing, anchored with metal

T-posts, and buried along the bottom edge to the best extent possible to prevent terrestrial wildlife, including California red-legged frogs, from entering the site.

- CRLF-5 Following completion of the installation of exclusion fencing, Service Approved Biologists would conduct a pre-project survey of the exclusion area for wildlife and special-status species, including California red-legged frog. All California red-legged frogs captured will be transported to the nearest suitable habitat outside of the exclusion area and released by a Service Approved Biologist. The Service Approved Biologist will repeat these surveys following any precipitation event greater than 0.2 inch during a 24-hour period.
- CRLF-6 A Service Approved Biologist will monitor any initial ground disturbance or vegetation removal within suitable aquatic, adjacent upland, or dispersal habitat identified following the adaptive habitat assessment procedures (as described in the PBO, Service 2018). However, after the initial ground disturbance/vegetation removal is complete, no further monitoring will be required within these bare-dirt areas.
- CRLF-7 Relocation: If California red-legged frogs are found within the project area during pre-project surveys, daily monitoring where required, or at any other time, all construction activity within the vicinity of the California red-legged frog occurrence (if any) will cease. If the project site is large and if the Service Approved Biologist is satisfied that work in a different area of the project can continue with no threat to California red-legged frogs, then that work would continue. Construction activities within the vicinity of the California red-legged frog occurrence will not begin or resume until the California red-legged frog is relocated by a Service Approved Biologist or the individual has left the construction area of its own volition. The Service Approved Biologist will relocate all life stages of California red-legged frogs the shortest distance possible to a location that is (1) within the same drainage, (2) contains suitable aquatic/upland habitat, and (3) is outside of the project impact area. All animals will be held in 5-gallon buckets until release. All animals held will be segregated by size such that predation is unlikely. The holding time will be minimized to the greatest extent feasible and the health of all held animals will be continuously monitored to evaluate the need for additional measures to protect the animals, such as aeration of water in holding buckets.
- CRLF-8 All exclusion fencing will be removed at the completion of construction activities.
- CRLF-9 To avoid transferring disease or pathogens between aquatic habitats during surveys and handling of amphibians, the Service Approved Biologists will follow decontamination procedures described in the Declining Amphibian Population Task Force's Code of Practice (Service 2002a).

- CRLF-10 Any open holes or trenches will be covered with plywood or metal sheets and/or supplied with an escape ramp if left overnight to minimize the risk of entrapment of California red-legged frogs or other wildlife.
- CRLF-11 Construction activities will not occur in previously undisturbed areas with potential for California red-legged frogs until 24 hours after an actual precipitation event greater than 0.2-inch accumulating within a 24-hour period.
- CRLF-12 No overnight staging of equipment or supplies will occur within 0.10 miles of aquatic habitat. Measures would be implemented that prevent California red-legged frog from accessing the staging area (e.g., drift fence barrier installed).
- CRLF-13 The Applicant will maintain exhaust ducts at SLC-6 to minimize standing water when operationally feasible, as verified by the Space Force, to help minimize the potential to attract California red-legged frogs to SLC-6.
- CRLF-14 The Applicant will continue to remove nonnative, invasive predators captured incidentally during the monitoring efforts described below (e.g., American bullfrogs).
- CRLF-15 The Applicant will continue to implement long-term monitoring of population and distribution trends associated with California red-legged frog populations within Jalama Creek, Honda Creek, Bear Creek, and the Santa Ynez River, as described below:

The Applicant will ensure that quarterly night surveys for California red-legged frog and spring tadpole surveys are conducted in lower Honda Creek, Bear Creek, the Santa Ynez River, and Jalama Creek to compare baseline California red-legged frog detection rate and occupancy data collected over the past 10 years and assess if there are any changes in California red-legged frog habitat occupancy, breeding behavior (calling), and breeding success (egg mass and tadpole densities). Data analysis will incorporate past and future habitat assessments to account for variables including but not limited to observed variation in extent of wetted habitat, quantified predator removal, and climatic factors. Within-site population trends will be assessed in relation to intensity of launch impacts experienced at each site to evaluate whether proximity to launch sites is related to occupancy, breeding behavior (calling), and breeding success (egg masses and tadpole densities).

The surveys will record and measure the following:

California red-legged frog detection density following the same survey methods conducted previously at these sites and throughout VSFB (MSRS 2024a); California red-legged frog locations and breeding evidence (e.g., calling, egg masses); environmental data during surveys (temperature, wind speed, humidity, and dewpoint) to determine if environmental factors are affecting California red-

legged frog detection or calling rates; annual habitat assessments to measure flow rates, stream morphology, depths, quantify suitable occupied habitat and sediment to determine if any changes in California red-legged frog metrics are associated with other environmental factors, such as drought; and locations and densities of co-occurring anurans, including bullfrogs and Baja California tree frogs (*Pseudacris regilla*).

- CRLF-16 The Applicant will continue to perform passive bioacoustics monitoring (Wildlife Acoustics Song-Meter 4 or similar technology) and will establish frog calling behavior baseline within each impacted breeding feature (Jalama Creek, Honda Creek, Bear Creek, and Santa Ynez River) and a control site at Arroyo Quemado for purposes of signal characteristic comparison. California red-legged frog calling behavior baseline will include applicable call characteristics (e.g., changes in signal rate, call frequency, amplitude, call timing, call duration, etc.). The Applicant will ensure that bioacoustic monitoring conducted is designed to best address confounding factors to appropriately characterize impacts of launch, static fire, and landing events on calling behavior. The California red-legged frog call characteristics described above will be analyzed from the sites on VSFB and Arroyo Quemado to determine if there are any differences that may be due to launch-related causes. The results will be analyzed in conjunction with long term population data to ensure that any observed changes in signal characteristics are not resulting in observable declines in population.
- CRLF-17 The Applicant will discontinue monitoring after 5 years from initiation of monitoring, which began with the 2023–2024 breeding season.

Western Snowy Plover

- WSP-1 The Space Force will continue to implement long-term monitoring of annual population and distribution trends associated with western snowy plover along Surf Beach.
- WSP-2 The Applicant will perform acoustic monitoring (rocket engine noise and sonic boom) at South Surf Beach during the first three Falcon Heavy missions to validate noise model predictions.
- WSP-3 The Applicant will perform geospatial analysis annually to identify declines in the western snowy plover population, nesting activity, and reproductive success that may result from cumulative effects of multiple Falcon launches and landings from SLC-4 and SLC-6. The Applicant will discontinue this analysis after 5 years from initiation, which began with the 2024 western snowy plover breeding season.
- WSP-4 The Applicant will use motion triggered video cameras during the breeding season (March 1 through September 30) to determine nest fates and potential impacts to nests during the first three Falcon Heavy launches and landings.

WSP-5 The Applicant will monitor active nests at South Surf Beach with motion triggered video cameras during the breeding season at whichever of the following is greater within the modeled 4 psf zone during the first three Falcon Heavy launches and landings to assess potential novel effects that may result from frequent launching: (i) 10 percent of active western snowy plover nests, or (ii) four active western snowy plover nests. The Applicant will monitor at whichever of the following is greater within the modeled 3 to 4 psf zone: (iii) 10 percent of active western snowy plover nests, or (iv) two active western snowy plover nests. The Applicant will monitor at whichever of the following is greater within the modeled 2 to 3 psf zone: (v) 5 percent of active western snowy plover nests, or (vi) four active western snowy plover nests.

Cameras will be placed in a manner to minimize disturbance to nesting plovers; this will be determined in the field based on the best judgement of a Permitted Biologist. The Applicant will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events. The Applicant will review western snowy plover nest camera recordings as soon as possible after the Falcon Heavy launch/landing events.

California Least Tern

- CLT-1 The Space Force will continue to implement long-term monitoring of annual population and distribution trends associated with California least tern.
- CLT-2 The Applicant will perform statistical analysis annually to identify declines in the California least tern population, nesting activity, and reproductive success that may result from cumulative effects of multiple Falcon launches and landings from SLC-4 and SLC-6. The Applicant will discontinue this analysis after 5 years from initiation, which began with the 2024 California least tern breeding season.
- CLT-3 The Applicant will perform acoustic monitoring (rocket engine noise and sonic boom) during the first three Falcon Heavy missions at the Purisima Point California least tern colony to validate noise model predictions.
- CLT-4 Motion triggered video cameras will be used during the breeding season (typically April 15 to August 15) to determine nest fates and potential impacts to nests during the first three Falcon Heavy launches and landings to reduce disturbance associated with human activity within breeding habitat.
- CLT-5 The Applicant will monitor during the first three Falcon Heavy launches and landings at whichever of the following is greater within the Purisima Point colony: (i) 10 percent of active California least tern nests, or (ii) four active California least tern nests.

Cameras will be placed in a manner to minimize disturbance to nesting terns; this will be determined in the field based on the best judgement of a Permitted Biologist. The Applicant will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events. The Applicant will review California least tern nest camera recordings as soon as possible following the Falcon Heavy launch/landing events.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

Section 7(a)(2) of the ESA requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. “Jeopardize the continued existence of” means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 402.02).

The jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which describes the current rangewide condition of the California red-legged frog, western snowy plover, California least tern, and southern sea otter, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which refers to the condition of the California red-legged frog, western snowy plover, California least tern, and southern sea otter in the action area, without the consequences to the California red-legged frog, western snowy plover, California least tern, and southern sea otter caused by the proposed action; (3) the Effects of the Action, which are all consequences to the California red-legged frog, western snowy plover, California least tern, and southern sea otter caused by the proposed action that are reasonably certain to occur; and (4) the Cumulative Effects, which evaluate the effects on the California red-legged frog, western snowy plover, California least tern, and southern sea otter of future State or private activities in the action area that are reasonably certain to occur.

For the section 7(a)(2) determination regarding jeopardizing the continued existence of the species, the Service begins by evaluating the effects of the proposed Federal action and the cumulative effects. The Service then examines those effects against the current status of the California red-legged frog, western snowy plover, California least tern, and southern sea otter to determine if implementation of the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of the California red-legged frog, western snowy plover, California least tern, and southern sea otter in the wild by reducing the reproduction, numbers, and distribution of that species.

STATUS OF THE SPECIES AND ITS CRITICAL HABITAT

Southern Sea Otter

Legal Status

The Service listed the southern sea otter as threatened in 1977 (42 FR 2965). Critical habitat was not designated. The factors leading to the listing included the southern sea otter's reduced population size and range, and increased tanker traffic and the corresponding potential for oil spills. The rulemaking also acknowledged the potential degradation of habitat caused by pollution or competition with humans. The southern sea otter is considered "depleted" under the Marine Mammal Protection Act (MMPA) by virtue of its listing status under the ESA and designated as a Fully Protected Species under California State law (California Fish and Game Code §4700). Fully protected species may not be taken¹ or possessed, except under a few narrow circumstances.

Under Public Law 99-625, the San Nicolas Island subpopulation was formerly considered to be experimental (52 FR 29754; August 11, 1987), but the experimental population designation was removed upon termination of the translocation program and its respective translocation and management zones (77 FR 75266; December 19, 2012). With the termination of the translocation program, the special status afforded to southern sea otters within the management and translocation zones pursuant to Public Law 99-625 also ended. However, the National Defense Authorization Act for Fiscal Year 2016 included provisions directing the Secretary of the Navy to establish Southern Sea Otter Military Readiness Areas (Areas) at San Nicolas Island and San Clemente Island (where sea otters do not currently occur). Military readiness activities conducted within these Areas are subject to certain exemptions under the ESA and MMPA.

Natural History

The sea otter is the second largest member of the family Mustelidae and the smallest fully aquatic marine mammal. All sea otters of the subspecies *Enhydra lutris nereis* are considered to belong to a single stock because of their recent descent from a single remnant population. Southern sea otters are geographically isolated from the other two recognized subspecies of sea otters, *E. l. lutris* and *E. l. kenyoni*, and have been shown to be distinct from these subspecies in studies of cranial morphology (Wilson et al. 1991, p. 22–36) and variation at the molecular level (Cronin et al. 1996, p. 546–557; Larson et al. 2002, p. 893–906; Beichman et al. 2022, p. 6–7).

Southern sea otters reach adult length at approximately 4 to 6 years of age, with females averaging 46.5 inches and males averaging 50 inches. Females reach adult weight at around this same age, averaging 46 pounds, whereas males continue to gain muscle mass until approximately 8 years of age, when they weigh, on average, 64 pounds. Typical life spans are 12

¹ Under California State law, "take" means to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" (California Fish and Game Code § 86).

to 18 years for females and 10 to 15 years for males (Tinker, pers. comm., 2014), although one female sea otter translocated to San Nicolas Island in 1987 as a juvenile was documented in 2006 to have reached at least 19 years of age in the wild (Costa and Kooyman 1982, p. 2761–2767).

Unlike most other marine mammals, sea otters have little subcutaneous fat. They depend on their clean, dense, water-resistant fur for insulation against the cold. Contamination of the fur by oily substances can destroy its insulating properties and lead to hypothermia and death (Costa and Kooyman 1982, p. 2761–2767). Sea otters also maintain a high level of internal heat production to compensate for their lack of blubber. Consequently, their energetic requirements are high, and they consume an amount of food equivalent to 20 to 25 percent of their body mass per day (Kenyon 1969, p. 284; Morrison et al. 1974, p. 218–229; Costa and Kooyman 1982, p. 2761–2767). Depending on factors such as habitat, sex, reproductive status, and per-capita prey availability, obtaining this quantity of food requires that sea otters spend, on average, 20 to 50 percent of the day foraging (Estes et al. 1986, pp 626–636; Ralls et al. 1996, pp 251–259; Yeates et al. 2007, pp 1960–1970; Tinker et al. 2008b, pp. 1781–1794, Tinker et al. 2019, pp. 117–151).

Mating and pupping occur throughout the year. The gestation period lasts approximately 6 months, consisting of a phase of 2 to 3 months during which the embryo remains unattached to the uterine wall (delayed implantation) and an implanted phase of 4 months (Jameson and Johnson 1993, pp. 156–167). On average across the range, a peak period of pupping occurs from October to January, with a secondary peak in March and April. Females typically give birth to a single pup, with care provided solely by the female for the approximately 6 months until weaning (Riedman and Estes 1990, p. 65); (Jameson and Johnson 1993, pp. 156–167). Pup rearing and provisioning impose high energetic costs on females, requiring them to increase foraging effort during this period and leaving them highly susceptible to stressors they may encounter when they come into estrous after weaning, such as parasite infections or aggression by males (Thometz et al. 2014, pp. 2053–2061; Tinker et al. 2019, pp. 167–195).

Sea otters rest alone or in groups called “rafts,” which may range from 2 to 20 or more animals, with larger groups more common among males. They tend to prefer areas with surface kelp canopies but will also rest in open water (Riedman and Estes 1990, p. 23). Sea otters sometimes haul out, although opportunities for hauling out vary spatially and temporally. Hauling out likely reduces thermal flux and thus overall energy requirements; as such, it may be especially important in times of nutritional stress, such as for end-lactation stage females (females that have recently weaned a pup and are entering estrous), which in areas of low per-capita prey abundance may be in poor body condition with minimal energy reserves (Tinker et al. 2019, p. 101).

Sea otter habitat is typically defined by the 131-foot depth contour (Laidre et al. 2001, p. 297). Depending on local bathymetry, most sea otters in California reside within 1.2 miles of shore. Southern sea otters forage in both rocky and soft-sediment communities in water depths generally 82 feet or less, although some animals utilize deeper waters. Sea otters occasionally make dives of up to 328 feet, but the vast majority of feeding dives (about 95 percent) occur in waters less than 131 feet in depth (Tinker et al. 2006b, pp. 1–253). Dive depth and dive pattern vary by sex (males tend to make dives greater than 82 feet more frequently than females),

geographic location, and diet specialization (Tinker et al. 2006b, pp. 194–195); (Tinker et al. 2007, pp. 330–342), as well as age and reproductive status (Tinker et al. 2019, pp. 93–116).

The home ranges of southern sea otters tend to consist of several heavily used areas with travel corridors between them. Animals often remain in an area for a long period of time and then suddenly move long distances. These movements can occur at any time of the year (Riedman and Estes 1990, p. 54). Sub-adult male southern sea otters have the largest home ranges, followed by adult males, sub-adult females, and adult females (Tinker et al. 2006b, p. 53). Compared to males, most female southern sea otters are more sedentary, with adult females rarely dispersing more than 12 miles within a 1-year period (Tinker et al. 2013, p. 73), although occasionally females travel longer distances of 25 to 31 miles as well (Tinker et al. 2006b, pp. 43–80). Juvenile males move further from natal groups than do juvenile females. Aggressive behavior exhibited towards the juvenile males by breeding males may be partially responsible for their more extensive travels (Ralls et al. 1996, pp. 1841–1849). Jameson (1998, pp. 6–8) noted that adult male sea otters are territorial and exclude juvenile and subordinate males from their territories. However, females move freely across these territories.

The density of southern sea otters within the population's range can largely be predicted by depth, kelp canopy cover, net primary productivity, benthic slope (distance to shore versus depth), and substrate type (Tinker et al. 2021a, p. 14). Rocky habitats that are topographically heterogeneous and support kelp forests are likely to support the greatest diversity and abundance of sea otter food resources, which include abalone, rock crabs, sea urchins, kelp crabs, clams, turban snails, mussels, octopus, barnacles, scallops, sea stars, and chitons. However, estuaries can also support high densities of sea otters. Rocky bottom habitats and estuaries support an average equilibrium density of greater than 26 individuals per square mile, whereas areas with sandy bottoms support much lower average equilibrium densities, 3.9 individuals per square mile (Tinker et al. 2021a, p. 14). Based on the spatial distribution of these habitat variables, the estimated carrying capacity of California is approximately 17,226 animals (95 percent CrI=9,739–30,087) (Laidre et al. 2001, p. 305).

Because of their consumption of large quantities of marine invertebrates, sea otters play a significant role in nearshore marine ecosystems of the North Pacific Ocean, enhancing not only kelp forests (Estes and Palmisano 1974, pp. 1058–1060; Estes et al. 1978, pp. 822–833; Duggins 1980, pp. 447–453) but also seagrass beds (Hughes et al. 2013, pp. 1–6). Sea otters are generally considered to be a keystone species in these communities. Keystone species are organisms that have large-scale community effects disproportionate to their abundance (Paine 1969, pp. 950–961). Kelp forests provide numerous direct and indirect benefits, including improved habitat for numerous invertebrate and fish species, reductions in coastal erosion, and carbon storage that can moderate changing climate conditions (Duggins et al. 1990, pp. 27–47; Wilmers 2012, pp. 409–415). Seagrasses also provide important benefits, such as habitat for many other species, shoreline protection, and carbon sequestration (Duarte et al. 2005, pp. 173–180; Waycott et al. 2009, pp. 12377–12381).

Rangewide Status

Southern sea otters occupy nearshore waters along the mainland coastline of California from San Mateo County to Santa Barbara County. A small subpopulation of southern sea otters also exists at San Nicolas Island, Ventura County, as a result of translocation efforts initiated in 1987. Historically, southern sea otters ranged from Punta Abreojos, Baja California, Mexico to Oregon (Riedman and Estes 1990; Valentine et al. 2008, p. 933). The estimated historical abundance of sea otters in California is between 16,000 and 20,000 animals (Lafferty and Tinker 2014, p. 1). The historical abundance of the subspecies in its entirety has not been estimated. During the 1700s and 1800s, the killing of sea otters for their pelts extirpated the subspecies throughout most of its range. A small population of southern sea otters survived near Bixby Creek in Monterey County, California, numbering a few dozen animals in 1914 (Bryant 1915, pp. 134–135). Since receiving protection under the International Fur Seal Treaty in 1911, southern sea otters have gradually expanded northward and southward along the central California coast.

Sea otter abundance varies across the range, with the highest densities occurring in the center portion (Seaside to Cayucos), where sea otters have been present for the longest. Rocky, kelp-dominated areas that are occupied primarily by females, dependent pups, and territorial males generally maintain the most stable sea otter densities from year to year, whereas sandy and soft-bottom habitats (particularly those in Monterey Bay, Estero Bay, and from Pismo Beach to Pt. Sal), which are typically occupied by non-territorial males and sub-adult animals of both sexes (and only rarely by adult females and pups), are more variable in abundance from year to year (Tinker et al. 2019, pp. 108–137). This variation is driven in part by the long-distance movements and seasonal redistribution of males (Jameson 1989, pp 159–172; Ralls and Siniff 1990, pp 6–8; Riedman and Estes 1990, p. 54; Ralls et al. 1996, pp. 1841–1849; Tinker et al. 2006b, pp. 43–80, b, p. 53, 2008a, pp. 560–565, 2013, p. 73).

Data on population size have been gathered for more than 50 years. In 1982, a standardized survey technique was adopted to ensure that subsequent counts were comparable (Estes and Jameson 1988, pp. 70–76). This survey method involves shore-based censuses of approximately 60 percent of the range, with the remainder surveyed from the air. In 2019, the population index (independent animals plus pups) was 2,962 (2,863 along the mainland and 99 at San Nicolas Island) (Hatfield et al. 2019, pp. 3–5). The 5-year average annual growth rate for the southern sea otter rangewide was essentially flat: 0.12 percent (0.13 percent along the mainland and 9.58 percent at San Nicolas Island) (Hatfield et al. 2019, p. 3). Beginning in 2020, only portions of the annual census have been completed (due to COVID-19 restrictions and a lack of plane availability in subsequent years). Survey methodology is currently being revised.

Recovery and Threats

On September 20, 2023, in response to a petition from the Pacific Legal Foundation, we published a 12-month determination that delisting the southern sea otter under the Endangered Species Act is not warranted (88 FR 64,870). Prior to receipt of the delisting petition, and in response to the availability of new scientific information concerning southern sea otter genetics, we initiated a new scientific analysis of the southern sea otter. This analysis included the

development of a species status assessment report (Service 2023b), which contains a thorough review of the taxonomy, life history, ecology, current status, and projected future status of the southern sea otter. Based on this analysis and the new science, we also reviewed the criteria for recovery and determined that revision of the recovery plan is appropriate. That revision is underway.

The hazards affecting sea otters vary across the occupied range, with shark bites strongly affecting subpopulations at the northern and southern ends of the mainland range and a suite of other hazards affecting subpopulations in its center (Tinker et al. 2021b, p. 20; Service 2023b). These other hazards include end-lactation syndrome, cardiac disease, acanthocephalan peritonitis, harmful algal bloom intoxication, protozoal infection, and human causes (e.g., boat strikes, shootings, and fishing gear entanglement). Oil spills are infrequent but remain a threat with potentially catastrophic effects across multiple subpopulations. (Tinker et al. 2006a, p 2309, Tinker et al. 2008b pp. 1781–1794, Tinker et al. 2013, p. 173).

California Red-Legged Frog

Legal Status

The California red-legged frog was federally listed as threatened on May 23, 1996 (61 Federal Register [FR] 25813). Revised critical habitat for the California red-legged frog was designated on March 17, 2010 (75 FR 12816, Service 2010b). The Service issued a recovery plan for the species on May 28, 2002 (Service 2002a, entire).

Natural History

The California red-legged frog uses a variety of habitat types, including various aquatic systems, riparian, and upland habitats. They have been found at elevations ranging from sea level to approximately 5,000 feet. California red-legged frogs use the environment in a variety of ways, and in many cases, they may complete their entire life cycle in a particular area without using other components (i.e., a pond is suitable for each life stage and use of upland habitat, or a riparian corridor is not necessary). Populations appear to persist where a mosaic of habitat elements exists, embedded within a matrix of dispersal habitat. Adults are often associated with dense, shrubby riparian or emergent vegetation and areas with deep (greater than 1.6 feet) still or slow-moving water; the largest summer densities of California red-legged frogs are associated with deep-water pools with dense stands of overhanging willows (*Salix* spp.) and an intermixed fringe of cattails (*Typha latifolia*) (Hayes and Jennings 1988, p. 147). Hayes and Tennant found juveniles to seek prey diurnally and nocturnally, whereas adults were largely nocturnal (Hayes and Tennant 1985, p. 604).

California red-legged frogs breed in aquatic habitats; larvae, juveniles, and adult frogs have been collected from streams, creeks, ponds, marshes, deep pools and backwaters within streams and creeks, dune ponds, lagoons, and estuaries. They frequently breed in artificial impoundments such as stock ponds, given the proper management of hydro-period, pond structure, vegetative cover, and control of exotic predators. While frogs successfully breed in streams and riparian

systems, high spring flows and cold temperatures in streams often make these sites risky egg and tadpole environments. An important factor influencing the suitability of aquatic breeding sites is the general lack of introduced aquatic predators. Accessibility to sheltering habitat is essential for the survival of California red-legged frogs within a watershed and can be a factor limiting population numbers and distribution.

California red-legged frogs are “irruptive” breeders where their breeding capacity is highly dependent on local environmental conditions, specifically the availability of cool water for egg deposition and larval maturation (Jennings and Hayes 1994, p. 62). California red-legged frogs breed from November to May and breeding activity typically begins earlier at southern coastal than northern coastal localities (Storer 1925, p. 2; Alvarez et al. 2013, pp. 547–548). Breeding may start as late as March or April in Sierra Nevada localities, due to low temperatures at these sites in January and February (Tatarian 2008, p. 16). Breeding in southern California localities may start as late as April, as exemplified in Matilija Canyon following the 2017 Thomas Fire days (P. Lieske, pers. comm., 2021). High water flows in the winter and spring also can delay breeding in streams and rivers (Fellers et al. 2001, p. 157). Female California red-legged frogs lay only one egg mass in a breeding year and each egg mass contains between 300 to 4,000 eggs (Storer 1925, p. 240). Frogs typically deposit egg masses in relatively shallow water (approximately 1.6 to 2 feet deep) on emergent vegetation within 4 feet of shore (Storer 1925, p. 239; Jennings and Hayes 1994, p. 64). However, the species can deposit eggs on a wide variety of substrates including boulders and cobbled substrate and submerged tips of overhanging branches, and egg masses have been documented 39 feet from shore and in water up to 10.5 feet deep (Alvarez et al. 2013, pp. 544–545; Wilcox et al. 2017, p. 68). California red-legged frog tadpoles hatch from egg masses after 6 to 14 days (Storer 1925, p. 241). Tadpole development and growth rates are variable and likely temperature dependent (Fellers 2005, pp. 552–554). Occasionally, tadpoles may overwinter and then metamorphose the following spring, a phenomenon so far observed in Santa Clara, Marin, Contra Costa, and San Luis Obispo Counties (Fellers et al. 2001, entire).

The juvenile California red-legged frog life stage is defined as the time after an individual undergoes metamorphosis (when they lose their tails and become small froglets) which typically occurs four to five months after hatching and it spans to when an individual is able to breed (Storer 1925, p. 241; Wright and Wright 1949, p. 422). On average, the juvenile life stage in California red-legged frogs is from about five months to three years of age. Immediately after metamorphosis, juveniles shelter near their natal pond. However, some juveniles may disperse in the fall to nearby moist uplands or different aquatic habitat to avoid predation by larger, older frogs. Hayes and Tennant (1985, p. 604) found juveniles to seek prey diurnally and nocturnally, whereas adults were largely nocturnal. During periods of wet weather, starting with the first rains of fall, some individual California red-legged frogs may make long-distance overland excursions through upland habitats to reach breeding sites. In Santa Cruz County, Bulger et al. (2003, p. 90) found marked California red-legged frogs moving up to 1.74 miles through upland habitats, via point-to-point, straight-line migrations regardless of topography, rather than following riparian corridors. Most of these overland movements occurred at night and took up to 2 months. Similarly, in San Luis Obispo County, Rathbun and Schneider (2001, p. 1302) documented the movement of a male California red-legged frog between two ponds that were 1.78 miles apart in

less than 32 days; however, most California red-legged frogs in the Bulger et al. (2003, p. 93) study were non-migrating frogs and always remained within 426 feet of their aquatic site of residence (half of the frogs always stayed within 82 feet of water). Rathbun et al. (1993, p. 15) radio-tracked three California red-legged frogs near the coast in San Luis Obispo County at various times between July and January; these frogs also stayed close to water and never strayed more than 85 feet into upland vegetation. Scott (2002, p. 2) radio-tracked nine California red-legged frogs in East Las Virgenes Creek in Ventura County from January to June 2001, which remained relatively sedentary as well; the longest within-channel movement was 280 feet and the farthest movement away from the stream was 30 feet.

After breeding, California red-legged frogs often disperse from their breeding habitat to forage and seek suitable dry-season habitat. Cover within dry-season aquatic habitat could include boulders, downed trees, and logs; agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, hayricks, or industrial debris. California red-legged frogs use small mammal burrows and moist leaf litter (Jennings and Hayes 1994, p. 64; Rathbun and Schneider 2001, p. 15); incised stream channels with portions narrower and deeper than 18 inches may also provide habitat (Service 2002a, p. 14). This type of dispersal and habitat use, however, is not observed in all California red-legged frogs and is most likely dependent on the year-to-year variations in climate and habitat suitability and varying requisites per life stage.

Although the presence of California red-legged frogs is correlated with still water deeper than approximately 1.6 feet, riparian shrubbery, and emergent vegetation (Jennings and Hayes 1994, p. 64), California red-legged frogs appear to be absent from numerous locations in its historical range where these elements are well represented. The cause of local extirpations does not appear to be restricted solely to loss of aquatic habitat. The most likely causes of local extirpation are thought to be changes in faunal composition of aquatic ecosystems (i.e., the introduction of invasive predators and competitors) and landscape-scale disturbances that disrupt California red-legged frog population processes, such as dispersal and colonization. The introduction of contaminants or changes in water temperature may also play a role in local extirpations. Additionally, these changes may promote the spread of predators, competitors, invasive plants, parasites, and diseases.

Rangewide Status

The historical range of the California red-legged frog extended coastally from southern Mendocino County and inland from the vicinity of Redding, California, southward to northwestern Baja California, Mexico (Storer 1925, p. 235; Jennings and Hayes 1985, p. 95; Shaffer et al. 2004, p. 2673). The California red-legged frog has sustained a 70 percent reduction in its geographic range because of several factors acting singly or in combination (Davidson et al. 2001, p. 465).

Over-harvesting, habitat loss, non-native species introduction, and urban encroachment are the primary factors that have negatively affected the California red-legged frog throughout its range (Jennings and Hayes 1985, pp. 99–100; Hayes and Jennings 1988, p. 152). Habitat loss and degradation, combined with over-exploitation and introduction of exotic predators, were

important factors in the decline of the California red-legged frog in the early to mid-1900s. Continuing threats to the California red-legged frog include direct habitat loss due to stream alteration and loss of aquatic habitat, indirect effects of expanding urbanization, competition or predation from non-native species including the bullfrog, catfish (*Ictalurus* spp.), bass (*Micropterus* spp.), mosquito fish (*Gambusia affinis*), red swamp crayfish (*Procambarus clarkii*), and signal crayfish (*Pacifastacus leniusculus*). Chytrid fungus (*Batrachochytrium dendrobatidis*) is a waterborne fungus that can decimate amphibian populations and is considered a threat to California red-legged frog populations.

Recovery and Threats

The 2002 final recovery plan for the California red-legged frog states that the goal of recovery efforts is to reduce threats and improve the population status of the California red-legged frog sufficiently to warrant delisting. The recovery plan describes a strategy for delisting, which includes: (1) protecting known populations and reestablishing historical populations; (2) protecting suitable habitat, corridors, and core areas; (3) developing and implementing management plans for preserved habitat, occupied watersheds, and core areas; (4) developing land use guidelines; (5) gathering biological and ecological data necessary for conservation of the species; (6) monitoring existing populations and conducting surveys for new populations; and (7) establishing an outreach program. The California red-legged frog will be considered for delisting when:

1. Suitable habitats within all core areas are protected and/or managed for California red-legged frogs in perpetuity, and the ecological integrity of these areas is not threatened by adverse anthropogenic habitat modification (including indirect effects of upstream/downstream land uses).
2. Existing populations throughout the range are stable (i.e., reproductive rates allow for long-term viability without human intervention). Population status will be documented through establishment and implementation of a scientifically acceptable population monitoring program for at least a 15-year period, which is approximately 4 to 5 generations of the California red-legged frog. This 15-year period should coincide with an average precipitation cycle.
3. Populations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual populations (i.e., when populations are stable or increasing at each core area).
4. The species is successfully reestablished in portions of its historical range such that at least one reestablished population is stable/increasing at each core area where California red-legged frogs are currently absent.
5. The amount of additional habitat needed for population connectivity, recolonization, and dispersal has been determined, protected, and managed for California red-legged frogs.

The recovery plan identifies eight recovery units based on the assumption that various regional areas of the species' range are essential to its survival and recovery. The recovery status of the California red-legged frog is considered within the smaller scale of recovery units as opposed to the overall range. These recovery units correspond to major watershed boundaries as defined by U.S. Geological Survey hydrologic units and the limits of the range of the California red-legged frog. The goal of the recovery plan is to protect the long-term viability of all extant populations within each recovery unit.

Within each recovery unit, core areas have been delineated and represent contiguous areas of moderate to high California red-legged frog densities that are relatively free of exotic species such as bullfrogs. The goal of designating core areas is to protect metapopulations that combined with suitable dispersal habitat, will support long-term viability within existing populations. This management strategy allows for the recolonization of habitat within and adjacent to core areas that are naturally subjected to periodic localized extinctions, thus assuring the long-term survival and recovery of the California red-legged frog.

Western Snowy Plover

Legal Status

The Service listed the Pacific Coast population of the western snowy plover as threatened on March 5, 1993 (Service 1993). We designated critical habitat in 1999 (Service 1999) and redesignated it in 2005 (Service 2005). In 2012, we issued a revised critical habitat designation which included a change in taxonomic nomenclature (Service 2012). We issued a recovery plan in August 2007 (Service 2007) and completed 5-year status reviews in 2006 and 2019 (Service 2006a, Service 2019a).

Natural History

The western snowy plover is a small shorebird in the family Charadriidae, a subspecies of the snowy plover (*Charadrius nivosus*). It is pale gray/brown above and white below, with a white collar on the hind neck and dark patches on the lateral breast, forehead, and behind the eyes. The bill and legs are black.

Foraging Behavior

Western snowy plovers are primarily visual foragers, using the run-stop-peck method of feeding typical of most plover species. They forage on invertebrates in the wet sand and amongst surf-cast kelp within the intertidal zone, in dry sand areas above the high tide, on salt pans, on spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. They sometimes probe for prey in the sand and pick insects from low-growing plants (Service 2007).

Breeding

The Pacific Coast population of the western snowy plover breeds primarily on coastal beaches from southern Washington to southern Baja California, Mexico. The main coastal habitats for nesting include sand spits, dune-backed beaches, beaches at creek and river mouths, and saltpans at lagoons and estuaries (Wilson 1980, p. 23; Page and Stenzel 1981, p. 12). Western snowy plovers nest less commonly on bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and gravel river bars (Wilson 1980, p. 9; Page and Stenzel 1981, p. 12; Tuttle et al. 1997, pp. 1–3; Powell et al. 2002, pp. 156, 158, 164). Nest site selection is influenced by habitat characteristics at both small and larger spatial scales. Western snowy plovers select nest sites with minimal debris and low vegetative cover, where vegetative cover is composed of low-growing plant species. At larger spatial scales (greater than 10 meters), adults preferentially select sites that have low vegetative cover with wider beaches, both of which suggest a preference for more open habitats that facilitate early detection of predators (Neuman et al. 2019, p. 4).

Their nests consist of a shallow scrape or depression, sometimes lined with beach debris (e.g., small pebbles, shell fragments, plant debris, and mud chips). As incubation progresses, western snowy plovers may add to and increase the nest lining. Driftwood, kelp, and dune plants provide cover for chicks that crouch near objects to hide from predators. Because invertebrates often occur near debris, driftwood and kelp are also important for harboring western snowy plover food sources (Page et al. 2009a).

Along the west coast of the United States, the nesting season of the western snowy plover extends from early March through late September. Generally, the breeding season may be 2 to 4 weeks earlier in southern California than in Oregon and Washington. Fledging (reaching flying age) of late-season broods may extend into the third week of September throughout the breeding range (Service 2007, p. 11).

The approximate periods required for western snowy plover nesting events are: 3 days to more than a month for scrape construction (in conjunction with courtship and mating), usually 4 to 5 days for egg laying, and incubation averaging 28.4 days in the early season (before May 8) to 26.9 days in the late season (Warriner et al. 1986, pp. 23–24). The usual clutch size is three eggs with a range from two to six (Page et al. 2009a). Both sexes incubate the eggs with the female tending to incubate during the day and the male at night (Warriner et al. 1986, pp. 23–24). Adult western snowy plovers frequently will attempt to lure people and predators from hatching eggs and chicks with alarm calls and distraction displays.

Western snowy plover chicks are precocial, leaving the nest with their parents within hours after hatching (Service 2007, p. 14). They are not able to fly for approximately 1 month after hatching; fledging requires 29 to 33 days (Warriner et al. 1986, p. 26). Broods rarely remain in the nesting area until fledging (Warriner et al. 1986, p. 28; Lauten et al. 2010, p. 10). Casler et al. (1993, pp. 6, 11–12) reported broods would generally remain within a 1-mile radius of their nesting area; however, in some cases would travel as far as 4 miles.

Wintering

In winter, western snowy plovers use many of the beaches used for nesting, as well as beaches where they do not nest. They also occur in man-made salt ponds and on estuarine sand and mud flats. In California, most wintering western snowy plovers concentrate on sand spits and dune-backed beaches. Some also occur on urban and bluff-backed beaches, which they rarely use for nesting (Page and Stenzel 1981, p. 12; Page et al. 1986, p. 148). South of San Mateo County, California, wintering western snowy plovers also use pocket beaches at the mouths of creeks and rivers on otherwise rocky points (Page et al. 1986, p. 148). Western snowy plovers forage in loose flocks. Roosting western snowy plovers will sit in depressions in the sand made by footprints and vehicle tracks, or in the lee of kelp, driftwood, or low dunes in wide areas of beaches (Page et al. 2009b). Sitting behind debris or in depressions provides some shelter from the wind and may reduce their detectability by predators.

Rangewide Status

Historical records indicate that nesting western snowy plovers were once more widely distributed and abundant in coastal Washington, Oregon, and California (Service 2007, p. 21). In Washington, western snowy plovers formerly nested at five coastal locations (WDFW 1995, p. 14) and at over 20 sites on the coast of Oregon (Service 2007, p. 24). In California, by the late 1970s, nesting western snowy plovers were absent from 33 of 53 locations with breeding records prior to 1970 (Page and Stenzel 1981, p. 27).

The first quantitative data on the abundance of western snowy plovers along the California coast came from window surveys conducted during the 1977 to 1980 breeding seasons by Point Reyes Bird Observatory (Page and Stenzel 1981, p. 1). Observers recorded an estimated 1,593 adult western snowy plovers during these pioneering surveys. The results of the surveys suggested that the western snowy plover had disappeared from significant parts of its coastal California breeding range by 1980 (Service 2007, p. 27).

Breeding and winter window survey data from 2005 to 2022 includes approximately 250 sites in Washington, Oregon, and California, with most sites located in California (Table 17). In California, biological monitors counted 1,830 western snowy plovers during the 2022 breeding window survey, and 4,196² western snowy plovers during the 2021 to 2022 winter window survey (Service 2022a, entire). Across the Pacific Coast range, the 2022 breeding window survey estimated 2,371 western snowy plovers, and the 2021 to 2022 winter window survey estimated 4,803 western snowy plovers in Washington, Oregon, and California (Service 2022a, entire). These numbers demonstrate that monitors counted a large percentage of all western snowy plovers in the Pacific Coast range in California during both winter and breeding window surveys.

Table 17. Pacific Coast western snowy plover breeding window survey results, in descending order from 2022 to 2005, for each recovery unit (RU1 through RU6) and the U.S. Pacific Coast (excludes the Baja California peninsula). All counts are breeding age adults and are uncorrected (raw). Recovery Units are

2 This number likely includes wintering inland birds that are not part of the listed Pacific Coast population.

RU1: Washington and Oregon; RU2: Northern California (Del Norte to Mendocino Counties); RU3: San Francisco Bay; RU4: Monterey Bay area (Sonoma to Monterey Counties); RU5: San Luis Obispo area (San Luis Obispo to Ventura Counties); RU6: San Diego area (Los Angeles to San Diego Counties) (Service 2019a, p. 3).

<i>Year</i>	<i>RU1</i>	<i>RU2</i>	<i>RU3</i>	<i>RU4</i>	<i>RU5</i>	<i>RU6</i>	<i>TOTAL (U.S. Pacific Coast)</i>
2023	487	64	368	308	676	433	2,336
2022	541	71	281	281	804	393	2,371
2021	624	84	263	292	737	358	2,358
2020	469	46	147	308	855	484	2,309
2019	479	41	190	303	807	397	2,217
2018	402	52	235	361	874	451	2,375
2017	342	56	246	369	856	464	2,333
2016	477	46	202	366	820	373	2,284
2015	340	38	195	348	963	376	2,260
2014	269	27	178	374	822	346	2,016
2013	260	23	202	261	754	326	1,826
2012	234	21	147	324	771	358	1,855
2011	202	28	249	311	796	331	1,917
2010	196	19	275	298	686	311	1,785
2009	182	15	147	279	707	257	1,587
2008	147	18	133	257	717	269	1,541
2007	175	26	207	270	676	183	1,537
2006	158	45	102	357	917	298	1,877
2005	137	41	124	337	969	209	1,817

Recovery and Threats

The primary objective of the recovery plan (Service 2007, p. 6) is to remove the Pacific Coast population of the western snowy plover from the list of endangered and threatened wildlife and plants by:

1. Increasing population numbers distributed across the range of the Pacific Coast population of the western snowy plover;

2. Conducting intensive ongoing management for the species and its habitat and developing mechanisms to ensure management in perpetuity; and
3. Monitoring western snowy plover populations and threats to determine success of recovery actions and refine management actions.

Outlined below are the delisting criteria for the Pacific Coast population of the western snowy plover (Service 2007, p. 7):

1. An average of 3,000 breeding adults has been maintained for 10 years, distributed among 6 recovery units as follows: Washington and Oregon, 250 breeding adults; Del Norte to Mendocino Counties, California, 150 breeding adults; San Francisco Bay, California, 500 breeding adults; Sonoma to Monterey Counties, California, 400 breeding adults; San Luis Obispo to Ventura Counties, California, 1,200 breeding adults; and Los Angeles to San Diego Counties, California, 500 breeding adults. This criterion also includes implementing monitoring of site-specific threats, incorporation of management activities into management plans to ameliorate or eliminate those threats, completion of research necessary to modify management and monitoring actions, and development of a post-delisting monitoring plan.
2. A yearly average productivity of at least one fledged chick per male has been maintained in each recovery unit in the last 5 years prior to delisting.
3. Mechanisms have been developed and implemented to assure long-term protection and management of breeding, wintering, and migration areas to maintain the subpopulation sizes and average productivity specified in Criteria 1 and 2. These mechanisms include establishment of recovery unit working groups, development and implementation of participation plans, development and implementation of management plans for Federal and State lands, protection and management of private lands, and public outreach and education.

Our current estimate (2,371 breeding adults) remains below the population size of 3,000 birds listed as a recovery objective in the recovery plan (Service 2007), although some local population sizes have surpassed recovery objectives for some areas (e.g., Monterey Bay, Oregon, Washington). Yearly average productivity (Criterion 2; number of fledglings per male) are not compiled annually for the entire U.S. Pacific Coast; however, the best available information indicates that the yearly average productivity has not been met (Service 2019a, p. 6).

Threats have not changed significantly since the 2006 5-year review. Evidence of habitat loss and degradation remains widespread; while the degree of this threat varies by geographic location, habitat loss and degradation attributed to human disturbance, urban development, introduced beachgrass, and expanding predator populations remain the management focus in all six recovery units. Efforts to improve habitat at current and historic breeding beaches, and efforts to reduce the impacts of human recreation and predation on nesting plovers, have improved western snowy plover numbers. Active vegetation and predator management and habitat restoration should be continued. Because of active management efforts, including increased

monitoring, use of predator exclosures at some sites, predator management, and expanded beach closures, western snowy plover population numbers have increased at some locations. However, despite active vegetation and predator management, we expect ongoing and projected changes in sea level and climate to affect coastal habitat suitability, nest survival, overwinter survivorship, and quality of nesting and roosting habitats (Service 2019a, p. 7).

California Least Tern

Legal Status

The Service listed the California least tern as endangered on June 2, 1970 (Service 1970). We issued a revised recovery plan for the species in 1985 (Service 1985) and 5-year status reviews in 2006 and 2020 (Service 2006b, Service 2020c). The Service has not designated critical habitat for the species. A taxonomic revision went into effect on August 30, 2023, changing the scientific name from *Sterna antillarum browni* to *Sternula antillarum browni* (Service 2023c).

Natural History

Foraging Behavior

California least terns forage in nearshore oceans, harbors, marina channels, tidal estuarine channels, and sheltered shallow bays (J. L. Atwood and Kelly 1984, pp. 35–36). Adults forage mostly within 2 miles of breeding colonies, and at many sites foraging is primarily in nearshore ocean waters less than 60 feet deep (Service 1985, p. 18). They feed on small fish that they catch by plunging into the water from flight. In a study of fish dropped by California least tern at 10 nesting areas, researchers found 49 species of fish, all individuals less than 1 year old. Northern anchovy (*Engraulis mordax*) and silverside species (*Atherinidae*) represented 67 percent of the total sample (Atwood and Kelly 1984, p. 38).

Breeding

California least terns are migratory colonial nesters, usually arriving in breeding areas by late April and departing in August (Massey and Davis 1974, pp. 6, 43). They exhibit a high degree of nest site fidelity from year to year; individuals often return to breed where they previously bred successfully or to their natal sites (i.e., where they hatched) significantly more than one would predict if birds nested randomly (Atwood and Massey 1988, pp. 391–393). After the initial nesting period that begins on their arrival in April, a second wave of nesting may occur from mid-June to early August. These are mainly re-nests after initial failures and second-year birds nesting for the first time (Massey and Atwood 1981, p. 596).

Nesting California least terns usually occupy a sand-shell beach relatively free of plant growth (Massey 1974, p. 5). The nest is typically a shallow, round depression, constructed by a bird sitting and kicking its feet backwards while rotating its body. This may occur several times before the bird lays an egg (Massey 1974, pp. 10–11; Wolk 1974, p. 52). California least terns may use “sideways building” after scrape construction, which consists of the sitting bird reaching

out with its bill to pick up additional nest material, such as small shells and shell fragments, and depositing them into the nest (Wolk 1974, p. 53).

Early in the breeding season, California least terns display night roosting behavior. Prior to incubation, they will sleep at night at varying distances from the nesting sites. Once incubation begins, birds roost at night on the nest. California least terns use roosting sites away from breeding colonies prior to egg laying, apparently for predator avoidance. By not sleeping within the colony until they lay eggs, they may delay nocturnal predators discovering the colony by 2 to 3 weeks (Service 1985).

California least terns begin incubation after laying the first egg. Both parents participate in incubation, which lasts 20 to 25 days (Massey 1974, pp. 15–16). Clutch size ranges from one to three eggs, with two eggs being most common (Massey 1974, p. 13; P.R. Ehrlich et al. 1988, p. 186).

California least tern chicks are semi-precocial (capable of a high degree of independent activity from birth) and parents can feed small fish to chicks within hours of hatching (Massey 1974, p. 17; Ehrlich et al. 1988, p. 186). Chicks will begin leaving the nest in 1 to 2 days (Massey 1974, p. 17) and fledge at approximately 20 days. Juveniles and adults will fish, loaf, preen, and roost together for several weeks after fledging; adults will continue to feed juveniles during this period (Massey 1974, p. 20).

Wintering

California least terns leave nesting areas by August to spend winter months along the west coast of Baja California, the west coast of Mexico, and further south, possibly from the Gulf of California to Guatemala (AOU 1957, p. 239; Service 1985, p. 17; Thompson et al. 1997, Distribution, Migration, and Habitat).

Rangewide Status

The historical breeding range of the California least tern extends along the Pacific coast from central California (Moss Landing) to southern Baja California (San Jose del Cabo). Observers documented potentially vagrant birds farther north in Alameda County, California (Grinnell and Miller 1944, p. 175; AOU 1957, p. 239). Since 1970, records of nesting sites extend from San Francisco Bay to Bahia de San Quintin, Baja California. The nesting range in California has been discontinuous, with most birds nesting in southern California from Santa Barbara County south through San Diego County (Service 1985, p. 3).

In 1969 and 1970, Craig (1971, pp. 1, 5) conducted breeding surveys in San Mateo, Orange, and San Diego Counties. Craig estimated 300 pairs at 15 sites in the three counties and made recommendations to prevent the extirpation of the California least tern in California, principally to protect existing sites from human disturbance and create new sites in areas also protected from disturbance and development (Craig 1971, entire). In 1980, 1981, 1982, and 1983, the California least tern breeding population in California was approximately 890 to 1,215; 963 to 1,171; 1,015

to 1,245; and 1,180 to 1,299 pairs, respectively (Service 1985, p. 21). Several studies attributed fluctuations in the number of breeding pairs and productivity to the El Niño Southern Oscillation, which results in limited food availability (Massey 1992, pp. 982–983; Caffrey 1995, p. 12; Robinette et al. 2015, p. 5, 10, 21–52). The effects on California least terns after a severe El Niño event may last several years (Massey 1992, pp. 976, 978, 982).

Surveys have become more standardized and frequent since the 1990s (Sin 2021, p. 5). Sin reported 4,097 to 5,598 breeding pairs across 45 nesting sites in California over the 2017 breeding season (Sin 2021, p. 3). A few sites contained most of the breeding activity in California during the 2017 season: Camp Pendleton, Naval Base Coronado, Batiquitos, Point Mugu, Huntington, and Alameda Point (Sin 2021, p. 3), a trend consistently observed in previous years (Frost 2016, p. 12, 2017, p. 11). These six sites represented 75 percent of the state nest total and contributed 65 percent of California’s fledgling production. The California Department of Fish and Wildlife provides annual reports of nesting California least terns in California; reports include numbers of breeding pairs, nesting sites, and fledgling to breeding pair ratios. Table 18 compiles nesting pair and breeding site data from 1969 to 1974, and 1990 to 2017.

Table 18. Numbers of breeding pairs and nesting sites across California; data compiled from California Department of Fish and Wildlife reports (Craig 1971, p. 1; Bender 1974a, p. 1, b, p. 1; Johnston and Obst 1992, pp. 3, 5–6; Caffrey 1993, p. 2, 1994, p. 2, 1995, p. 3, 1997, p. 3, 1998, p. 3; Keane 1998, p. 3, 2000, p. 5, 2001, p. 3; Patton 2002, p. 3; Marschalek 2005, p. 3, 2006, p. 3, 2007, p. 3, 2008, p. 3, 2009, p. 3, 2010, p. 3, 2011, p. 3, 2012, p. 3; Frost 2013, p. 3, 2015, p. 3, 2016, p. 3, 2017, p. 3; Sin 2021, p. 3)

<i>Year</i>	<i>Approximate Number of Breeding Pairs</i>	<i>Number of Nesting Sites</i>
2017	4,097–5,598	45
2016	3,989–4,661	42
2015	4,202–5,295	41
2014	4,232–5,786	41
2012	4,293–6,421	41
2011	4,826–6,108	40
2010	6,437–6,699	41
2009	7,130–7,352	41
2008	8,223–8,226	36
2007	6,744–6,989	35
2006	7,006–7,293	31
2005	6,865–7,341	28
2004	6,354–6,805	32
2000	4,521–4,790	37
1999	3,451–3,674	36
1998	4,141–4,182	30
1997	4,017	38
1996	3,330–3,392	35
1995	2,585–2,611	37

<i>1994</i>	2,792	36
<i>1993</i>	2,400	35
<i>1992</i>	2,106	38
<i>1991</i>	1,830	26
<i>1990</i>	1,706	28
<i>1974</i>	582	20
<i>1973</i>	624	19
<i>1969– 1970</i>	300	15

Recovery and Threats

The primary goals outlined in the 1985 recovery plan are to prevent extinction and return the California least tern population to a stable, non-endangered status. The Service may consider reclassification to threatened status if 1,200 breeding pairs in California occur in 15 secure management areas with a 3-year mean reproduction rate of 1 (one fledgling per breeding pair) (Service 1985, p. 26). The Service may consider delisting if the population reaches 1,200 breeding pairs distributed in at least 20 of 23 coastal management areas with the following provisions:

1. Sufficient habitat to support at least 1 viable colony (consisting of a minimum of 20 breeding pairs with a 5-year mean reproductive rate of at least 1 young fledged per year, per breeding pair) at each of the 20 coastal management areas managed to conserve California least terns (which must include San Francisco Bay, Mission Bay, and San Diego Bay); and
2. Assured land ownership and management objectives for future habitat management for the benefit of California least terns, and assessment of the security and status of Baja California colonies for incorporation into recovery objectives (Service 1985, pp. 25–26).

The breeding population of California least terns currently exceeds Objective 1 for recovery. The estimated number of California least tern breeding pairs has increased from approximately 624 pairs in 1973 to a peak of approximately 7,100 pairs in 2009. The number of breeding pairs has dropped in the past few years from the peak to estimates of 3,989 pairs in 2016 and 4,097 pairs in 2017. In the 2006 5-year review, we acknowledged the species had far exceeded this population objective (Service 2006b, p. 3).

Objective 2 for recovery does not identify explicitly specific threats to alleviate but rather is a proxy for whether there is a reduction in threats to reproduction and fecundity. In the 2006 5-year review, we concluded that based on the population data at that time, the Service could likely consider the species recovered without meeting this goal (Service 2006b, p. 5), as the sharp growth in pairs had occurred while estimated fledgling rates were below 1 fledglings per pair. Objective 2 utilizes this same definition of viability for secure nesting site requirements, though it is unclear from the recovery criteria if sites must maintain this level of viability for 3 or 5 years (Service 1985, pp. 25–26).

Overall, progress is being made toward satisfying the recovery criteria. However, as we concluded in the 2006 5-year review and based on recent data, we should revise the recovery plan and update it to provide threats-based recovery criteria and address the other shortcomings of the recovery plan. Areas of the plan that need updating include inclusion of Mexico populations of California least terns, further analysis of the fledgling per pair ratio, and future impacts from a changing climate, such as sea level rise (Service 2020c, p. 62).

In the five-factor analysis in our 2020 5-year status review, we found that rising sea levels as a result of changing climate conditions (Factor A) may in the future pose a substantial threat to nesting habitat of the California least tern; that predation (Factor C) continues to threaten the California least tern (this threat is reduced, though not eliminated, by predator management conducted at the majority of active colonies, and predator management is confounded when the predator is a protected species); that food availability (Factor E) poses a threat to California least terns though its impact varies from year to year with an uncertain overall magnitude; and that cumulative impacts of food availability, predation, and destruction of nesting habitat together pose a substantial threat to the persistence of the California least tern, although management at a majority of the U.S. nesting sites helps to reduce the impact of these combined threats. Though there are few data available on nesting areas in Mexico, lack of legal protection and conservation measures result in a higher degree of threats attributable for nesting California least terns than in the United States (Service 2020c, p. 69).

While the California least tern has met the population size recommended in the recovery plan for downlisting, the population has been recently declining and exhibiting poor reproductive success, and multiple ongoing threats continue to impact the species. Therefore, we determined that current information does not support reclassifying the California least tern at this time. Additional information on threats, management techniques, and current population models should be obtained before reassessing the taxon again in the future (Service 2020c, p. 70).

ENVIRONMENTAL BASELINE

The implementing regulations for section 7(a)(2) (50 CFR 402.02) define the environmental baseline as “the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency’s discretion to modify are part of the environmental baseline.”

Action Area

Regulations implementing the ESA describe the “action area” as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50

CFR 402.02). Consequently, the action area for this consultation includes all areas where the proposed action will result in modifications to the land, air, and water. The action area for this biological opinion includes the construction footprint and demolition associated with SLC-6; potential launch and landing sonic boom footprints; all areas potentially impacted by launch and landing engine noise or by a sonic boom of 1 psf or greater during landing at VSFB, including the northern Channel Islands; areas potentially impacted by sonic booms during first stage/booster landings on a barge in the Pacific Ocean, and areas of southern Santa Barbara, Ventura, and northern Los Angeles counties that may be impacted by sonic booms of 1 psf or greater during ascent; and four water extraction wells located within the San Antonio Creek Basin and the 9.5 miles of San Antonio Creek downstream habitat (Appendix A, all Figures).

To summarize, the Service considers all areas within the noise and overpressure effect areas, as described above, and water extraction within the San Antonio Creek Basin to encompass the entirety of the action area.

Habitat Characteristics of the Action Area

The proposed action includes more frequent utilization of existing launch sites (SLC-4 and SLC-6) located in south VSFB, including the retrofit/expansion of SLC-6.

SLC-4 currently contains predominantly ruderal and developed areas. SLC-4 is located immediately north of Spring Canyon, 0.75 mile southwest of Bear Creek, and approximately 0.5 mile east of Surf Beach. Primary vegetation types within the near vicinity of SLC-4 include Central Coast Scrub, Central Dune Scrub, Central Coastal Arroyo Willow Riparian Forest and Scrub, and Bishop Pine Forest (30 CES 2021, Appendix A, Figure 2). Spring Canyon also contains dense eucalyptus stands. The Applicant currently removes vegetation to just above ground level within a 3.327-acre impact area of Spring Canyon that is affected by liquid and water vapor expelled from the flame duct, an action previously consulted on in 2017 (Service 2017; 2017-F-0480). The Applicant also currently conducts additional mowing surrounding SLC-4 in previously disturbed portions.

SLC-6 is largely developed. The primary vegetation types within the vicinity of SLC-6 are similar to SLC-4 described above. Red Roof Canyon is approximately 0.5 mile to the north. An unnamed drainage crosses from the east to west but is largely channelized as it passes through the immediate area.

The Launch Noise Effect and Overpressure Effect Areas include the vast majority of VSFB apart from a small northern portion of the installation. The Launch Noise Effect Area also includes a wide diversity of native and non-native habitat types including multiple riparian features, central dune scrub, maritime chaparral, live oak woodland, and pine forest (30 CES 2021, Appendix A, Figure 2). Riparian features located within the Launch Noise Effects Area contains aquatic habitat with deep ponded features as well as Central Coast Arroyo Willow Riparian Forest and Scrub (30 CES 2021, Appendix A, Figure 2).

A limited portion of proposed project's water extraction would occur within San Antonio Creek, a perennial feature that contains intact Central Coast Arroyo Willow Riparian Forest and Scrub (30 CES 2021, Appendix A, Figure 2).

Off VSFB components include portions of mainland California between eastern Santa Barbara County to northern Los Angeles County as well as narrow linear pathways across Santa Rosa Island and Santa Cruz Island (Appendix A, Figure 4A-N). The mainland California portion includes a diverse array of native and non-native habitats including the Los Padres National Forest and large portions of urban development. Santa Rosa Island is one of California's Channel Islands and is managed by the National Park Service as part of the Channel Islands National Park. The topography of Santa Rosa Island in the overpressure effects area is generally mountainous, with elevations ranging between sea level and 1,000 feet above mean sea level and includes a variety of vegetation types including coastal sage scrub and chaparral.

Existing Conditions in the Action Area

SLC-4 is an active launch site occupying approximately 122 acres in the south base of VSFB. Prior to 2022, SLD 30 has generally supported an average of 6.2 rocket launches per year with very recent highs of 17 launches in 2022, 29 in 2023, and 50 in 2024.

SCL-6 is a minimally used launch site occupying approximately 132 acres in the south base of VSFB. The complex was originally built for the Titan launch program and later modified to support the shuttle program. The last launch from SLC-6 was in 2022.

Other active or permitted launch programs that are not yet realized and may be cancelled also occur within the Launch Noise Effect Area making the true potential for collective launch numbers difficult to ascertain. However, the Space Force has confirmed that no more than 110 launches could occur annually in the future. The Applicant constitutes the vast majority of all recent launches from VSFB with a marked increase in launch frequency from SLC-4 between 2022 and 2024.

The Space Force has clarified that the water source for all base operations has transitioned to State Water. The only period in which well water from San Antonio Creek is utilized is during an annual maintenance period which typically occurs in late October to early November and lasts approximately 2 to 3 weeks. (MSRS 2024a, p. 28; York, pers. comm. 2024).

In February 2024, the Service first reviewed available historic NASA Visible and Infrared Imaging Radiometer Suite (VIIRS) data and recognized an increase in the lighting levels associated with SLC-4 occurred between 2020 and 2024. At present, the surrounding area of SLC-4 is exposed to similar artificial light at night levels as is observable within the city of Lompoc (NASA 2024b; c).

Mainland California encompasses a large area that is comprised of both natural areas and urban development that experience variable degrees of both lighting and noise disturbance. Santa Rosa Island generally encompasses undisturbed natural areas.

Previous Consultations in the Action Area

On May 14, 2021, Vandenberg Air Force Base changed its name to Vandenberg Space Force Base. Consultations prior to this date refer to the Air Force. The Service includes recent consultations within the on VSFB portion of the Action Area below.

1. August 9, 2001: The Service issued a final biological opinion for the Evolved Expendable Launch Vehicle (EELV) Program, which included the Delta IV program at SLC-6 (1-8-99-F-27; Service 2001). We determined the proposed action would not jeopardize the unarmored three-spine stickleback, tidewater goby, brown pelican (*Pelecanus occidentalis*; since delisted), California red-legged frog, western snowy plover, and southern sea otter. This biological opinion is still active for current SLC-6 activities.
2. June 2, 2006: The Service issued a biological opinion for landscape maintenance activities associated with the EELV program (1-8-06-F-18; USFWS 2006a). We determined the proposed project would not jeopardize Gaviota tarplant (*Deinandra increscens* ssp. *villosa*). Subsequently, a genetic study was conducted in 2006 to clarify taxonomic status of Gaviota tarplant. Based on this study, the tarplant originally identified as Gaviota tarplant at SLC-6 was determined not to be Gaviota tarplant based on this study and subsequent morphological analysis and the biological opinion is not warranted.
3. November 2, 2006: The Service issued a biological opinion for the Expendable Launch Vehicle (ELLV) program and associated landscape maintenance activities (1-8-07-F-1R; USFWS 2006b) that analyzed the effects from the proposed project on the El Segundo blue butterfly (*Euphilotes battoides allyni*). However, results of a study published in 2020 indicated the El Segundo blue butterfly occurring in Los Angeles County are genetically distinct from the *Euphilotes* species found in northern Santa Barbara County and the *Euphilotes* on VSFB and adjacent areas are not the federally endangered El Segundo blue butterfly (Dupuis et al. 2020) and the biological opinion is not warranted.
4. September 9, 2014: The Service issued a biological opinion to the Air Force for the proposed replacement of the 13th Street Bridge on the Santa Ynez River. We concluded that the proposed action was not likely to jeopardize the continued existence of the tidewater goby and California red-legged frog. The National Marine Fisheries Service also issued a biological opinion (WCR-2014-1093) for effects on the federally endangered southern California Distinct Population Segment of the southern steelhead (*Oncorhynchus mykiss*).
5. February 4, 2015: The Service issued a biological opinion to the Air Force for the proposed beach management plan for VAFB. We concluded that the proposed action was not likely to jeopardize the continued existence of the El Segundo blue butterfly, California red-legged frog, California least tern, and western snowy plover.
6. December 3, 2015: The Service issued a programmatic biological opinion to the Air Force for routine mission operations and maintenance activities at VAFB. We concluded that the proposed action was not likely to jeopardize the continued existence of the Vandenberg monkeyflower, beach layia, Gaviota tarplant, Lompoc yerba santa, vernal

- pool fairy shrimp, El Segundo blue butterfly, California red-legged frog, tidewater goby, unarmored threespine stickleback, California least tern, and western snowy plover.
7. December 12, 2017: The Service issued a biological opinion to the Air Force for the proposed launch, boost-back, and landing of the Falcon 9 first stage at SLC-4. We concluded that the proposed action was not likely to jeopardize the continued existence of the El Segundo blue butterfly, California red-legged frog, California least tern, and western snowy plover. This project began in the spring of 2018 and is currently ongoing.
 8. November 21, 2018: The Service issued a reinitiation of a biological opinion to the Air Force on routine mission operations and maintenance activities at VAFB for changes to California red-legged frog-specific avoidance and minimization measures. We concluded the proposed action was not likely to jeopardize the continued existence of the California red-legged frog or alter effects of the proposed activities on the beach layia, *Gaviota tarplant* (*Deinandra increscens* ssp. *villosa*), Lompoc yerba santa (*Eriodictyon capitatum*), Vandenberg monkeyflower (*Diplacus vandenbergensis*), vernal pool fairy shrimp (*Branchinecta lynchi*), El Segundo blue butterfly (*Euphilotes battoides allyni*), tidewater goby, unarmored threespine stickleback, California least tern, and western snowy plover.
 9. November 18, 2020: The Service issued a biological opinion to the Air Force for the Blue Origin Orbital Launch Site at SLC-9 Project. We determined that the proposed action was not likely to jeopardize the continued existence of the California least tern, western snowy plover, and California red-legged frog. This action has not yet occurred to date.
 10. September 26, 2022: The Service issued a final biological opinion to the Space Force for the Honda Bridge Replacement Project. We determined that the proposed action was not likely to jeopardize the continued existence of beach layia (*Layia carnosa*) or the California red-legged frog. This project was reinitiated in 2024 due to anticipated capture and relocation take exceedance (2022-0027813-S7-001-R001). The Service understands this action is currently in progress.
 11. October 4, 2022: The Service issued a final biological opinion to the Space Force for the Terran 1 Launch Program (Relativity Space, Inc.) at SLC-11 Project. We determined that the proposed action was not likely to jeopardize the continued existence of the western snowy plover and the California red-legged frog. This action has not yet occurred to date.
 12. March 22, 2023: The Service issued a final reinitiation of the 2017 biological opinion of the Applicant's project at SLC-4 from the existing 12 launches to 36 launches annually (with launch rate not to exceed 3 times a month separated by every 8 days) (Service 2023a; 2022-0013990-S7-001). We determined that the proposed action was not likely to jeopardize the continued existence of the western snowy plover, California least tern and the California red-legged frog. The Service understands this action is currently in progress.
 13. April 25, 2023: The Service issued a final biological opinion to the Space Force for the Phantom Launch Program at SLC-5 Project. We determined that the proposed action was not likely to jeopardize the continued existence of the western snowy plover and the California red-legged frog. This action has not yet occurred to date.
 14. August 28, 2024: The Service issued a final reinitiation of the 2023 biological opinion of the Applicant's project at SLC-4 to include 16 additional launches between October 1 to

December 31, 2025 (with launch rate not to exceed 50 in 2024, launch rate on average every 5 days) (Service 2024a; 2022-0013990-S7-001-R001). We determined that the proposed action was not likely to jeopardize the continued existence of the western snowy plover, California least tern, the California red-legged frog, and the proposed southwestern pond turtle. The Space Force later requested project amendment to include 16 additional launches from January 1 to February 28, 2025, in addition to doubling the amount for western snowy plover mitigation to offset harassment, which the Service agreed to. The Service understands this action is complete.

Condition (Status) of the Species in the Action Area

Southern Sea Otter

Occurrence on VSFB

There is a small and persistent breeding colony at the boat harbor near Sudden Flats approximately 5.5 miles south of SLC-4 and 2 miles south of SLC-6. Southern sea otters regularly occur in this area and between the Boat House and Jalama Creek on south VSFB.

Southern sea otters also inhabit nearshore waters off the coast of VSFB between Purisima Point and Point Arguello (30 CES 2021; Appendix B, Figures A4–1 and A4–2). Less often there is a smaller breeding colony near Purisima Point approximately 8.25 miles from SLC-4 and 12 miles from SLC-6.

Previous monitoring efforts have documented up to 118 otters in the nearshore waters off of VSFB, with as many as 55 adult otter individuals at one time in the Sudden Flats area (30 CES 2021; Tab A4). Annual spring surveys performed by USGS document persistent populations in this area with a recent high of 49 adults and 4 pups in 2023 (SLD 30 2025, p. 115). Southern sea otter demographic data from USGS between 2009 to 2019 (Hatfield et al. 2019) included 3-year running averages per ATOS (As the Otter Swims) USGS designated segment per approximately 500-meter section of coastline surveyed. Following preliminary geospatial analysis, relevant ATOS sections for VSFB within the action area include from 972 in the north to 1,094 in the south. Using linear density estimated during surveys, in 2019, this portion of the coastline was most recently anticipated to support linear density of 62.1 southern sea otters collectively. Between 2009 and 2019 across the same region, the average supported linear density was approximately 73.7 southern sea otters.

Since 2016, VSFB biologists have documented an increase in dead southern sea otters within the base's coastline with at least 21 mortalities documented between 2016 to 2022 attributed to predation from great white sharks (*Carcharodon carcharias*) (30 CES 2021; A4-2). Similarly, USGS data demonstrates declines between 2009 and 2019 of estimated linear density (decline across 115 out of 121 ATOS sections) with experts also indicating that shark bites are expected to be the most significant demographic factor in this region (L. Carswell, pers. comm., 2025).

Occurrence outside of VSFB

Southern sea otter demographic data from USGS between 2009 to 2019 includes ATOS sections off VSFB within the action area. These sections include 1,095 (at Jalama Beach) to 1,154 (approximately 2.25 miles west of Gaviota State Beach which is the anticipated geographic extent of the mainland southern sea otter range and where available USGS survey data begins). Using linear density estimated during surveys, in 2019, this portion of the coastline was most recently anticipated to support linear density of 102.2 southern sea otters collectively.

Southern sea otters are not expected south of Gaviota State Beach. No southern sea otter populations are known to occur at the Channel Islands with the exception of San Nicolas Island which is outside of the project action area.

California Red-legged Frog*Population within VSFB*

California red-legged frogs have been documented in nearly all permanent streams and ponds on VSFB, as well as most seasonally inundated wetland and riparian sites (MSRS 2022a, p. 33). Spring Canyon is an ephemeral drainage located approximately 200 feet south of SLC-4 and approximately 3.2 miles north of SLC-6. Throughout the majority of the drainage there is no definable channel and minimal evidence of potential pooling or surface water flow. Several small areas of Spring Canyon may constitute suitable habitat for California red-legged frogs during wet periods when adequate surface water is present (MSRS 2022a, p. 27). A Permitted Biologist reassessed the drainage following an above-average rain year in July 2017 and found no suitable California red-legged frog breeding habitat within the Vegetation Removal Area or downstream. Between 2017 and 2022, the Space Force performed 11 survey efforts within the Spring Canyon Vegetation Removal Area and found no suitable breeding habitat or California red-legged frog individuals, likely a result of the protracted drought conditions in Santa Barbara County (MSRS 2022a, p. 28). It is therefore unlikely that California red-legged frogs occupy the existing Vegetation Removal Area on a regular basis, other than as transitory habitat.

Bear Creek, located approximately within 1 mile to the northeast of SLC-4 and approximately 4.7 miles northeast of SLC-6, is within the Launch Noise Effect and Overpressure Effect Areas. A night survey of the Bear Creek Lagoon in late February 2024 documented 12 adult and 11 juvenile California red-legged frog (MSRS 2024a, p. 110).

Biologists have consistently documented a moderately sized population and breeding habitat of California red-legged frogs over the last 10 years across variable survey efforts within Honda Creek. Honda Creek is located approximately 2 miles south of SLC-4 and 1.2 miles north of SLC-6 and is within the Launch Noise Effect and Overpressure Effect Areas. Noise modeling projects Honda Creek would receive levels at least 120 dB L_{max} of engine noise during launches and up to 6 psf (143.14 dB) during boost-backs of Falcon 9 from SLC-4 and SLC-6. More noise modeling projects that Honda Creek would receive levels of at least 120 dB L_{max} of engine noise during launches and static fire tests as well as up to 13 psf (149.86 dB) from boost-backs of

Falcon Heavy from SLC-6. However, past realized monitoring results indicate Honda Creek has received an instantaneous sonic boom with overpressure level of 2.4 psf (comparable noise level of up to 135 dB L_{max}), which were the realized levels recorded during previous Falcon 9 launch monitoring (MSRS 2022a, p. 4). Using protocol night California red-legged frog survey information between 2013 and 2022, adult frogs encountered ranged between 1 to 12 individuals with the current average annual high number being 7.2 adult individuals within the approximate anticipated Launch Noise Effect and Overpressure Effect Areas. Honda Creek includes multiple deep pond features that support breeding, including 68 juveniles in 2017 and with 50 tadpoles and over 13 egg masses observed in 2022 (USSF, unpublished data, 2022). In April 2024, 8 adult and 7 juvenile California red-legged frogs were documented during a night survey on the lower Honda Creek stretch, exceeding the average number of adults (7.2) observed on this same stretch over the past 11 years (MSRS 2024a, p. 110).

The Santa Ynez River and San Antonio Creek are both large perennial features. Large portions of each feature are included in the Launch Noise Effects and Overpressure Effect Areas. The Santa Ynez River is located approximately 4 miles north of SLC-4 while San Antonio Creek is located approximately 10 miles north. Regarding SLC-6, the Santa Ynez River is approximately 14 miles north and San Antonio Creek is approximately 18 miles north. Both features are thought to support large populations of California red-legged frog and breeding habitat (MSRS 2016, p. 37, MSRS 2022a, p. 34) although the presence of non-native predators (e.g. bullfrogs) is considered to be a current threat.

San Antonio Creek contains the incomplete San Antonio Creek Oxbow Restoration expansion area. Additionally, the proposed well water extraction area is in San Antonio Creek and includes 9.5 miles of downstream habitat between Barka Slough to the estuary.

Historically, California red-legged frogs have been found in water treatments ponds and evaporation ponds on the south end of SLC-6 (Christopher 2002). The ponds were assessed in February 2024 and the results showed that the ponds were either dry or served as transitory habitat for California red-legged frogs (SLD 30 2025, p. 49).

The Space Force has assessed California red-legged frog habitat suitability within drainages and the historic water treatment ponds within and surrounding SLC-6 (SLD 30 2025, p. 49). The drainages on the south side of SLC-6 are assumed to be potential transitory habitat exhibiting ephemeral surface water flow in response to seasonal storms. At the southwestern corner of SLC-6, the southern drainage transitions to potential aquatic, non-breeding habitat. The drainages on the north side of SLC-6 are determined to be potential transitory habitat, and the surrounding terrestrial habitat are also determined to be potential transitory habitat. No deep pool habitat suitable for supporting breeding California red-legged frogs are present directly where project activities will occur. Open water and flow were observed, which were likely to be long-lived during seasons with average to above average rainfall. Although open water, suitable aquatic and riparian vegetation, and refugia were observed, there were no deep pool habitat (> 0.7 meter) that could support California red-legged frog breeding. Therefore, the Space Force concludes that the drainage only serves as a suitable site for temporary occupation by transiting

California red-legged frogs. Recent aerial imagery indicated these features do not appear to hold water.

Additionally, Shuman Creek and Canada del Jolloru supports California red-legged frog population and breeding habitat. California red-legged frogs have also been documented in isolated natural wetlands on south VSFB (MSRS 2024a, p. 48). Suitable upland dispersal habitat exists throughout VSFB between the various riparian zones and ponds. The vast majority of the Launch Noise Effect and Overpressure Effect Areas support areas of dense vegetation that could provide shelter for dispersing California red-legged frogs, especially during wet periods.

Population outside VSFB

Jalama Creek is located just outside of VSFB and within the Launch Noise and Overpressure Effect area (Tables 29 and 30; Appendix A, Figures 2P–R, 3KL, and 4I). This feature is known to support a California red-legged frog population and suitable breeding habitat (MSRS 2024a, p. 48).

California red-legged frogs occupy the south coast of Santa Barbara County, including Gaviota Creek, Arroyo Honda, Arroyo Quemado, and other nearby creeks and tributaries. There are also observations of California red-legged frogs from San Antonio Creek in Ojai, Las Virgenes Creek near Calabasas, and the Ventura River near Casitas Springs, from 2000 to 2016 (MSRS 2024a, p. 50).

Western Snowy Plover

Population within VSFB

VSFB provides important nesting and overwintering habitat for western snowy plovers, which includes all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Wall Beach on north VSFB to the rock cliffs at the south end of Surf Beach on south VSFB (approximately 12.5 miles). VSFB averaged 225 breeding adults between 2014 to 2019 making it approximately 25 percent of Recovery Unit 5 and approximately 10 percent of the entire species range. Available historical data has shown that VSFB has consistently supported the largest populations of breeding western snowy plovers across the entire species range while simultaneously supporting high numbers of overwintering individuals.

The nearest observation of western snowy plovers to the action area's Launch Noise Effect Area is on the southern end of Surf Beach, approximately 0.8 miles northwest of SLC-4. (Appendix A, Figures 2S–2U). The breeding population of western snowy plovers on VSFB has been highly variable but relatively stable since 2007. Historically, VSFB has achieved the identified recovery goal of 400 breeding adults, with a mean of 420 breeding adults in 2004 (SRS 2004, p. 13). South beaches alone have demonstrated capacity to support 327 breeding adults and up to 393 nests historically (SRS 2004, pp. 13 and 19). Although these high levels were not maintained for more than a year, between 2013 and 2020, South Beaches have routinely surpassed estimated

capacity of 150 breeding adults (Table 19). The last four years have seen declines in breeding adults and nesting attempts on South Beaches, with increases on northern beaches.

Tables 19 and 20 outline the number of nests and breeding adults per year within south base and north base beaches. The Applicant began launching from SLC-4 in 2018, increasing launch cadence to 36 in 2023 and 50 in 2024. South beaches have and would continue to receive the highest projected launch and sonic boom disturbances associated with the project.

Table 19. Number of known western snowy plover nests per year from 2013 to 2024 within the modeled greater than 3 psf (south base beaches, encompassing Wall to South Surf Beach) contour zones (Robinette et al. 2013; 2015; 2016a; b, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024).

Year	Nest Initiated	Breeding Adult
2024	191	105
2023	179	93
2022	201	126
2021	240	123
2020	256	152
2019	261	189
2018	314	210
2017	320	170
2016	234	179
2015	275	212
2014	252	124
2013	178	165

Table 20. Number of known western snowy plover nests per year from 2013 to 2024 within the modeled 1 to 3 psf (north base beaches, CA-84 encompassing Minuteman Beach to Purisima Point) contour zones (Robinette et al. 2013; 2015; 2016a; b, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024).

Year	Nest Initiated	Breeding Adult
2024	284	204
2023	157	142
2022	230	106
2021	232	112
2020	197	113
2019	165	109
2018	171	99
2017	153	79
2016	151	110
2015	162	97
2014	175	81
2013	129	125

VSFB is also an important overwintering location for western snowy plover, supporting 360 roosting plovers in total in 2024. More specifically, VSFB South Beaches (comprised of Surf Beach North and South, and Wall Beach), supported 146 roosting plovers in 2024 (Service, unpublished data, 2024b). Table 21 below demonstrates that overwintering populations have been variable across the number of individuals observed on South Beaches (Service 2024c).

Table 21. VSFB Overwintering western snowy plover population counts.

YEAR	Number of overwintering individuals Across VSFB	Number of overwintering individuals on South Beaches
2024	360	146
2023	214	62
2022	256	143
2021	289	152
2020	221	116
2019	290	199
2018	117	80

Northern Channel Islands

On the northern Channel Islands (NCI), the western snowy plover occurs in various locations on Santa Rosa, Santa Cruz, and San Miguel Islands. Biologists consider the western snowy plover a permanent resident of Santa Rosa Island, an occasional summer resident of Santa Cruz Island inhabiting the east side of the island, and an occasional winter resident of San Miguel Island. Biologists do not regularly monitor western snowy plovers on the NCI; however, they do conduct breeding and winter window surveys on the NCI when feasible. Since 2005, biologists have observed as many as 37 western snowy plovers on Santa Rosa Island during the annual breeding window survey, although this has decreased to between 5 and 16 western snowy plovers since 2008 (Service unpubl. data 2022b). Winter observations on Santa Rosa Island from 2006 to 2020 ranged between 250 to 170, with declines between 2021 and 2024 of less than 50 individuals reported (Service unpubl. data 2023d)(Service unpubl. data 2023d; Whitaker and Mazurkiewicz 2024). Biologists have not observed any western snowy plovers at San Miguel Island during breeding window surveys since 2005 (Service unpubl. data 2022b). The Service received new information indicating that winter observations on San Miguel Island (near Point Bennett) fluctuate widely and have ranged from 0 to over 120 individuals between 2012 and 2019, with less than 40 individuals reported between 2020–2023 and none observed in 2024 (Whitaker and Mazurkiewicz 2024, entire).

Mainland CA

Off VSFB mainland California populations of the western snowy plover occur in various locations of the action area (eastern Santa Barbara to northern Los Angeles County). The western snowy plover is a permanent, year-round resident. Plover populations in the region between Santa Barbara and north Los Angeles counties have a slight decreasing trend, with breeding

window surveys counting between approximately 675 and 975 birds counted since surveys began in 2005.

California Least Tern

Historically, California least terns nested in colonies in several locations along the coastal strand of the north VSFB coastline. The current primary colony site at VSFB for the California least tern is at Purisima Point, approximately 8 miles north of SLC-4. This site is on a relatively undisturbed bluff-top in open dune habitat. California least terns forage in the lagoon formed at the mouth of the Santa Ynez River, approximately 3.7 miles north of SLC-4, and at other near-shore locations at VSFB. After young California least terns have fledged in late summer, they will disperse to these locations to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (MSRS 2022a, p. 41). Both the Purisima Point colony site and Santa Ynez River foraging site fall within the Launch Noise Effect Area and Overpressure Effect Area (Appendix A, Figures 2V–X, 3O–P, and 4N).

VSFB supports only a small percentage of California’s breeding population of California least tern; however, the population on VSFB remains significant as it is one of only three breeding colonies between Monterey and Point Conception. Though this population is one of the smallest in the range, VSFB tends to be an overall reproductively successful site with 37 breeding pairs and 40 nests initiated in 2024 (Table 21). Variability in reproductive success has been associated with predation and prey availability, with predation having a greater impact on hatching success and prey availability having a greater impact on fledging success (Robinette et al. 2024, p. 3).

Table 21. Number of known California least tern nests per year from 2013 to 2024 at the Purisima Point colony (Robinette et al. 2013; 2015; 2016a; b, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024).

Year	Nests Initiated	Breeding Pairs
2024	40	37
2023	42	39
2022	45	42
2021	34	27
2020	12	10
2019	47	42
2018	83	60
2017	28	27
2016	27	25
2015	22	22
2014	21	17
2013	15	15

California least tern presence on VSFB is limited during the breeding season and the species does not overwinter within the action area.

Recovery

Southern Sea Otter

In the recovery plan for southern sea otter, the Service designated ecoregions and populations across the species range. VSFB is located within the Monterey ecoregion and carries the Point Conception (PC) subpopulation. Additionally, the project noise and overpressure area overlap with the southern California ecoregion, which carries with the individuals the Santa Barbara (SB) subpopulation.

The 5-year review described that within the PC subpopulation, as of 2019, there was a negative 5.5 percent decrease to the population size over 5 years (Service 2023b). The estimated carrying capacity of the PC coastal segment is 810 (95 percent CrI 572–1147) southern sea otters. As for the SB subpopulation, an average of 2 individuals were found over 3 years, and there was a 0 percent population change in the 5-year review (Service 2023b). The estimated carrying capacity of this coastal segment is 165 (95 percent CrI 53–398) southern sea otters.

Actions needed for recovery for southern sea otters include monitoring demographics and life history parameters, protecting the population and reducing and eliminating human activities that cause stress, conducting research to understand factor(s) limiting the growth rate of populations, and refine recovery goals from which management actions can be identified and implemented (Service 2003). As stated in the INRMP, VSFB has committed to protecting the rocky coastline from degradation to the greatest extent practical as well as coordinating with the Service and CDFW for recovering dead and stranded sea otters that come ashore (USAF 2015).

California Red-legged Frog

In the recovery plan for California red-legged frog, the Service revised recovery units and identified core areas that are watersheds, or portions thereof, that biologists determined essential to the recovery of the California red-legged frog. VSFB is located within the Northern Transverse Ranges and Tehachapi Mountains Recovery Unit and Core Area 24, Santa Maria River-Santa Ynez River. This core area is important because it is currently occupied, contains a source population, and provides connectivity between source populations (Service 2002a, pp. 6, 146).

In this recovery unit, biologists consider the lower drainage basin of San Antonio Creek, the adjacent San Antonio Terrace, and San Antonio Lagoon to be among the most productive areas for California red-legged frogs in Santa Barbara County (Christopher 1996, as cited in Service 2002a, p. 10). Most of this area occurs on VSFB.

Recovery task 1.24 identifies that the conservation needs in Core Area 24 are (1) to protect existing populations; (2) reduce contamination of habitat (e.g., clean contaminated ponds on VSFB); (3) control non-native predators; (4) implement management guidelines for recreation; (5) cease stocking dune ponds with non-native, warm water fish; (6) manage flows to decrease impacts of water diversions; (7) implement guidelines for channel maintenance activities; and (8)

preserve buffers from agriculture such as in lower reaches of Santa Ynez River and San Antonio Creek (Service 2002a, p. 75).

Western Snowy Plover

In the recovery plan for western snowy plover, the Service designated six recovery units across the range. VSFB is located within Recovery Unit (RU) 5, which includes San Luis Obispo, Santa Barbara, and Ventura Counties. RU5 supports the greatest number of western snowy plovers in the range (approximately half of the U.S. population) and has the greatest amount of available suitable habitat (Service 2007, p. 142).

In 2019, the population trajectory of RU5 was considered stable, positive, with minimal annual fluctuation (Service 2019a, p. 5). Annual monitoring reports from several of the larger sites, including VSFB, report fecundity results that exceed the recovery criterion in most years (Service 2019a, p. 5). As of 2024, the draft 5-year review and communication with the Arcata USFWS indicate that RU4 and RU5 show non-growth trends while RU1, 2, 3, and 6 show statistically significant growth (Service 2024d, p. 8). Between 2018 and 2023, the most recent available data indicates that RU5 is the only recovery unit experiencing notable downward population trajectory. RU5 population has not attained or exceeded the recovery target in any survey year (Service 2024d, p. 8; July 9th 2024, pers. comm. Arcata FWS Office).

In 2024, across both North and South Beaches, VSFB recorded 309 breeding adults. Collectively, this is an increase from reported low numbers in 2023 but below the identified 400 breeding adult site recovery goal. In 2022, VSFB comprised approximately 26 percent of breeding adults in RU5, 12 percent of California's breeding population, and 10 percent of breeding adults rangewide (Service 2022c, entire). Table 22 outlines average numbers of breeding adults counted during breeding window surveys from 2014 to 2022. Percentages illustrate the numbers of breeding western snowy plovers at VSFB relative to numbers rangewide, across California, and within RU5.

Table 22. 2014–2022 breeding adult averages from uncorrected (raw) breeding window survey numbers for the Pacific Coast range of the western snowy plover, California, RU5, and VSFB with relative percentages (Service 2022c)(Service 2022c)

Area Surveyed	2014–2022 Averages	Percent of Range	Percent of CA	Percent of RU5
Rangewide	2,283	100	-	-
California Only	1,843	81	100	-
RU5	857	38	47	100
VSFB	226	10	12	26

California Least Tern

In the recovery plan for California least tern, the Service identified the Purisima Point and Santa Ynez River locations on VSFB, but not VSFB itself, as part of Management Area D. The Service

described Purisima Point as a location to develop and implement management plans/programs for secure nesting habitat, and the Santa Ynez River Mouth as a known post-breeding site. Ten or 12 pairs of California least terns were known to have nested at the Santa Ynez River mouth. The Space Force observed some fledglings but did not take a census. The recovery plan stated that enhancing nesting in the area should be investigated (Service 1985, pp. 13, 22, 57–58).

In the 2020 5-year status review, the Service described VSFB as a secure and managed site with a minimum of 20 breeding pairs within the Santa Maria Basin region with increasing reproductive success, suitable and occupied habitat, and threats of predation and food availability. In 2016, breeding pairs on VSFB accounted for less than 1 percent of breeding pairs in the range. Most breeding pairs (60 percent) breed in San Diego County. In 2017, the Space Force reported a minimum of 19 breeding pairs with a min-max fledglings per pair ratio of 0.30 to 0.42 (Service 2020c, pp. 10, 24, 49, 96).

The VSFB INRMP provides some avoidance consideration in project design and seasonal implementation for California least tern (USAF 2015, pp. 24–25). The 2015 Beach Management Plan (Service 2015b) includes management of recreational access, habitat restoration, and predator management. Section 7 consultations and NEPA documents identify project-specific monitoring and protection measures that the Space Force implements as required. Key threats to California least terns include habitat loss through invasion by non-native plant species; predation by other wildlife species; and disturbance.

EFFECTS OF THE ACTION

The implementing regulations for section 7(a)(2) define effects of the action as “all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action” (50 CFR 402.02).

In conducting this analysis, we have considered factors such as previous consultations, 5-year reviews, published scientific studies and literature, and the professional expertise of Service personnel and other academic researchers with aspects directly related to the sensitive species involved in determining whether effects are reasonably certain to occur. We have also determined that certain consequences are not caused by the proposed action, such as the increase or spread of disease, poaching, or collecting, because they are so remote in time, or geographically remote, or separated by a lengthy causal chain, so as to make those consequences not reasonably certain to occur.

Effects of the Proposed Action on the Southern Sea Otter

Operational Lighting

The proposed project is likely to increase acute artificial night lighting. The demolition and construction of SLC-6 includes the development of new permanent lighting infrastructure. Increased rocket cadence from SLC-4 and novel cadence from SLC-6 would constitute increases in overall temporary, acute lighting impacts from frequent operation (flare) especially when launch or landings at VSFB occur at night.

Several launches from SLC-4 over the past two years have been conducted at night. Although not likely, the proposed project does not have restrictions that would prevent all proposed 100 launches occurring at night. Reviewing available historical light pollution satellite data (NASA 2024b; c), photos of Falcon-9 flare during a night launch, and video footage from night launches of rocket vehicles demonstrate the potential magnitude of acute lighting levels generated from associated rocket flare. Following this review, we anticipate that the proposed project has the potential to increase southern sea otter exposure to artificial light pollution in the vicinity of SLC-4 for any launches occurring at night.

Following a review of this information, the proposed project is likely to increase southern sea otter's exposure to artificial light pollution in the vicinity of VSFB. Southern sea otters transit in areas along the coast as close as 0.5 mile from SLC-6 with known pupping grounds located approximately 1.5 miles away. Average illumination levels and duration are to be reasonably expected to increase due to novel infrastructure lighting associated with SLC-6 construction, increased operation of SLC-4 and SLC-6, and associated sky-glow. Sky-glow is an increase in the apparent brightness of the night sky from artificial lighting, often enhanced by clouds or fog which frequently occur off the coast of VSFB. We reviewed the VIIRS dataset, which demonstrates a significant increase in the lighting levels in the vicinity surrounding SLC-4 occurred between 2017 and 2023 (NASA 2024b; c), which occurred in tandem with the large increase in past night operations to support 28 launches in 2023.

Although refined specific light monitoring information is needed, available VIIRS 2023 data indicates that SLC-4 infrastructure and operational lighting as well as existing SLC-6 infrastructure appear to be routinely illuminating adjacent southern sea otter transitory habitat at low levels. In addition, each night launch has the potential to generate short term (approximately 1 to 3 minutes depending on if a terrestrial boost-back is involved) higher levels of artificial night lighting as a result of associated rocket flare (Service 2025c). Consequently, the proposed project has the potential to increase the number of days that southern sea otter occupied habitat could be illuminated by assumed low levels of site lighting and high levels of acute rocket flare as a result of associated sky-glow.

Little information exists on the effects of increased lighting on southern sea otters, a primarily diurnal species. Increased project-related lighting off VSFB could include general effects to southern sea otters such as increased disturbance, impacts to circadian rhythm, and chronic increase in stress hormone levels which can lead to physiological effects over time. Increased

lighting may also lead to indirect effects such as increased hunting time if southern sea otter prey items are newly attracted to these areas, with other focused research demonstrating increased marine species richness with prolonged artificial lighting at night exposure in shallow coral reef environments (Weschke et al. 2024). Increased lighting, in particular prolonged artificial lighting, can contribute to increased shark presence. An increase in shark bite mortality rates could result if southern sea otter silhouettes are more easily detectable under increased lighting. Limited available literature supports that increased shark attacks on humans are statistically correlated with lunar illumination of greater than 50 percent (French et al. 2021). Although these types of effects on southern sea otters from increased lighting should be considered when looking at long term demographic trends during proposed monitoring (SSO-1), more information is needed to determine extent of effects from increased project lighting. However, we expect this effect to be more likely for individuals nearest the launch complexes. Past annual spring surveys performed by USGS documented persistent populations of southern sea otter with existing high rates of shark bites as previously discussed in the status of the species.

Launch Noise and Overpressure

Sound pressure and overpressure produced by the proposed project activities (i.e. disturbance from launch, landing, and static fire events) have the potential to affect southern sea otters if present offshore at the time of demolition or a launch. Immediately off the coast approximately 0.5 mile where southern sea otters would be expected to infrequently transit, the maximum anticipated noise levels during any launch from either facility would be up to 140 dB L_{max} . Potentially occupied southern sea otter areas would also experience sonic booms with overpressure levels up to 8 psf (145 dB) during each boost-back landing at SLC-4 and levels up to 10 psf (147 dB) during each boost-back landing at SLC-6 (Table 23 and Table 24). The location of the southern sea otter breeding colony area near Southern Flats is located approximately 5.5 miles away (SLD 30 2025, p. 176) and would experience slightly lower noise levels with maximum anticipated levels of up to 129 dB L_{max} during launches, and sonic boom overpressure levels up to 8 psf (145 dB). Noise effects from limited demolition and construction activities of SLC-6 are expected to be similar or less than those discussed below.

Table 23. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at southern sea otter localities (SLD 30 2025, p. 174).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Nearest Coastline	122	130	140	130	120	130	130	110	135
VSFB Harbor	108	108	116	120	119	125	128	118	129
Sudden Ranch	108	108	116	120	119	125	128	118	129

Table 24. Estimated maximum sonic boom levels (psf) and their equivalent estimated noise events (dB) from the boost-backs at southern sea otter localities (SLD 30 2025, p. 174).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Nearest Coastline	7–8	144.5–145.6	10	147.6	10	147.6
VSFB Harbor	3.5–4	138.5–139.6	5-8	141.6–145.6	5–8	141.6–145.6
Sudden Ranch	2–3	133.6–137.1	3	137.1	3	137.1

Permanent threshold shifts (PTS) and temporary threshold shifts (TTS), measures in which normal hearing sensitive in a species would be anticipated to be permanently or temporary impacted, have yet to be determined for the southern sea otter. We reviewed updated surrogate thresholds for otariid pinnipeds, closely related marine mammals, developed by the National Marine Fisheries Service (NMFS 2024), as well as recent lower estimates from independent research (Southall et al. 2019, p. 154) provided in the M-weighting unit. M-weighting is adjusted for the hearing sensitivity of otariids and other marine carnivores per Southall et al. 2019. The application of M-weighted thresholds to unweighted exposure levels is a conservative approach to help determine if thresholds are exceeded (i.e., unweighted dB would be greater than the same levels with an M-weighted filter applied). Summary Tables 25 – 26 below are sourced from MSRS (2025, p. 175).

Table 25. In-air impulsive noise thresholds for TTS and PTS in otariid pinnipeds in peak decibels and equivalent pounds per square foot (SLD 30 2025, p. 175).

TTS (unweighted; re 20 µPa)	PTS (unweighted; re 20 µPa)
171 dB L _{max} (148.2 psf)	177 dB L _{max} (295.7 psf)

Source: NMFS 2024

L_{max} = maximum sound pressure level; dB = decibels; dB re 20 µPa = decibels related to 20 micropascals

Table 26. In-air non-impulsive noise thresholds for TTS and PTS in otariid pinnipeds (SLD 30 2025, p. 175).

TTS (M-weighted*; re 20 µPa)	PTS (M-unweighted; re 20 µPa)
157 dB SEL	177 dB SEL

Source: Southall et al. 2019

SEL = sound exposure level; dB = decibels; dB re 20 µPa = decibels related to 20 micropascals

* M-weighted is based on a filter applying otariid hearing sensitivity presented in Southall et al. 2019.

The provided modeling indicates that southern sea otters could experience sonic booms up to 10 psf (147.6 dB). The Space Force has also provided that the highest realized level measured during a Falcon Heavy double booster landing at the Kennedy Space Center in Florida during the Arabsat 6A mission on April 11, 2019 was 7.7 psf (145.3 dB) at a distance of 0.3 mile from the landing pads (James et al., 2020). The M-weighted SEL equivalent comparisons were not

provided. However, the Space Force included modeling and realized sonic boom monitoring (for the same vehicle, at a closer distance), were below levels estimated to cause a TTS for in-air impulsive noise.

Similarly for launch noise, the maximum anticipated noise level during any launch from either facility would be up to 140 dB L_{max} . During the Arabsat 6A Falcon Heavy launch, recorders located 0.3 mile away measured 152 dB unweighted SEL. The modeling and the realized noise monitoring (for the same vehicle, at a closer distance) would also be less than the 157 dB M-weighted SEL estimated threshold for TTS. The Falcon 9, with only one first stage compared to the equivalent of three first stages on the Falcon Heavy, is a quieter vehicle. Consequently, using the provided information, the Service does not expect that southern sea otters would experience any associated temporary or permanent hearing loss as a result of Falcon 9 from SLC-4 or SLC-6 or Falcon Heavy launches from SLC-6.

Following review of 2023 annual pinniped launch monitoring report (USSF 2024b, p. 14–21 (Section 4.3)), the Space Force agreed to proactively include novel improved real-time video monitoring efforts to discern if southern sea otters behaviorally respond to launch disturbance. In previous analysis, although the Service anticipated that southern sea otter may be startled by launch noise, we concurred with the Space Force's determination that rocket launches may affect but were unlikely to adversely affect southern sea otters. This concurrence was predominantly based on the understanding that southern sea otters are notably less sensitive to noise when compared with Pacific harbor seals and California sea lions, and have previously shown rapid acclimatization to frequent hazing noise disturbance (Davis et al. 1988, pp. 7, 14). We expected that individuals may already exhibit a degree of habituation due to the existing launch environment and did not anticipate full dive behavioral responses. However, two recent video monitoring efforts conducted for the Transporter 11 Mission on August 16, 2024, and the OneWeb-4 Launch on October 19, 2024, indicate that southern sea otters perceive launch disturbance and exhibited both alert and full dive responses. This monitoring documenting full dive response within breeding populations is new information that indicates that there may be an adverse effect to southern sea otters from rocket launches.

The Applicant Transporter 11 launch occurred during daytime at 11:56 AM and included visual disturbance, initial launch noise disturbance of 112 dB L_{max} and subsequent landing disturbance including booster noise and a sonic boom measuring 2.12 psf (134 dB SPL). Two monitoring areas (site one and site two) were located within the Sudden Ranch. Site one contained two different groups of rafting otters while site two contained a single individual. Video monitoring indicated that site one's first rafting group, referred to as the 'boat house raft' had six otters and two pups present at rest and rafting prior to launch. During launch, video footage depicts that all otters visibly alert with two individuals diving underwater within the same minute of the launch, resurfacing shortly thereafter. Biologists depict that pups are presumably still present but unable to see them and it is unclear if one mother-pup pair dove (MSRS 2024b, p. 10). During the subsequent sonic boom, five otters raised their head and one dove. The monitoring report indicates that previously observed pups are not detectable following the launch or sonic boom event (MSRS 2024b, p. 13). Site one's second raft location had two adult otters which both alerted and dove in response to the launch noise, resurfaced, and then alerted in response to the

sonic boom. Site two had one adult otter which dove in response to the initial launch noise, resurfaced, and dove several more times. During vehicle landing, the same individual made head movements towards SLC-4, did not respond visibly to the sonic boom, but dove again in response to the booster landing noise (MSRS 2024b, p. 11). Across monitoring sites, otters resumed resting within a half an hour of the landing event.

The Applicant OneWeb-4 Falcon 9 launch from SLC-4 occurred during nighttime at 10:13PM and included visual disturbance, initial noise disturbance, and booster noise and a sonic boom. No associated noise levels were provided (MSRS 2024c). Thermal equipment was utilized during monitoring to detect southern sea otter individual response using heat signature. A total of five otters were present immediately prior to the launch and all individuals dove in response to peak launch noise as well as peak bright light from launch vehicle as judged by monitors. There was no detectable reaction from the four otter individuals that had resurfaced during the subsequent sonic boom. A fifth and sixth otter were later encountered having moved west of the initial raft.

In summary, both video monitoring events indicate that southern sea otters perceive launch disturbance and behaviorally respond, exhibiting repeat alert and dive responses. Disturbance-induced activity that involves flee movement has associated energetic costs, which is thought to trigger the need to increase daily prey consumption to account for expended energy (Barrett 2019, p. 26). Ongoing routine launch disturbance to southern sea otters in the vicinity of the boat harbor could adversely affect the local southern sea otter population, potentially resulting in increased foraging times and reduced resting time. There may be higher anticipated impacts to reproductive females if they experience caloric insufficiency (Barrett 2019, pp. 32–33). Additional energetic demands on reproductive females can deplete energetic reserves and result in a condition called end-lactation syndrome, which has been documented to cause maternal deaths each year (Chinn et al. 2016, entire), most notably in resource limited environments with high intra-specific species competition. Additionally, routinely inducing dive responses in southern sea otters from a resting state can also impact the species' thermo-regulation. Thermo-insulation of southern sea otters depends almost entirely on their fur with body temperatures maintained principally through behavior such as grooming, keeping flippers above the water, and improving pelt insulation through blowing air into it. As endotherms, protection from heat loss is important for southern sea otters living in water, which has high thermal conductivity compared with air and creates a dynamic challenge for the species to maintain approximate body temperatures of 38.1 degrees Celsius (Riordan et al. 2023, p. 10). In addition, it is also worth noting that even in the event that a southern sea otter does not visibly respond to launch disturbance, hidden energetic costs including increases in stress hormone, increased heart rate, and decreased sleep efficiency could have long-term impacts if they occur frequently and routinely. Such effects to individuals over time could lead to population level effects.

Consequently, routine launch disturbance has the potential to impact feeding, rafting, and breeding behavior. However, referencing methodology found in Yeates et al. (2007), the Space Force provided energetic costs estimates for both males and lactating females related to anticipated disturbance based on existing monitoring footage. Most of the species' reactions documented during Falcon-9 launches were short dives with some individuals swimming for

approximately nine minutes in addition to diving (SLD 30 2025, p. 182). Swimming is approximately two times as great as resting metabolic rate (Yeates et al. 2007). Using the metabolic rates, activity budget, and energetic costs for males reported in Yeates et al. (2007), the Space Force calculated that the energetic cost to a male southern sea otter disturbed from rest and swimming for 10 minutes would be an increase of approximately 1 percent over one day (Table 27). The Space Force has indicated there would only be approximately two launch events per week and not all southern sea otter individuals are expected to react to this degree (most were observed to resume normal behavior within 2 to 3 minutes).

For a lactating female southern sea otter with a large post-natal coat pup, the Space Force applied a correction factor, per Thometz et al. (2016), to generate Table 28 below using the same methods, with the assumption that lactating females have similar behavior rates as males throughout a day and we expect this effect on energetic expenditure on females would be minimal.

Table 27. Activity budget and energetic expenditure for “normal” and “disturbed” male southern sea otter, adapted from Yeates et al. (2007). (Note: bold values reflect assumed changes in energetic expenditure due to a 10-minute disturbance from resting to swimming. Total MJ per day calculated assuming a mean body mass of adult male sea otters is 27.7 kg) (SLD 30 2025, p. 177).

Behavior	Proportion of 24-hr day normal	Minutes day ⁻¹ normal	Proportion of 24-hr day disturbed	Minutes day ⁻¹ disturbed	MJ day ⁻¹ kg ⁻¹ normal	MJ day ⁻¹ kg ⁻¹ disturbed	Total MJ day ⁻¹ normal	Total MJ day ⁻¹ disturbed
Resting	0.402	579	0.395	569	0.156	0.154	4.33	4.27
Feeding	0.363	522	0.363	522	0.224	0.224	6.22	6.22
Grooming	0.091	131	0.091	131	0.077	0.077	2.21	2.21
Swimming	0.085	122	0.092	132	0.072	0.078	1.94	2.16
Other	0.073	105	0.073	105	0.051	0.051	1.39	1.39
						Total MJ	16.09	16.25

MJ = megajoule, kg = kilogram

Table 28. Activity budget and energetic expenditure for “normal” and “disturbed” lactating female southern sea otter, adapted from Yeates et al. (2007). (Note: bold values reflect assumed changes in energetic expenditure due to a 10-minute disturbance from resting to swimming. Total MJ per day calculated assuming a mean body mass of a lactating female sea otters is 21.3 kg).

Behavior	Proportion of 24-hr day normal	Minutes day ⁻¹ normal	Proportion of 24-hr day disturbed	Minutes day ⁻¹ disturbed	MJ day ⁻¹ kg ⁻¹ normal	MJ day ⁻¹ kg ⁻¹ disturbed	Total MJ day ⁻¹ normal	Total MJ day ⁻¹ disturbed
Resting	0.402	579	0.395	569	0.237	0.233	5.05	4.97
Feeding	0.363	522	0.363	522	0.388	0.388	8.27	8.27
Grooming	0.091	131	0.091	131	0.097	0.097	2.08	2.08
Swimming	0.085	122	0.092	132	0.091	0.098	1.93	2.09
Other	0.073	105	0.073	105	0.078	0.078	1.66	1.66
						Total MJ	19.00	19.07

MJ = megajoule, kg = kilogram

As previously mentioned, southern sea otters that routinely alert and dive from resting state could increase associated energetic costs and lead to the need to increase daily prey consumption to account for expended energy (Barrett 2025a, p. 26). The Space Force's calculations demonstrate that the energetic cost of a lactating female southern sea otter disturbed from rest and swimming for 10 minutes should be an increase of less than 1 percent over one day (0.07 MJ increase). Then, following methods used in Barrett et al. (2025b), the Space Force determined that the additional feeding requirements needed to meet this cost is 17 kcal, or approximately the equivalent of 3 urchins (SLD 30 2025, p. 178). The above analysis should constitute a relatively conservative estimate and supports that anticipated effects should be insignificant from approximately 2 launches a week. In addition, we consider that the near shore environments off the coast of VSFB are thought to be resource abundant with relatively low sea otter density and corresponding high prey availability (Thometz et al. 2014, pp. 1553–1554). In this location, we anticipate that southern sea otter populations will likely be able to readily adjust foraging rates to account for potentially increased energetic costs through caloric supplementation.

No clear thresholds of disturbance that may induce observable population level effects exist, and more information is needed to understand full extent and magnitude of effects. The Space Force has not documented any mortality or injury as a result of previous infrequent launch disturbance from individual launches (30 CES 2023, p. A4–6). The Space Force's previous launch monitoring program for southern sea otters focused on before and after counts of the population. This monitoring data during low levels (generally less than 10 launches a year) of space launch activities since 1998 indicate that low numbers of launch noise and visual disturbances did not substantially affect the number of southern sea otters in the nearshore marine environments of VSFB (MSRS 2022a, p. 71). Southern sea otters adjacent to LF-05 on north base have historically experienced launch noise of 136.6 dB SPL associated with Peacekeeper launches and continue to experience 127.8 dB SPL associated with Minuteman III launches with no obvious observed effects on populations before or after launching (SRS 1999). Previous monitoring conducted during the Applicant Sentinel 6A launch mission that contained a boost-back and landing actions with similar noise and overpressure levels on November 21, 2020 documented similar before and after launch counts of southern sea otters (MSRS 2021a, p. 3). Biologists have not detected any discernible impact to southern sea otter populations from past launch activity of lower levels.

Previous research on southern sea otters also found that they may acclimate to disturbance (Curland 1997). The author compared otter behavior in areas with and without human-related disturbance (e.g., kayaks, boats, divers, planes, sonic booms, and military testing at Fort Ord) near Monterey, California. Southern sea otters spent more time traveling in areas with disturbance compared to those without disturbance; however, there was no significant differences in the amount of time spent resting, foraging, grooming, and interacting, suggesting that southern sea otters were capable of becoming acclimated to regular disturbances from a variety of sources, including military noise (Curland 1997).

Project-related activities will also impact southern sea otters via visual disturbance during launch and landing events from SLC-4 and SLC-6. We expect effects would not be greater than the noise disturbance effects occurring simultaneously as described above. We anticipate the

proposed project's adverse effects of brief behavioral reactions to launch disturbance. The Space Force will continue to monitor southern sea otter population levels annually to detect and understand potential unanticipated novel effects that may occur over time (SSO-1).

Launch Debris

If a launch anomaly component or associated debris struck a southern sea otter on the water surface, it could result in disturbance, injury, or death to the individual. However, there is an extremely low probability of strike potential, as southern sea otters are not known to regularly occur and congregate under the proposed Falcon 9 launch azimuths (MSRS 2022a, pp. 6, 46). Therefore, launch anomalies are not likely to occur and not covered under this analysis.

Transport/Harbor Operations

Following vehicle landings that occur downrange on a dronship in the Pacific Ocean, the Applicant would transport the reclaimed vehicle first to the Port of Long Beach and then back to the VSFB Harbor via a 'roll-on-roll-off' barge. A tugboat would pull the barge from the Port of Long Beach into the VSFB Harbor. The proposed action would include up to 76 tugboat events annually, utilizing roll-on-roll-off operations to the VSFB Harbor.

Effects to southern sea otters from project activities in the VSFB harbor could include startle-response, waking sleeping otters due to increased harbor usage, and associated noise and lights. Although boats can hotel in the harbor overnight, roll-on-roll-off operations occur during daytime hours. If a boat must hotel in the harbor overnight, its lights are turned on before dusk and then kept on until morning which would increase light disturbance in the vicinity of the harbor. The project's tugboats would be required to operate under a lighting management plan to reduce potential impacts to rafting otters from visual disturbance (SSO-PBO-2; SLD 30 2024, p. 39)(SSO-PBO-2; SLD 30 2024, p. 39). Across all base operations up to 25 night-operations per year could occur which would also limit the overall potential for effect (30 CES 2022, p. 30). We anticipate that if southern sea otters are in the vicinity they would move to other available areas nearby.

Motorized vessels may also strike an individual southern sea otter and cause direct injury or death if moving at fast speed. However, when at the dock, boats generally operate under auxiliary power and thus do not move much. Within the harbor, boats operate at low speeds (generally 1 to 3 knots). Outside the harbor, boats do not exceed 10 knots (USSF 2024a). The Space Force would require the project proponent to maintain reduced wake speeds to avoid direct injury to southern sea otter individuals (SSO-PBO-3) and routinely require that a Qualified Biologist survey the area and brief all project personnel operating watercraft with instructions to avoid any identified occupied areas. The Qualified Biologist will have the authority to halt work activities if personnel do not adhere to instructions (Refer to SSO-1 to 4 in Tab A4, 30 CES 2023). Previous monitoring efforts have not documented abnormal behavior, mortality, or injury of southern sea otters as a result of existing harbor utilization activities (30 CES 2023; Tab 4, pp. 6–7).

Although the Service anticipates that increased harbor utilization, particularly at night, will reasonably increase the frequency at which the species is encountered during project activities, available information does not suggest that it would be reasonably certain to lead to injury or mortality of the species at this time. Continued southern sea otter population monitoring (SSO-1) will also help ensure that the Space Force is able to detect any unanticipated effects over time to ensure consistency with this analysis.

Effects of the Proposed Action on the California Red-legged Frog

Construction and Demolition of SLC-6

Project construction and demolition would take place at any point of the year. Construction activities would occur during day or night, but demolition activities would only occur during the day. Because of project timing, SLC-6 associated construction and demolition activities, ground disturbance, and vegetation removal activities may result in the injury or mortality of California red-legged frogs due to entrapment, trampling, or crushing by work equipment, materials, and vehicles, at any point of the year. The Space Force did not conduct protocol California red-legged frog surveys within the immediate vicinity of SLC-6, but previous habitat surveys indicate there exists ephemeral and intermittent drainage habitat that could support the transitory individuals within the immediate area. Although California red-legged frogs have been recorded in the near vicinity historically, records indicate they were occupying deep water anthropogenic ponds within the SLC-6 perimeter. These ponds have since been decommissioned and no longer hold water. Recent surveys were conducted during above-average rainfall. We expect relatively low likelihood of California red-legged frogs occurring within the SLC-6 construction area as the proposed project's relative proximity to known occupied California red-legged frog suitable transitory habitat is within Honda Creek and a pond north of SLC-6. The drainages on the south side of SLC-6 are determined to be potential transitory habitat exhibiting ephemeral surface water flow in response to seasonal storms.

California red-legged frogs have the potential to disperse through the proposed Action Area. The Space Force conducted biological surveys of SLC-6 and the surrounding area in February and March 2024 to assess for presence of California red-legged frogs and its suitable habitat. Two areas within the SLC-6 fence line are currently holding enough water to be potentially attractive habitat to California red-legged frogs, including the vault structure and the flame trench. Experienced biologists have assessed these features to be 'attractive nuisances' to transiting frogs, indicating there is reasonable likelihood the species may utilize them temporarily during upland movements. California red-legged frogs could readily enter and exit the flame trench which exhibits a gentle slope. The vault is also an open feature which California red-legged frogs could enter and presents an entrapment hazard. SLD 30 Conservation staff recently installed escape ramps to prevent animal entrapment. During prior surveys of the site, biologists did not note any visual or auditory evidence of California red-legged frog presence. Neither feature has elements such as vegetation or shelter that would make them suitable for long-term occupancy, and no suitable breeding habitat was observed. To minimize the potential to attract California red-legged frogs to SLC-6, the Applicant will minimize standing water in exhaust ducts (CRLF-13).

Increased traffic to and from SLC-6 has the potential to harm or kill transitory California red-legged frogs during the wet season. Additionally, potential effects to California red-legged frogs that could be dispersing through the construction and demolition area include trampling and crushing by personnel, vehicles, or equipment, and overall disturbance due to construction noise. Construction related injury or mortality could be higher during the wet season (November through March), when California red-legged frogs are expected to move across the landscape. Due to the highly disturbed condition and low-quality habitat within the work sites themselves, the Service does not anticipate California red-legged frogs to regularly disperse through the construction and demolition area. The Space Force will require implementation of minimization measures to greatly reduce any potential adverse effects to the California red-legged frog. For example, the Space Force will ensure that Project construction and demolition activities in an undisturbed area cease until 24 hours after a precipitation event greater than 0.2-inch rain when California red-legged frogs would be expected to make dispersal movements (CRLF-11).

Launch pad construction would require vegetation clearing for the hangar, where transitory individuals could occur. The Applicant will ensure that construction and demolition disturbances will be kept to the minimum extent necessary (GM-3). The Applicant, under direction from a Qualified Biologist, will establish exclusion fencing areas (CRLF-3 and CRLF-4) to prevent California red-legged frogs from entering areas of anticipated disturbance. Following completion of fencing, the Space Force will require that Qualified Biologists relocate any California red-legged frogs encountered during work activities that are in harm's way to the nearest suitable habitat (CRLF-2). Work activities may create open holes or trenches that could entrap California red-legged frogs if left open overnight and lead to subsequent work-related injury or mortality. Therefore, the Applicant will minimize the potential for effects by securely covering any open holes or trenches with plywood or metal sheets if left overnight, as well as having a Qualified Biologist search any open holes and trenches the following morning for entrapped animals (CRLF-10).

The proposed project's demolition and construction of SLC-6 may produce temporary and persistent elevated noise levels. Using guidance provided by the Federal Transit Administration (FTA), the Service assumes the proposed project's construction would result in intermittent noise produced by pile driving equipment of 101 dB and persistent noise with average levels of 85 dB (at 50 feet from the source) across an 8-hour period (FTA 2006, p. 12–6, 12–8). We assume noise levels would attenuate to some degree from the construction source at SLC-6 within nearby habitat. Demolition and construction noise levels may disturb or potentially alter the behavior of California red-legged frogs if they occur in the vicinity.

If a transitory individual moved through ephemeral aquatic habitat near the work areas during demolition activities, the individual may be exposed to noise levels from 0.42 psf (120 dB L_{max}) to 4.17 psf (140 dB L_{max}). Although the potential exists for California red-legged frogs to disperse through the work site and adjacent areas, considering available records and recent survey information, the species dispersal movements within and directly adjacent to work areas would be uncommon. In addition, California red-legged frog response to demolition noise is anticipated to be temporary with any exposed individuals resuming normal behavior shortly

thereafter. To help minimize potential effects, the Space Force will ensure that a Service Approved Biologist surveys the construction site for transitory California red-legged frogs prior to the initiation of work (CRLF-5).

Construction and demolition activity has the potential to create associated ground vibration within adjacent California red-legged frog habitat (i.e., Honda Creek) to SLC-6. We cannot anticipate the level or duration of substrate vibration from the construction and demolition activities at this time, but we assume that low levels of vibration may occur routinely for extended periods for construction, and instantaneously for detonation of explosives. We assume that potential construction related vibration produces low frequencies, which attenuates less readily than high frequency (Norton et al. 2011, p. 658). Since the construction and demolition of SLC-6 would occur within 1.4 miles of the nearest California red-legged frog breeding habitat, we also assume that vibration from construction activities will not overlap with California red-legged frog breeding habitat.

If construction causes small scale erosion into adjacent ephemeral drainages, the quality of any connected California red-legged frog habitat may be degraded. The Space Force will ensure that the Stormwater Pollution Prevention Plan will be implemented (GM-6). Any implementation of erosion control materials has the potential to injure individual California red-legged frogs or disturb their habitat. However, we expect these effects would be temporary and minimized by the presence of a Qualified Biologist that will attempt to capture and relocate any California red-legged frogs encountered within the project area (CRLF-7).

Capture and relocation of California red-legged frogs may cause injury or death as a result of improper handling, containment, transport, or release into unsuitable habitat. Although we do not have an estimated survivorship for translocated California red-legged frogs, intraspecific competition, lack of familiarity with the location of potential breeding, feeding, and sheltering habitats, and increased risk of predation reduces survivorship of translocated wildlife in general. The Space Force will minimize effects by using Service Approved Biologists, limiting the duration of handling, requiring proper transport of individuals, and identifying suitable relocation sites (CRLF-7). The Service expects the relocation of individuals from vegetation management and water release areas to greatly reduce the overall level of injury and mortality, if any, which would otherwise occur. Having only experienced biologists engage in the activity would greatly reduce the potential for injury or mortality due to mishandling.

Accidental spills of hazardous materials, careless fueling or oiling of vehicles and equipment, and associated runoff could impact California red-legged frogs if materials enter adjacent aquatic habitat. Vehicle and worker movement within staging areas may also injure or crush any California red-legged frogs that enter these areas during wet season. The Space Force will limit fueling and maintenance locations to within the SLC-6 Right of Entry or designated utility corridors which the Service understands is previously disturbed habitat. Additionally, the Space Force will require that these areas and individual equipment or supplies staged overnight will be located at least 0.10 mile away from potential California red-legged frog aquatic habitat (CRLF-12). The Space Force will ensure that the Applicant implements measures to deter California red-legged frogs from accessing designated staging areas (e.g., drift fence barriers) and survey these

areas accordingly (CRLF-3 and CRLF-4). The Space Force will ensure that the Applicant does not stage equipment or supplies overnight within 0.10 mile of aquatic habitat. Measures would be implemented that prevent California red-legged frog from accessing the staging area (e.g., drift fence barrier installed) (CRLF-12). The Space Force will ensure that Qualified Biologists inspect equipment and staging areas for cleanliness and gas and oil leaks daily and require that contractors immediately address any unanticipated leaks or spills (GM-5).

Firebreak Installation and Maintenance

Effects related to SLC-4 and SLC-6 firebreak maintenance activities for California red-legged frog are included in the existing PBO (8-8-12-F-49R), and all applicable avoidance, minimization, and monitoring measures required under the PBO will be implemented.

Launch Operations Effects on Base

Operational Lighting

The proposed project could generate effects associated with increased artificial lighting at night. The majority of prior launches were conducted at night. We reviewed available historical light pollution satellite data (NASA 2024b; c) and video footage from night launches of similar vehicles that demonstrate the potential magnitude of acute lighting levels generated from associated rocket flare. Following a review of this best available information, the proposed project could increase exposure to artificial light pollution in the vicinity of SLC-4 and SLC-6.

The increases in launch cadence at SLC-4 and new operational usage and launch cadence at SLC-6 would increase average illumination of the site during the day and nighttime. The existing light pollution dataset demonstrates a significant increase in the lighting levels surrounding the vicinity of SLC-4 occurred between 2020 and 2024, likely as a result of the large increase in night operations in Falcon 9 launches. VIIRS data indicates that current SLC-4 operational lighting may be routinely illuminating associated California red-legged frog riparian and upland dispersal habitat from associated sky-glow. Sky-glow is an increase in the apparent brightness of the night sky as a result of artificial lighting, often enhanced by clouds or fog. Each night launch also has the potential to generate short term (approximately 1 to 3 minutes depending on if a terrestrial boost-back is involved) of higher levels of artificial night lighting because of associated rocket flare.

The newly introduced construction lighting at night and permanent lighting after construction of SLC-6 could create adverse effects on California red-legged frogs. With related anurans, artificial lighting can result in changes in hormone production and growth, as well as altered activity levels such as increased movement and foraging (Baker and Richardson 2006; Wise 2007; Hall 2016; May et al. 2019). Numerous anurans have been shown to increase foraging activity surrounding permanent light sources (Buchanan 2006), likely attributed to increased concentrations of prey levels resulting from insects' attraction to the presence of ultraviolet light (Longcore and Rich 2017, p. 25). The number of insects attracted to a lamp is disproportionately affected by the emission of ultraviolet light, regardless of the proportion of ultraviolet radiation

emitted (Barghini and Souza De Medeiros 2012, entire; Seymoure, pers. comm., 2023), indicating that even ‘low-UV’ lighting options attract insects. Permanent ultraviolet lighting adjacent to roadways or parking areas associated with SLC-4 and SLC-6 launch facility may result in higher likelihood of vehicle strikes if California red-legged frogs increase foraging in these areas in combination with increased worker and vehicle presence. Launch operations may physically injure or destroy California red-legged frog individuals if lighting surrounding the launch pad attracts them and they come within close vicinity of features including parking lots or the flame bucket.

Considering the existing VIIRS data and that SLC-4 and SLC-6 are within the near vicinity to Honda Creek and Bear Creek, we anticipate that increased artificial lighting associated with the proposed project’s increase in launching has the potential to result in the gradual degradation of California red-legged frog riparian and upland habitat. To attempt to minimize these effects, the Space Force will require the Applicant to develop a lighting plan for the proposed project (GM-2).

Flame Duct Use and Vegetation Clearance

At SLC-4, each of the proposed launches requires water release associated with the flame bucket with liquid water directed to the v-ditch feature and a minimum amount of water vapor directed towards Spring Canyon. The maximum temperature of the water vapor would be 130 degrees Fahrenheit at the point it would reach Spring Canyon. However, individuals are unlikely to occur in this area, thus we do not expect California red-legged frogs to be affected by these water releases. Between 2017 to 2022, the Space Force has conducted 11 survey efforts within the Spring Canyon Vegetation Removal Area and found no suitable breeding habitat or California red-legged frog individuals (MSRS 2022a, p. 28). Therefore, the likelihood that California red-legged frogs occupy the Vegetation Removal Area (or adjacent SLC-4 existing firebreaks) on a regular basis, other than for transitory upland habitat, is unlikely.

Capture and relocation of California red-legged frogs may cause injury or death as a result of improper handling, containment, transport, or release into unsuitable habitat. Although we do not have an estimated survivorship for translocated California red-legged frogs, intraspecific competition, lack of familiarity with the location of potential breeding, feeding, and sheltering habitats, and increased risk of predation reduces survivorship of translocated wildlife in general. The Space Force will minimize effects by using Service Approved Biologists, limiting the duration of handling, requiring proper transport of individuals, and identifying suitable relocation sites (CRLF-5 and CRLF-6). The Service expects the relocation of individuals from vegetation management and water release areas to greatly reduce the overall level of injury and mortality, if any, which would otherwise occur. Having only experienced biologists engage in the activity would greatly reduce the potential for injury or mortality due to mishandling.

The Applicant has constructed a civil diversion structure and retention basin to minimize the amount of water entering ephemeral streams, or transitory California red-legged frog habitat, from water release activities. The Space Force will ensure that the Applicant will implement the following measures: (1) The Applicant will follow the site-specific Stormwater Pollution

Prevention Plan already implemented for SLC-4 and SLC-6; (2) The Applicant will implement the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; (3) The Applicant will collect any rocket propellant in the retention basin using absorbent pads prior to discharge to the spray field; and (4) The Applicant will fully implement the procedures in VSFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill (GM-6). The civil diversion structure and collection of fuel with absorbent pads should reduce the potential for effects to California red-legged frogs. Provided the various plans and practices to control contaminants and sedimentation are effective, these measures should also reduce the potential for such impacts on California red-legged frog habitat should the species inhabit the area in the future.

The Space Force anticipates the proposed project's launches would produce a diminutive amount of soot byproduct. If soot or other similar launch related byproducts contact dispersing California red-legged frogs or enter adjacent occupied waterbodies, the Service assumes it has the potential to injure or kill California red-legged frogs due to their highly permeable skin and susceptibility to waterborne pollutants (Jung 1996, p. i; Llewelyn et al. 2019, p. 1). However, the Space Force references a comparable launch assessment (FAA 2019, entire) and expects that the actual amount of soot produced would be diminutive, being that it would subsequently burn up in the exhaust plume (Kaisersatt, pers. comm. 2022). Low concentrations of hydrocarbons consistent with high-purity kerosene rocket propellant were found in Spring Canyon soils (Tetra Tech 2025), but we do not know if the magnitude of the pollutants would negatively affect California red-legged frogs. Consequently, the proposed project's launch byproducts are unlikely to impact dispersing California red-legged frogs or their aquatic habitats since the likelihood of California red-legged frogs occurring is low.

Water Extraction

For most of the proposed project, the Space Force would source water from an existing connection between State Water and the VSFB water supply system. However, annually SLD 30 will utilize four water wells in the San Antonio Creek Basin for two to three weeks. During those two to three weeks, the Space Force would authorize that approximately 5.3 million gallons (16.4 acre-feet) could be extracted from the groundwater basin annually. Increasing water extraction could reduce flow rates, hydration periods, or water levels in San Antonio Creek and negatively impact California red-legged frogs. There has been habitat change within Barka Slough driven by increasing groundwater withdrawals from the San Antonio Creek groundwater basin for agriculture on and off VSFB. Since the 1980's, withdrawals have exceeded the recharge rate for the basin (Public Works 2010 as referenced in MSRS 2022b, p. 5). Since the 1950's, ground water levels have dropped between 33 to over 98 feet (USGS 2019). However, the Space Force indicates that the proposed project's water usage would be negligible and would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek (SLD 30 2025, p. 123–124). Similarly, referencing previous analysis (USGS 2019, p. 5) and associated discussion with hydrologists involved with the associated hydrological modeling (Faunt and Cromwell 2021 USGS, pers. comm.), the proposed project's

proposed 16.4 acre-feet extraction amount would not be anticipated to result in measurable decline of streamflow or associated aquatic habitat.

Factors including future surrounding water usage (e.g., collective existing and future launch program needs, surrounding agriculture, etc.), as well as increased variability of annual precipitation due to changing climate conditions, including shorter wet seasons and longer dry periods, may influence true effects (Myers et al. 2017, pp. 15, 59). An extended model created by USGS on the impacts of water extraction from San Antonio Creek to California red-legged frogs downstream in Barka Slough demonstrated different impacts at different times of the year (Culling et al. 2025). Timing of utilizing the four water wells creates various impacts to Barka Slough habitat and to California red-legged frogs. The modeled impacts to stream flow are higher from March to May, moderate through July, and lower through October. Stream disconnection may increase predation risk and risk of exposure to elevated temperatures. However, the model indicates that utilizing the four wells from April to June are less likely to impact California red-legged frogs from stream disconnection. Overall, we expect effects from this to be minimal due to the duration of the proposed extraction (two weeks). Continued monitoring and analyses are necessary to understand the impacts of the proposed project's extraction levels over time.

Launch Vibration

Launches from SLC-4 and SLC-6 would cause vibrations to California red-legged frog habitats. We cannot anticipate the level of substrate vibration from Falcon Heavy launches at this time, but it is reasonable to assume that low levels of vibrations may occur routinely for a short period (up to 5 minutes every 5 days) during the operation at SLC-6. We also assume that potential launch related vibrations may be of low frequency which attenuates less readily than high frequency (Norton et al. 2011, p. 658).

The Space Force monitored the vibrations of Falcon 9 launch and boost-back from SLC-4 in 2024 at Spring Canyon, Bear Creek, and Oxbow. The vibration intensity sampled at Spring Canyon (0.21 mile from the launch pad) was approximately 90 hertz, Bear Creek (1.41 miles from the launch pad) was 60 hertz, and at Oxbow restoration site (10.84 miles from the launch pad) was approximately 5 hertz and the intensity of the vibration was reported to be reduced by 99 percent on the surface and 90 percent underground from SLC-4 (Bunyan 2025, p. 10). Each vibration event lasted up to 4 minutes. The intensity of the vibration at Spring Canyon was reported to be approximately equivalent to a magnitude 3 to 4 earthquake several miles from the epicenter of an earthquake and at Bear Creek was approximately equivalent to a magnitude 2 or less earthquake (Winant, T., pers. comm., as cited in SLD 30 2025, p. 133). While earthquakes of 2 to 4 magnitude may be common in the general area, the earthquakes are usually caused by tectonic shifts miles underground versus at or near the surface for rocket launches. The closer to the surface that seismic vibrations occur, the more intense the vibrations, the further the vibration travels and the slower the vibrations attenuate (USGS 2025).

We have no specific data on the response of California red-legged frogs to varying levels or duration of exposure to launch operation vibration, and so we use available research on the

effects of vibration on related anurans as a surrogate. Overnight low frequency vibrations (7, 15, and 100 Hz) had effects on early embryonic development, such as significant levels of physiological effects (heterotaxia defined by the abnormal position of the heart, gall bladder, and/or gut loop), with some treatments inducing neural tube defects as well as bent tail morphology (Vandenberg et al. 2012b, pp. 3–5). Other research has demonstrated negative effects of anthropogenic vibration on anuran communication. Vibratory playbacks during 13 days from sunset until dawn significantly decreased the call rate and a smaller number of toads ceased calling activity completely or abandoned their call sites (Caorsi et al. 2019, p. 2). These findings suggest that the launch related vibration that occurs during the breeding season and routine exposure to low frequency vibration could adversely affect California red-legged frogs and negatively impact breeding and recruitment success during launch operations. The Space Force’s study on vibration from Falcon 9 rocket launches indicated that low level frequency vibrations overlap California red-legged frog habitat. However, the study collected data from terrestrial habitats and not aquatic habitats which may attenuate vibration differently. We assume vibrations from Falcon Heavy launches would be greater in magnitude in comparison to Falcon 9 launches. More information is needed to determine the magnitude and intensity of vibrations from Falcon launches within California red-legged frog aquatic habitat. We expect these effects to California red-legged frog breeding habitat to be limited to areas closer to SLC-4 and SLC-6.

Launch Noise and Overpressure

Sound pressure and overpressure produced by the proposed project activities (launch, landing, and static test fire events) affect California red-legged frogs on and off VSFB where they would experience variable noise levels up to 130 dB L_{max} and variable overpressure levels up to 9.5 psf (147 dB) during the up to 100 launches, 24 terrestrial boost-backs, and 50 static test fires of Falcon 9 and Falcon Heavy from SLC-4 and SLC-6 (Table 29 and Table 30). Noise modeling predicts Bear Creek would receive noise levels between 120 to 130 dB L_{max} of engine noise during launches and understood overpressure levels of up to 7 psf (144.5 dB) during boost-backs (See Appendix A, Figures 2P–R, 3K–L, and 4I).

Table 29. Estimated maximum engine noise levels (dB L_{max}) from Falcon 9 and Falcon Heavy vehicles at California red-legged frog localities (SLD 30 2025, p. 130).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Honda Creek	118	120	125	122	119	125	129	120	130
Santa Ynez River	110	105	118	118	108	112	112	106	116
Jalama Creek	<100	<100	108	108	105	112	108	<100	110
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 30. Estimated maximum overpressure levels (psf) and their equivalent estimated noise events (dB) from the boost-backs at California red-legged frog localities (SLD 30 2025, p. 130).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Honda Creek	6	143	9.5	147	9.5	147
Santa Ynez River	4–5	139.6–141.5	2.5	135.5	2.5	135.5
Jalama Creek	2–3	133.6–137	3	137	3	137
San Antonio Creek	2.2	134.4	1–2	127.6–133.6	1–2	127.6–133.6

The proposed project's launch operations would produce noise and overpressure levels that may adversely affect California red-legged frogs. There are no studies on the effects of noise and overpressure on California red-legged frogs, but available literature on the effects of noise disturbance on anurans in general has grown in recent years (Zaffaroni-Caorsi et al. 2022, entire). A previous study reviewed the effects of noise exposure on bullfrogs. Although no specific acoustic thresholds were determined during the study, researchers exposed American bullfrogs to sound levels greater than 150 dB SPL for 20 to 24 hours straight, which produced observable damage to their inner ears (Simmons et al. 2014, p. 1629). Bullfrogs' inner ears showed physical signs of recovery between 3 to 9 days after noise exposure. A population of breeding California red-legged frogs is known to occur approximately 1 mile north of SLC-4 within Bear Creek and 2 miles south within Honda Creek. Anticipated noise exposure from Falcon launches and sonic booms from SLC-4 and SLC-6 (Table 29 and Table 30) does not reach the noise treatment levels that the bullfrogs experienced in the Simmons et al. 2014 study.

Although the proposed project's maximum noise levels are only slightly lower than those documented to produce observable damage to bullfrog ears, the duration of the noise events would be much shorter (1 min per launch with a 17 second landing coupled with instantaneous sonic boom). However, the specific acoustic thresholds of California red-legged frog are unknown, and the realized levels of an individual launch may vary. If the proposed project's noise levels did result in hearing damage to California red-legged frogs, it may temporarily deafen them. The Service assumes the California red-legged frog inner ear recovery period may be similar to the 3- to 9-day recovery period exhibited by American bullfrogs. Routine deafening of a portion of breeding populations within the most proximate features including Bear Creek and Honda Creek may alter California red-legged frogs' ability to effectively communicate across the breeding season when frogs are calling with the potential to result in overall lower likelihood of reproductive success. California red-legged frogs that exhibit hearing loss may have a decreased ability to detect danger which increases their risk of predation. However, without refined specific acoustic threshold information, we are unable to determine if the proposed project would result in routine auditory harm of California red-legged frogs. We consider that although specific acoustic thresholds are not available, the bullfrog surrogate study used higher noise levels (greater than 150 dB) with significantly longer exposure duration (20 to 24 hours). The same study reported that shorter duration (4 hours) of levels below 150 dB did not produce observable damage resulting in deafening of individuals (Simmons et al. 2014). Using this available information, the Service does not anticipate that project activities would result in hearing loss. However, additional information is needed to help better understand the potential for auditory harm at realized noise levels.

California red-legged frog call rate changes could be correlated with stress and hearing damage. The Space Force performed short-term California red-legged frog call rate monitoring following a single Falcon 9 launch event (MSRS 2022c, entire, MSRS 2024d, pp. 12, 15–16). Although monitoring documented notable increases in call rate following an individual launch, data were not collected over a sufficient amount of time (6 days) to be able to analyze results in a meaningful manner for this analysis. To address the need for better information, the Applicant will implement long-term, passive bioacoustic monitoring during the California red-legged frog breeding season to characterize the baseline noise environment and determine if there are changes to call rate that may indicate inner ear damage but not complete hearing loss (CRLF-16).

In addition to call rate, changes in other signal characteristics, including amplitude, frequency, duration, and complexity, may be impacted with the introduction of novel noise disturbance. Changes (increases or decreases) to an individual's signal characteristics may represent energetic and vocal performance trade-offs. Receiver interpretation of altered signals may influence assessment of signaler quality. This could impact the fitness of California red-legged frogs over the duration of the proposed project. Anurans rely heavily on acoustic signals to attract females and to defend resources against rivals. Research on noise pollution from vehicles have demonstrated changes in male calling behavior (Schwartz et al. 2002; Cunnington and Fahrig 2010) and female choosiness of mates (Gerhardt et al. 1996; Gerhardt and Brooks 2009). Additionally, there is an energetic cost to increasing call characteristics (Parris 2002), and consequences can include inhibiting growth rate (Given 1988), lower reproductive output (Gibbons and McCarthy 1986), and increased risk of desiccation (Heatwole et al. 1969 as referenced in Yeo and Sheridan 2019). All can lead to decreases in population size. Potential changes in signal frequency could also reduce transmission distance and overall reduce signal efficiency. Changes to signal frequency can affect reproductive success in frogs (Witte et al. 2001). Although more information is needed regarding how rocket noise disturbance may impact California red-legged frog signaling performance and fitness, using the best available information, the Service understands the proposed routine noise disturbance over the duration of the proposed project has the potential to impact the breeding success of affected California red-legged frogs during every breeding season.

Similarly, launch noise and overpressure associated with sonic booms may impact all California red-legged frogs in the action area by altering their non-breeding behavior. California red-legged frogs may react to individual project related launch noise and overpressure created by sonic booms by startling or remaining immobile making them more susceptible to predation (Tennessen et al. 2014a, p. 6) or desiccation. They may also react to launch related disturbances by diving into water or retreating away from the affected areas. The proposed project's boost-back overpressure disturbance in combination with routine launch ascent noise disturbance and separate static test fires would subject local California red-legged frog populations to novel and routine disturbance frequency. Acute disturbance on average every five days on an annual basis of the proposed project has the potential to induce novel effects because of repetitive (chronic) stress.

Chronic stress, such as frequent exposure to noise and overpressure disturbance, can cause chronically high levels of stress hormone (Troianowski et al. 2017). Prolonged elevated stress

hormone concentrations can have deleterious effects on growth, survival, reproduction, and immune function (Sapolsky et al. 2000; Tennessen et al. 2014b). Relatively recent research demonstrates that increases in advertisement calling rate may be correlated with stress hormone production, which can result in an overall tradeoff in energy otherwise allocated for immunocompetence (Troianowski et al. 2017; Park and Do 2022). Consequently, we consider that repetitive stress incurred during the wet season, when California red-legged frogs are more active, may magnify the effect of these behavioral responses by altering breeding behaviors such as migration and calling. However, no specific thresholds of disturbance level or frequency are known. There are considerable differences between amphibian species' response to anthropogenic noise, indicating the need for species specific research to better determine potential impacts to California red-legged frog reproductive success and viability over time from novel anthropogenic acoustic disturbance (Simmons and Narins 2018). Although the project may result in effects to dispersal behavior, calling, and stress hormone accumulation that could have deleterious physiological effects and overall degrade the quality of existing habitat, we are unable to adequately anticipate the magnitude of any specific response at this time until the novel effects of the project activity on the species are studied.

The Space Force provided preliminary audiogram analysis which suggests there would not be overlap in the species' hearing sensitivity and low frequency noise produced by rocket launches. Specifically, the provided audiogram analysis suggests that California red-legged frogs may only be able to perceive a negligible portion of the launch noise, hearing less than 25 dB (indicating this is the human equivalent of whispering) across the entire launch event (MSRS 2024a, p. 106). However, there is still uncertainty around the hearing capabilities of California red-legged frogs. Previously provided audiogram samples between available surrogate species within the same taxonomic groups can vary widely and help to demonstrate the need for species specific established hearing curves to defensibly support conclusions of minimal perception. Consequently, specific disturbance levels and frequency thresholds that may impact California red-legged frogs are unknown.

Following review of the effects of the proposed action, we anticipate degradation in the quality of adjacent California red-legged frog aquatic and dispersal habitat in the vicinity of VSFB due to associated noise and overpressure disturbance from routine launching. Preliminary monitoring of California red-legged frogs during high launch years (e.g. 2023 and early 2024) has not shown immediate declines in breeding populations in Honda Creek and Bear Creek (MSRS 2024a, p. 110). However, confounding factors, including the notable rehydration of breeding habitat on VSFB during the 2023–2024 rain year after consecutive years of extreme drought between 2012 and 2022 (Palmer Drought Severity Index; NOAA 2024) may reasonably be influencing current population numbers. This would mean potential associated effects may not be detected over the short-term without proper statistical analysis.

Launch Operations Effects Off VSFB (Mainland California – eastern Santa Barbara, Ventura, and northern Los Angeles Counties)

Launch Noise and Overpressure

Of the estimated 75 percent of launches occurring annually that could utilize the easterly trajectory, approximately 65 percent could create sonic booms with the potential to impact California red-legged frogs within the identified occupied localities (SLD 30 2025, p. 139). Although the California red-legged frogs that occur in Santa Barbara, Ventura, and Los Angeles Counties could experience ascent sonic booms up to 4.5 psf (140.6 dB), the Space Force has indicated this is extremely unlikely to occur (Table 31). The majority of potential sonic booms would be between 0 to 1 psf (127.5 dB) (SLD 30 2025, p. 140). However, recent information indicates that 0.1 to 1 psf correlates to 107 to 127.5 dB, noise levels that are substantially higher than previously expected ambient noise levels. Additionally, we have continued to review the Space Force produced audiograms with subject matter experts. These experts have provided opposing conclusions and have recommended that until additional information is provided, the Service should reasonably expect that the species likely both perceive and thus could be adversely affected by project noise (J. Tennessen, pers. comm., 2022; R. Dooling, pers. comm., 2024).

We expect general effects from sonic boom noise to be similar to our analysis discussed above but understand that based on the provided modeling information for the proposed project, any potential effects are unlikely to manifest and would be overall negligible considering the sonic boom's associated noise level magnitude is far lower, of very short duration, likely comparable to ambient existing noise levels, and would occur relatively infrequently. To ensure these assumptions are correct, continued monitoring of realized sonic boom and associated noise levels is necessary.

Table 31. Model results of proportion of the sonic boom levels that overlap with the 6.2 mile buffer of California red-legged frog localities in mainland California with the largest number possible in parentheses (SLD 30 2025, p. 140).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0–1	199	308	64.6%
1–2	84	308	27.3%
2–3	35	308	11.4%
3–4	8	308	2.6%
4–5	4 (4.5 psf)	308	1.3%

Effects of the Proposed Action on the Western Snowy Plover

Construction and Demolition of SLC-6

The western snowy plover is not anticipated to be impacted by construction and demolition activities at SLC-6.

Launch Operations Effects on Base*Operational Lighting*

The proposed project has the potential to generate effects associated with increased artificial lighting at night. The Service has previously required that the Space Force provide specific lighting levels that are currently being produced at SLC-4 and on adjacent habitat including Surf Beach from existing launch operations to help inform the Service's ability to anticipate potential for lighting effects from the proposed project. This information currently being drafted by the Applicant but has not yet been provided to the Service (Whitsitt-Odell, pers. comm., 2025).

No new lighting infrastructure would be added to SLC-4. However, increased operational usage of the existing SLC-4 facility and the addition of SLC-6 could reasonably increase average illumination across Surf Beach from sky-glow.

Several launches from SLC-4 over the past two years have been conducted at night. Although not likely, the proposed project does not have restrictions that would prevent all proposed 100 launches occurring at night. Reviewing available historical light pollution satellite data (NASA 2024b; c), photos of Falcon-9 flare during a night launch, and video footage from night launches of rocket vehicles demonstrate the potential magnitude of acute lighting levels generated from associated rocket flare. Following this review, we anticipate that the proposed project has the potential to increase western snowy plover exposure to artificial light pollution in the vicinity of SLC-4 for any launches occurring at night

The VIIRS dataset demonstrates a substantial increase in the lighting levels in the vicinity surrounding SLC-4 occurred between 2017 and 2023 (NASA 2024b; c), potentially as a result of the large increase in past night operations to support 28 launches in 2023. Existing lighting infrastructure at SLC-4 did not eliminate novel associated light pollution. SLC-4 is located 0.8 mile from adjacent western snowy plover habitat in South Surf Beach. Although refined specific light monitoring information is needed, the VIIRS data indicates that SLC-4 operational lighting may already be routinely illuminating adjacent habitat, including nearby beaches, at low levels. In addition, each night launch has the potential to generate short term (approximately 1 to 3 minutes depending on if a terrestrial boost-back is involved) higher levels of artificial night lighting as a result of associated rocket flare. Although there is clear potential for project associated lighting to increase, without specific light-monitoring information, we are currently unable to anticipate specific lighting levels to help us reasonably predict the magnitude of potential effects from the proposed project. Reviewing the best information currently available, the proposed project has the potential to increase the number of days that western snowy plover breeding and overwintering habitat on Surf Beach could be illuminated by low levels of site lighting and higher levels of acute rocket flare as a result of associated sky-glow.

Routine increases in project-related lighting on Surf Beach are expected to result in degradation of the habitat and disrupt roosting behaviors and potentially cause displacement of individuals. Previous research has demonstrated that significant declines were found in the likelihood of plovers roosting in locations where exposure to artificial night lighting exceeded routine

illuminance levels as low as approximately one half a full moon (threshold of 50 millilux irradiance for effect, with 50 percent of their peak probability of presence above 100 millilux) (Simons et al. 2021, p. 5). The study suggests that the disruption of behaviors related to roosting associated with elevated levels of artificial night lighting are likely a result of perceived increased predation risk in illuminated coastal areas. This is consistent with existing research on related shorebird nocturnal behavior, where data suggests that species use darkness as a refuge to help avoid detection from nocturnal predators (Mouritsen 1992, entire). The area most likely to be exposed to increased project-related lighting would be South Surf Beach, although the existing data indicates that the entirety of Surf Beach may be affected (NASA 2024b; c). Surf Beach is an important overwintering location for the western snowy plover, supporting 146 roosting plovers in 2024 (refer to Table 21, Condition of Status of Species).

Following discussion of the available data with lighting experts, VIIRS data cannot alone be used to compare to identified lighting thresholds in existing literature as a result of differences in lighting unit (radiance). Additionally, VIIRS data alone should not be used to assess lighting trends, particularly within smaller sample areas (e.g. Surf Beach alone) due to issues of scale. Lighting specialists have recommended that site specific light monitoring would be needed to ground truth experienced light levels and duration within western snowy plover habitat to begin to adequately understand and assess effects to the species. Consequently, more information is needed to clearly predict the magnitude of potential impacts at this time. We expect increased lighting from the proposed project, launching and complex lighting, would affect roosting behavior and potentially displacement resulting in overall habitat degradation of Surf Beach.

Launch Noise and Overpressure

Noise and overpressure modeling has been updated for this consultation to reflect both disturbance magnitude and extent from actual launch data. The updated modeling indicates that the entire VSFB western snowy plover population (both breeding and overwintering) would fall within the Launch Noise Effect Area (Table 32 and Table 33). All of the VSFB western snowy plover population is also located within the Overpressure Effect Area (Appendix A, Figures 3M–N, and 4J–M). The majority of South Base, including all of Surf Beach, could experience instantaneous levels of up to 4 to 7 psf (139.6 to 144.5 dB) during terrestrial boost-back events.

Table 32. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at western snowy plover localities (SLD 30 2025, p. 150).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
South Surf Beach	122	130	130	115	111	118	119	111	123
Guadalupe Dunes	<100	<100	<100	<100	<100	<100	<100	<100	103
Jalama Beach	<100	<100	107	105	102	108	110	102	112

Table 33. Estimated maximum sonic boom levels (psf) and their equivalent estimated noise events (dB) from the boost-backs at western snowy plover localities (SLD 30 2025, p. 150).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
South Surf Beach	7–8	144.5–145.6	4	139.6	4	139.6
Guadalupe Dunes	1	127.6	<1	<127.6	<1	<127.6
Jalama Beach	2	133.6	3	137.1	3	137.1

Acoustic Harm

After conferring with avian hearing experts, we anticipate effects from repeated launch noise disturbance events between 110 to 130 dB SPL associated with 100 launch ascents and between 2 to 7 psf (133 to 145 dB) (SLD 30 2025, pp. 90–95) during 24 terrestrial boost-backs to result in hearing damage. In addition to this damage from short, high magnitude noise exposure, communication masking and disturbance could result in changes in species abundance and distribution (Dooling, R., pers. comm. 2024).

Repetitive launch noise disturbance events have the potential to damage western snowy plover hair cell receptors and result in hearing loss. Auditory damage across species can occur, even if low frequency noise is not thought to be readily perceptible (Kugler et al. 2014; Williams 2014). Available guidelines indicate that avian hearing damage can occur during single impulse (blast) levels of 140 dBA and multiple impulse noise source types (e.g. jackhammer, pile driver) levels of 125 dBA (Dooling and Popper 2007, p. 25). Noise sources used to generate this guidance are of low frequency, generally expected to be similar to rocket launches and landings.

Surf Beach has the highest likelihood for injury due to its proximity to SLC-4 (0.8 mile away). Approximately half of Surf Beach would be exposed to noise levels greater than 120 dB SPL during every launch ascent from SLC-4 (KBR 2025, p. 11) (Appendix A, Figure 2S). All of Surf Beach and Wall Beach would be exposed to sonic boom levels up to 4 psf (139.6 dB; estimated greater than 125 dBA) during landings (Appendix A, Figure 3M–N).

Existing research shows that birds exhibit some resistance to hearing damage, particularly as a result of their ability to regenerate auditory hair cells (Stone and Rubel 2000, p.1; Dooling et al. 2008, entire). However, the magnitude, duration, and frequency of noise disturbance events would likely play a role in the potential to induce routine hearing loss and can also vary by species. Data on the specific acoustic thresholds of the western snowy plover are not available. Consequently, we have reviewed available research conducted on other avian species as a surrogate. Previous research has demonstrated that when the Japanese quail (*Coturnix coturnix*) was exposed to a 1.5 kilohertz octave band noise at 116 dB SPL for four hours, individuals showed hearing loss of up to 50 dB SPL immediately following exposure, with hearing loss most severe at frequencies at and above 1 kilohertz and with considerable variation between subjects (Niemiec et al. 1994). This indicates that following exposure at these levels, quail would need normal noises to be 50 dB SPL louder to hear them. Quail and other avian species have the ability to regenerate auditory hair cells following acoustic trauma (Ryals and Rubel 1988; Dooling et al. 2008). Niemiec et al (1994) demonstrated that quail hearing improved and

recovered within 8 to 10 days following exposure. This is a longer period than is being considered during the proposed project (acute launch noise disturbance on average 3 to 4 days, or twice a week). Following repeat exposure, the amount of time it took for quail's hearing to recover increased. Although birds show recovery of sensitivity and hair cell receptors, the amount of hearing loss and recovery rates differ among avian species (Ryals et al. 1999; Beason 2004). Ryals et. al (1999) conducted a comparative study that tested different bird species (including quail and budgerigars (*Melopsittacus undulatus*) under similar noise exposure of 112 to 118 dB SPL for 12 hours). Quails showed significantly greater susceptibility to hearing loss and acoustic trauma with a permanent threshold shift of approximately 20 dB SPL as long as one year following exposure (Ryals et al. 1999, p. 74). In comparison, budgerigars showed much faster recovery, to within 10 dB SPL within three days. Existing literature also indicates that there is considerable variation among species in the amount of acoustic trauma and the time involved in hearing loss and recovery while explaining that these differences cannot be predicted from a species' appearance or behavior (Ryals et al. 1999; Dooling and Popper 2007, p. 26). Reviewing the available avian auditory damage estimated guidelines and available literature, the proposed project's noise levels can exceed estimates that could cause acoustic injury. However, the proposed project noise events would occur at shorter durations (up to one minute for each launch and approximately 17 seconds for any landings with an instantaneous sonic boom) compared to some studies. Due to the anticipated frequency of high-level disturbance and repetitive exposure, we anticipate some level of routine hearing damage in western snowy plovers. These effects may occur across a large portion of Surf Beach, which was most recently estimated to support approximately 105 breeding adults (191 nests) and 146 overwintering western snowy plovers in 2024 (refer to Table 21, Condition of Status of Species).

In the event that the proposed project's repetitive frequent launch noise events result in hearing loss, reasonable effects would include loss or disruption in communication cues, masking, increased vigilance or distraction leading to decreased foraging effort, and the decreased ability to detect predators. Collectively, these effects would likely result in decreased reproductive success and long-term survival across a large portion of the VSFB population. Additional studies would help us further assess the magnitude of anticipated effects to western snowy plovers.

Disturbance and Geographic Displacement

Independent from auditory harm, western snowy plovers may still be disturbed by the proposed project noise to the extent that population abundance and distribution across VSFB could be impacted. The Space Force recently updated their western snowy plover audiogram analyses using a different avian surrogate species (domesticated budgerigar) which suggests the western snowy plover may be perceiving launch noise disturbance to a greater extent than originally anticipated. This supports the documented minor behavioral reactions, such as startling and hunkering, observed during launch monitoring (SLD 30 2025, p. 152). Additionally, existing literature indicates perception of disturbance (including injury) cannot be predicted from a species' appearance or behavior alone (Ryals et al. 1999; Dooling and Popper 2007, p. 26), which we expect could be similarly applied in regards to perceived stress. Coordination with avian hearing experts indicates potential effects from routine noise disturbance may include masking of effects (R. Dooling, pers. comm., 2024).

The majority of the proposed project will have similar launch noise and sonic boom disturbance levels as most operations involve the same launch vehicle from the same location. The proposed project includes up to 100 launches and 24 terrestrial boost-backs of the Falcon 9 rocket. Seventy of those launches and 12 of those boost-backs would occur at SLC-4. Biologists monitored the June 18, 2022 Falcon 9 SARah-1 mission and reported a hunker response but no short-term differences in bird abundance before and after launch and boost-back (D. Robinette and Rice 2022, p. 1–2, 13). In 2024, video nest monitoring continued to demonstrate that western snowy plovers behaviorally respond to individual launch events to varying degrees. Across all 2024 launch events, 95 percent documented alert, 69 percent documented startle, 35 percent documented hunkering, and 5 percent documented a flush response off nests with similar rates of captured reactions to landing and sonic booms (SLD 30 2025, p. 157). Space Force data indicates that there were no significant short-term changes in incubation rates, overall plover abundance, or nest attendance before and after the launches and boost-back events. Overall nest abandonment rates were lower in 2024 compared to 2023 when a high abandonment rate was documented for the South Surf Beach section closest to SLC-4, which the Space Force indicates was likely attributed to many high surf and wind events during 2023. Additionally, both hatch rates and abandonment rates were similar among north and south VSFB beaches in 2024 (SLD 30 2025, p. 157). From 2019 to 2024, there have been five cases of egg failures found within areas that are exposed to launch and landing noise that may have been damaged on or around the date of the launch (SLD 30 2025, p. 157). Comparing egg failure rates with other plover management sites outside of the project impact area, egg failure rates at VSFB do not appear to be atypical at this time (Service, unpublished data, 2024). Continuing to document damaged eggs found in otherwise healthy nests will be important to determine whether their occurrence increases with increased launch cadence over time (Robinette et al. 2025, pp. 53–55). Damaged or failed eggs would lead to less recruitment and a lower population over time.

We expect western snowy plovers to perceive and behaviorally respond to the proposed project's launch noise and sonic boom disturbance. In the event launch noise disturbance of sufficient magnitude occurs frequently enough to disturb western snowy plover, we anticipate this would result in changes in species abundance and distribution across VSFB beaches. We expect this to be demonstrated by western snowy plovers continuing to move from southern beaches to northern beaches away from SLC-4 (SWCA 2025). This migration of the population could increase due to the increase in the number of launches (from 50 to 100).

Information indicates that the current launch cadence (up to 50 launches per year) has caused western snowy plovers to move from south beaches on VSFB to more northern beaches away from SLC-4 (SWCA 2025). The proposed project's disturbance frequency of 100 launches per year is expected to continue and potentially further displace western snowy plover populations away from the areas of highest noise as discussed above. Although we do not have an estimated survivorship of displaced western snowy plovers, this could result in injury or death to individuals as a result of increased intraspecific or interspecific competition, lack of familiarity with new locations of potential breeding, feeding, and sheltering habitats, and increased risk of predation. Each of these factors would reduce survivorship of displaced individuals in general. Although the overall population numbers on VSFB did not significantly change, the analysis suggests that western snowy plovers are selecting habitat farther from launch activities to reduce

their exposure to engine noise and overpressure (SWCA 2025, p. i, entire). Using the information included in SWCA (2025), we expect the proposed project to result in increased displacement from the increase in the number of launches.

In recent years, breeding adult western snowy plover numbers on southern VSFB beaches have shown a curvilinear trend, increasing from 2009 through 2017 and then decreasing 2018 through 2024. Adult numbers on northern VSFB beaches show the opposite trend with numbers increasing since 2017 as demonstrated in Figure 8A (Robinette et al. 2024, p. 30). However, SWCA (2025) did not detect changes in overall western snowy plover abundance and productivity from increased launch frequency through calendar year 2024 within beach segments across VSFB (covering approximately 13.8 miles of coastline). This analysis did not find significant relationships between snowy plover hatch or fledge rate with modeled launch noise (SWCA 2025, p. i, entire). We expect at some point the northern beaches could reach a carrying capacity for western snowy plover breeding where additional western snowy plovers will not successfully breed or be further displaced.

Referencing Figure 8B (Robinette et al. 2024), the Space Force, in support of western snowy plover recovery goals, worked to restore a portion of south beaches (Wall Beach) between 2013 and 2014. The Space Force originally hypothesized that breeding adult population increases on southern beaches observed starting in 2015 were likely a result of this restoration work. The Space Force suggested the trend of breeding adult plover movement starting in 2018 from south beaches to northern beaches may be driven by regrowth of vegetation within restoration sites on southern beaches, which reduces the amount of previously available nesting habitat (Robinette et al. 2024, p. 4). However, initial aerial review and subsequent GIS analysis of available vegetation data indicates that between approximately 2015 to 2024, vegetation cover in this area remained relatively consistent, did not demonstrate substantial regrowth over this period, and still constitutes suitable western snowy plover nesting habitat.(less than 15 percent cover; Service 2019b, unpublished review of GIS data, p. 4). The recent multivariate statistical analysis also indicates increased launch frequency is a likely cause of breeding adult plover movement starting in 2018 from south beaches to northern beaches (SWCA 2025, p. i, entire).

The first time that multiple SpaceX Falcon 9 operations from SLC-4 occurred during the western snowy plover breeding season was in 2018. Referencing the multivariable statistical analysis (SWCA 2025), along with discussions with subject matter experts feedback, routine launch disturbance during sensitive periods, such as breeding season, appears to likely be a contributing factor to observed trends of breeding adult displacement. Additional analysis conducted by the Service utilizing available data between 2020 and 2024 indicates a statistically significant continued declining trend in western snowy plover residency time during the breeding season within the southern beaches proximate to SLC-4 when compared with northern beaches, which largely remained constant. This provides additional support that the species is spending less time on breeding grounds at southern beaches and could negatively affect breeding success over time.

Effects of the Proposed Action on the California Least Tern

Construction and Demolition of SLC-6

The California least tern is not anticipated to be impacted by construction and demolition activities at SLC-6. California least tern nesting habitat is located over 11 miles from SLC-6 facility and is not anticipated to be impacted by construction and demolition activities.

Launch Noise and Overpressure

The known California least tern nesting location at Purisima Point is approximately 8 miles north of SLC-4 and approximately 11.3 miles north of SLC-6. The known roosting location at the Santa Ynez River lagoon is approximately 3.7 miles north of SLC-4 and approximately 7 miles north of SLC-6. Both locations are within the Launch Noise Effect Area (Appendix A, Figure 2S–U). Launch noise and boost-back landings would last less than 1 minute and static fire noise events would last less than 7 seconds. To convert sonic boom overpressure into instantaneous noise disturbance (dB; $L_{\max}$) for the proposed project, we utilized past monitoring results of Falcon 9 launches and boost-backs at SLC-4 for comparison which ranged from 128.6 to 135.9 $L_{\max}$ at the California least tern monitoring location at Purisima Point (Robinette and Rice 2019a, p. 14; Dan Robinette and Rice 2022, p. 13; D. Robinette and Rice 2022, p. 13).

California least terns at Purisima Point would experience noise levels of approximately 112 dB $L_{\max}$ during launch events, 102 dB $L_{\max}$ during static fire events, and less than 100 dB $L_{\max}$ during boost-back landings for Falcon 9 rockets at SLC-4. California least terns in this area would also experience sonic boom overpressures of approximately 3 psf during SLC-4 boost-back landings. California least terns at Purisima Point would experience noise levels of approximately 108 dB $L_{\max}$ during launch events, 105 dB $L_{\max}$ during static fire events, and 102 dB $L_{\max}$ and between 1 to 2 psf during boost-back landings for Falcon 9 rockets at SLC-6. Falcon Heavy rockets are expected to produce noise levels of approximately 113 dB $L_{\max}$ during launch events, 110 dB $L_{\max}$ during static fire events, and approximately 102 dB $L_{\max}$ and between 1 to 2 psf during boost-back landings for rockets at SLC-6.

California least terns at the Santa Ynez River would experience noise levels of approximately 118 dB $L_{\max}$ during launch events, 110 dB $L_{\max}$ during static fire events, and approximately 105 dB and between 4 to 5 psf during SLC-4 boost-back landings. California least terns at the Santa Ynez River would experience noise levels of approximately 112 dB $L_{\max}$ during launch events, 118 dB $L_{\max}$ during static fire events, and 108 dB $L_{\max}$ and approximately 2.5 psf during boost-back landings for Falcon 9 rockets at SLC-6. Falcon Heavy rockets are expected to produce noise levels of approximately 116 dB $L_{\max}$ during launch events, 112 dB $L_{\max}$ during static fire events, and approximately 106 dB $L_{\max}$ and approximately 2.5 psf during boost-back landings for rockets at SLC-6.

Table 34. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at California least tern localities (SLD 30 2025, p. 162).

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Purisima Point	102	<100	112	105	102	108	110	102	113
Santa Ynez River	110	105	118	118	108	112	112	106	116

Table 35. Estimated maximum Falcon sonic boom levels (psf) and their respective noise events (dB) during landings at California least tern localities (SLD 30 2025, p. 162).

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Landing	Noise Event	Landing	Noise Event	Landing	Noise Event
Purisima Point	3	137.1	1–2	127.6–133.6	1–2	127.6–133.6
Santa Ynez River	4–5	139.6–141.6	2.5	135.5	2.5	135.5

Up to 174 launch related disturbance events could occur annually. Even with two separate launch complexes, due to time requirements for refurbishing vehicle components, payload preparation, and site preparation, we anticipate only approximately 40 of the proposed 100 annual launches would overlap the period when California least terns are typically present at VSBF (April 15 through August 15). Although unlikely, there are no restrictions to prevent all boost-back landings and static test fires occurring while California least terns are present.

Although pre- and post-launch monitoring have reported variable responses to launch noise, California least terns have shown substantial launch related disturbance during the breeding season (typically April 15 to August 15). Two Delta II launches occurred in May and July of 1997 at SLC-2, located 0.4 mile east of Purisima Point, and subjected the California least tern breeding site to sound levels greater than 124 dB. Biologists observed abandonment of up to five nests and the death of a chick due to exposure (BioResources 1997, pp. 13, 21). These two Delta II launches reduced reproductive success of the 1997 breeding season (Service 2015c, p. 123). Additionally, Delta II launches from SLC-2 in 2002 and 2005, when California least terns were arriving at the colony, may have caused temporary or permanent emigration from the colony as attendance decreased following the launches (Robinette et al. 2003, p. 17; Robinette 2006, pp. 15, 19). For comparison, the Space Force characterized the sound profile for launch noise generated by this Delta II vehicle at SLC-2 at the Purisima Point nesting colony during the April 1999 launch. Sound reaching the recording site had an unweighted peak of 135.5 dB (SRS 1999). SLC-2 is significantly closer than SLC-4 and SLC-6 to the California least tern nesting colony and thus launches from SLC-4 and SLC-6 would have a reduced visual disturbance on the nesting colony. The 1997, 2002, and 2005 Delta II launches that resulted in nest abandonment and potentially temporary or permanent emigration from the colony, do have similar noise impacts as the sonic boom noise levels anticipated from the proposed action; however, the Delta launch noise that produced impacts occurred over a period of minutes while the proposed project's sonic boom would be instantaneous.

Due to the proposed number of launches and lack of restrictions on timing, we expect that launches during the California least tern arrival period will occur over the duration of this project. We are unable to determine how many launches or how often (in years) this may occur. As a result, we anticipate that individuals may emigrate from the colony temporarily or for that breeding season. However, we do not anticipate nest abandonment in large numbers multiple years in a row.

In contrast to the above launches, monitoring of non-breeding California least terns for the June 2007 Delta II launch and monitoring of nesting California least terns during the June 2008 and June 2011 Delta II launches did not document any mortality of adults, young, or eggs, or any abnormal behavior as a result of the launches (MSRS 2007, 2008, 2011). These launches also occurred at SLC-2 and assumed to have generated comparable noise levels to the Delta II sound profile discussed above. Additionally, on June 12, 2019, the SpaceX Falcon 9 boost-back created an estimated sonic boom overpressure of 2.66 psf which converts to an instantaneous noise disturbance of 135.9 L_{max} and 127.7 dB SEL at the California least tern monitoring location at Purisima Point. Biologists reported that incubating California least terns began flushing off their nests before they heard the sonic boom from the boost-back landing in the video and that it is possible the birds were reacting to boost-back noise not captured by the video or to something unrelated. All California least terns returned to their nests within minutes after the boost-back. They did find one California least tern egg damaged, and although they could not attribute the egg damage to a California least tern reacting to the sonic boom, they could not conclusively discount it either. Hatching rates were similar to those from previous years when no launches occurred. Biologists reported no difference in nest attendance or bird abundance before and after the launch and boost-back, and they concluded that this launch and boost-back did not significantly affect California least terns nesting on VSFB (Robinette and Rice 2019a, pp. 1, 14–15, b, pp. 1, 14–15).

Biologists monitored California least terns for the June 18, 2022 Falcon 9 SARah-1 mission with boost-back and first stage recovery at SLC-4 that created an estimated sonic boom overpressure of 1.1 psf which converts to an instantaneous noise disturbance of 128.6 dB at the California least tern monitoring location at Purisima Point (Dan Robinette and Rice 2022, p. 13; D. Robinette and Rice 2022, p. 13). They noted that incubating California least terns reacted to both the launch and sonic boom produced by the return flight of the first-stage with more intense reactions to the sonic boom (Dan Robinette and Rice 2022, p. 1; D. Robinette and Rice 2022, p. 1). They observed a response to the launch and sonic boom for all five California least tern nests with cameras in which reactions ranged from alert with minor head movements to a startle effect (i.e., calm before the sonic boom with a jolt and quick head movements when the sonic boom hit). One incubating adult displayed a startle effect and lifted both wings slightly as the boom sounded; however, all California least terns remained on their nests for both the launch and sonic boom (Dan Robinette and Rice 2022, p. 9; D. Robinette and Rice 2022, p. 9). However, 38 non-incubating California least terns flushed in the background of cameras in response to the launch and sonic boom disturbances (Dan Robinette and Rice 2022, p. 10; D. Robinette and Rice 2022, p. 10). Biologists reported no difference in nest attendance or bird abundance before and after launch and boost-back, and they concluded that this launch and boost-back did not significantly

affect California least tern nesting on VSFB (Dan Robinette and Rice 2022, p. 1–2, 13; D. Robinette and Rice 2022, p. 1–2, 13).

These past monitoring results suggest that the California least tern response to noise is related to timing within the nesting cycle and that launch operations that occur during the breeding season, particularly the early courtship season, may disturb nesting. At the beginning of the nesting season when California least terns are arriving at the breeding colony, noise occurrences seem to disturb adults more easily, but once courtship and nest-tending begins, the adults are more tenacious (MSRS 2021b, p. 52). Additionally, studies show that a closely related species, the crested tern (*Sterna bergii*), began to exhibit startle responses at approximately 85 dBA of aircraft noise when exposed for 30 seconds to 35 seconds (Brown 1990, pp. 587–588). Considering this and past monitoring reports, we expect the nesting colony at Purisima Point and the foraging California least terns at the Santa Ynez River lagoon may startle if projected noise levels occur. We expect the proposed action could result in short-term effects including interruption of courtship or breeding activities, flushing from nests, interruptions in foraging, and behavioral reactions, such as head raising, body shifting, moving short distances, and flapping of wings. Startle responses during nesting may result in nest abandonment or dislodging of eggs from nest scrapes; adults may leave chicks unattended and vulnerable to elements or predation. We do not expect abandoned eggs and chicks to survive if adults do not return to the nest. Non-observable physiological responses of California least terns to noise disturbance may include an increased heart rate or altering of metabolism and hormone balance. These responses may cause energy expenditure, reduced feeding, habitat avoidance, reproductive losses, and bodily injury resulting in increased vulnerability to predation (Radle 2007, p. 5).

Although we need more information on specific noise level and frequency thresholds that may impact California least terns at various stages during the breeding season, we anticipate the proposed project's noise disturbance to be of short duration (1 minute during launches and boost-backs and less than 7 seconds during static test fire events). Additionally, noise and overpressure modeling do not account for topography and consequently projected noise and overpressure levels are likely an overestimate as topographic features can attenuate noise (MSRS 2021b, p. 51, MSRS 2022a, p. 8). Noise estimates for SLC-4 activities are based off recordings from past launches and landings and are expected to be precise for future operations. However, estimates for SLC-6 activities will need to be compared to recordings from future launches including Falcon Heavy (CLT-3). However, several factors can play a part in the overall stability of a nesting colony including past reproductive success, food availability, and the size of the colony (Robinette et al. 2003, pp. 25–26). California least terns are more likely to return to a colony that experienced good reproductive success in the past and that had an adequate food source, and larger colonies tend to be more stable than smaller colonies (Robinette et al. 2003, pp. 25–26). Thus, even though later in the nesting season adults may exhibit more tenacity, there are other factors that could contribute to instability within the colony and noise from the existing project may contribute to a colony's stability.

Considering the increase in launch cadence, the proposed project has the potential to contribute to long-term adverse effects that result from routine intermittent acute noise disturbance. The proposed project would contribute to the disturbance frequency of the existing launch noise

disturbance baseline. Falcon 9 launch rates at VSFB have drastically increased over the past few years – from 3 in 2021, 13 in 2022, 30 in 2023, and 52 in 2024.

The proposed project's disturbance frequency has the potential to displace California least tern populations, potentially stimulating migration away from noisy areas. Although we do not have an estimated survivorship of displaced California least terns, this could result in injury or death to individuals as a result of increased intraspecific competition, lack of familiarity with new locations of potential breeding, feeding, and sheltering habitats, and increased risk of predation. All of which reduces survivorship of displaced wildlife in general.

Due to the location of the SLC-4 and SLC-6 facility in relation to the subject California least tern habitat at Purisima Point and the Santa Ynez River lagoon, California least terns may experience visual disturbance from launch operations. We expect effects would not be greater than the noise disturbance effects occurring simultaneously as described above.

With current information, we cannot adequately determine the anticipated impacts of the proposed project annually on the California least tern population at Purisima Point and the Santa Ynez River lagoon. Until the novel effects of the project activity including the launch cadence are studied, we are unable to anticipate the specific response of individuals or population level effects at this time.

Off VSFB Effects

We expect California least terns at off VSFB locations to be subjected to the same effects described above but to a significantly lower magnitude.

Effects on Recovery

Southern Sea Otter

The effects from the proposed project are expected to be temporary and to not effect recovery of the species at this time. We expect that southern sea otters will continue to occupy the same areas and successfully breed. Additionally, the monitoring proposed by the Space Force will detect any changes to the species and population should they occur.

California Red-legged Frog

The Service anticipates that project operations will result in breeding habitat degradation from frequent launch disturbance events across the vicinity of VSFB and most likely within features including Bear Creek, Honda Creek, San Antonio Creek, and Jalama Creek. Although we expect potential effects from the increased frequency of launch disturbance may occur, we are unable to anticipate the exact magnitude of potential effects at this time with the available information until further monitoring information is available. Although the function of VSFB major riparian features including Honda Creek, Bear Creek, and the Santa Ynez River is not specified within the recovery plan, the recovery plan states the goal of protecting existing California red-legged

frog populations within Core Area 24 (Service 2002a, p. 75). We expect that the proposed project will not hinder the ability of the species to meet recovery criteria within Core Area 24, within the northern Transverse Ranges and Tehachapi Mountains Recovery Unit, or rangewide.

Western Snowy Plover

The Service anticipates that project operations (routine high magnitude noise disturbance and increased lighting across the full year) are anticipated to cause habitat degradation across occupied western snowy plover breeding and overwintering habitat, with the highest levels of anticipated degradation across Surf Beach. The Space Force conducted a multivariate statistical analysis and has indicated that launch noise is likely causing a portion of breeding adults to move (displacement) from southern beaches to northern beaches over time (SWCA 2025, p. i; entire) but has not reduced the overall population on base. We anticipate that the northern beaches could reach an unknown breeding carrying capacity at some time in the future. Currently, we expect that short-term adverse effects will include routine behavioral stress reactions to breeding and overwintering western snowy plovers. Non-observable physiological responses of western snowy plover to noise disturbance may include an increased heart rate or altering of metabolism and hormone balance. These responses may cause energy expenditure, reduced feeding, and habitat avoidance or displacement across a single season or over time that results in increased vulnerability to predation (Radle 2007, p. 5). Although we expect potential effects from the further increased frequency of launch disturbance to occur, we are unable to anticipate the exact magnitude of potential effects at this time with the available information until further monitoring information is available. The Space Force has removed a prior commitment to conservation actions to ensure no net loss if a population decline is detected (Service 2023a, 2024a). However, we expect that the proposed project will not adversely affect the ability of the species to meet recovery criteria.

California Least Tern

The Service anticipates that project operations may result in habitat degradation across occupied California least tern habitat at Purisima Point and the Santa Ynez River lagoon. Although potential long-term effects of increased launch noise disturbance frequency may occur, we are unable to anticipate the magnitude of potential effects at this time with the available information. We do not currently anticipate that the proposed project would interfere with the recovery goals provided in the 1985 recovery plan for the species (Service 1985, entire). We expect that the proposed project will not adversely affect the ability of the species to meet recovery criteria.

Summary of Effects

Southern Sea Otter

In summary, we expect adverse effects to southern sea otters to occur due to the proposed action from project operational lighting, noise, and overpressure disturbance from routine launching and landings. We anticipate southern sea otters would move to other areas, have alert reactions, and diving in response to disturbance.

California Red-legged Frog

In summary, we expect adverse effects to California red-legged frogs to occur due to the proposed action. Project operational lighting, vibration, noise, and overpressure disturbance from routine launching and landings would degrade California red-legged frog habitat across VSFB. The proposed project has the potential to induce auditory harm, as well as physiological and behavioral responses in California red-legged frogs present in the action area. We cannot adequately determine the magnitude of effects to California red-legged frogs located across VSFB until the novel effects of the project activity are studied.

Western Snowy Plover

In summary, we expect adverse effects to western snowy plovers to occur due to the proposed action. Project operational lighting, noise, and overpressure disturbance from routine launching and landings would degrade occupied western snowy plover habitat across VSFB with the highest effects expected across Surf Beach. The proposed project has the potential to induce auditory harm as well as behavioral and physiological responses in western snowy plovers present in the action area including western snowy plovers continuing to move away from beaches closest to launch complexes. The Service cannot adequately determine the magnitude of effects to western snowy plover populations located across VSFB beaches until the novel effects of the project activity are studied.

California Least Tern

In summary, we expect adverse effects to California least terns to occur due to the proposed action. Project noise and overpressure disturbance from routine launching and landings could degrade California least tern habitat at Purisima Point and the Santa Ynez River. The proposed project has the potential to induce behavioral responses that could affect breeding. The Service cannot adequately determine the magnitude of effects to California least terns at Purisima Point and the Santa Ynez River until the novel effects of the project activity, including launch cadence, are studied.

CUMULATIVE EFFECTS

Cumulative effects are “effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation” (50 CFR § 402.02). We do not consider future Federal actions that are unrelated to the proposed action in this section because they require separate consultation pursuant to section 7 of the ESA. We are unaware of any future State or private actions that are reasonably certain to occur in the action area.

CONCLUSION

The regulatory definition of “to jeopardize the continued existence of the species” focuses on assessing the effects of the proposed action on the reproduction, numbers, and distribution, and

their effect on the survival and recovery of the species being considered in the biological opinion. For that reason, we have used those aspects of the southern sea otter, California red-legged frog, western snowy plover, and California least tern as the basis to assess the overall effect of the proposed action on the species.

Our conclusions are contingent on the implementation of the project as described in this biological opinion. If the applicant fails to implement the project as described in this biological opinion, we will consider this conclusion invalid.

Southern Sea Otter

We do not expect the proposed action to affect the reproduction, numbers, distribution, or recovery of the southern sea otter due to the expected frequency and magnitude of the effects discussed.

Conclusion

After reviewing the current status of the southern sea otter, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the southern sea otter. We have reached this conclusion for the following reasons:

1. The project would have no effect on reproduction of the species.
2. The project would cause no decrease in the number of individuals.
3. The project would not reduce the species' distribution rangewide.
4. The project would not cause any effects that would preclude our ability to recover the species.

Any adverse effects are expected to be temporary.

California Red-legged Frog

Reproduction

The proposed project would not result in the physical loss of California red-legged frog breeding habitat. However, we expect the proposed project would routinely degrade the breeding habitat across the action area, particularly within features adjacent to SLC-4 and SLC-6 including Bear Creek, Honda Creek, and portions of the Santa Ynez River due to lighting, noise, overpressure, and potential for vibration associated with the proposed action's increase in launch operations. Although we anticipate some adverse effects to breeding and breeding behavior, we do not expect the proposed project to appreciably reduce California red-legged frog reproduction.

Numbers

We are unable to determine the exact number of California red-legged frogs that could occur in the action area that the proposed project may affect because existing survey data are insufficient to estimate population numbers, and the numbers of individuals in the action area likely vary from year to year. Proposed project activities could affect individual California red-legged frogs to the point of injury or death. Project operations may result in routine stress on California red-legged frogs in the action area, particularly within Honda Creek, Bear Creek, and portions of the Santa Ynez River. The proposed project may contribute to cumulative sublethal effects that cause decline over the longer term. The number of California red-legged frogs that the proposed activities may affect would likely constitute a moderate portion of the total VSFB population. However, we assume this number would be relatively small across the entirety of the species' range. We conclude that the proposed project could reduce the number of California red-legged frog locally on VSFB. Although there was no population baseline established prior to launching, we do not expect the proposed project to appreciably reduce the California red-legged frog population.

Distribution

The proposed project would routinely degrade occupied aquatic California red-legged frog habitat across the action area, particularly within Honda Creek, Bear Creek, and the Santa Ynez River due to lighting, noise, overpressure, potential vibration associated with the proposed action's operations. Consequently, in the event the proposed project results in reduced occupation of California red-legged frog within Honda Creek, Bear Creek, or the Santa Ynez River, this may constitute a large reduction in the overall distribution of the species across south base and across the VSFB population as a whole. We do not anticipate that any observed reduction would appreciably reduce the distribution across the northern Transverse Ranges and Tehachapi Mountains Recovery Units. We consequently conclude that the proposed project is not likely to appreciably reduce the distribution of the California red-legged frog.

Recovery

The proposed project would degrade occupied aquatic California red-legged frog habitat across the action area, particularly within Honda Creek, Bear Creek, and the Santa Ynez River due to lighting, noise, overpressure, potential vibration associated with the proposed action's operations. VSFB major riparian features, including Honda Creek, Bear Creek, and the Santa Ynez River are within California red-legged Core Area 24 (Service 2002a, p. 75). Although we expect potential effects from the increased frequency of launch disturbance may occur, we do not expect that the proposed project will hinder the ability of the species to meet recovery criteria within Core Area 24, within the northern Transverse Ranges and Tehachapi Mountains Recovery Unit, or rangewide.

Conclusion

After reviewing the current status of the California red-legged frog, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the California red-legged frog. We have reached this conclusion for the following reasons:

1. The project would have a moderate effect on reproduction of the species on VSFB but would not appreciably reduce reproduction of the species rangewide.
2. The project would cause a moderate decrease in the number of individuals on VSFB.
3. The project would not reduce the species' distribution rangewide.
4. The project would not cause any effects that would preclude our ability to recover the species.

Western Snowy Plover

Reproduction

The proposed project would not result in the physical removal of western snowy plover habitat. However, the Service anticipates that the proposed project would constitute routine degradation of breeding and overwintering habitat across the action area, particularly beaches on VSFB and especially Surf Beach. This degradation is expected due to lighting, noise, and overpressure associated with the proposed action's increase in launch and landing operations. We also expect the continued movement of western snowy plovers away from the southern beaches on VSFB to the north beaches. This movement could introduce intraspecific competition, including nest site selection and availability over time, potentially reducing breeding success should those beaches reach carrying capacity. Until the novel effects of the project activity are studied, the Service is unable to anticipate the specific response to western snowy plover breeding success, but we do not expect a significant decline in reproduction rangewide from the proposed project.

Numbers

Nearly 25 percent of western snowy plover in RU-5 and approximately 10 percent of the western snowy plover population rangewide occur on VSFB. In 2024, Surf Beach alone was estimated to support approximately 105 breeding adults (191 nests) and 146 overwintering western snowy plovers (refer to Table 3, Condition of Status of Species). Although western snowy plovers numbers have shifted between beaches, the overall numbers of plovers on VSFB have remained steady (SWCA 2025). We conclude that the proposed project is not expected to reduce the overall numbers of western snowy plovers on the base or within RU5. Thus, with current information we do not anticipate the proposed action will appreciably reduce the numbers of the western snowy plover.

Distribution

We expect the proposed project to continue to reduce the occupation of south Surf Beach. With the proposed project's increase in launch rate (100 launches with 70 from SLC-4), we anticipate the potential for a further reduction in occupation. This would constitute a decrease in the overall distribution of the species across south base and across the VSFB population. Although an analysis shows reduced numbers of western snowy plovers on beaches closest to SLC-4 and an increase in northern beaches farther away, the overall numbers of plovers on VSFB have remained steady (SWCA 2025). We conclude that the proposed project will reduce western snowy plover distribution across VSFB, but not within RU5. Thus, with current information we do not anticipate the proposed action will appreciably reduce the distribution of western snowy plovers.

Recovery

Due to both the numbers of western snowy plover and quantity of habitat supported, VSFB plays a critical role in the species' recovery (Service 2007). We anticipate that project operations would result in habitat degradation across occupied western snowy plover overwintering habitat on VSFB, with the highest levels of routine disturbance and degradation associated with Surf Beach adjacent to SLC-4. We anticipate that the proposed project operations (routine high magnitude noise disturbance and increased lighting across the full year) constitute habitat degradation across occupied western snowy plover breeding and overwintering habitat, with the highest levels of anticipated degradation associated across Surf Beach. The Space Force conducted a multivariate statistical analysis that indicates that launch noise is likely causing a portion of breeding adults to move (displacement) from southern beaches to northern beaches over time (SWCA 2025, p. i; entire). We anticipate that the northern beaches could reach an unknown breeding carrying capacity at some time in the future. This would reduce the amount of habitat available for breeding at VSFB and within RU5. Nonetheless, we do not currently anticipate that the proposed project would prohibit the overall recovery goals for the species provided in the 2007 recovery plan for the species (Service 2007, entire).

Conclusion

After reviewing the current status of the western snowy plover, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the western snowy plover. We have reached this conclusion for the following reasons:

1. The project would have a moderate effect on reproduction of the species but would not appreciably reduce reproduction of the species rangewide.
2. The project would cause a moderate decrease in the number of individuals.
3. The project would not reduce the species' distribution rangewide.
4. The project would not cause any effects that would preclude our ability to recover the species.

California Least Tern

Reproduction

Monitoring of nesting California least terns for past individual launches has reported variable responses to launch noise disturbances. Project operations create the potential for long-term effects that may result in overall habitat degradation across occupied California least tern breeding habitat at Purisima Point. Although potential long-term effects of increased launch noise disturbance frequency may occur, we are unable to anticipate the magnitude of potential effects at this time with the available information. Due to the proposed number of launches and lack of restrictions on timing, we expect that launches during the California least tern arrival period will occur over the duration of this project. We are unable to determine how many launches or how often (in years) this may occur. As a result, we anticipate that individuals may emigrate from the colony temporarily or for that breeding season. However, we do not anticipate nest abandonment in large numbers multiple years in a row. Therefore, we do not anticipate the proposed action will appreciably reduce the reproductive capacity of California least terns.

Numbers and Distribution

VSFB supports only a small percentage of California's breeding population of California least terns; however, the population on VSFB remains significant as it is one of only three breeding colonies between Monterey and Point Conception, and we expect the Space Force to continue managing and monitoring the VSFB colony (CLT-1). Monitoring of nesting California least terns for past individual launches have not reported notable differences in abundance or distribution. Although potential long-term effects of increased launch noise disturbance frequency may occur, the Service is unable to anticipate the magnitude of potential effects at this time with the available information. In the event the proposed project results in colony abandonment of California least terns at Purisima Point, this would constitute a reduction in the distribution of the species across the VSFB population. We expect this would be a temporary (one season) effect. Although the proposed project may temporarily reduce California least tern distribution in the action area and across VSFB, we do not expect the proposed action will appreciably reduce the overall numbers or distribution of the California least tern.

Recovery

Though recovery goals at VSFB have not been achieved, a minimum of 20 breeding pairs annually and 1.0 fledgling per breeding pair, the rangewide numbers of California least terns have exceeded recovery goals of 1.0 fledgling per breeding pair for an overall population increase. Additionally, though threats of predation and food availability exist, we consider VSFB a secure and managed site with increasing reproductive success and suitable and occupied habitat. We expect effects of the proposed action would not diminish these overall trends, and consequences of the proposed action would not appreciably interfere with recovery goals or overall recovery of the California least tern.

Conclusion

After reviewing the current status of the California least tern, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the California least tern. We have reached this conclusion for the following reasons:

1. The project would have a low effect on reproduction of the species, but would not appreciably reduce reproduction of the species rangewide.
2. The project would cause a low decrease in the number of individuals.
3. The project would not reduce the species' distribution rangewide.
4. The project would not cause any effects that would preclude our ability to recover the species.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened wildlife species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement and occurs as a result of the action as proposed.

AMOUNT OR EXTENT OF TAKE

Southern Sea Otter

The Service does not anticipate that the proposed action will incidentally take any southern sea otters. Although the Effects of the Action section above discusses that implementation of the proposed action has the potential to cause adverse effects to the species, that does not mean that the effects conform to the regulatory definition of take. The Service must provide a reasoned basis for a likelihood of take in order to anticipate and exempt it. No southern sea otter take is anticipated or exempted from the proposed action. Therefore, no reasonable and prudent measures and terms and conditions are provided below. If during southern sea otter annual population monitoring, the Space Force detects unanticipated declines in local populations over time that are otherwise unexplainable and support that take is occurring as a result of the proposed action, then the Space Force should immediately request reinitiation of formal consultation.

California Red-legged Frog

We anticipate that some California red-legged frogs will be taken as a result of the proposed action. We expect the incidental take to be in the form of capture, injury, harass, kill, and harm, which includes the associated degradation of suitable habitat resulting from increased frequency of launch disturbance. We cannot quantify the precise number of California red-legged frogs that may be taken as a result of the actions that Space Force has proposed because California red-legged frogs move over time; for example, animals may have entered or departed the action area since the time of pre-construction surveys. The protective measures proposed by Space Force are likely to prevent direct mortality or injury of most individuals during demolition and construction at SLC-6. In addition, finding a dead or injured California red-legged frog is unlikely. Consequently, we are unable to reasonably anticipate the actual number of California red-legged frogs that would be taken by the proposed project; however, we must provide a level at which formal consultation would have to be reinitiated. The Environmental Baseline and Effects Analysis sections of this biological opinion indicate that adverse effects to California red-legged frog may be moderate given the potential for moderate abundance of California red-legged frog in the vicinity of SLC-4 and SLC-6 (e.g. Honda Creek, Bear Creek, Santa Ynez River and Jalama Creek). We, therefore, anticipate that take of California red-legged frogs may also be moderate. We also recognize that for every California red-legged frog found dead or injured, other individuals may be killed or injured that are not detected, so when we determine an appropriate take level, we are anticipating that the actual take would be higher, and we set the number below that level.

Similarly, for estimating the number of California red-legged frogs that would be taken by capture, we cannot predict how many may be encountered. While the benefits of relocation (i.e., minimizing mortality) outweigh the risk of capture, we must provide a limit for take by capture at which consultation would be reinitiated because high rates of capture may indicate that some important information about the species in the action area was not apparent (e.g., it is much more abundant than thought). Conversely, because capture can be highly variable, depending upon the species and the timing of the activity, we do not anticipate a number so low that reinitiation would be triggered before the effects of the activity were greater than what we determined in the Effects Analysis.

The Space Force must contact our office immediately to reinitiate formal consultation if they observe the following:

- i. California red-legged frog monitoring data indicates a 20 percent decrease for any 3 consecutive years from the established baseline, unless the cause of decline can conclusively be attributed to a catastrophic natural event such as extreme drought in the area or wildfire; or
- ii. Three adult or juvenile California red-legged frogs are found dead or wounded per year or 10 total for the life of the proposed project; or
- iii. Ten individual California red-legged frogs are captured for the duration of the consultation.

Western Snowy Plover

We anticipate that some western snowy plovers will be taken as a result of the proposed action. We expect the incidental take to be in the form of injury, harass, harm, and kill. We expect the incidental take to be in the form of injury if project operations disturb the species to a degree that results in changes to behavior patterns including breeding, sheltering, and feeding; physiological responses that result in bodily injury. We expect monitoring methods as proposed by the Space Force will be sufficient to track effects to and take of western snowy plover.

We cannot quantify the precise number of individuals that may be taken due to fluctuations in population. However, we do not anticipate a number so low that reinitiation would be triggered before the effects of the activity were greater than what we determined in the Effects Analysis.

The Space Force must contact our office immediately to reinitiate formal consultation if they observe the following:

- i. Western snowy plover monitoring data indicates a 20 percent reduction in breeding population or nests for any three consecutive years at Surf Beach (North and South combined), unless those years demonstrate similar documented population declines across the species range (e.g., El Niño/La Niña, avian flu, etc.); or
- ii. Western snowy plover monitoring data indicates a 20 percent reduction for any three consecutive years basewide, unless those years demonstrate similar documented population declines across the species range (e.g., El Niño/La Niña, avian flu, etc.).

We expect that any mortality from increased predation, intraspecific competition, or startling (eggs) will be observed through the monitoring data and reflected in a declining population trend over time.

California Least Tern

We anticipate that all California least terns present in the action area will be taken as a result of the proposed action. We expect the incidental take to be in the form of injury or kill if launch or sonic boom noise and/or overpressure disturb nesting to the degree of causing nest or chick abandonment, damage to eggs, or physiological responses that result in bodily injury; or harm from the potential degradation of suitable habitat resulting from increased frequency of noise disturbance associated with routine launch activities. We cannot quantify the precise number of individuals that may be taken due to fluctuations in population and unspecified timing of the proposed launching, static test fires, and landings. We expect monitoring methods as proposed by the Space Force will be sufficient to track effects to and take of California least terns.

The Space Force must contact our office immediately to reinitiate formal consultation if they observe any of the following:

- i. California least tern monitoring data indicates that the species' nesting establishment exhibits 20 percent fewer nests for three consecutive years at the Purisima Point colony, unless those years demonstrate similar documented population declines across the species range (e.g., El Niño/La Niña, avian flu, etc.); or
- ii. Four California least terns of any life stage in a breeding season (egg, chick, or adult) are found injured or killed, not conclusively attributed to other mortality causes such as predation. This includes eggs and chicks in an abandoned nest defined by the attending adults present before a launch do not return to the nest for more than eight hours after the launch.

REASONABLE AND PRUDENT MEASURES

The measures described below are non-discretionary and must be undertaken by the Space Force or made binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Space Force has a continuing duty to regulate the activity covered by this incidental take statement. If the Space Force (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Space Force must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of the incidental take of California red-legged frog, western snowy plover, and California least tern:

1. The Space Force must reduce potential for injury or mortality from lighting to California red-legged frogs and western snowy plovers.
2. The Space Force must adequately monitor effects and take from full project implementation to ensure they are consistent with this analysis.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the ESA, the Space Force must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline reporting and monitoring requirements. These terms and conditions are non-discretionary.

The following term and condition implements reasonable and prudent measure 1:

Lighting plans (Avoidance and Minimization Measure GM-2) for SLC-4 and SLC-6 must reduce the potential for artificial lighting on the landscape with the intention to reduce scatter into natural, undeveloped areas to the maximum degree possible incorporating the recommendations provided to the Applicant by IMEG Corporation (Whitsitt-Odell, pers. comm., 2025).

The following terms and conditions implement reasonable and prudent measure 2:

- 2a. To adequately monitor potential effects from the proposed project, the Space Force must ensure the monitoring included in the Description of the Proposed Action (Avoidance and Minimization Measures WSP-3, CLT-2, CRLF-15, and CRLF-16) continues for 5 years following full execution of the proposed action (i.e., completion of construction of SLC-6 and implementation of increased launch program at SLC-4 and SLC-6). Following these five years, the Space Force, developed in coordination with the Service, must implement a monitoring plan to continue detecting and tracking take of listed species from the proposed project.
- 2b. The Space Force must monitor vibrations from three Falcon Heavy launches and boostbacks to determine magnitude, frequency, and distance. Results of the monitoring must be presented in units for understanding ecological effects of vibration on California red-legged frog.

REPORTING REQUIREMENTS

Pursuant to 50 CFR 402.14(i)(3), the Space Force must report the progress of the action and its impact on the species to the Service as specified in this incidental take statement.

The Space Force must submit a final report within 90 days following completion of the proposed construction of SLC-6 project and provide an annual report by February 15 for each fiscal year (October through September) that activities are conducted pursuant to this biological opinion to the Service's Ventura Fish and Wildlife Office via electronic mail. The reports must describe all activities that were conducted under this biological opinion, including activities and conservation measures that were described in the proposed action and required under the terms and conditions, and discuss any problems that were encountered in implementing conservation measures or terms and conditions and any other pertinent information. The report(s) must also include the following information:

1. Documentation of any impacts of the proposed activities on southern sea otters, California red-legged frog, western snowy plover and California least tern; results of biological surveys and observation records; documentation of the number of individuals of any life stage of California red-legged frog, western snowy plover and California least tern injured or killed; the date, time, and location of any form of take; approximate size and age of those individuals taken; and a description of relocation sites or rehabilitation outcomes for captured individuals.

2. Results from all monitoring described within this biological opinion.
3. The Space Force must submit federally listed species observations over the course of the project to the California Natural Diversity Database (CNDDDB).

The report should also include a discussion of any problems encountered implementing the terms and conditions and other protective measures, recommendations for modifying the terms and conditions to enhance the conservation of federally listed species, and any other pertinent information.

DISPOSITION OF DEAD OR INJURED SPECIMENS

As part of this incidental take statement and pursuant to 50 CFR 402.14(i)(1)(v), upon locating a dead or injured California red-legged frog, western snowy plover or California least tern, initial notification within 3 working days of its finding must be made by telephone and in writing to the Ventura Fish and Wildlife Office (805-644-1766). The report must include the date, time, location of the carcass, a photograph, cause of death or injury, if known, and any other pertinent information.

The Space Force must take care in handling injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible state. The Space Force must transport injured animals to a qualified veterinarian. Should any treated California red-legged frog, western snowy plover or California least tern survive, the Space Force must contact the Service regarding the final disposition of the animal(s).

The remains of a California red-legged frog, western snowy plover or California least tern, must be placed with educational or research institutions holding the appropriate State and Federal permits, such as the Santa Barbara Natural History Museum (Contact: Paul Collins, Santa Barbara Natural History Museum, Vertebrate Zoology Department, 2559 Puesta Del Sol, Santa Barbara, California 93460, (805) 682-4711, extension 321), Western Foundation of Vertebrate Zoology (Contact: Linnea S. Hall, Ph.D., Executive Director, Western Foundation of Vertebrate Zoology, 439 Calle San Pablo Camarillo, CA 93012, (805) 388-9944), or the Cheadle Center for Biodiversity and Ecological Restoration (CCBER) (CCBER, Herpetological Collection, University of California, Santa Barbara, Harder South, Building 578, MS-9615 Santa Barbara, CA 93106-9615).

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. The conservation recommendations below are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information and can be used by the Space Force to fulfill their 7(a)(1) obligations.

1. We recommend the Space Force support landscape-level efforts to further partnerships dedicated to protecting the military mission by preserving natural and working lands and improving the status of listed species, such as Sentinel Landscapes.
2. We recommend that the Space Force incorporate the Service's recommended Conservation Strategy shared February 2025 (York 2025). This, or a very similar strategy, will be important to provide the Space Force flexibility for the military's mission while supporting listed species conservation by improving habitat and increasing sensitive species populations off VSFB.
3. We recommend the Space Force develop and implement a program for a phased approach to increasing launch operations to align with the Department of Defense and Department of Interior's Conservation Policy Initiative. This program would develop and promote conservation and recovery initiatives while promoting increased flexibility for military mission activities.
4. We recommend that the Space Force expands and finishes the Oxbow Restoration project due to initial developments reporting restoration success (i.e., frogs occurring and calling on site) (Kaisersatt, pers. comm., 2025).
5. We recommend that the Space Force work with the Applicant to design the launch schedule such that launches, particularly launches with associated boost-backs involving terrestrial landing, occur to the maximum extent possible outside of sensitive breeding windows for listed species.
6. We recommend that the Space Force continue to coordinate with researchers familiar with study design involving short- and long-term ecological effects of chemical and sensory pollutants, especially sound and vibration, for the species present on VSFB. We also recommend that the Space Force implement a basewide monitoring strategy to address the potential for compounding impacts of collective launches across the base before additional private launch companies begin to operate.
7. We recommend that the Space Force continue to monitor and assess potential effects of project launch and associated boost-back activities on the adjacent western monarch butterfly overwintering site located in Spring Canyon and elsewhere in the near vicinity of SLC-4 and SLC-6. We recommend that monitoring of the on VSFB monarch butterfly populations be conducted in a manner sufficient to assess potential changes in habitat use patterns and population levels. We recommend that the Space Force implement measures outlined in Appendix B.
8. We recommend that the Space Force implement avoidance and minimization measures and the studies related to southwestern pond turtles as described in the terms and conditions of the 2024 SpaceX Biological and Conference Opinion (Service 2024a).

The Service requests notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed and proposed species or their habitats.

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the reinitiation request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the exemption issued pursuant to section 7(o)(2) may have lapsed and any further take could be a violation of section 4(d) or 9.

If you have any questions regarding this matter, please contact our Section 7 inbox by electronic mail at fw8venturasection7@fws.gov with the project title and reference number (2022-0013990-S7-001-R003) in the subject line.

Sincerely,

Catherine Darst
Field Supervisor

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- Griffith, J. 2020. Email from Jane Griffith, Griffith Wildlife Biology, to Chris Dellith, USFWS Biologist, regarding an update on National Fish and Wildlife Foundation least Bell's vireo surveys. Email sent June 30, 2020.
- Griffith, J. 2024. Email from Jane Griffith, Griffith Wildlife Biology, to Chris Dellith, USFWS Biologist, regarding results on 2023 Santa Maria National Fish and Wildlife Foundation least Bell's vireo surveys. Email sent January 23, 2024.
- Kaisersatt, S. 2022. Email from Samantha Kaisersatt, Chief, Environmental Conservation 30 CES VSFB, USSF to Sarah Termondt, USFWS Biologist, regarding soot.
- Kaisersatt, S. 2023. Email from Samantha Kaisersatt, Chief, Environmental Conservation 30 CES VSFB, USSF to Chris Diel, USFWS Assistant Field Supervisor, regarding clarification on SpaceX Reinitiation. Dated January 17, 2023.
- Kaisersatt, S. 2024b. Email from Samantha Kaisersatt, Chief, Environmental Conservation 30 CES VSFB, USSF to Chris Diel, USFWS Assistant Field Supervisor, regarding initial SpaceX response to additional information request attachment. Sent May 1, 2024.
- Kaisersatt, S. 2025. Email from Samantha Kaisersatt, Chief, Environmental Conservation 30 CES VSFB, USSF to Christopher Diel, USFWS Assistant Field Supervisor and Biologist, regarding California red-legged frogs at the San Antonio Creek oxbow restoration site.
- Lieske, Patrick, Forest Wildlife Biologist, US Forest Service, Solvang, CA. 2021. Electronic mail to Dou-Shuan Yang, Biologist, US Fish and Wildlife Service, Sacramento, California. Subject: California red-legged frog data – Matilija Creek Watershed, dated October 1, 2021.
- Seymoure, B. 2023. Email from Brett Seymoure, Assistant Professor of Biological Sciences, University of Texas at El Paso, to Sarah Termondt, USFWS Biologist, regarding UV Lighting.
- [SpaceX] Space Exploration Technologies Corporation. 2024. Communication during July 2, 2024. In person meeting held at VSFB with Microsoft Teams virtual component between USFWS Region 8 Office, USFWS Ventura Field Office, SpaceX, and USSF; including

Paul Souza (USFWS Regional Director), Kiko Dontchev (SpaceX) and Col. Mark Shumaker (USSF) regarding agreement to bridge consult for 14 launches from SLC-4 between October to December 31, 2024.

[SpaceX] Space Exploration Technologies Corporation. 2025. March 18, 2025, Microsoft Teams Meeting between Ventura USFWS, SpaceX, Mantech, and USSF 30 CES. Meeting notes with pers. comm. Brian Powell statement that 1 psf (127dB) was considered a low level, John Lebonite indicating it would not be perceptible outside following Service questions following review of dB conversions, OSHA safety standards, sonic boom complaint studies, and discussion with NASA and BYU presentation indicating human disturbance is likely at lower levels standing outside.

[USSF] U.S. Space Force. 2024b. Email response from Tiffany Whitsitt-Odell, Biologist 30 CES USSF to Sarah Termondt, USFWS Biologist, regarding questions with launch schedule. Email dated July 12, 2024.

Whitsitt-Odell, T. 2025. Email from Tiffany Whitsitt-Odell, Biologist 30 CES USSF, to Chris Diel, USFWS Assistant Field Supervisor and Biologist, regarding SLC6 lighting plan. Sent June 27, 2025.

York, D. 2024. Email from Darryl York (30 CES VSFB, USSF) to Sarah Termondt, USFWS Biologist, regarding clarifications on State Water VSFB use and maintenance period. Sent July 23, 2024.

York, D. 2025. Email from Darryl York (30 CES VSFB, USSF) to Cat Darst, USFWS Field Supervisor, regarding USFWS Proposed Conservation Strategy for VSFB 100 Launches. February 14, 2025.

APPENDIX A – Figures

Sound Level Comparison Chart

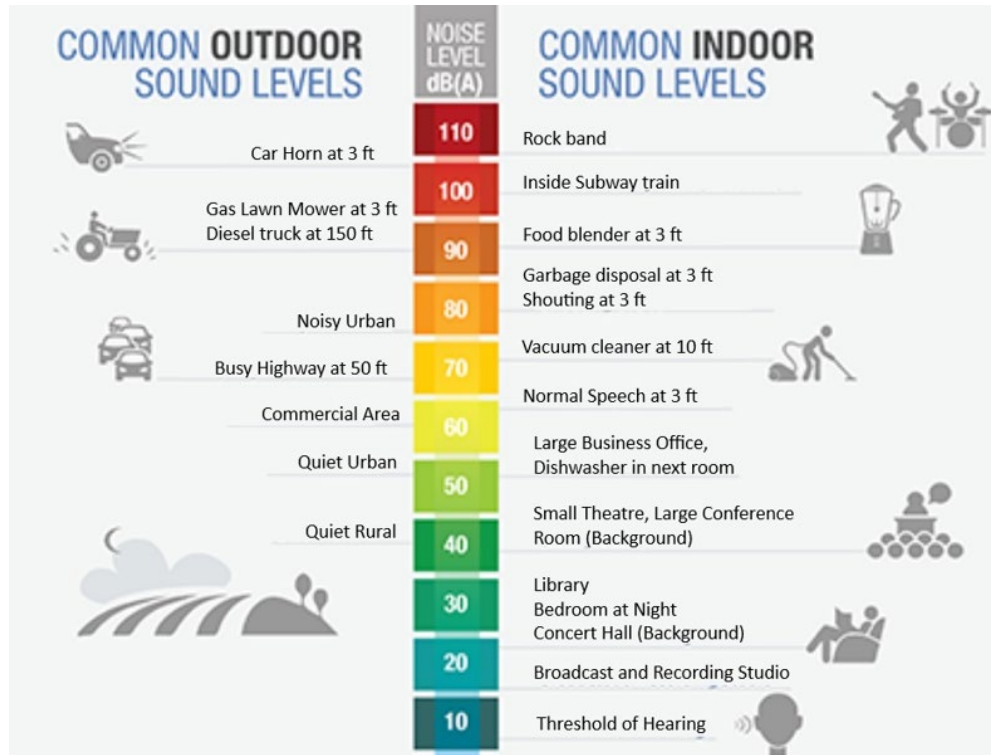


Figure 1A. Sound level comparison chart (FAA 2022).

Launch Noise Effect Area

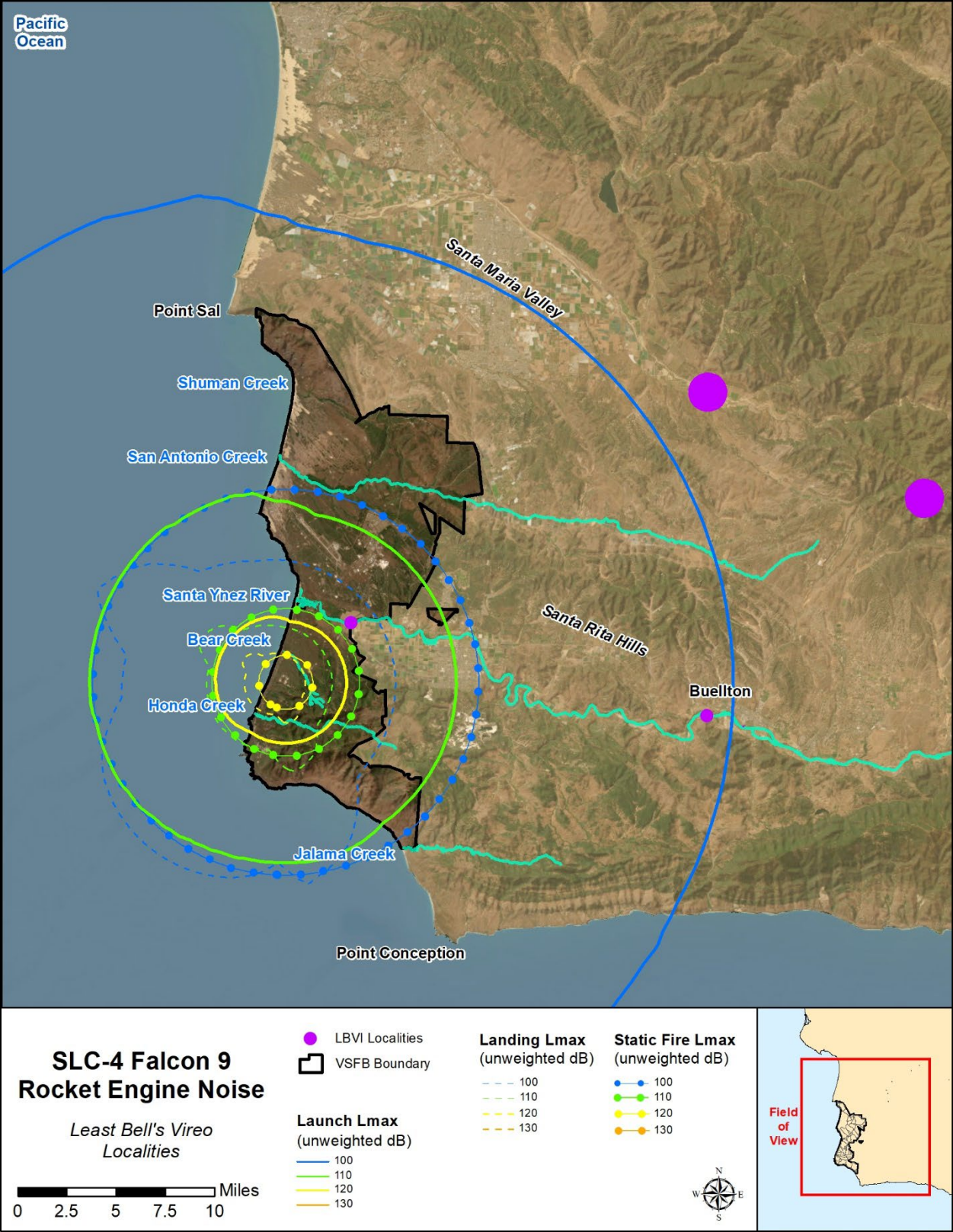


Figure 2A. Least Bell's vireo occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

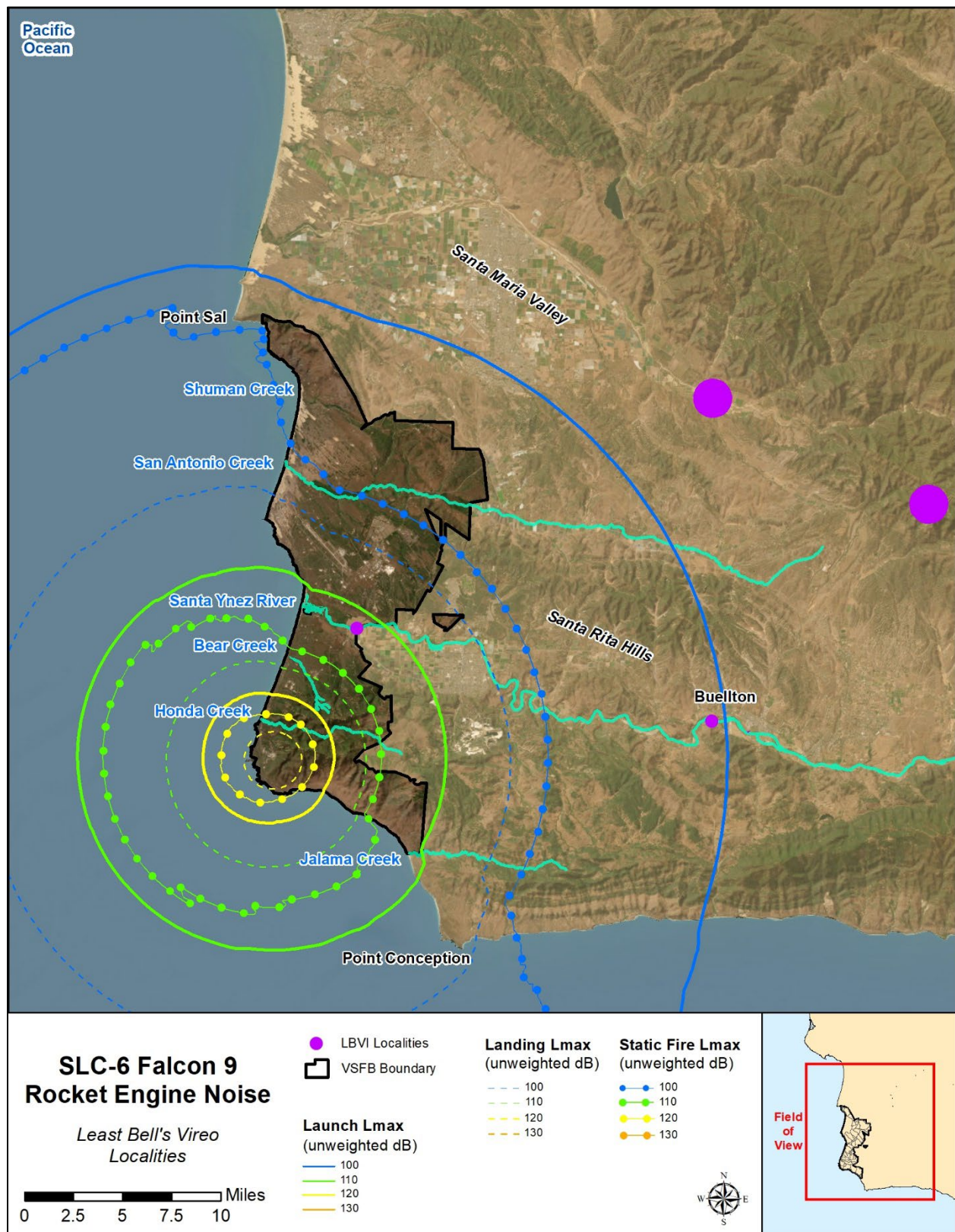


Figure 2B. Least Bell's vireo occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

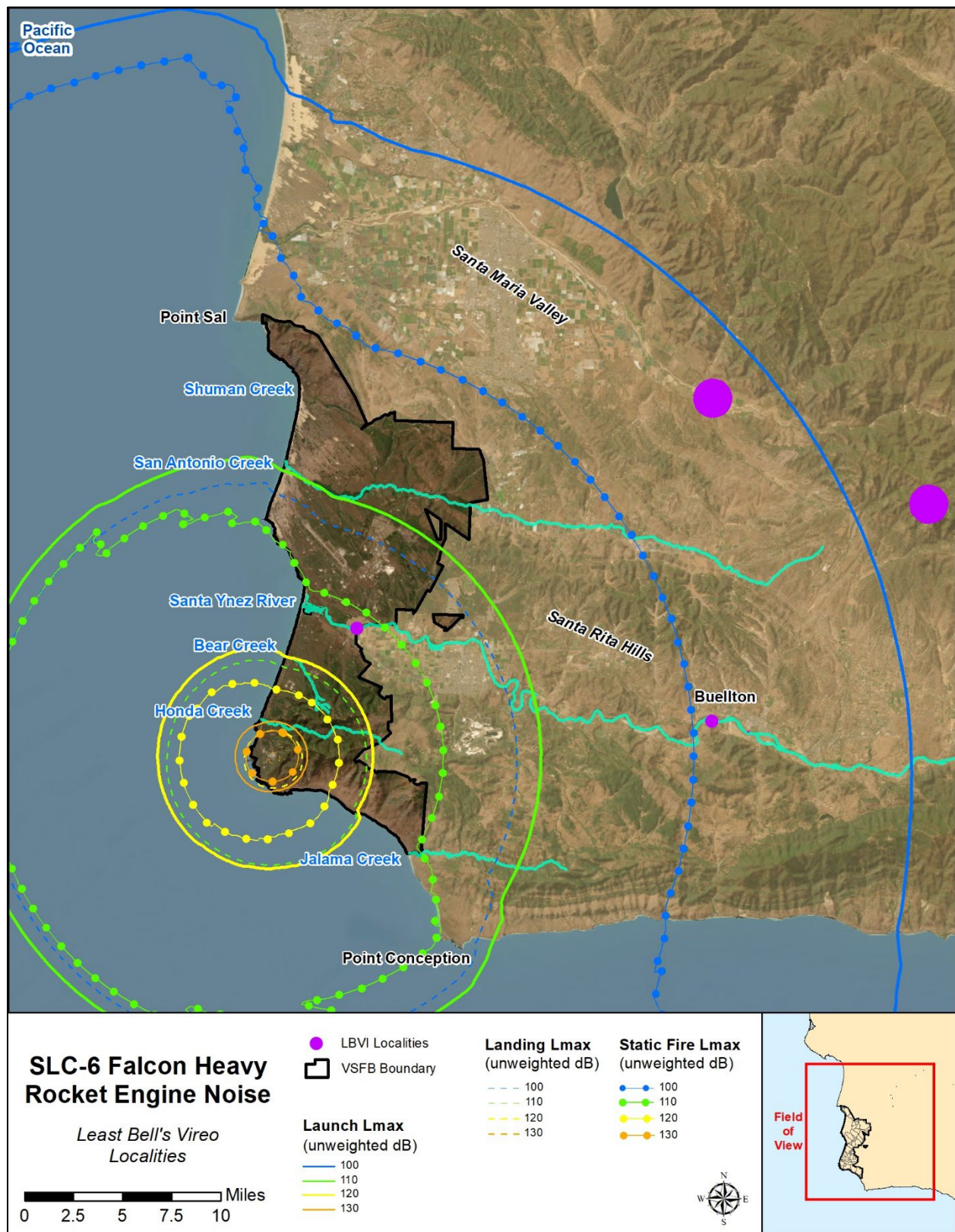


Figure 2C. Least Bell's vireo occurrences and SLC-6 Falcon Heavy rocket noise in the project Launch Noise Effect Area.

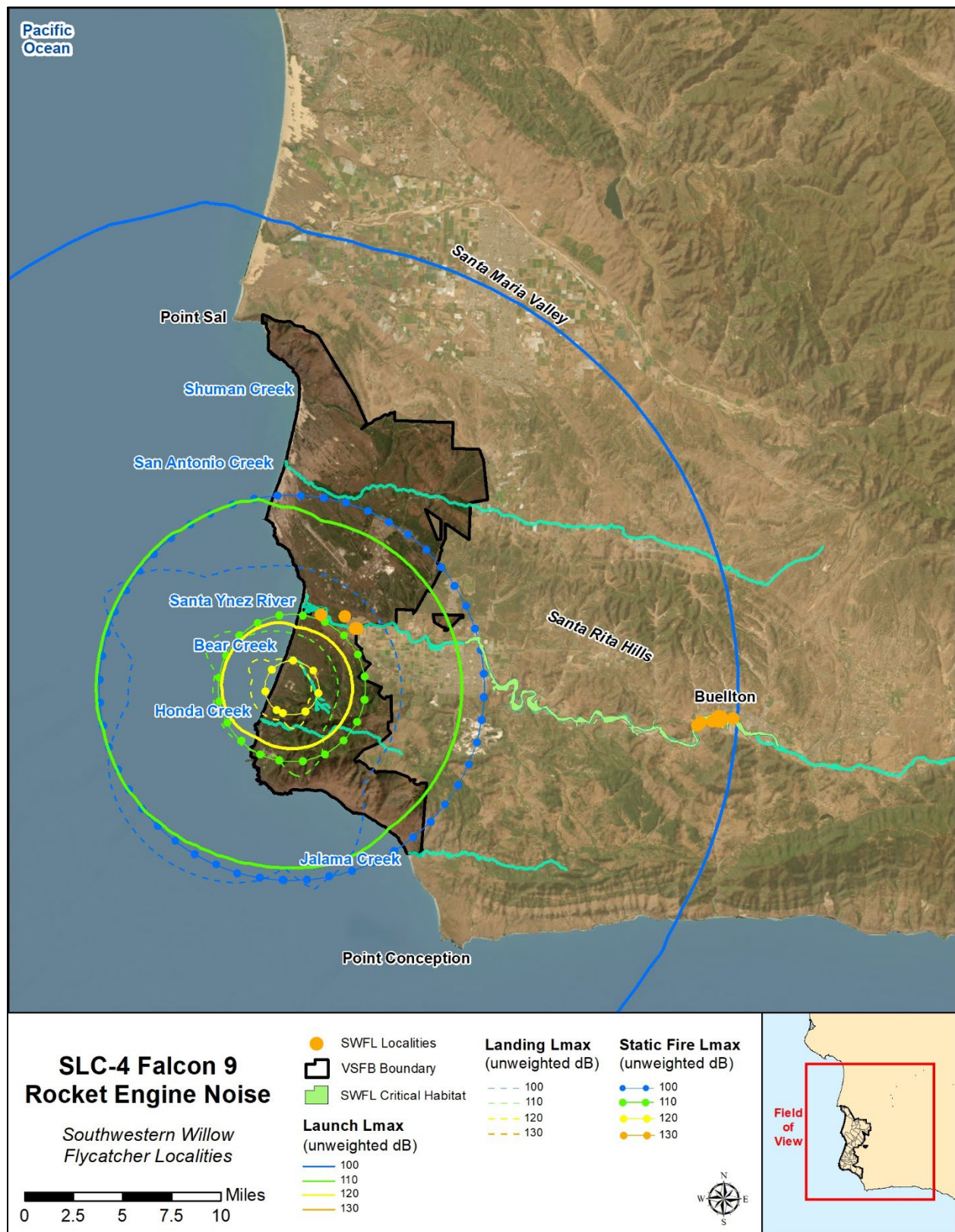


Figure 2D. Southwestern willow flycatcher occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

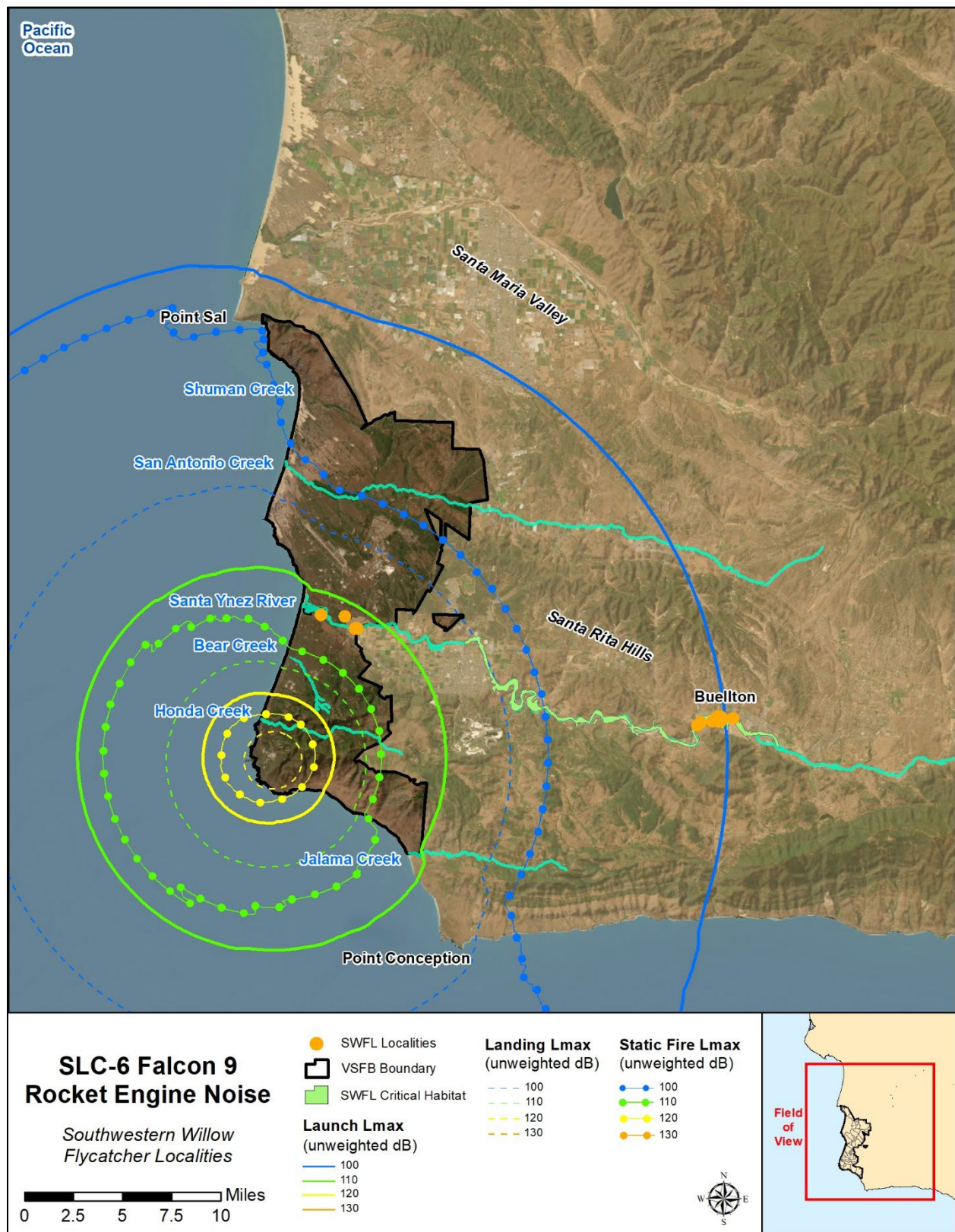


Figure 2E. Southwestern willow flycatcher occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

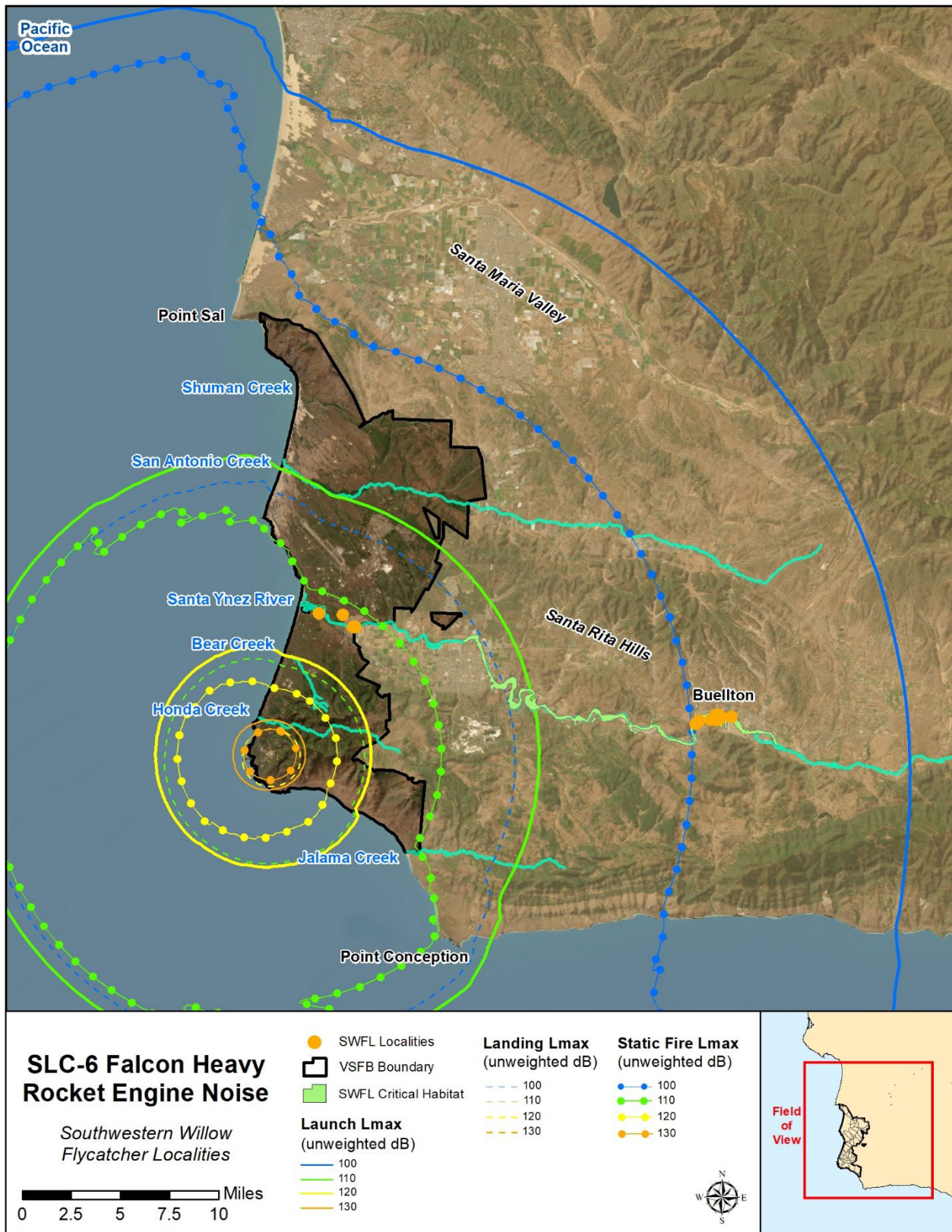


Figure 2F. Southwestern willow flycatcher occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

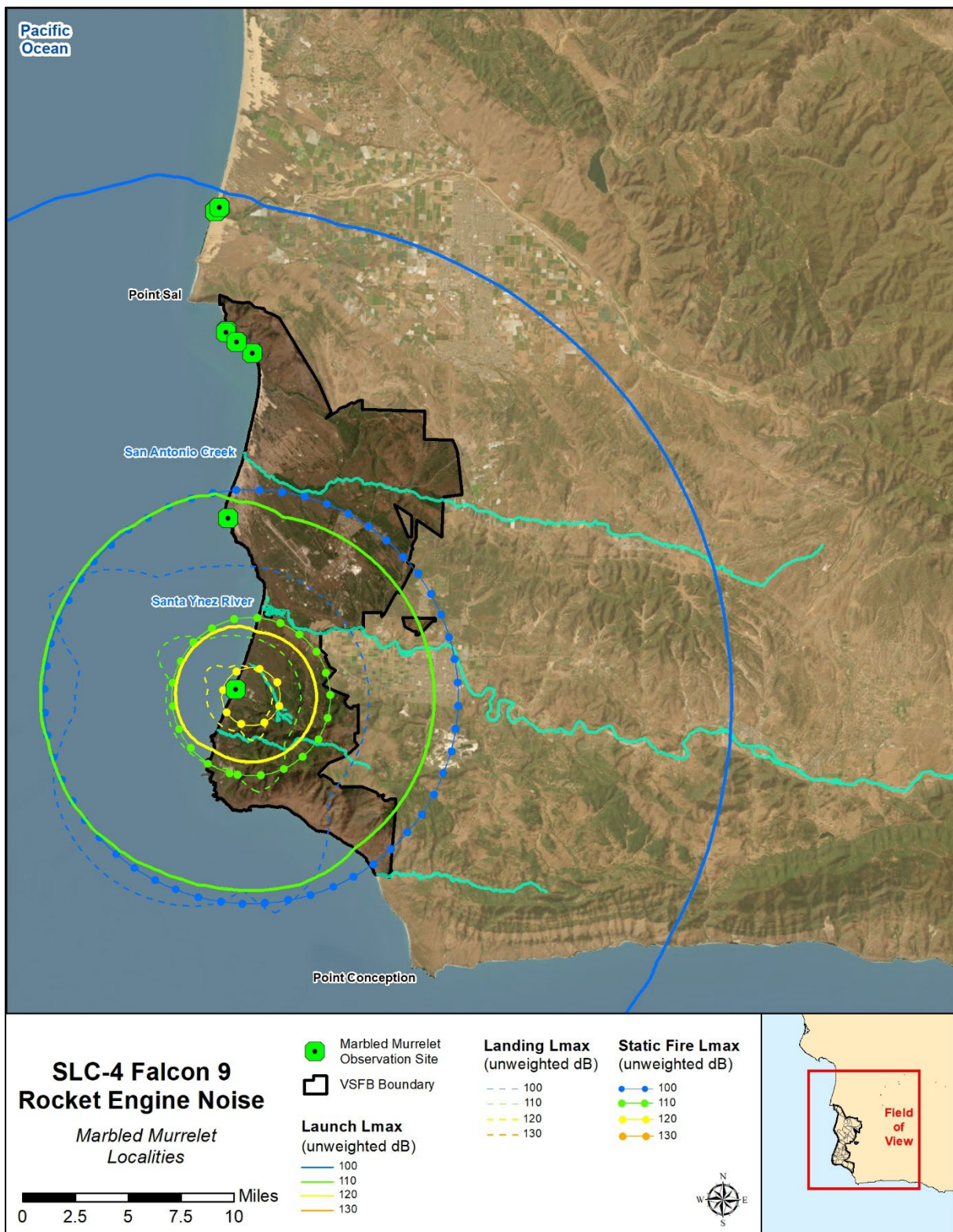


Figure 2G. Marbled murrelet occurrence observation sites and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

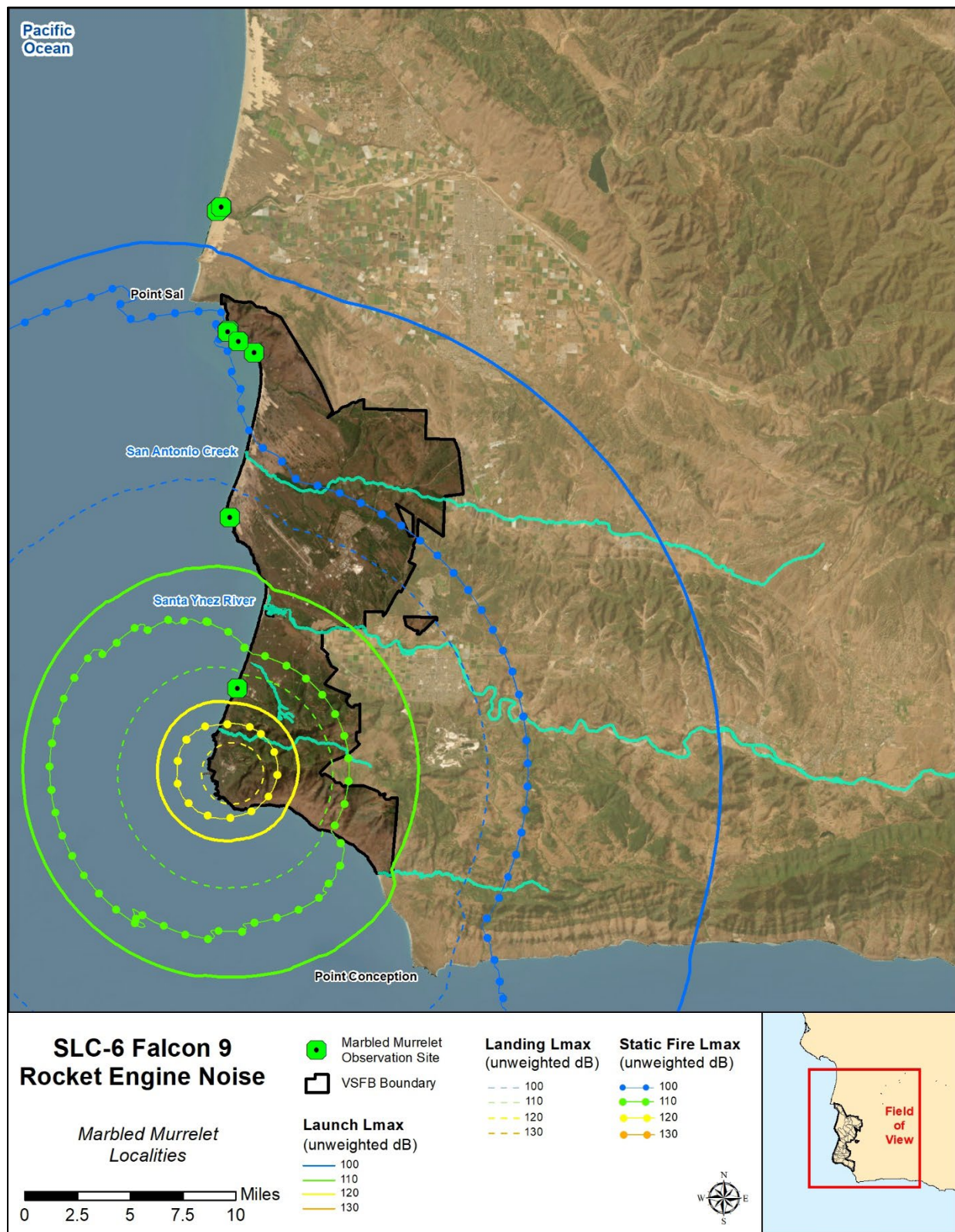


Figure 2H. Marbled murrelet occurrence observation sites and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

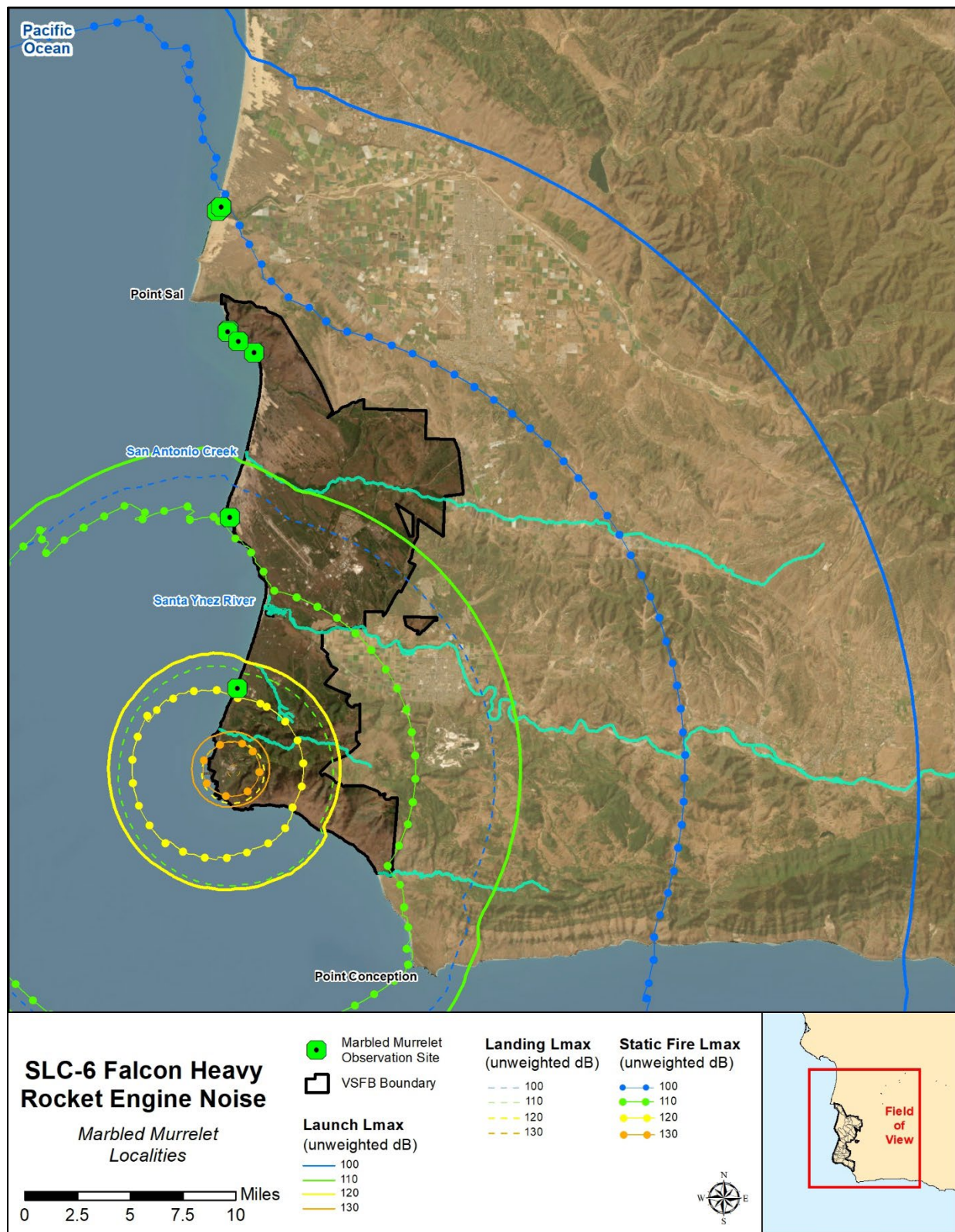


Figure 2I. Marbled murrelet occurrence observation sites and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

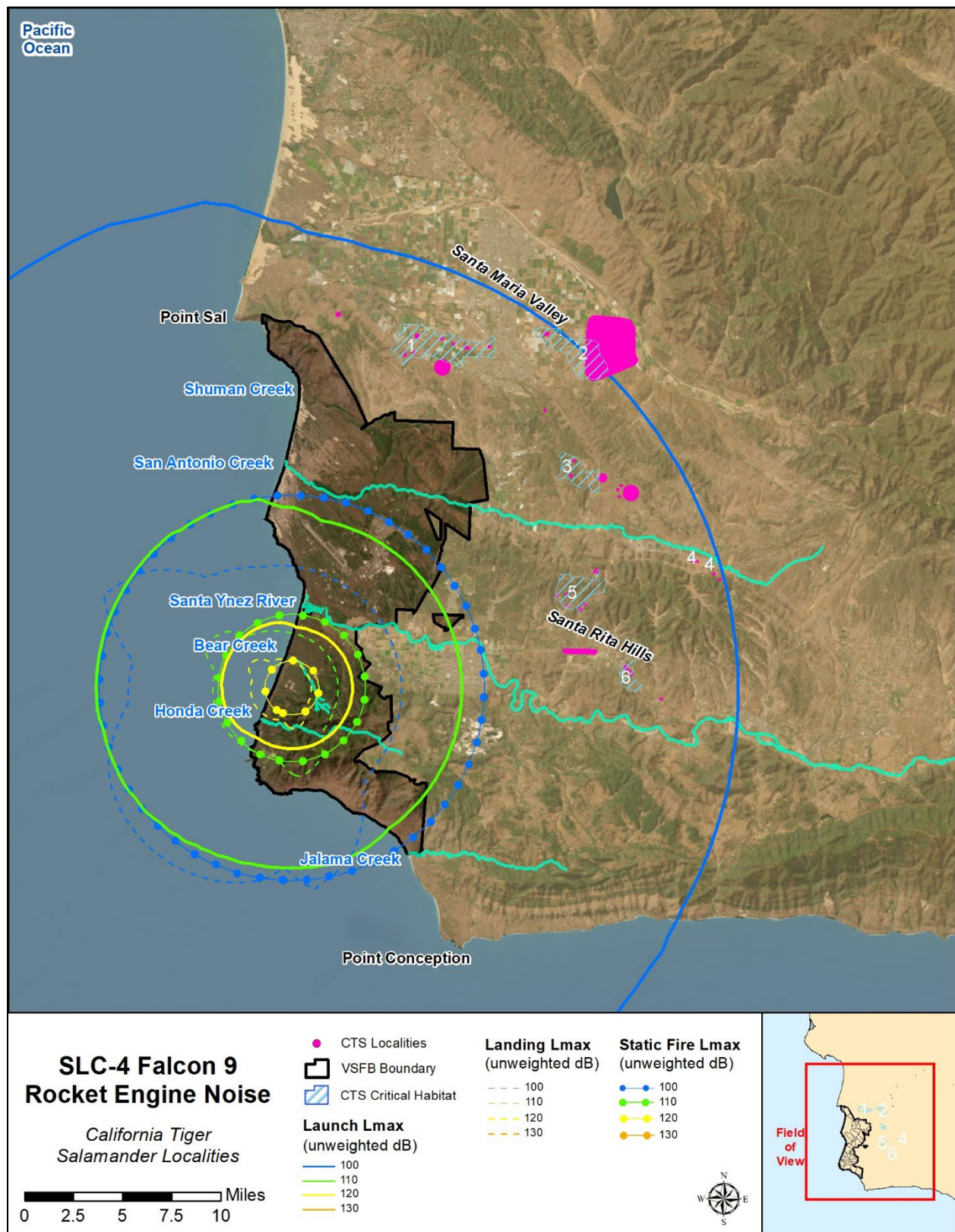


Figure 2J. California tiger salamander occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

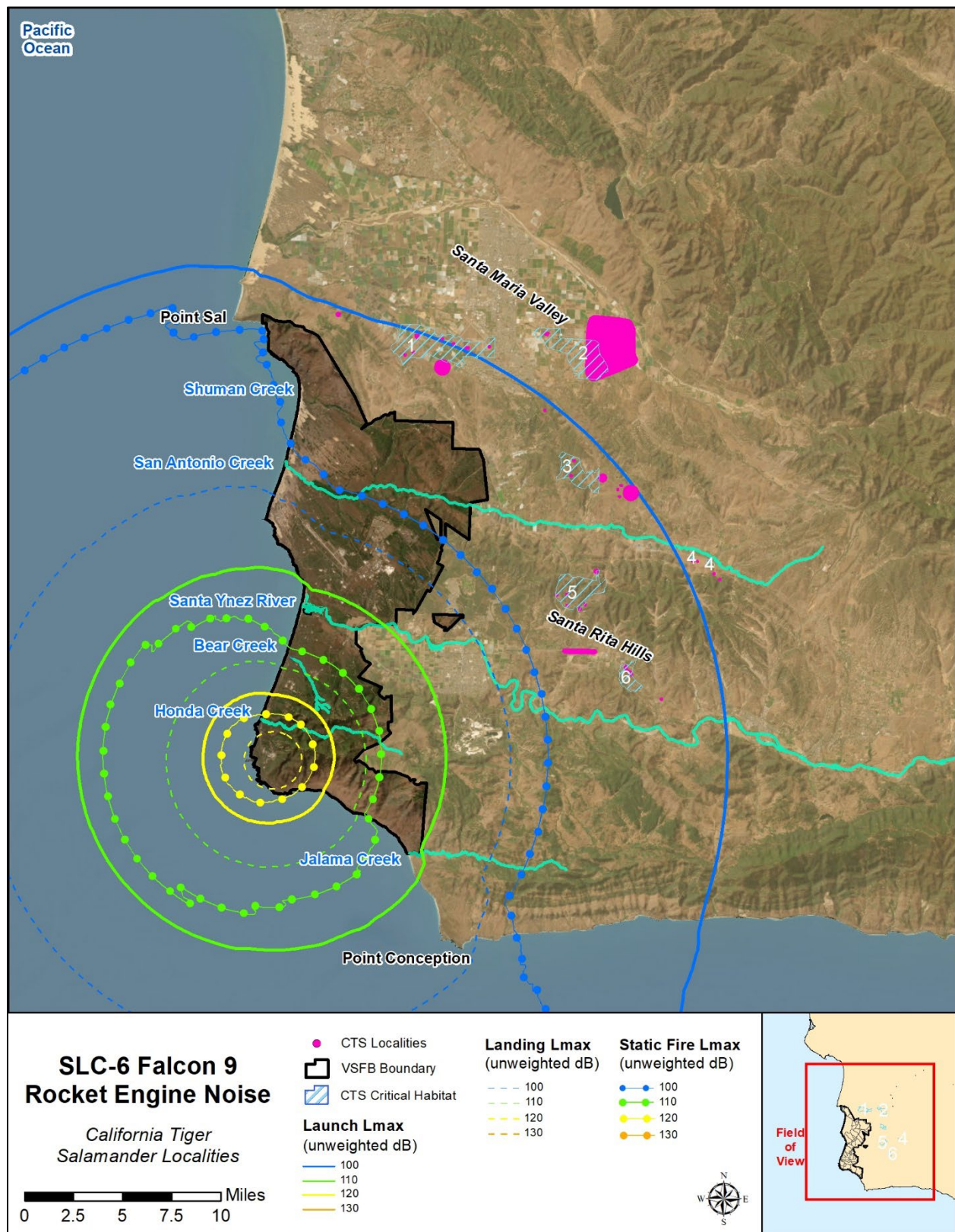


Figure 2K. California tiger salamander occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

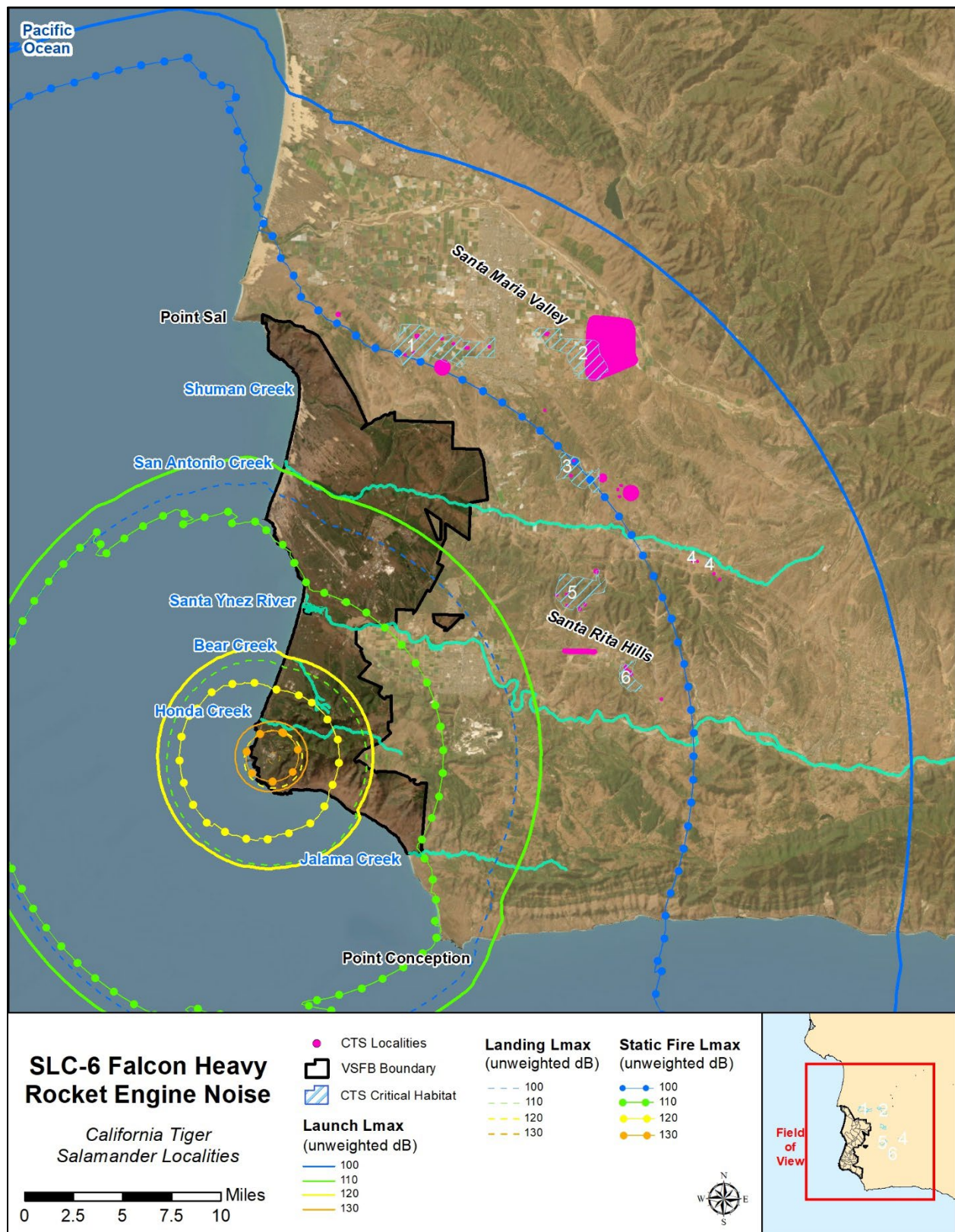


Figure 2L. California tiger salamander occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

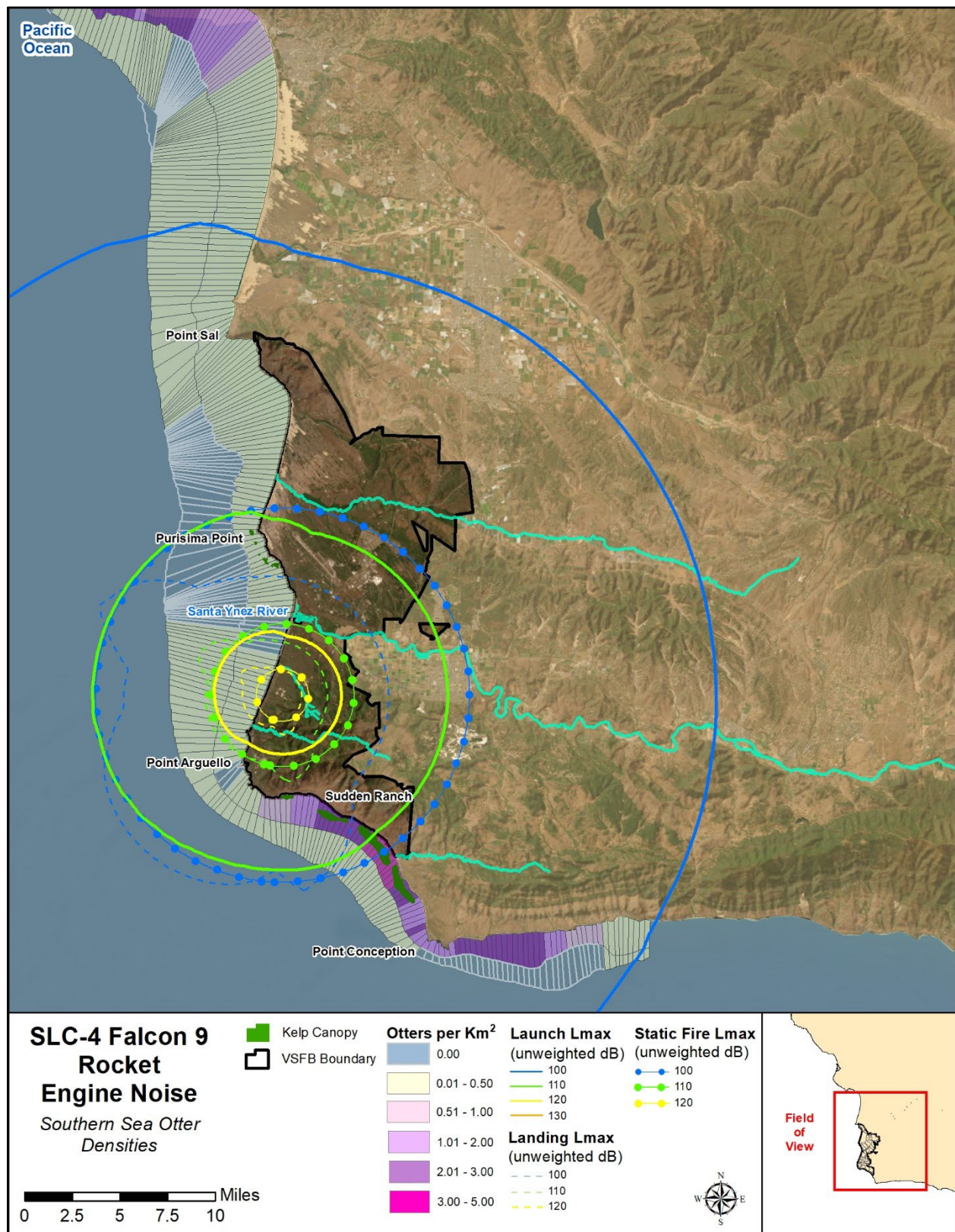


Figure 2M. Southern sea otter occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

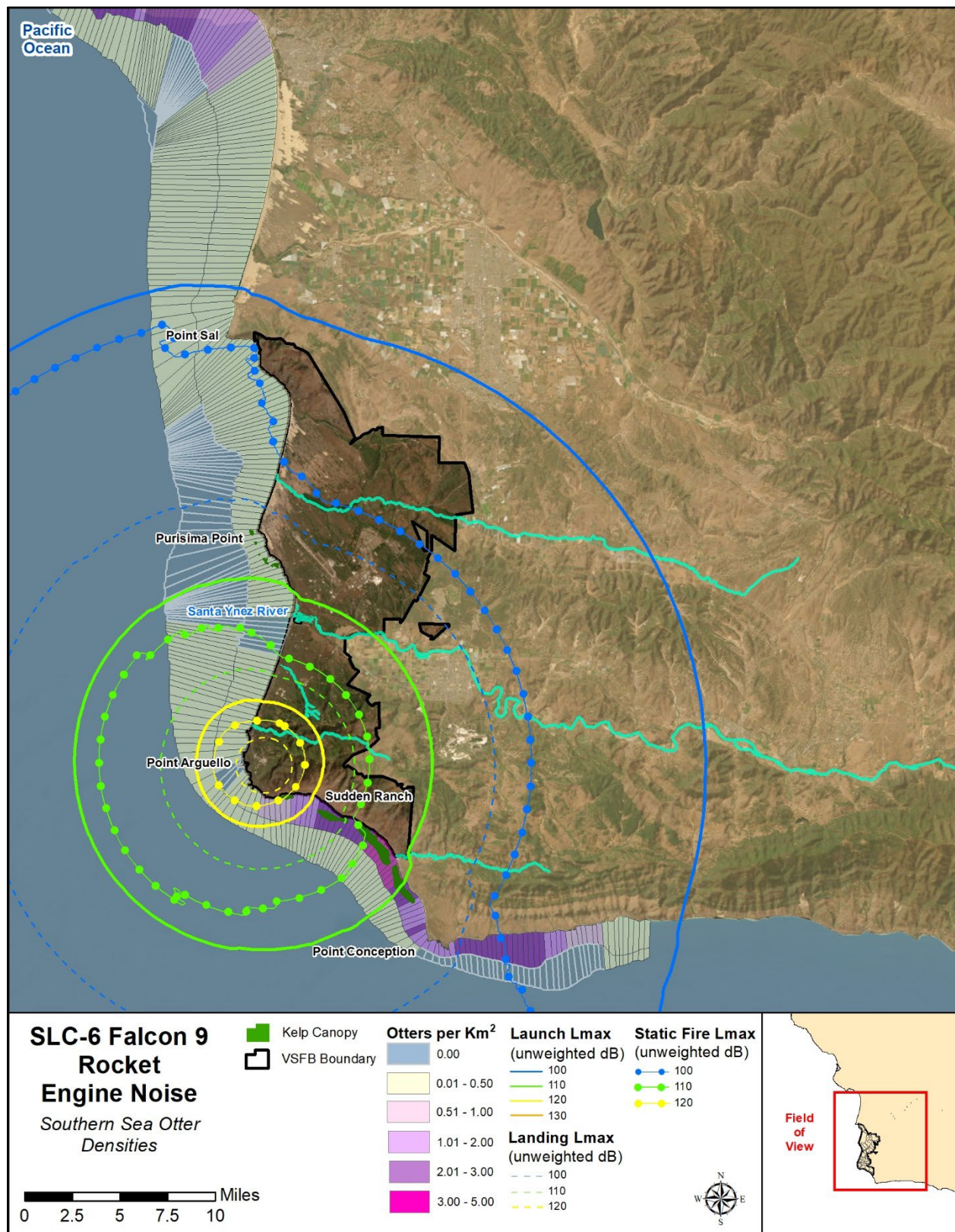


Figure 2N. Southern sea otter occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

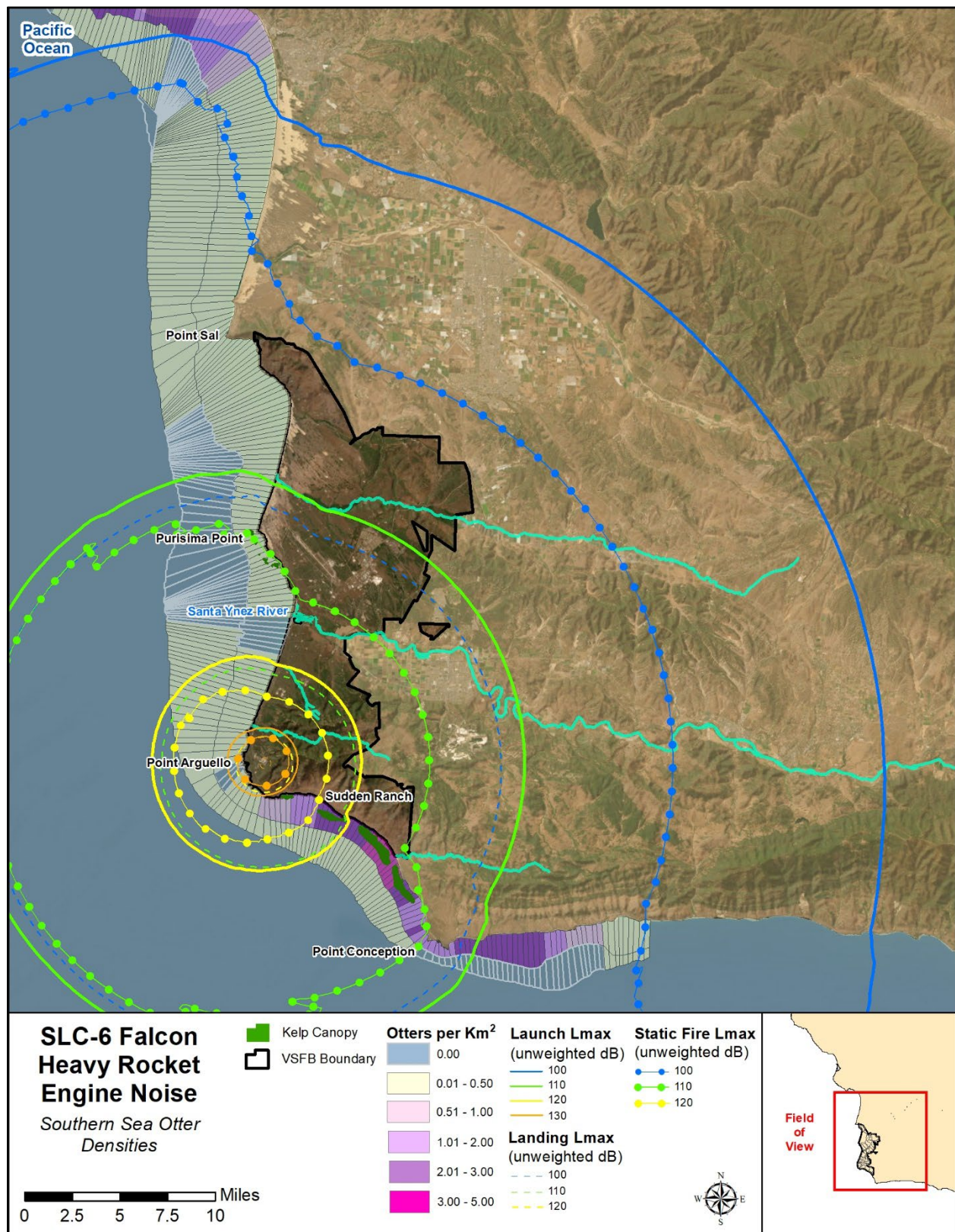


Figure 20. Southern sea otter occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

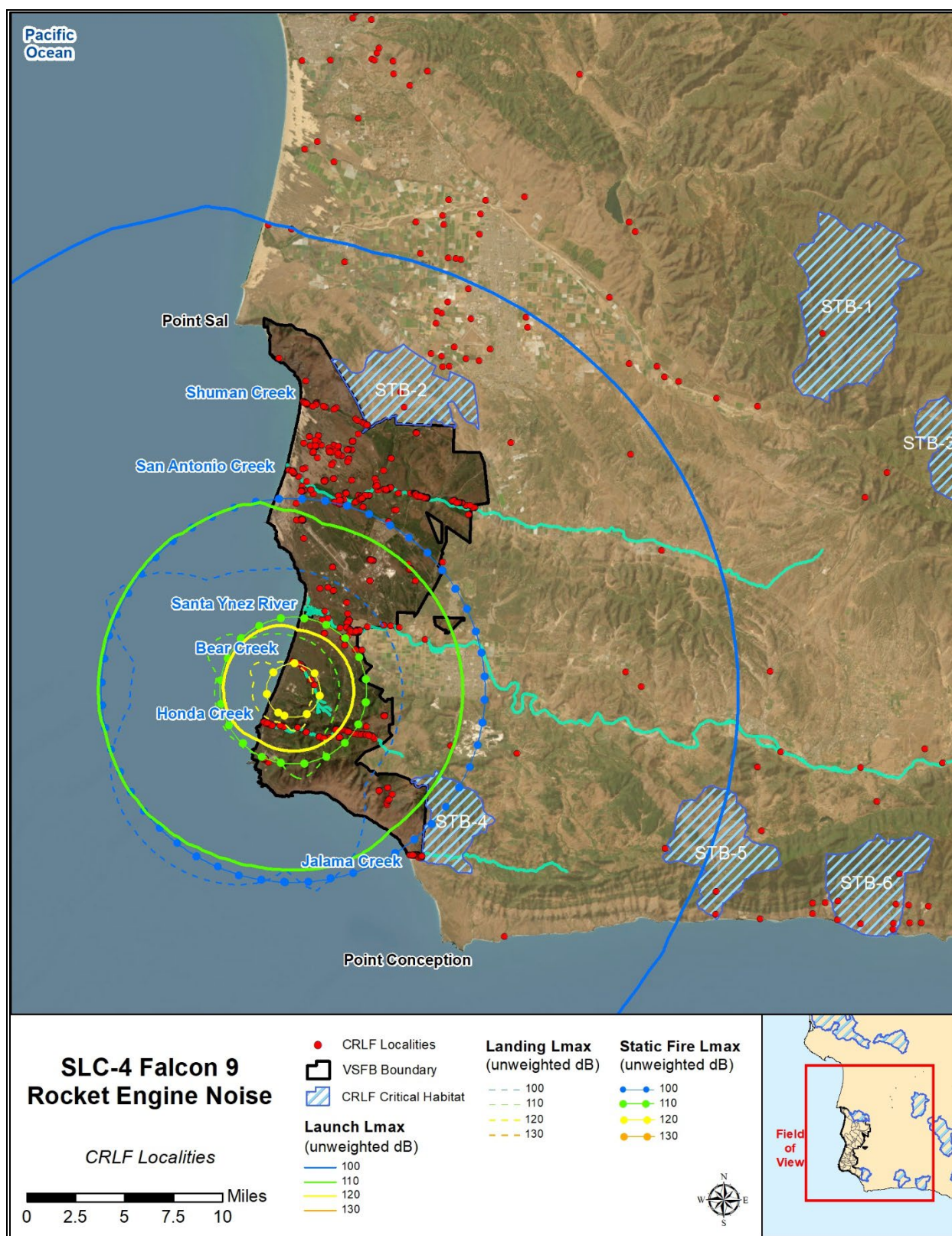


Figure 2P. California red-legged frog occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

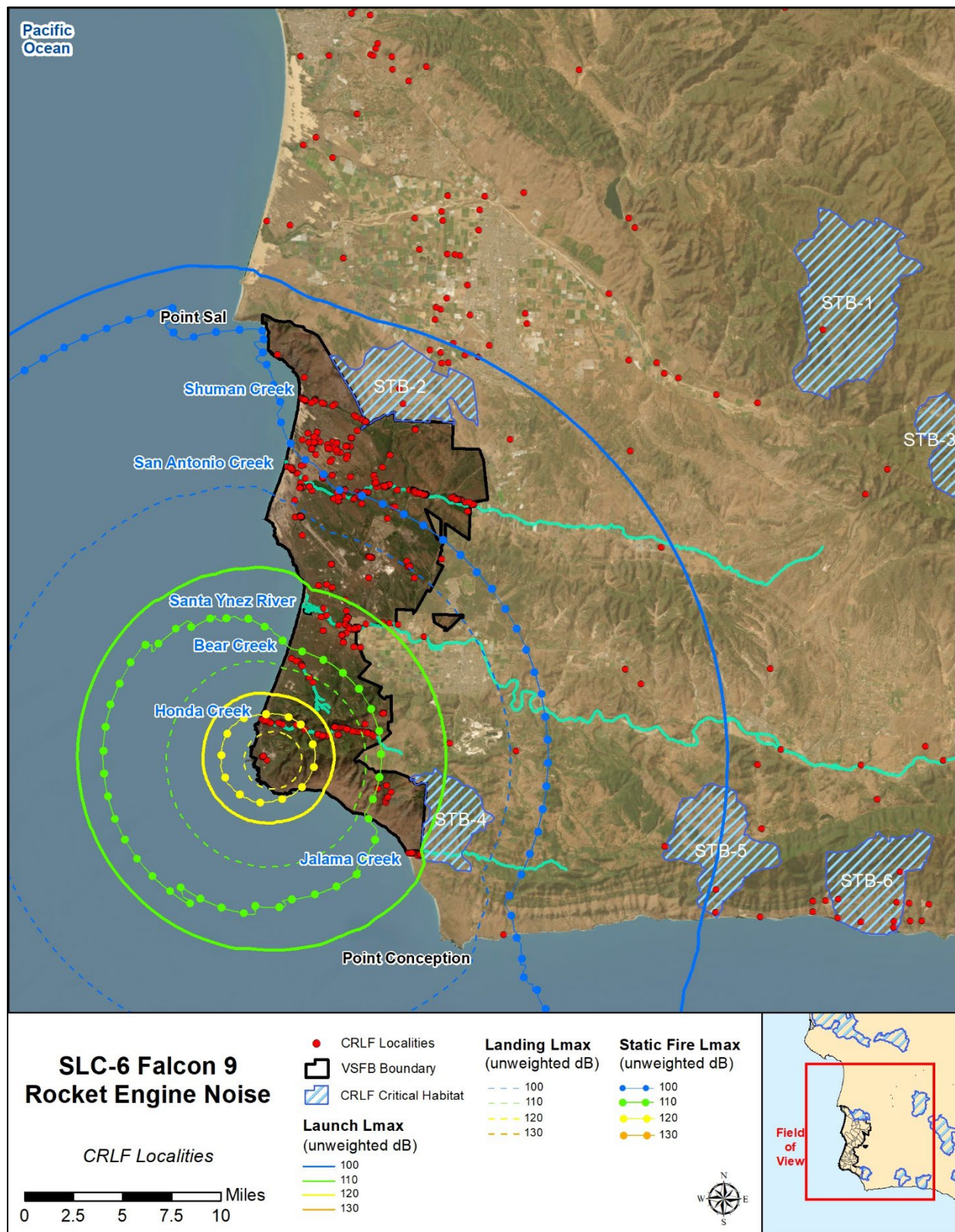


Figure 2Q. California red-legged frog occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

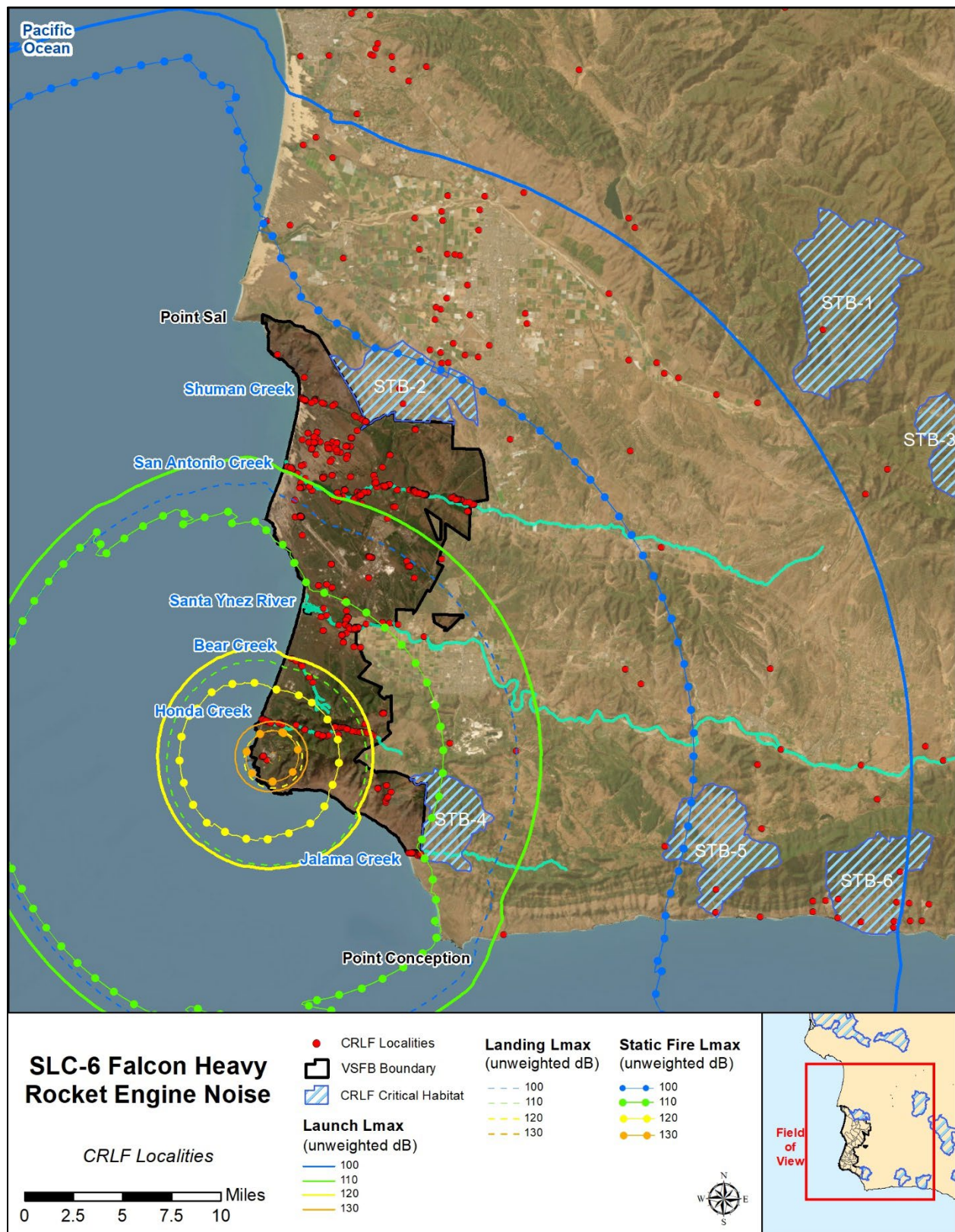


Figure 2R. California red-legged frog occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

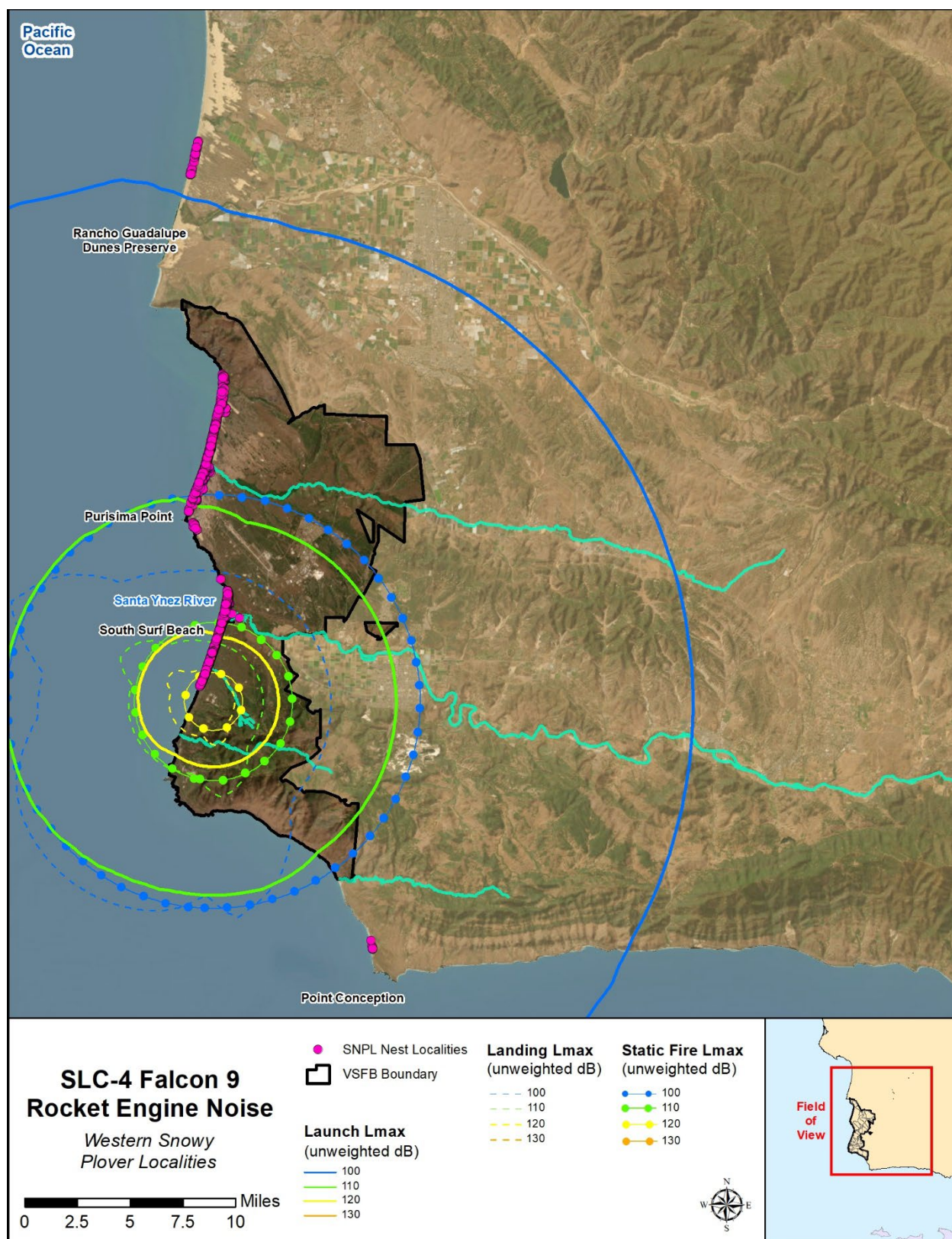


Figure 2S. Western snowy plover occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

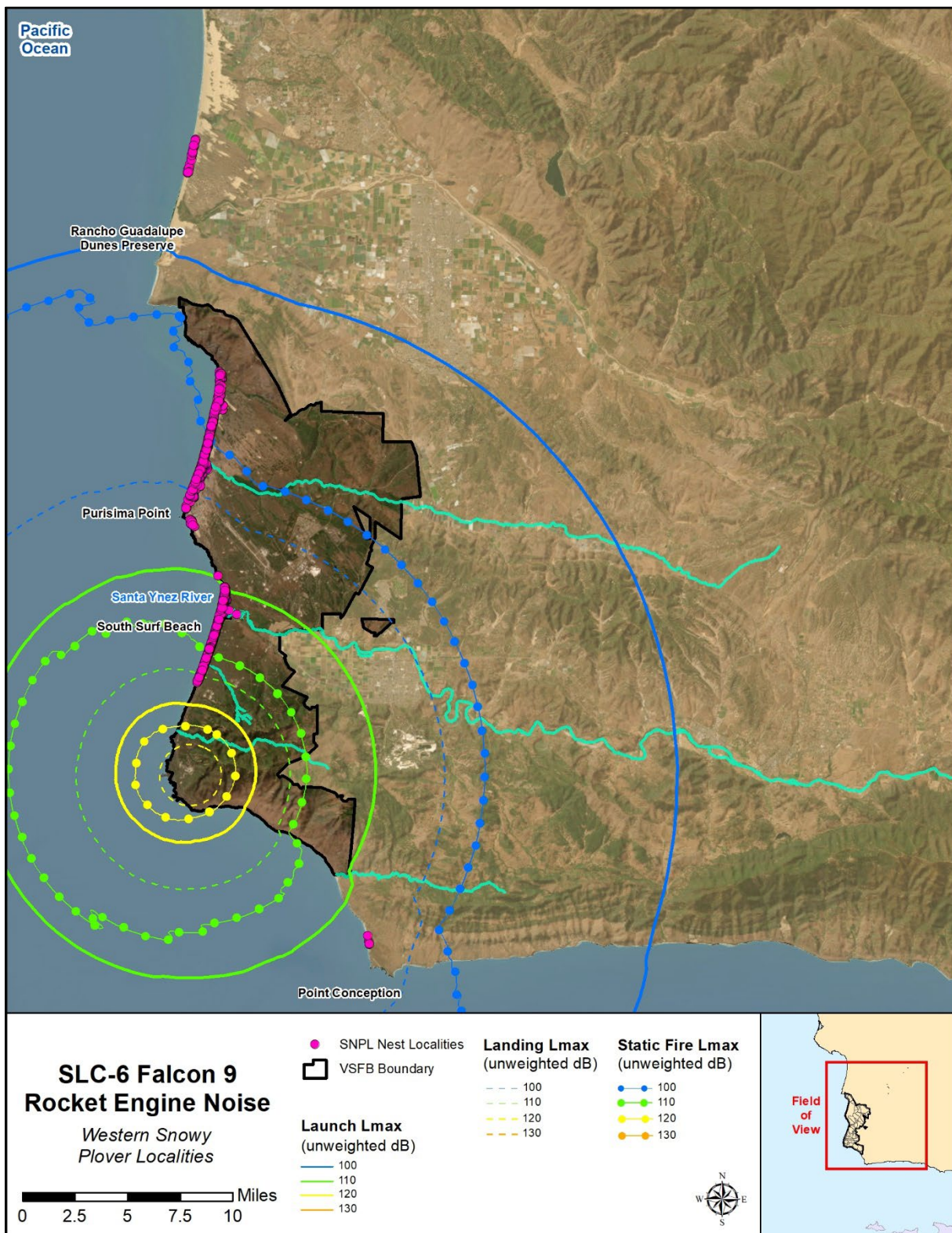


Figure 2T. Western snowy plover occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

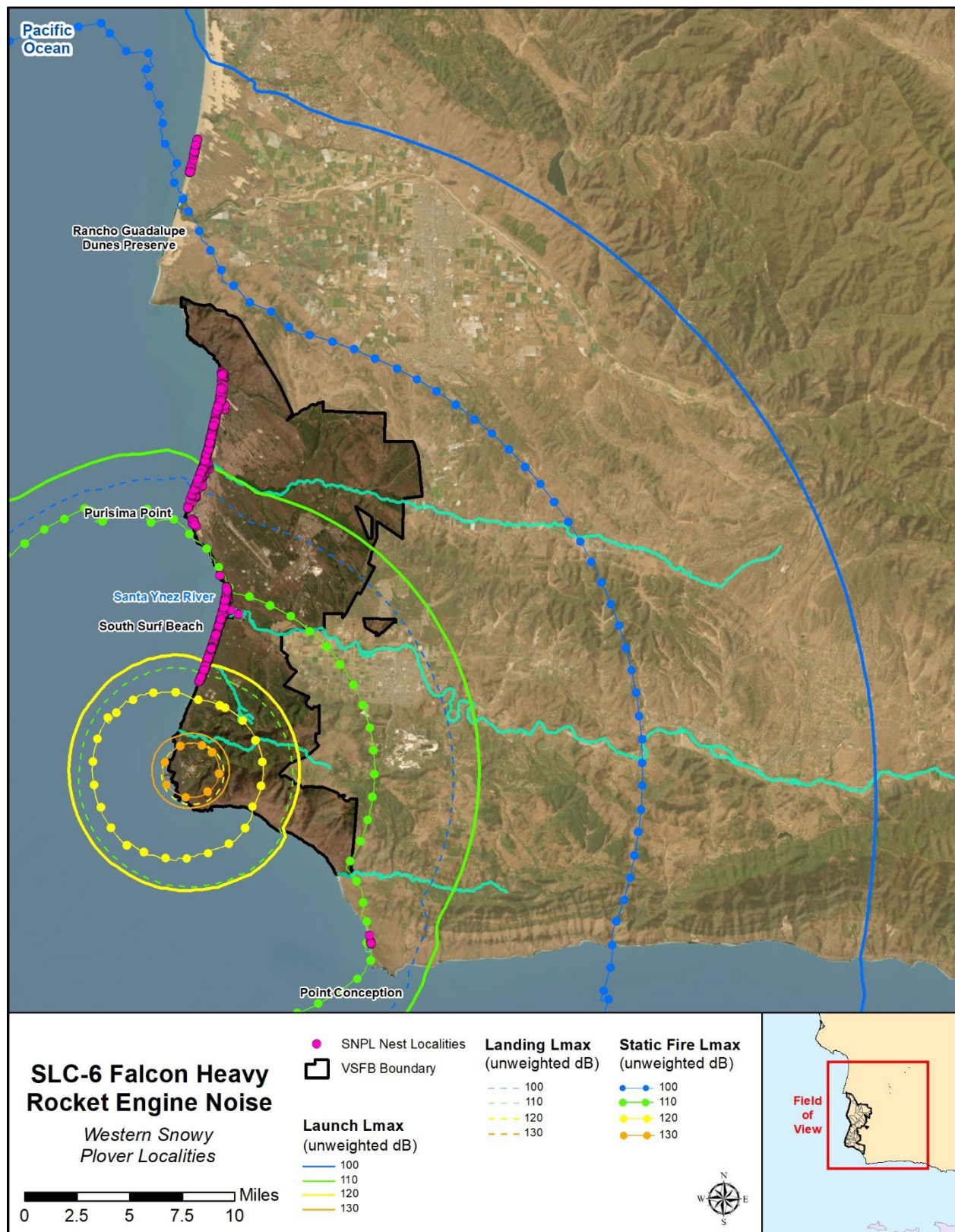


Figure 2U. Western snowy plover occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

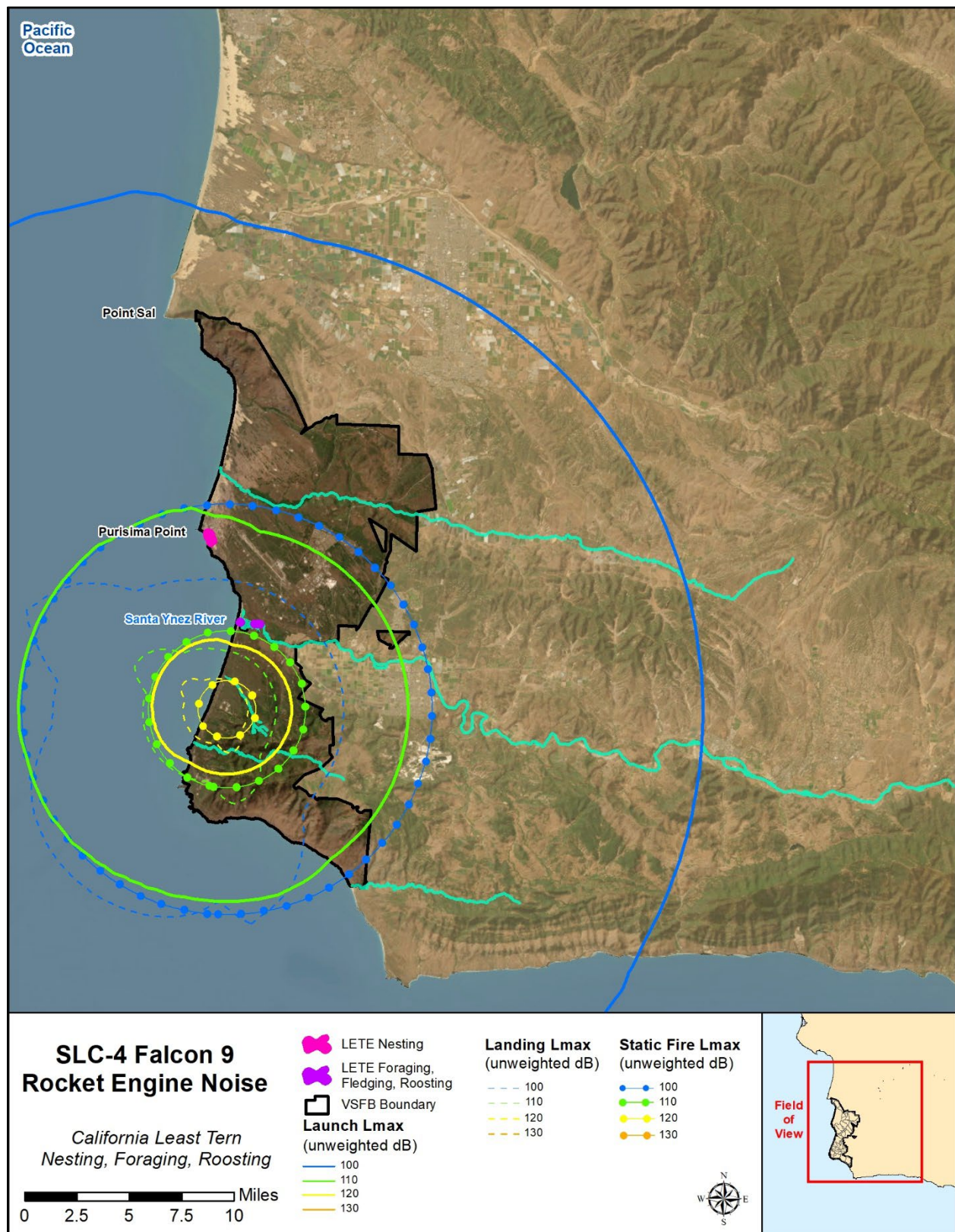


Figure 2V. California least tern occurrences and SLC-4 Falcon 9 rocket noise in the project Launch Noise Effect Area.

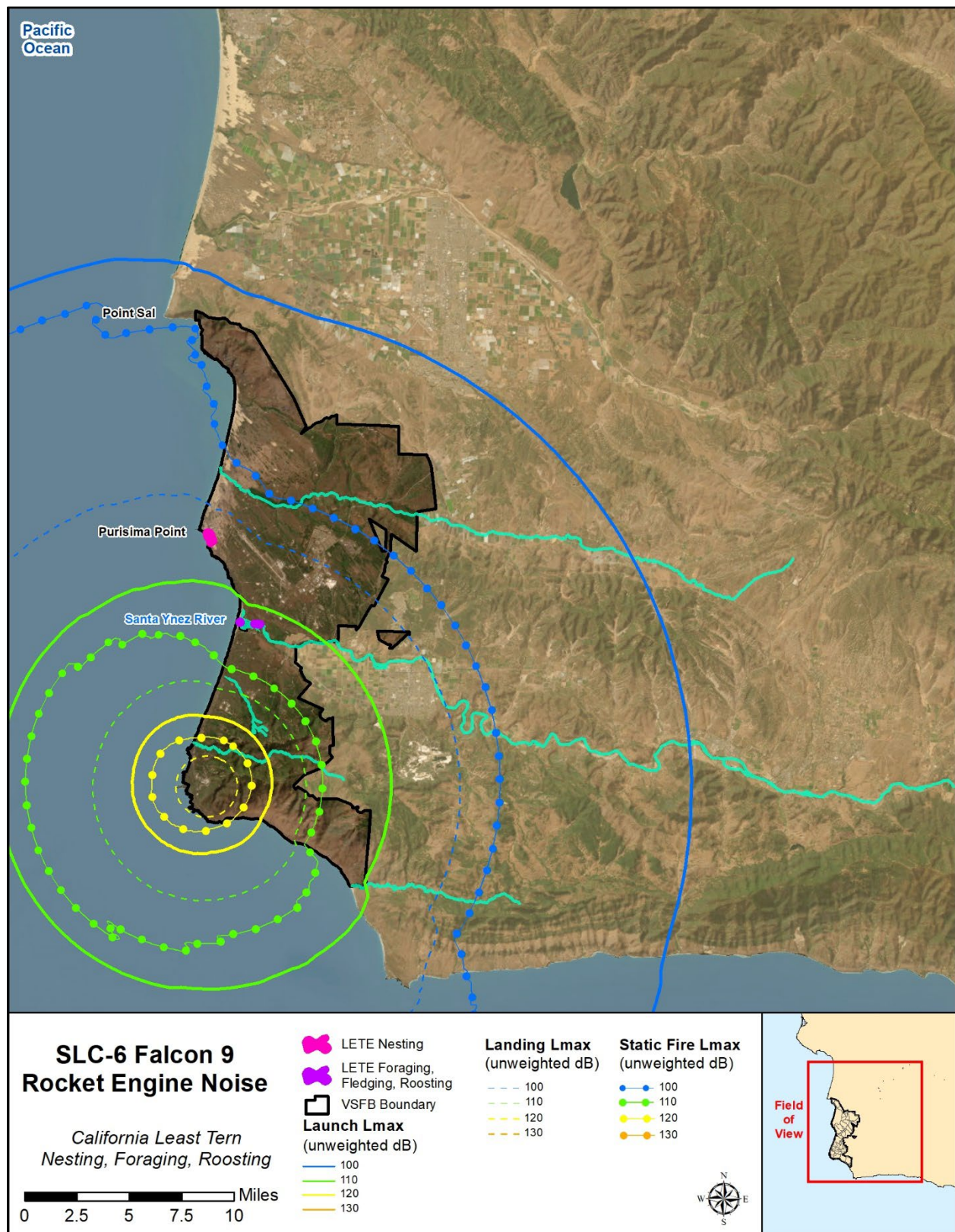


Figure 2W. California least tern occurrences and SLC-6 Falcon 9 rocket noise in the project Launch Noise Effect Area.

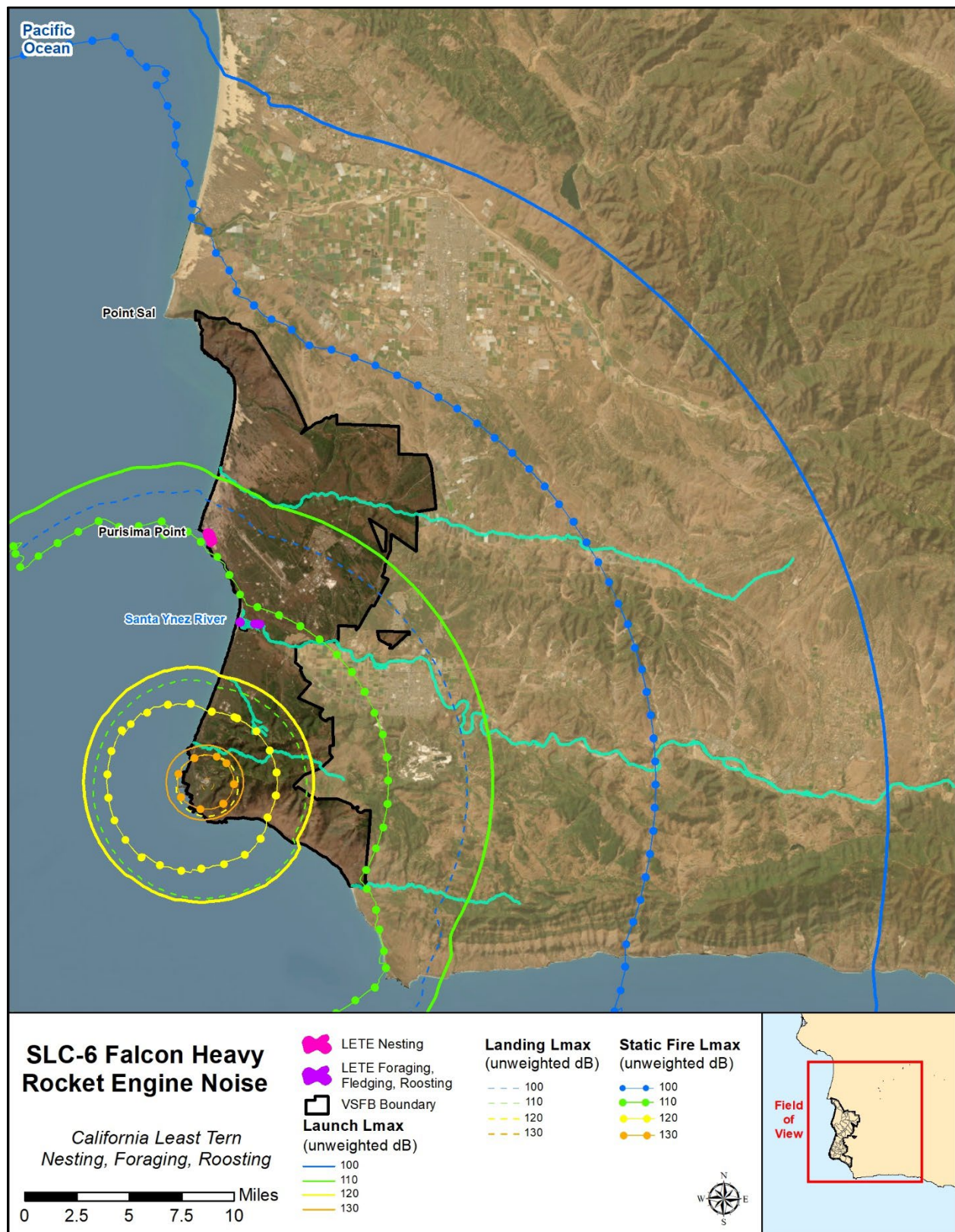


Figure 2X. California least tern occurrences and SLC-6 Falcon 9 Heavy rocket noise in the project Launch Noise Effect Area.

Sonic Boom Overpressure Effect Area; Launch Descent (boost-back landing)

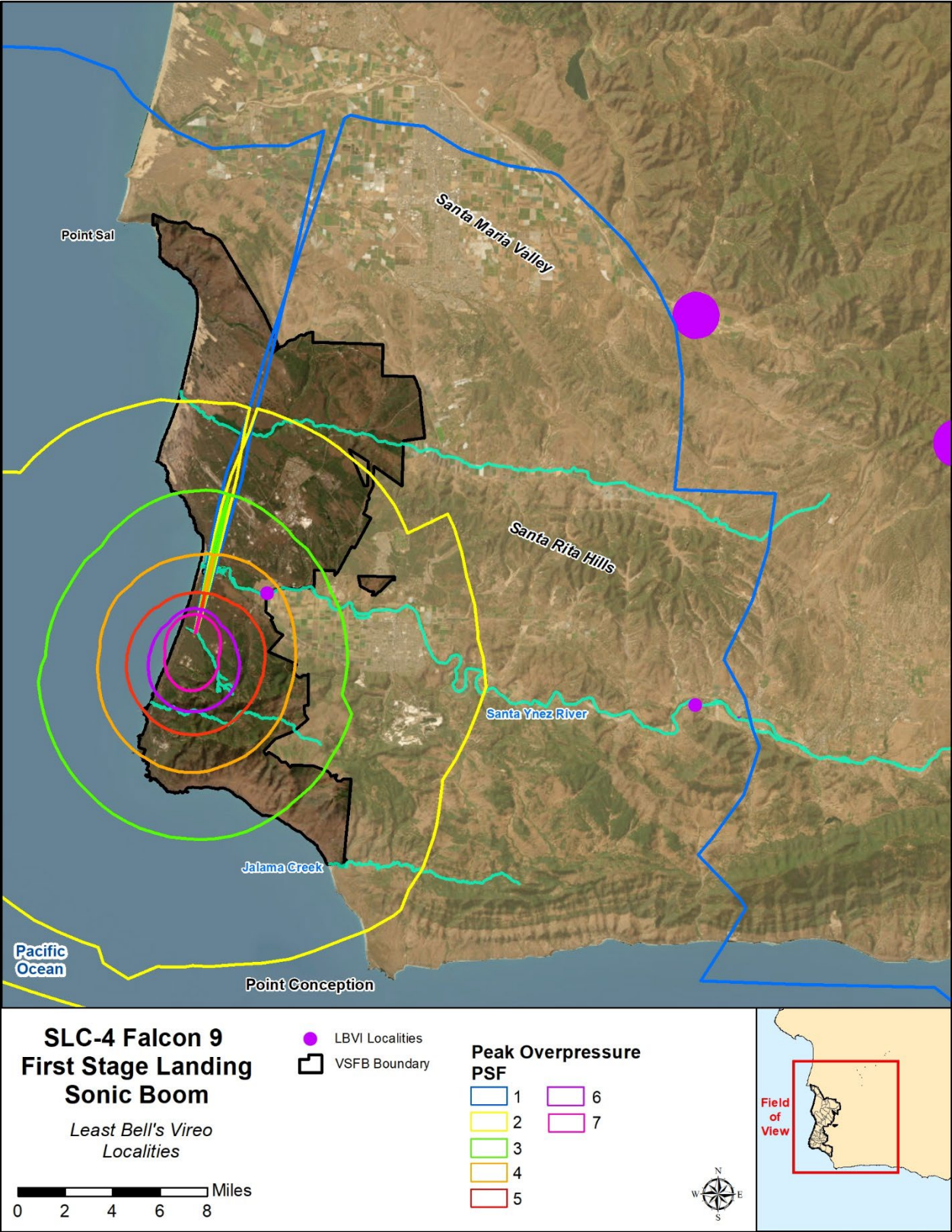


Figure 3A. Least Bell's vireo occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

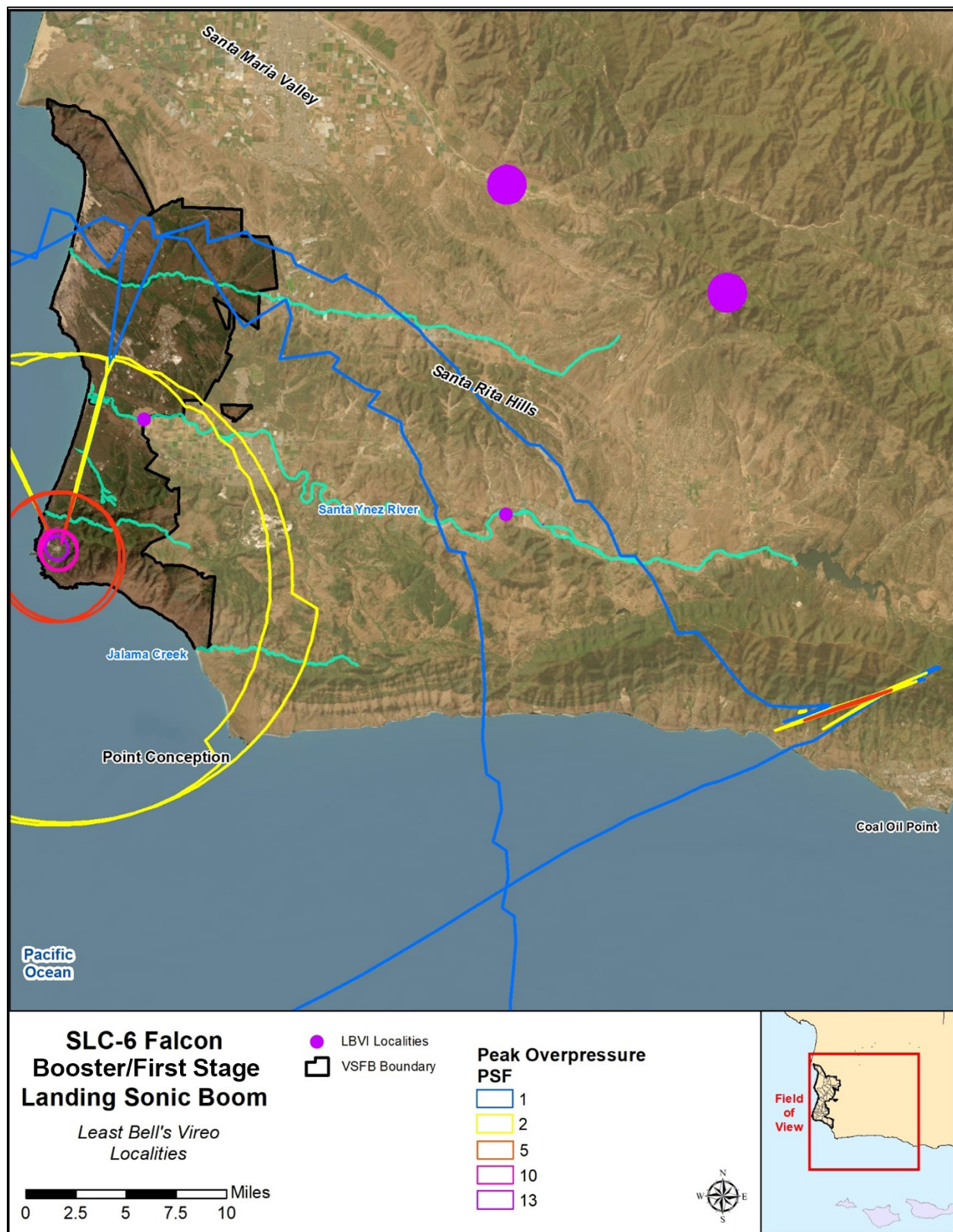


Figure 3B. Least Bell's vireo occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

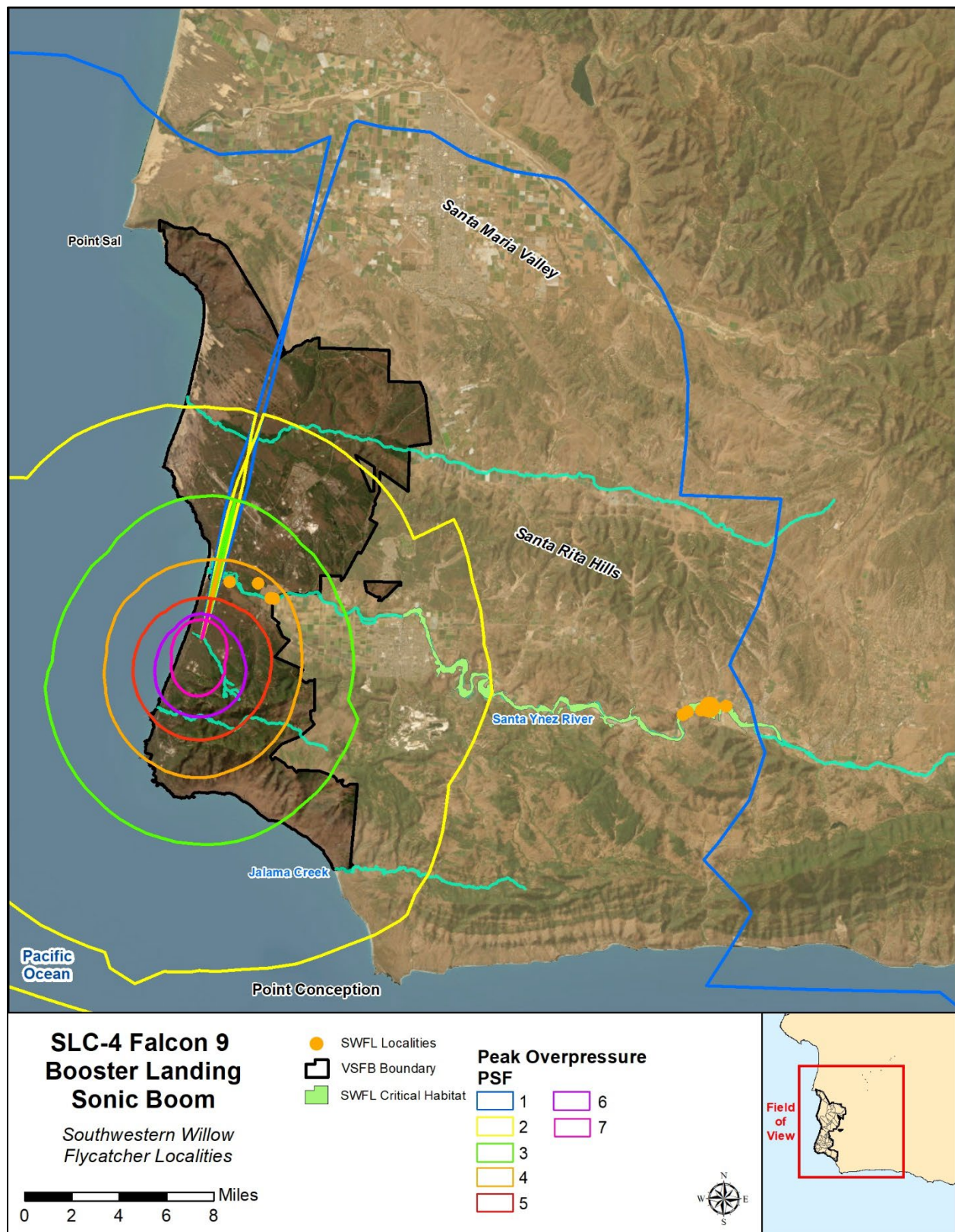


Figure 3C. Southwestern willow flycatcher occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 booster landing at SLC-4.

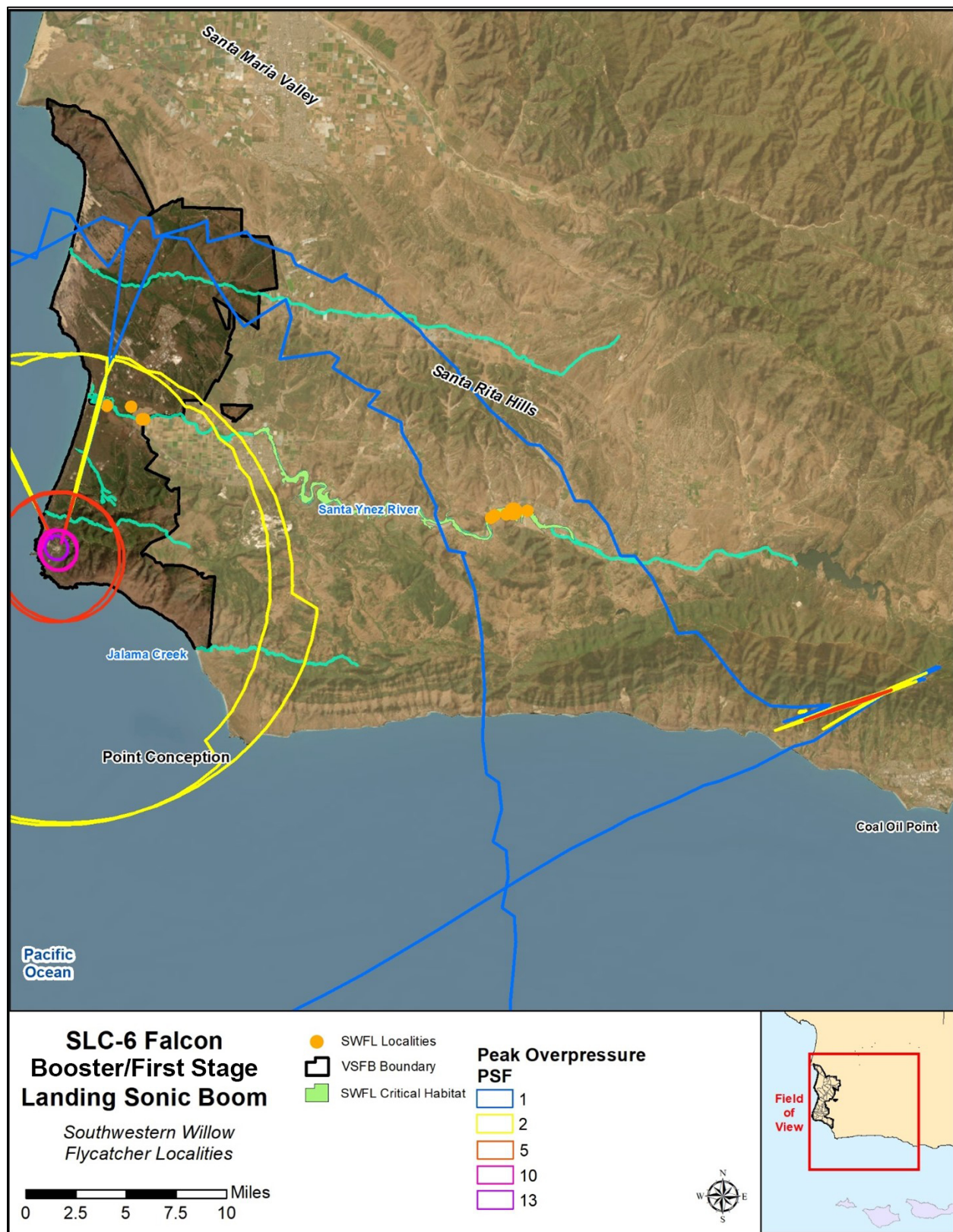


Figure 3D. Southwestern willow flycatcher occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

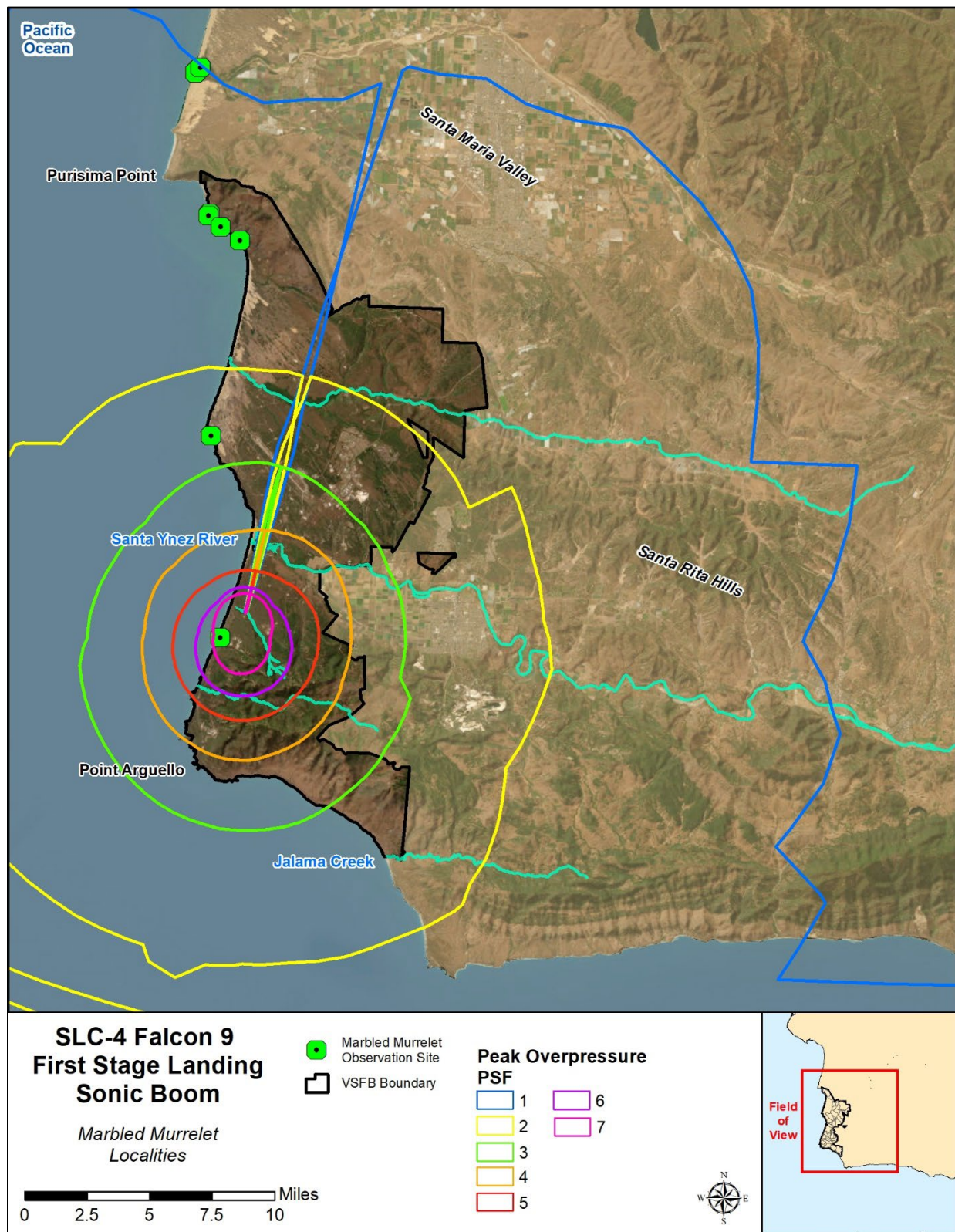


Figure 3E. Marbled murrelet occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

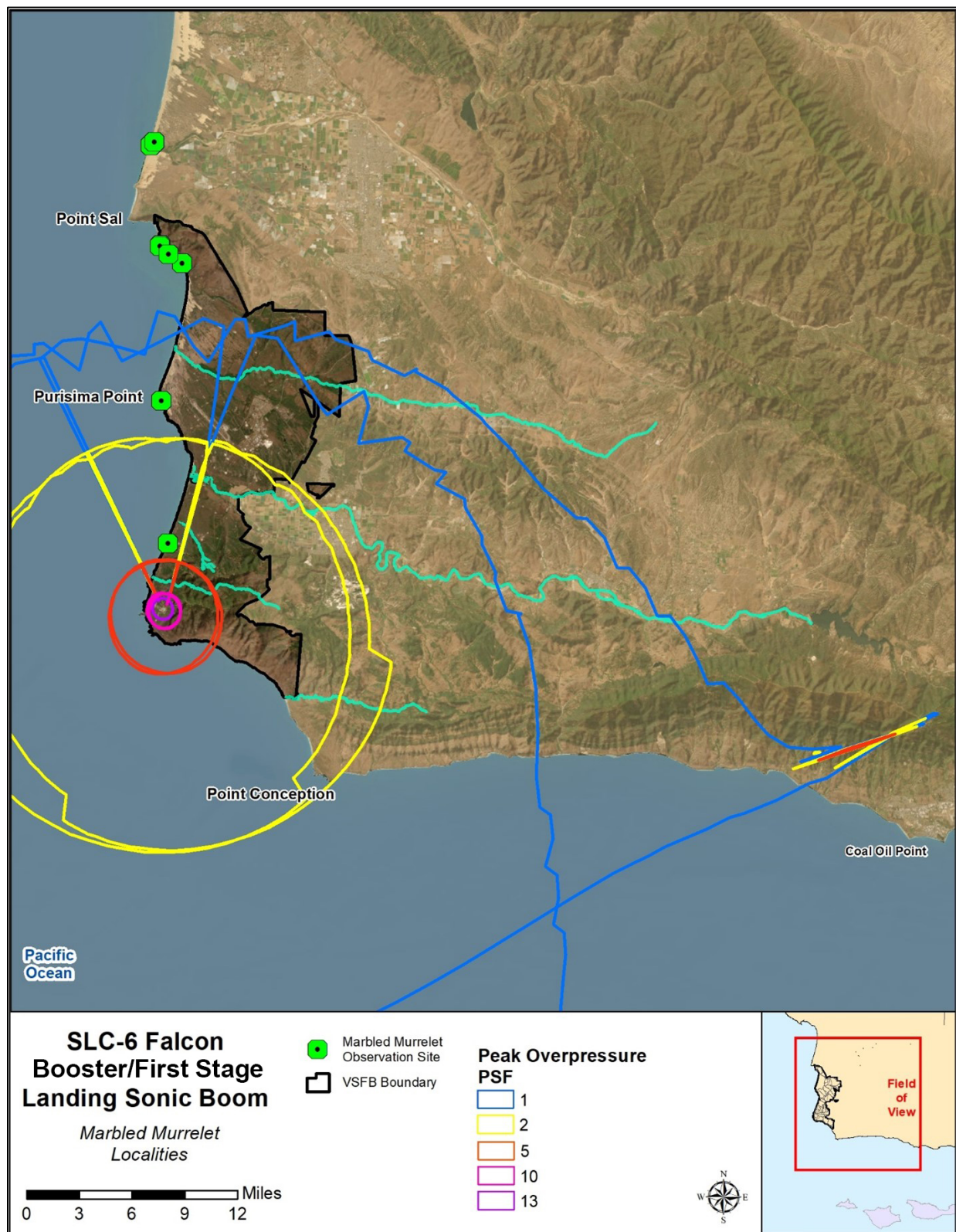


Figure 3F. Marbled murrelet occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

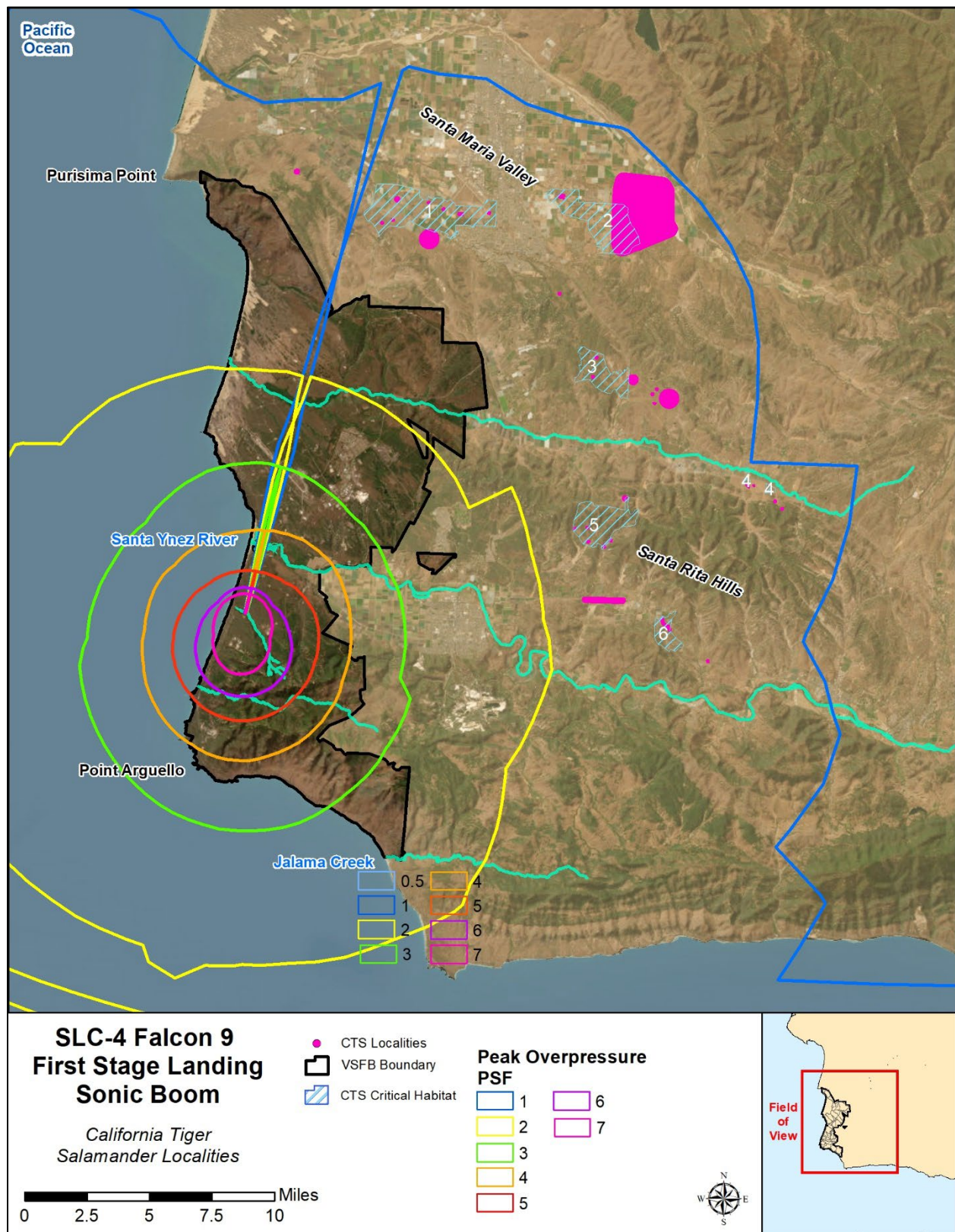


Figure 3G. California tiger salamander occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

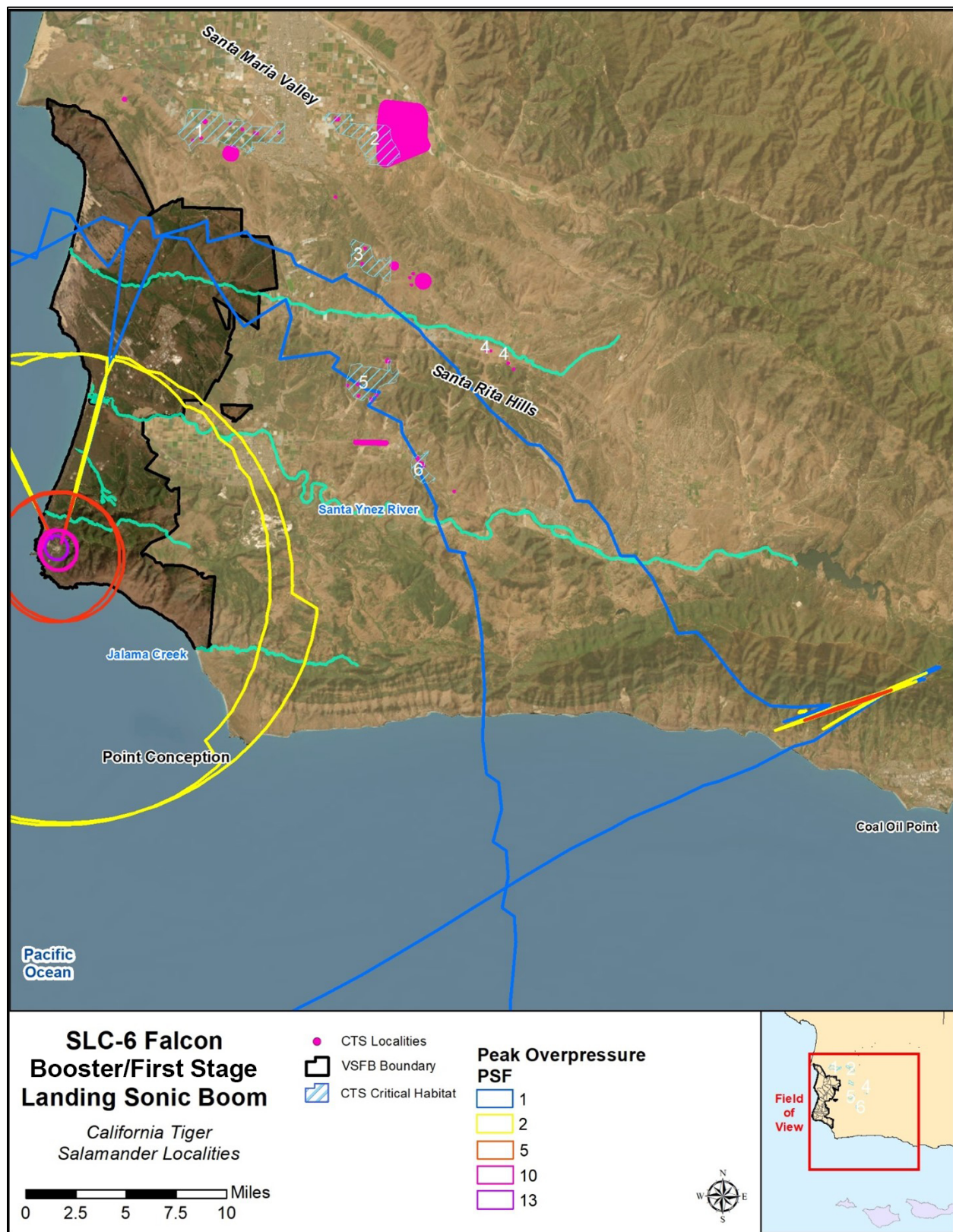


Figure 3H. California tiger salamander occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

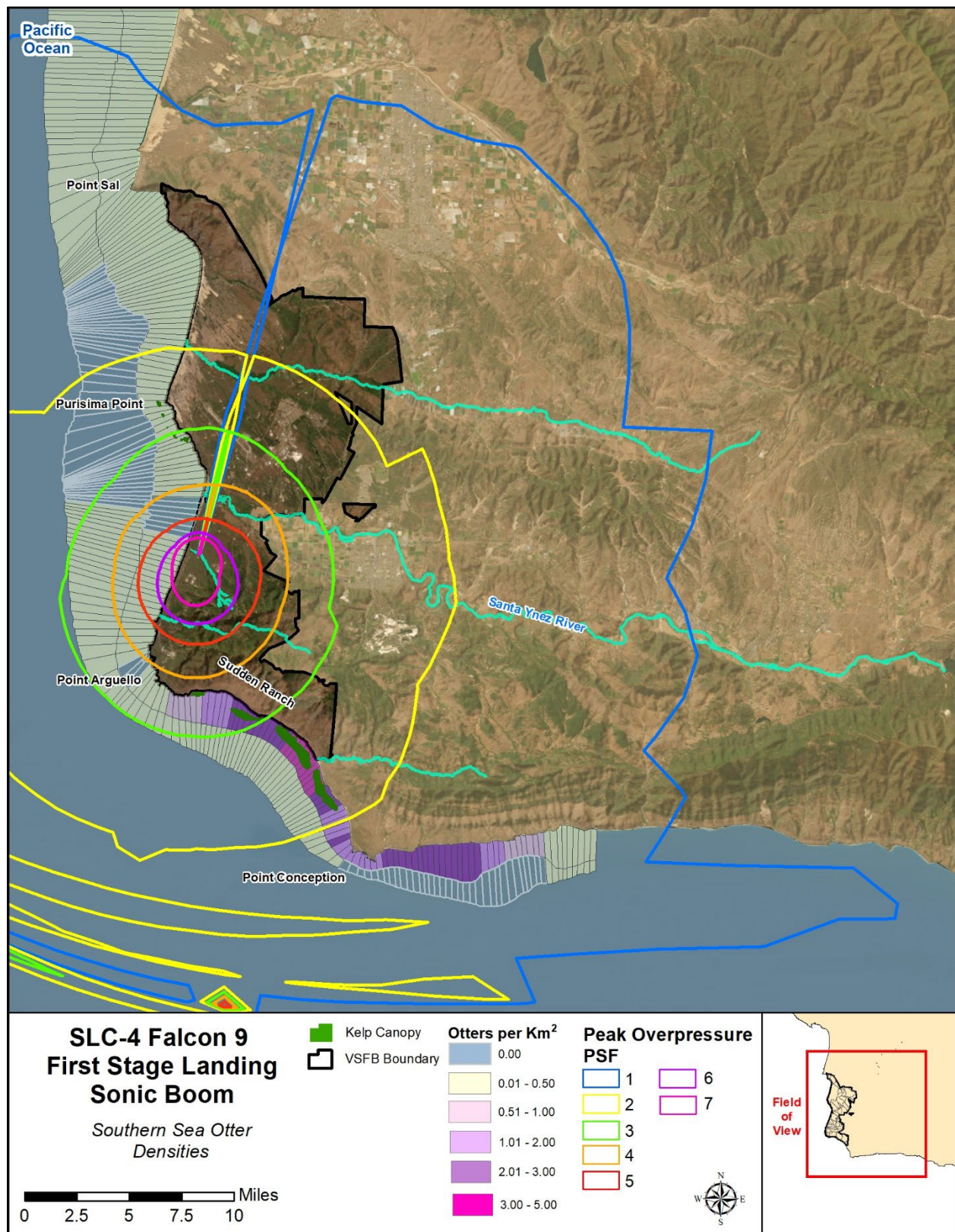


Figure 3I. Southern sea otter occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

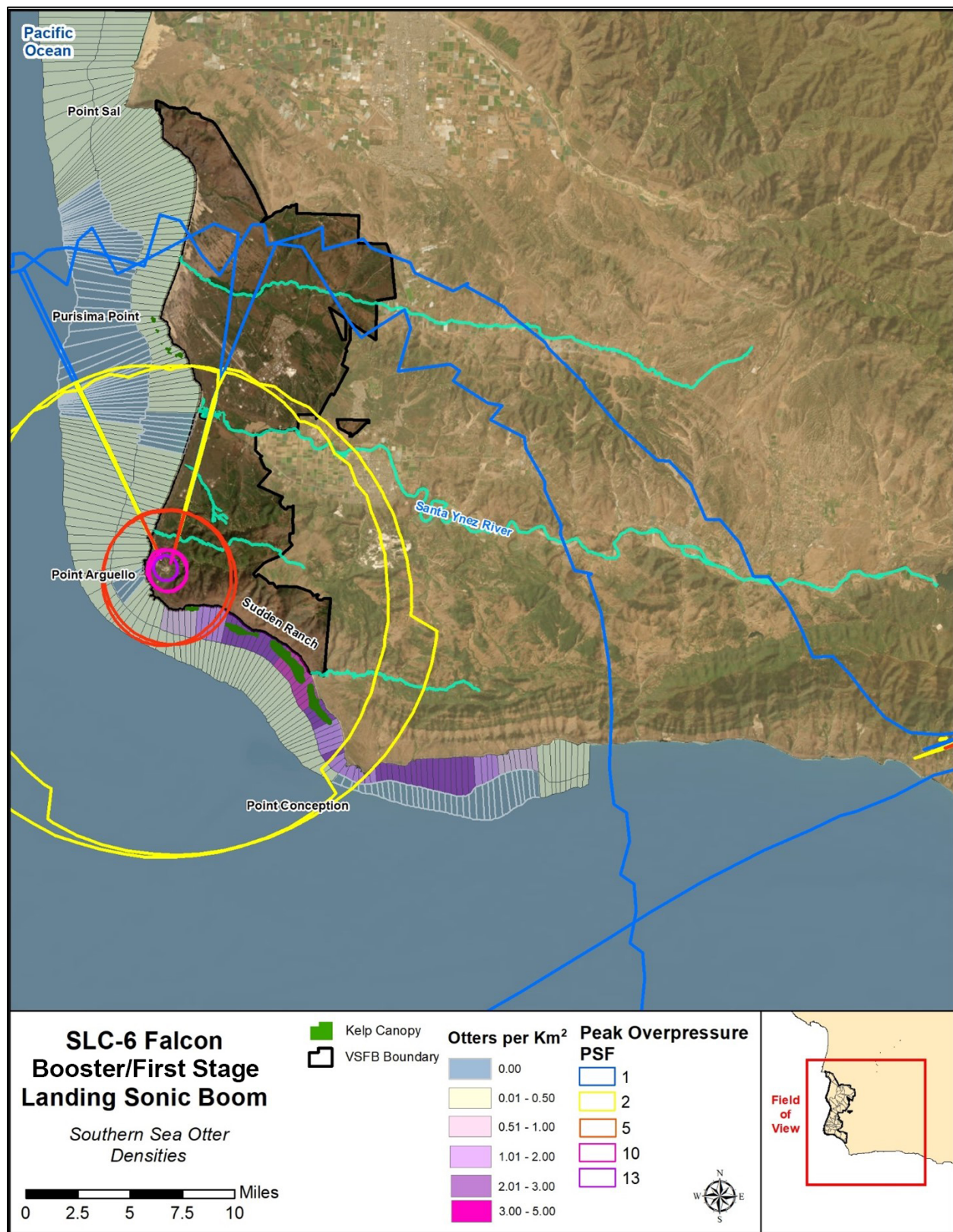


Figure 3J. Southern sea otter occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

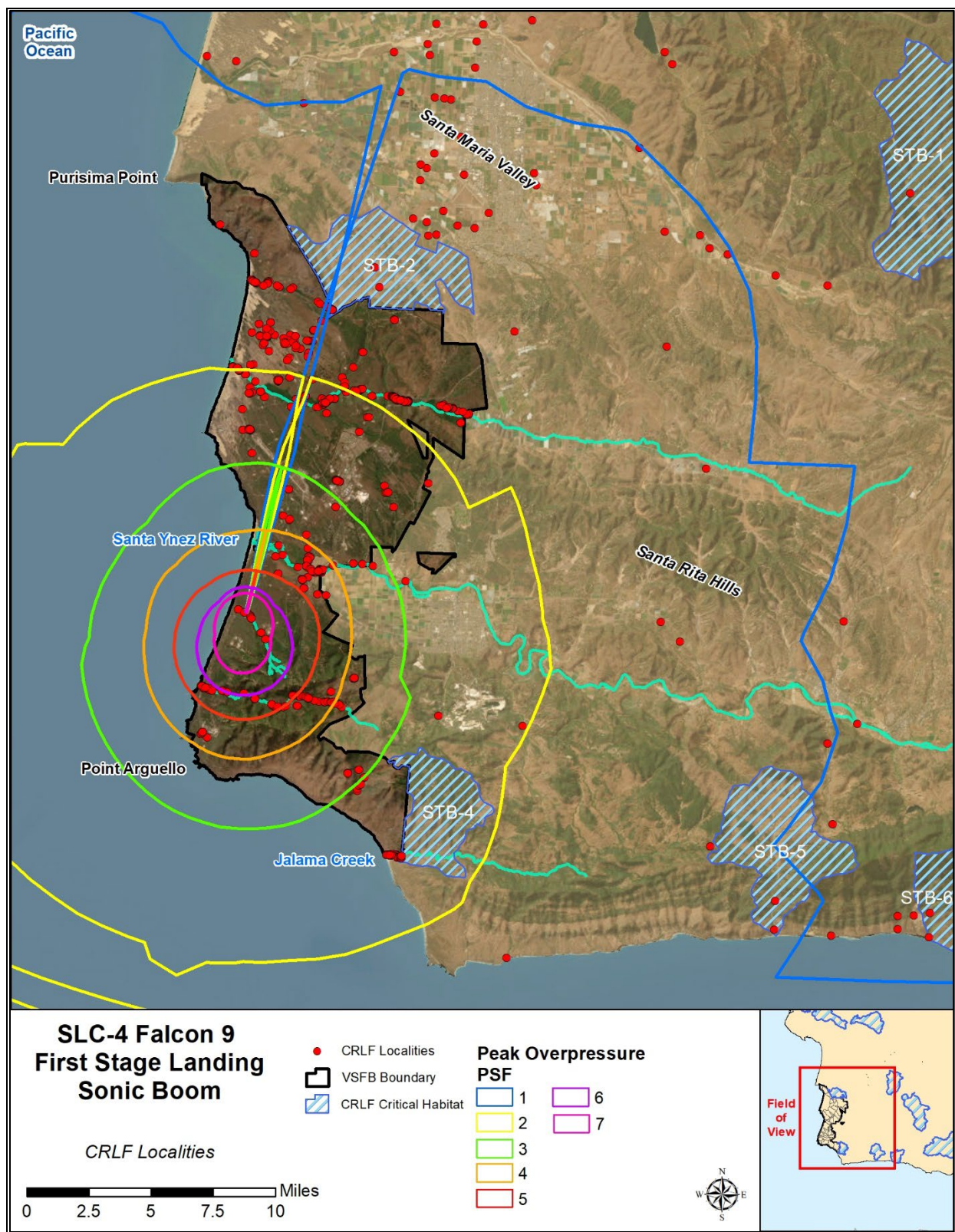


Figure 3K. California red-legged frog occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

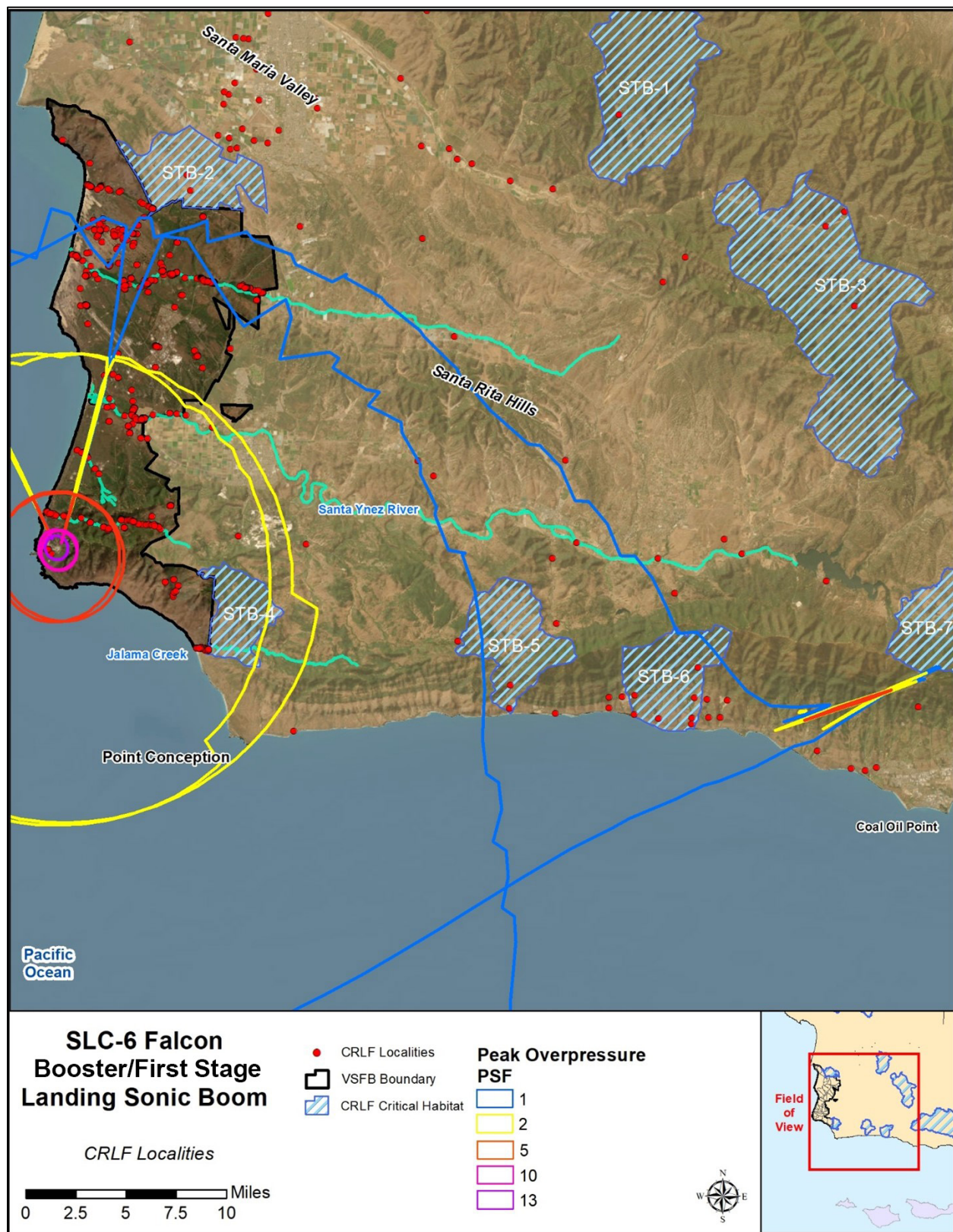


Figure 3L. California red-legged frog occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

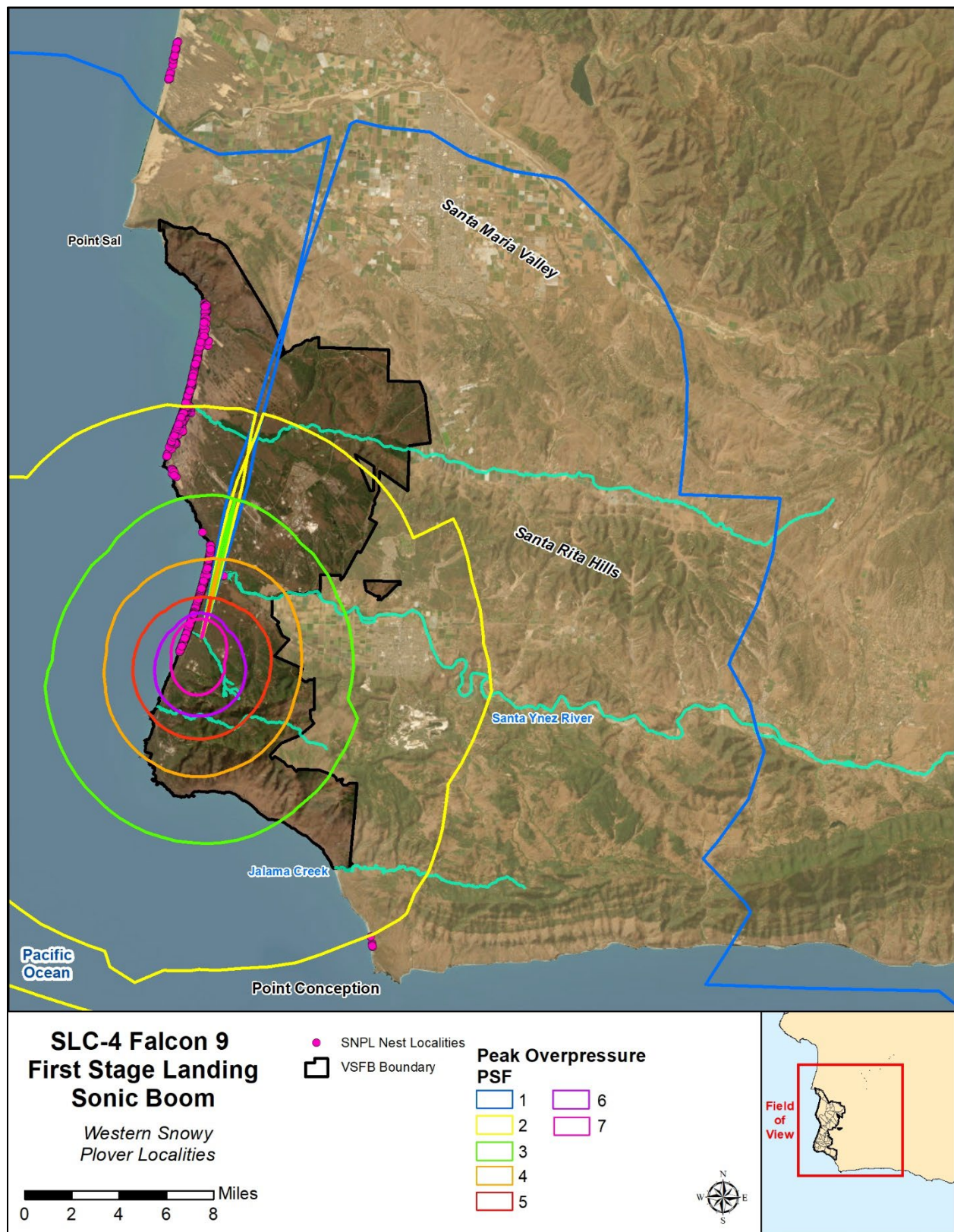


Figure 3M. Western snowy plover occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

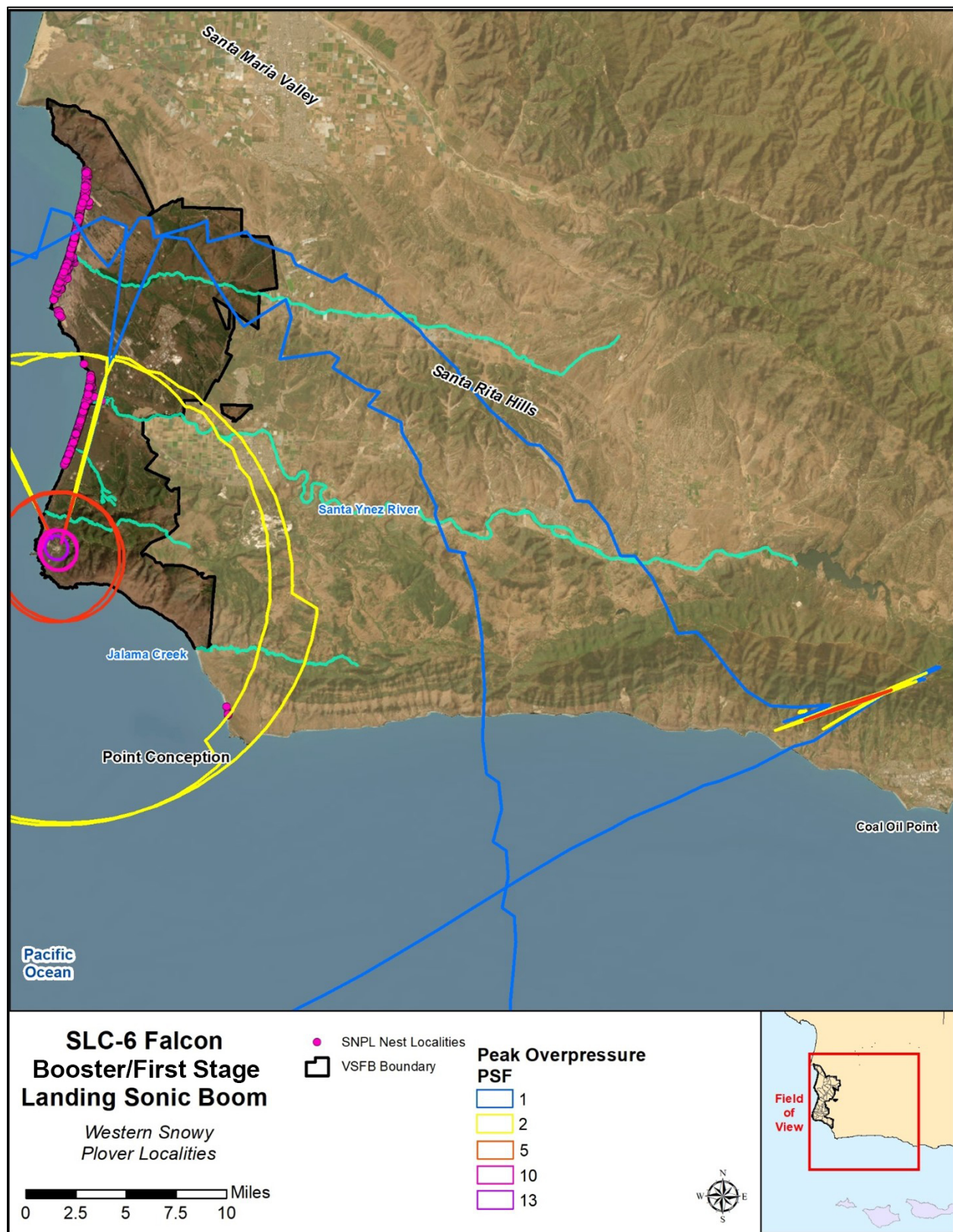


Figure 3N. Western snowy plover occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

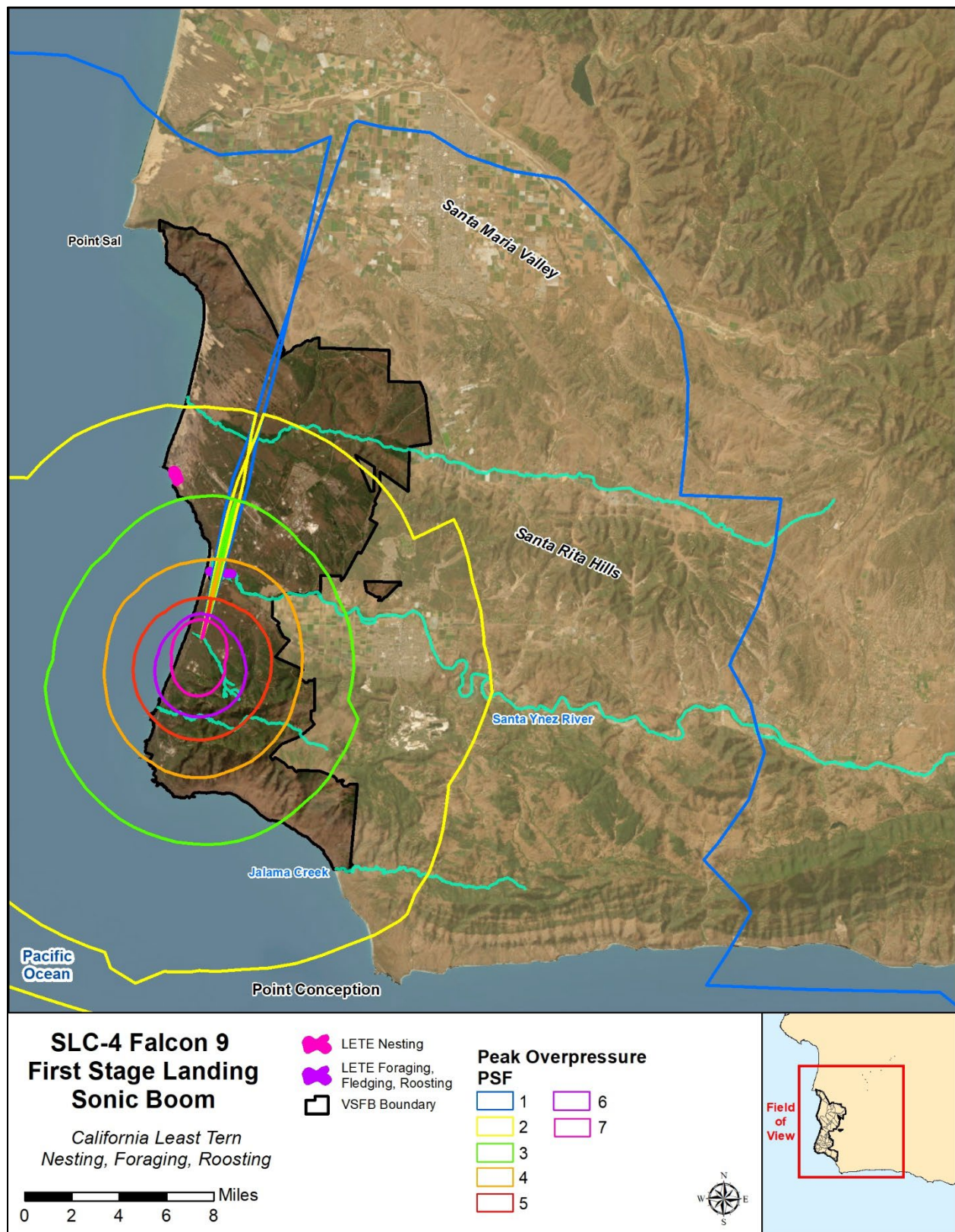


Figure 3O. California least tern occurrences and the project Sonic Boom Overpressure Effect Area during Falcon 9 first stage landing at SLC-4.

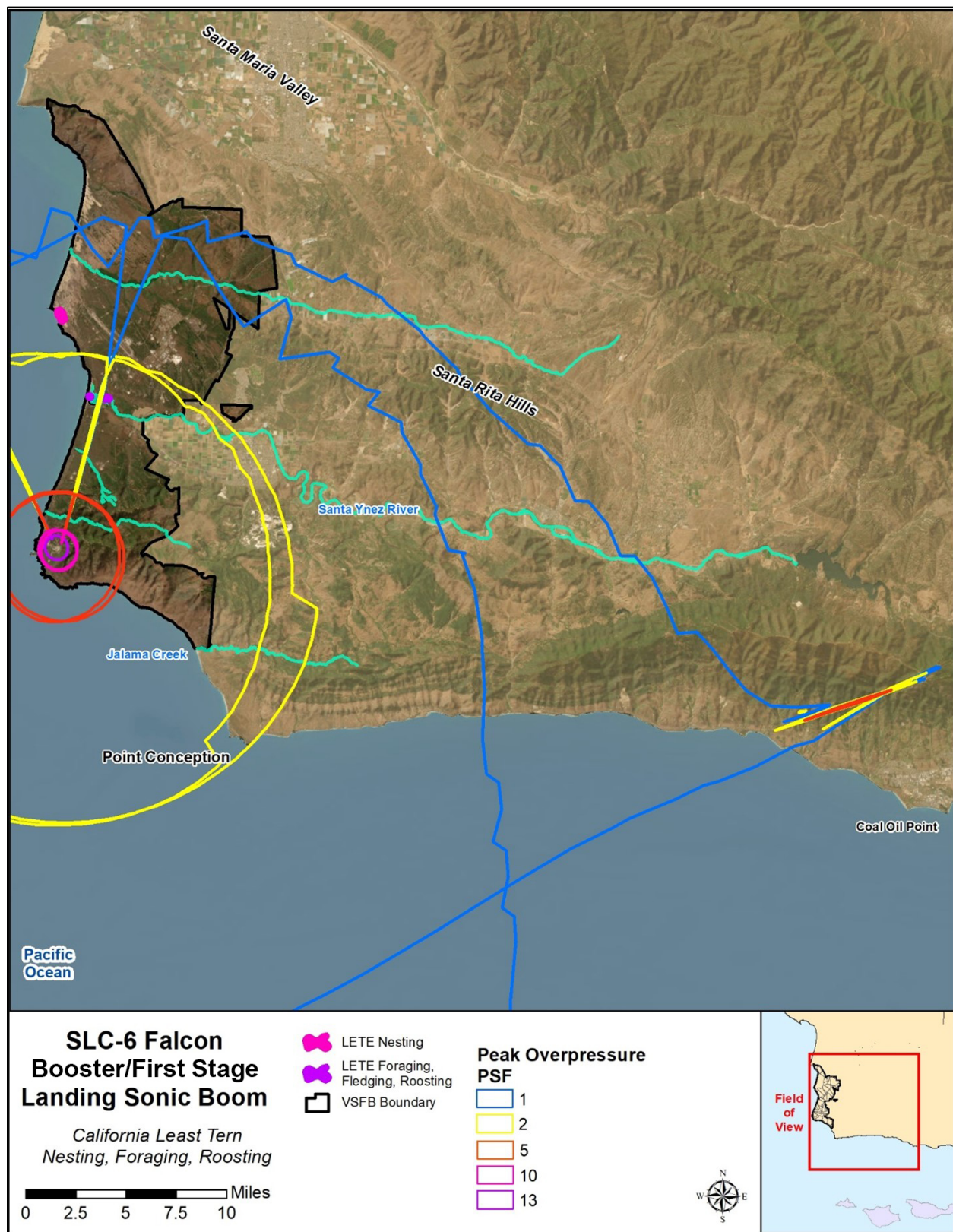


Figure 3P. California least tern occurrences and the project Sonic Boom Overpressure Effect Area during Falcon booster/first stage landing at SLC-6.

Sonic Boom Overpressure Effect Area; Launch Ascent

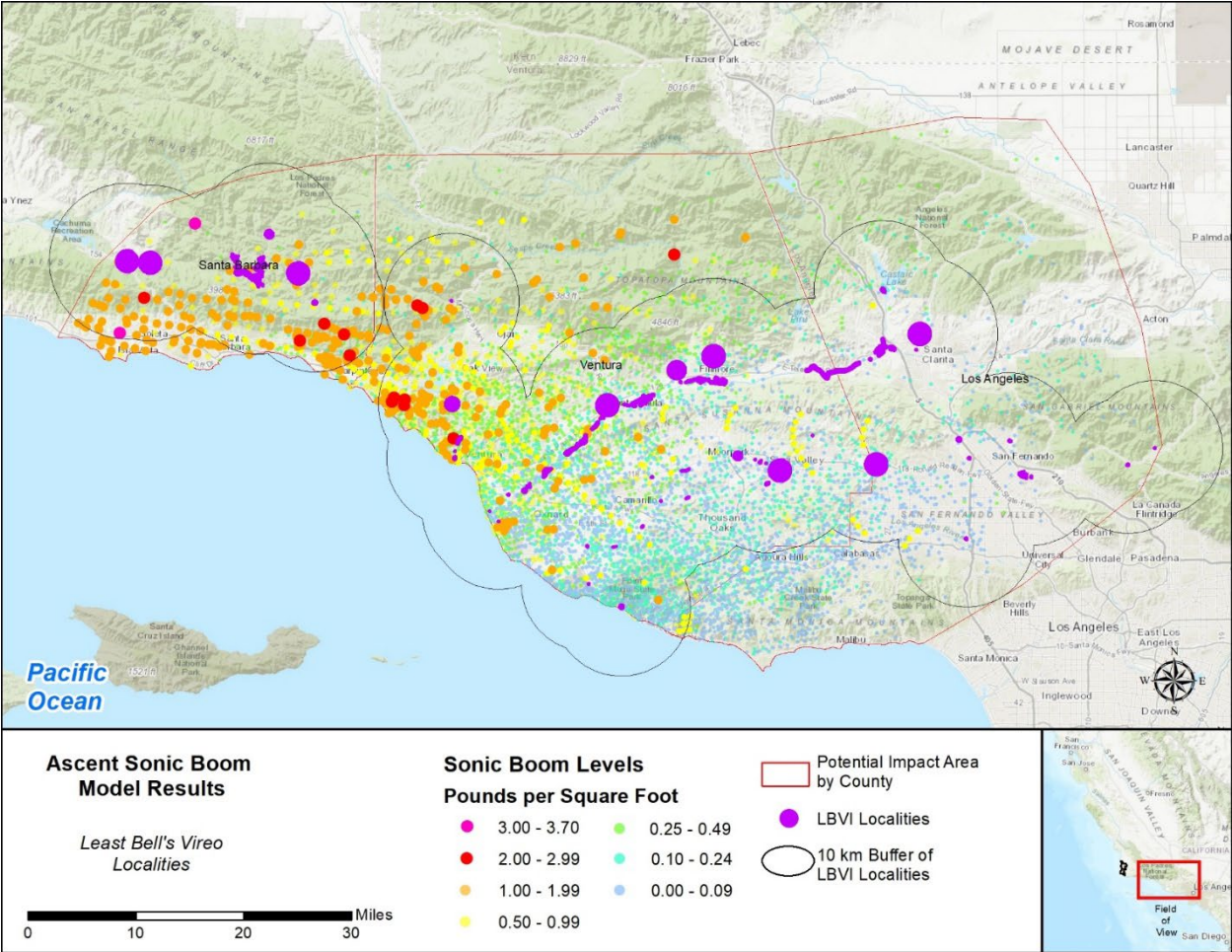


Figure 4A. Least Bell's vireo occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

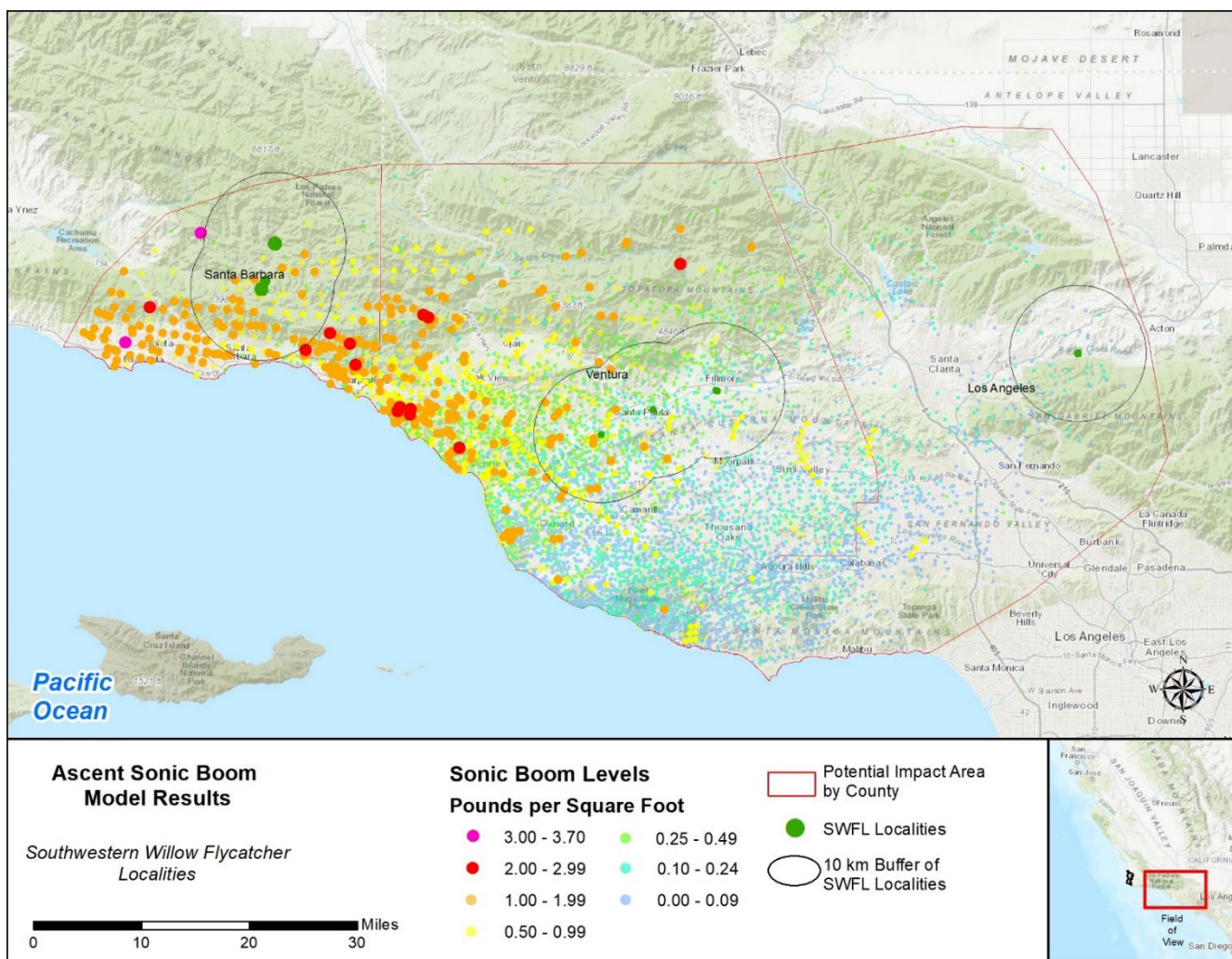


Figure 4B. Southwestern willow flycatcher occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

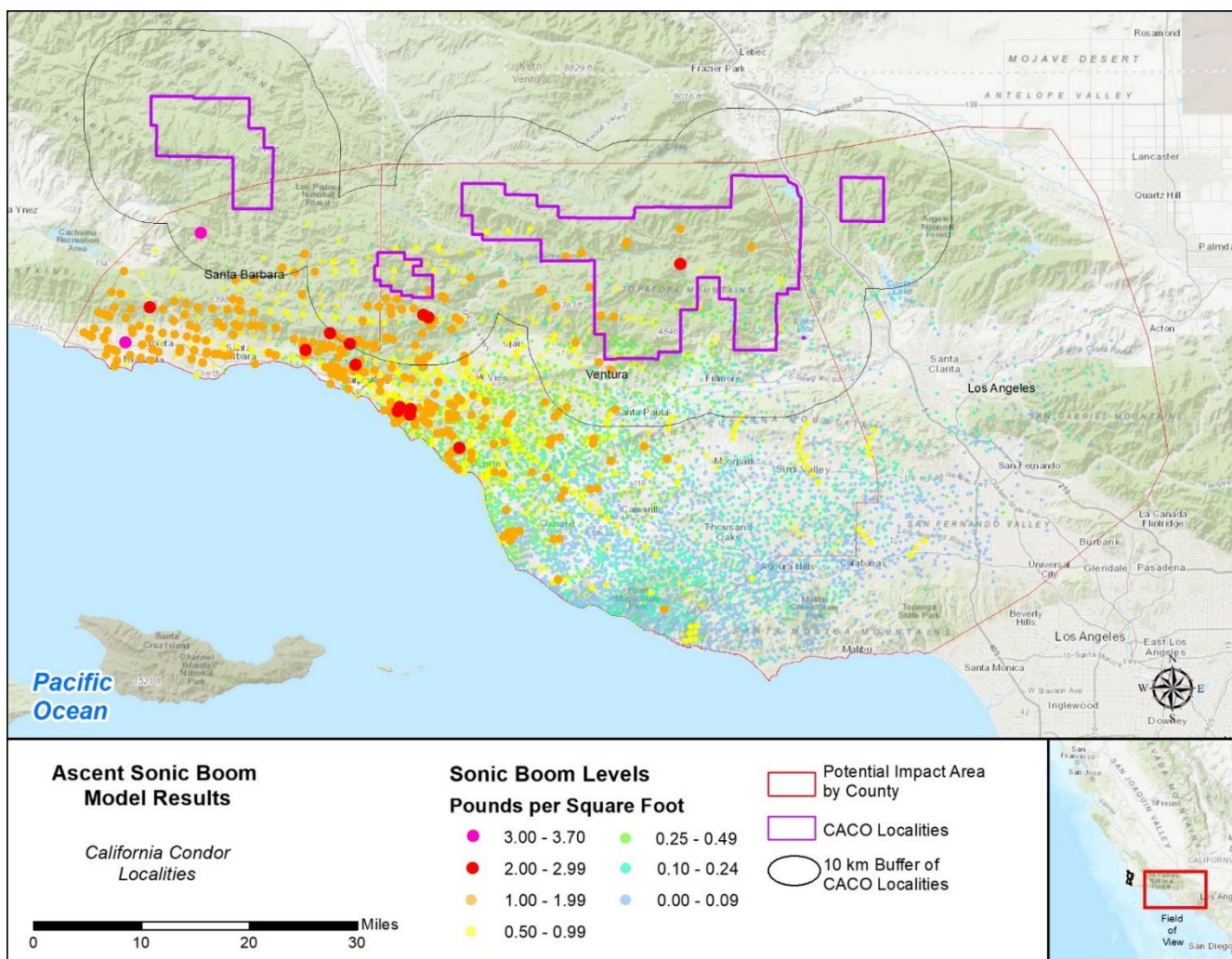


Figure 4C. California condor occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

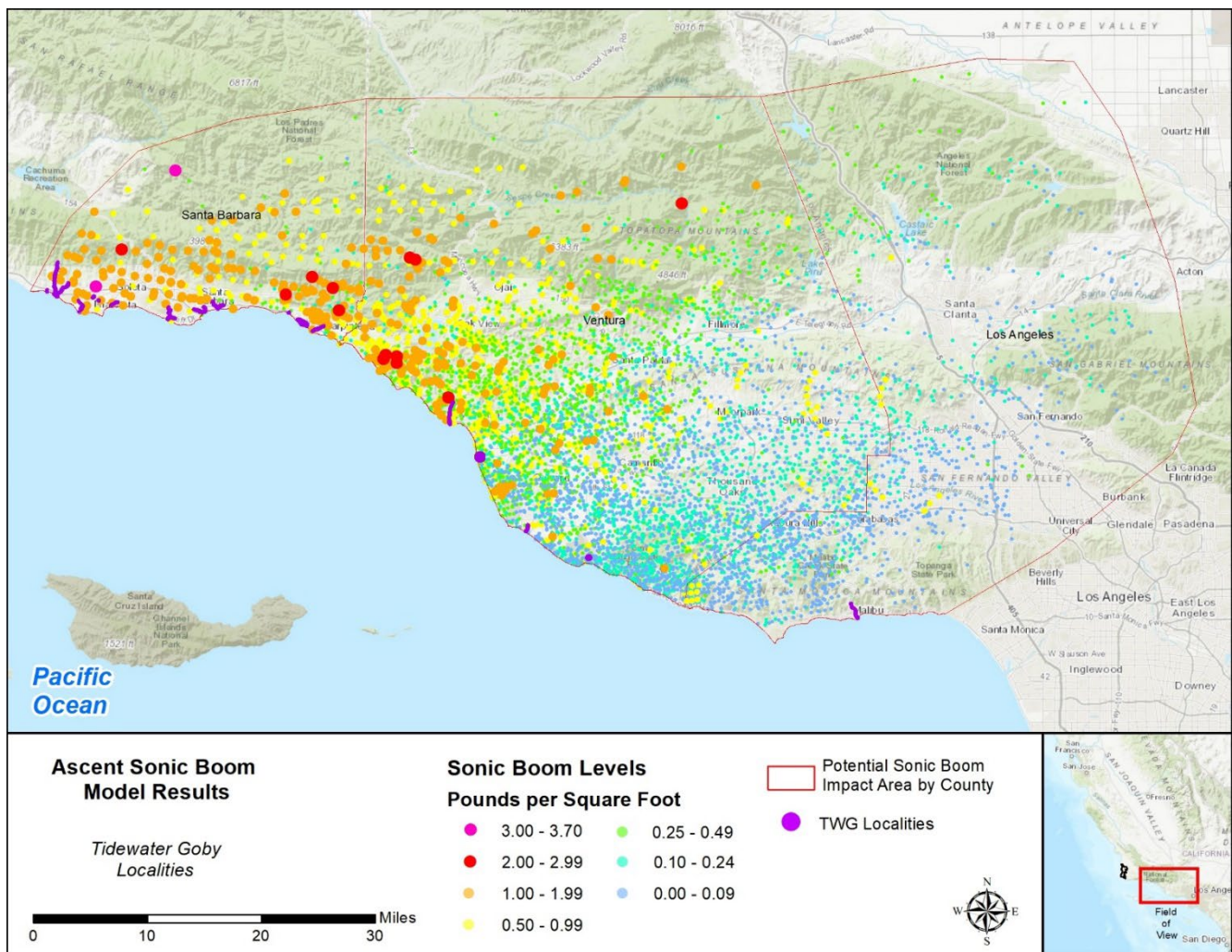


Figure 4D. Tidewater goby occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

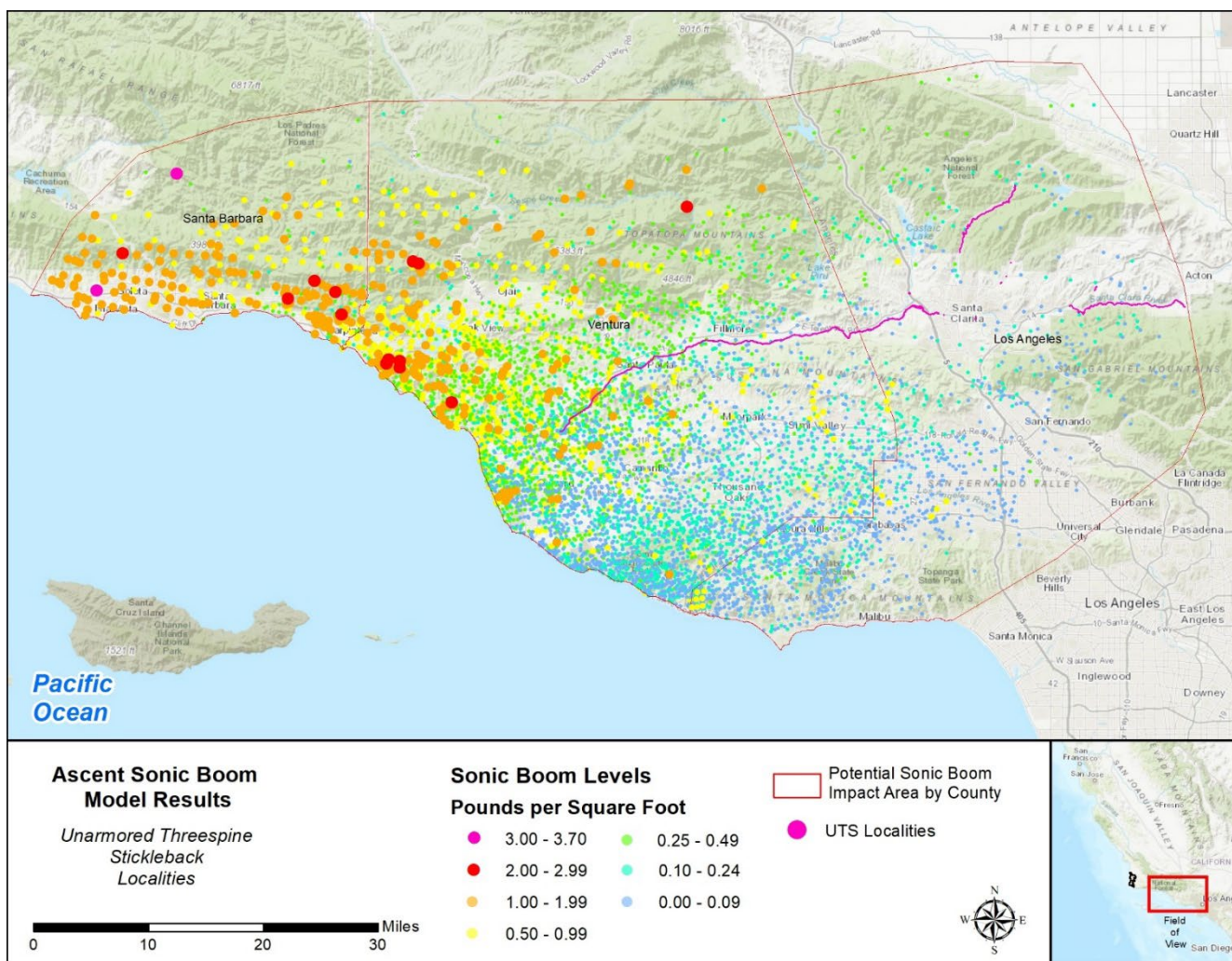


Figure 4E. Unarmored threespine stickleback occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

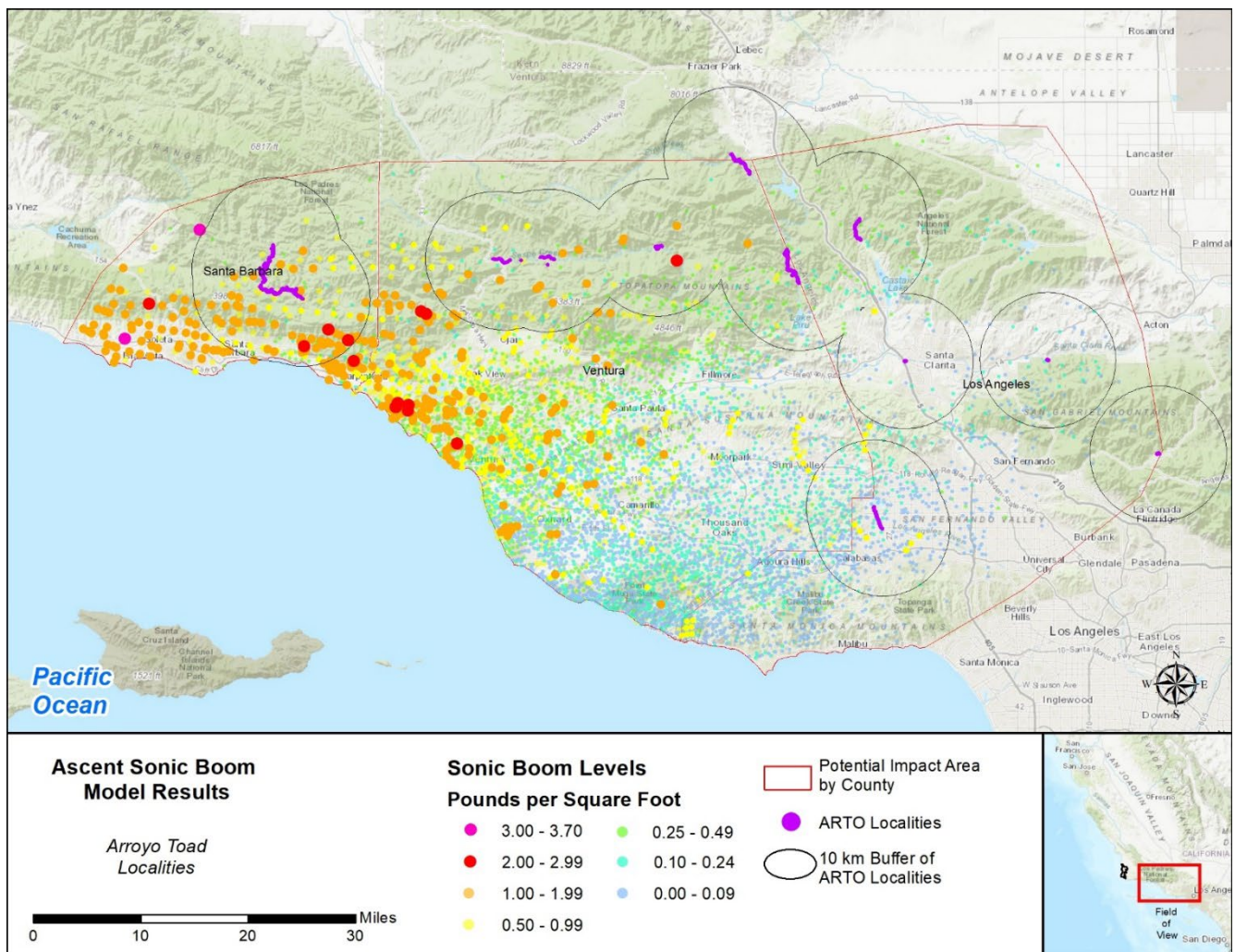


Figure 4F. Arroyo toad occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

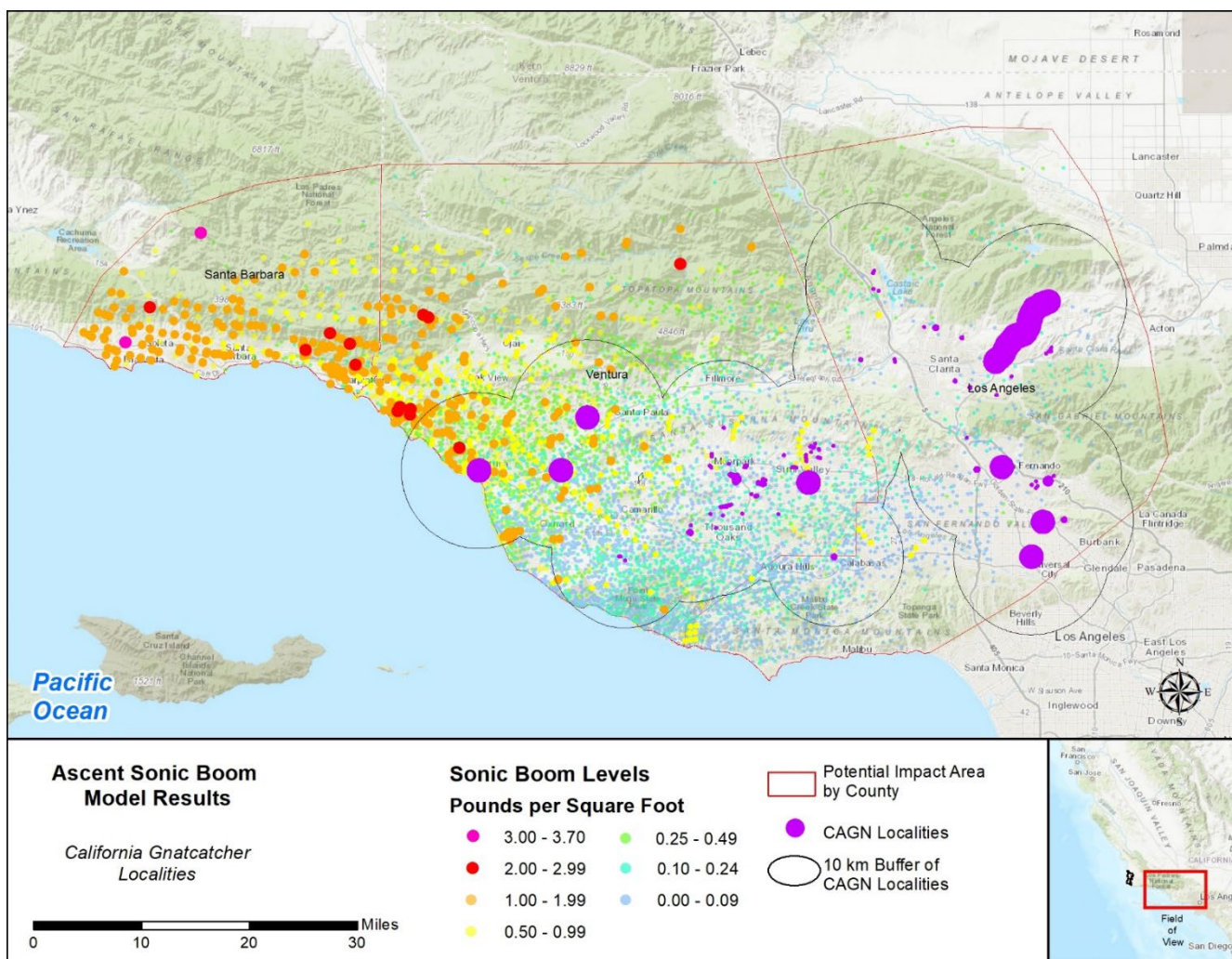


Figure 4G. Coastal California gnatcatcher occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

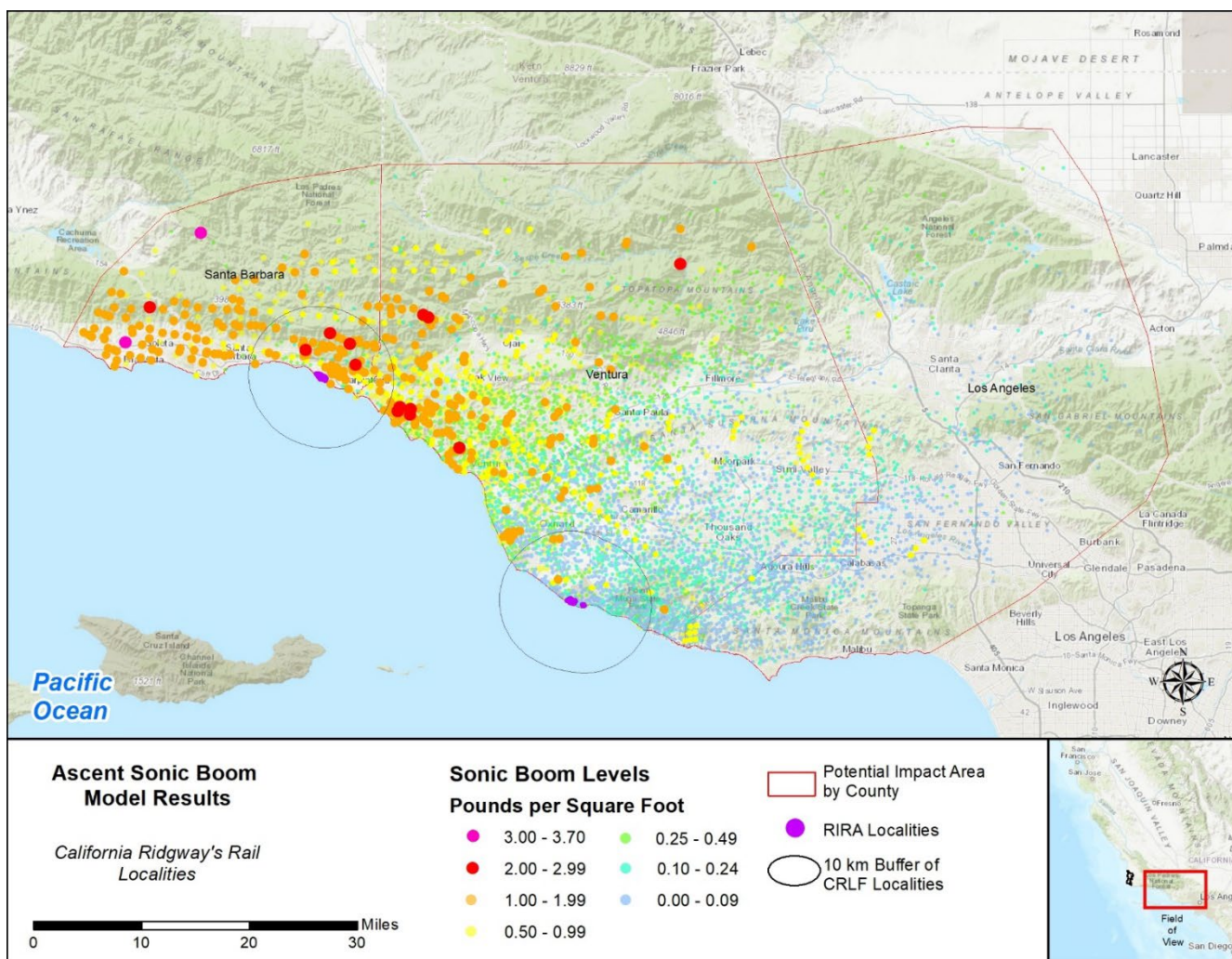


Figure 4H. California ridgway's rail occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

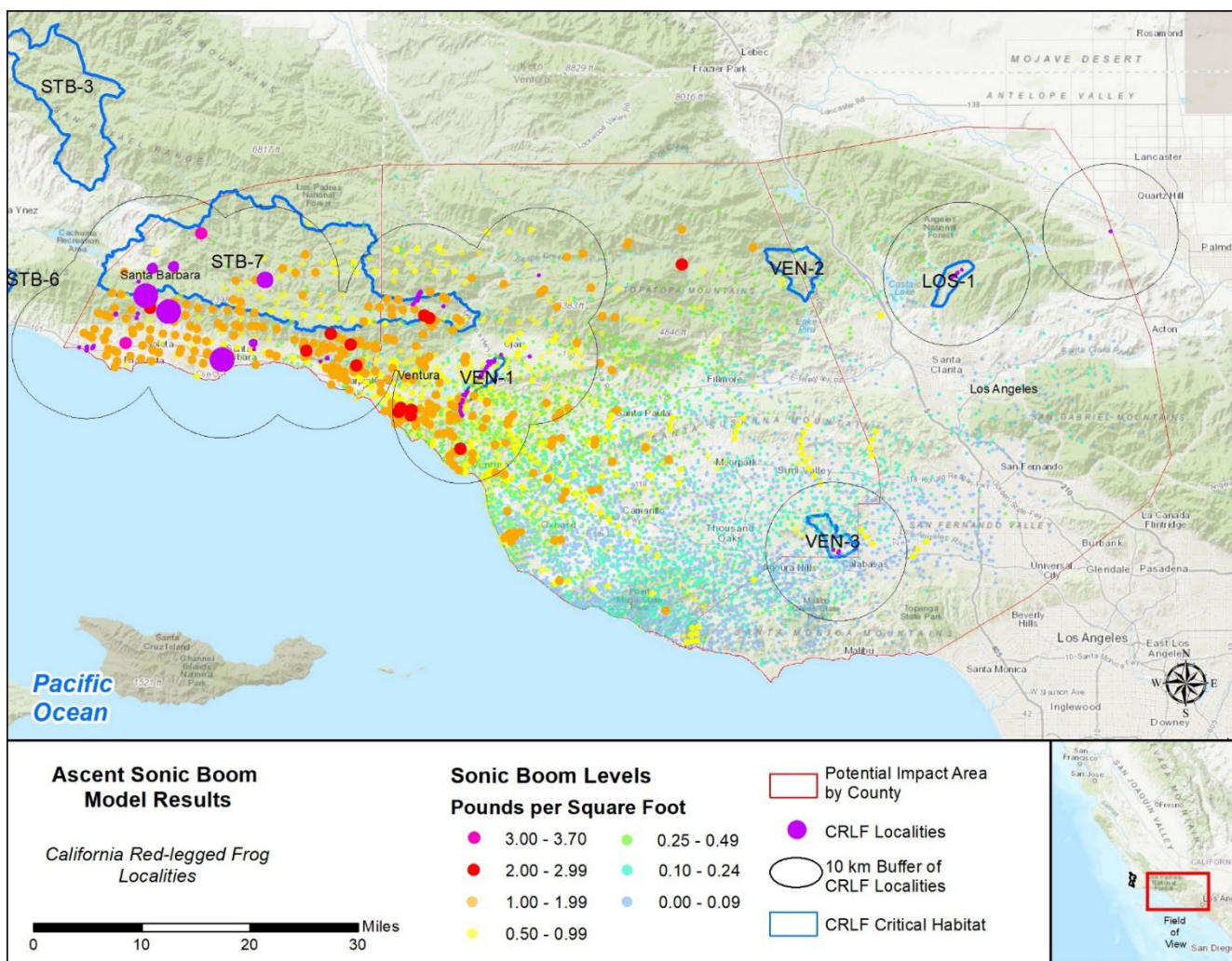


Figure 4I. California red-legged frog occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

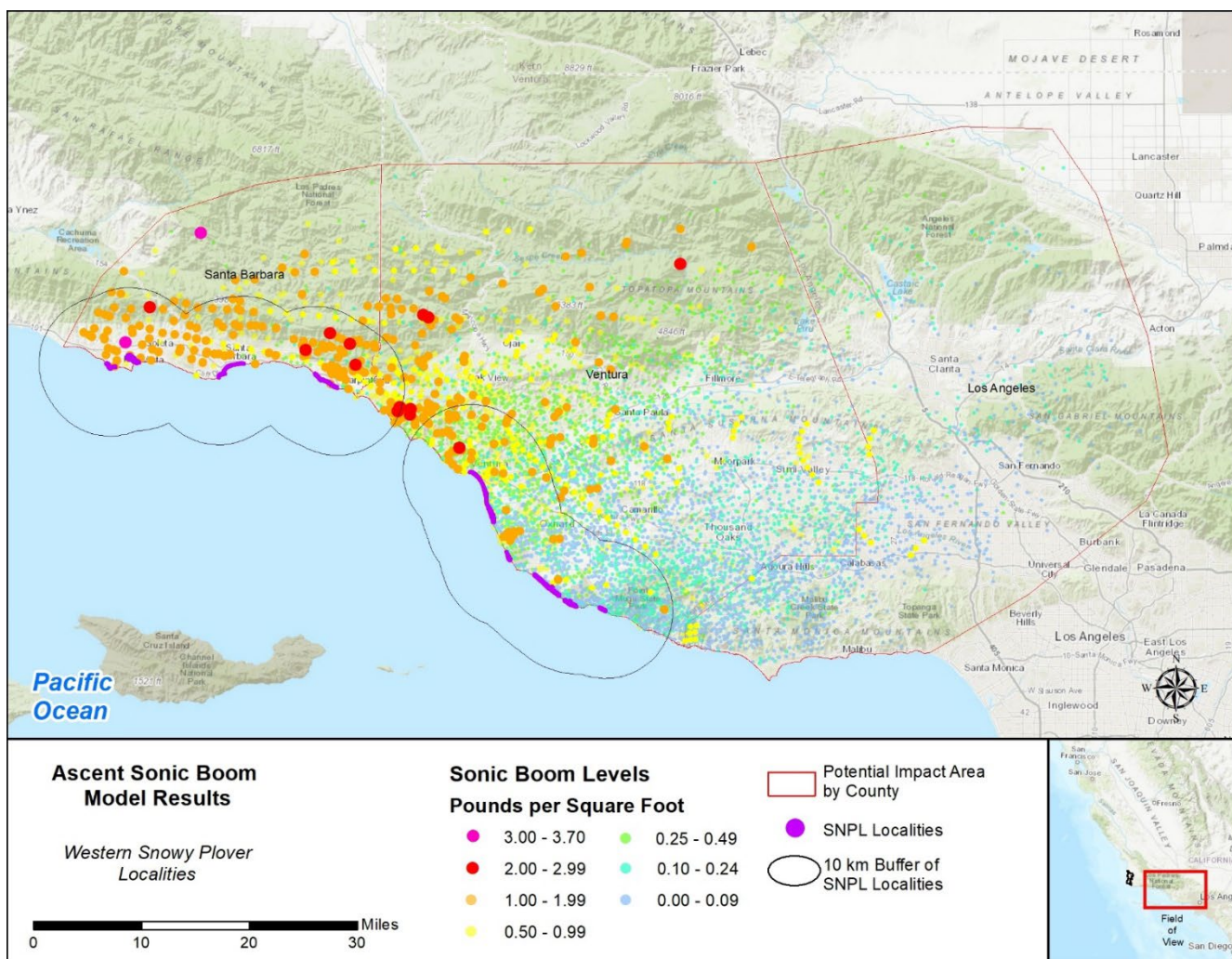


Figure 4J. Western snowy plover occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

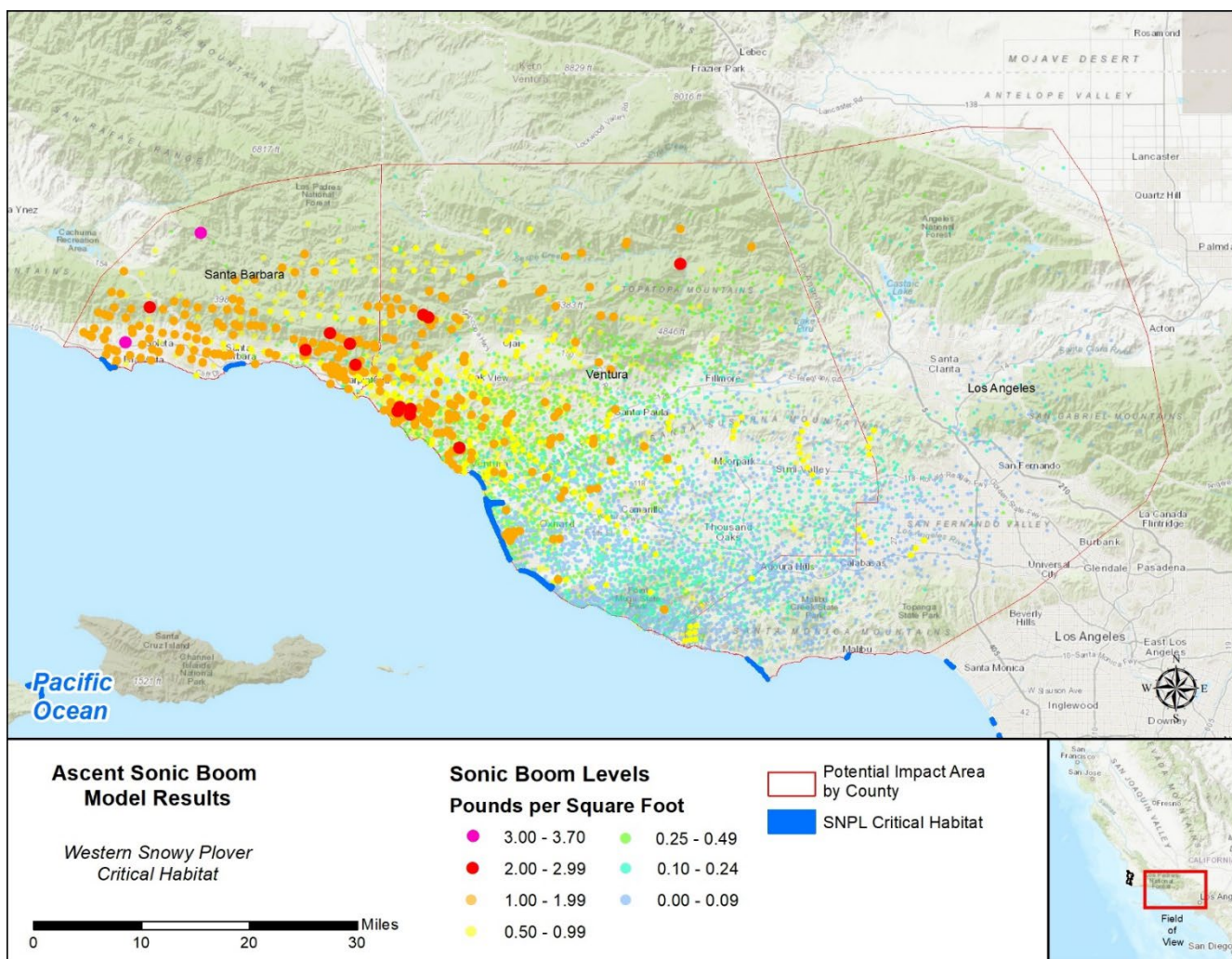


Figure 4K. Western snowy plover Critical Habitat and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.



Figure 4L. Western snowy plover Critical habitat and a sample launch ascent from SLC-4 Falcon 9 demonstrates the potential of overpressure of up to 5 psf, which could impact the northern Channel Islands.

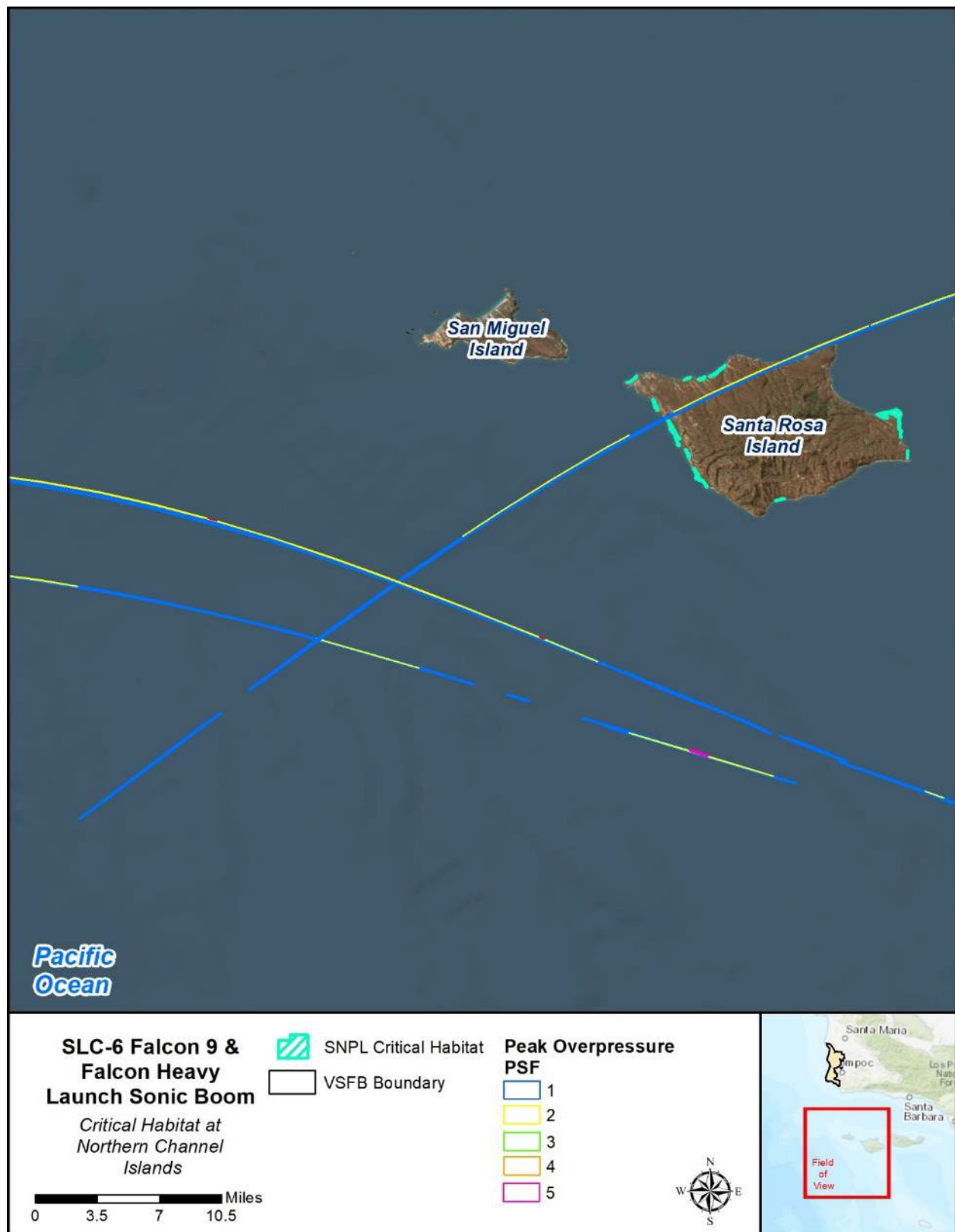


Figure 4M. Western snowy plover Critical habitat and two samples of launch ascents from SLC-6 Falcon 9 and Falcon Heavy demonstrate the potential of overpressure of at least 1 psf, which could impact the northern Channel Islands.

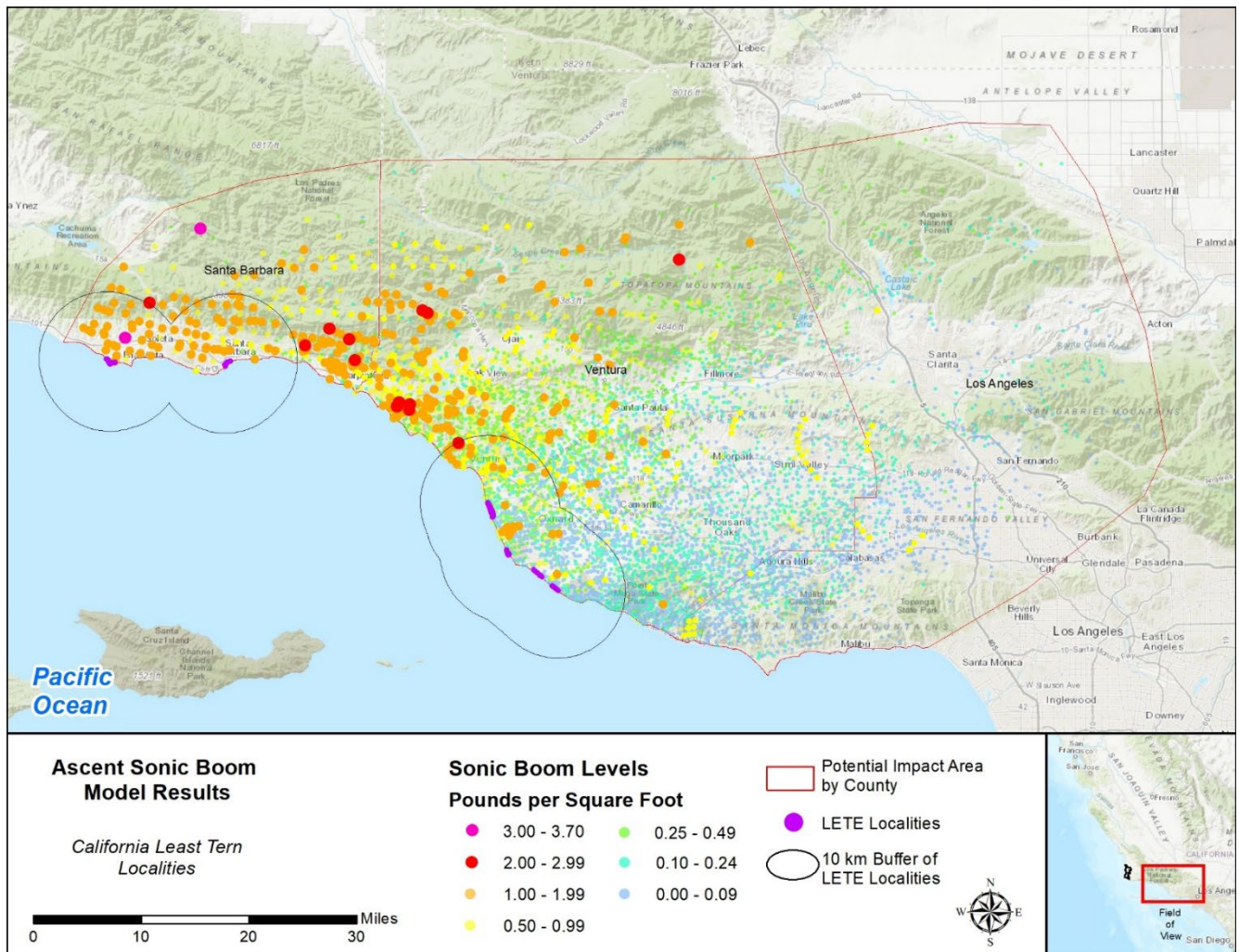


Figure 4N. California least tern occurrences and the Sonic Boom Overpressure Effect Area impacting mainland California during launch ascent.

Northerly Barge Landing Boom

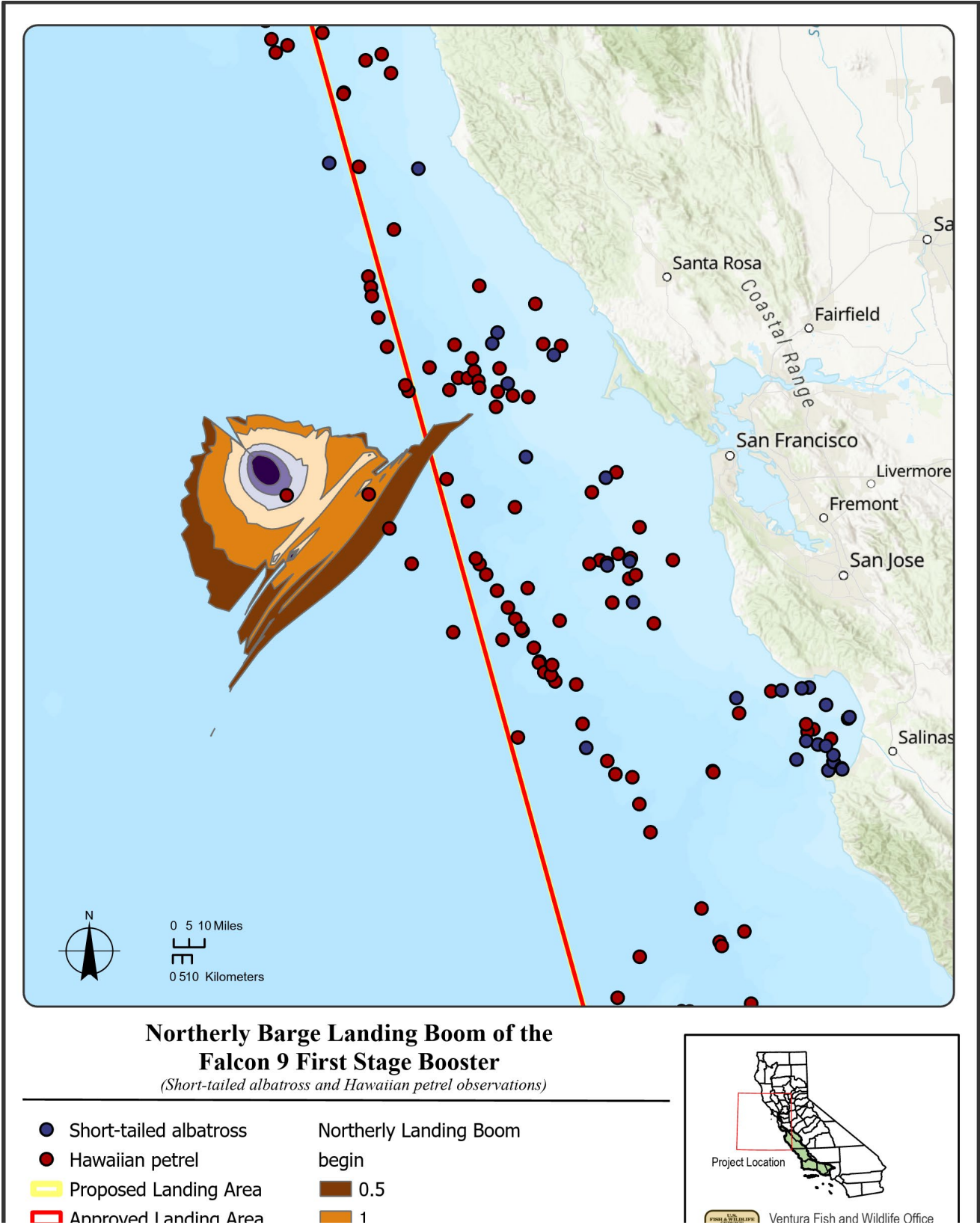


Figure 5A. Short-tailed albatross and Hawaiian petrel e-bird observations and the northerly barge landing sonic boom of the Falcon 9 first stage booster.

Construction Activities



Figure 6A. Proposed Construction Site Plan at SLC-6.

Boost-back Landing Operations

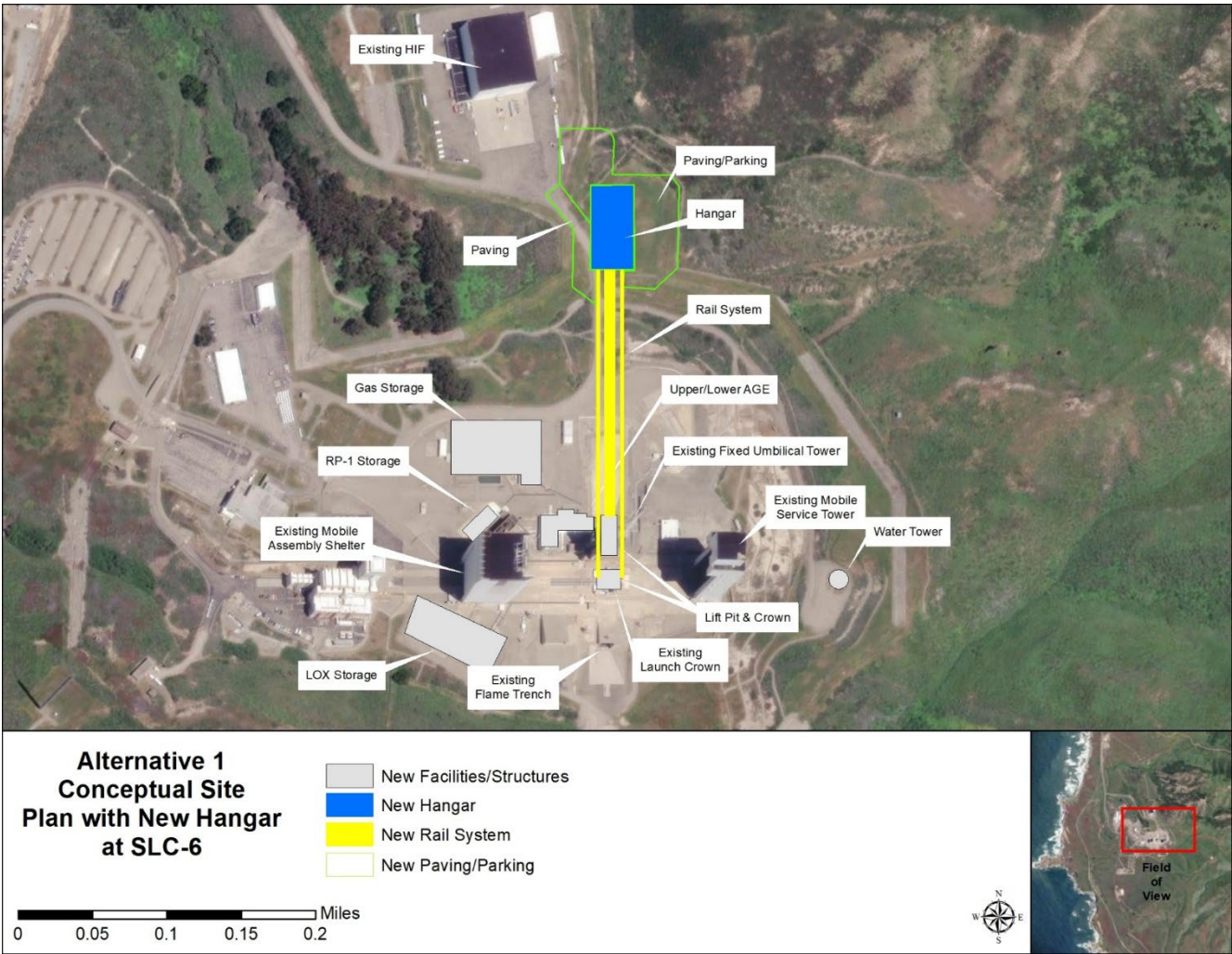


Figure 7A. Booster Recovery Area at SLC-6.

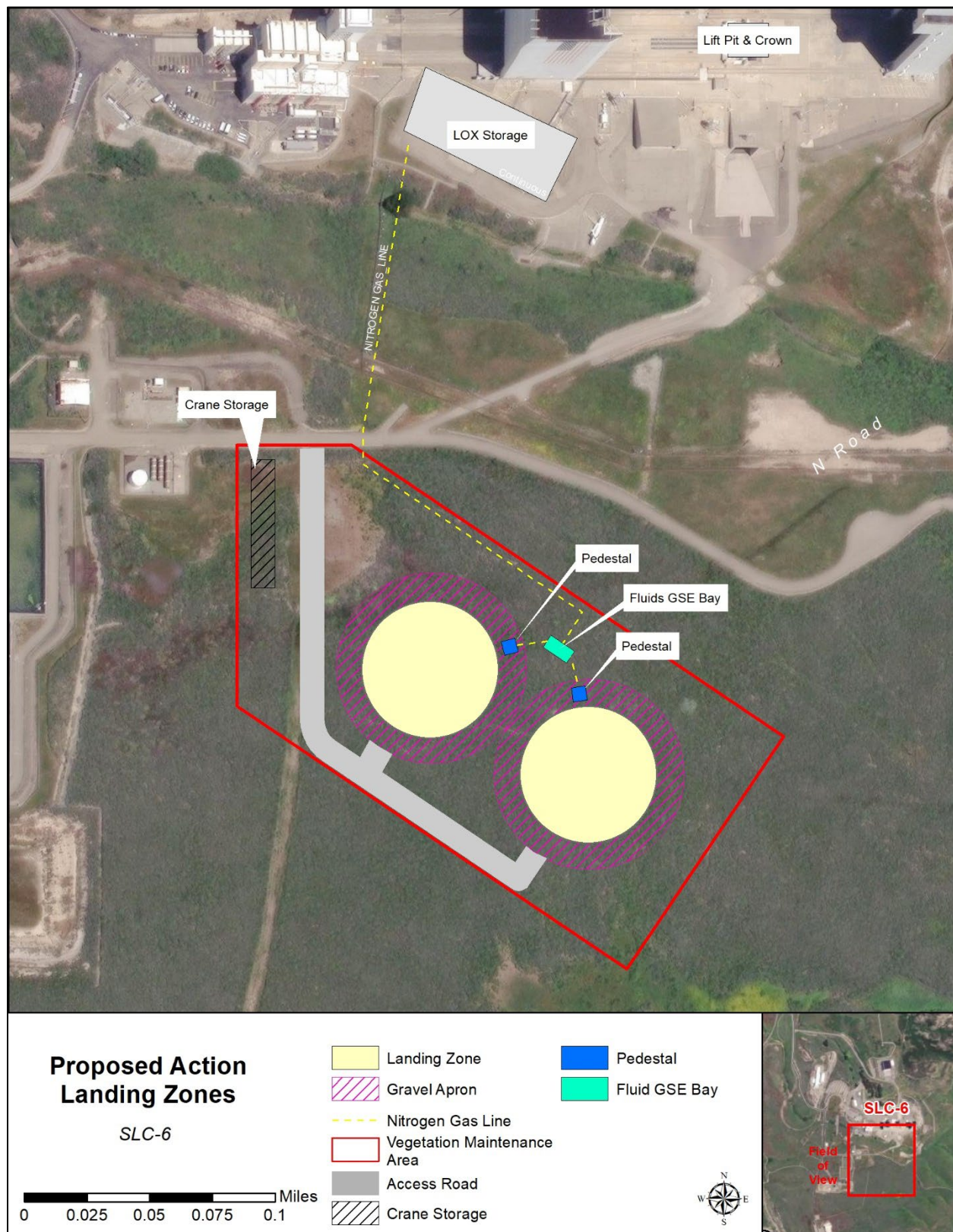


Figure 7B. Proposed Landing Zones at SLC-6.

Western Snowy Plover Annual Breeding Population Trends

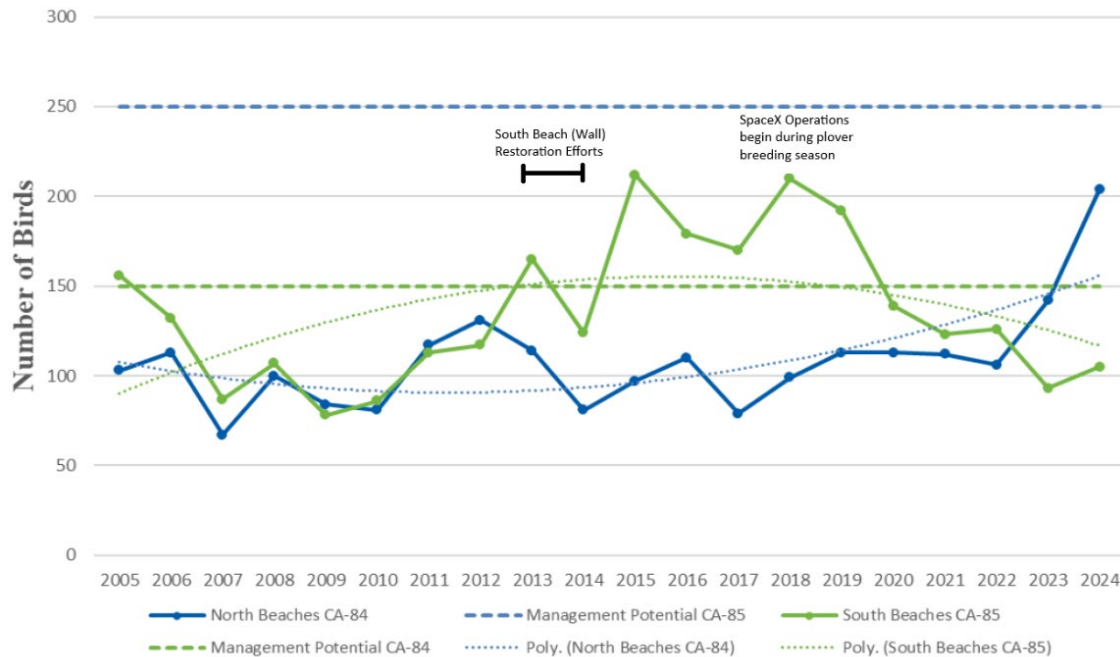


Figure 8A. Trends in annual breeding population on North and South Beaches, assessed using maximum number of adults observed during window surveys 2005-2024. Dotted lines show the polynomial trendline.

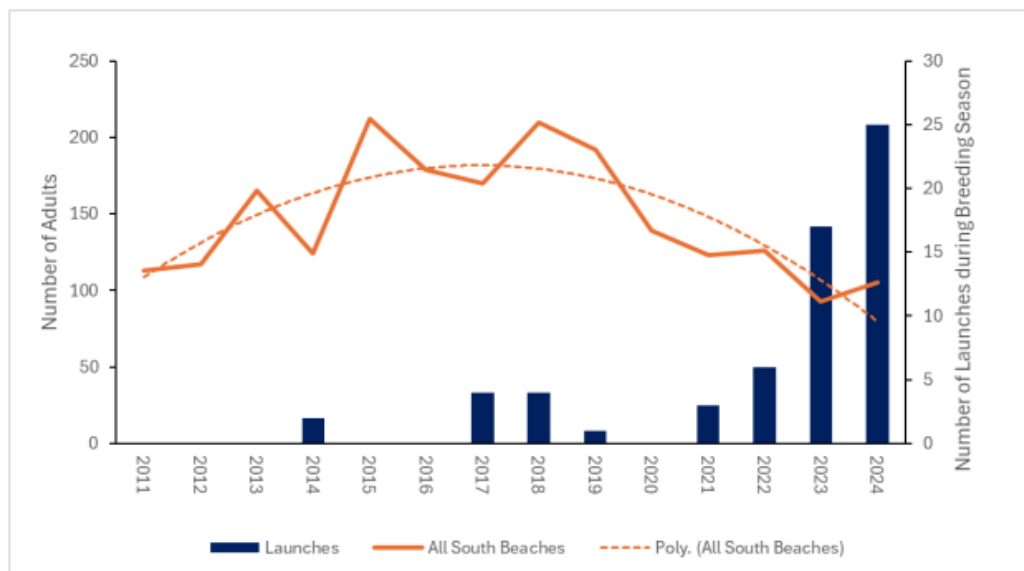


Figure 10. Trends in annual breeding population for all South Beaches with a polynomial trendline over the total number of launches during the breeding season (March-September) from south base launch facilities (SLC 3, 4 and 6).

Figure 8B. Trends in annual breeding population for all South Beaches with a polynomial trendline over the total number of launches during the breeding season (March to September) from south base launch facilities.

APPENDIX B – Conservation Strategy

Proposed Conservation Strategy for VSFB 100 Launches

Goal:

- Provide flexibility for the military’s mission while supporting listed species conservation.
- Create regional gains in species’ populations or critical habitat elements due to proactive conservation actions that are accounted for and credited to achieve DOD’s goal of no net loss.
- Leverage existing collaborations and partnerships including Sentinel Landscapes, Recovery and Sustainment Partnership, and Integrated Natural Resource Management Plan to provide conservation benefits.

Recommended Conservation Actions for 100 launches

To promote conservation of plover, tern, frog, and turtle, we recommend the following be incorporated into the proposed project description for 100 launches:

Western snowy plover and California least tern

- Offsite predator management, enforcement, and habitat restoration on an equal length of shoreline habitat to habitat that will experience launch impacts. The area where we expect demographic impacts meets the following criteria:
 - Occupied breeding and overwintering habitat that will experience routine high level multi-sensory disturbance including acute noise of >125dB(A) ¹ and/ or increased lighting reaching 50 millilux² (e.g., ~8 km of Surf Beach using current understood SLC-4 Falcon-9 operational impacts). We understand there is high potential that shorebirds in this area will experience repeat auditory harm, declines in roosting success, decreased residency time, and displacement, which we expect is likely to lead to both short and long-term demographic effects³.
 - Baseline annual cost: \$130,000/km, with an additional 3% annual inflation, 4% fund management, 10% contingency.
- Cease any in-person launch monitoring and reduce nest camera monitoring efforts (A&M-6, 9, T&C 10-11 per Service 2023, 2022-0013990-S7-001).

¹ This area is where information from previous launches have demonstrated levels where we expect repeated adverse effects including the potential for injury or harm to plovers and terns. Potential for auditory harm from repeat impulse noise threshold within Dooling, R. J., and A. N. Popper. 2007. The Effects of Highway Noise on Birds. Report prepared for the California Department of Transportation Division of Environmental Analysis. 74 pp. Please note that more recent available information depicting lower potential and future realized thresholds should also be considered (refer to Heller and Benkafadar 2025 acoustic harm study proposal; 110-125 dB SPL).

² Anticipated lighting threshold for reduced roosting success within Simons, A. L., K. L. M. Martin, and T. Longcore. 2021. Determining the Effects of Artificial Light at Night on the Distributions of Western Snowy Plovers (*Charadrius nivosus.nivosus*) and California Gunion (*Leuresthes tenuis*) in Southern California. *Journal of Coastal Research* 38(2). Available online: <<https://bioone.org/journals/journal-of-coastal-research/volume-38/issue-2/JCOASTRES-D-21-00107.1/Determining-the-Effects-of-Artificial-Light-at-Night-on-the/10.2112/JCOASTRES-D-21-00107.1.full>>. Accessed June 18, 2024.

³ Refer to pages 89-96 of the effects analysis within U.S. Fish and Wildlife Service. 2024. Biological Opinion on the Launch, Boost-Back, and Landing of the Falcon 9 First Stage at Space Launch Complex 4 (SLC-4) with project modification to include up to 16 additional launches between October 1 and December 31, 2024, Vandenberg Space Force Base, Santa Barbara County, California. (2022-0013990-S7-001-R001). Ventura Fish and Wildlife Office, Ventura, California. 130 pp.

- Continue current “regular” on-base plover and tern monitoring programs across the base as part of section 7(a)1 and other consultations (Service 2015, 8-8-12-F-11R).
- Monitor launch impacts and management action effectiveness for plover and terns (using data collected 2025 to end of BO term, and in-progress model created by SpaceX’s contractor, SCWA)
- ✓ If 5 years of monitoring indicate conservation actions are demonstrating greater population gains than the goal of no net loss, and/or combined sensory disturbance data indicate a less than expected impact, Space Force/SpaceX will work with the Service to determine where less restoration/management is needed.
- ✓ If 5 years of monitoring indicate conservation actions are unable to quantifiably demonstrate the goal of no net loss has been attained, and/or combined sensory disturbance data indicate a greater than expected impact, Space Force/SpaceX will provide additional funding that supports expanded restoration work in coordination with the Service or develop a suitable alternative to achieve the goal of no net loss.

California red-legged frog and southwestern pond turtle

For implementation as part of 100 launch proposed project4:

- Conduct predator management for bullfrogs and crayfish on base along San Antonio Creek and Santa Ynez River on an annual basis equivalent to 1 part time staff person during breeding season in addition to incidental work conducted during species surveys.
- Conduct frog and turtle habitat restoration of Miguelito wetlands or similar local site.
- Reduce proposed quarterly frog and turtle surveys to biannual effort (including surveys during appropriate breeding seasons).
- Monitor launch impacts and management action effectiveness for frogs and turtles (using data collected 2025 to end of BO term and future analysis involving agreed upon control site)
- ✓ If 5 years of monitoring indicate conservation actions are demonstrating greater population gains than the goal of no net loss, Space Force/SpaceX will work with the Service to determine where less restoration/management is needed.
- ✓ If 5 years of monitoring indicate conservation actions are unable to quantifiably demonstrate the goal of no net loss has been attained, Space Force/SpaceX will conduct additional conservation actions that supports expanded restoration work in coordination with the Service.

Western Monarch Butterfly Conservation Recommendations:

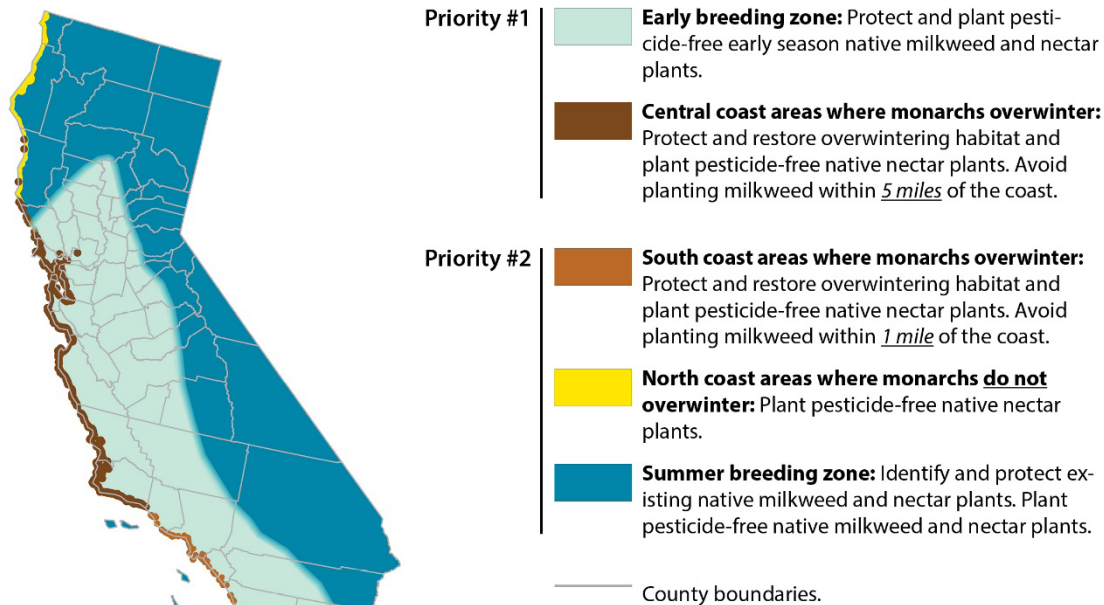
Purpose: Section 7(a)(1) of the Endangered Species Act of 1973 (ESA), directs federal agencies to use their authorities to further the purpose of the ESA, by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid and minimize the adverse effects of a proposed action, implement recovery plans, or to develop information that is useful for the conservation of listed

⁴ Refer to pages 67-75 and 77-88 of the species effects analysis within U.S. Fish and Wildlife Service. 2024. Biological Opinion on the Launch, Boost-Back, and Landing of the Falcon 9 First Stage at Space Launch Complex 4 (SLC-4) with project modification to include up to 16 additional launches between October 1 and December 31, 2024, Vandenberg Space Force Base, Santa Barbara County, California. (2022-0013990-S7-001-R001). Ventura Fish and Wildlife Office, Ventura, California. 130 pp.

species. The purpose of the following conservation recommendations is to encourage federal agencies to incorporate monarch butterflies as applicable into their Environmental Assessments and Biological Assessments associated with Section 7 Biological Opinions, when in consultation with the U.S. Fish & Wildlife Service.

Background: The western migratory monarch butterfly population has declined by more than 99 percent since the 1980s. An estimated 4.5 million monarchs overwintered on the California coast in the 1980s, whereas in 2020, the population estimate for overwintering monarchs was less than 2,000 butterflies. This extreme population decline is likely due to multiple stressors across the monarch's range, including the loss and degradation of overwintering groves; pesticide use, particularly insecticides; loss of breeding and migratory habitat; climate change; parasites and disease. Historically, the majority of western monarchs spent the winter in forested groves near the coast from Mendocino County, California, south into northern Baja California, Mexico. In recent years, monarchs have not clustered in the southern-most or northern-most parts of their overwintering range, and there are year-round residents in some areas of the coast. This resident phenomenon is likely due to a combination of climate change and an abundance of residential-planted non-native, tropical milkweed that is available for monarchs year-round. Migratory western monarchs depart the overwintering groves in mid-winter to early-spring. Throughout the spring and summer, monarchs breed, lay their eggs on milkweed, and migrate across multiple generations within California and other states west of the Rocky Mountains. In an attempt to reverse the severe population decline of western monarch butterflies, and to protect other pollinators as well, we encourage implementation of the conservation recommendations listed below. Please see Figure 1 for suggested areas to focus voluntary conservation actions in California. Western monarch conservation actions outside of California are also important, especially for the larger pollinator community. Recommendations for other western states are addressed in the "All Breeding and Migratory Zones" section of this document.

Priority Action Zones in California for Recovering Western Monarchs



San Diego Zoo
Wildlife Alliance

Figure 1. Priority Monarch Habitat Restoration Areas in California.

Coastal California Overwintering Habitat: Western monarchs migrate to the California coast, and cluster in a specific set of forested tree groves during the fall and winter each year. Overwintering groves provide protection from inclement weather and possess suitable vegetation and microclimate conditions for monarchs (e.g., roosting trees, wind protection, dappled sunlight, nectar sources, water and/or dew for hydration, high humidity, and an absence of freezing temperatures). In the overwintering zone of the coast (i.e., within five miles of the coast from Mendocino County south through Santa Barbara County, and within one mile of the coast from Ventura County south through San Diego County), we recommend the following:

1. Protect, manage, enhance and restore monarch butterfly overwintering groves ([Find An Overwintering Site](#)).
2. Use only native, insecticide-free plants for habitat restoration and enhancement actions.
3. Conduct overwintering grove habitat assessment(s), and develop and implement long-term grove management plans, as applicable. Management plan actions for groves may include, but are not limited to:
 - a. Enhance roosting trees within overwintering groves and within 1/2 mile of groves by planting trees (e.g., Monterey pine (*Pinus radiata*), Monterey cypress (*Cupressus macrocarpa*), Coast redwood (*Sequoia sempervirens*), coast live oak (*Quercus agrifolia*), Douglas fir (*Pseudotsuga menziesii*), Torrey pine (*Pinus torreyana*), western

sycamore (*Platanus racemosa*), bishop pine (*Pinus muricata*) and others, as appropriate for location).

- b. Avoid the removal of trees or shrubs within 1/2 mile of overwintering groves, except for specific grove management purposes, and/or for human health and safety concerns. The maintenance of trees and shrubs within a 1/2 mile of these sites provides a buffer to preserve the microclimate conditions of the winter habitat.
 - c. Conduct management activities (e.g., tree trimming, mowing, burning and grazing) in monarch overwintering groves from March 16-September 14 (outside of estimated timeframe when monarchs are likely present), in coordination with a monarch biologist.
 - d. Enhance nectar sources by planting fall/winter blooming forbs or shrubs within overwintering groves and within one mile of the groves ([Nectar Planting Lists](#)).
4. Protect monarchs, other pollinators, and their habitats from pesticides (i.e., insecticides and herbicides). Specific recommendations may vary by site.
- a. Avoid the use pesticides within one mile of overwintering groves, particularly when monarchs may be present. If pesticides are used, then conduct applications from March 16-September 14, when possible.
 - b. Screen all classes of pesticides for pollinator risk to avoid harmful applications, including biological pesticides such as *Bacillus thuringiensis* ([UC Integrated Pest Management](#)).
 - c. Avoid the use of neonicotinoids or other systemic insecticides, including coated seeds, any time of the year in monarch habitat due to their ecosystem persistence, systemic nature, and toxicity.
 - d. Consider non-chemical weed control techniques, when possible ([Cal-IPC Non-chemical BMPs](#)).
 - e. Avoid herbicide application on blooming flowers. Apply herbicides during young plant phases, when plants are more responsive to treatment, and when monarchs and other pollinators are less likely to be nectaring on the plants.
 - f. Whenever possible, use targeted application herbicide methods, avoid large-scale broadcast applications, and take precautions to limit off-site movement of herbicides (e.g., drift from wind and discharge from surface water flows).
 - g. Separate habitat areas from areas receiving chemical treatments with a pesticide-free spatial buffer and/or evergreen vegetative buffer of coniferous, non-flowering trees to capture chemical drift. The appropriate monarch and pollinator habitat spatial buffer

size depends on several factors, including weather and wind conditions, but at a minimum, the habitat should be at least 40 feet from ground-based pesticide applications, 60 feet from air-blast sprayers, and 125 feet from any systemic insecticide applications or seed-treated plants.

5. To minimize the spread of the pathogen *Ophryocystis elektroscirrha* (OE), and to encourage natural monarch migration, do not plant non-native tropical milkweed (*Asclepias curassavica*). OE is able to build up on tropical milkweed, because these plants are evergreen, and they do not die back in the winter. OE can be debilitating and/or lethal to monarchs.
6. Remove tropical milkweed that is detected, and replace it with nectar plants suitable for the location ([Nectar Planting Lists](#)).
7. To assist in maintaining normal migration behavior, do not plant any type of milkweed within five miles of the coast from Mendocino County south through Santa Barbara County, and within one mile of the coast south of Santa Barbara County.
8. After appropriate training, conduct grove monitoring for butterflies during the Western Monarch Counts each fall and winter. When possible, report when monarchs arrive and depart the groves each year ([Western Monarch Count](#)).
9. To provide benefits for monarchs and other pollinators anywhere on the landscape within the overwintering zone, install a mosaic of nectar plants that bloom throughout the year, as is feasible ([Nectar Planting Lists](#)).

Breeding and Migratory Habitat: Monarch butterflies breed and migrate across multiple generations each year throughout the western U.S. The early breeding zone (i.e., Priority 1) is an estimated area in California where monarchs are likely to breed and/or lay their eggs on milkweed after departing the overwintering groves in mid-winter to early spring each year (See Figure 1, above). Early emerging milkweed species are likely a limiting factor on the landscape in the early breeding zone and may be associated with the severe population decline of western monarchs, and these plants are essential to successfully create the next generation of migratory butterflies. For monarch breeding and migratory habitat, we recommend the following:

Priority 1 Zone:

1. Enhance and maintain habitat in the Priority 1 early breeding zone of California, (Figure 1, above), by identifying and protecting existing habitat, and planting native, insecticide-free early-emerging milkweed species (e.g., *Asclepias vestita*, *A. californica*, *A. eriocarpa*, *A. cordifolia*, *A. erosa*), and flowering plants that are available to monarchs from January-April, as appropriate for the project location ([Nectar Planting Lists; Milkweed Seed Finder](#)).

For All Breeding and Migratory Zones:

2. Use only native, insecticide-free plants for habitat restoration and enhancement actions.

3. Enhance and maintain habitat in the Priority 2 zone of California (Figure 1, above) and in other western States, by identifying and protecting existing habitat, and planting milkweed species and flowering plants that are appropriate for the location ([Nectar Planting Lists; Milkweed Seed Finder](#)).
4. Conduct management activities such as mowing, burning and grazing in monarch breeding and migratory habitat outside of the estimated timeframe when monarchs are likely present (Figure 2, Recommended Management Timing Map, below).
5. Protect monarchs, other pollinators, and their habitats from pesticides (i.e., insecticides and herbicides).
 - a. Avoid the use of pesticides when monarchs may be present, when feasible (Figure 2, Recommended Management Timing Map, below).
 - b. Screen all classes of pesticides for pollinator risk to avoid harmful applications, including biological pesticides such as *Bacillus thuringiensis* ([UC Integrated Pest Management](#)).
 - c. Avoid the use of neonicotinoids or other systemic insecticides, including coated seeds, any time of the year in monarch habitat due to their ecosystem persistence, systemic nature, and toxicity.
 - d. Consider non-chemical weed control techniques, when feasible ([Cal-IPC Non-chemical BMPs](#)).
 - e. Avoid herbicide application on blooming flowers. Apply herbicides during young plant phases, when plants are more responsive to treatment, and when monarchs and other pollinators are less likely to be nectaring on the plants.
 - f. Whenever possible, use targeted application herbicide methods, avoid large-scale broadcast applications, and take precautions to limit off-site movement of herbicides (e.g., drift from wind and discharge from surface water flows).
 - g. Separate habitat areas from areas receiving treatment with a pesticide-free spatial buffer and/or evergreen vegetative buffer of coniferous, non-flowering trees to capture chemical drift. The appropriate monarch and pollinator habitat spatial buffer size depends on several factors, including weather and wind conditions, but at a minimum, the habitat should be at least 40 feet from ground-based pesticide applications, 60 feet from air-blast sprayers, and 125 feet from any systemic insecticide applications or seed-treated plants.

6. To minimize the spread of the pathogen *Ophryocystis elektroscirrha* (OE), do not plant non-native tropical milkweed (*Asclepias curassavica*). OE can build up on tropical milkweed and infect monarchs, because these plants are evergreen and do not die back in the winter. OE can be lethal to monarchs.
7. Remove tropical milkweed that is detected, and replace it with milkweed and nectar plants appropriate for the location ([Nectar Planting Lists](#); [Milkweed Seed Finder](#)).
8. Report milkweed and monarch observations from all life stages, including breeding butterflies, to the [Monarch Milkweed Mapper](#) or via the [project portal](#) in the iNaturalist smartphone app.

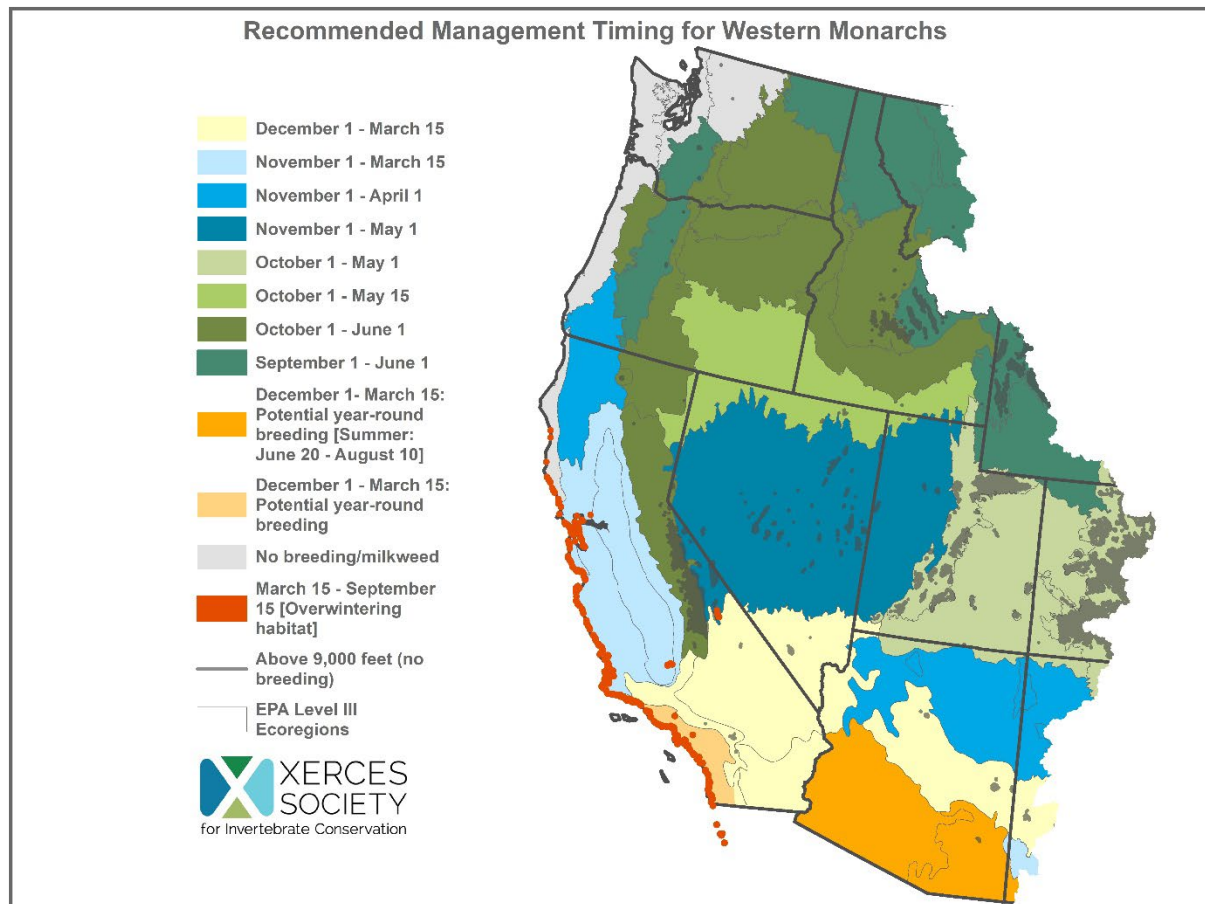


Figure 2. Recommended Management (i.e., mowing, burning, grazing, pesticide applications) Timing Windows in the western U.S. by Zone.

Notes: The management timing windows illustrated in Figure 2 represent approximate recommendations of timeframes to conduct management actions. These timeframes are based upon the best available current information and may be updated in the future. Each year and site is different, so when possible, please consider surveying milkweed plants for the early life stages of monarchs prior to burning, mowing, grazing or applying pesticides.



**DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 30**

9 April 2025

Gretchen Swinehart
30 CES/CEI
1028 Iceland Avenue
Vandenberg SFB CA 93437-6010

Ms. Catherine Darst
United States Fish and Wildlife Service
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003

Dear Ms. Darst

In accordance with section 7 of the Endangered Species Act of 1973, Vandenberg Space Force Base requests reinitiation of Biological Opinion 2022-0013990-S7-001 for Launch, Boost-Back and Landing of the Falcon 9 First Stage at Space Launch Complex (SLC) -4 at Vandenberg Air Force Base, Santa Barbara County, California to include an increase in launch cadence and SLC-6 modifications and launch operations. The potential impacts of increased noise from launch and landing activities are comprehensively discussed within the attached Biological Assessment (BA).

This BA evaluates the potential effects of a proposed increase in Falcon launch cadence and modifications to SLC-6 on federally listed (endangered and threatened) species and their Critical Habitat.

Due to the critical timeline, we request the opportunity to review a Draft Biological Opinion by 22 July 2025. Please contact me at gretchen.swinehart@spaceforce.mil or Tiffany Whitsitt-Odell at tiffany.whitsitt-odell@spaceforce.mil if you have any questions.

Sincerely

SWINEHART.G
RETCHEN.123
0170823
GRETCHEN SWINEHART
Chief, Installation Management Flight

Digitally signed by
SWINEHART.GRETCHEN.
1230170823
Date: 2025.04.09
15:36:15 -07'00'

Attachment:
Biological Assessment for Falcon Cadence Increase and SLC-6 Modifications at Vandenberg Space Force Base, California



United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE

Ecological Services
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003



IN REPLY REFER TO:
2022-0013990-S7-001-R003

April 24, 2025

Beatrice L. Kephart, Chief
Installation Management Flight
30 CES/CEI
1028 Iceland Avenue
Vandenberg Space Force Base, California 93437

Subject: Acknowledgment of Request to Initiate Formal Consultation for the Launch, Boost-Back, and Landing of Falcon 9 First Stage cadence increase at Space Launch Complex 4 and 6, with introduction of Falcon Heavy vehicle and modifications of SLC-6, Vandenberg Space Force Base, Santa Barbara County, California.

Dear Beatrice Kephart:

This letter acknowledges our receipt of your request, dated April 9, 2025, for initiation of formal consultation, pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (Act). The requested consultation concerns the potential effects of the U.S. Space Force's (Space Force) authorization of the Launch, Boost-Back, and Landing of Falcon 9 First Stage cadence increase at Space Launch Complex (SLC) 4 and 6, with introduction of Falcon Heavy vehicle and modifications of SLC-6 on the federally endangered California least tern (*Sterna antillarum browni*), short tailed albatross (*Phoebastria albatrus*), southwestern flycatcher (*Empidonax traillii extimus*), least bell's vireo (*Vireo bellii pusillus*), Hawaiian petrel (*Pterodroma sandwichensis*), Santa Barbara Distinct Population Segment of California tiger salamander (*Ambystoma californiense*), California condor (*Gymnogyps californianus*), unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), tidewater goby (*Eucyclogobius newberryi*), arroyo toad (*Anaxyrus californicus*), light-footed Ridgway's rail (*Rallus obsoletus levipes*), the federally threatened marbled murrelet (*Brachyramphus marmoratus*), California gnatcatcher (*Polioptila californica californica*), California red-legged frog (*Rana draytonii*), southern sea otter (*Enhydra lutris nereis*), and western snowy plover (*Charadrius nivosus nivosus*) and its critical habitat.

All information required of you to initiate consultation was either included with your request letter, the revised biological assessment, or is otherwise accessible for our consideration and reference, and we are in coordination with your staff regarding additional supplemental information. We have assigned file number 2022-0013990-S7-001-R003 to this consultation. Please refer to that number in future correspondence on this consultation. We expect to provide

you with our draft biological opinion on or before July 23, 2025. Once complete, this consultation will supersede all previous consultations for Space Force's authorization of SpaceX's Falcon 9 program at Vandenberg Space Force Base, including the conclusions, incidental take statements, reasonable and prudent measures, and terms and conditions.

As a reminder, the Act requires that, after the initiation of formal consultation, the lead federal agency may make no irreversible or irretrievable commitment of resources that could preclude the formulation or implementation of reasonable and prudent alternatives to avoid jeopardizing the continued existence of endangered or threatened species or destroying or modifying critical habitat [Section 7(d)]. If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact our office at fw8venturasection7@fws.gov.

Sincerely,

Christopher J. Diel
Assistant Field Supervisor

cc:

Darryl York
Samantha Kaisersatt
Tiffany Whitsitt-Odell



**Biological Assessment for
Falcon Cadence Increase and SLC-6 Modifications at
Vandenberg Space Force Base, California**

9 April 2025

Prepared for

Space Launch Delta 30, Installation Management Flight Environmental Assets
1028 Iceland Avenue, Bldg. 11146
Vandenberg Space Force Base, California 93437

Prepared by

ManTech SRS Technologies, Inc.
300 North G Street
Lompoc, CA 93436

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ACRONYMS AND ABBREVIATIONS

%	percent
ac	acre(s)
AGE	aerospace ground equipment
ARTO	arroyo toad
BA	Biological Assessment
BO	Biological Opinion
CAGN	coastal California gnatcatcher
CDFW	California Department of Fish and Wildlife
C.F.R.	Code of Federal Regulations
CNDDDB	California Natural Diversity Database
CRLF	California red-legged frog
DAF	Department of the Air Force
dB	decibel(s) unweighted
dBA	A-weighted decibel(s)
DPS	Distinct Population Segment
E	east
ESA	Endangered Species Act
ESBB	El Segundo blue butterfly
FR	Federal Register
ft	foot or feet
ft ²	square foot or feet
GTP	Gaviota tarplant
HIF	Horizontal Integration Facility
INRMP	Integrated Natural Resources Management Plan
IPaC	Information for Planning and Consultation
kHz	kilohertz
LBVI	least Bell's vireo
LETE	California least tern
LOX	liquid oxygen
MAMU	marbled murrelet
mi	mile(s)
MSRS	ManTech SRS Technologies, Inc.
OCA	other carnivores in-air
OHV	off-highway vehicle
PBO	Programmatic Biological Opinion
PCE	primary constituent elements
PPV	peak particle velocity
psf	pounds per square foot
PTS	permanent threshold shift
RIRA	light-footed Ridgeway's rail
RP-1	rocket propellant 1
RORO	roll-on-roll-off
SLC	Space Launch Complex
SLC-4E	Space Launch Complex 4 East
SLC-4W	Space Landing Complex 4 West
SLM	sound level meter

SNPL	western snowy plover
SpaceX	Space Exploration Technologies
SSO	southern sea otter
TTS	temporary threshold shift
TWG	tidewater goby
ULA	United Launch Alliance
U.S.	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTS	unarmored threespine stickleback
VSFB	Vandenberg Space Force Base (formerly Vandenberg Air Force Base [VAFB])
W	west

1 Introduction

1.1 Background & Consultation History

The purpose of this Biological Assessment (BA) is to address the effects of a proposed increase in Falcon launch cadence and modifications to Space Launch Complex (SLC) 6 on federally listed (endangered and threatened) species and their Critical Habitat as required by section 7 of the Endangered Species Act (ESA) of 1973 (16 United States Code [U.S.C.] section 1536). The Department of the Air Force's (DAF) Proposed Action is to authorize an increase in the annual Falcon launch cadence at Vandenberg Space Force Base (VSFB) through launch and landing operations at SLC-4 and SLC-6, including modification of SLC-6 for Falcon 9 and Falcon Heavy launch vehicles to support future United States (U.S.) Government and commercial launch service needs. The DAF would also authorize an increase in Falcon 9 launches from SLC-4. No modification of SLC-4 is proposed. The overall launch cadence for Falcon 9 and Falcon Heavy at both SLCs, combined, would be 100 launches per year. The DAF is the Action Agency and the Applicant is Space Exploration Technologies (SpaceX) Pursuant to section 7(a) of the ESA of 1973 (16 U.S.C. section 1536(a)), as amended, the DAF, is required to consult with the United States Fish and Wildlife Service (USFWS) for those actions it has determined may affect ESA-listed species or their Critical Habitat. The DAF is the lead agency for the purposes of this BA.

1.1.1 SLC-4 Consultation History

The USFWS has previously analyzed effects from the SpaceX Falcon 9 launch program at SLC-4. Specifically, the USFWS completed five biological opinions (BO; USFWS 2010, 2011, 2014a, 2017a, 2023, 2024a) and issued four concurrence letters (USFWS 2014b, 2015a, 2022a; 2024b) regarding the effects of the Falcon launch program at SLC-4, which are summarized below.

In the BO dated 10 December 2010 (USFWS 2010), the USFWS consulted on the modification and operation of Space Launch Complex 4 East (SLC-4E) for the new Falcon 9 and Falcon Heavy Space Vehicle Program. The USFWS concurred that modification of SLC-4E, launch noise, and visual disturbance from space vehicle launches from this facility may affect, but were not likely to adversely affect the California least tern (LETE, *Sternula antillarum browni*), western snowy plover (SNPL, *Charadrius nivosus*), or southern sea otter (SSO; *Enhydra lutris nereis*). Although Falcon Heavy launches at SLC-4 were included in the agency action evaluated in the 2010 BO, infrastructure to support Falcon Heavy was never constructed. Thus, SLC-4 would require extensive modification and Falcon Heavy is no longer planned to operate at SLC-4.

The DAF requested reinitiation for SLC-4 on 25 May 2011 due to a change in the effects determination for the California red-legged frog (CRLF; *Rana draytonii*), from “no effect” to “may affect, not likely to adversely affect.” In the resulting BO (USFWS 2011), the USFWS again concurred that launch noise and visual disturbance from space vehicle launches from this facility may affect, but were not likely to adversely affect the CRLF, LETE, SNPL.

On 10 October 2013, the DAF informed the USFWS of the discharge of water into Spring Canyon during the launch of a Falcon 9 rocket on 29 September 2013. The DAF determined future launches from SLC-4E would be conducted with a dry flame duct to prevent discharge to Spring Canyon. In a letter dated 29 August 2014, the USFWS concurred that launch activities at SLC-4E

may affect, but were not likely to adversely affect CRLF that may occur in suitable habitat in Spring Canyon (USFWS 2014b).

In the BO dated 22 December 2014 (USFWS 2014a), the DAF consulted with the USFWS on the proposed in-flight abort test and improvements at Space Landing Complex 4 West (SLC-4W) which included constructing a 300-foot (ft) diameter concrete pad to accommodate future landings of Falcon 9 first stage, two new access roads, and a new “FireX” fire control system. The USFWS concurred that the proposed activities may affect, but were not likely to adversely affect the LETE, SNPL, or SSO. The USFWS authorized incidental take of CRLF resulting from site improvements and, for frogs, capture, and relocation.

On 2 July 2015, the DAF consulted with the USFWS on Falcon 9 boost-back landing operations, which would occur up to 10 times per year at SLC-4W or at sea. The anticipated engine noise at landing was less than the noise generated during launch (i.e., ascent), and the anticipated sonic boom overpressure was up to a maximum of 2.0 pounds per square foot (psf). The USFWS concurred that boost-back landings of the Falcon 9 first stage at SLC-4W may affect, but were not likely to adversely affect the CRLF, LETE, SNPL, or SSO (USFWS 2015a).

In the BO dated 12 December 2017 (USFWS 2017a), the DAF consulted with the USFWS on the launch of the Falcon 9 from SLC-4E, and the first stage boost-back and landing at SLC-4W up to 12 times per year, use of up to 200,000 gallons of water in the flame duct, construction of a civil structure and retention basin to divert and retain a portion of the water expelled from the flame duct, removal of vegetation in Spring Canyon to minimize potential effects to nesting birds, and habitat enhancement to mitigate for impacts on riparian vegetation. The USFWS concurred that these activities may affect, but were not likely to adversely affect the California condor (*Gymnogyps californianus*), marbled murrelet (MAMU; *Brachyramphus marmoratus*), and SSO, and may affect, and would likely adversely affect CRLF, LETE, and SNPL. The USFWS also concurred that the proposed project would not affect designated Critical Habitat for any species.

In an email communication dated 13 October 2022, the USFWS agreed that the effects from increasing the number of Falcon 9 launches from 12 to 14 in 2022 were consistent with existing analyses and reinitiation was not warranted (USFWS 2022a).

Impacts due to DAF maintenance of firebreaks surrounding both SLC-4E and SLC-4W and activities conducted at the harbor were addressed in the Programmatic Biological Opinion (PBO) under routine operations and maintenance activities at VSFB (USFWS 2015).

On 21 March 2023, the USFWS issued a BO (2022-0013990-S7-001; USFWS 2023) to the DAF for an increase in the SpaceX Falcon 9 launch cadence from 12 to 36 launches per year at SLC-4 on VSFB. The USFWS concurred that these activities may affect, but were not likely to adversely affect MAMU, SSO, California condor, unarmored threespine stickleback (UTS; *Gasterosteus aculeatus williamsoni*), and tidewater goby (TWG; *Eucyclogobius newberryi*) and may affect, and would likely adversely affect CRLF, LETE, and SNPL.

On 28 August 2024, the USFWS issued a BO (2022-0013990-S7-001-R001; USFWS 2024a) to the DAF to conduct up to 16 Falcon 9 launches from SLC-4 between 1 October and 31 December 2024 on VSFB. The USFWS concurred that the addition of 16 launches between 1 October 2024 and 31 December 2024, may affect, but was not likely to adversely affect the UTS, TWG, California tiger

salamander (CTS; *Ambystoma californiense*), arroyo toad (ARTO; *Anaxyrus californicus*), MAMU, California gnatcatcher (CAGN; *Polioptila californica californica*), California condor, coastal light-footed Ridgeway's rail (RIRA; *Rallus obsoletus levipes*), and SSO, and Critical Habitat for these species, where designated. The USFWS also concurred that the Proposed Action would likely adversely affect the CRLF, SNPL, LETE, and the proposed threatened southwestern pond turtle (*Actinemys pallida*, 88 Federal Register [FR] 68370-68399). This consultation also included informal conference on the proposed western spadefoot (*Spea hammondi*), which is under review for potential listing under the ESA. The USFWS concurred that the Proposed Action may affect but is not likely to adversely affect the western spadefoot toad on the basis of insignificant effects (USFWS 2024a). In an email communication dated 17 December 2024, in response to a DAF request, the USFWS extended the 2024 BO (USFWS 2024a) to include 16 additional Falcon 9 launches from SLC-4 between 1 January and 28 February 2025 (USFWS 2024b).

1.1.2 SLC-6 Consultation History

The USFWS issued DAF a BO for the Evolved Expendable Launch Vehicle (EELV) Program, which included the Delta IV program at SLC-6 on 9 August 2001 (1-8-99-F-27; USFWS 2001) which analyzed the impacts from the EELV launch vehicle and associated harbor dredging on the UTS, TWG, brown pelican (*Pelecanus occidentalis*; since delisted), CRLF, SNPL, and SSO. BO 1-8-99-F-27 remains the active BO for SLC-6 activities.

On 2 June 2006, the USFWS provided DAF with another BO for landscape maintenance activities associated with the EELV program (1-8-06-F-18; USFWS 2006a) that analyzed the effects on Gaviota tarplant (GTP; *Deinandra increscens* ssp. *villosa*). Subsequently, a genetic study was conducted in 2006 to clarify taxonomic status of GTP. Based on this study, GTP was limited geographically to the type locality in Gaviota, California (Point Conception, Sudden Peak (outside of the VSFB boundary), and Lion's Head on north VSFB (Baldwin 2009). Therefore, the tarplant originally identified as GTP at SLC-6 was determined not to be GTP based on this study and subsequent morphological analysis.

On 2 November 2006, the USFWS issued DAF another BO for the EELV program and associated landscape maintenance activities (1-8-07-F-1R; USFWS 2006b) that analyzed the effects from the proposed project on the El Segundo blue butterfly (ESBB; *Euphilotes battoides allyni*). However, results of a study published in 2020 indicated the ESBB occurring in Los Angeles County are genetically distinct from the *Euphilotes* species found in northern Santa Barbara County and the *Euphilotes* on VSFB and adjacent areas are not the federally endangered ESBB (Dupuis et al. 2020).

1.1.3 Purpose of Current Consultation

The purpose of this BA is to review the potential effects of an increase in the SpaceX Falcon 9 launch cadence from 36 launches per year (approved under BO 2022-0013990-S7-001) and an additional 16 launches approved between October and December 2024 (approved under BO 2022-0013990-S7-001-R001) to 100 launches per year at VSFB and modifying SLC-6 to support the Falcon 9 and Falcon Heavy launches and landings on the federally listed TWG, UTS, CTS, CRLF, ARTO, MAMU, southwestern willow flycatcher (SWFL; *Empidonax traillii extimus*), least Bell's vireo (LBVI; *Vireo bellii pusillus*), SNPL, LETE, California condor, CAGN, RIRA, short-tailed albatross

(*Phoebastria* (=Diomedea) *albatrus*), Hawaiian petrel (*Pterodroma sandwichensis*), SSO, and Critical Habitat for these species, where designated. Following each launch, SpaceX would perform a landing of the first stage(s), either downrange on a droneship or at landing zones at VSBF. The proposed annual numbers and locations of launches and landings of each vehicle are discussed in detail in Section 2.2.5 (Launch and Landing Operations).

1.2 Other Species Considered

Three additional ESA-listed species were considered during the analysis of this project for inclusion in this BA, but it was determined that Lompoc yerba santa, beach layia, and GTP don't occur within the Action Area. Lompoc yerba santa (*Eriodictyon capitatum*) and beach layia (*Layia carnosa*) occur in the region; however, the habitat where ground disturbing activities would occur is not suitable for beach layia, and Lompoc yerba santa was not found during biological surveys of the Action Areas during October and November 2023. Physical impacts will not extend into areas occupied by these species. In addition, SpaceX will not use solid rocket fuel, so there is no potential deposition of acidic compounds on the landscape. Therefore, consideration of these species is not included in this BA. Although suitable habitat for GTP exists in the Action Area, where physical impacts would occur, the area was surveyed by a qualified biologist and only the common unlisted grassland tarplant (*Deinandra increscens* ssp. *increscens*) was present. The area was surveyed outside of the peak blooming period, but plants were still extant and identifiable. Based on plant morphology and the characteristics of the flowers still present, none of the tarplant stands matched the accepted phenotype of Gaviota tarplant. Therefore, consideration of these three species is not included in this BA.

The non-listed monarch butterfly (*Danaus plexippus*) overwinters on VSBF and has been proposed for listing as threatened (89 FR 100662-100716). Although there are no requirements in the ESA to consult or confer on actions due to their effects on candidate species, the Department of Defense (DOD) proactively initiated formal conference with the USFWS under Section 7(a)(4) of the ESA pursuant to the DOD's 7(a)(1) Conservation Strategy for the Monarch Butterfly for Mission and Mission Sustainment Operations within the Continental United States. The Proposed Action included a Conservation Strategy and routine mission and mission sustainment activities that may affect monarch habitat and/or individuals. The Conservation Strategy was developed in collaboration with the USFWS to ensure the program will serve the purposes of advancing monarch conservation and continuing to fulfill DOD's responsibilities under 7(a)(1). The USFWS issued a Conference Opinion (CO) on 10 December 2024, which determined that the DOD's proposed launch, reentry, and infrastructure improvement activities are not likely to jeopardize the continued existence of the monarch butterfly (USFWS 2024c). Therefore, monarch butterfly is not considered further in this BA.

2 Project Description

2.1 Project Location

VSBF occupies approximately 99,100 acres (ac) of central Santa Barbara County, California, and is approximately halfway between San Diego and San Francisco (Figure 2.1-1). VSBF occurs in a transitional ecological region that includes the northern and southern distributional limits for many plant and animal species. The Santa Ynez River and State Highway 246 divide VSBF into two

distinct parts: North Base and South Base. SLC-4 is located on South Base, approximately 4.0 miles (mi) south of the Santa Ynez River and 0.9 mi east of the Pacific Ocean. SLC-4E is the existing launch facility for the Falcon 9 program and SLC-4W is the existing landing facility for the Falcon 9 program. SLC-6 is 3.6 mi south of SLC-4, approximately 1.0 mi east of the Pacific Ocean (Figure 2.1-1).

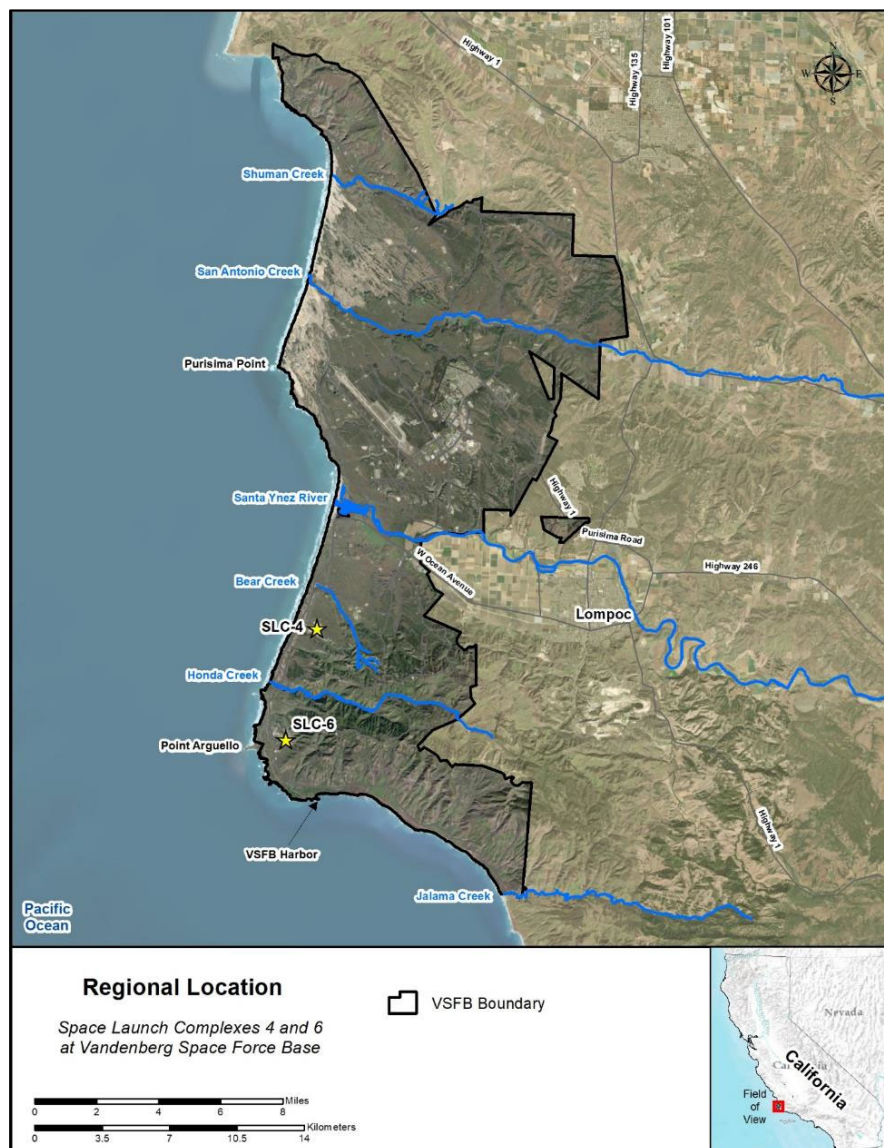


Figure 2.1-1. Regional location of SLC-4 and SLC-6.

2.2 Proposed Action

The Proposed Action is to increase the annual Falcon 9 launch cadence at VSFB and modify SLC-6 to support the Falcon launch vehicles. Under the Proposed Action, SpaceX would launch Falcon 9 and Falcon Heavy vehicles from VSFB up to 100 times per year from SLC-6 and SLC-4 combined. Following each launch, SpaceX would perform a boost-back and landing of the first stage and side boosters (side boosters would only land for Falcon Heavy missions) up to 100 times, either

downrange on a droneship or at landing zones at SLC-4 and SLC-6. As approved in prior environmental documents, no more than 12 first stage landings would occur at SLC-4 per year. SpaceX proposes to construct landing zones adjacent to SLC-6 to support up to 17 landing operations per year from SLC-6, as described below.

2.2.1 Launch Vehicle

A detailed description of Falcon 9 can be found in the prior 2017, 2023, and 2024 BOs (USFWS 2017a, 2023, 2024a). There are no significant changes to the Falcon 9 compared to the iteration of the vehicle analyzed in prior BOs. Falcon Heavy is a heavy-lift vehicle with the ability to lift approximately 141,000 pounds into low Earth orbit. Merlin engines are used on both stages of Falcon Heavy. The center core of the Falcon Heavy is equivalent to a single Falcon 9 rocket and the two side boosters are essentially the same design as a Falcon 9 first stage booster; thus, Falcon Heavy uses the same type of propellants as Falcon 9. Additionally, Falcon Heavy uses the same second stage as Falcon 9. A comparison of Falcon 9 and Falcon Heavy is shown in Figure 2.2-1.



Figure 2.2-1. Falcon 9 and Falcon Heavy launch vehicles.

2.2.2 SLC-6 Modifications

2.2.3 Construction and Demolition Activities at SLC-6

SpaceX would modify SLC-6 to support Falcon 9 and Falcon Heavy launches. Construction is expected to take approximately 18 months and would start in late 2025, depending on acquisition of the lease by SpaceX. However, construction could occur more quickly than this timeline. Initial demolition of large structures that cannot support Falcon vehicles would occur concurrently with construction of Falcon-specific infrastructure. The major construction activities would occur during approximately the first 12 months of construction. The remaining construction time would primarily involve construction and activation of infrastructure such as fluid systems.

Proposed infrastructure includes commodity storage tanks, a vehicle erector, water tower(s), ground supporting equipment, and a rail system from the hangar to the launch pad (Figure 2.2-2). Where practicable, existing infrastructure would be modified. This could include modifications to

the liquid oxygen storage, launch pad apron, access road between the launch pad and a new hangar, and fence line. The existing flame trench would be retained and converted to a unidirectional water-cooled flame diverter, and a deluge/acoustic suppression system would be installed. A water reclamation system may be used that could pump residual deluge water back into the water storage tanks. Work would generally occur in previously disturbed areas and on existing impervious surfaces, but some earthwork is anticipated. Construction may occur at any time of the day or night.

A hangar would be required for vehicle processing. The DAF would authorize SpaceX to construct a new approximately 62,000 square foot (ft²) hangar north of the launch pad to support Falcon 9 and Falcon Heavy integration and processing (Figure 2.2-2). Areas around the hangar would be filled and graded to provide rear access to the hangar. Approximately 40,000 cubic yards of fill would be required and would be sourced locally. Approximately 244,000 ft² of additional impervious area would be added to construct this hangar. Existing stormwater infrastructure is expected to be adequate to support this additional impervious area but would be confirmed during final design of the site. SpaceX would modify the existing access road by widening the road and adding a rail system between the launch pad and the existing Horizontal Integration Facility (HIF) for transport of the Falcon vehicle between a new hangar to the launch pad (Figure 2.2-2). The SLC-6 fence would be relocated and vehicular access from Luner Road to N Road would be removed.

Four existing structures would be demolished (mobile service tower, mobile assembly shelter, fixed umbilical tower, and launch crown; Figure 2.2-2). Mechanical shears would be used to cut the building sections into manageable sizes. Cranes would be utilized in order to assist with any heavy lifts of the structure. An excavator with a thumb attachment would be used to move the manageable pieces to a dump truck that would haul out the material. The excavators and backhoes to be used would be track mounted. Any staging or temporary storage of materials would occur in the areas of disturbance shown on the figure. Demolition work would occur during daylight hours. The duration of demolition activities may last up to 6 months.

Table 2.2-1 summarizes potential noise levels from typical construction equipment used in demolition and how far that sound typically propagates. Daily sound levels would vary depending on the type of activity occurring that day and equipment used, but generally sound would remain within the vicinity of SLC-6.

Table 2.2-1. Estimated received sound levels of standard construction equipment at various distances used during demolition activities.

Estimated Received Noise Levels (unweighted dB [^])	Distance from Source (ft)			
	Shears*	Jackhammer*	Crane*	Welder/Torch*
120	3.2	1.5	--	--
110	10	4.5	1.8	--
100	32	14	5.6	2.5
90	100	45	18	7.9
80	320	140	56	25

* Source: Washington State Department of Transportation 2012

[^] dB = decibels

Explosives would be used in one instance to remove one structure, during which four approximately 50-pound explosive charges would be detonated simultaneously. This will cause a short impulsive sound, similar to those experienced during first stage landing events at SLC-4, but over a much smaller area. A linear propagation model (International Ammunition Technical Guidelines 2021) was used to estimate the resultant noise levels and affected areas. The distance at which the impulsive noise caused by the explosion would attenuate to 140 dB L_{max} (4.17 psf) is estimated to be approximately 0.57 mi from SLC-6, 130 dB L_{max} (1.32 psf) at approximately 1.19 mi, and 120 dB L_{max} (0.42 psf) at approximately 3.79 mi (Figure 2.2-3).

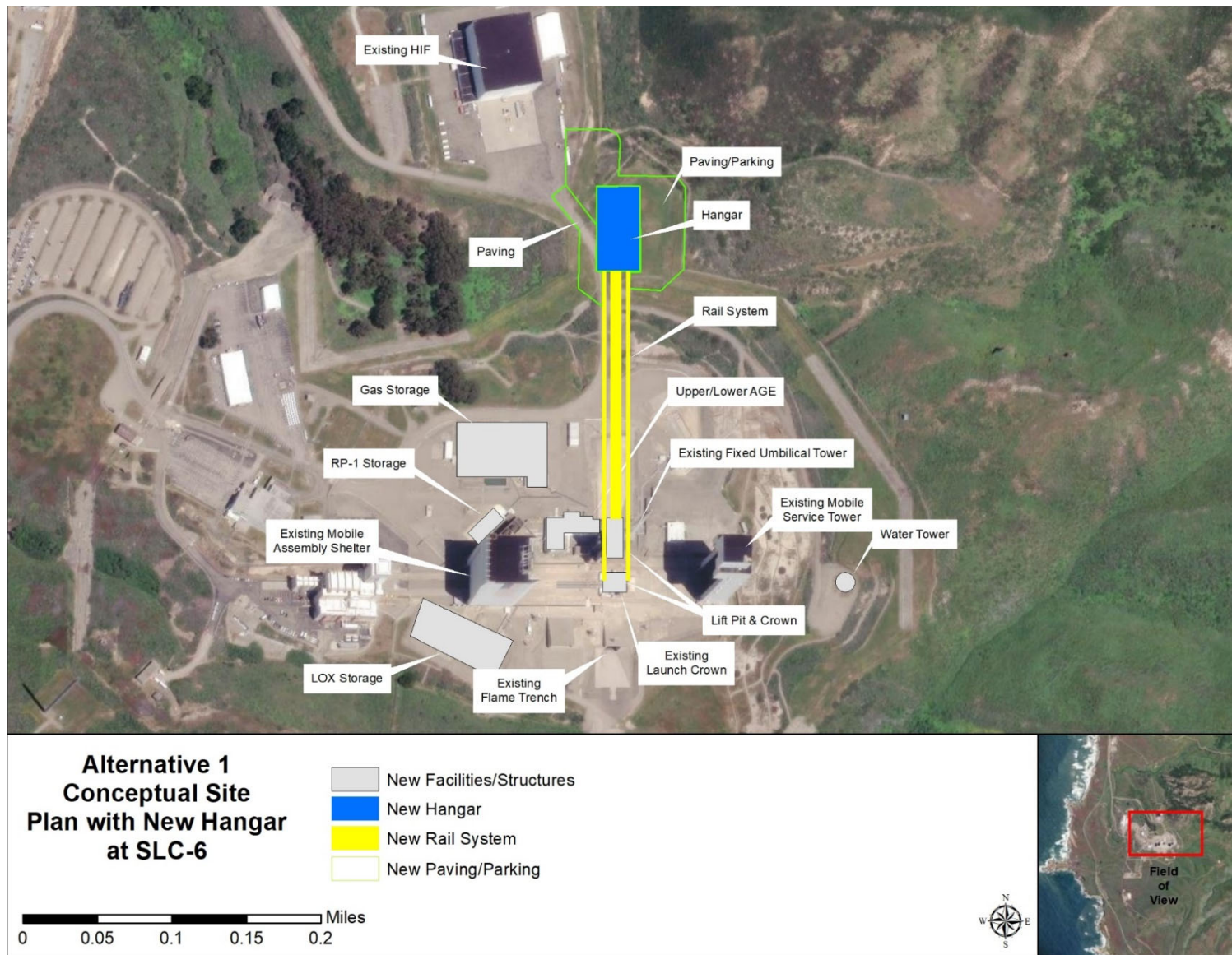


Figure 2.2-2. SLC-6 conceptual site plan; AGE = aerospace ground equipment, LOX = liquid oxygen, RP-1 = rocket propellant-1

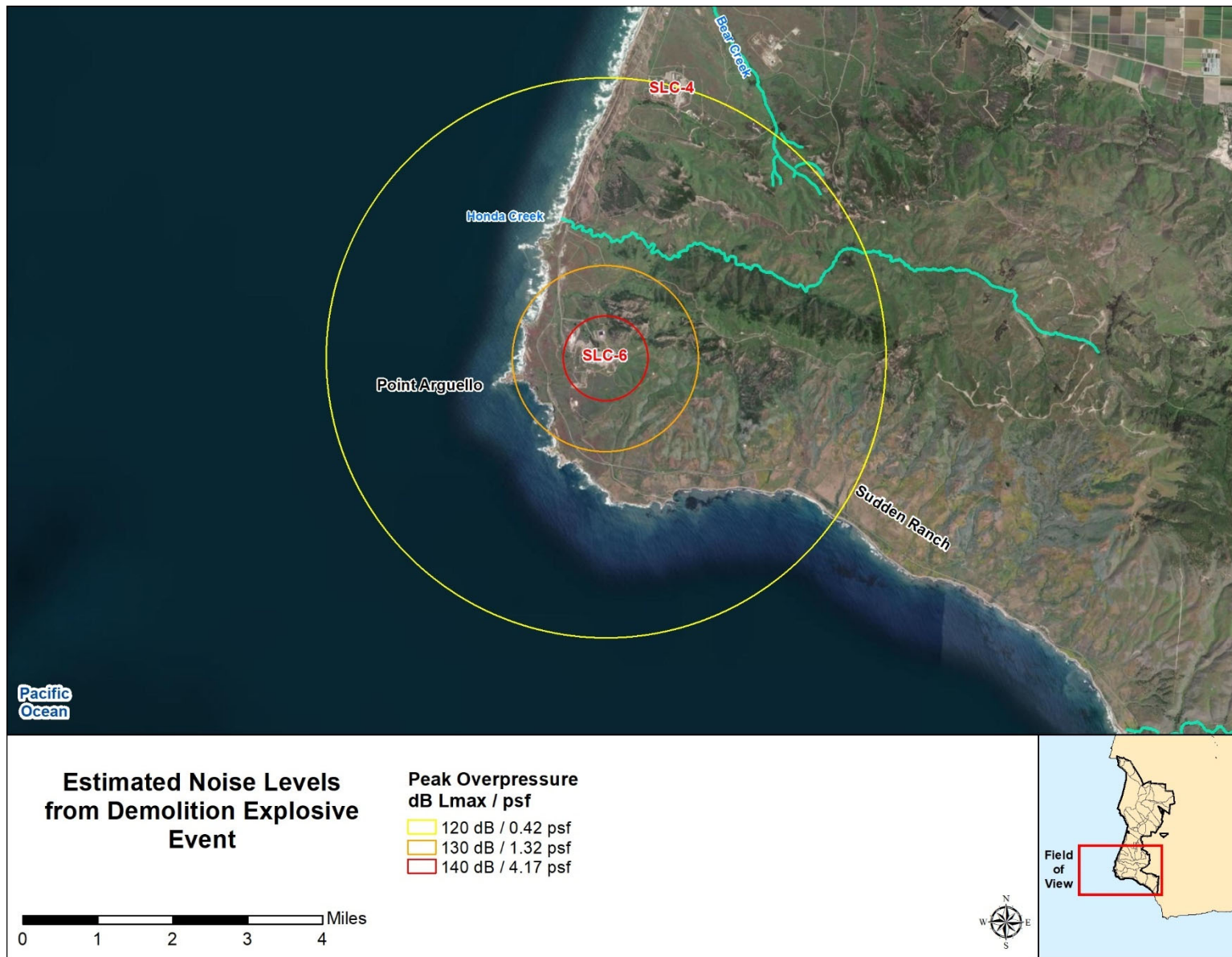


Figure 2.2-3. Estimated impulsive noise levels from explosives used during demolition.

2.2.4 Construction of SLC-6 Landing Zones & Firebreaks

SpaceX would construct two landing zones south of SLC-6 to support landing of first stage Falcon boosters launching from SLC-6. Each landing zone would be made up of a 280-ft diameter concrete pad surrounded by a 60-ft gravel apron, for a total diameter of 400 ft. SpaceX would construct a new nitrogen gas line from SLC-6 to a fluids bay at the landing zones. The fluids bay is used to send nitrogen to different systems of the booster after landing. A 30-ft by 30-ft pedestal, which is approximately 15-ft tall, would be constructed at each landing pad. The first stage booster is lifted onto the pedestal during post-flight processing to remove the landing legs prior to transport. Crane storage, a cleared area to lay down cranes when not in operation, is proposed on the western site boundary. Each landing zone would have a connection to the existing road to support booster transport. Approximately 16 acres would be cleared to construct the landing zones and approximately 7 acres would be impervious upon completion of construction. A conceptual layout of the landing zones is shown in Figure 2.2-4. Any fill would be purchased from local existing off base suppliers, and/or if using any sources on-base, the fill would be obtained from preexisting, established borrow pits, which are covered under an existing BO (8-8-10-F-5) and related regulatory permitting. Proposed landing zones at SLC-6 would take approximately 2 to 4 months to construct, including the length of time for the concrete to cure.

A new firebreak is proposed south of the landing zones. Cypress Ridge Road and N Road would also be improved to ensure suitable access for fire defense. These improvements are anticipated to be within the existing roadway footprints. The proposed firebreak is approximately 50 ft wide, shown in Figure 2.2-5 and would connect to the existing firebreak for SLC-8. Cypress Ridge Road, an existing fire access road, would be improved within its existing footprint to protect against potential erosion. Vegetation maintenance would occur within the vegetation maintenance area depicted in Figure 2.2-4 and Figure 2.2-5.

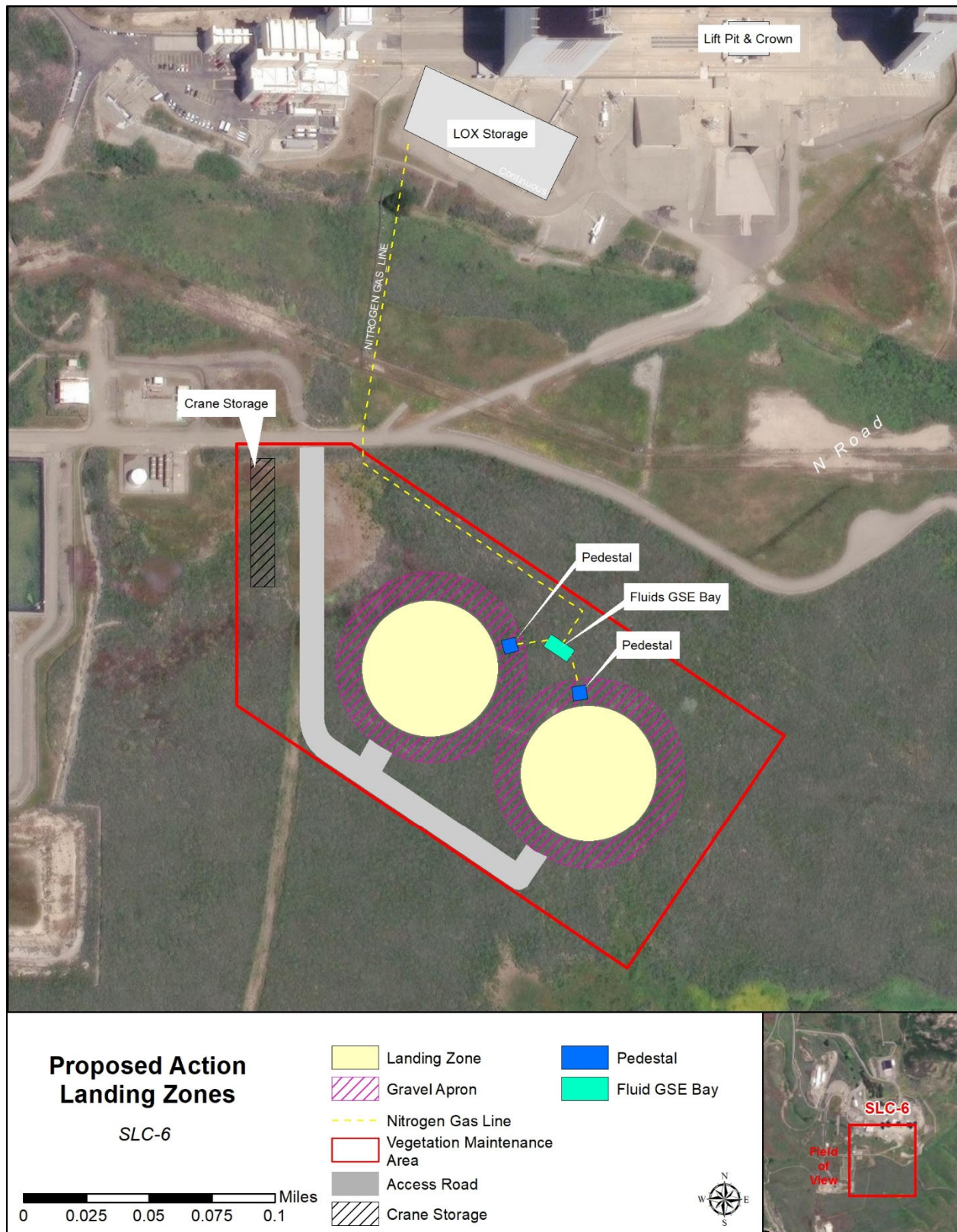


Figure 2.2-4. Conceptual site layout for construction of new landing zones.

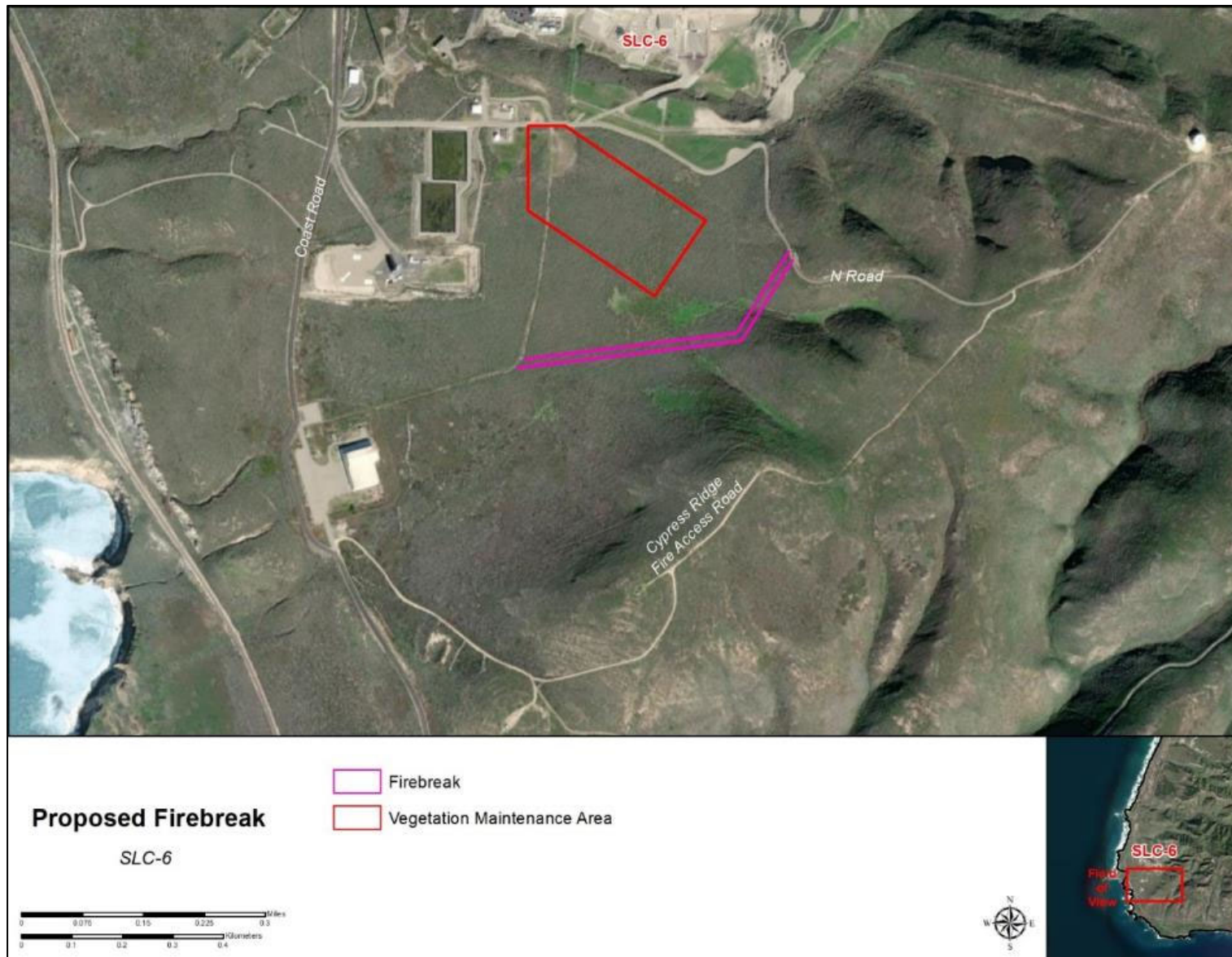


Figure 2.2-5. Proposed Firebreak.

2.2.5 Launch and Landing Operations

One to three days before each launch, a static fire test, which lasts a few seconds, may be conducted. The need to conduct a static fire test depends on the mission, but there would be no more than 50 static fire events per year (up to 30 at SLC-4 and 20 at SLC-6). Due to weather conditions, orbital mechanics (i.e. destination orbit, inclination, eccentricity, and altitude), airspace considerations, and range availability, launch operations could occur at any time of day or night and at any time during the year.

DAF proposes to authorize an increase in SpaceX's Falcon launch cadence at VSFB to 100 launches per year. SpaceX has continued to improve its turn-around time between launches, which has provided more opportunity for launches at SLC-4. The introduction of SLC-6 provides additional capacity for Falcon launches, including Falcon Heavy. SpaceX would launch Falcon Heavy up to 5 times per year at SLC-6. Launches of Falcon 9 would be spread between SLC-4 and SLC-6. At full cadence launches would typically occur one to four days apart. However, launches could occur from both launch complexes on the same day, though this is expected to be infrequent. An estimated launch schedule is included in Table 2.2-2, which is based on SpaceX's anticipated manifest over the next five years.

Table 2.2-2. Past and estimated future Falcon launch frequency.

Year	SLC-4	SLC-6		Total
	Falcon 9	Falcon 9	Falcon Heavy	
2019	2	-	-	2
2020	1	-	-	1
2021	3	-	-	3
2022	13	-	-	13
2023	28	-	-	28
2024	46	-	-	46
2025	70	-	-	70
2026	70	11	1	82
2027	70	25	5	100
2028	70	25	5	100
2029	70	25	5	100
2030	70	25	5	100

Trajectories from SLC-4 would remain within the previously analyzed azimuth range of 140 to 325 degrees. Trajectories from SLC-6 would also fall within this range. Although trajectories from both SLCs would vary between 140 and 325, depending on mission-specific requirements, up to 100 missions per year could fly an easterly trajectory with a launch azimuth between 140 and 155 degrees. For missions launching from SLC-4, SpaceX would land the first stage, either downrange on a droneship in the Recovery Area (Figure 2.2-6) or at the existing landing zone at SLC-4 or at the proposed landing zones at SLC-6 (Figure 2.2-4). SpaceX would continue to land up to 12 first stages at SLC-4 each year. In addition, up to 12 missions each year would utilize the proposed landing zones at SLC-6, including 10 boosters landing simultaneously during a maximum of 5 Falcon Heavy missions per year, which would land the two side boosters at the same time at SLC-

6. The Falcon Heavy center core first stage booster is typically expended each launch but may land on an offshore dronship. Estimated first stage booster landings are included in Table 2.2-3. Including potential Falcon 9 expendable missions, up to 10 launches per year may include expendable first stages that would be deposited anywhere within the recovery area depicted in Figure 2.2-6

Table 2.2-3. Launches with First Stages/Boosters to VSFB.

Year	SLC-4	SLC-6	Total
2025	12	2	14
2026	12	12	24
2027	12	12	24
2028	12	12	24
2029	12	12	24
2030	12	12	24

When first stages and fairings land in the downrange recovery area (Figure 2.2-6), the dronship would continue to transport first stage boosters and fairings from the Port of Long Beach to the VSFB harbor via a “roll-on-roll-off” (RORO) barge, as described in the 2023 BO (USFWS 2023), or over roads if ocean conditions are too rough to support barge operations. The Proposed Action would include up to 100 events per year utilizing RORO operations.

SpaceX would utilize approximately 70,000 gallons of water per launch at SLC-4, as described in the 2023 BO (USFWS 2023). Falcon Heavy would use up to approximately 1.5 million gallons of water per launch and Falcon 9 would use up to approximately 200,000 gallons per launch at SLC-6. More water is required at SLC-6 because the existing flame bucket is substantially larger than at SLC-4, thus requiring more water to achieve the same operational objectives in reducing vibration below the vehicle. In addition, a maximum of 1.37 million gallons (4.20 ac-ft) per year would be required to support the personnel and operational activities at SLC 4, a maximum of 1.19 million gallons (3.64 ac-ft) per year to support personnel at Buildings 398 and 520, and 1.10 million gallons (3.36 ac-ft) per year would be required to support the personnel and operational activities at SLC-6. Therefore, at maximum cadence, the Proposed Action would use up to 21.1 million gallons (65.6 ac-ft) of water per year. VSFB primarily relies on State Water, which is sourced from precipitation and groundwater, primarily from snowmelt in the Sierra Nevada mountains. However, during annual maintenance that lasts two to three weeks, VSFB utilizes four water wells in the San Antonio Creek Basin.

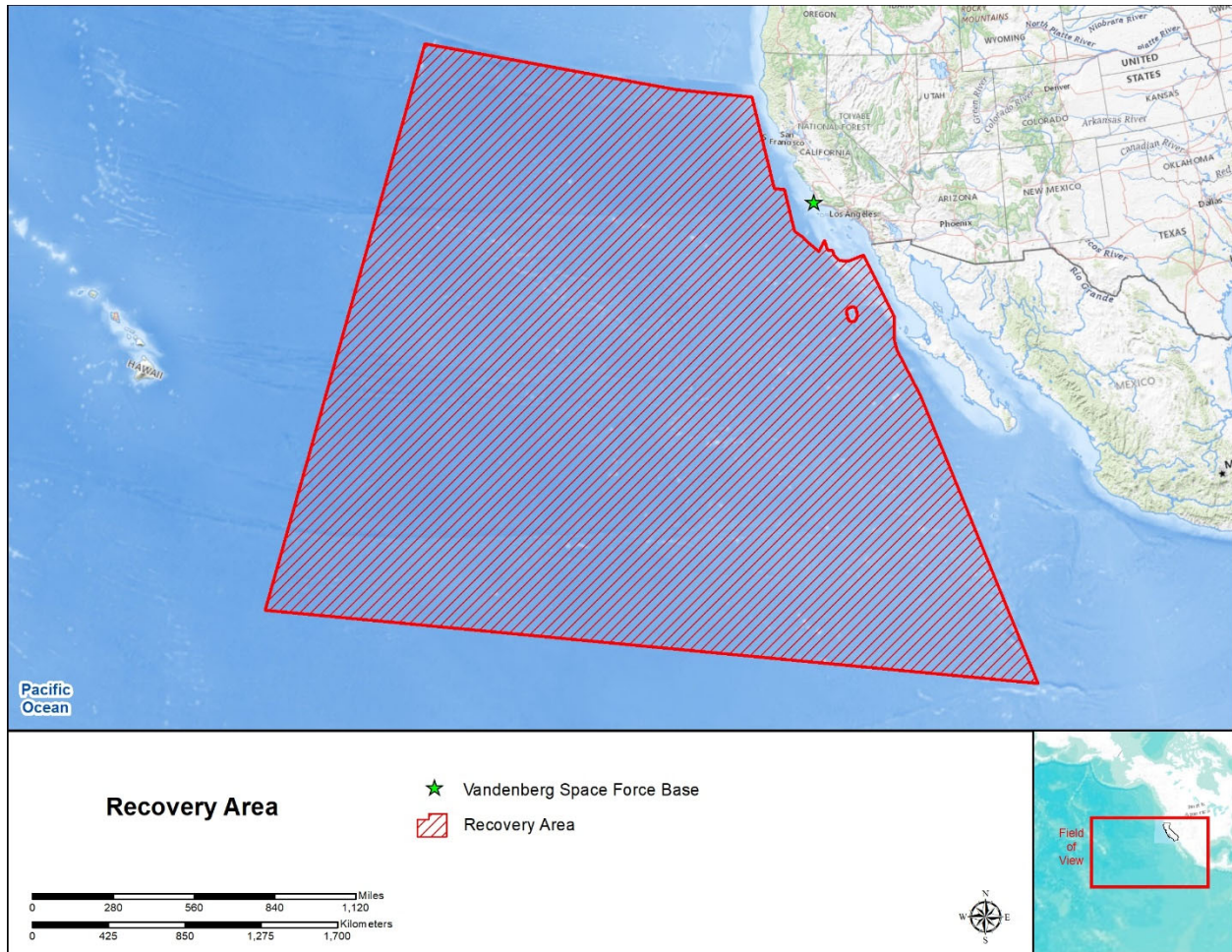


Figure 2.2-6. Recovery area.

2.2.6 Launch and Landing Noise

Rockets create two different types of noises during ascent and descent: 1) noise generated from the rocket engines (rocket engine noise) during launch and landing; and 2) sonic boom noise caused by the overpressure (i.e., shock wave) that is generated as the vehicle reaches supersonic speeds during its ascent and descent. The potential levels and impact locations of these different types of noises must be modeled by different methods because the physics and mathematical calculations in predicting their attributes are also very different. Sonic boom levels are typically presented in psf values; however, they can be directly translated into dB as well. To aid reviewers in assessing and understanding potential effects of sonic booms, Table 2.2-4 provides various sonic boom levels described in this document and their corresponding dB values.

Table 2.2-4. Pounds per square foot to peak dB (unweighted) conversion chart.

PSF	Peak dB (L _{max})
1	127.58
2	133.60
3	137.12
4	143.15
5	141.56
6	143.15
7	144.48
8	145.64
9	146.67
10	147.58
11	148.41
12	149.17
13	149.86

Falcon rocket engine noise was modeled using a software package called RNoise (KBR 2024). This sophisticated model incorporates numerous components, including the acoustic power of the rocket engine source, forward flight effects, the angle from the source to the receiver (directivity), Doppler effect, propagation between the source and receiver (ray path), atmospheric absorption, and ground interference to estimate received noise levels. RNoise assumes the surface of the earth is flat and therefore does not account for attenuation due to landforms. Therefore, the estimates of engine noise levels below are conservative for areas shielded by hills, bluffs, or other features, such as buildings or dense vegetation.

Figures depicting launch and landing noise modeling results are included in Chapter 4 under relevant species accounts (see Figure 4.3-1 through Figure 4.16-5). During Falcon 9 launches from SLC-4 and SLC-6, engine noise produced during launches would be audible across VSFB and the surrounding areas. Engine noise during Falcon 9 first stage landings at SLC-4 and SLC-6 would impact a smaller area, between Purisima Point and Point Conception along the coast and inland to Lompoc. During the 5 annual projected Falcon Heavy launches from SLC-6, a larger area would receive engine noise since there are 3 first stages on the launch vehicle. Noise during Falcon Heavy launches would reach the Santa Maria Valley and the Gaviota Coast. When landing at SLC-4 or SLC-6, landing engine noise follows the associated launch engine noise by approximately 5 to 7 minutes and typically occurs slightly before or simultaneous with the sonic boom that impacts land. Static fire engine tests at SLC-4 and SLC-6, which typically occur 1 to 3 days prior to launch and last up to 7 seconds per event, would also generate engine noise across VSFB and off base areas, including the Santa Rita Hills and Gaviota Coast.

Falcon Heavy sonic boom impacts were modeled using PCBoom software (KBR 2024). During ascent, a sonic boom (overpressure of impulsive sound) typically with a peak of approximately 3.0 to 5.0 psf, but up to approximately 8.0 psf, would be generated. Depending on the launch trajectory, the sonic boom may or may not impact the surface of the earth. Since 2017, approximately 10 percent of the ascent sonic booms generated during Falcon 9 launches from

SLC-4 did not impact the surface of the earth because the ascent of the rocket was too steep. When ascent sonic booms do impact the earth’s surface, they primarily impact the Pacific Ocean, but often overlap the Northern Channel Islands (NCI; see example shown in Figure 4.9-8). From 2017 through 20 October 2024, of the launches that produced ascent sonic booms that impacted the surface of the earth, approximately 67% have impacted the NCI. As discussed in the 2023 Section 7 consultation (USFWS 2023), modeling determined that sonic booms generated during ascent for missions with northerly mission profiles (launch azimuth between 305 and 325 degrees) will only impact the ocean’s surface with no impacts to land.

For easterly trajectories (launch azimuth between 140 and approximately 150 degrees), ascent sonic booms may impact eastern Santa Barbara County, Ventura County, and Los Angeles County on the mainland (Figure 2.2-7). The vast majority of the ascent sonic booms that would overlap these areas are predicted to be less than 1.0 psf. The highest level predicted to potentially impact each species’ populations varies for each of the species considered in this BA and is presented in Section 5.1. Even with identical trajectories, atmospheric conditions create considerable variation in where ascent sonic booms impact and the level at which they impact. To account for this variation, PCBoom can utilize meteorological parameters in the model that affect where and at what level a sonic boom may impact the surface of the Earth. In the late 1990’s, SRS Technologies, Inc. assembled a series of daily meteorological profiles across 10 years (1984-1994, one per day for 10 years) from radiosonde data for weather balloons released by the VSFB weather squadron. These data include pressure, temperature, wind speed, and wind direction along an elevational profile from ground, every 1,000 ft, to 110,000 ft. Figure 2.2-7 depicts the overlaid output from PCBoom for 8 representative SpaceX easterly trajectories using this meteorological data. Each trajectory was run between 29 and 40 times, with each run representing 1 of between 29 and 40 randomly selected meteorological profiles that capture potential weather conditions throughout the year (308 model outputs total). Only 13% of model runs resulted in sonic booms that overlapped eastern Santa Barbara County, 85% of model runs resulted in sonic booms that overlapped Ventura County and 58% of model runs resulted in sonic booms that overlapped western Los Angeles County (Figure 2.2-7). Of the sonic booms model results that overlapped each county, the proportion of the ranges of predicted boom levels across each area is shown in Table 2.2-5.

Table 2.2-5. Proportion of sonic boom ranges in level (psf) overlapping eastern Santa Barbara, Ventura, and Los Angeles Counties as depicted in Figure 2.2-7.

County	Percentage of Sonic Boom Levels Overlapping			
	0-1 psf	1-2 psf	2-3 psf	3+ psf
Santa Barbara	12.0%	7.8%	1.3%	0.3% (3.7 psf)
Ventura	84.7%	19.5%	2.9% (2.3 psf)	0%
Los Angeles	100% (0.8 psf)	0%	0%	0%

During first stage landings at SLC-4, PCBoom modeling has predicted that landing (i.e., descent) sonic booms may reach up to approximately 7 psf in the area around SLC-4 (see Figure 4.3-2 for an example from the Bandwagon-2 mission in December 2024, but also Appendix A for potential variability). However, during the Transporter 10 mission, a 9.86 psf sonic boom was measured at Honda Creek, 2.1 mi south of SLC-4 (Appendix B). The 1 psf contour may extend as much as

approximately 27 mi north of SLC-4 and up to approximately 38 mi to the east (see Appendix A for examples).

Falcon 9 first stage landings at SLC-6 would have similar extents and levels as landings at SLC-4, although shifted to the south. For Falcon Heavy missions at SLC-6, two boosters would land nearly simultaneously at SLC-6. Modeling predicted that the boosters would produce sonic booms up to 13 psf in the immediate area surrounding SLC-6 and the 1 psf contour would extend approximately 17 mi north and 40 mi to the east of SLC-4 (Figure 4.3-5). Focal booms (relatively small areas where high sonic boom levels may occur) are predicted to reach up to an estimated 5 psf approximately 40 mi to the east (Figure 4.3-5).

Although unlikely, sonic booms up to 3.1 psf may also impact the NCI during landing events at SLC-4, SLC-6, or on droneships in offshore areas near VSFB, depending on the landing trajectory and weather conditions. However, during the majority of downrange droneship landings in the proposed landing areas, sonic booms would be directed entirely at the ocean surface without impacting any land. Landing sonic booms can vary substantially depending on mission requirements and the associated landing trajectories and various examples of sonic booms model results for Falcon 9 landings at SLC-4 are included in Appendix A to depict that variability.

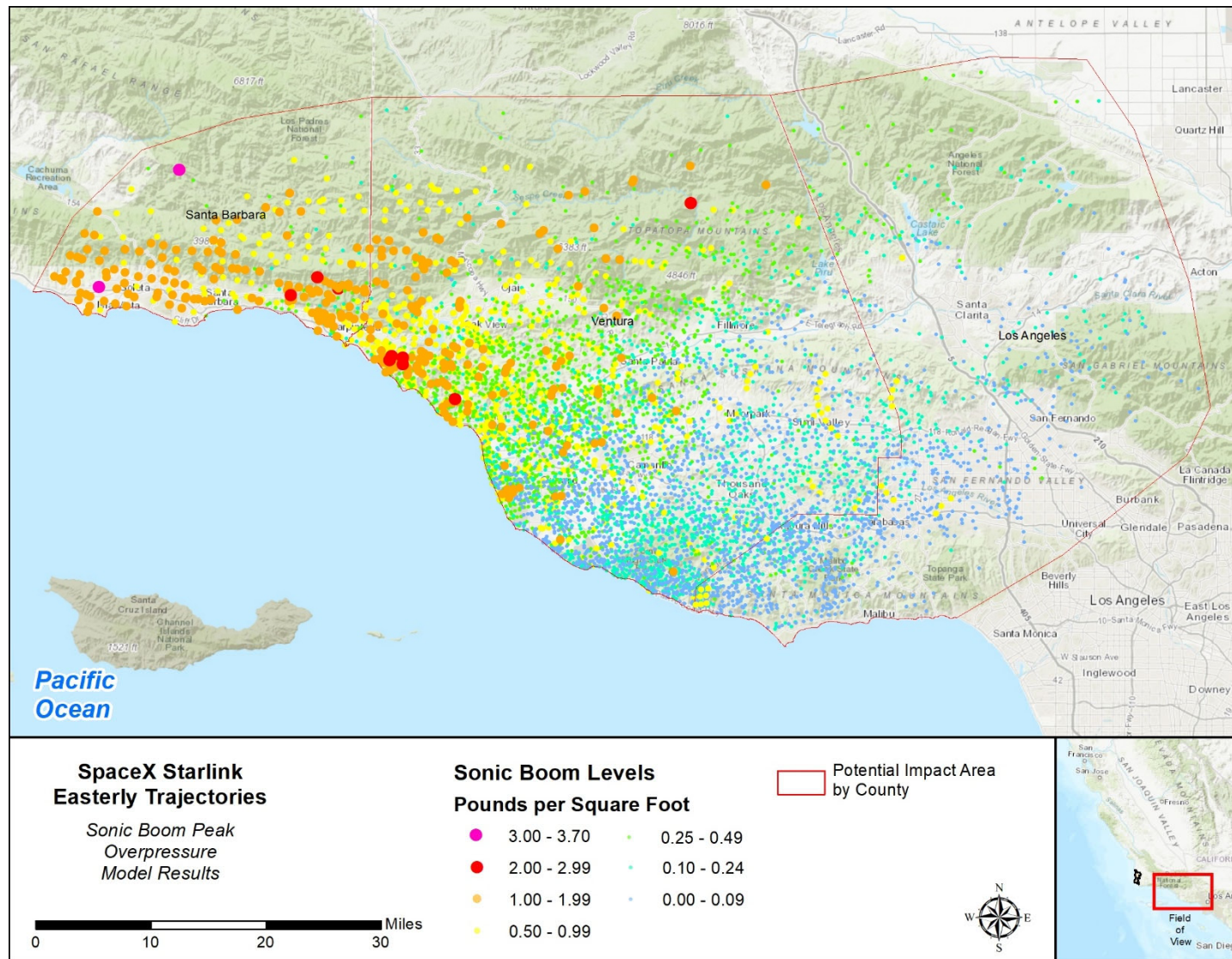


Figure 2.2-7. Potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties. Note: the model output represents 190 model runs (190 potential meteorological profiles) and is cropped to only show those results that overlaid mainland California.

2.3 Conservation Measures

The conservation measures listed below would be implemented to avoid, minimize, and monitor the effects of the Proposed Action on the CRLF, SNPL, LETE, SWFL, LBVI, and SSO. These measures are intended to supersede all measures included in prior SpaceX Falcon launch program BOs. There are no conservation measures proposed for TWG, UTS, or CTS. Without altering trajectories or landing locations which are driven by mission-specific requirements, there are no feasible methods to minimize the intensity of the sonic boom. Applying water deluge during launch reduces engine noise in the vicinity of the launch pad. The estimates of engine noise levels are also conservatively high, since the modeling does not consider attenuation due to landforms.

Conservation Measures included in this BA require various levels of biological competency from personnel completing specific tasks, as defined below:

- **Permitted Biologist:** Biologist with a valid and current USFWS section 10(a)(1)(A) Recovery Permit or specifically named as an approved biologist in a project-specific BO or the VSFB PBO. The Action Agency will coordinate with the USFWS prior to assigning permitted biologists to this project.
- **USFWS Approved Biologist:** Biologist with the expertise to identify listed species and species with similar appearance. The Action Agency will review and approve the qualifications or authorization forms from each individual, and then submit a request to the USFWS for review and approval no less than 15 days prior to initiating any of the monitoring activities associated with the Proposed Action. Each resume will list their experience and qualifications to conduct specific actions that could potentially affect listed species and their habitats. A USFWS approved biologist could train other biologists and personnel during surveys and project work; in some cases, a USFWS approved biologist could also provide on-site supervision of other biologists.
- **Qualified Biologist:** Biologist trained to accurately identify specific federally listed species and their habitats by either a permitted or USFWS approved biologist. This person could perform basic project monitoring but would need to have oversight from a permitted or USFWS approved biologist. Oversight will require a permitted or USFWS approved biologist to be available for phone/email consultation during the surveys and to have the ability to visit during monitoring/survey activities if needed.

The Action Agency will require 30 CES/CEIEA and USFWS approval of all USFWS Approved Biologists, which will be personnel who are familiar with and possess necessary qualifications to be approved for capture, handle, and release species as stated above. These biologists will be responsible for monitoring, surveying, and other biological field activities. They will also be responsible for relocating species at risk of being directly killed or injured by project related activities (such as CRLF).

2.3.1 General Conservation Measures

The following protection and monitoring measures would apply to all aspects of the Proposed Action to protect and minimize effects on biological resources:

- A USFWS-approved biologist shall brief all construction personnel prior to participating in construction and demolition activities at SLC-6. At a minimum, the training would include

a description of the listed species and sensitive biological resources occurring in the area, the general and specific measures and restrictions to protect these resources during project implementation, applicable provisions of the ESA and the necessity of adhering to those provisions, and the penalties associated with violations of the ESA.

- The Applicant would develop a lighting management plan for SLC-6. The Action Agency would provide a copy of the plan to the USFWS.
- The Applicant will ensure that construction and demolition disturbances be kept to the minimum extent necessary to accomplish project objectives.
- The Applicant will ensure that all human-generated trash at the project site will be disposed of in proper containers and removed from the work site and properly secured in a suitable trash container at the end of each workday, all food waste will be properly contained, and trash will be removed from the work area weekly throughout the course of the proposed project.
- The Applicant will ensure that a Qualified Biologist inspects any construction equipment left overnight prior to the start of work the following day. The Qualified Biologist will check equipment for presence of special-status species in the vicinity and for fluid leaks and immediately let 30 CES/CEIEA know to coordinate subsequent actions prior to the start of work.
- The Action Agency will ensure that the Applicant implements the following measures at SLC-4 and SLC-6: (1) the site-specific Stormwater Pollution Prevention Plan; (2) the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; (3) collect any rocket propellant seen floating in the retention basin using absorbent pads prior to discharge to the spray field; and (4) the procedures in VSFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill.

2.3.2 California Red-legged Frog

- Qualified biological monitors, approved by USFWS and 30 CES/CEIEA, including personnel who are familiar with and possess necessary qualifications to be approved for capture, handle, and release of CRLF, shall be present to monitor construction and demolition activities at SLC-6 where deemed necessary by the Action Agency throughout the length of the project to minimize impacts on this species. The biological monitors shall be responsible for delineating areas where special-status species are located or concentrated, relocating special-status species in jeopardy of being killed or injured by construction, and inspecting equipment and equipment staging areas for fluid leaks. Prior to the onset of construction activities, qualification submittals of biologist(s), who would conduct the monitoring, surveying, species relocation, and other biological field activities shall be submitted by 30 CES/CEIEA to the USFWS for approval.
- Prior to construction activities at SLC-6, any CRLF shall be removed by a USFWS-approved biologist from an exclusion area within the project site and relocated, to the nearest suitable habitat location at least 500 ft away to decrease the likelihood of recapture through the process described below. These activities would be accomplished prior to the start of construction and only under the direct supervision of a USFWS-approved biologist.

- **Exclusion Area.** An exclusion area (or potentially multiple separate exclusion areas) would be established around previously undisturbed areas where construction activities would occur and require vegetation removal, fill placement, and CRLF removal/exclusion to avoid impacts to this species.
 - Under direction of a qualified biologist, the exclusion area would be encircled with minimum 3-ft-high silt fencing, anchored with metal T-posts, and buried along the bottom edge to the best extent possible to prevent terrestrial wildlife, including CRLF, from entering the site.
 - Following completion of the installation of exclusion fencing, USFWS-approved biologists would conduct a pre-project survey of the exclusion area for wildlife and special-status species, including CRLF. All CRLF captured would be transported to the nearest suitable habitat outside of the exclusion area and released by a USFWS-approved biologist. The USFWS-approved biologist will repeat these surveys following any precipitation event greater than 0.2 inch during a 24-hour period.
 - A USFWS-approved biologist will monitor any initial ground disturbance or vegetation removal within suitable aquatic, adjacent upland, or dispersal habitat identified following the adaptive habitat assessment procedures (as described in the PBO, USFWS 2018). However, after the initial ground disturbance/vegetation removal is complete, no further monitoring would be required within these bare-dirt areas.
 - **Relocation:** If CRLF are found within the project area during pre-project surveys, daily monitoring where required, or at any other time, all construction activity within the vicinity of the CRLF occurrence (if any) will cease. If the project site is large and if the USFWS-approved biologist is satisfied that work in a different area of the project can continue with no threat to CRLF, then that work would continue. Construction activities within the vicinity of the CRLF occurrence will not begin or resume until the CRLF are relocated by a USFWS-approved biologist or the individual has left the construction area of its own volition. The USFWS-approved biologist will relocate all life stages of CRLF the shortest distance possible to a location that is (1) within the same drainage, (2) contains suitable aquatic/upland habitat, and (3) is outside of the project impact area. All animals would be held in 5-gallon buckets until release. All animals held would be segregated by size and species such that predation would be unlikely. The holding time would be minimized to the greatest extent feasible and the health of all held animals would be continuously monitored to evaluate the need for additional measures to protect the animals, such as aeration of water in holding buckets.
 - The exclusion fencing would be removed at the completion of construction activities.
- To avoid transferring disease or pathogens between aquatic habitats during the course of surveys and handling of amphibians, the biologist(s) shall follow decontamination procedures described in the Declining Amphibian Population Task Force's Code of Practice (USFWS 2002a).

- Any open holes or trenches will be covered with plywood or metal sheets and/or supplied with an escape ramp if left overnight to minimize the risk of entrapment of CRLF or other wildlife.
- Construction activities will not occur in previously undisturbed areas with potential for CRLF occurrence until 24 hours after an actual precipitation event greater than 0.2-inch accumulating within a 24-hour period.
- No overnight staging of equipment or supplies would occur within 0.10 mi of aquatic habitat. Measures would be implemented that prevent CRLF from accessing the staging area (e.g., drift fence barrier installed).
- The Applicant will maintain exhaust ducts and associated v-ditch at SLC-4 and SLC-6 to be free of standing water to the maximum extent possible between launches to help minimize the potential to attract CRLF to SLC-4 and SLC-6.
- The Applicant would continue to remove nonnative, invasive predators captured incidentally during the monitoring efforts described below (e.g., bullfrogs [*Lithobates catesbeianus*]).
- The Applicant will continue to implement long-term monitoring of population and distribution trends associated with CRLF populations within Jalama Creek, Honda Creek, Bear Creek, and the Santa Ynez River, as described below:
 - The Applicant will conduct quarterly night surveys for CRLF and spring tadpole surveys of lower Honda Creek, Bear Creek, the Santa Ynez River, and Jalama Creek to compare baseline CRLF detection rate and occupancy data collected over the past 10 years and assess if there are any changes in CRLF habitat occupancy, breeding behavior (calling), and breeding success (egg mass and tadpole densities). Data analysis will incorporate past and future habitat assessments to account for variables including but not limited to observed variation in extent of wetted habitat, quantified predator removal, and climatic factors. Within-site population trends will be assessed in relation to intensity of launch impacts experienced at each site to evaluate whether proximity to launch sites is related to occupancy, breeding behavior (calling), and breeding success (egg masses and tadpole densities). The Applicant will record and measure the following during the surveys:
 - CRLF detection density following the same survey methods conducted previously at these sites and throughout VSFB (see MSRS 2024a);
 - CRLF locations and breeding evidence (e.g., calling, egg masses);
 - environmental data during surveys (temperature, wind speed, humidity, and dewpoint) to determine if environmental factors are affecting CRLF detection or calling rates;
 - annual habitat assessments to measure flow rates, stream morphology, depths, quantify suitable occupied habitat and sediment to determine if any changes in CRLF metrics are associated with other environmental factors, such as drought; and
 - locations and densities of co-occurring anurans, including bullfrogs and Baja California tree frogs (*Pseudacris hypochondriaca*).

- The Applicant will continue to perform passive bioacoustics monitoring (Wildlife Acoustics Song-Meter 4 or similar technology) and will establish frog calling behavior baseline within each impacted breeding feature (Jalama Creek, Honda Creek, Bear Creek, and Santa Ynez River) and a control site at Arroyo Quemado for purposes of signal characteristic comparison. CRLF calling behavior baseline will include applicable call characteristics (e.g., changes in signal rate, call frequency, amplitude, call timing, call duration, etc.). The Applicant will ensure that bioacoustic monitoring conducted is designed to best address confounding factors in order to appropriately characterize impacts of launch, static fire, and landing events on calling behavior. The CRLF call characteristics described above will be analyzed from the sites on VSFB and Arroyo Quemado to determine if there are any differences that may be due to launch-related causes. In addition, the results will be analyzed in conjunction with long term population data to ensure that any observed changes in signal characteristics are not resulting in observable declines in population.
- The Applicant will discontinue monitoring after 5 years from initiation of monitoring, which began with the 2023-2024 breeding season.

2.3.3 Western Snowy Plover

- The Action Agency will continue to implement long-term monitoring of annual population and distribution trends associated with SNPL along Surf Beach.
 - The Applicant will perform acoustic monitoring (rocket engine noise and sonic boom) at South Surf Beach during the first three Falcon Heavy missions to validate noise model predictions.
 - The Applicant will perform geospatial analysis annually to identify declines in the SNPL population, nesting activity, and reproductive success that may result from cumulative effects of multiple Falcon launches and landings from SLC-4 and SLC-6. The Applicant will discontinue this analysis after 5 years from initiation, which began with the 2024 SNPL breeding season.
- The Applicant will use motion triggered video cameras during the breeding season (1 March through 30 September) to determine nest fates and potential impacts to nests during the first three Falcon Heavy launches and landings.
 - The Applicant will monitor active nests at South Surf Beach with motion triggered video cameras during the breeding season at whichever of the following is greater within the modeled 4.0 psf zone to assess potential novel effects that may result from frequent launching: (i) 10% of active SNPL nests, or (ii) 4 active SNPL nests. The Applicant will monitor at whichever of the following is greater within the modeled 3.0 to 4.0 psf zone: (iii) 10% of active SNPL nests, or (iv) 2 active SNPL nests. The Applicant will monitor at whichever of the following is greater within the modeled 2.0 to 3.0 psf zone: (v) 5% of active SNPL nests, or (vi) 4 active SNPL nests.

- Cameras will be placed in a manner to minimize disturbance to nesting plovers; this will be determined in the field based on the best judgement of a permitted biologist.
- The Applicant will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events.
- The Applicant will review SNPL nest camera recordings as soon as possible after the Falcon Heavy launch/landing events.

2.3.4 California Least Tern

- The Action Agency will continue to implement long-term monitoring of annual population and distribution trends associated with LETE.
 - The Applicant will perform statistical analysis annually to identify declines in the LETE population, nesting activity, and reproductive success that may result from cumulative effects of multiple Falcon launches and landings from SLC-4 and SLC-6. The Applicant will discontinue this analysis after 5 years from initiation, which would begin with the 2024 LETE breeding season.
- The Applicant will perform acoustic monitoring (rocket engine noise and sonic boom) during the first three Falcon Heavy missions at the Purisima LETE colony to validate noise model predictions.
- Motion triggered video cameras will be used during the breeding season (typically 15 April to 15 August) to determine nest fates and potential impacts to nests during the first three Falcon Heavy launches and landings to reduce disturbance associated with human activity within breeding habitat.
 - The Applicant will monitor at whichever of the following is greater within the Purisima Point colony: (i) 10% of active LETE nests, or (ii) 4 active LETE nests.
 - Cameras will be placed in a manner to minimize disturbance to nesting terns; this will be determined in the field based on the best judgement of a permitted biologist.
 - The Applicant will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events.
 - The Applicant will review LETE nest camera recordings as soon as possible following the Falcon Heavy launch/landing events.

2.3.5 Southern Sea Otter

- The Action Agency will continue to conduct SSO population surveys at the current levels to monitor the densities and distribution of SSO along VSFB's coastline.

2.3.6 Conservation Measures Implemented under the Programmatic Biological Opinion

In addition to the measure proposed above, the Action Agency will continue to implement the following measures that are relevant to MAMU, California condor, and SSO, as required under the Programmatic Biological Opinion (PBO 8-8-12-F-49R):

- The Action Agency will ensure that annual MAMU population surveys will continue to be conducted at the current levels to monitor the frequency and distribution of MAMU within the action area.
- Prior to any launch, the Action Agency will determine if any California condors are present by coordinating with Service and Ventana Wildlife Society personnel. The Action Agency will contact the USFWS if California condors appear to be near or within the area affected by a launch from SLC-4. In the unlikely event that a California condor is nearby, Qualified Biologists will monitor California condor movements in the vicinity of VSFB and coordinate with the USFWS to analyze data before, during, and after launch events to determine whether any changes in movement occur. The Action Agency will coordinate with current USFWS personnel, including Arianna Punzalan, Supervisory Wildlife Biologist, USFWS California Condor Recovery Program, at arianna_punzalan@fws.gov or (805) 377-5471; or Steve Kirkland, California Condor Field Coordinator, USFWS California Condor Recovery Program, at steve_kirkland@fws.gov or 805-766-4630. The Space Force will also coordinate with current Ventana Wildlife Society personnel, including Joe Burnett, Senior Wildlife Biologist, at joeburnett@ventanaws.org or 831-800-7424.
- The Action Agency will require that project-related boats that utilize the harbor during hours of darkness operate under a lighting management plan to reduce potential impacts to rafting SSO and other marine mammals from visual disturbance.
- As depicted in the 2022 Programmatic Biological Assessment, the Action Agency will require the project proponent to adhere to the following measures in regard to watercraft speed within and adjacent to the VSFB Harbor: a) Within the harbor during hours of daylight, personnel will maintain a speed of less than 11.5 miles per hour (10 knots) if SSO are present and maintain a minimum of 80 feet of separation from rafting SSO; b) Within the harbor during hours of darkness, personnel will maintain a speed of less than 11.5 miles per hour (10 knots) at all times; c) Outside the harbor, personnel will maintain speeds of less than 17 miles per hour (15 knots) within depths of less than approximately 80 feet which correlates to approximately 5.5 mi from shore; d) Outside the harbor during hours of daylight, personnel will maintain a minimum of 325 feet of separation from rafting SSO and 30 feet of separation from kelp. If this separation distance is determined to be infeasible in coordination with the Qualified Biologist, personnel will maintain a 'no wake' speed (5 miles per hour/4.3 knots) when within 30 feet of kelp.
- The Action Agency would continue to conduct surveys for SWFL and LBVI within suitable habitat on VSFB during the breeding season every third year contingent upon funding.

3 Methods and Action Area

3.1 Action Area

The USFWS's regulations define the "Action Area" as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 Code of Federal Regulations [C.F.R.] section 402.02). Impacts on listed species were considered for all

areas potentially impacted by the potential disturbances caused by construction, launch and landing activities (visual impacts, engine noise, sonic booms, fairing and first stage recovery), and increased water use to support increased launch cadence. The resulting Action Area (Figure 3.1-1 through Figure 3.1-3) encompasses the following:

- construction site at SLC-6 (Figure 2.2-2 and Figure 2.2-4 through **Error! Reference source not found.**);
- landing and recovery area (Figure 2.2-6);
- potential launch and landing sonic boom footprints, areas potentially impacted by sonic boom of 1 psf or greater during landing at VSFB, areas potentially impacted by launch and landing sonic booms of 1 psf or greater at the NCI, areas potentially impacted by sonic booms during first stage/booster landings on a barge in the Pacific Ocean, and areas of southern Santa Barbara, Ventura, and northern Los Angeles Counties that may be impacted by sonic booms of 1 psf or greater during ascent;
- 100 dB (unweighted) contour modeled for Falcon Heavy launch engine noise (which encompasses both the launch and landing engine noise footprints for Falcon 9 and Falcon Heavy at SLC-4 and SLC-6); and
- San Antonio Creek Basin, which is utilized for two to three weeks each year as the source of VSFB water during annual maintenance of the State Water system.

The portion of the Action Area defined by the potential ascent sonic boom footprint over mainland southern California included all areas that could potentially receive a sonic boom of 1 psf or greater, although the statistical likelihood of a 1-psf-or-greater sonic boom would also be very low for much of this area.

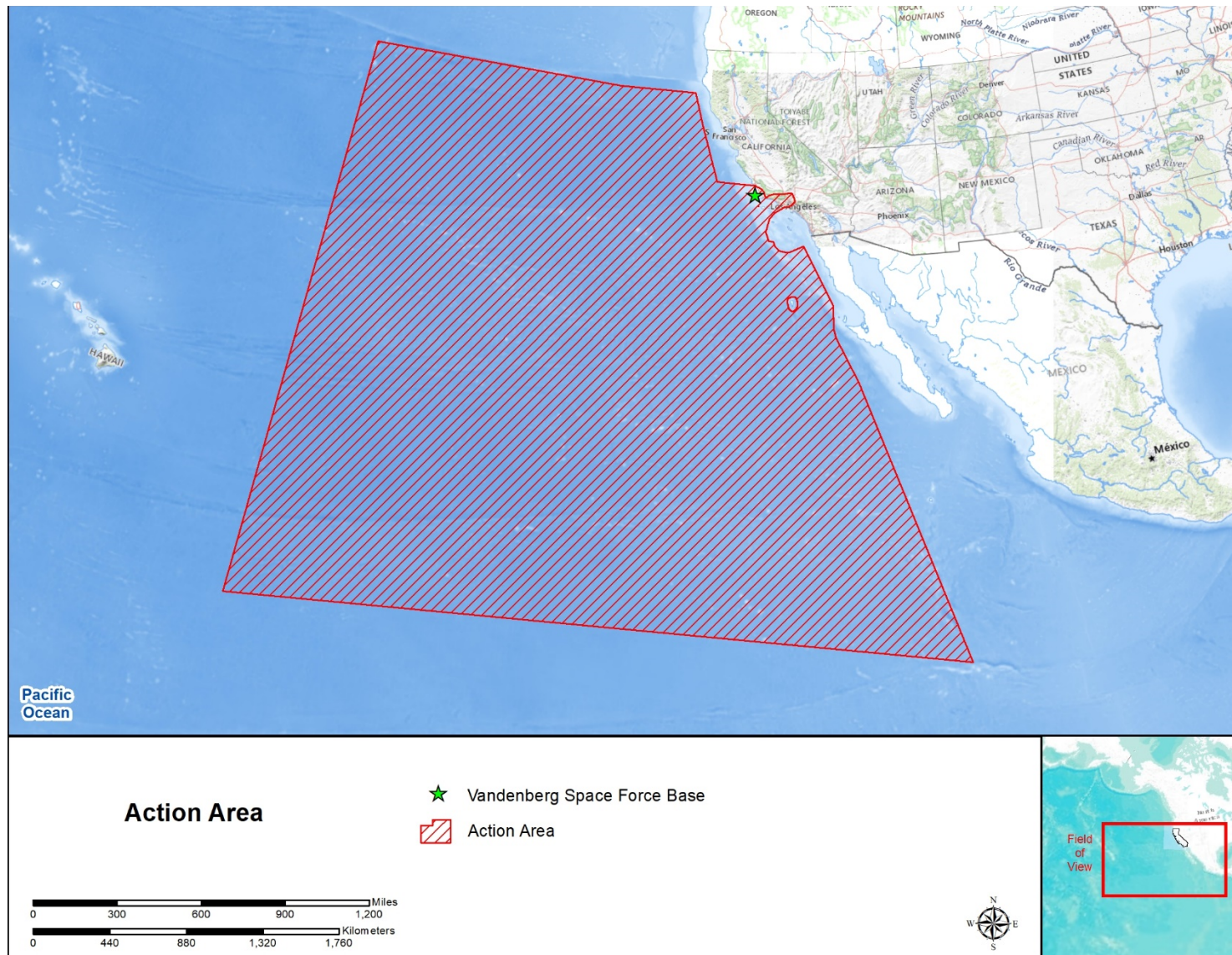


Figure 3.1-1. Action Area.

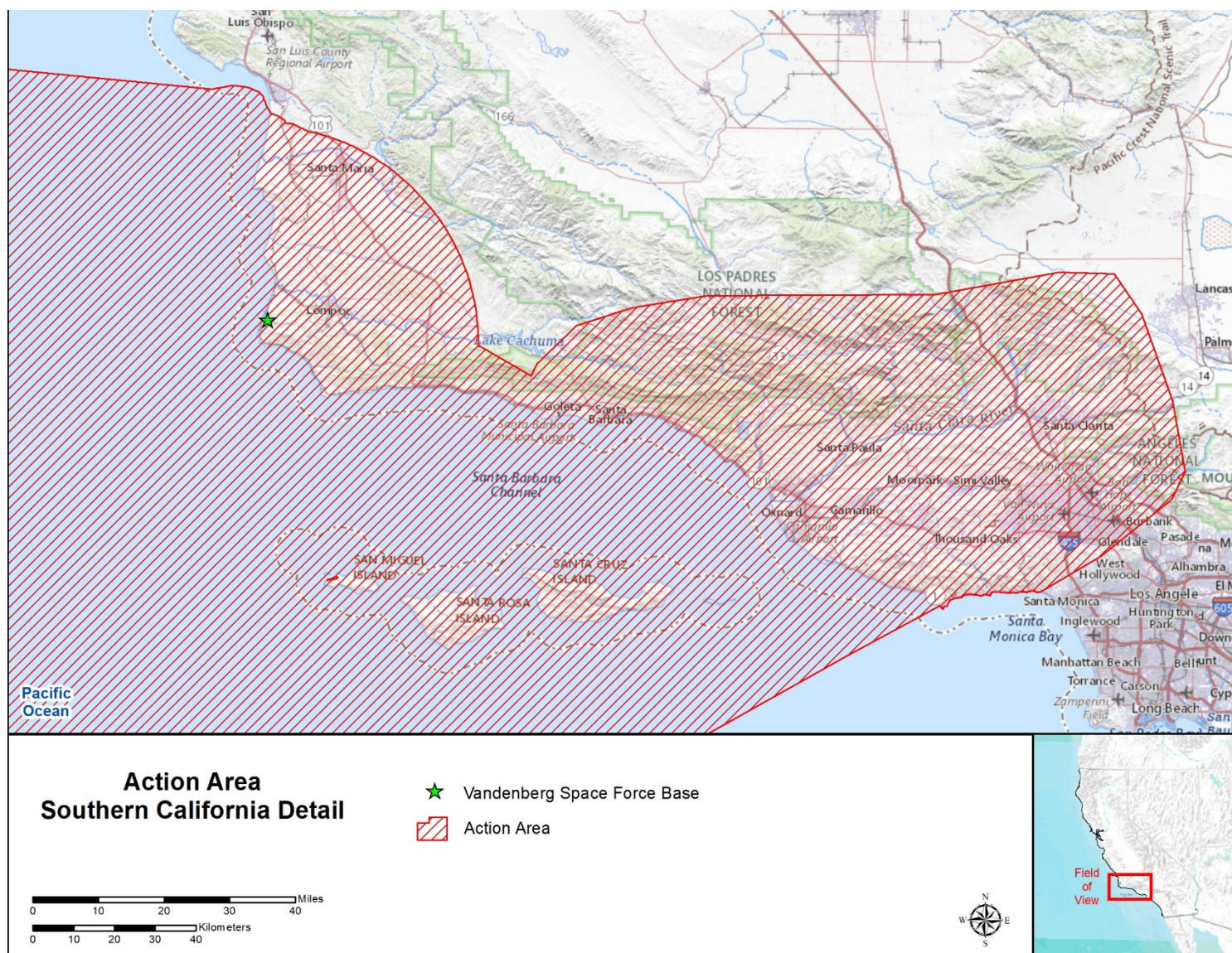


Figure 3.1-2. Action Area - Southern California Detail.

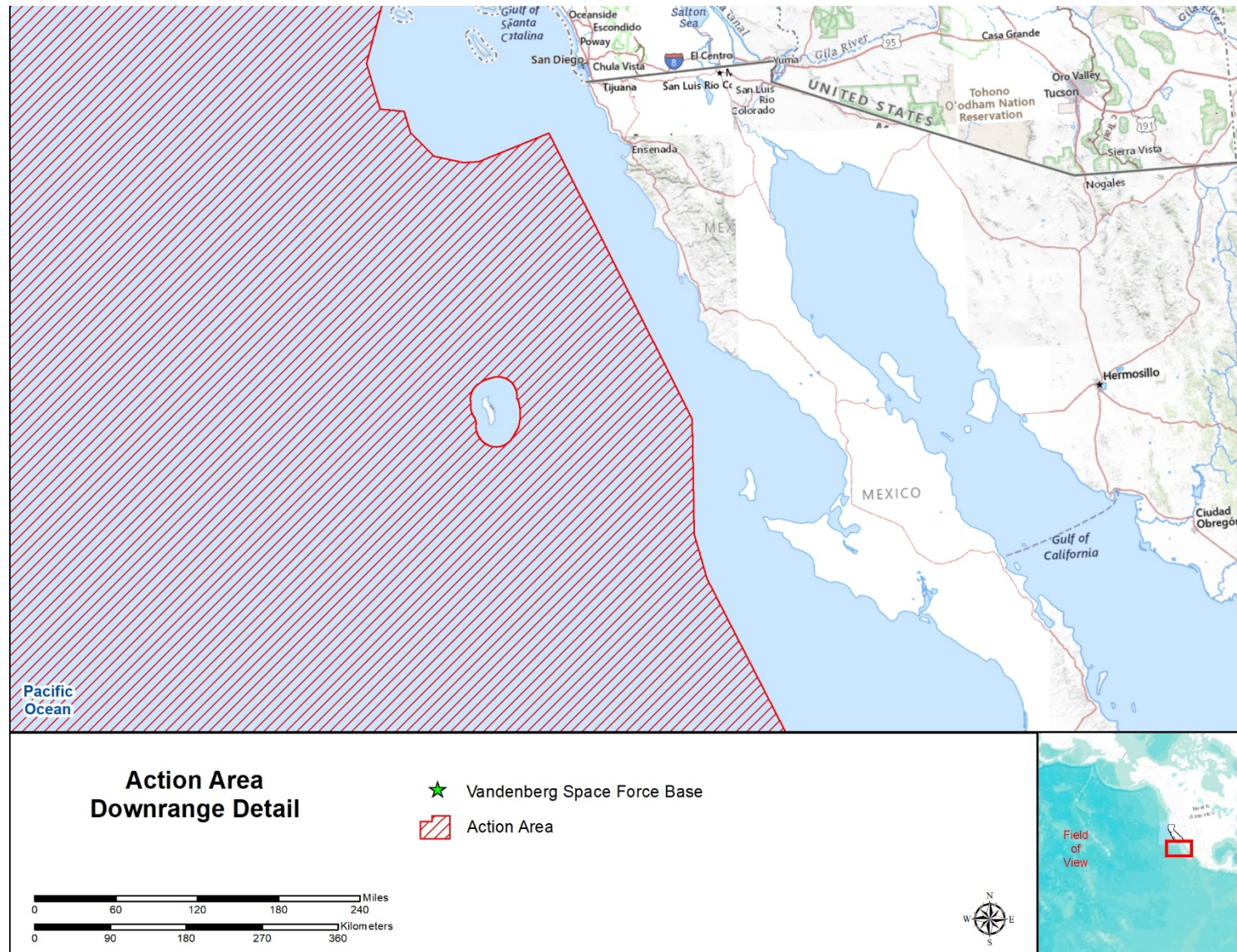


Figure 3.1-3. Action Area - Downrange Detail.

3.2 Methods

Biological surveys of the area surrounding SLC-4 were performed as part of the 2017 BA (ManTech SRS Technologies, Inc. [MSRS] 2017a). There was no need to perform additional field surveys at SLC-4 for this BA because the Proposed Action does not require any construction-related ground disturbance at this location, the maximum number of first stage landings (12) at SLC-4W would not change from what was described in the 2023 and 2024 BOs (USFWS 2023, 2024), and recent survey data are available for all relevant species in the areas potentially impacted at that location. Biological surveys of the proposed construction areas at SLC-6 were performed during October and November 2023. A qualified biologist performed meandering surveys throughout the areas where construction is proposed, mapping any federally listed species encountered and assessing habitat for suitability and potential occurrence of these species. Existing special status species monitoring data, survey reports, and California Natural Diversity Database (CNDDB) records (California Department of Fish and Wildlife [CDFW] 2024), and the USFWS Information for Planning and Consultation (IPaC) website were reviewed to assess the potential occurrence, distribution, and habitat use of federally listed species around SLC-6 and within the broader Action Area.

4 Status of the Species

Table 4.0-1 summarizes all federally listed, proposed, and candidate species and critical habitat occurring within the Action Area that were not dismissed from analyses of effects. Specific discussion on species occurrence in the Action Area and overlap with Critical Habitat are included in the descriptions of the status of each species below.

Table 4.0-1. Federally listed species and critical habitat occurring within the Action Area.

Common Name	Scientific Name	Federal Listing	Critical Habitat Occurrence in the Action Area	Source
Tidewater Goby	<i>Eucyclogobius newberryi</i>	Endangered	Yes	IPaC, CNDDDB, VSFB survey records
Unarmored Threespine Stickleback	<i>Gasterosteus aculeatus williamsoni</i>	Endangered	No	IPaC, CNDDDB, VSFB survey records
California Tiger Salamander Santa Barbara (DPS)	<i>Ambystoma californiense</i>	Endangered	Yes	IPaC, CNDDDB
California Red-legged Frog	<i>Rana draytonii</i>	Threatened	Yes	IPaC, CNDDDB, VSFB survey records
Arroyo Toad	<i>Anaxyrus californicus</i>	Endangered	Yes	IPaC, CNDDDB
Marbled Murrelet	<i>Brachyramphus marmoratus</i>	Threatened	No	IPaC, CNDDDB, VSFB survey records, eBird 2024
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	Endangered	Yes	IPaC, CNDDDB, VSFB survey records
Least Bell's Vireo	<i>Vireo bellii pusillus</i>	Endangered	Yes	IPaC, CNDDDB, VSFB survey records
Western Snowy Plover	<i>Charadrius nivosus</i>	Threatened	Yes	IPaC, CNDDDB, VSFB survey records
California Least Tern	<i>Sternula antillarum browni</i>	Endangered	No	IPaC, CNDDDB, VSFB survey records

Common Name	Scientific Name	Federal Listing	Critical Habitat Occurrence in the Action Area	Source
California Condor	<i>Gymnogyps californianus</i>	Endangered	Yes	IPaC, CNDDDB, VSFB survey records
California Gnatcatcher	<i>Polioptila californica californica</i>	Threatened	Yes	IPaC, CNDDDB, VSFB survey records
Light-footed Ridgeway's Rail	<i>Rallus obsoletus levipes</i>	Endangered	No	IPaC, CNDDDB, VSFB survey records
Short-tailed Albatross	<i>Phoebastria (=Diomedea) albatrus</i>	Endangered	No	IPaC
Hawaiian Petrel	<i>Pterodroma sandwichensis</i>	Endangered	No	IPaC
Southern Sea Otter	<i>Enhydra lutris nereis</i>	Threatened	No	IPaC, VSFB survey records, USGS 2020

4.1 Tidewater Goby (Federally Listed Endangered Species)

4.1.1 Status

The TWG was listed as endangered on 7 March 1994 (59 FR 5494). On 24 June 1999, the USFWS proposed to remove the populations occurring north of Orange County, California, from the endangered species list (64 FR 33816). In November 2002, the USFWS withdrew this proposed delisting rule and retained the TWG's listing as endangered throughout its range (67 FR 67803). The USFWS published a Recovery Plan for the TWG in 2005 (USFWS 2005). In January 2014, USFWS proposed to reclassify the TWG from endangered to threatened (79 FR 14340-14362). In addition, the USFWS is considering a proposed taxonomic split between northern and southern populations of this species, with an expectation to delist the northern population (including all individuals at VSFB). A decision on this proposal has not been made.

4.1.2 Life History

The TWG is a small, bottom-dwelling fish found in California's coastal estuaries, wetlands, lagoons, and lower reaches of coastal streams and rivers. It is an annual species, with individuals typically not living for more than a year. TWG population size is heavily influenced by environmental conditions. In years experiencing high rains, when lagoons are breached, TWG numbers fall as fish are washed out to sea. Individuals able to access refugia, such as that provided by vegetation in littoral marshes, are able to survive flood events. These surviving individuals breed after the lagoons close, allowing populations to rebound the following summer.

(Swift et al. 1989). Breeding may occur year-round (Swenson 1999), with peak spawning activity usually occurring during the spring and a second peak during the late summer (Swift et al. 1989).

The key threat to TWG is the degradation of coastal lagoons as a result of diversion of water (dewatering streams affects marsh habitat extent, and alters temperature and salinity within the marshes), pollution from agricultural and sewage effluents, siltation (often through sediment generated during cattle overgrazing and feral pig activity), and coastal development. In addition, introduced predatory fish (especially centrarchids and channel catfish [*Ictalurus punctatus*], crayfish [*Procambarus clarkii*], and mosquito fish [*Gambusia affinis*]) pose a direct threat to TWG populations through predation of eggs, young, and adults.

4.1.3 Occurrence within the Action Area

TWG have been reported in all the major drainages on VSFB, including Shuman Creek, San Antonio Creek, the Santa Ynez River, Honda Creek, and Jalama Creek (Swift et al. 1997). TWG typically favors areas within the fresh-saltwater interface with salinities of less than 12 parts per thousand (Swift et al. 1989). However, this species will range into fresh water and has been recorded up to 7.5 mi upstream from the ocean in the Santa Ynez River (Swift et al. 1997).

Potential habitat for TWG within the Action Area includes Honda Creek, the Santa Ynez River, Jalama Creek, and San Antonio Creek. TWG were first found in the Honda estuary lagoon in 1995 (Lafferty et al. 1999). The species was again documented in 2001; however, seine net surveys conducted in Honda Creek in 2008 indicated that TWG were no longer present (MSRS 2009a). Seine net surveys were again conducted in Honda Creek in 2015 and 2016 with no TWG present (MSRS 2016a, 2018a). Despite being easily detectable in shallow water with a flashlight during night frog surveys, no TWG were observed during night CRLF surveys of the Honda Creek estuary for SpaceX launch monitoring activities in January 2022 (J. LaBonte, pers. obs.). Seine surveys conducted in 2024 also failed to document any TWG in Honda Creek (MSRS, unpubl. data).

In 2013, the Honda Creek estuary lagoon dried and stayed dry through 2016 before rehydrating in the winter of 2016–2017 (MSRS 2018a). Since 2017, the lagoon has been subject to drying during late summer months, making any longer-term occupancy by fish dependent on being able to establish in areas east of Coast Road, but the narrowness and shallowness of the creek in this area makes this unlikely. Occurrence within Honda Creek would be dependent on TWG recolonizing the lagoon if it fills and breaches in response to winter rains. Unless environmental conditions return to a consistently wetter regime conducive to perennial water in the Honda lagoon, any TWG occupancy is likely to be of short duration.

On VSFB, TWG currently occur in the Santa Ynez River from the estuary to 13th Street Bridge and San Antonio Creek, being mostly concentrated in the San Antonio Creek lagoon as compared to its channel (Swift 1999; MSRS 2018b). TWG also occur in Jalama Creek (MSRS 2016a). To the southeast of VSFB, in the region potentially impacted by ascent sonic booms during missions with easterly trajectories, TWG occur in most coastal streams, bays, and estuaries in southeastern Santa Barbara, Ventura, and southwestern Los Angeles Counties (Figure 4.1-1; CDFW 2024).

4.1.4 Critical Habitat

The USFWS issued a final rule for designation of Critical Habitat for the TWG on 6 February 2013 (78 FR 8745-8819). VSFB was exempted from Critical Habitat designation under Section 4(a)(3) of the ESA. USFWS has adopted VSFB's Integrated Natural Resources Management Plan (INRMP; U.S. Air Force 2021), prepared under Section 101 of the Sikes Act (16 U.S.C. 670a). The potential ascent sonic boom footprint from missions with easterly trajectories overlaps Critical Habitat Units SB-8, 9, 10, 11, and 12, VEN-1, 2, 3, and 4, and LA-1, 2, 3, and 4 (**Figure 4.1-2**).

The primary constituent elements (PCE) for TWG Critical Habitat include the following:

- (1) Persistent, shallow (in the range of approximately 0.3 to 6.6 ft) still-to-slow-moving lagoons, estuaries, and coastal streams with salinity up to 12 parts per thousand, which provide adequate space for normal behavior and individual and population growth that contain one or more of the following:
 - (a) Substrates (e.g., sand, silt, mud) suitable for the construction of burrows for reproduction;
 - (b) Submerged and emergent aquatic vegetation, such as *Potamogeton pectinatus*, *Ruppia maritima*, *Typha latifolia*, and *Scirpus* spp., that provides protection from predators and high flow events; or
 - (c) Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.

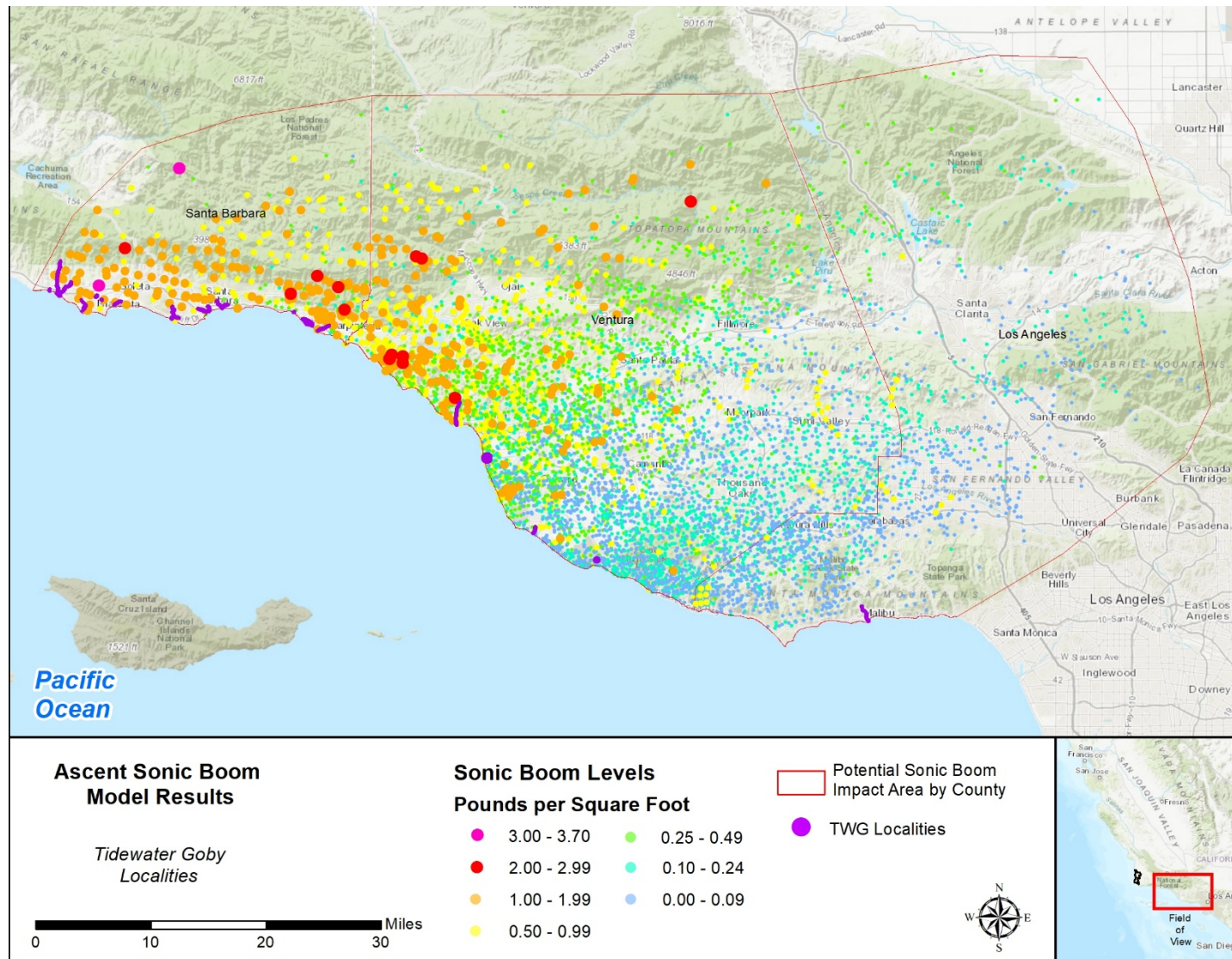


Figure 4.1-1. TWG localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.6).

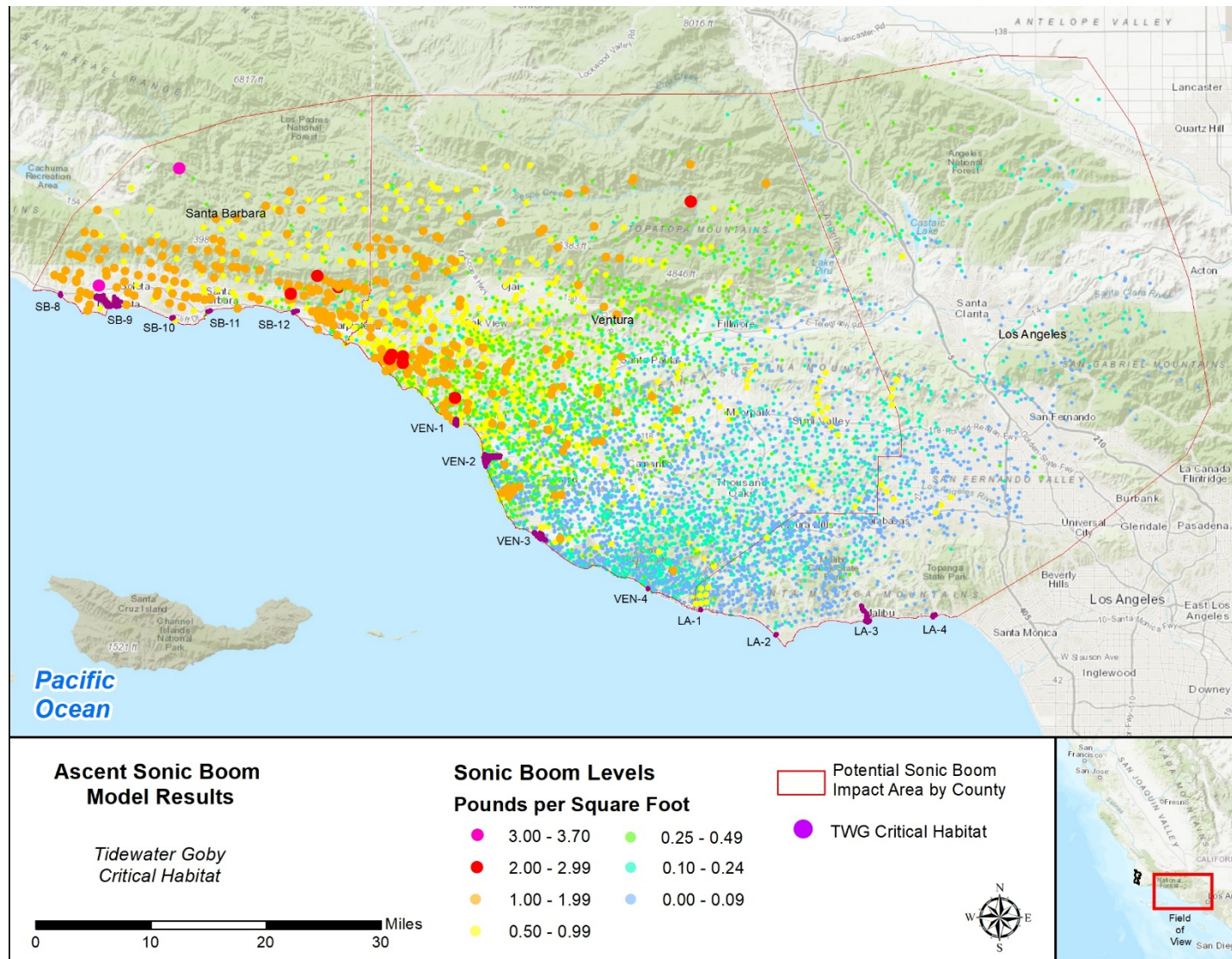


Figure 4.1-2. TWG Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.2 Unarmored Threespine Stickleback (Federally Listed Endangered Species)

4.2.1 Status

The UTS was listed as endangered in 1970 (35 FR 16047-16048). A Recovery Plan was issued in 1985 (USFWS 1985a).

4.2.2 Life History

UTS are small fish (approximately 6 centimeters) that are short-lived (i.e., rarely surviving 2–3 years; USFWS 1985a). UTS reproduce throughout the year with highest recruitment noted from May to September (USFWS 1985a). These fish are opportunistic feeders and primarily feed on invertebrates and aquatic insects (USFWS 1985a). The key threats to UTS conservation include urbanization, eutrophication, stream channelization, groundwater removal, reduced water quality, and invasive species. In San Antonio Creek, UTS coexist with other native and introduced species, many of which likely prey on UTS.

4.2.3 Occurrence in the Action Area

UTS were abundant throughout the Los Angeles basin but were reported to be extirpated by 1942. As of 1985, UTS was generally restricted to the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.2-1) and the San Antonio Creek drainage in Santa Barbara County (USFWS 1985a, CDFW 2024). On VSFB, UTS have been found in San Antonio Creek from Barka Slough to the lagoon with UTS primarily occupying the creek channel (ManTech 2009a, Swift 1999).

UTS were introduced into Honda Creek, south of SLC-5, in 1984 (MSRS 2009a). Extensive aquatic surveys conducted in 2008, 2016, and 2017 did not detect any fish in the creek (MSRS 2009a, 2016a, 2018a). Additionally, between 2008 and 2022, Honda Creek has gone through multiple cycles of drying and rehydration, which would preclude occupancy by and persistence of fish.

4.2.4 Critical Habitat

Critical Habitat for the UTS was proposed in 1980 (45 FR 76012-76015) but has not been finalized.

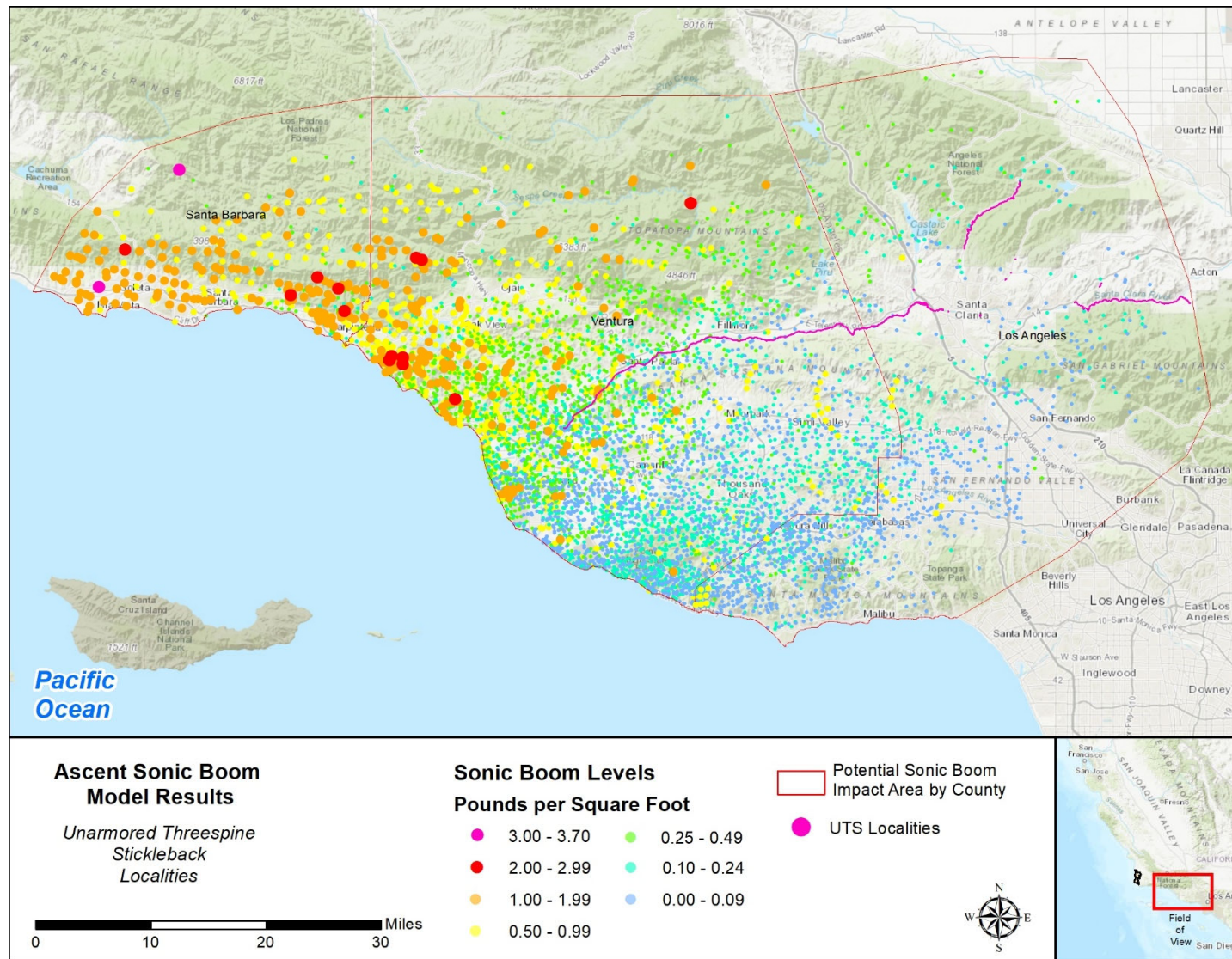


Figure 4.2-1. UTS localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.3 California Tiger Salamander (Federally Listed Endangered Species)

4.3.1 Status

The USFWS listed the CTS Santa Barbara DPS as federally endangered on 21 September 2000 (65 FR 57242). The USFWS finalized a recovery plan for the Santa Barbara DPS in 2016 (USFWS 2016).

4.3.2 Life History

CTS is a large, stocky salamander that inhabits low-elevation (under 1,500 ft) seasonal ponds and grasslands. Manmade livestock and other ponds have become an important component of the specie's habitat. The species spends most of its life underground in small mammal burrows. Outside of the breeding season, CTS are typically found in burrows at depths between 0.2 m and 1.36 m underground, where it is believed that they remain active year-round (Barry & Shaffer 1994). CTS occupied burrows are typically within 1 mi of their breeding ponds. (Barry & Shaffer 1994; Nafis 2023).

Winter rain events trigger CTS to emerge from burrows to seek breeding ponds, usually between November and January, depending on timing of heavy rain events (Loredo & Van Vuren 1996; Trenham et al. 2000; Cook et al. 2006; USFWS 2016). CTS may migrate up to one mi or more before reaching a breeding pond. Males typically arrive before females and remain aboveground longer than females. After mating, the salamander returns to its burrow. Eggs, which are laid underwater on features such as blades of grass and twigs, typically hatch 10 to 28 days after deposition. Although larvae development can be delayed during periods of persistent cold weather, CTS typically emerge as terrestrial metamorphic salamanders between May and August and disperse into upland subterranean habitat.

CTS larvae prey on a variety of invertebrates, including zooplankton and crustaceans, as well as aquatic insects. Larger larvae also eat tadpoles. Adults may eat small invertebrates and vertebrates (USFWS 2016). The key threats to conservation of CTS include habitat loss and fragmentation; invasive species that prey on CTS or may hybridize with them; drought; disease; predation; and some agricultural and rangeland activities.

4.3.3 Occurrence within the Action Area

The Santa Barbara County Distinct Population Segment (DPS) of CTS is the southernmost extent of the species. USFWS has identified six metapopulation areas within this DPS and estimates that there are 60 known breeding ponds within these metapopulation areas scattered through the Santa Maria Valley, south to the Santa Rita Hills (Figure 4.3-1 through Figure 4.3-5). CTS does not occur on VSFB. The nearest CTS breeding pools are approximately 14 mi east of SLC-4 in the Santa Rita Hills. CTS have not been detected on VSFB during regular protocol surveys of suitable habitat since 2006 (Collins 2006; Sweet et al. 2008, 2010; MSRS 2016b, 2020, 2022a).

4.3.4 Critical Habitat

The USFWS designated Critical Habitat for the Santa Barbara County DPS on 24 November 2004 (69 FR 68568) and does not include VSFB. The Action Area includes designated Critical Habitat Units 1, 2, 3, 4, 5, and 6 for the Santa Barbara DPS of the CTS (Figure 4.3-1 through Figure 4.3-5). The PCE's for CTS Critical Habitat include the following:

- (1) Standing bodies of fresh water (including natural and manmade (e.g., stock ponds), vernal pools, and other ephemeral or permanent water bodies which typically support inundation during winter rains and hold water for a minimum of 12 weeks in a year of average rainfall.
- (2) Upland habitats adjacent and accessible to and from breeding ponds that contain small mammal burrows or other underground habitat that CTS depend upon for food, shelter, and protection from the elements and predation.
- (3) Accessible upland dispersal habitat between occupied locations that allow for movement between such sites.

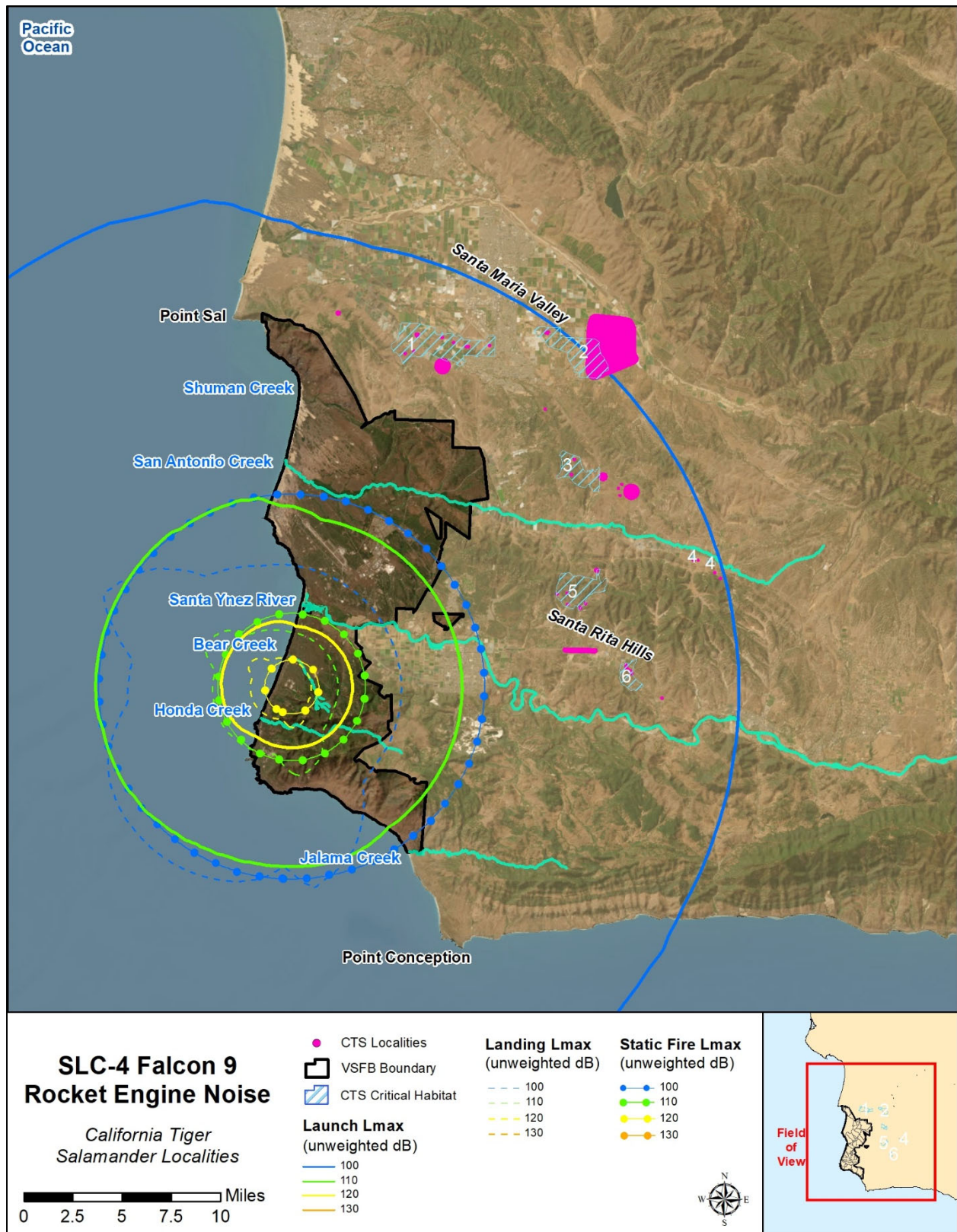


Figure 4.3-1. California tiger salamander localities, Critical Habitat, and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

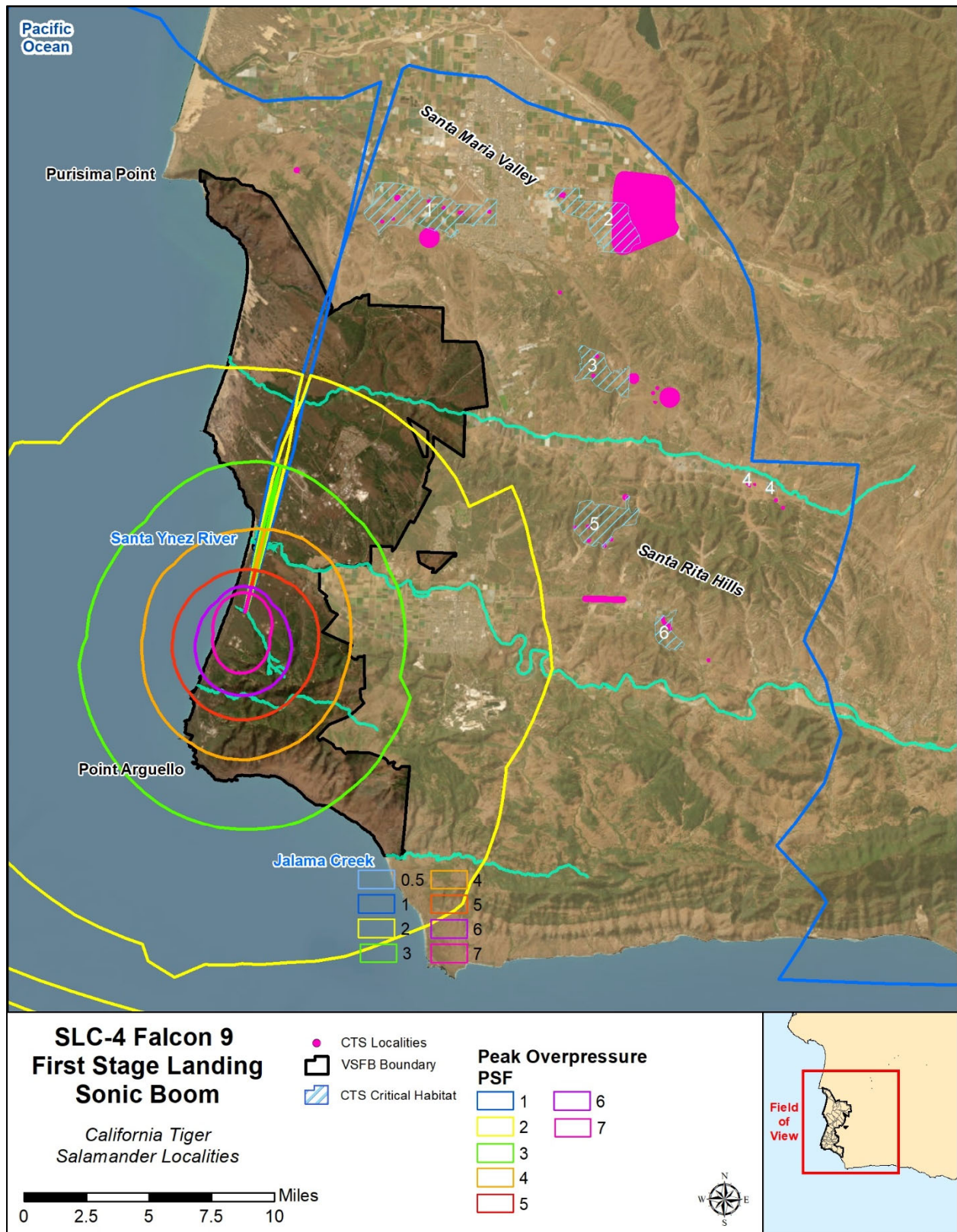


Figure 4.3-2. California tiger salamander localities, Critical Habitat, and sample SLC-4 landing sonic boom model result.

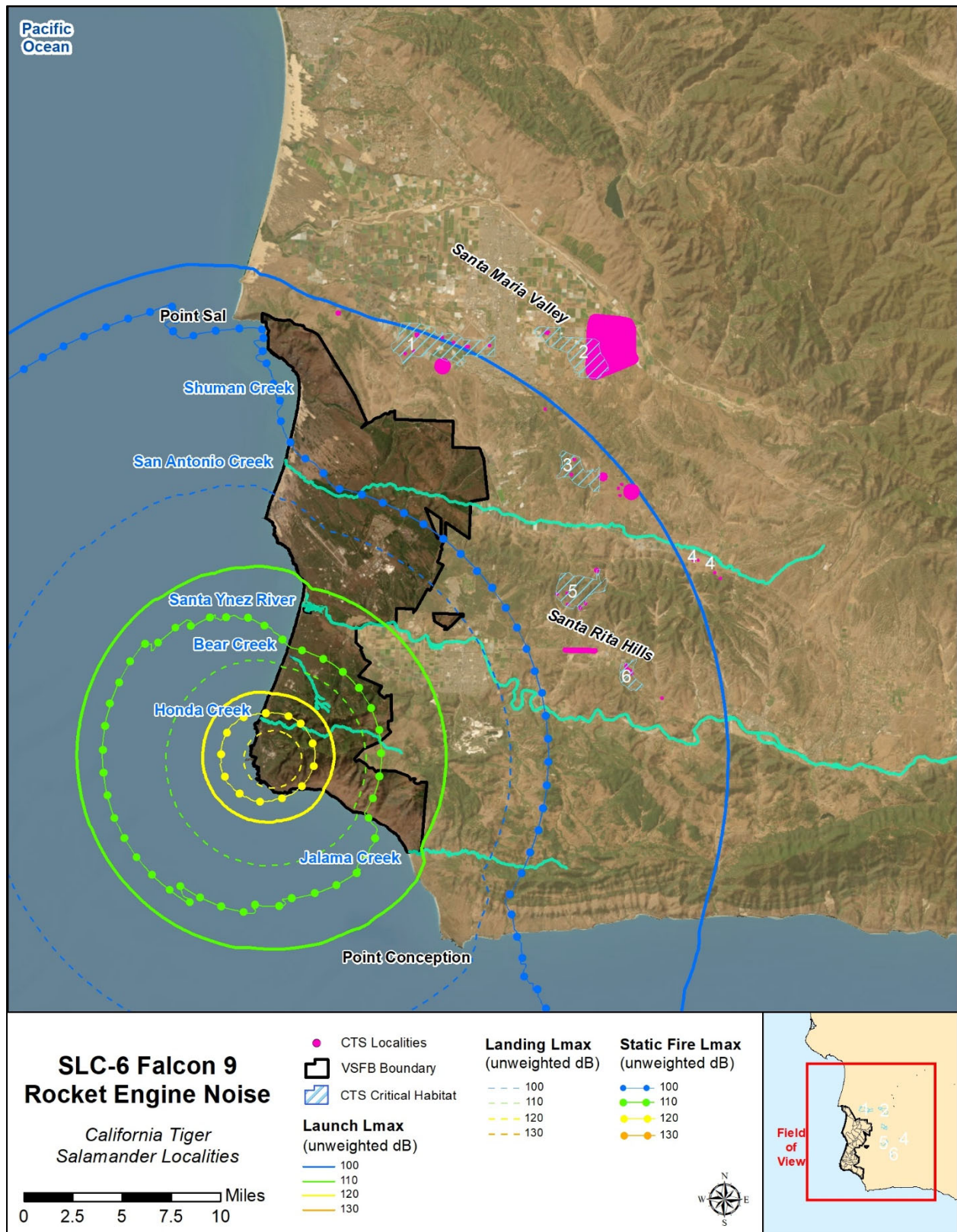


Figure 4.3-3. California tiger salamander localities, Critical Habitat, and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

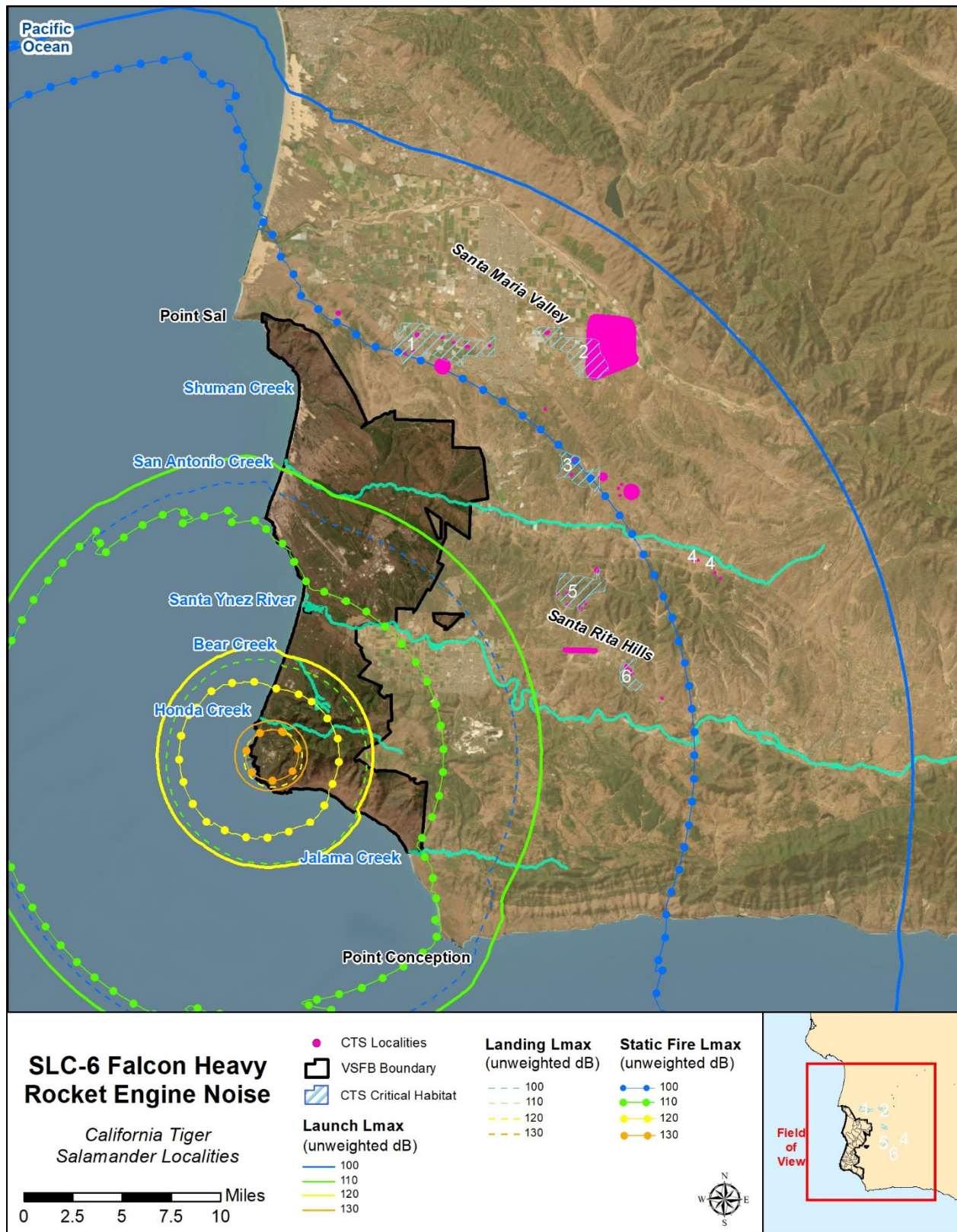


Figure 4.3-4. California tiger salamander localities, Critical Habitat, and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

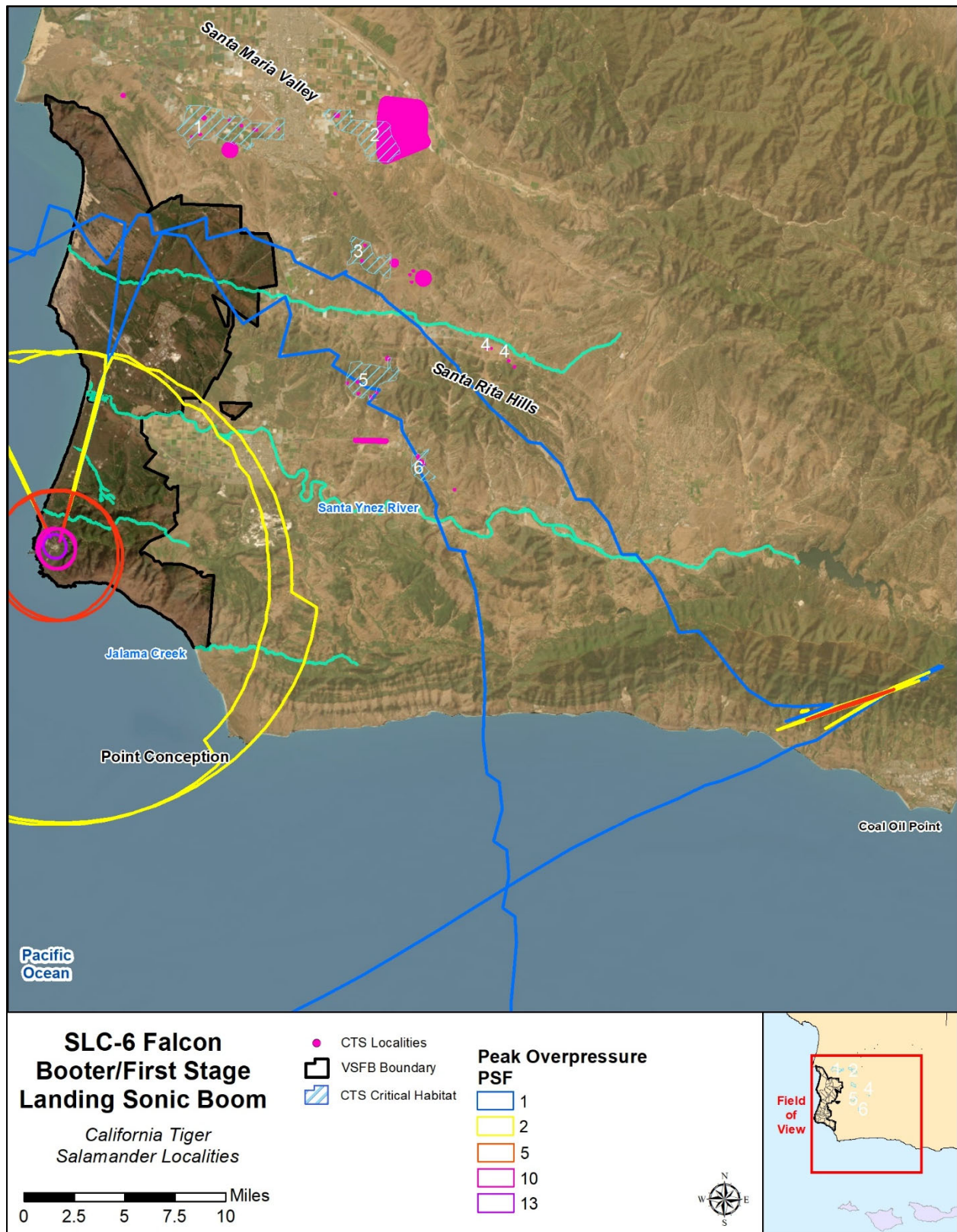


Figure 4.3-5. California tiger salamander localities, Critical Habitat, and two sample sonic boom model results for SLC-6 booster/first stage landing events.

4.4 California Red-Legged Frog (Federally Listed Threatened Species)

4.4.1 Status

The UFSWS listed the CRLF as threatened on 23 May 1996 (61 FR 25813-25833). In 2002, USFWS issued a Recovery Plan for the CRLF (USFWS 2002b).

4.4.2 Life History

The CRLF is a member of the family Ranidae and is California's largest native frog. In order to breed, CRLF require water bodies with sufficient hydroperiods and compatible salinity levels to accommodate larval and egg development. Breeding typically takes place from November through April with most egg deposition occurring in March. Eggs require 7 to 28 days, depending on water temperature, to develop into tadpoles. Tadpoles typically require 11 to 20 weeks to develop into terrestrial frogs (USFWS 2002b), although some individuals may overwinter in the tadpole stage (Fellers et al. 2001; A. Abela, pers. obs.).

Adult CRLF have been documented traveling distances of over 1.0 mi (1.6 km) during the wet season and spending considerable time in terrestrial riparian vegetation (Tatarian 2008). Christopher (2018) found that 90% of the CRLF observations at VSFB within the dry season occurred within 197 ft of riparian or other aquatic habitats. It is thought that riparian vegetation provides good foraging habitat, as well as good dispersal corridors, due to canopy cover and presence of adequate moisture (USFWS 2002b).

Habitat loss and degradation, combined with over-exploitation and introduction of exotic predators, were important factors in the decline of CRLF in the early to mid-1900s. Continuing threats to CRLF include direct habitat loss due to stream alteration and loss of aquatic habitat through drought and groundwater declines, and indirect effects of expanding urbanization, competition, or predation from non-native species including the bullfrog, catfish (*Ictalurus* spp.), bass (*Micropterus* spp.), mosquitofish, and crayfish. Chytrid fungus (*Batrachochytrium dendrobatidis*) is a waterborne fungus that can decimate amphibian populations and is considered a threat to CRLF populations.

4.4.3 Occurrence within the Action Area

The DAF has been conducting baseline studies of CRLF populations on VSFB since the late 2000's. These survey data, collected during periods of time with very low launch cadence provide the most appropriate baseline. CRLF have been documented in nearly all permanent streams and ponds on VSFB as well as most seasonally inundated wetland and riparian sites (Figure 4.4-1 through Figure 4.4-6; Christopher 2002). CRLF have been consistently documented in Honda Creek (Christopher 2002; MSRS 2009a, 2016a, 2018a, 2021a) and during SpaceX launch monitoring activities in January 2022 (MSRS 2022b). The Santa Ynez River, San Antonio Creek, Shuman Creek, Bear Creek, Canada del Jolloru, and Jalama Creek, have CRLF populations and suitable breeding habitat (Christopher 2002; MSRS 2009b, 2014a, 2018a). CRLF have also been documented in isolated natural wetlands on south VSFB (Christopher 2002; MSRS 2018a). CRLF were consistently found in 3 decommissioned wastewater treatment pools approximately 0.5 mi west of SLC-6 in the late 1990's up to 2001 (Figure 4.4-6; Christopher 2002); however, these pools have been almost completely dry for the past 20 years (A. Abela, M. Ball, and J. LaBonte, pers.

obs.). These ponds were assessed in February 2024 and the northern pond was completely dry; the southern pond had shallow standing water that would not support anything more than temporary transitory habitat (Figure 4.4-6; A. Abela, pers. obs.). One adult CLRF was observed in 2001 at the Industrial Wastewater Treatment Ponds, approximately 0.4 mi southwest of SLC-6 (Figure 4.4-6); however, that was likely a transient as these two ponds rarely contain water, and when water is present it is shallow (less than 3 inches) and evaporates quickly. When they were assessed in February 2024, they had standing water that would not support anything more than temporary transitory habitat (Figure 4.4-6).

Two drainages border SLC-6, one to the north and one to the south (Figure 4.4-6). These drainages were assessed for CRLF habitat in February and March 2024. Although some surface water was observed, there was no deep pool habitat suitable for supporting breeding CRLF. Adjacent to SLC-6, they were determined to hold surface water flow inconsistently in response to seasonal storms that would only serve as temporary transitory habitat for CRLF. At the southwestern corner of SLC-6, the southern drainage transitions to potential aquatic, non-breeding habitat (Figure 4.4-6). Open water and flow were observed, which was determined to likely be long-lived during seasons with average to above average rainfall. Although open water, suitable aquatic and riparian vegetation, and refugia were observed, there was no deep pool habitat (> 0.7 meters) that could support CRLF breeding. Therefore, the drainage could likely serve as a suitable site for temporary occupation by CRLF. No visual or auditory evidence of CRLF presence was observed.

During the February and March 2024 CRLF habitat assessment, two areas within the SLC-6 fenceline were observed holding enough water to be potentially attractive habitat to CRLF: a “vault” structure and the “flame trench” (Figure 4.4-7 and Figure 4.4-8). Due to the lack of maintenance of the site since 2022, these structures have collected water during rainstorms and were determined to be “attractive nuisances.” The volume of water in both structures could be attractive to transiting frogs. The flame trench is sloped; thus animals can enter and exit. The vault presents an entrapment hazard since it has steep walls with no escape ladder. No visual or auditory evidence of CRLF presence was noted. Neither site has elements such as vegetation or shelter that would make them suitable for long-term occupancy, and no suitable breeding habitat was observed.

Spring Canyon is an ephemeral drainage located approximately 200 ft south of SLC-4. Spring Canyon has no definable channel through the majority of the drainage and minimal evidence of potential pooling or flow of surface water (MSRS 2014b). In July 2017, after an above-average rain year, a USFWS-permitted biologist reassessed the drainage in support of the 2017 Falcon 9 BA (MSRS 2017a) and found no significant changes from the habitat assessment conducted in 2013, which had less than average rainfall levels. Both the 2013 and 2017 assessments showed there was no suitable breeding habitat within the vegetation removal area or downstream. Since 2017, 11 survey efforts were undertaken associated with the 2017 BO, and no suitable habitat has been found. The nearest suitable habitat for CRLF is Bear Creek, approximately 1.2 mi north of Spring Canyon.

Approximately 2 mi south of SLC-4, suitable CRLF breeding habitat is found in Honda Creek, along with scattered CRLF localities in minor wetlands and drainages, across south VSFB, including Bear

Creek located 1.0 mi northeast of SLC-4 (Christopher 2002; MSRS 2009b, 2014a). Suitable upland dispersal habitat exists throughout VSFB between the various riparian zones and ponds on Base but, as noted above, dispersal into these upland habitats on VSFB is limited. CRLF also occur throughout San Antonio Creek on VSFB from Barka Slough to the estuary (MSRS 2009a, 2009b, 2016a).

CRLF on the south coast of Santa Barbara County, including Gaviota Creek, Arroyo Honda, Arroyo Quemado, and other nearby creeks and tributaries are also within the Action Area due to noise impacts associated with the Falcon Heavy launch and landing activities at SLC-6 (Figure 4.4-4). Additionally, within the areas potentially impacted by ascent sonic boom from missions with easterly trajectories, the CNDDDB lists observations of CRLF from San Antonio Creek in Ojai, Las Virgenes Creek near Calabasas, and the Ventura River near Casitas Springs, from 2000 to 2016 (Figure 4.4-9; CDFW 2024).

4.4.4 Critical Habitat

The USFWS issued a final rule revising the CRLF's Critical Habitat on 16 March 2010 (75 FR 12816–12959). The USFWS excluded VSFB from CRLF Critical Habitat designation pursuant to Section 4(b)(2) of the ESA. Off-base, the Action Area includes STB-2, STB-4, STB-5, and STB-6 as a result of noise impact areas from Falcon 9 and Falcon Heavy launch and landing activities at SLC-4 and SLC-6 (Figure 4.4-1 through Figure 4.4-5). The potential ascent sonic boom footprint from missions with easterly trajectories overlaps STB-7, VEN-1, VEN-2, VEN-3, and LOS-1 (Figure 4.4-9).

The PCE for CRLF Critical Habitat include the following:

- (1) Space for individual and population growth and for normal behavior;
- (2) Food, water, air, light, minerals, or other nutritional or physiological requirements;
- (3) Cover or shelter;
- (4) Sites for breeding, reproduction, or rearing (or development) of offspring; and
- (5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

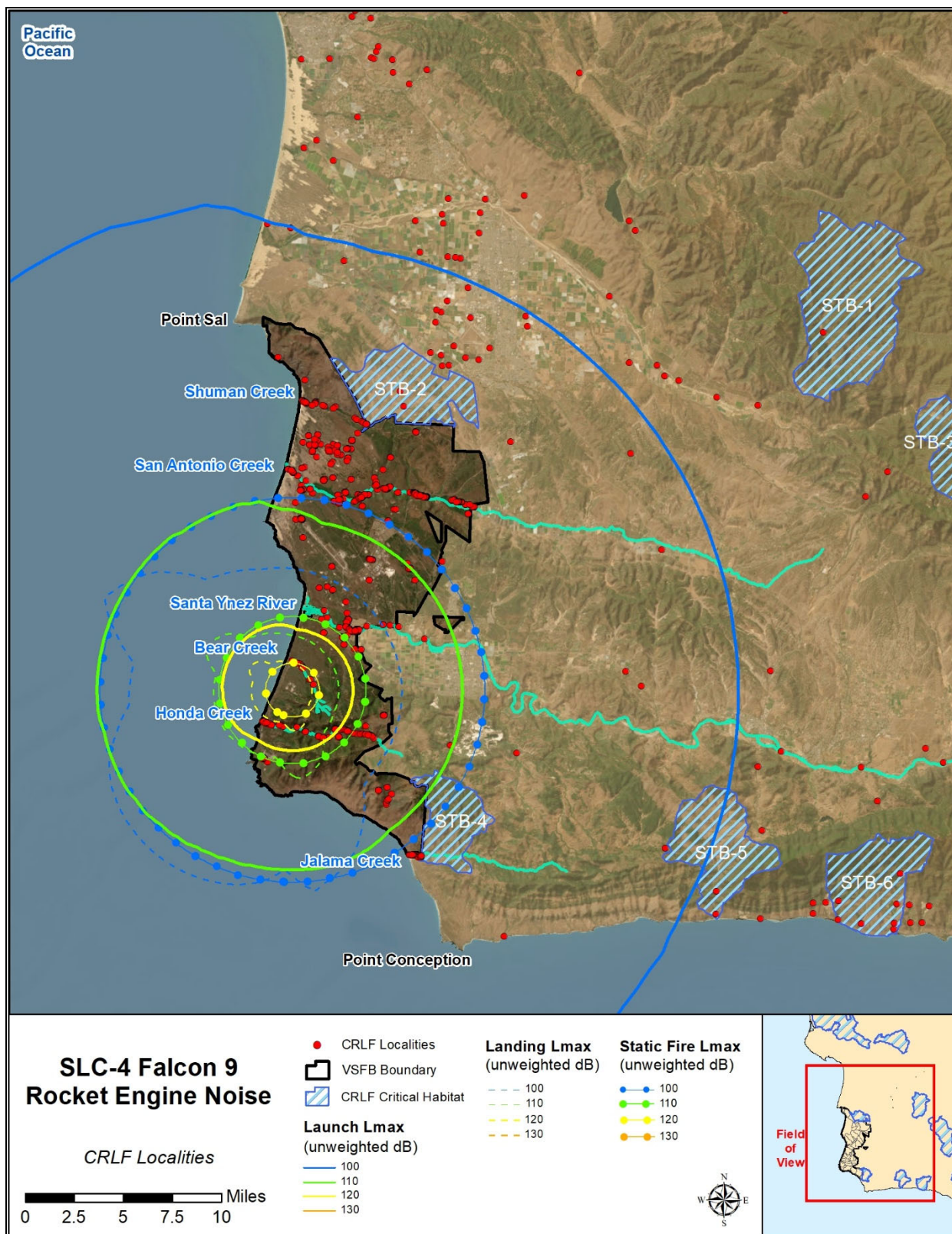


Figure 4.4-1. California red-legged frog localities, Critical Habitat, and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

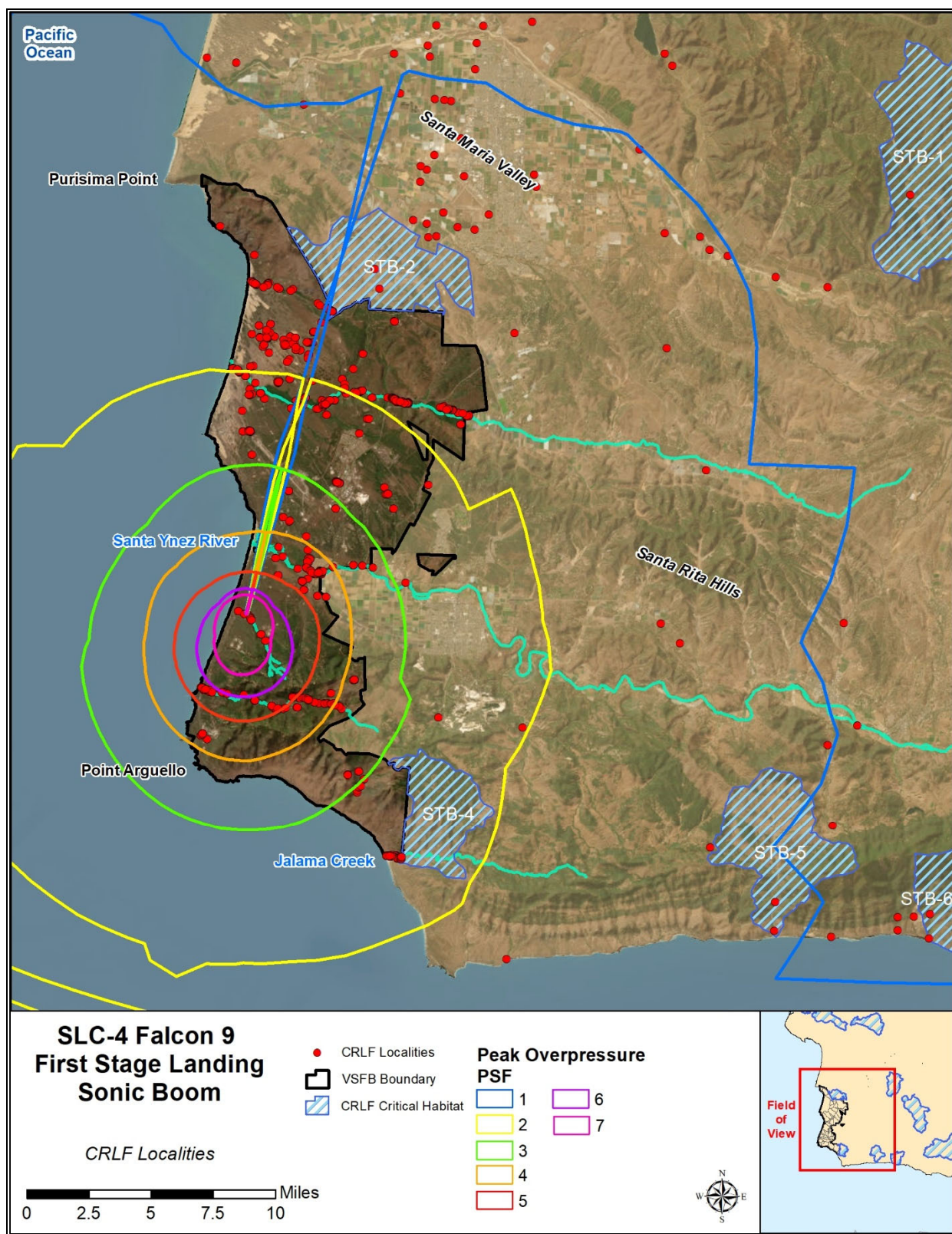


Figure 4.4-2. California red-legged frog localities, Critical Habitat, and sample SLC-4 landing sonic boom model results.

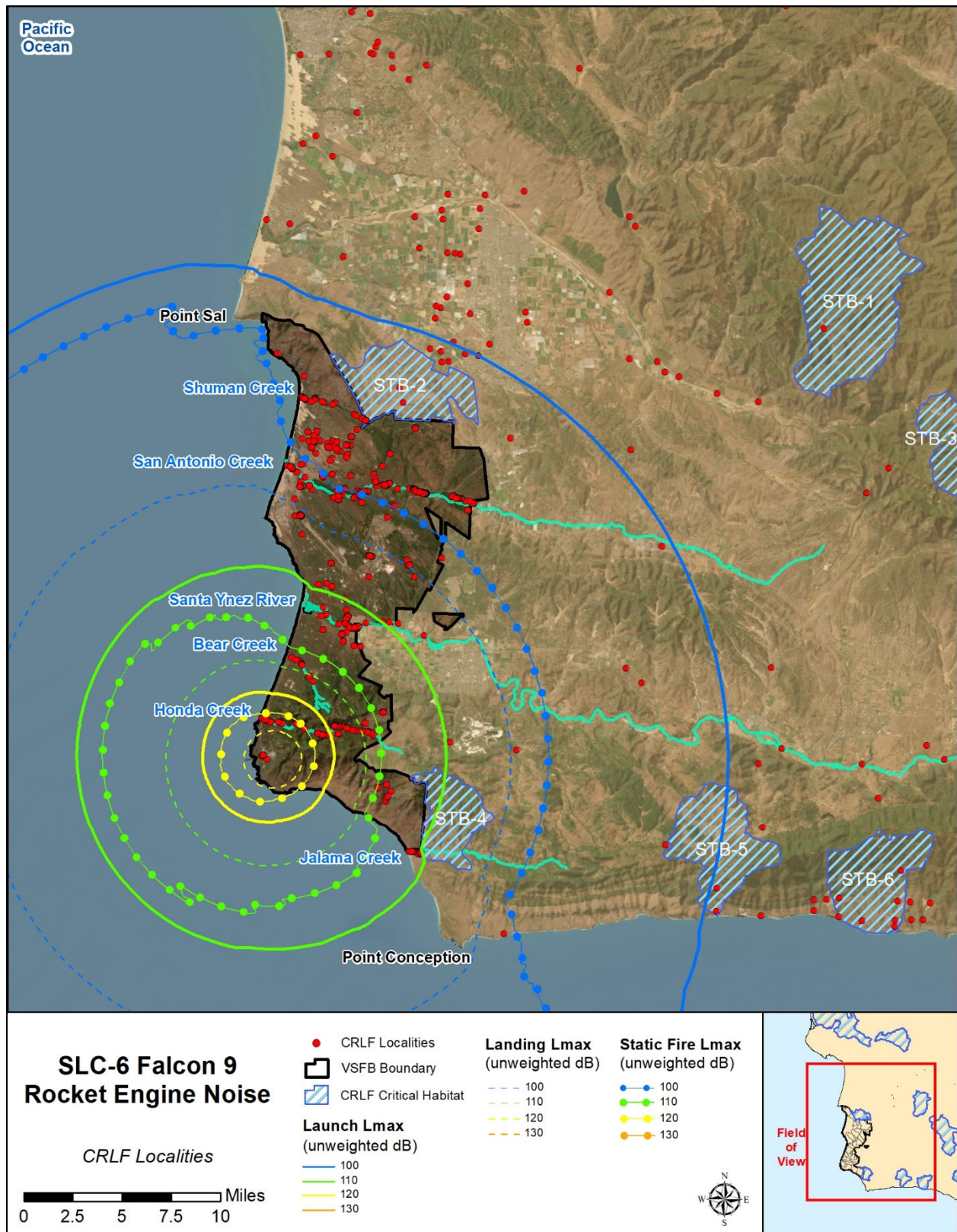


Figure 4.4-3. California red-legged frog localities, Critical Habitat, and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

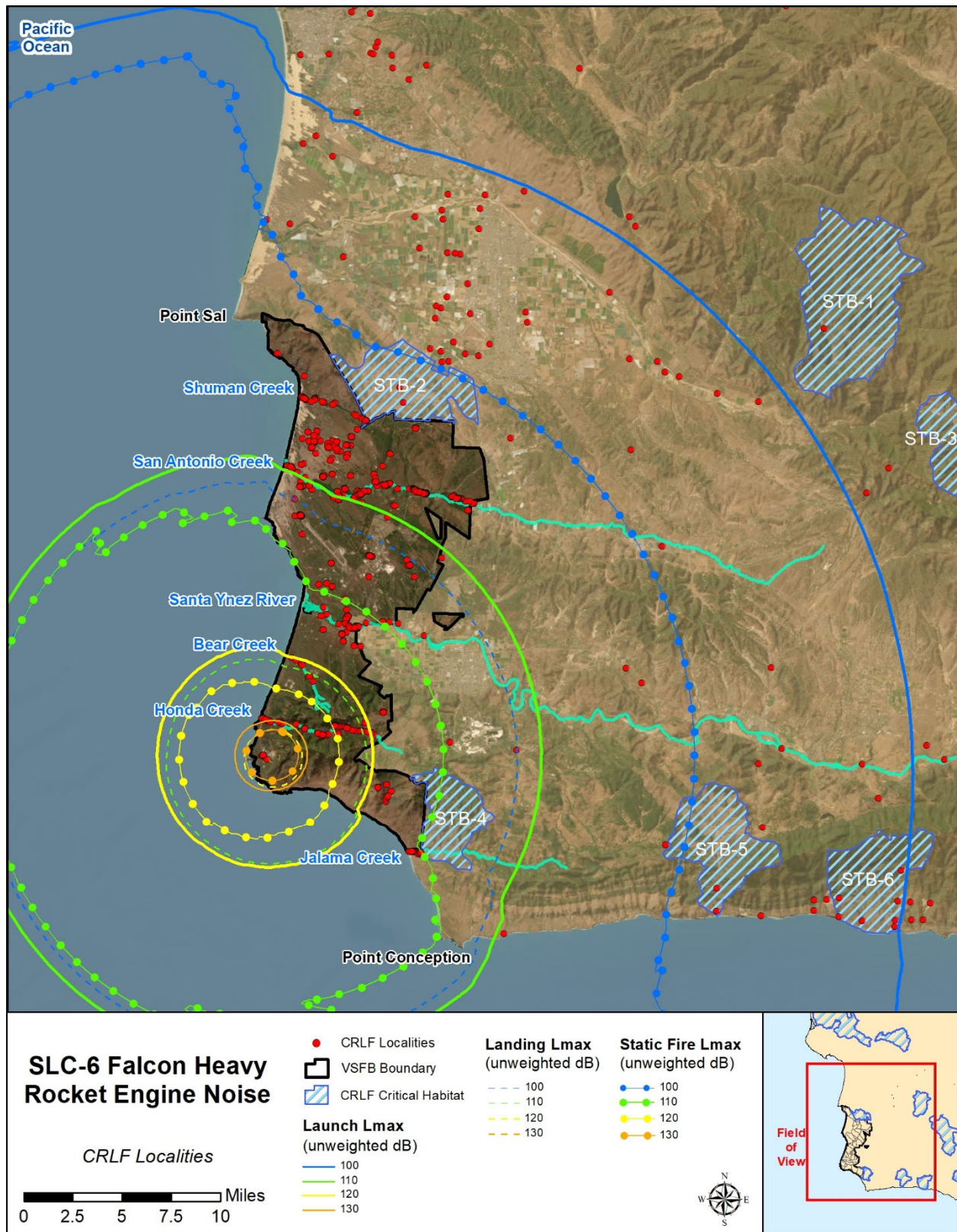


Figure 4.4-4. California red-legged frog localities, Critical Habitat, and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

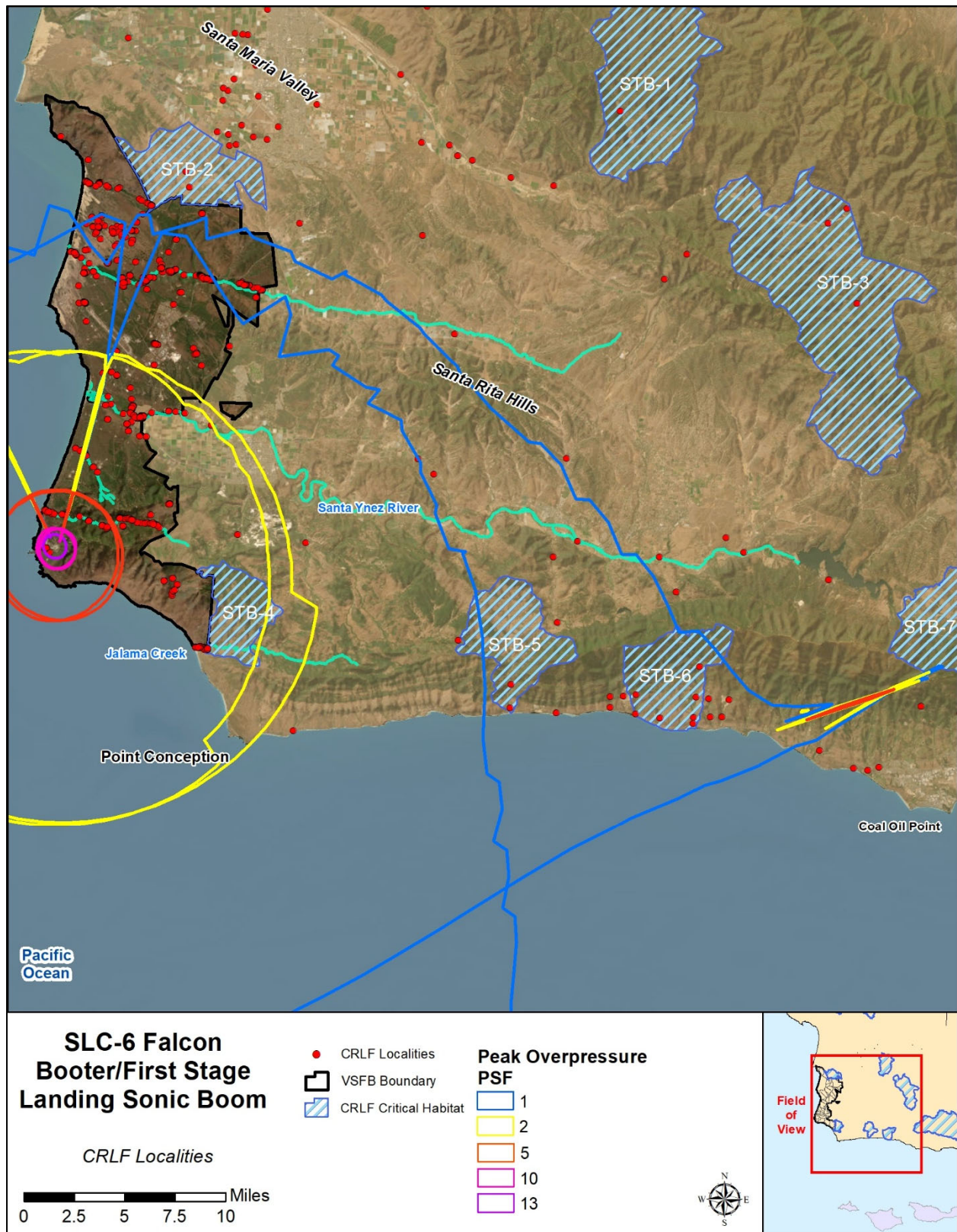


Figure 4.4-5. California red-legged frog localities, Critical Habitat, and two sample SLC-6 booster/first stage landing sonic boom model result.

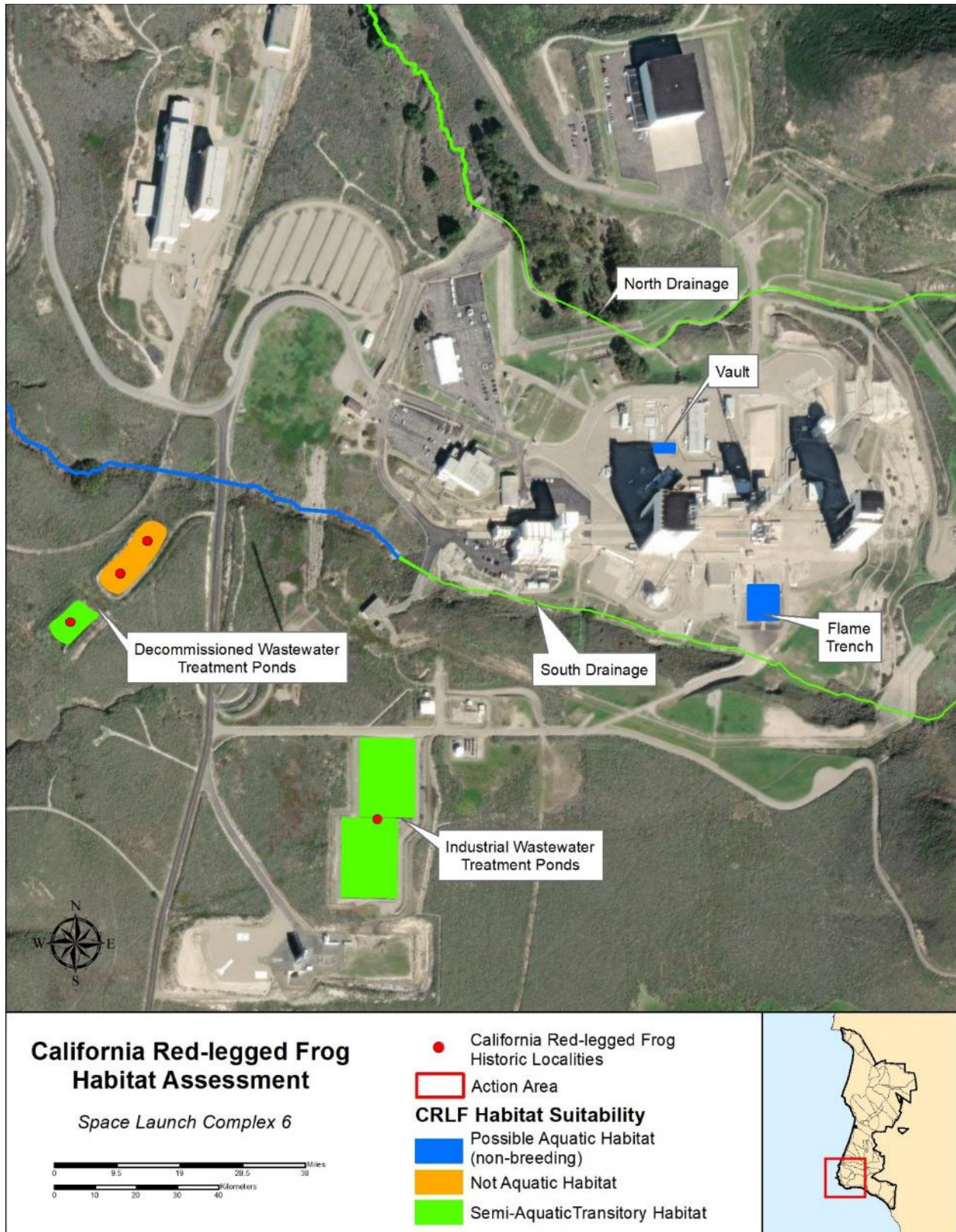


Figure 4.4-6. California red-legged frog habitat assessment of SLC-6.



Figure 4.4-7. Vault structure at SLC-6.



Figure 4.4-8. Flame trench at SLC-6.

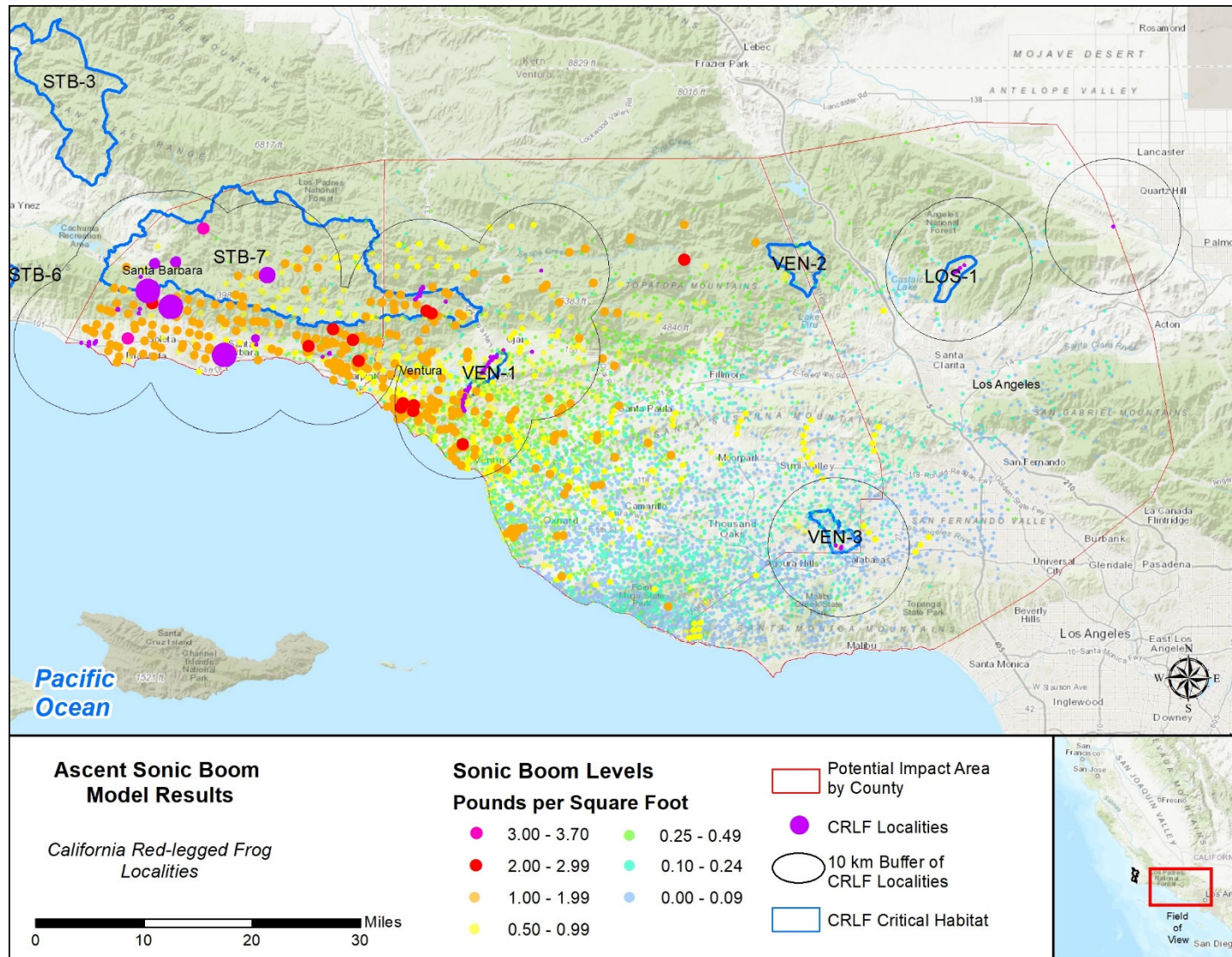


Figure 4.4-9. CRLF localities, Critical Habitat, and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.6).

4.5 Arroyo Toad (Federally Listed Endangered Species)

4.5.1 Status

The USFWS listed the ARTO as endangered on 16 December 1994 (59 FR 64859-64867). The USFWS published a recovery plan for the ARTO in 1999 (USFWS 1999).

4.5.2 Life History

ARTO are relatively small toads that are typically found in shallow pools and sandy or gravelly streams and creeks with sandy terraces with oaks, cottonwoods, or willows. Breeding occurs from February through July at open stretches with gravel or sandy substrates. Eggs hatch within four to six days and larvae require up to 85 days to develop into toads. Juveniles and adults burrow and overwinter on sandy terraces. ARTO's primary prey are native ant species, but may forage on a variety of invertebrates. Key threats to ARTO conservation include development of dams and water diversions; agriculture; off-road vehicles; invasive species that prey on ARTO; drought; and wildfires.

4.5.3 Occurrence within the Action Area

ARTO does not occur on VSFB but does occur within the region potentially impacted by ascent sonic booms during missions with easterly trajectories (Figure 4.5-1). Specifically, these areas include the upper Santa Ynez River, Sespe Creek, Piru Creek, and the upper Santa Clara River (Figure 4.5-1).

4.5.4 Critical Habitat

The USFWS issued a revised designation of Critical Habitat for the ARTO in 2011 (76 FR 7245-7467). In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, the Action Area overlaps Critical Habitat within inland Santa Barbara, Ventura, and Los Angeles Counties (Figure 4.5-2). The PCE for ARTO Critical Habitat include the following:

(1) Rivers or streams with hydrologic regimes that supply water to provide space, food, and cover needed to sustain eggs, tadpoles, metamorphosing juveniles, and adult breeding toads. Breeding pools must persist a minimum of 2 months for the completion of larval development. However, due to the dynamic nature of southern California riparian systems and flood regimes, the location of suitable breeding pools may vary from year to year.

- Breeding pools that are less than 6 inches deep;
- Areas of flowing water with current velocities less than 1.3 ft per second; and
- Surface water that lasts for a minimum of 2 months during the breeding season (a sufficient wet period in the spring months to allow arroyo toad larvae to hatch, mature, and metamorphose).

(2) Riparian and adjacent upland habitats, particularly low-gradient (typically less than 6%) stream segments and alluvial streamside terraces with sandy or fine gravel substrates that support the formation of shallow pools and sparsely vegetated sand and gravel bars for breeding and rearing of tadpoles and juveniles; and adjacent valley bottomlands that

include areas of loose soil where toads can burrow underground, to provide foraging and living areas for juvenile and adult arroyo toads.

(3) A natural flooding regime, or one sufficiently corresponding to natural, that: (A) Is characterized by intermittent or near-perennial flow that contributes to the persistence of shallow pools into at least mid-summer; (B) Maintains areas of open, sparsely vegetated, sandy stream channels and terraces by periodically scouring riparian vegetation; and (C) Also modifies stream channels and terraces and redistributes sand and sediment, such that breeding pools and terrace habitats with scattered vegetation are maintained.

(4) Stream channels and adjacent upland habitats that allow for movement to breeding pools, foraging areas, overwintering sites, upstream and downstream dispersal, and connectivity to areas that contain suitable habitat.

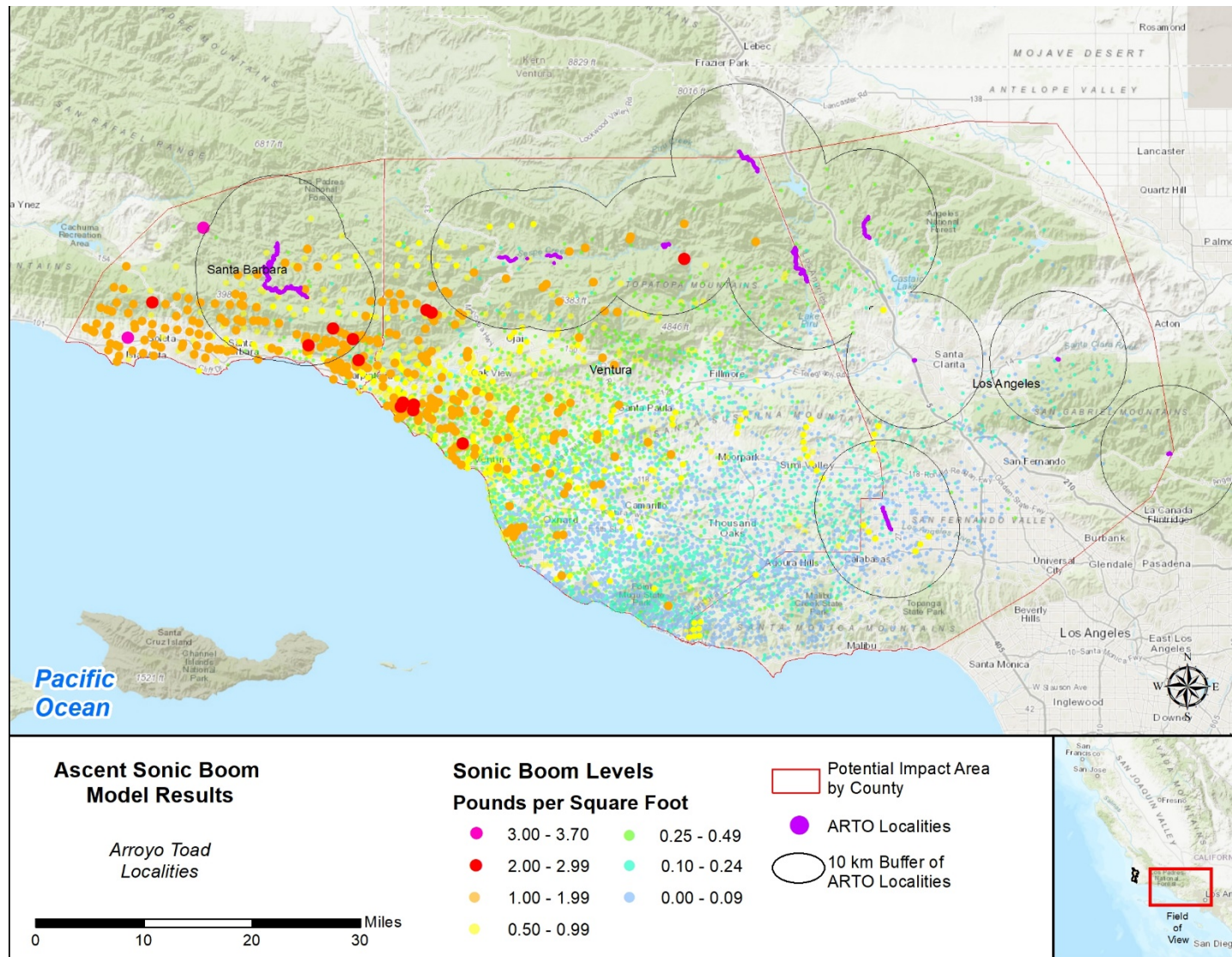


Figure 4.5-1. ARTO localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

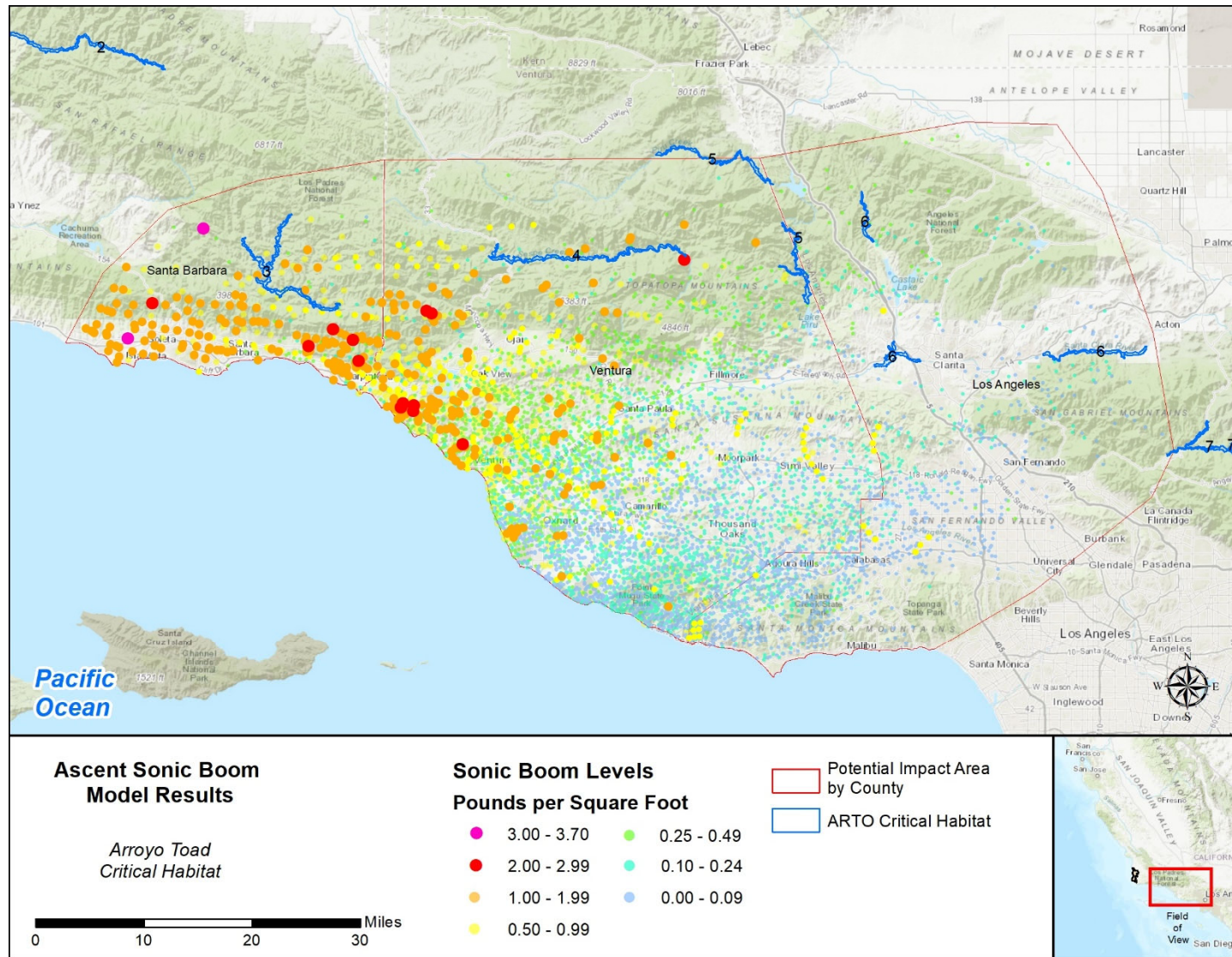


Figure 4.5-2. ARTO Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.6 Marbled Murrelet (Federally Listed Threatened Species)

4.6.1 Status

The USFWS listed the MAMU as threatened on 1 October 1992 (57 FR 45328) and published a Recovery Plan for the species in 1997 (USFWS 1997). The USFWS completed a 5-year review of the species in 2009 (USFWS 2009).

4.6.2 Life History

The MAMU is a small seabird that breeds along the Pacific coast. It forages in nearshore marine waters on small fish and invertebrates, and flies inland to breed. The species requires abundant prey within foraging habitat. Among alcids, the species is unique because it uses old-growth coniferous forests and mature trees for nesting (USFWS 1997). MAMU are wing-pursuit divers.

Although little was historically known about the MAMU movement and home range, more information is becoming available. The first MAMU nest was not documented until 1974. Since then, the MAMU's home range has been determined to be 253 square miles (mi²) for non-nesters and 93 mi² for nesters within California. In addition, at-sea resting areas have also been observed an average of 3.2 mi from the mouths of drainages. MAMU spend nighttime hours resting in the ocean in these at-sea resting areas and commute to foraging areas during the day. Nests have been observed from sea level to 5,020 ft (USFWS 2009). The primary threats to MAMU conservation include habitat loss due to urbanization and logging; oil spills; climate change; and entanglement hazards in the ocean.

4.6.3 Occurrence Within the Action Area

MAMU range from Alaska to California and may occur as far south as Baja California. The species is considered rare to very rare much of the year in Santa Barbara County. However, the species may be present north of VSFB in the late summer and would be considered casual in the spring (Lehman 2020; eBird 2024). There is no known or suitable breeding habitat for MAMU on VSFB. As such, only non-breeding individuals would occur within portions of the Action Area subject to noise impacts (Figure 4.6-1 through Figure 4.6-5; eBird 2024).

MAMU have been observed semi-regularly off the coast in nearshore waters between the Santa Maria River and offshore of VSFB from on-land observation sites (Figure 4.6-1 through Figure 4.6-5; eBird 2024). Specifically, one individual was observed at an unreported distance offshore from an observation site located approximately 0.5 mi west of SLC-4 in 2011 (Figure 4.6-1 through Figure 4.6-5; eBird 2024). Two separate sightings were also documented in 1995 offshore of Purisima Point (Figure 4.6-1 through Figure 4.6-3; eBird 2024). MAMU has never been documented breeding on VSFB, nor is any old-growth coniferous forest present on VSFB or in the Action Area.

4.6.4 Critical Habitat

The USFWS designated Critical Habitat for the MAMU on 24 May 1996 (61 FR 26257) and revised this designation on 4 August 2016 (81 FR 51348–51370). There is no designated Critical Habitat for this species within or adjacent to the Action Area. The nearest Critical Habitat is over 160 mi to the north near Santa Cruz, California.

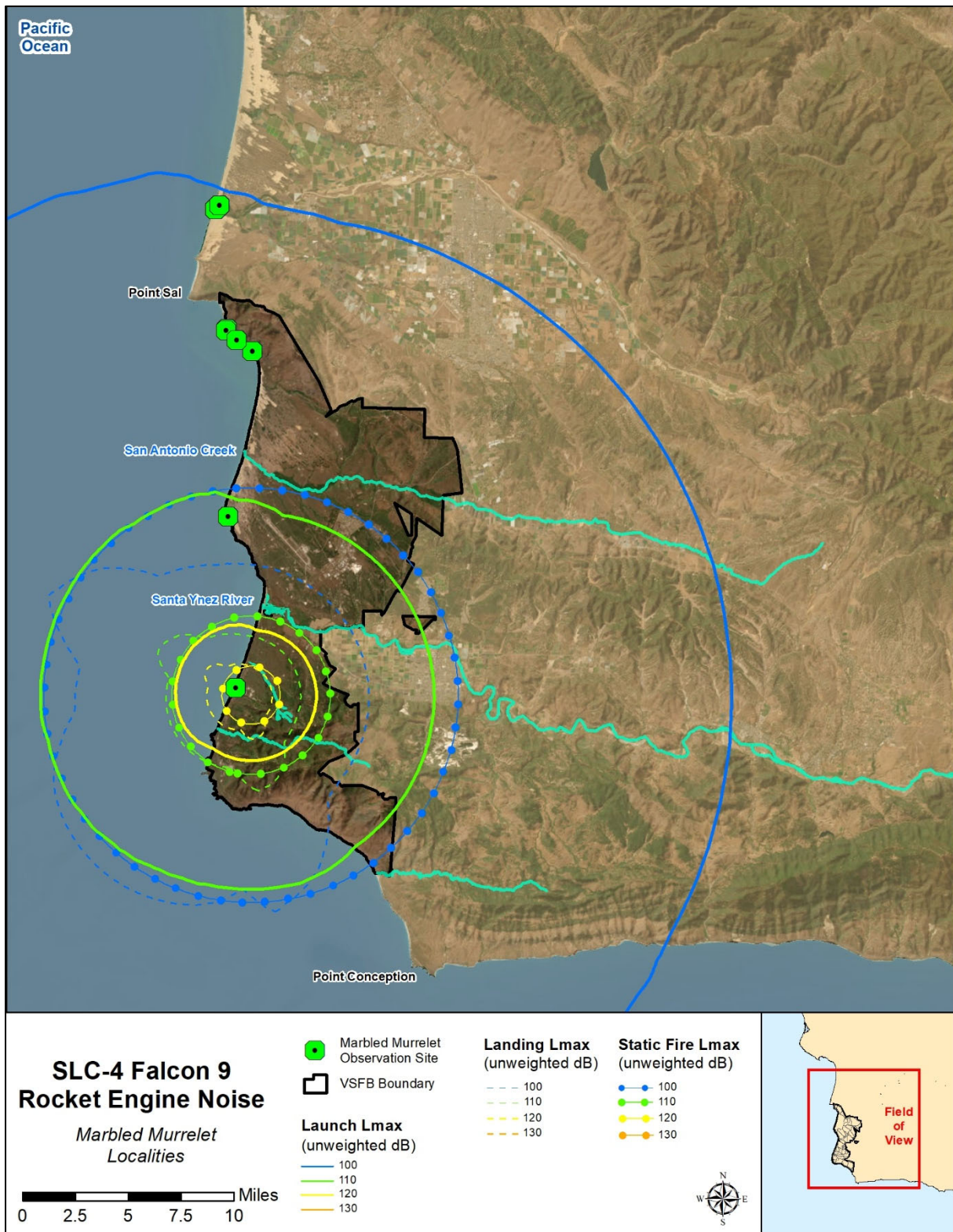


Figure 4.6-1. Marbled murrelet observation sites and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise (Note: birds were observed at an unrecorded distance offshore of these observation sites).

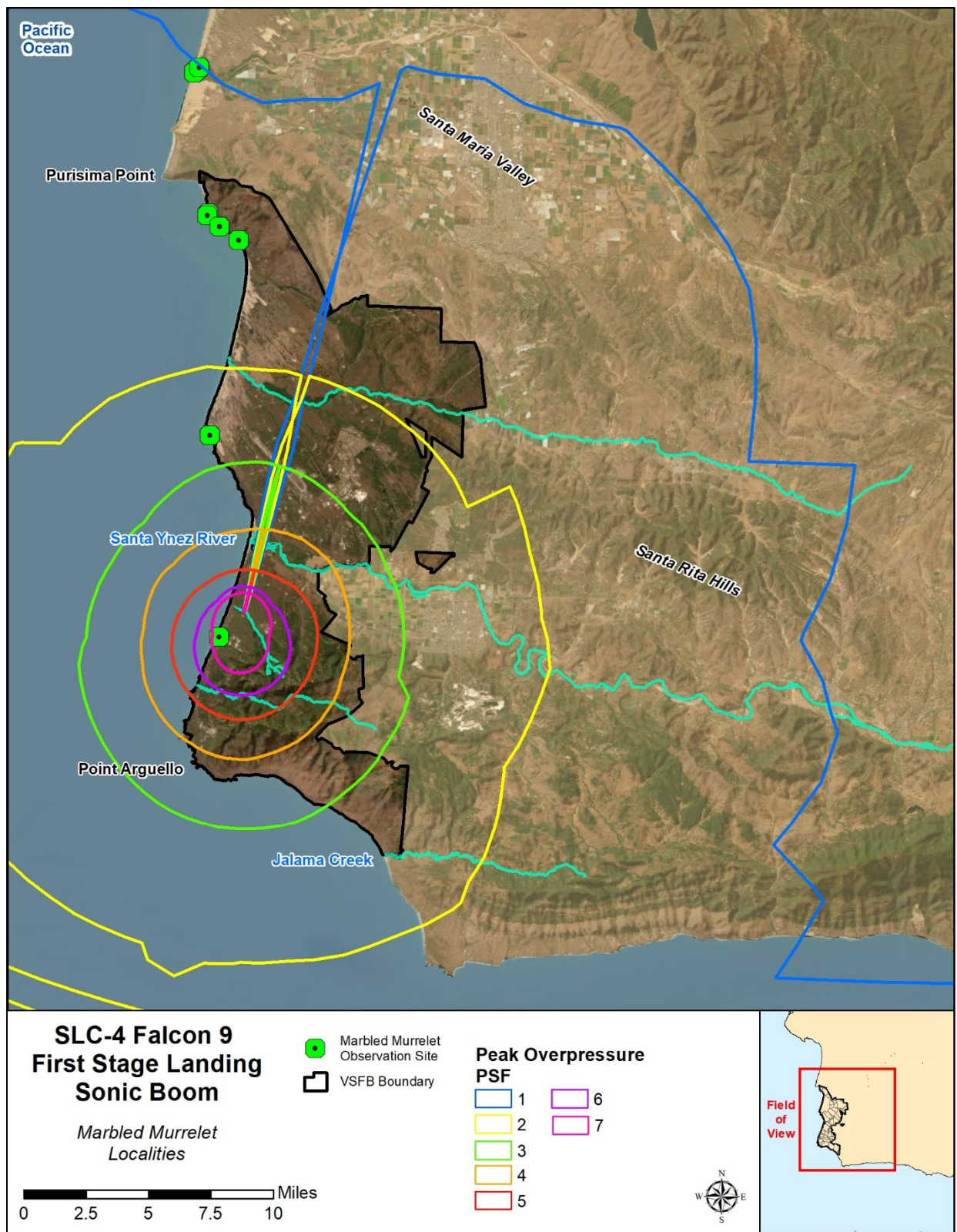


Figure 4.6-2. Marbled murrelet observation sites and sample sonic boom model results for SLC-4 landing events (Note: birds were observed at an unrecorded distance offshore of these observation sites).

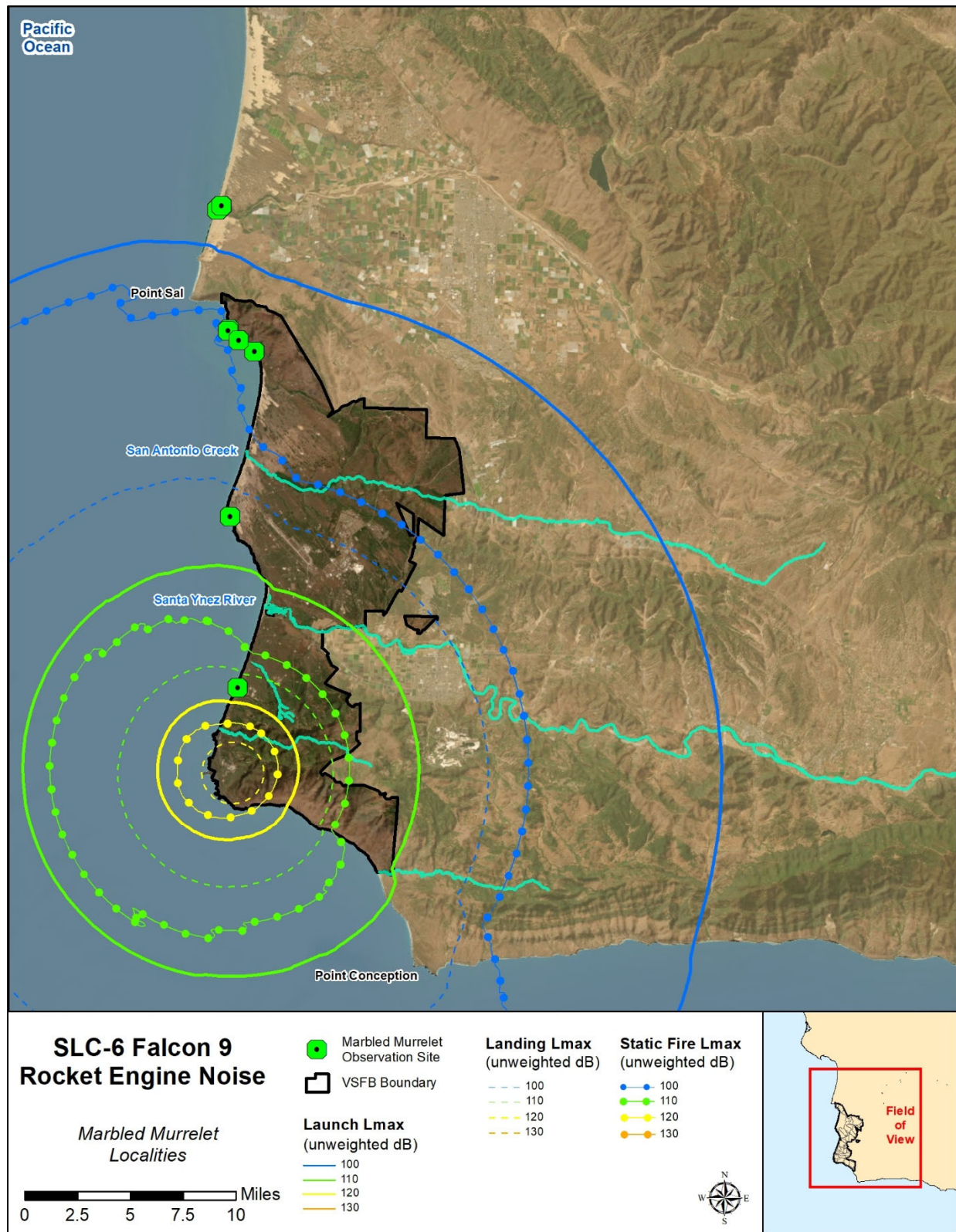


Figure 4.6-3. Marbled murrelet observation sites and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise (Note: birds were observed at an unrecorded distance offshore of these observation sites).

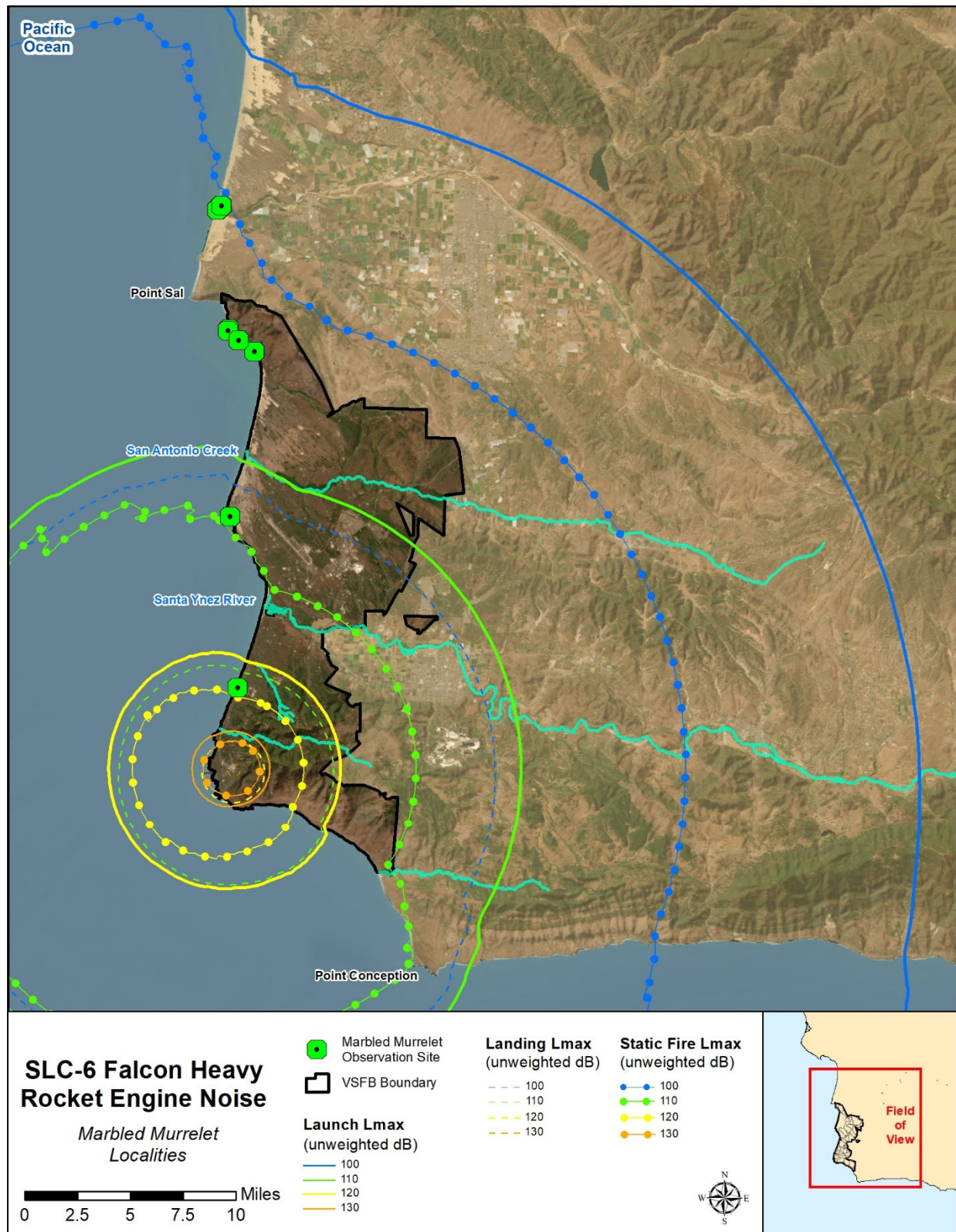


Figure 4.6-4. Marbled murrelet observation sites and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise (Note: birds were observed at an unrecorded distance offshore of these observation sites).

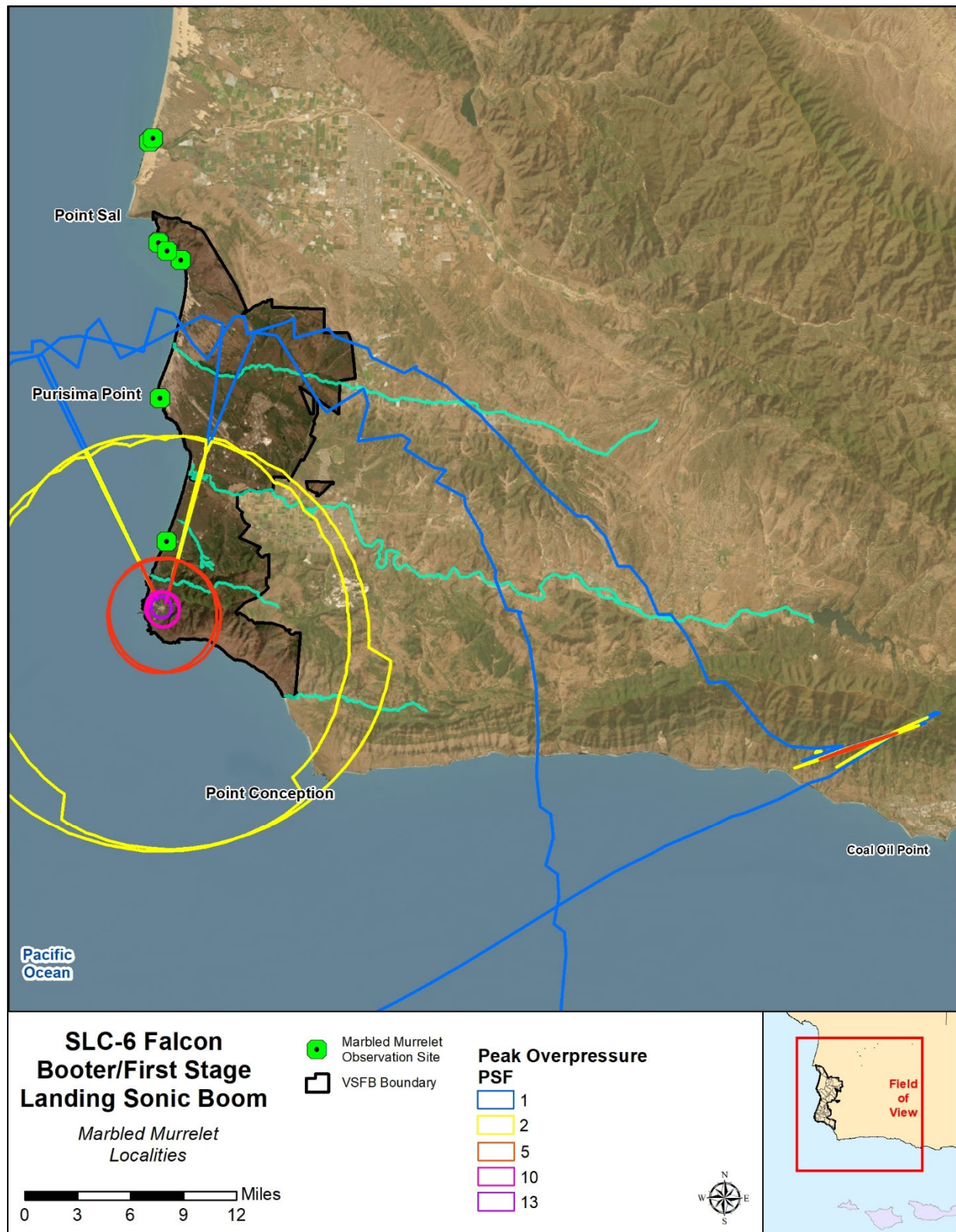


Figure 4.6-5. Marbled murrelet observation sites and two sample sonic boom model results for SLC-6 booster/first stage landing events (Note: birds were observed at an unrecorded distance offshore of these observation sites).

4.7 Southwestern Willow Flycatcher (Federally Listed Endangered Species)

4.7.1 Status

The USFWS listed the SWFL as endangered on 27 February 1995 (60 FR 10695-10715). In 2002, USFWS issued a Final Recovery Plan to stabilize and restore SWFL populations (USFWS 2002b).

4.7.2 Life History

SWFL in California, are spring and summer residents of willow thickets in riparian habitats. SWFLs typically arrive at breeding grounds in early May and depart in August after breeding has been completed. SWFL are closely tied to dynamic riparian habitats featuring an overlapping mosaic of dense willows, wetlands, and open water. SWFL historically bred along the Santa Ynez River on VSFB west of the 13th Street Bridge, but progressive changes to habitat in this area has largely eliminated favored SWFL breeding habitat on VSFB. The key threats to SWFL conservation include habitat loss due to water impoundments, groundwater pumping, and altered streamflow; habitat alteration by invasive plants; urban development; fire; and nest parasitism by brown-headed cowbirds (*Molothrus ater*).

4.7.3 Occurrence in the Action Area

The first documented SWFL breeding territory on the Santa Ynez River on VSFB was found at the Miguelito Wetland in 1992 (Figure 4.7-1 through **Error! Reference source not found.**; Ball et al. 2012). This site is approximately 3.9 mi north of SLC-4, but it has not been occupied since 1994 (Ball et al. 2012). A small population of between one and six SWFL was consistently found from 1995 to 2003 further east along the Santa Ynez River at two sites: an area immediately west of the 13th Street Bridge and the Wildlife Natural Resources Area (Figure 4.7-1 through Figure 4.7-5). The 13th Street Bridge territory included a nest site near the 13th Street Bridge (Holmgren & Collins 1999) where breeding was documented in 1998 (Farmer et al. 2003). SWFL were last seen at this site in 2000, which was subsequently destroyed by high water flow events during the winter storms of 2000-2001 (Farmer et al. 2003). SWFL were last documented at the Wildlife Natural Resources Area in 2003 (Farmer et al. 2003) and have not been re-documented during subsequent surveys.

Riparian point count surveys conducted on the Santa Ynez River on VSFB from 2004 to 2011 did not detect SWFL in the vicinity of the 13th Street Bridge (Seavy et al. 2012). SWFL were also not detected during targeted surveys of the Santa Ynez River for SWFL in 2003, 2004, 2012, and 2017 (SRS Technologies, Inc. 2004; Ball et al. 2012; Southern Sierra Research Station 2017). In addition, four surveys in the riparian forest on VSFB along the Santa Ynez River during the 2011 breeding season did not detect the species (DiGaudio et al. 2011). If SWFL were to be present on VSFB during a launch event, they would likely be migrating or foraging and present for a short period of time.

Historic modifications to the Santa Ynez River, including the installation of the former 35th Street Bridge and the bridges at 13th Street and Floredale Avenue have resulted in increased straightening and channelization of flow. The historic impacts contributed to the progressive downcutting of the Santa Ynez River and lead to a gradual separation of the river elevation from riparian habitat (ESA PWA 2010). As the level of the channel dropped, much of the riparian

habitat on the upper terrace of the floodplain was cut off from regular inundation (ESA PWA 2010). Consequently, aging riparian trees were not being replaced and interstitial wetlands have disappeared, rendering this habitat unsuitable for SWFL occupancy. The riparian habitat along the incised channel is largely confined to narrow banks and lacks complexity. This progressive deterioration of the floodplain has likely contributed to the absence of SWFL from the Santa Ynez River on VSFB in recent years, and future SWFL breeding on VSFB is unlikely. Both the 13th Street Bridge and Floredale Bridges have been re-designed and replaced in recent years to allow more river movement, but effects on downstream habitats have yet to be determined.

One territorial male SWFL was incidentally detected at the Santa Ynez River adjacent to Buellton, approximately 24.5 mi east of SLC-6, in 2022; pairing was suspected but not confirmed (Griffith Wildlife Biology 2022). This area was historically occupied, with the most recent prior documented detections in 2017 (Southern Sierra Research Station 2017).

In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, SWFL occur in the upper Santa Ynez River and the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.7-6; CDFW 2024).

4.7.4 Critical Habitat

The USFWS issued a final rule on SWFL Critical Habitat on 3 January 2013 (78 FR 344-534). The USFWS excluded VSFB from SWFL Critical Habitat designation pursuant to Section 4(a)(3) of the ESA, based on the implementation of an INRMP (U.S. Air Force 2021). Off-base, Critical Habitat has been designated along the Santa Ynez River from Lompoc to Buellton (Figure 4.7-1 through Figure 4.7-5). In the region potentially impacted by ascent sonic booms during missions with easterly trajectories SWFL occur in the upper Santa Ynez River, the Ventura River, and the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.7-6). Critical habitat has been designated in these areas (Figure 4.7-7).

The PCEs for SWFL Critical Habitat include the following:

- (1) Riparian vegetation. Riparian habitat along a dynamic river or lakeside, in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs and some combination of:
 - (a) Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 6 to 98 ft. Lower-stature thickets (6 to 13 ft tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests;
 - (b) Areas of dense riparian foliage at least from the ground level up to approximately 13 ft above ground or dense foliage only at the shrub or tree level as a low, dense canopy;
 - (c) Sites for nesting that contain a dense (about 50 to 100%) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground);
 - (d) Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a

variety of habitat that is not uniformly dense. Patch size may be as small as 0.25 ac or as large as 175 ac.

(2) Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs Homoptera).

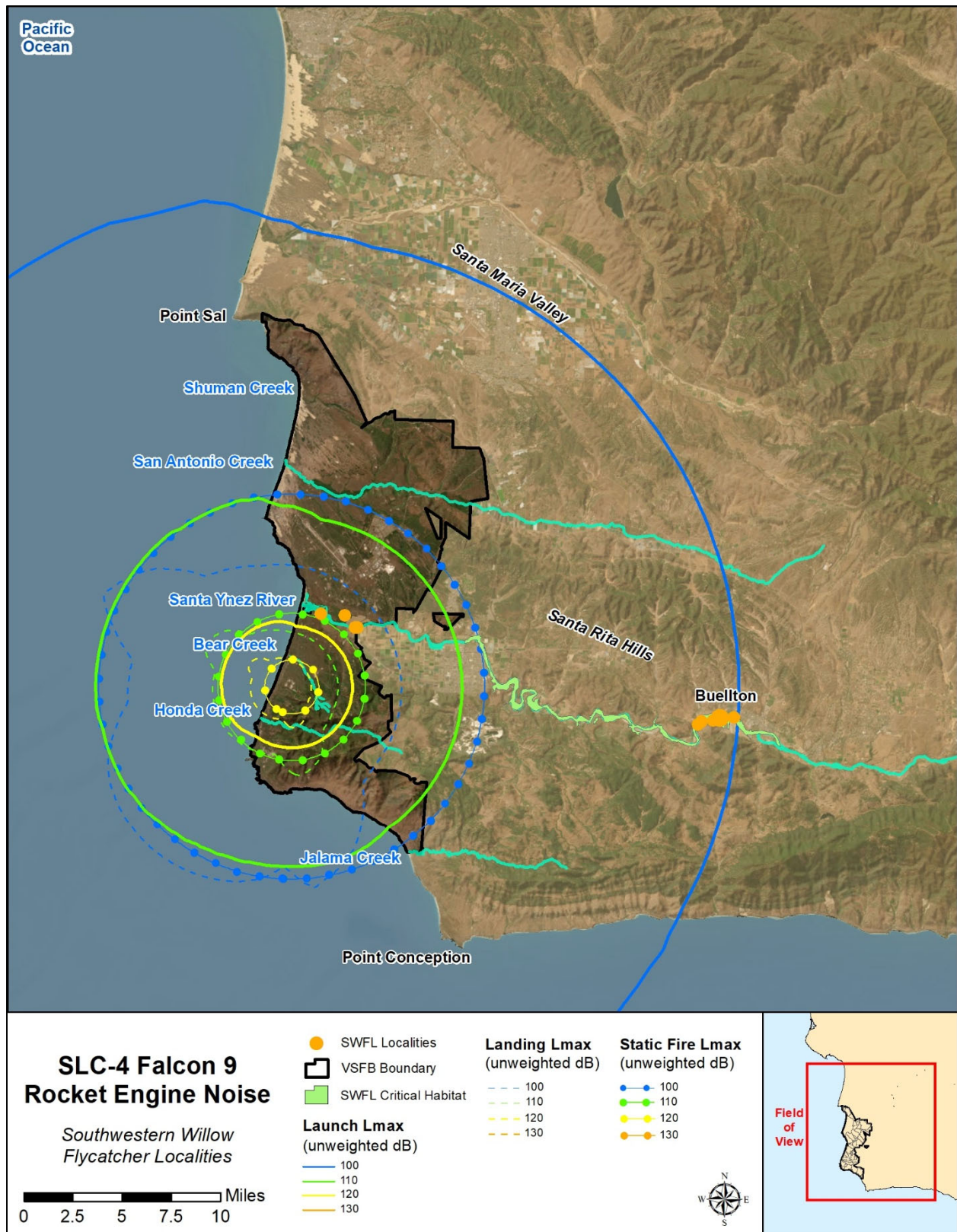


Figure 4.7-1. Southwestern willow flycatcher localities and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

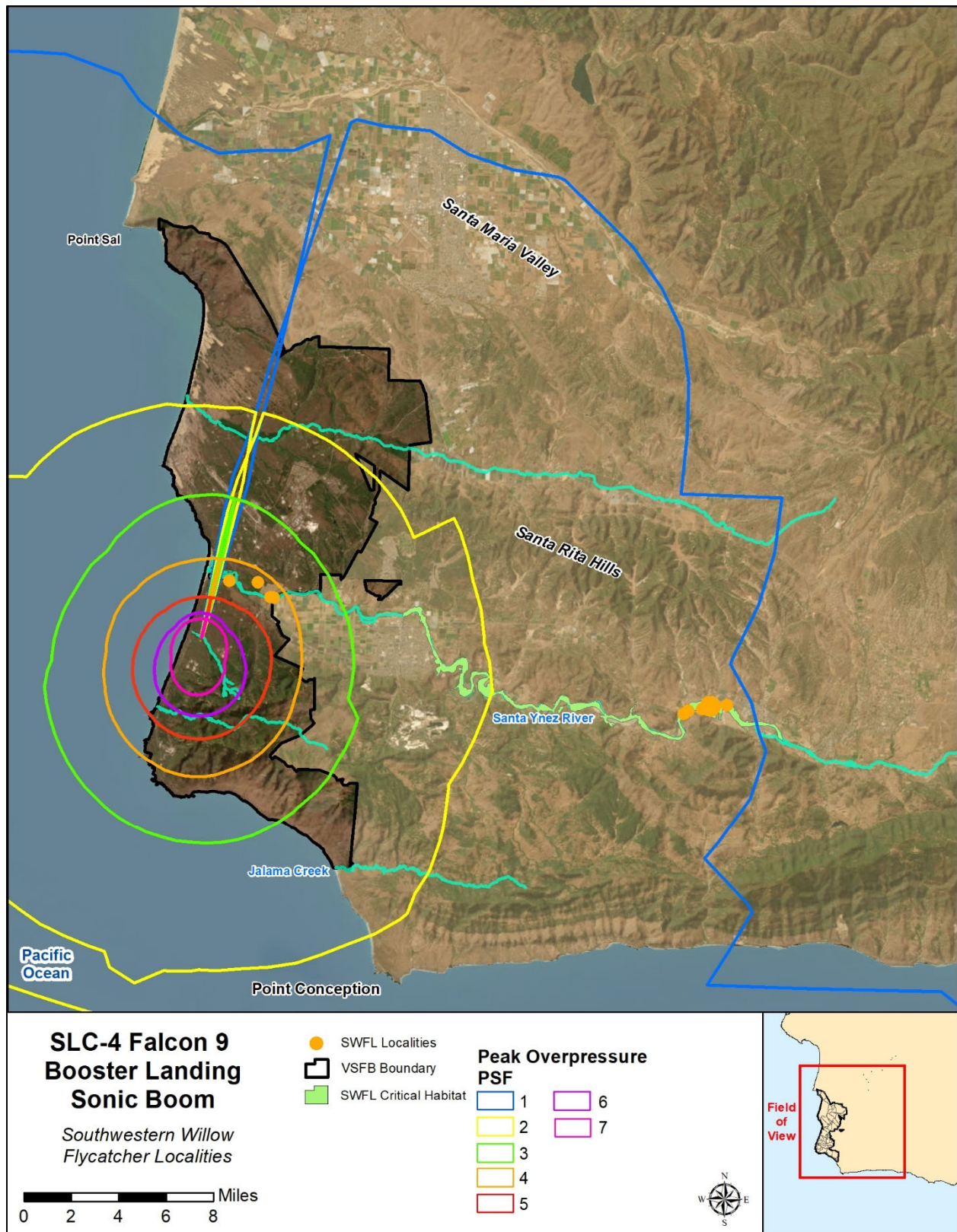


Figure 4.7-2. Southwestern willow flycatcher localities and sample SLC-4 landing sonic boom model results.

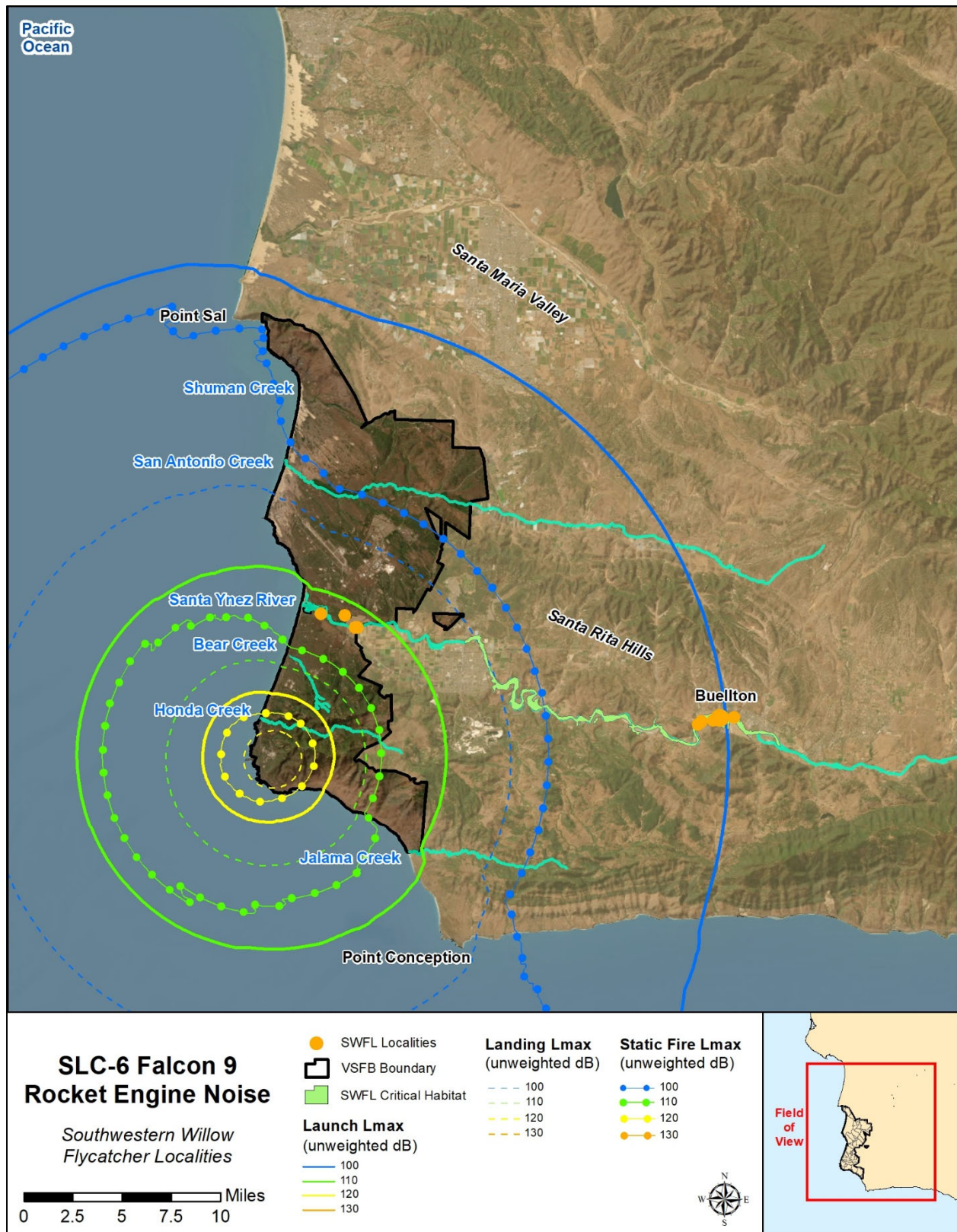


Figure 4.7-3. Southwestern willow flycatcher localities modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

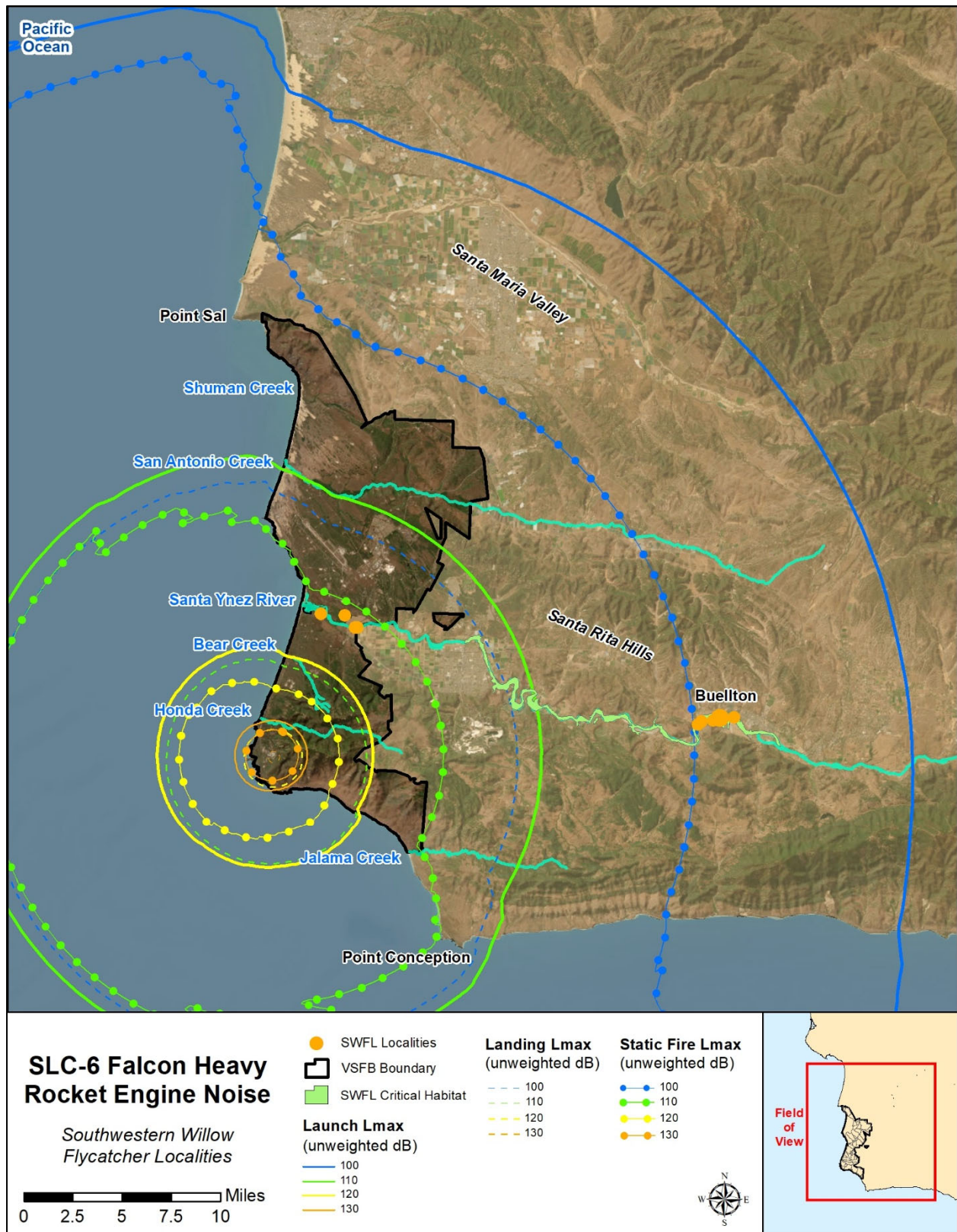


Figure 4.7-4. Southwestern willow flycatcher localities and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

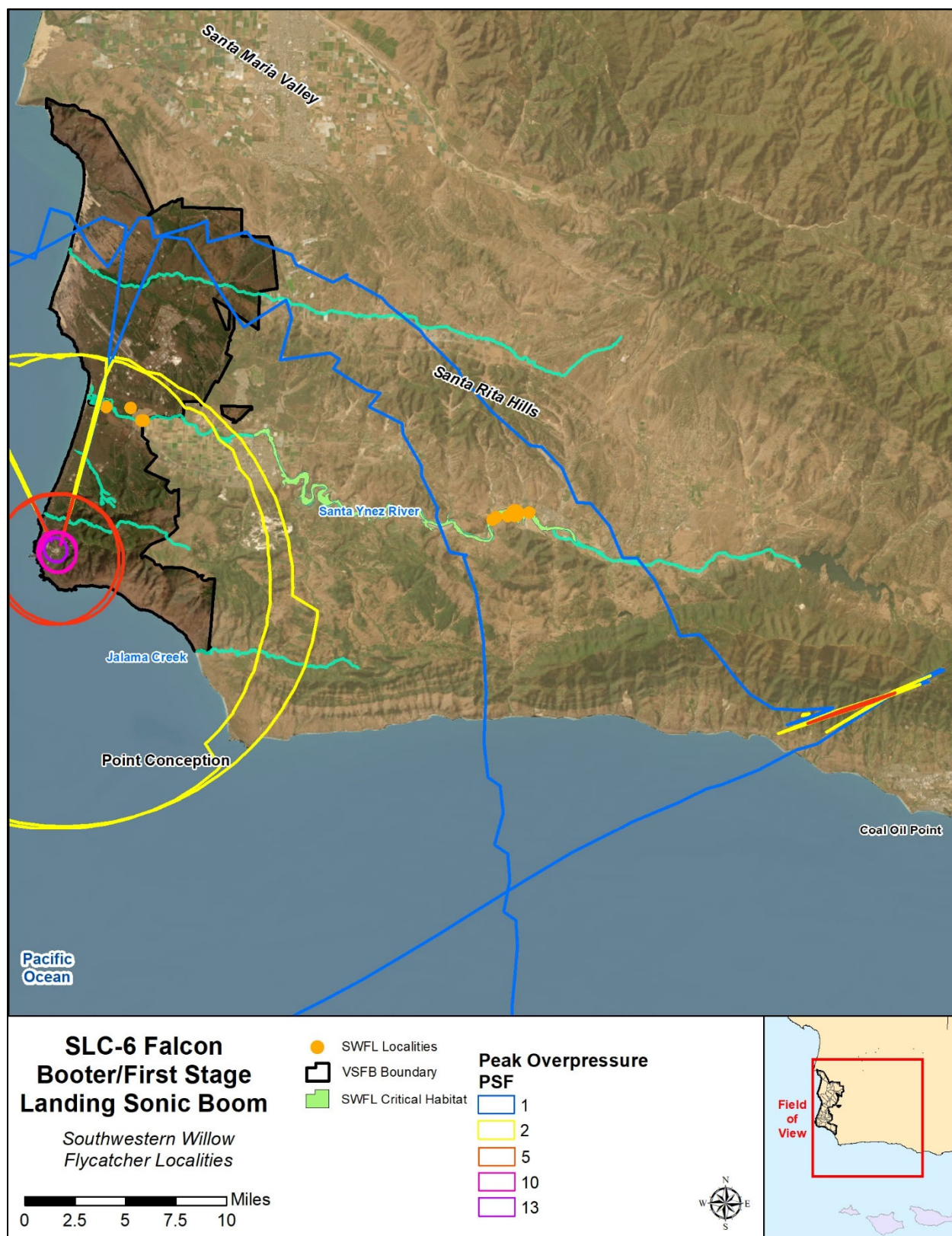


Figure 4.7-5. Southwestern willow flycatcher localities and two sample SLC-6 booster/first stage landing sonic boom model results.

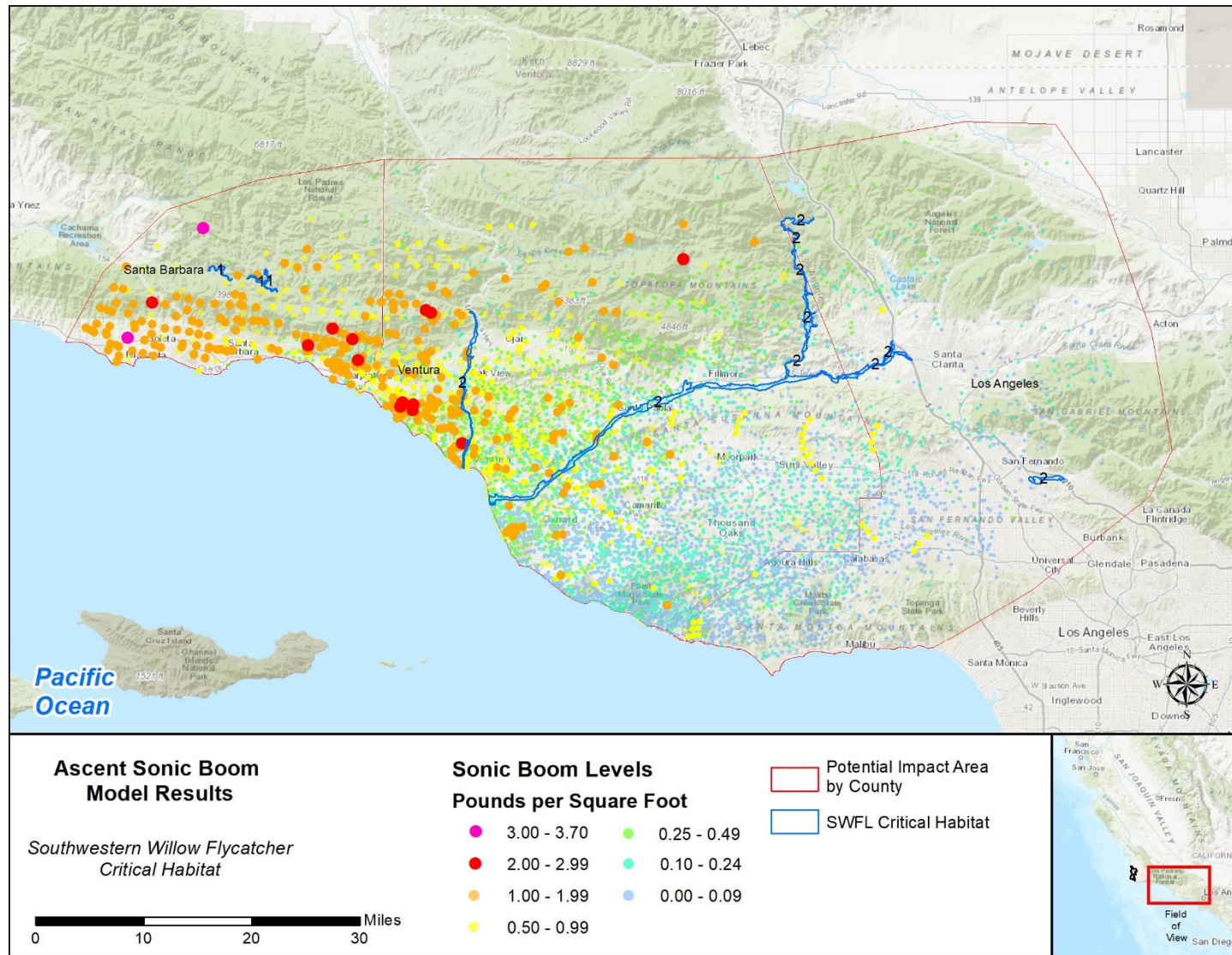


Figure 4.7-7. SWFL Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.8 Least Bell's Vireo (Federally Listed Endangered Species)

4.8.1 Status

The USFWS listed the LBVI as federally endangered in May 1986 (51 FR 16474-16482). A draft recovery plan was published in 1998 (USFWS 1998).

4.8.2 Life History

The LBVI is a small bird that is approximately 4.5 to 5 inches in length. This species has short, rounded wings, a short straight bill, and a faint white eye ring. Feathers are mostly gray above and pale below. LBVI forage in bushes and shrubs, preying on spiders and insects (USFWS 1998). LBVI overwinter in southern Baja California, Mexico (Kus 2002) and migrate north to nest from mid-March to April (USFWS 1998). Breeding habitat in coastal California is primarily willow-riparian woodlands (USFWS 1998). The primary threats to LBVI conservation include habitat loss due to development and agriculture; nest parasitism by brown-headed cowbirds; habitat alteration as a result of invasive plants; and habitat degradation due to fires, groundwater extraction, and changes in streamflow regimes; and drought.

4.8.3 Occurrence within the Action Area

Currently, most LBVI occur in eight counties south of Santa Barbara, with approximately half of all birds occurring on drainages within Marine Corps Base Camp Pendleton in San Diego County. LBVI, however, occurs as far north as Gilroy (Santa Clara County), and nesting birds have been documented at the Santa Clara River (Ventura County) and the Mojave River (San Bernardino County) as well. LBVI generally winter in southern Baja California, Mexico (Kus 2002).

Potential habitat for LBVI exists on VSFB and off-base in Santa Barbara County. There are no breeding records for LBVI on VSFB, and, until 2023, there were only 2 documented records of occurrence, both of which are east of the 13th Street Bridge and Santa Ynez River crossing approximately 7.6 mi northeast of SLC-6 (Figure 4.8-1 through Figure 4.8-5; CDFW 2024). Both of these records are more than 20 years old (Holmgren and Collins 1999). LBVI was not detected in riparian point count surveys conducted on VSFB in 1998, annually from 2000 to 2005, 2008, and 2010 (Seavy et al. 2012). However, in 2023, one lone male was detected in June at the Santa Ynez River near 13th Street Bridge (VSFB, unpublished data; Figure 4.8-1 through Figure 4.8-5). The individual was not detected on follow-up surveys and presumed to be a transient unpaired male.

In the off-Base project area, LBVI has been recorded at the Santa Ynez River adjacent to Buellton, approximately 24.5 mi east of SLC-6. In 2016, one territorial male was detected. This male was, however, presumed to be unpaired based on behavior (CDFW 2024; Figure 4.8-1 through Figure 4.8-5). A single male was again detected at this location in 2020, a transient male in 2021, and a territorial male in 2022 (Griffith Wildlife Biology 2022). The territorial male was not detected during multiple subsequent surveys conducted later in 2022 (Griffith Wildlife Biology 2022). At the Santa Maria River/Sisquoc River 4 paired males were detected in 2022, at locations approximately 28.0 to 30.1 mi northeast of SLC-6. Three of these pairs successfully raised young (Griffith Wildlife Biology 2022). In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, LBVI occur across eastern Santa Barbara, Ventura, and western Los Angeles Counties (Figure 4.8-6; CDFW 2024).

4.8.4 Critical Habitat

The USFWS designated Critical Habitat for this species in February 1994 (59 FR 4845-4867). In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, Critical Habitat has been designated in the upper Santa Ynez River in eastern Santa Barbara County and the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.8-7). The essential physical and biological features identified in the designation that support feeding, nesting, roosting, and sheltering are described as: “riparian woodland vegetation that generally contains both canopy and shrub layers, and includes some associated upland habitats” (59 FR 4845-4867).

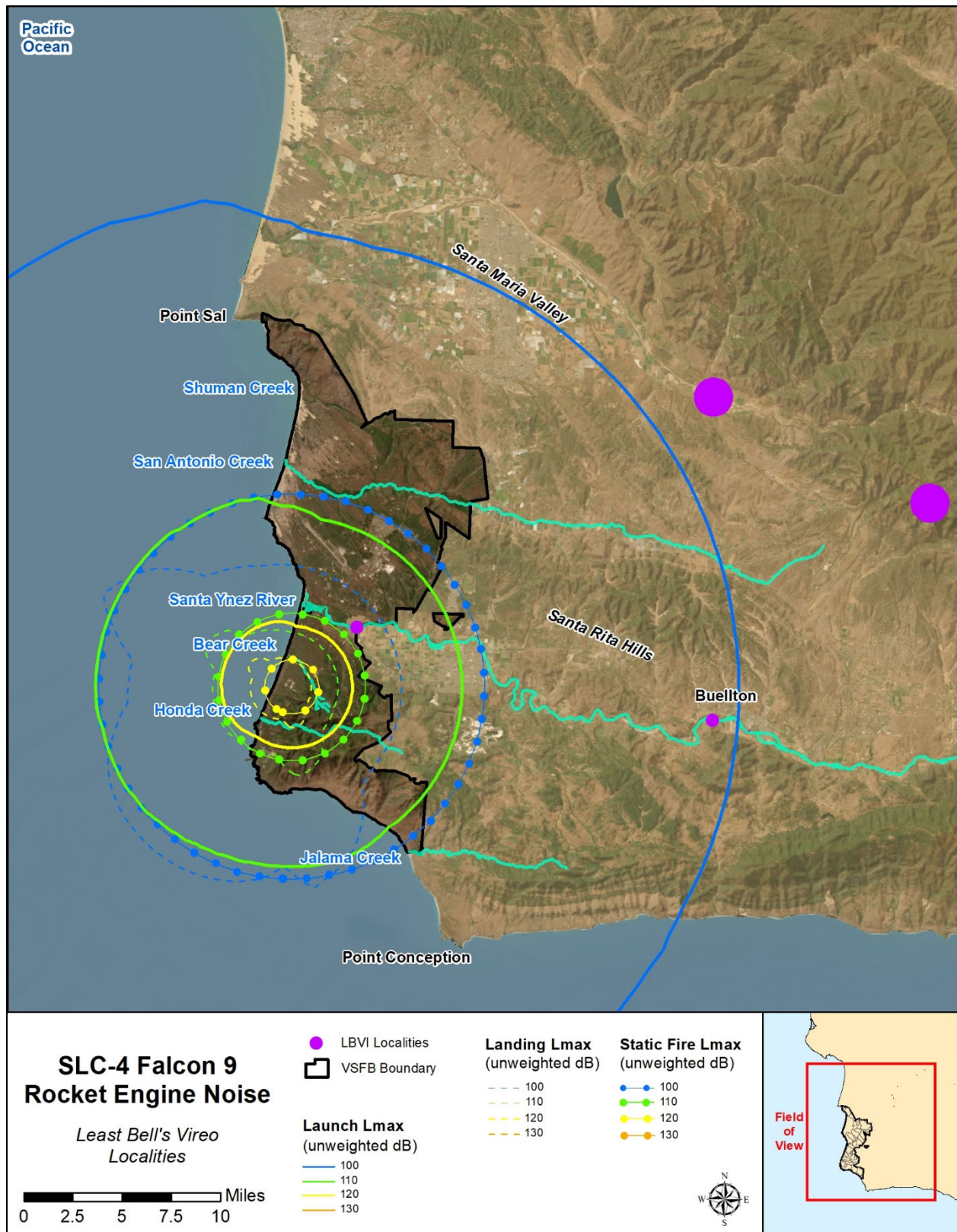


Figure 4.8-1. Least Bell's vireo localities and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

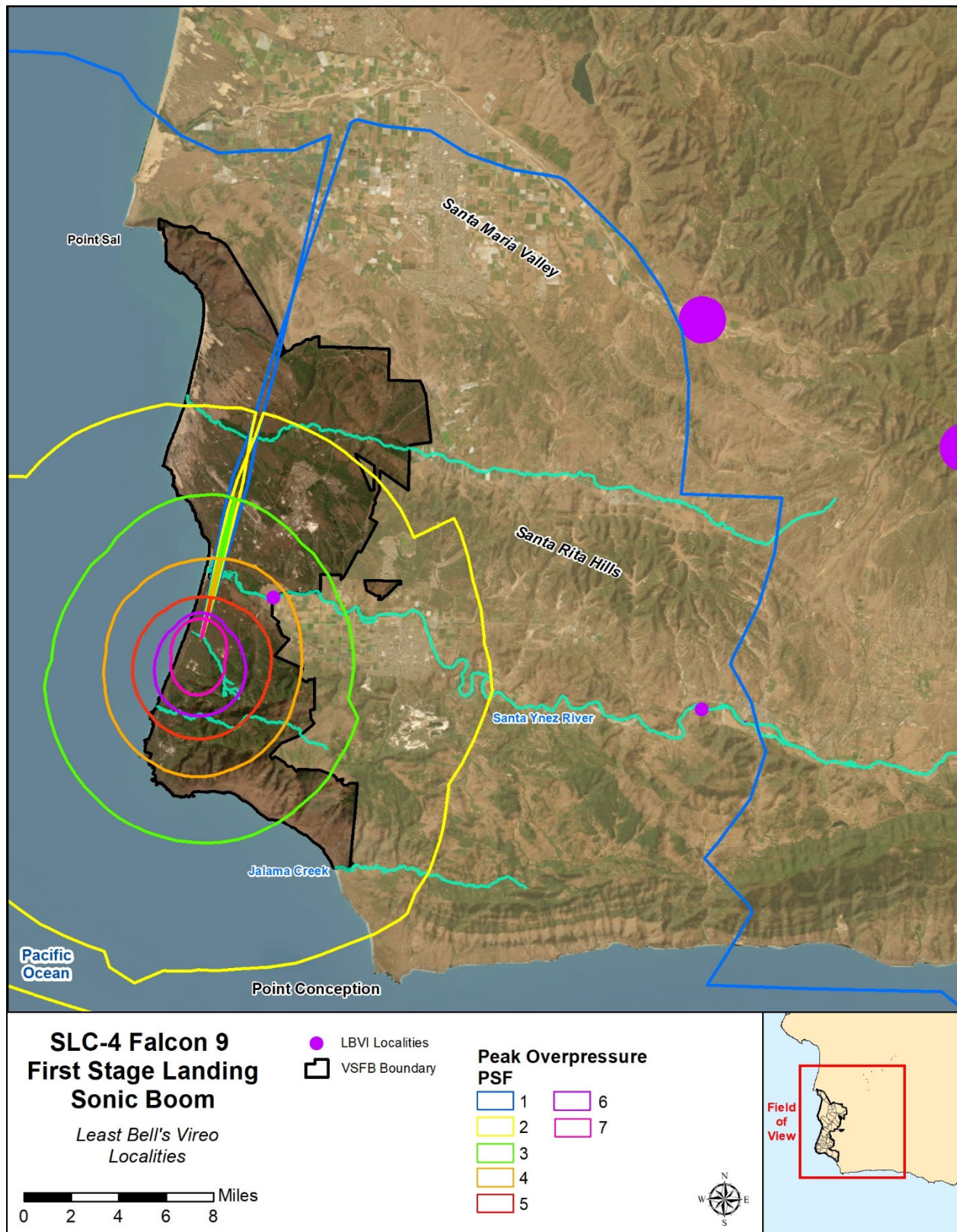


Figure 4.8-2. Least Bell's vireo localities and sample SLC-4 landing sonic boom model results.

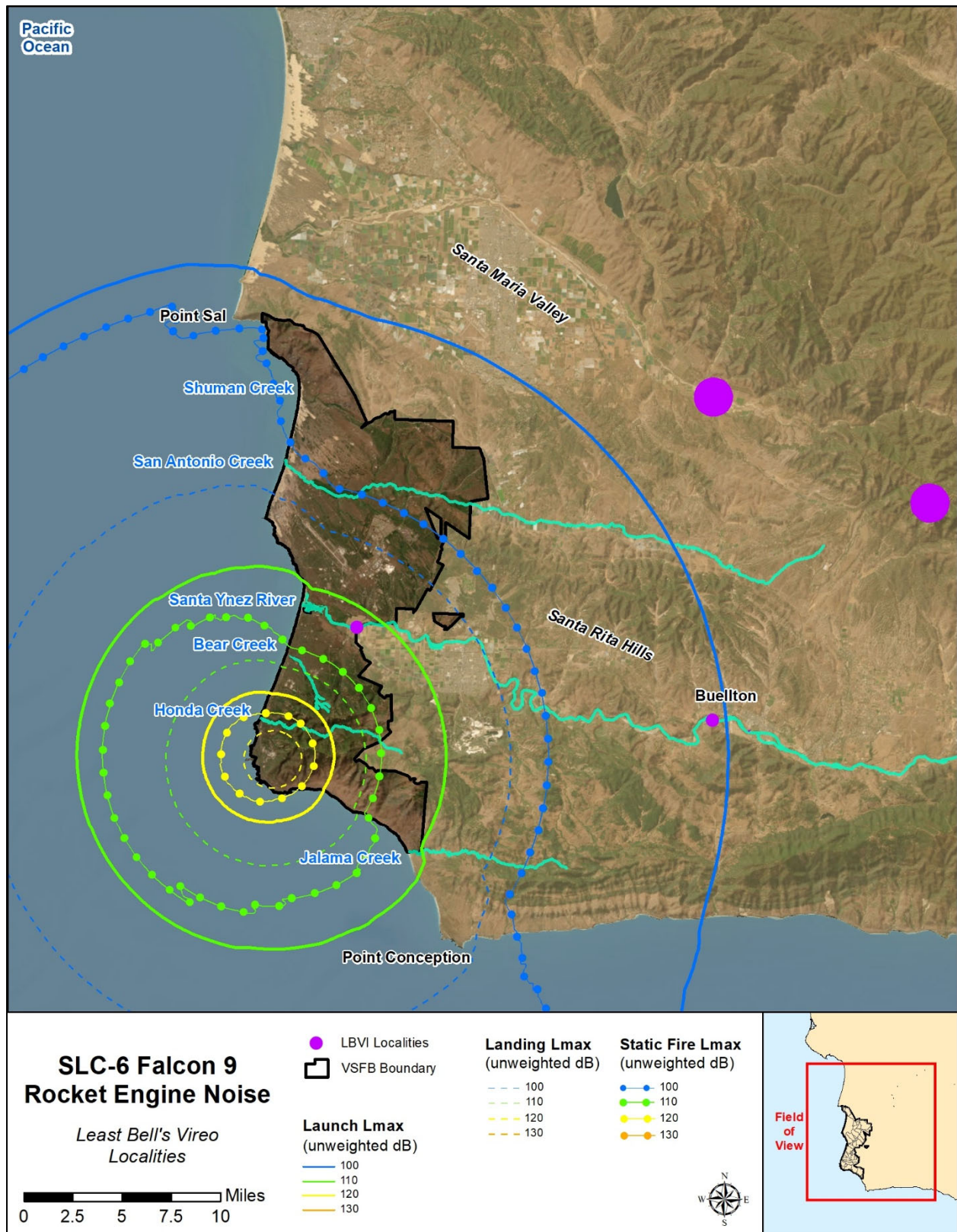


Figure 4.8-3. Least Bell's vireo localities modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

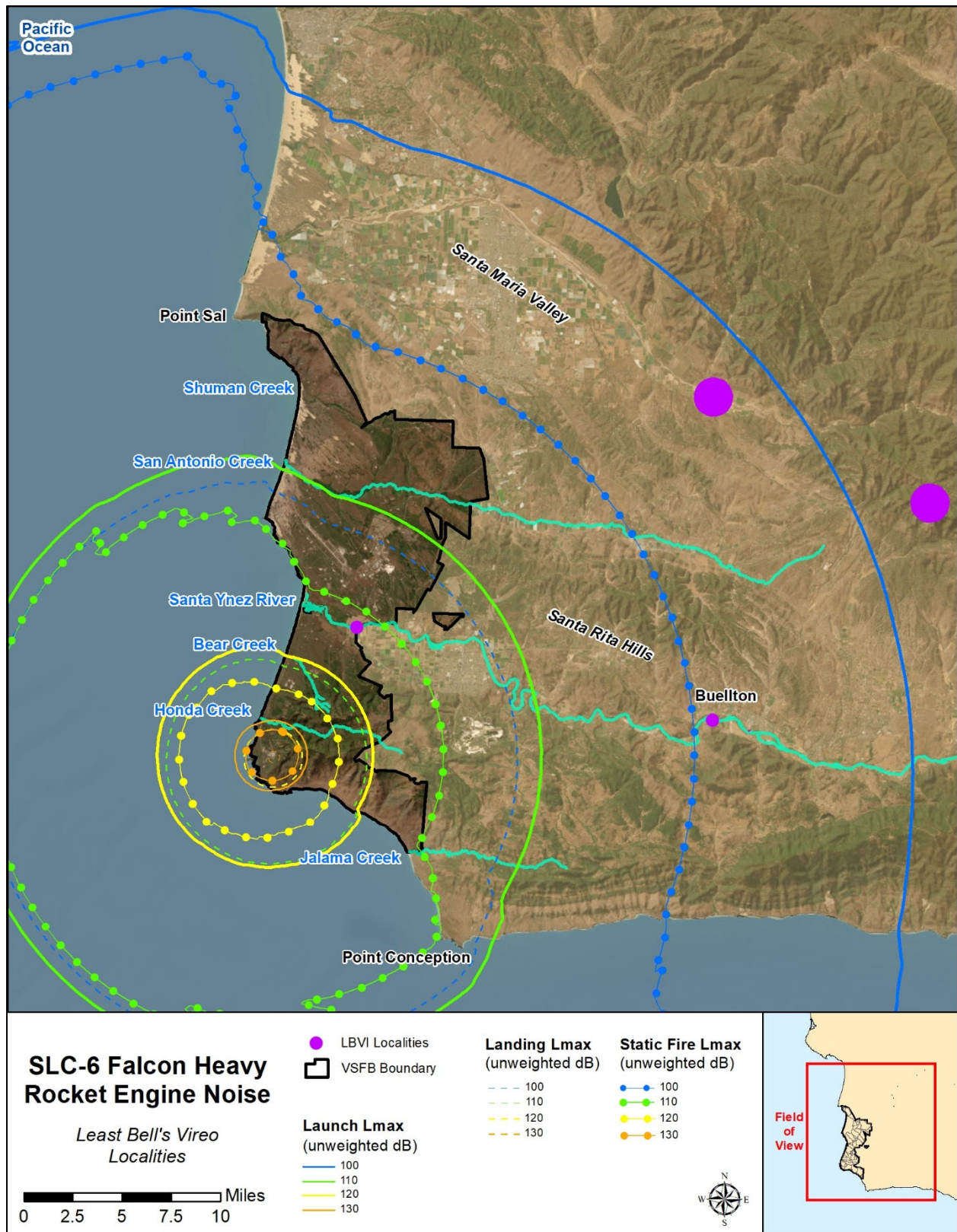


Figure 4.8-4. Least Bell's vireo localities and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

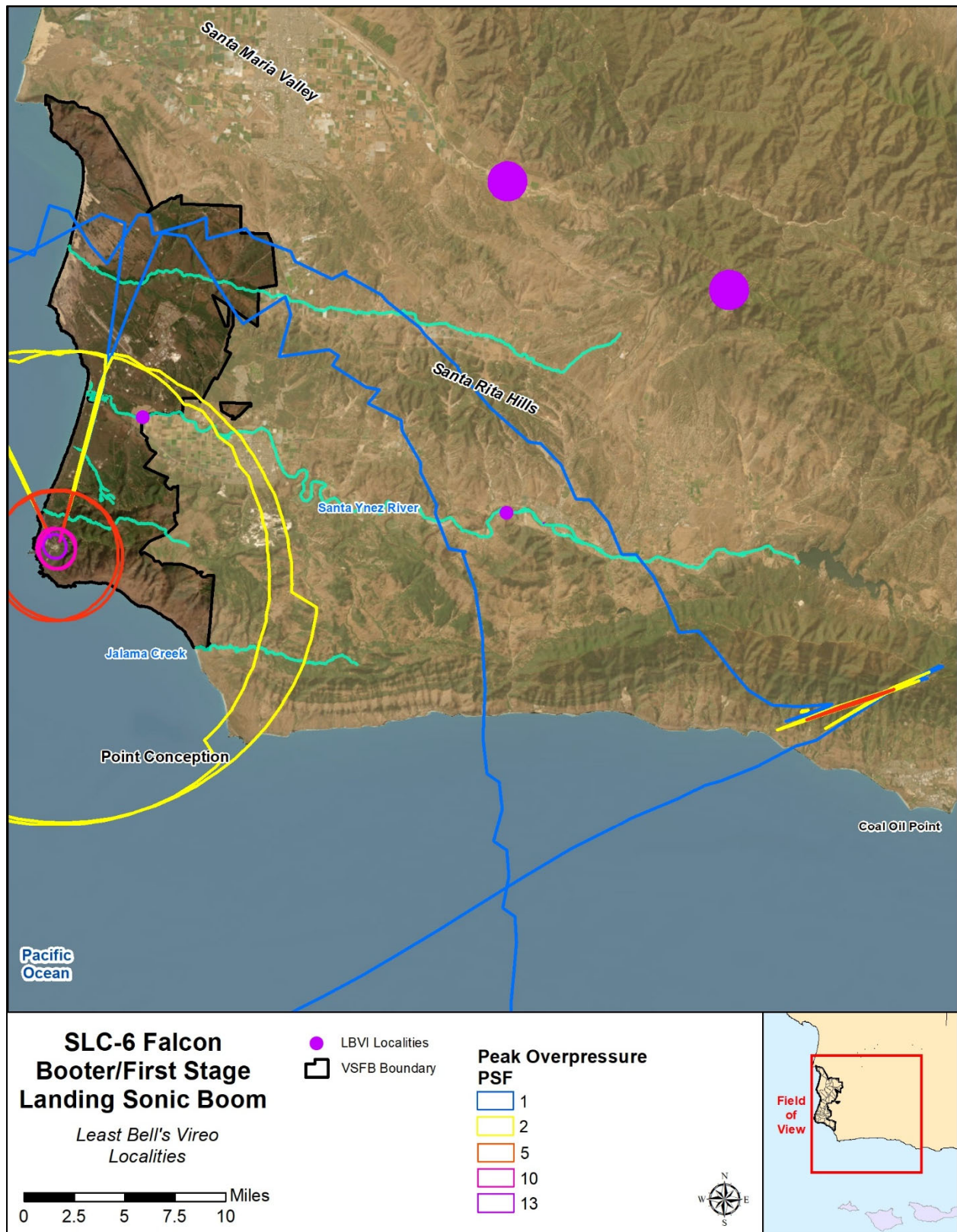


Figure 4.8-5. Least Bell's vireo localities and two sample SLC-6 landing sonic boom model results.

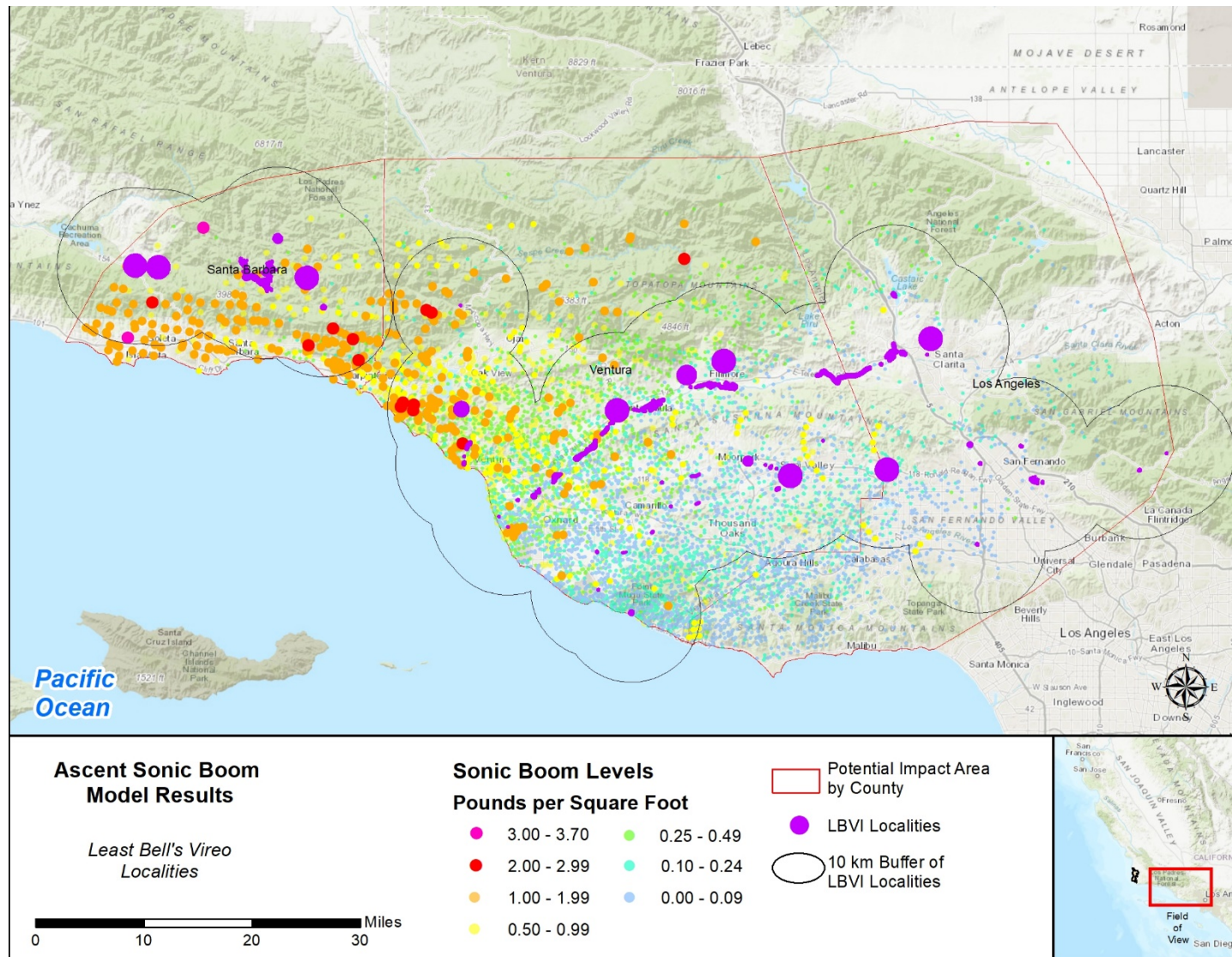


Figure 4.8-6. LBVI localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.6).

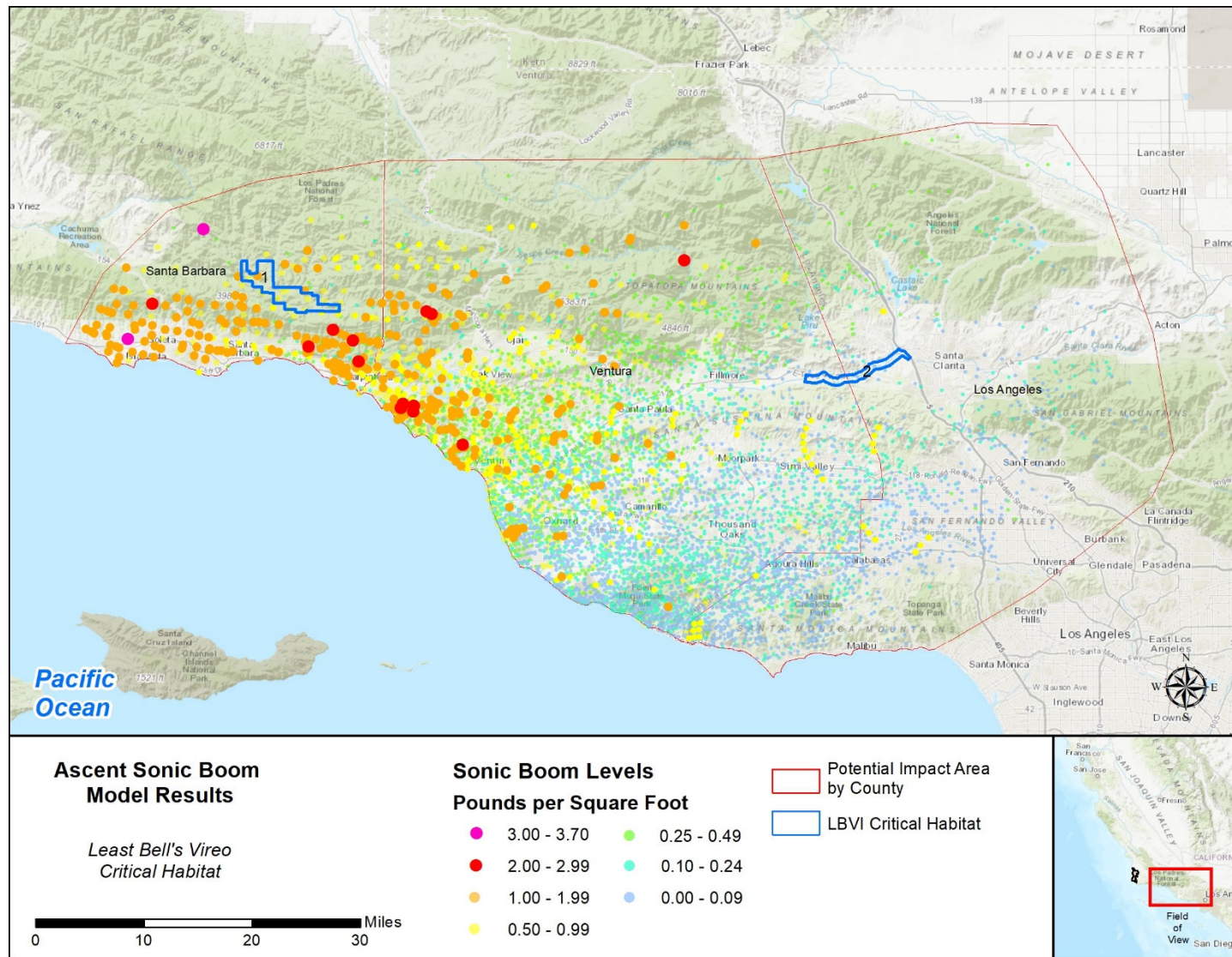


Figure 4.8-7. LBVI Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.6).

4.9 Western Snowy Plover (Federally Listed Threatened Species)

4.9.1 Status

The USFWS listed the Pacific coast population of the SNPL as federally threatened in March of 1993 (58 FR 12864–12874) and published a recovery plan for the Pacific coast population in 2007 (USFWS 2007).

4.9.2 Life History

The SNPL is a small shorebird with a pale tan back, white underparts, and dark patches on the sides of the neck reaching around to the top of the chest. The Pacific coast population of snowy plovers is limited to individuals that nest adjacent to tidal waters. The population's range extends from Southern Washington to Baja California, Mexico. The nesting season is typically from March through September. Key threats to SNPL conservation include habitat loss and degradation due to coastal development, off-road vehicle use, and invasive species; human activities including recreation; predation by ravens, crows, coyotes, dogs, cats, racoons, and other species; and sea level rise.

4.9.3 Occurrence within the Action Area

VSFB provides important breeding and wintering habitat for SNPL, which includes all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Minuteman Beach to the pocket beaches and dune areas adjacent to Purisima Point on north VSFB (approximately 7.7 mi). Also included are all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Wall Beach south to the rock cliffs at the south end of Surf Beach on South VSFB (approximately 4.8 mi).

VSFB has consistently supported one of the largest populations of breeding SNPL along the west coast of the United States (Robinette et al. 2016), resulting in a large dataset on the effects of VSFB-related activity on the SNPL. The DAF has performed annual monitoring of SNPL since 1993 (Robinette et al. 2021). The breeding population of SNPL on VSFB has been relatively stable since 2007, with 235 adults in 2021 (Robinette et al. 2021) and 309 adults in 2024 (Robinette et al. 2024d). The nearest SNPL nesting area to SLC-4 and SLC-6 is on South Surf Beach, approximately 0.7 mi northwest of SLC-4 and 4.1 mi northwest of SLC-6 (Figure 4.9-1 through Figure 4.9-3).

The SNPL is considered a permanent resident of Santa Rosa Island. On San Miguel Island, a high count of 61 SNPL was documented during the 2016–2017 winter window survey (USFWS 2017c); however, counts at San Miguel Island typically document very few to no individuals, as evident by no SNPL detected on San Miguel Island during the 2024 winter window surveys (USFWS 2024d).

In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, SNPL occur at various open sandy beaches along the coastline (Figure 4.9-8; CDFW 2024).

4.9.4 Critical Habitat

The USFWS designated Critical Habitat for the SNPL in 1999 and revised this designation on 29 September 2005 (70 FR 56969–57119) and on 19 June 2012 (77 FR 36727). VSFB was

exempted from Critical Habitat designation under Section 4(a)(3) of the ESA. The nearest Critical Habitat is approximately 8 mi south of VSFB on Santa Rosa Island (Figure 4.9-6 and Figure 4.9-7). In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, Critical Habitat has been designated at various sandy beaches along the coast of eastern Santa Barbara, Ventura, and Los Angeles Counties (Figure 4.9-9). The USFWS listed the following PCEs:

Sandy beaches, dune systems immediately inland of an active beach face, salt flats, mud flats, seasonally exposed gravel bars, artificial salt ponds and adjoining levees, and dredge spoil sites, with:

- 1) Areas that are below heavily vegetated areas or developed areas and above the daily high tides;
- 2) Shoreline habitat areas for feeding, with no or very sparse vegetation, that are between the annual low tide or low-water flow and annual high tide or high-water flow, subject to inundation but not constantly under water, that support small invertebrates, such as crabs, worms, flies, beetles, spiders, sand hoppers, clams, and ostracods, that are essential food sources;
- 3) Surf or water-deposited organic debris, such as seaweed (including kelp and eelgrass) or driftwood located on open substrates that supports and attracts small invertebrates described in PCE 2 for food, and provides cover or shelter from predators and weather, and assists in avoidance of detection (crypsis) for nests, chicks, and incubating adults; and.
- 4) Minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators, which provide relatively undisturbed areas for individual and population growth and for normal behavior.

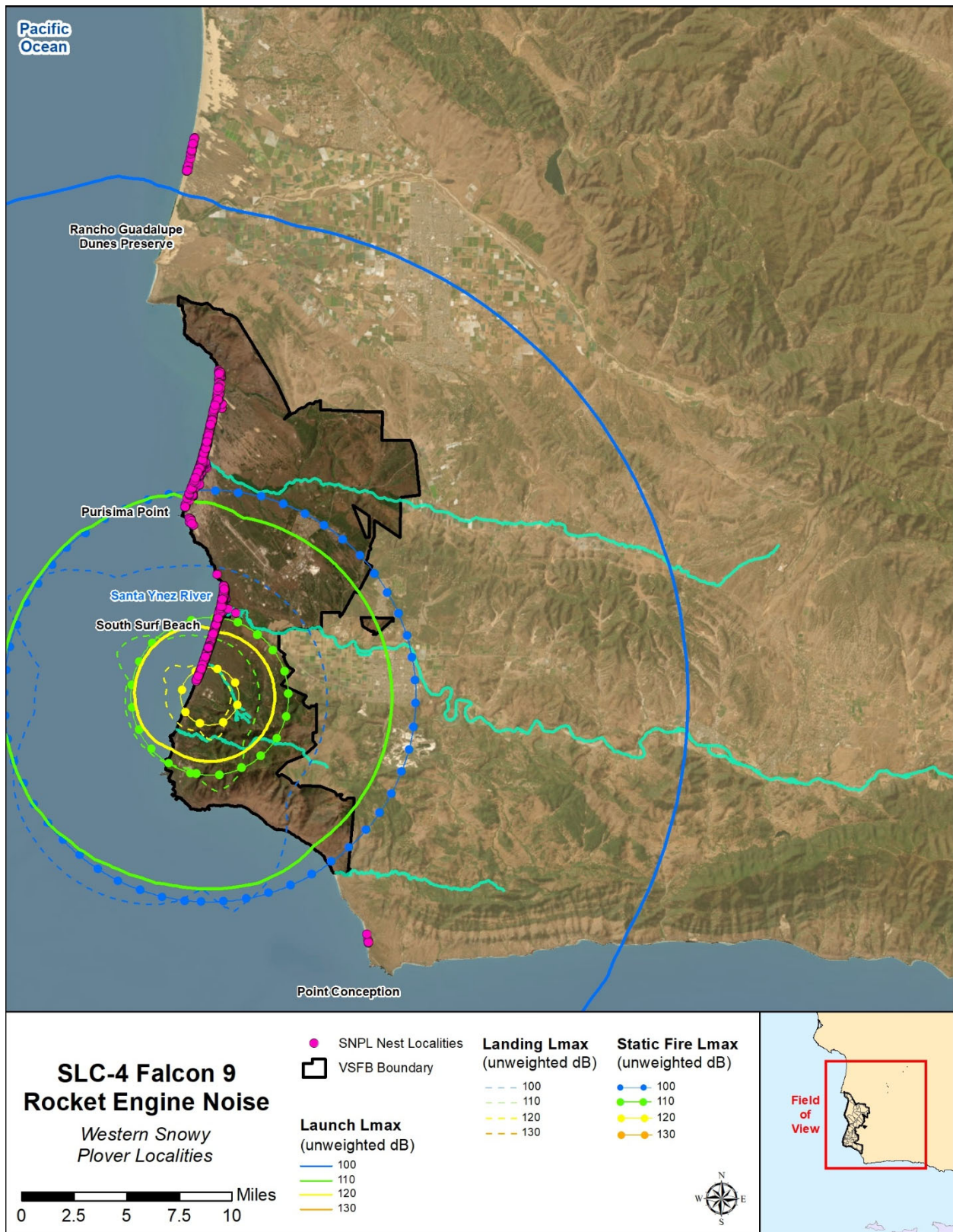


Figure 4.9-1. Western snowy plover nesting localities and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

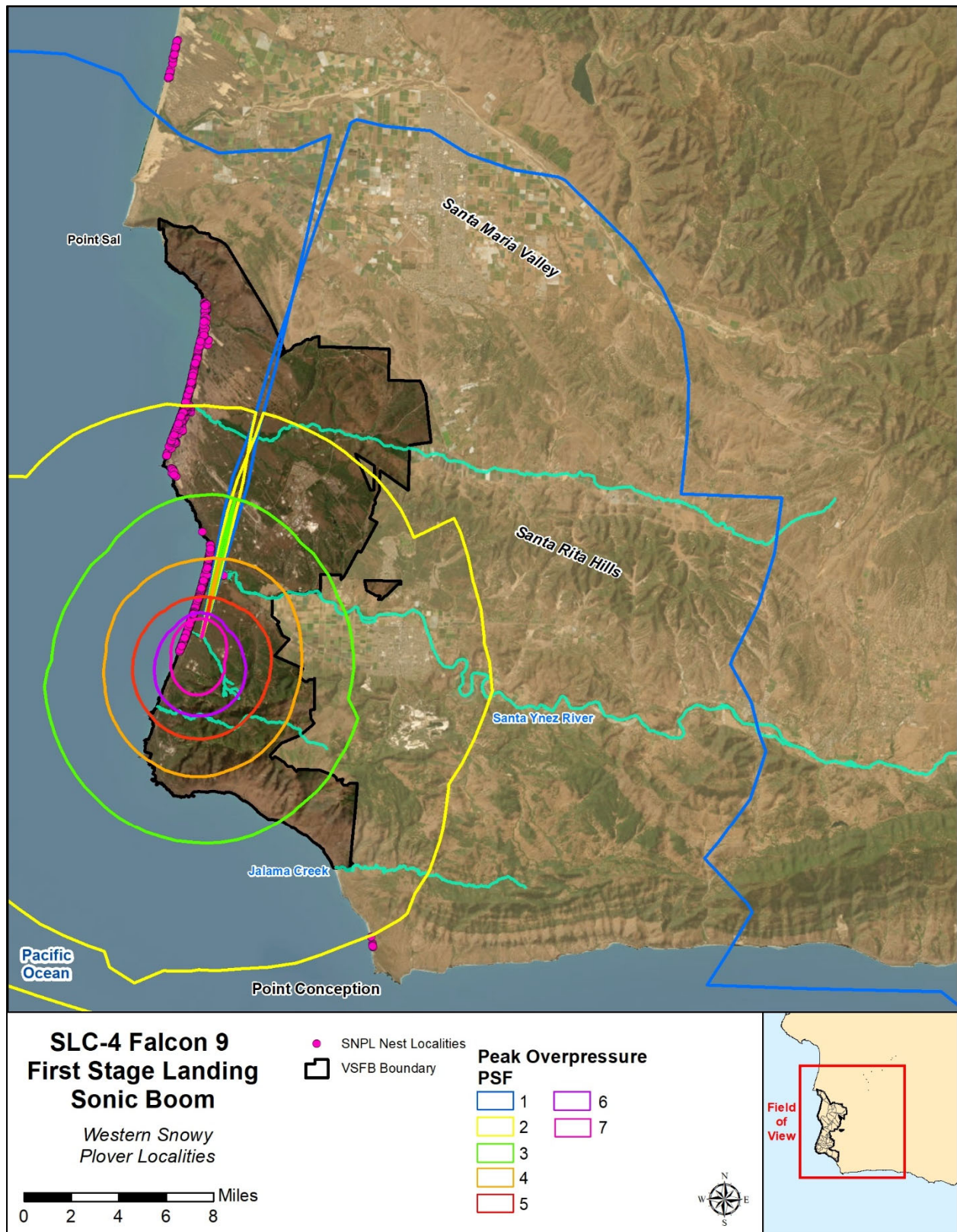


Figure 4.9-2. Western snowy plover nesting records and sample SLC-4 landing sonic boom model results.

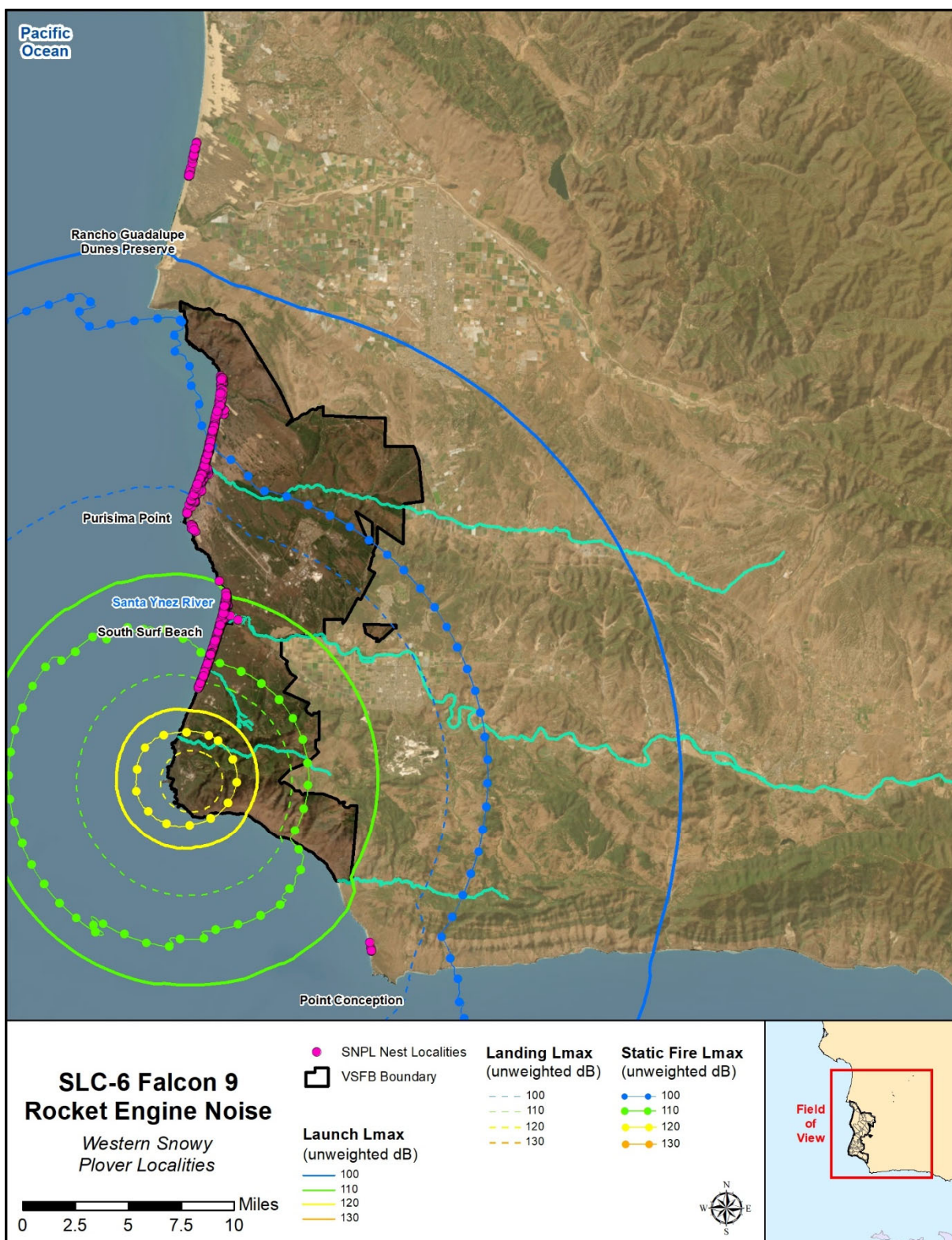


Figure 4.9-3. Western snowy plover nesting localities and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

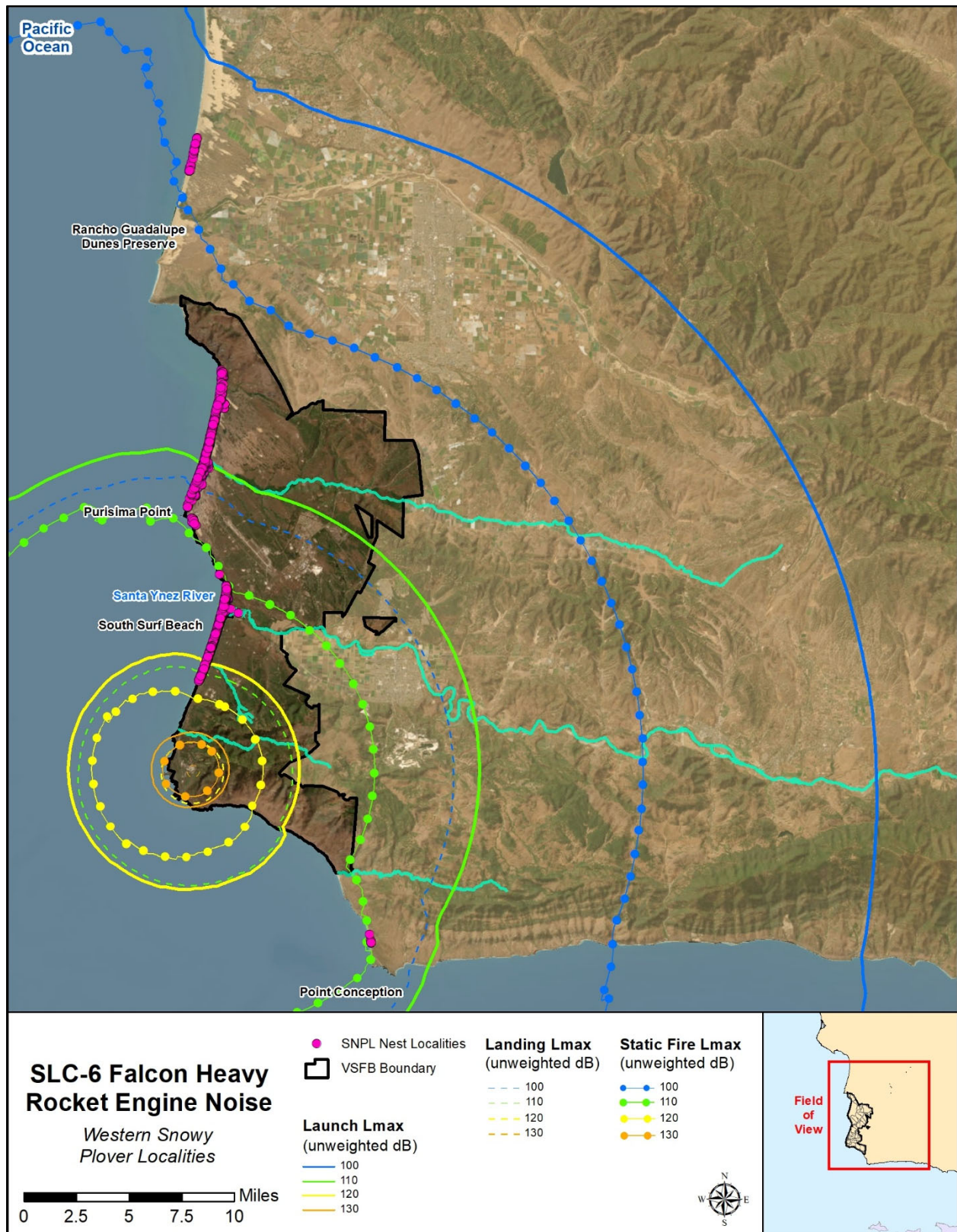


Figure 4.9-4. Western snowy plover nesting localities and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

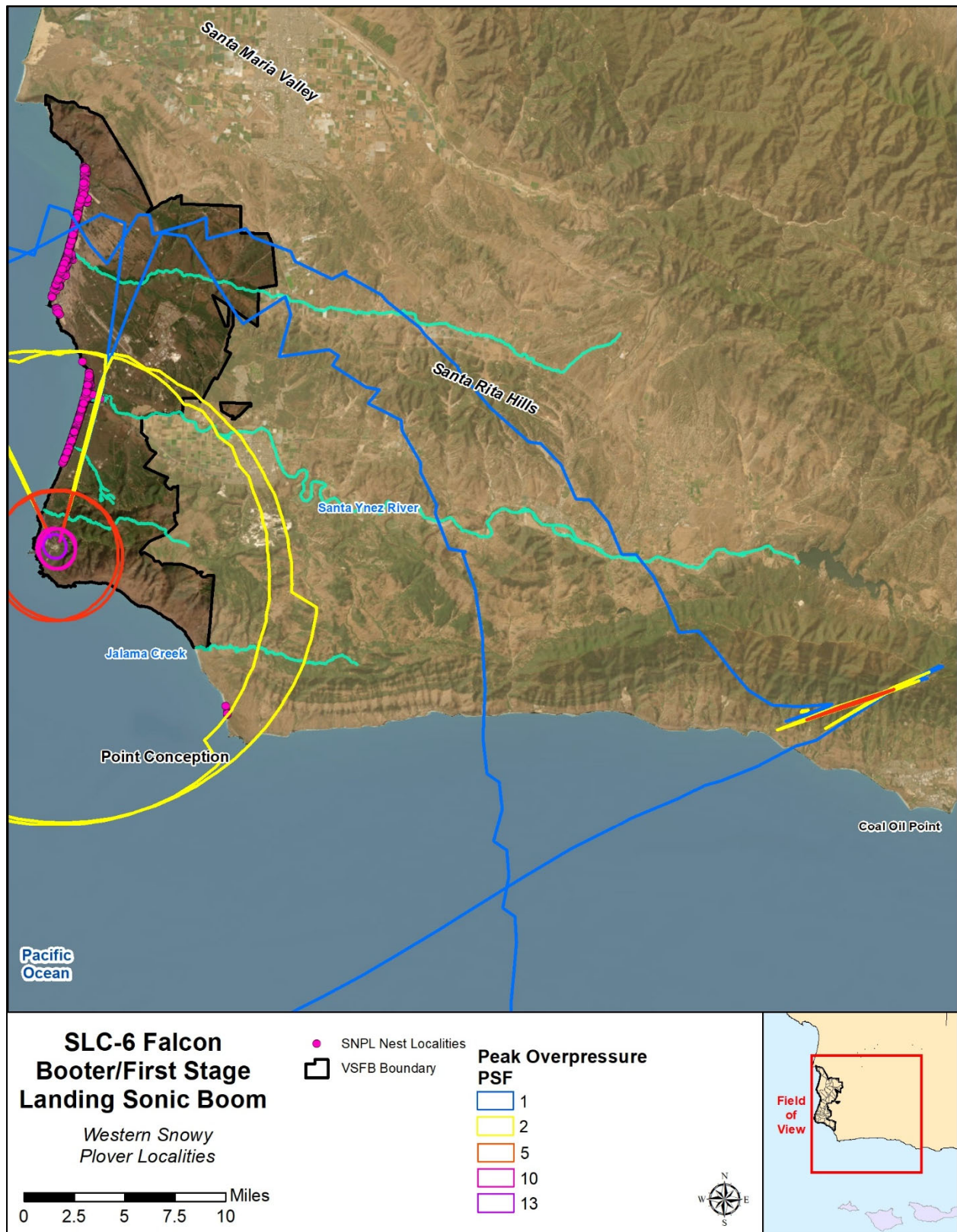


Figure 4.9-5. Western snowy plover nesting records and two sample sonic boom model results for SLC-6 booster/first stage landing events.



Figure 4.9-6. Critical Habitat for the western snowy plover and sample SLC-4 Falcon 9 launch sonic boom model results (Note: variation in model results for a variety of potential trajectories shows a sonic boom of 1 psf or greater may impact any of the critical habitat units on Santa Rosa Islands).



Figure 4.9-7. Critical Habitat for the western snowy plover and two samples of SLC-6 Falcon 9 and Falcon Heavy launch sonic boom model results.

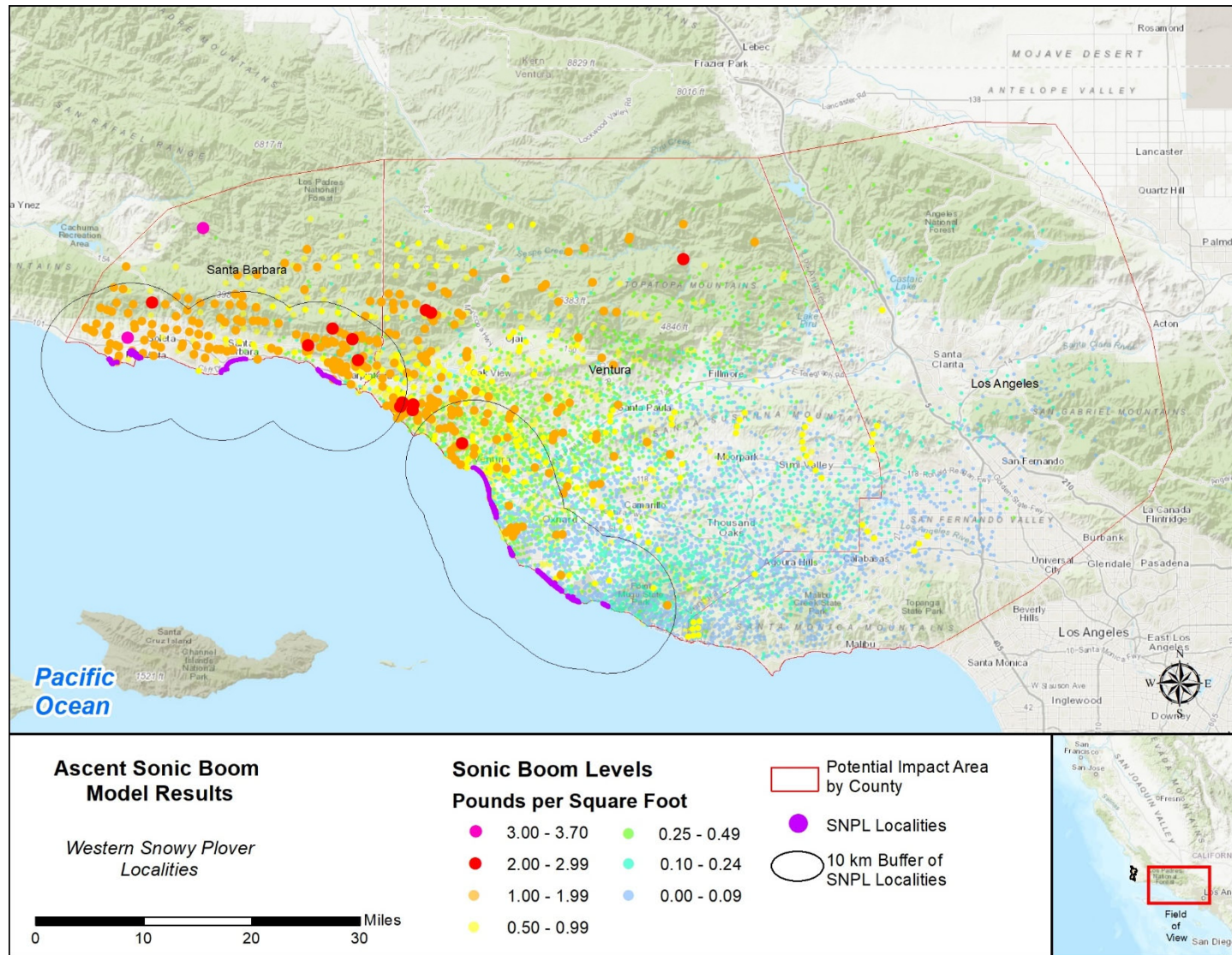


Figure 4.9-8. SNPL localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

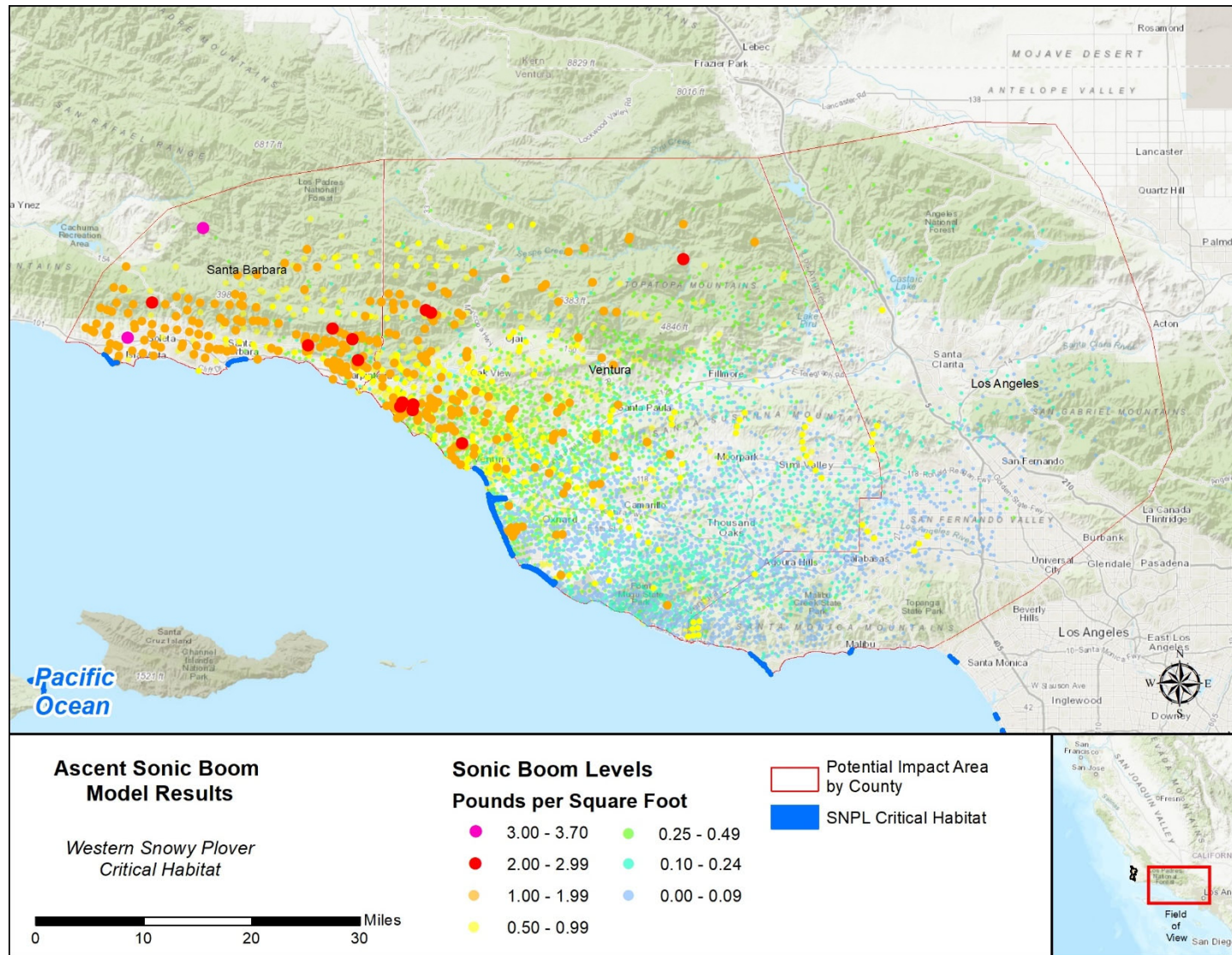


Figure 4.9-9. SNPL Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.10 California Least Tern (Federally Listed Endangered Species)

4.10.1 Status

The USFWS listed the LETE as federally endangered on 13 October 1970 (35 FR 16047–16048) and published a recovery plan for the species in 1985 (USFWS 1985b).

4.10.2 Life History

The LETE is the smallest of the North American terns and is found along the Pacific Coast of California, from San Francisco southward to Baja California. It has a distinctive black cap with stripes running across the eyes to the beak. The upper parts are gray and the underparts are white. The California populations are localized and increasingly fragmented due to coastal development resulting in habitat loss. LETE are migratory and winter along the Pacific coast of Southern Mexico and the Gulf of California. They usually arrive at breeding grounds by the last week of April and return to wintering grounds in August. This species nests in colonies on relatively open beaches kept free of vegetation by natural scouring from tidal or wind action. The primary threats to LETE conservation include habitat loss due to coastal development; habitat degradation resulting from invasive plant species and off-road vehicle use; dredging and pollution which can reduce foraging grounds; predation by dogs, cats, raccoons, coyotes, ravens, and other wild animals; human disturbance including recreation; and food shortages which can be caused by unfavorable ocean conditions.

4.10.3 Occurrence in the Action Area

Historically, LETE nested in colonies in several locations along the coastal strand of the north VSFB coastline. Since 1998, except for two nests established south of San Antonio Creek in 2002, LETE have nested only at the primary colony site, in relatively undisturbed blufftop open dune habitat at Purisima Point. The population of LETE at VSFB represents a small percentage of the known breeding colonies. Robinette et al. (2024d) observed a breeding population of 32 pairs of LETE on VSFB in 2024.

Although this population is small, VSFB is one of only three breeding colonies that nest between Monterey and Point Conception. This colony is approximately 8 mi north of SLC-4 (Figure 4.10-1 through Figure 4.10-5). Adult LETE forage in the Santa Ynez River lagoon and estuary, approximately 3.7 mi north of SLC-4. After young LETE have fledged in late summer, they will disperse to this location to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (Robinette & Howar 2010).

In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, LETE breeding occur at several open sandy beaches in eastern Santa Barbara and Ventura Counties (Figure 4.10-6; CDFW 2024).

4.10.4 Critical Habitat

The USFWS has not designated Critical Habitat for the LETE.

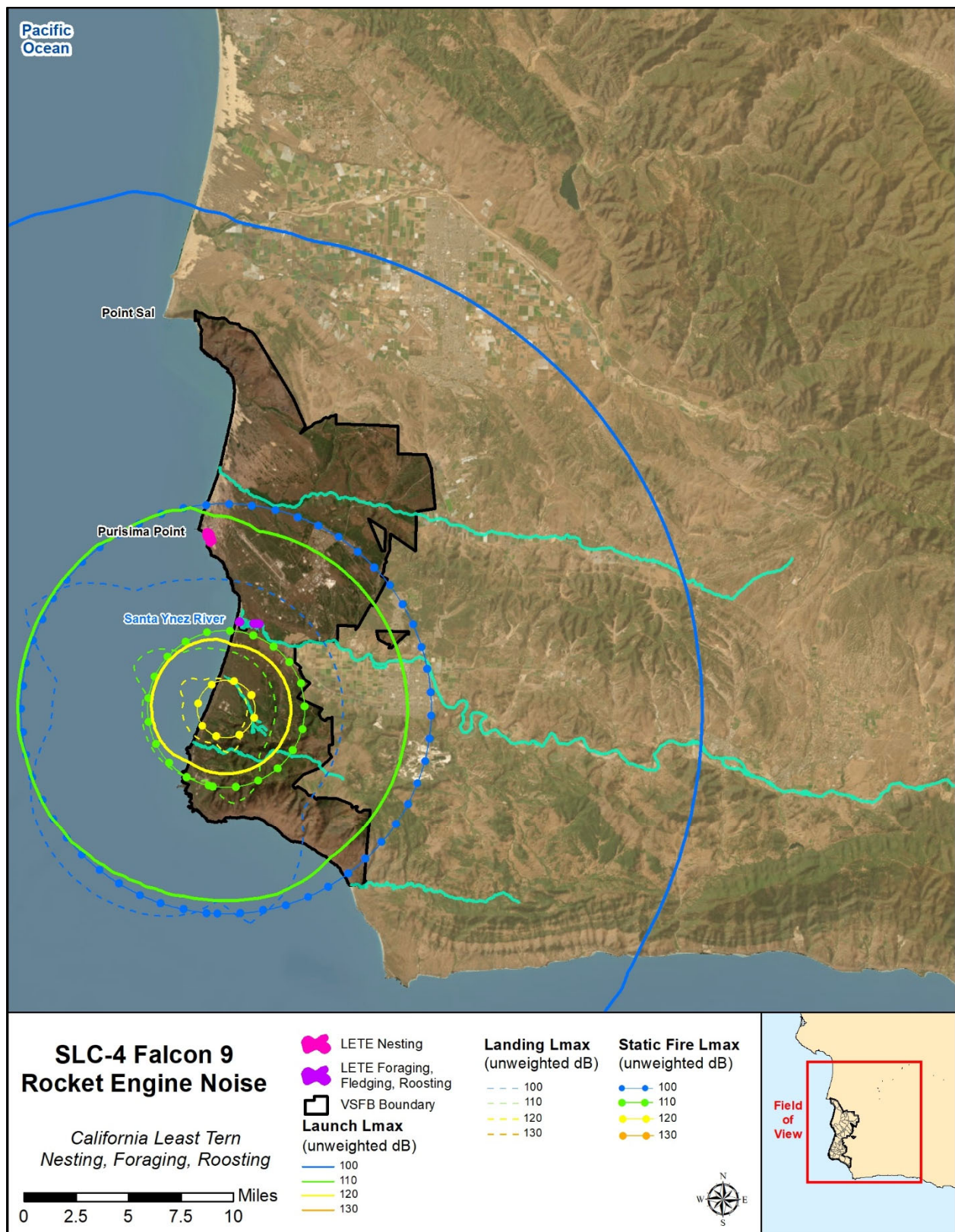


Figure 4.10-1. California least tern foraging, roosting, and nesting areas and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

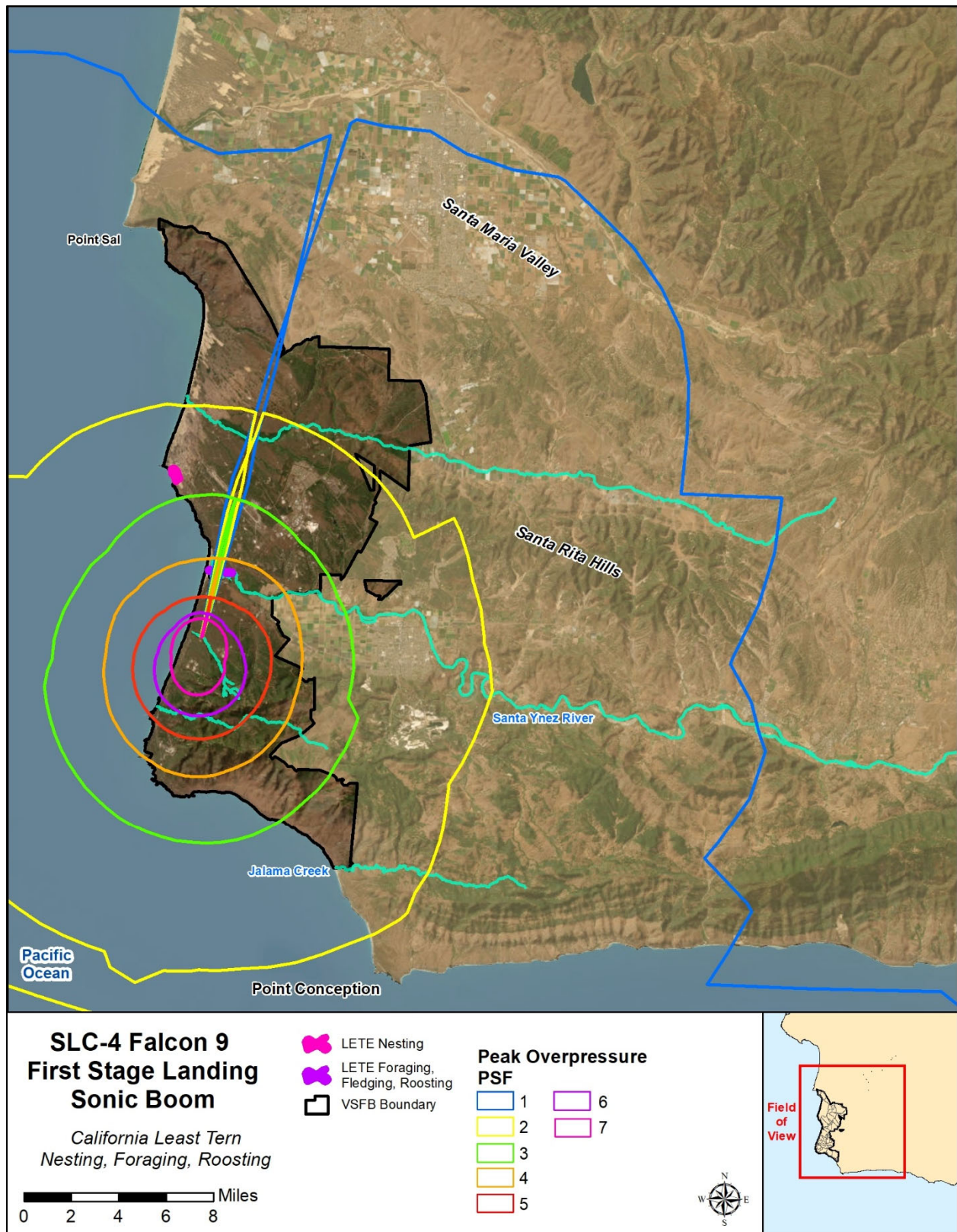


Figure 4.10-2. California least tern foraging, roosting, and sample SLC-4 landing sonic boom model results.

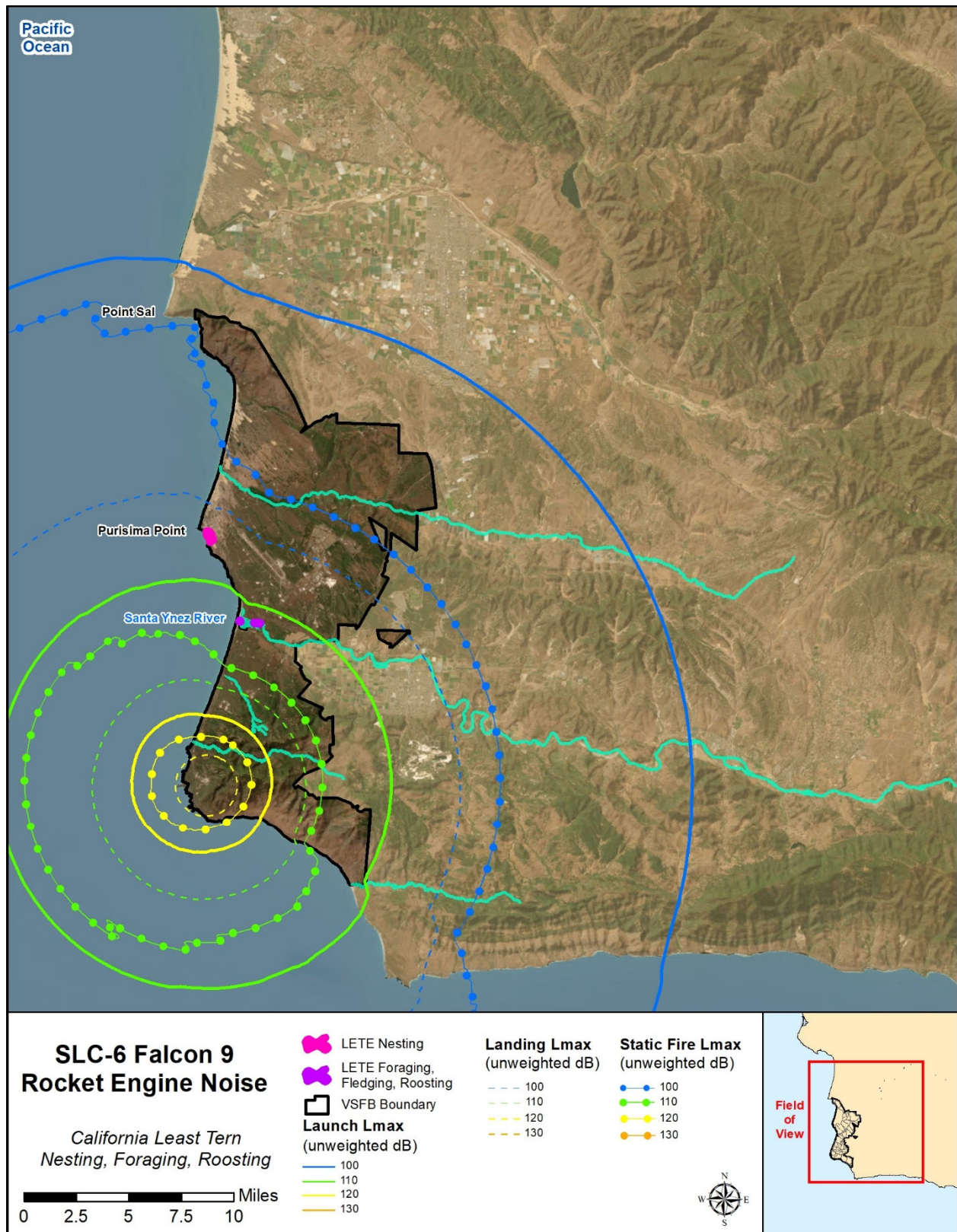


Figure 4.10-3. California least tern nesting, foraging, and roosting areas, and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

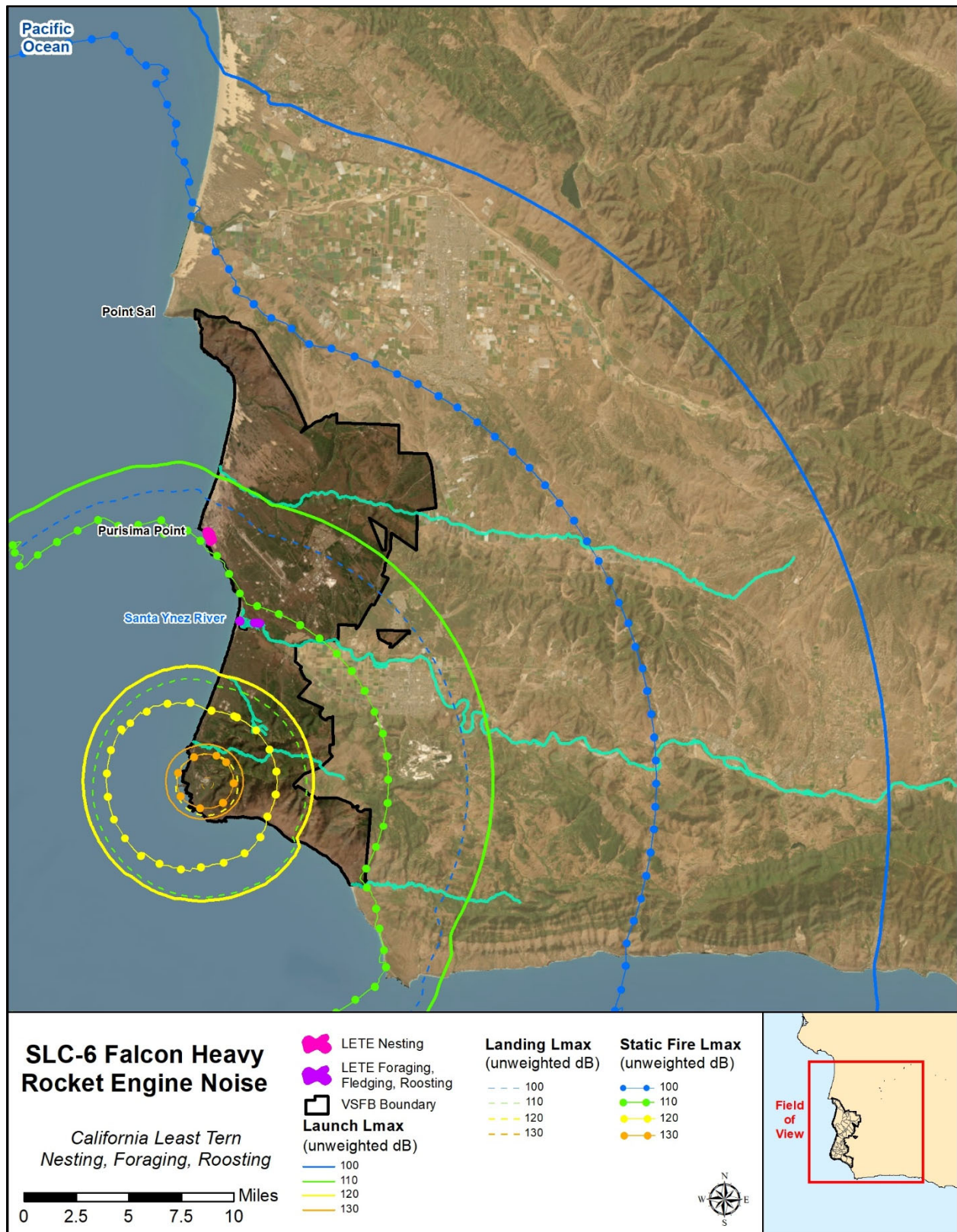


Figure 4.10-4. California least tern nesting, foraging, and roosting areas, and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

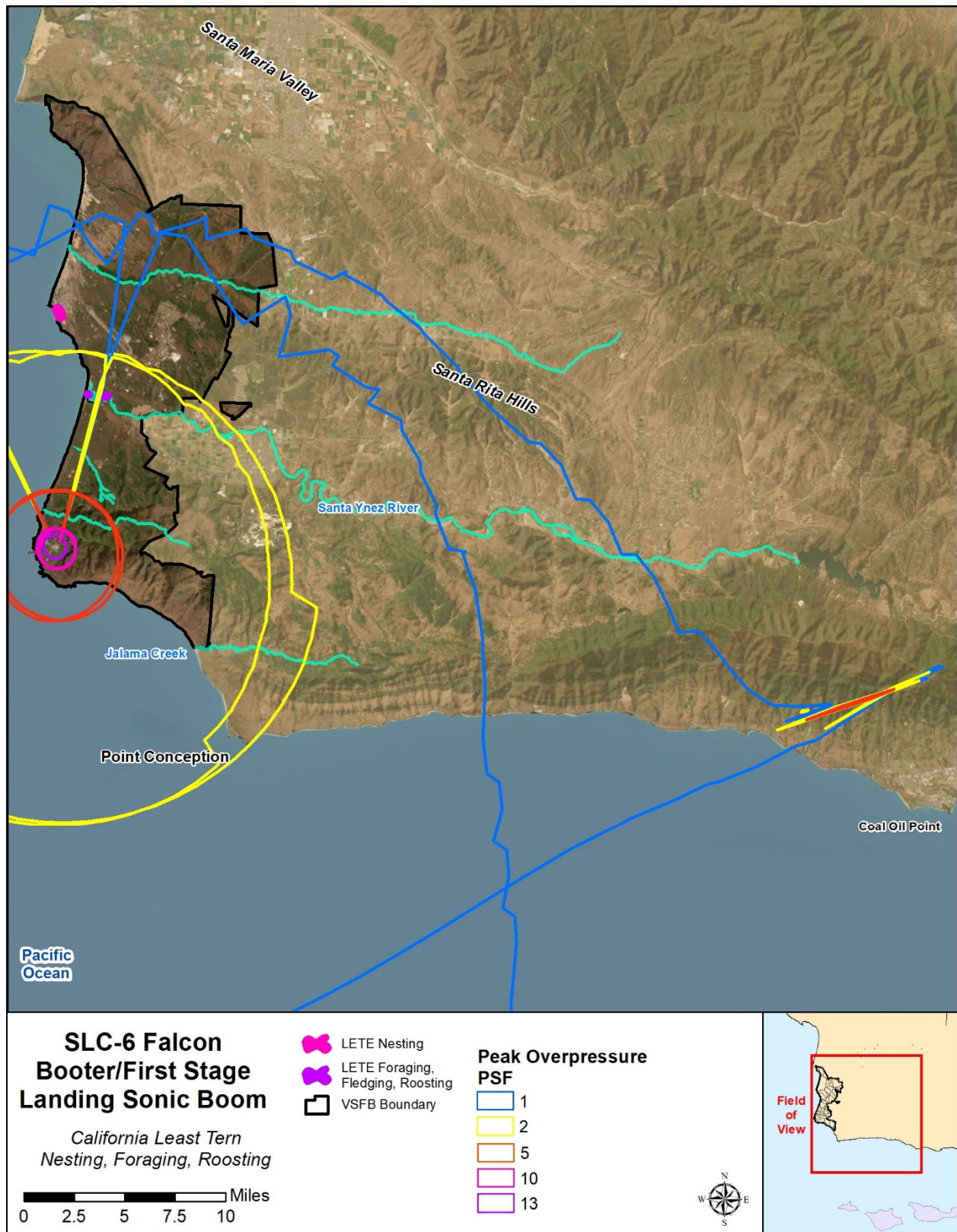


Figure 4.10-5. California least tern nesting, foraging, and roosting areas, and two sample sonic boom model results for SLC-6 booster/first stage landing events.

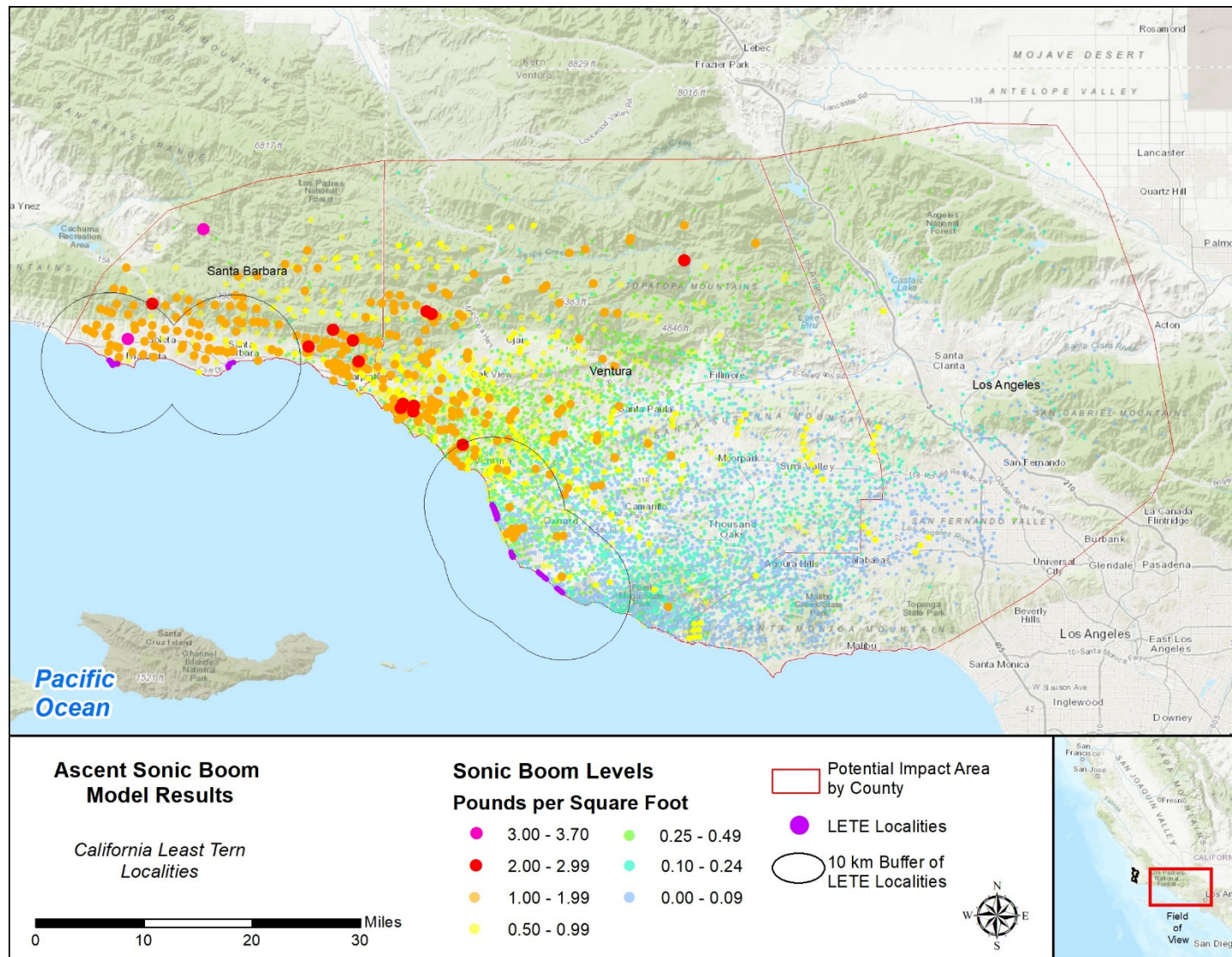


Figure 4.10-6. LEТЕ localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.11 California Condor (Federally Listed Endangered Species)

4.11.1 Status

The USFWS listed the California condor as endangered on 11 March 1967 (32 FR 4001) and completed a Recovery Plan for the species on 25 April 1996 (USFWS 1996). In 1982, there were only 23 California condors in existence. To prevent the condor from going extinct, all remaining condors were placed into a captive breeding program in 1987. The USFWS and its partners began releasing condors back into the wild in 1992. The nearest release site to the Action Area is Bitter Creek National Wildlife Refuge (USFWS 2017b). Other release sites include the Ventana Wilderness and Pinnacles National Park.

4.11.2 Life History

Condors nest in rock formations (e.g., ledges and crevices) and less frequently in giant sequoia trees (*Sequoiadendron giganteum*). They normally lay a single egg between late January and early April. Both parents incubate the egg and share responsibilities for feeding the nestling after hatching. Condors require large remote areas and can range up to 150 mi a day in search of food. Chicks usually take their first flight around 6 to 7 months from hatching. The cause of the California condor's decline is inconclusive, but experts believe that lead poisoning and hunting greatly contributed to their decline (USFWS 1996).

4.11.3 Occurrence within the Action Area

The California condor's current range does not include VSFB. However, in March 2017, the DAF learned that telemetry data from USFWS showed there was a California condor ranging within VSFB. This condor was SB 760 ("VooDoo"), an immature, non-reproductive female (USFWS, personal communication, 27 March 2017). SB 760 hatched in captivity on 22 May 2014. She was released at the Ventana Wilderness on 9 November 2016 (Ventana Wildlife Society 2017). SB 760 departed the VSFB area on or about 22 April 2017 and, several months later, SB 760 was found deceased as a result of drowning in an uncovered water tank in northern San Luis Obispo County.

VSFB natural resource managers maintain routine communications with the USFWS and the Ventana Wildlife Society for SpaceX launch monitoring requirements and condors have not been present since this event. However, given the wide-ranging nature of this species, it is possible individuals may occur on VSFB in the future.

In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, California condors occur year-round in the Sisquoc, Matilija, Sespe, and Piru areas (Figure 4.11-1; CDFW 2024).

4.11.4 Critical Habitat

The USFWS designated Critical Habitat for the California condor in 1976 and revised it in 1977 (42 FR 47840). The potential ascent sonic boom footprint from missions with easterly trajectories overlaps the Sisquoc-San Rafael, Matilija, and Sespe-Piru Critical Habitat units (Figure 4.11-2). The designation did not include a description of Critical Habitat Physical and Biological Features.

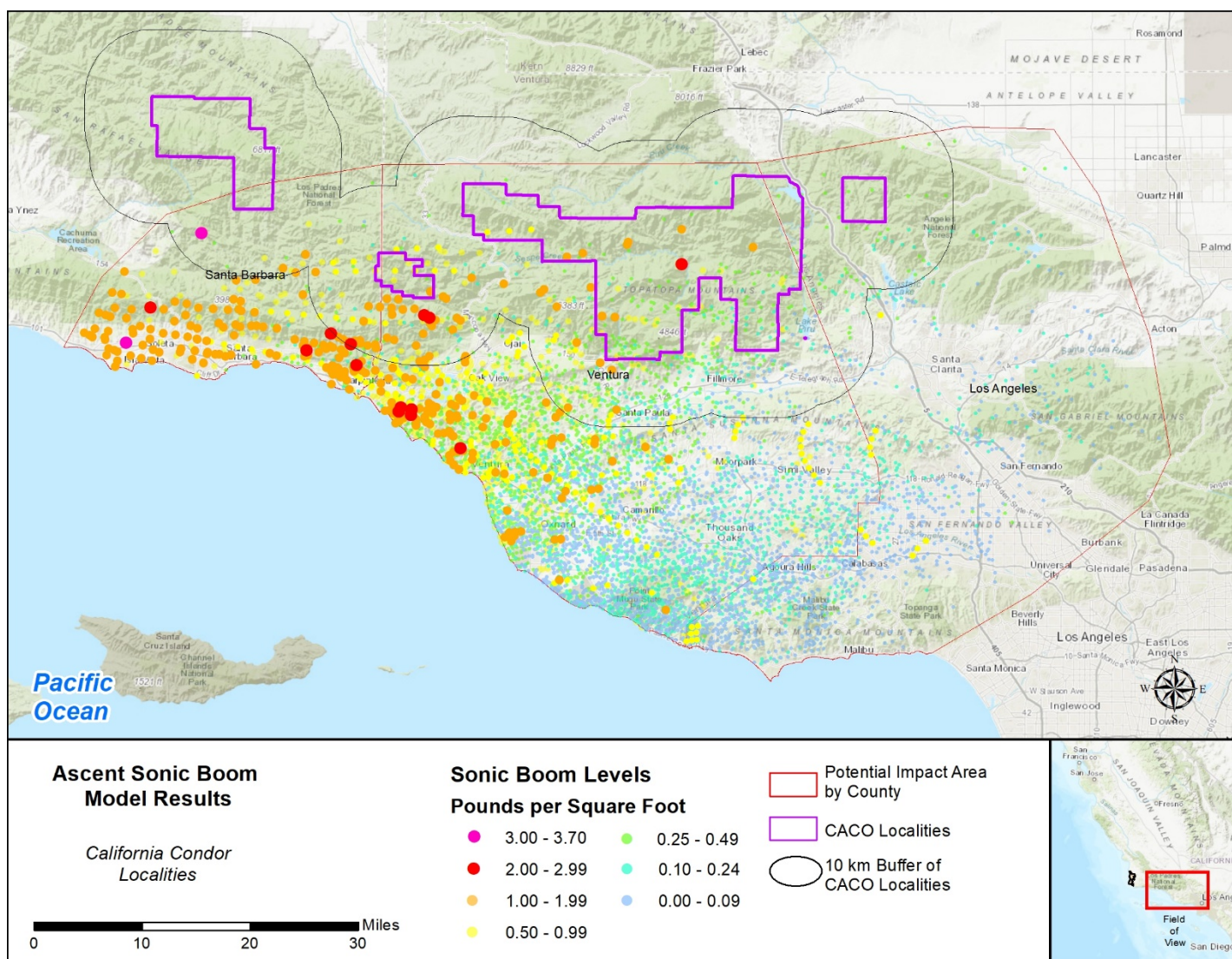


Figure 4.11-1. California condor localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: CACO = California condor; sonic boom model output is explained in Section 2.2.4).

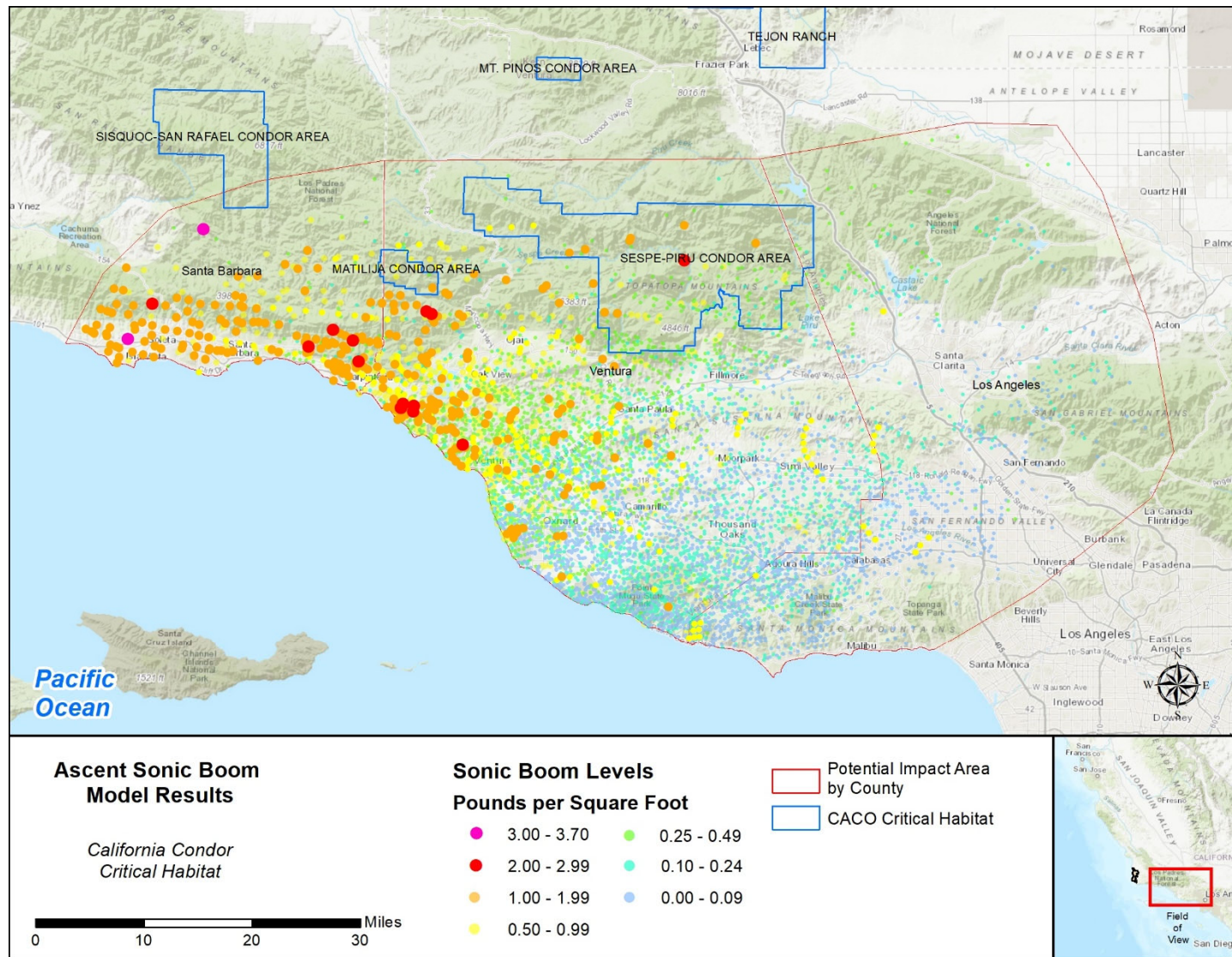


Figure 4.11-2. California condor Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.12 Coastal California Gnatcatcher (Federally Listed Threatened Species)

4.12.1 Status

The USFWS listed the CAGN as federally threatened on 30 March 1993 (58 FR 16742-16757). The USFWS has not published a Recovery Plan for this species.

4.12.2 Life History

The CAGN is a small, nonmigratory bird that nests from late February through July in coastal sage scrub habitat from coastal Baja California, Mexico, north to Ventura County in California. CAGN prey on insects and spiders. Because they are found exclusively in coastal sage scrub, this species has been heavily impacted by coastal development in California.

4.12.3 Occurrence within the Action Area

CAGN does not occur on VSFB. In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, CAGN occur across southern Ventura and western Los Angeles Counties (Figure 4.12-1; CDFW 2024).

4.12.4 Critical Habitat

The USFWS issued a revised designation of Critical Habitat for the CAGN in 2007 (72 FR 72010-72213). The potential ascent sonic boom footprint from missions with easterly trajectories overlaps Unit 13 in western Los Angeles and Ventura Counties (Figure 4.12-2). The PCEs for CAGN are:

- (i) Dynamic and successional sage scrub habitats: Venturan coastal sage scrub, Diegan coastal sage scrub, Riversidean sage scrub, maritime succulent scrub, Riversidean alluvial fan scrub, southern coastal bluff scrub, and coastal sage-chaparral scrub in Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties that provide space for individual and population growth, normal behavior, breeding, reproduction, nesting, dispersal and foraging; and
- (ii) Non-sage scrub habitats such as chaparral, grassland, riparian areas, in proximity to sage scrub habitats as described above that provide space for dispersal, foraging, and nesting.

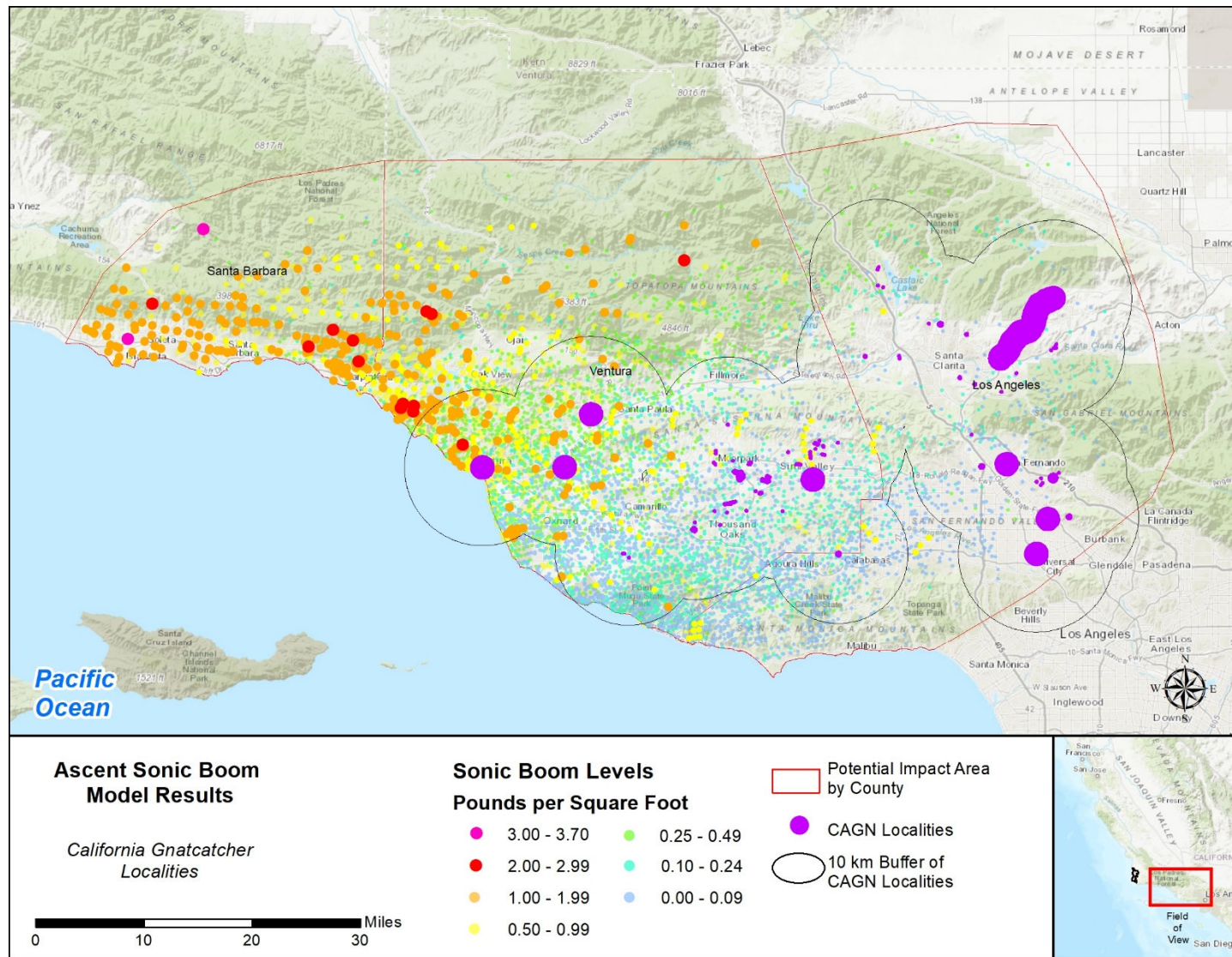


Figure 4.12-1. CAGN localities and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

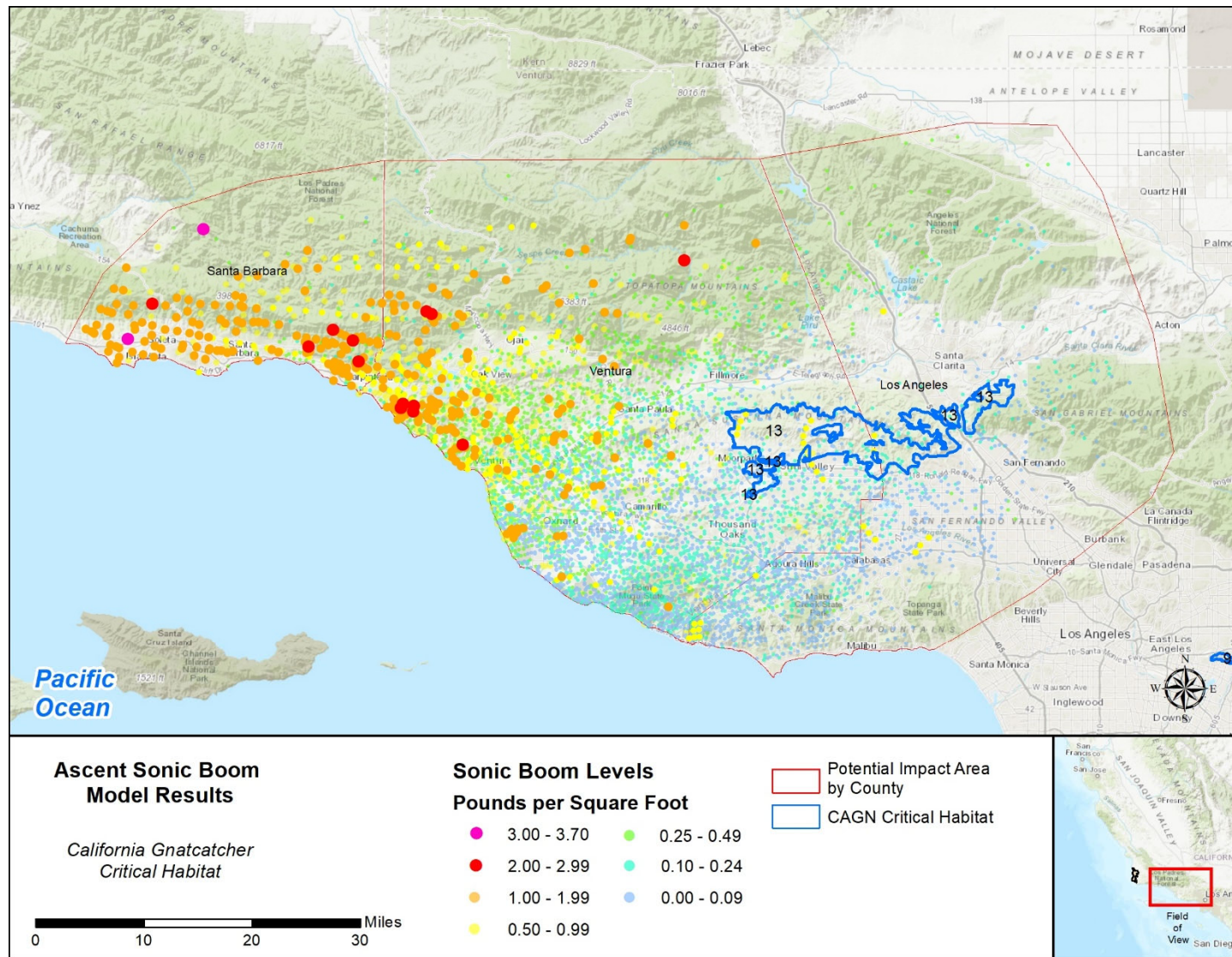


Figure 4.12-2. CAGN Critical Habitat and potential ascent sonic boom impact areas in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: sonic boom model output is explained in Section 2.2.4).

4.13 Light-footed Ridgeway's Rail (Federally Listed Endangered Species)

4.13.1 Status

The USFWS listed the RIRA as federally threatened on 13 October 1970 (35 FR 16047-16048). The USFWS published a Recovery Plan that included this species in 2014 (79 FR 10830-10831).

4.13.2 Life History

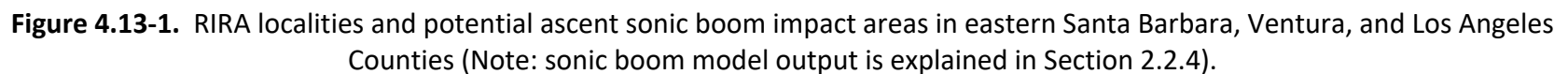
RIRA can be found in southern California coastal salt marshes. This species nests in cordgrass and construct their nests of dried cordgrass, which is intertwined at its edges with upright stems of living cordgrass so that it floats up and down on the tides, held in place by the living stems. The geographic range of the species is from their over-wintering habitat in Central America to Baja California and Southern California. RIRA depends entirely on salt marsh habitat for feeding, resting, and nesting. RIRA are generalists, foraging for invertebrates while utilizing the cover of tidal marsh vegetation. Key threats to RIRA conservation include loss of coastal wetlands; habitat degradation due to dredging, siltation, and pollution; predation by cats, dogs, raccoons, coyotes, and other wild predators; and sea level rise.

4.13.3 Occurrence within the Action Area

RIRA does not occur on VSFB. In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, RIRA occurs at the Carpinteria Salt Marsh and the marshes at Naval Base Ventura County Point Mugu (Figure 4.13-1; CDFW 2024).

4.13.4 Critical Habitat

The USFWS has not designated Critical Habitat for this species.



4.14 Short-tailed Albatross (Federally Listed Endangered Species)

4.14.1 Status

The USFWS listed the short-tailed albatross as federally endangered on 31 July 2000 (65 FR 147) and published a Recovery Plan in 2008 (USFWS 2008). Most recently, the USFWS completed a 5-year review of the species in 2020 (USFWS 2020).

4.14.2 Life History

Short-tailed albatross primarily nest on Torishima Island in the Izu Islands of Japan (USFWS 2008). This species is monogamous and philopatric to nesting areas and breeds at 5 or 6 years of age. During the incubation and brooding cycle (October through June) adults forage in the coastal waters of Honshu Island, Japan (Suryan et al. 2008). Adults leave the nesting colony in Late May and early June, chicks fledge soon after, dispersing across the North Pacific Ocean (Austin 1949). The primary threats to short-tailed albatross conservation include injury and mortality due to fishing bycatch; oil spills; plastic pollution; invasive predators on nesting islands; and sea level rise which could affect nesting habitat.

4.14.3 Occurrence within the Action Area

There are approximately 7,365 individuals, primarily concentrated around the breeding islands of Torishima and the Senkaku Islands, making their density relatively high in those areas, but very low across the vast expanse of the Pacific Ocean. In the summer, short-tailed albatross forage throughout the North Pacific Ocean (Sanger 1972; Suryan et al. 2007) and therefore may be found in the offshore recovery area (Figure 2.2-6) in very low densities.

4.14.4 Critical Habitat

The USFWS has not designated Critical Habitat for this species.

4.15 Hawaiian Petrel (Federally Listed Endangered Species)

4.15.1 Status

The USFWS listed the Hawaiian petrel as federally endangered on 11 March 1967, pursuant to the ESA. The USFWS published a Recovery Plan in 1983 (USFWS 1983) and an amendment to the Recovery Plan in 2019 (USFWS 2019). The USFWS completed the most recent 5-year review of the species in 2022 (USFWS 2022b).

4.15.2 Life History

After fledging, Hawaiian petrels spend the first several years of their lives at sea and do not typically begin breeding until they are six years old. Individuals may not breed each year, but live greater than 30 years. This species primarily preys on squid but also feeds on fish, crustaceans, and plankton. Key threats to Hawaiian petrel conservation include injury and mortality due to fishing bycatch; introduced predators on nesting islands; feral ungulates that degrade nesting habitat; plastic pollution; and sea level rise which may affect nesting habitat.

4.15.3 Occurrence within the Action Area

Hawaiian petrel ranges in the central Pacific Ocean and breeds only in the main Hawaiian Islands, though there are specimen records from Japan, Philippines, and Moluccas at the western edge of the distribution. Most of the Hawaiian petrel global population breeds on the island of Maui within Haleakala National Park. The Hawaiian petrel typically feeds far offshore but tends to feed closer to shore during spring than in the fall. This species favors open ocean water conditions, with an average sea surface temperature of 80 degrees Fahrenheit, sea surface salinity of 34 parts per thousand, wind speed of 19 miles per hour, and a wave height of 5 ft.

The Hawaiian petrel occurs largely in equatorial waters of the eastern tropical Pacific, generally from 10 degrees South to 20 degrees North. The Hawaiian petrel may occur in open ocean waters throughout western and southern portions of the recovery area. But given the vast expanse of the ocean that these birds inhabit, their at-sea density is relatively low.

4.15.4 Critical Habitat

The USFWS has not designated Critical Habitat for this species.

4.16 Southern Sea Otter (Federally Listed Threatened Species)

4.16.1 Status

The USFWS listed the SSO as federally threatened on 14 January 1977 (42 FR 2965) and published a Recovery Plan in 2003 (USFWS 2003). The USFWS completed a 5-year review of the species in 2015 (USFWS 2015b).

4.16.2 Life History

The SSO is the smallest species of marine mammal in North America. It inhabits the nearshore marine environments of California from San Mateo County to Santa Barbara County with a small geographically isolated population around San Nicolas Island. On occasion, SSOs have been observed beyond these limits and have been documented as far south as Baja, Mexico (USFWS 2015b).

This species breeds and gives birth year-round and pups are dependent for 120 to 280 days (average 166 days; Riedman & Estes 1990). SSO are opportunistic foragers known to eat mostly abalones, sea urchins, crabs, and clams. They play a key ecological role in kelp bed communities by controlling sea urchin grazing. The primary threats to SSO conservation include oil spills; loss of kelp forests along the California coast; overfishing which has depleted some food sources; pathogens that cause disease from pets and livestock; entanglement with fishing gear; and direct conflict with humans, including shootings and boat strikes.

4.16.3 Occurrence within the Action Area

SSOs occur regularly off the coast of VSFB, with animals typically concentrated in the kelp beds between the Boat House and Jalama Creek on south VSFB (Figure 4.16-1 through Figure 4.16-5). Annual spring surveys performed by United States Geological Survey (USGS) document persistent populations in nearshore waters in this area (USGS Western Ecological Resource Center 2017, 2018, 2020). As many as 55 adult SSO have been documented in the Sudden Flats area at one time (SRS Technologies, Inc. 2006a). More recently, a high of 49 adults and 4 pups were observed

in March 2023 in the Sudden Flats area during monitoring for a Falcon 9 launch (MSRS, unpubl. data).

Historically, the Purisima Point area has also supported a persistent otter population with as many as 18 adult SSO documented in the area at one time (SRS Technologies, Inc. 2002). During the last three annual spring census counts that were performed (2017, 2018, and 2019), however, there is a running average of only one otter within the Purisima Point area (USGS Western Ecological Resource Center 2017, 2018, 2020). Transitory SSO also occasionally traverse the coast between Purisima Point and Point Arguello.

4.16.4 Critical Habitat

The USFWS has not designated Critical Habitat for this species.

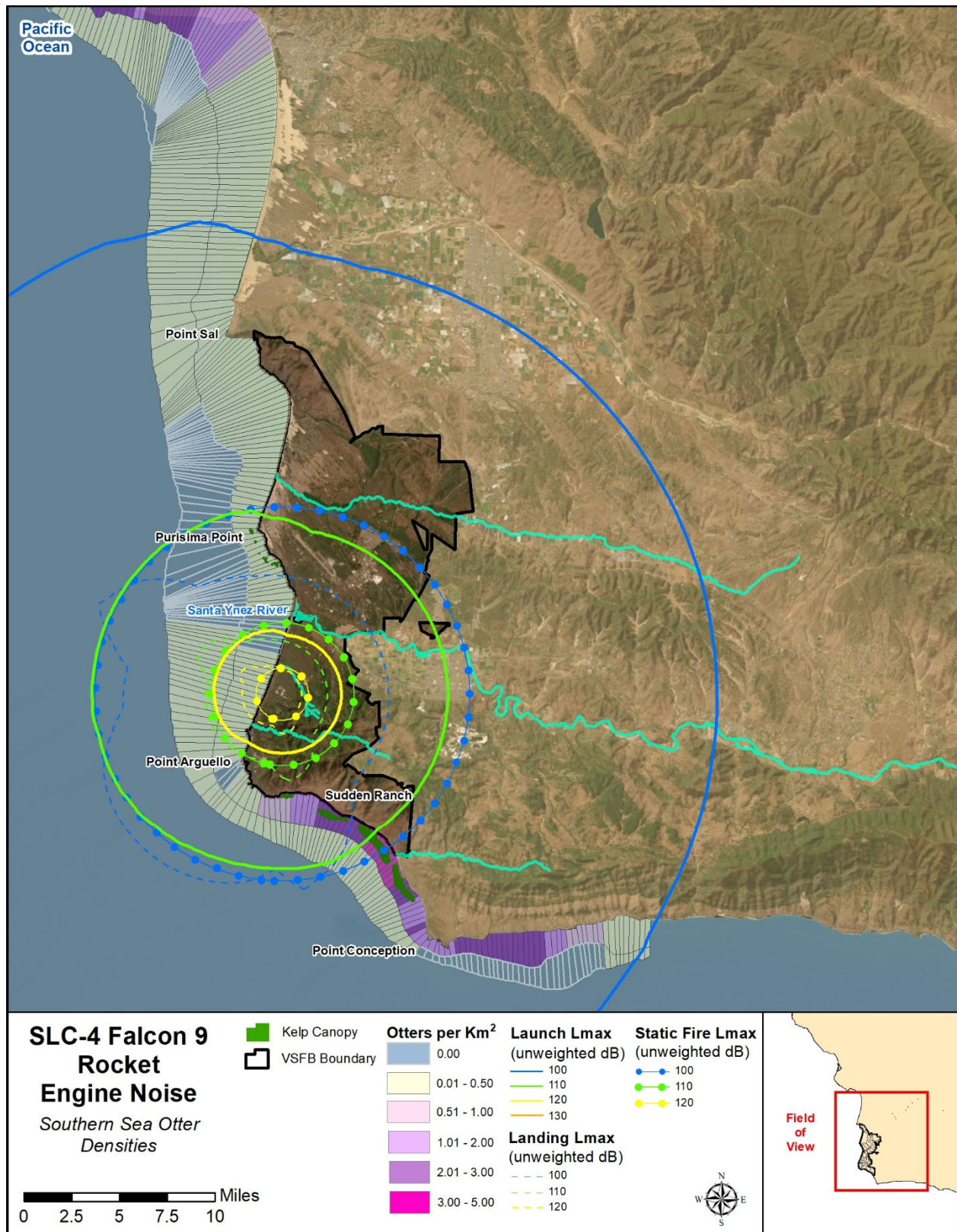


Figure 4.16-1. Southern sea otter densities and areas and modeled Falcon 9 SLC-4 static fire, launch, and landing rocket engine noise.

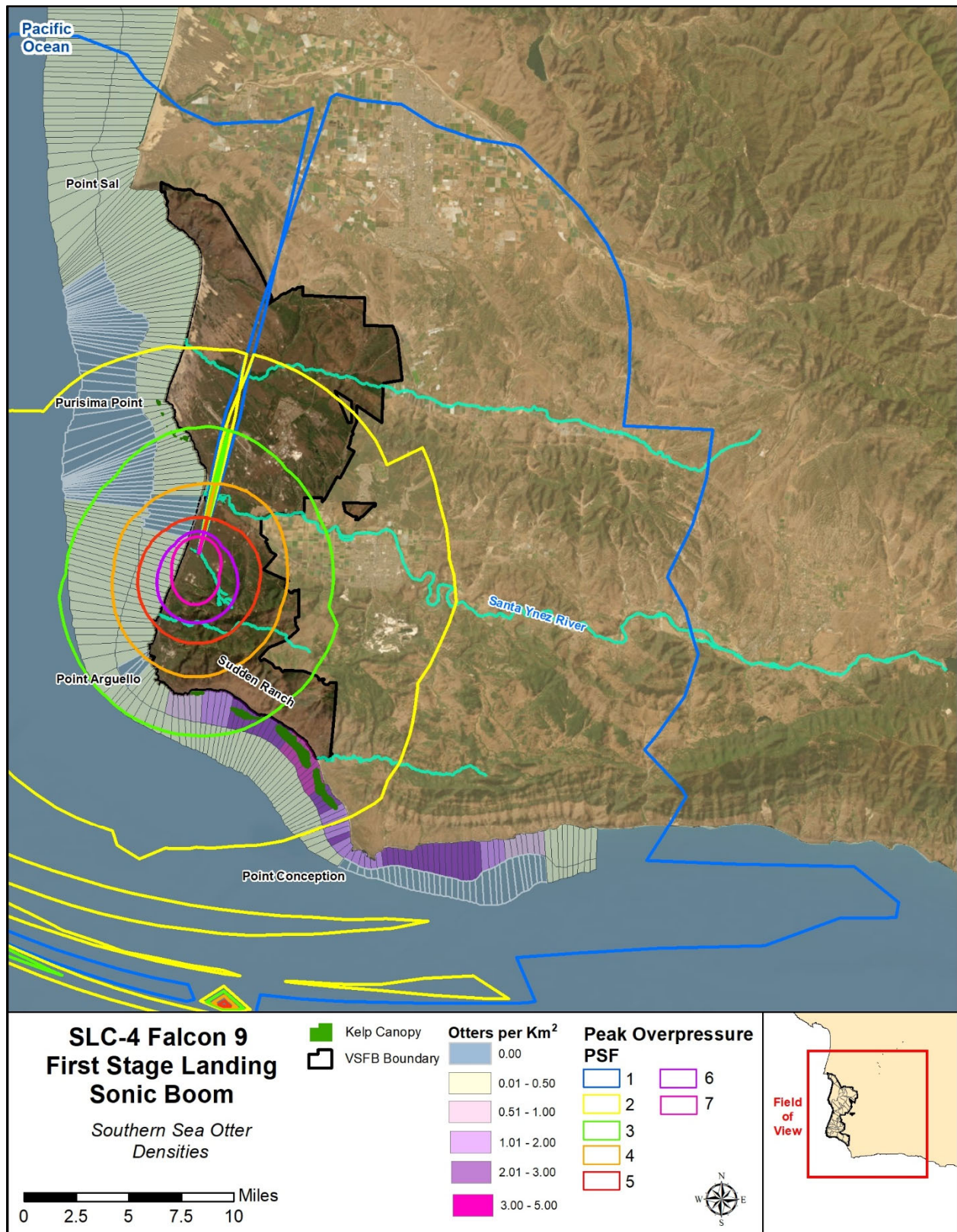


Figure 4.16-2. Southern sea otter densities and sample SLC-4 landing sonic boom model results.

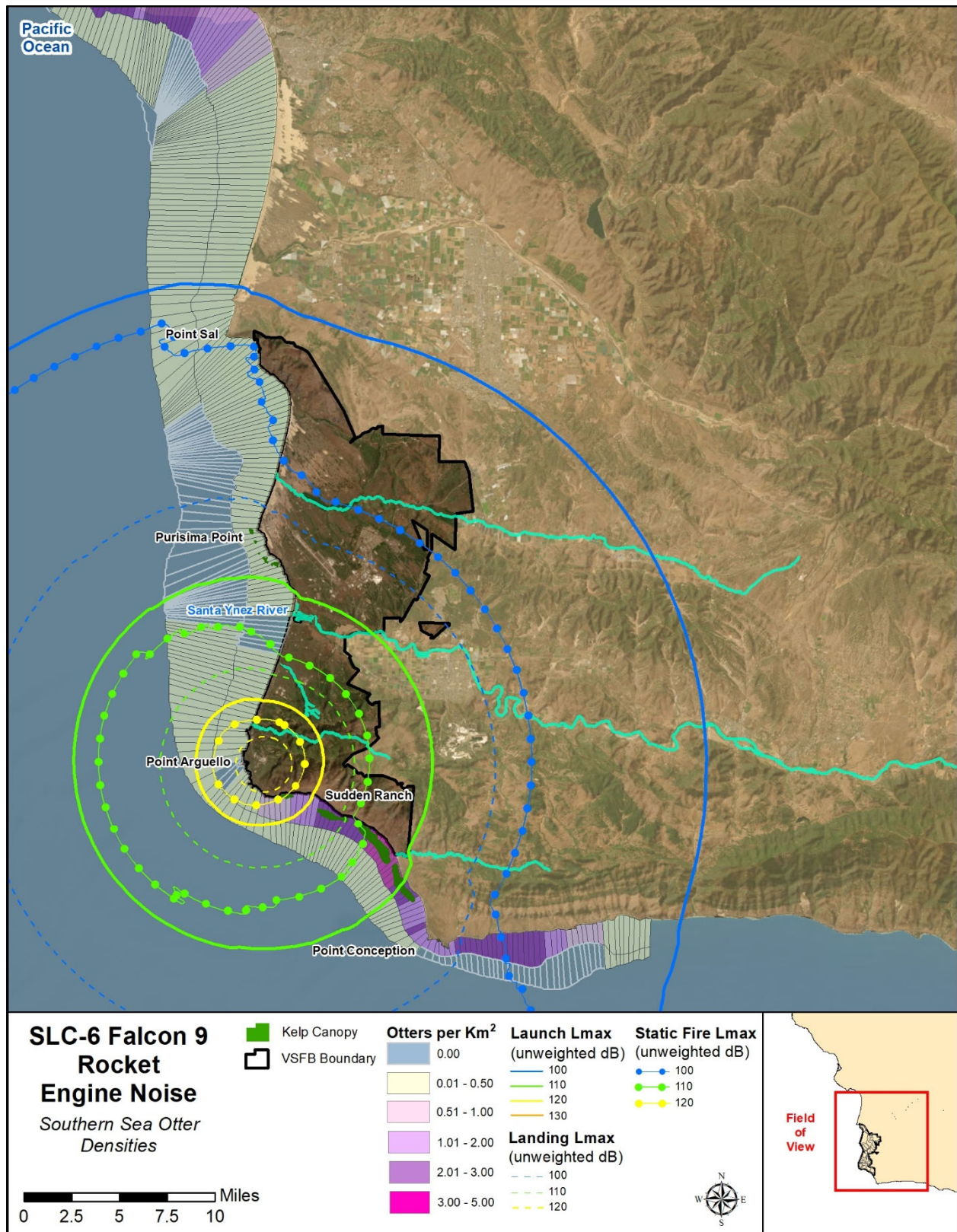


Figure 4.16-3. Southern sea otter densities and modeled Falcon 9 SLC-6 static fire, launch, and landing rocket engine noise.

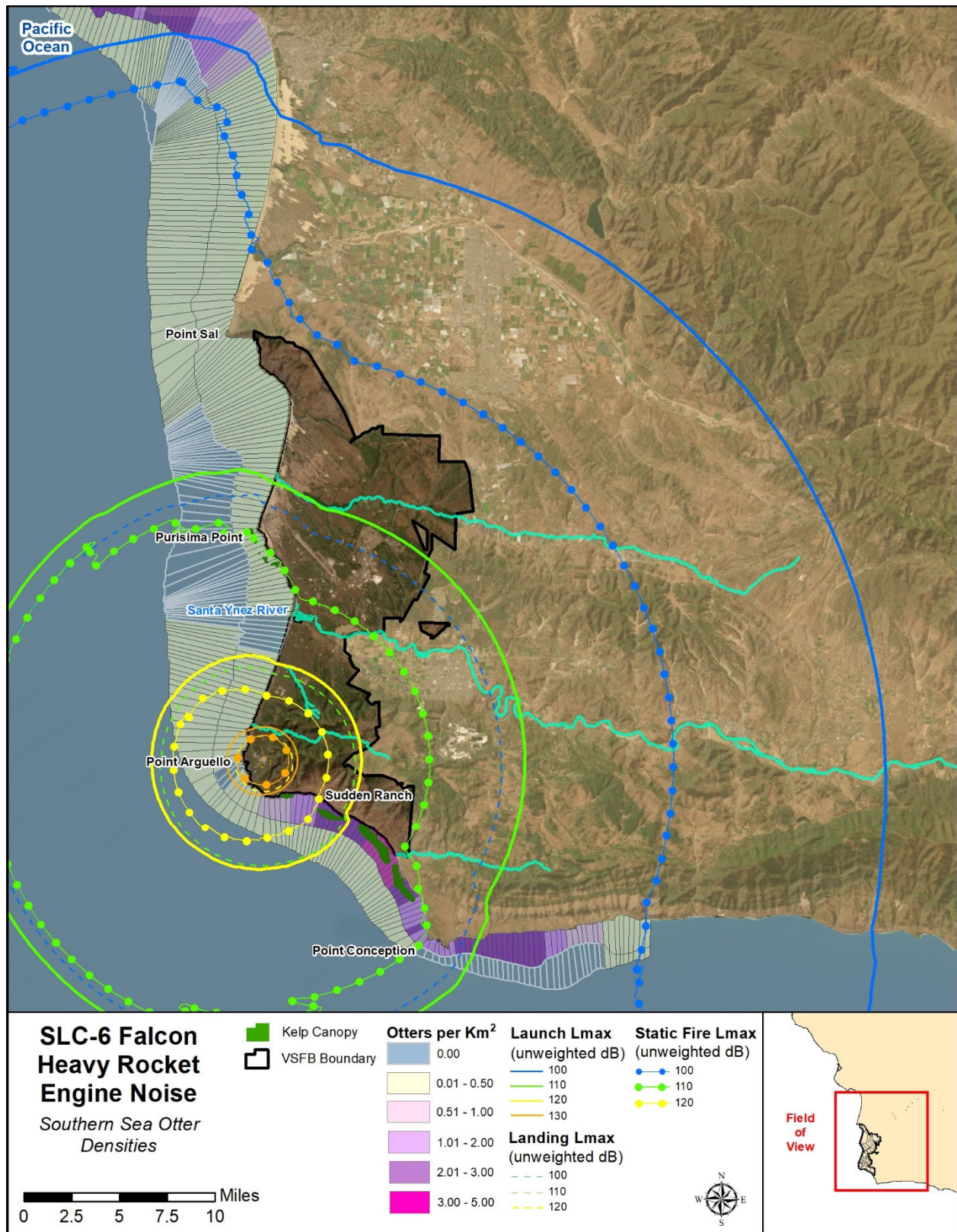


Figure 4.16-4. Southern sea otter densities and modeled Falcon Heavy SLC-6 static fire, launch, and landing rocket engine noise.

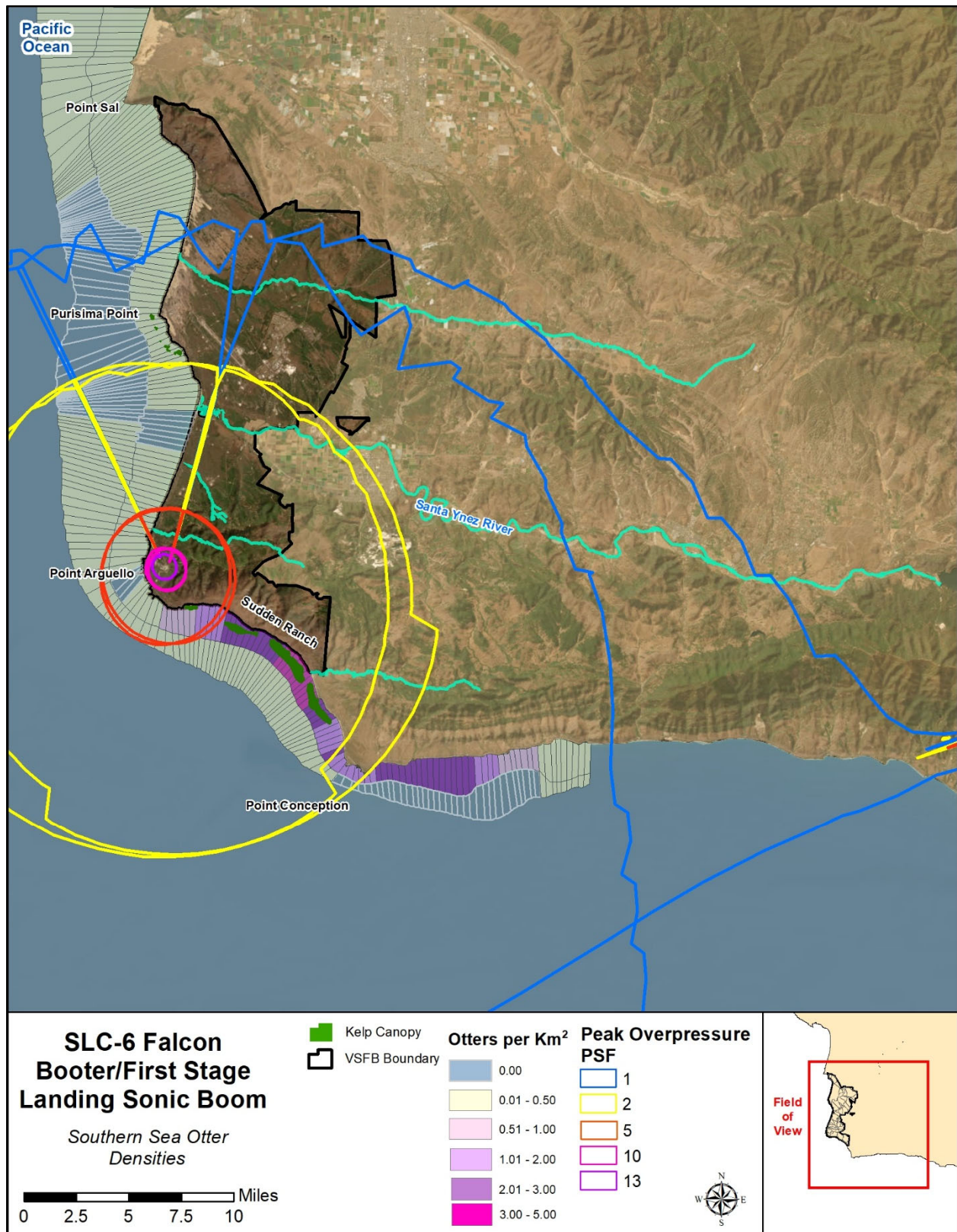


Figure 4.16-5. Southern sea otter densities and two sample SLC-6 booster/first stage landing sonic boom model results.

5 Analysis of Effects of the Proposed Action

"Effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur "but for" the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

5.1 Effects of Action on Species

The potential direct impacts to species that may be caused by the Proposed Action vary by species, but include loss or degradation of habitat, injury or mortality during construction and water releases, and disturbance due to noise, vibration, and visual cues. Potential indirect impacts could result from water use, which is currently extracted from the San Antonio Creek Basin. Indirect impacts that may affect some species include potential long-term effects of increasing the launch frequency on VSFB over the next several years.

Noise is one consequence that could potentially impact species. Determining how much noise energy overlaps with the hearing sensitivity of an animal that may be affected by noise exposure is critical to evaluating the potential effect the noise will have (Halfwerk et al. 2011; Francis & Barber 2013). For those species that would frequently be exposed to noise on or near VSFB from the Proposed Action, a species-specific frequency-weighting filter was developed following methods in Southall et al. (2019) and used in analyses below. These included the CRLF, SNPL, and SSO. Best available hearing data, from the most closely related taxa for which data were available, were used to estimate audiograms (a graph of audible thresholds for standardized frequencies) in combination with other audiometric data (i.e., equal loudness, equal latency, and temporary threshold shift measurements, and/or vocal range) to derive auditory weighting functions for each species. Weighting functions have been primarily developed and evaluated systematically in humans (A-weighted decibels [dBA]), with very limited efforts to develop them for non-human animals. These functions are like "band-pass" filters—they include a central region corresponding to greatest sensitivity and susceptibility to noise, along with lower- and higher-frequency regions where the relative sensitivity is lower (reflected as negative values on these curves).

Weighting functions provide a means of calculating how a noise exposure would be perceived by a specific species or taxon with similar hearing capabilities and how it may potentially affect the hearing of an animal given the extent to which the frequency spectra match frequency-specific hearing sensitivity. The effect of noise exposure on an animal is determined by first weighting (filtering) the noise exposure using the weighting function—analogous to adding the weighting function amplitude (in dB) to the noise spectral amplitude (in dB) at each frequency. Next, the weighted noise spectrum is integrated across frequency to obtain a species- or taxon-specific weighted noise exposure level, which describes exposure for the entire frequency range with a single metric. The weighting function generally appears as the inverse of the audiogram, with less weighting being applied near the center of the audiogram. For each species where relatively frequent launch-related noise exposure is analyzed below, a discussion of how species-specific weighting functions were developed is presented.

This approach and the results of these analyses were independently reviewed by Dr. Robert Dooling and Dr. Lucas Hall. Dr. Dooling is Professor Emeritus at the University of Maryland Department of Psychology and noted expert in comparative aspects of hearing and acoustic communication with over 250 scientific publications. Dr. Hall is Assistant Professor of Biology at California State University Bakersfield studying how environmental change alters long-term dynamics of wildlife in human-modified landscapes with 54 scientific publications in conservation biology, community ecology, animal behavior, spatial ecology, and bioacoustics. Both authors provided valuable feedback that led to improvements in these analyses and validation of the expected effects of noise exposure presented herein.

Finally, note that the anticipated noise levels presented in this section are estimated based on model results. Over the past two decades a large amount of field noise recordings of various space vehicles over a broad geographic area at and around VSFB, including over 115 recordings of the Falcon 9 vehicle over the past 6 years, have shown that the models are reasonably good at predicting experienced levels. However, actual received levels may vary slightly from predicted levels as a result of various factors, including meteorology, landforms that attenuate noise, and slight differences in trajectories.

5.1.1 Tidewater Goby

5.1.1.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on TWG.

5.1.1.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at TWG habitat and extant localities are presented in Table 5.1-1 and Table 5.1-2 and Figure 4.4-1 through Figure 4.4-5. The estimate for engine noise are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). Actual measurements at Honda Creek during Falcon 9 missions from SLC-4 had an average launch noise level of 115.6 dB L_{max} (n=13), although in one instance (Starlink G8-1) launch a noise level of 127.9 dB L_{max} was measured, exceeding the modeled estimate of 125 dB L_{max} . The average landing noise level measured at Honda Creek is 104.3 dB L_{max} (n=3), substantially below the estimated level of 120 dB L_{max} . Appendix B includes all noise levels measured during Falcon 9 launches as of 24 January 2025.

Table 5.1-2 presents sonic boom levels predicted from the model produced for the Falcon 9 Bandwagon-2 mission in December 2024, which had a relatively large geographic impact area and relatively higher levels predicted than for other missions and therefore was used for this BA to represent a potential worst-case scenario (see Appendix A for variability). Of the locations listed in Table 5.1-1, sonic boom measurements have only been recorded at Honda Creek. The mission-specific model results for landing events that have required CRLF monitoring have predicted sonic booms ranging from 1 to 5.5 psf at Honda Creek for Falcon 9 landing events at SLC-4 (Appendix B). Measured sonic boom levels at Honda Creek for these missions have averaged 5.04 psf (n=7) and ranged from 2.42 to 9.86 psf (Transporter 10; Appendix B).

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Table 5.1-1. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at TWG habitat and extant localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Honda Creek	118	120	125	122	119	125	129	120	130
Santa Ynez River	110	105	118	118	108	112	112	106	116
Jalama Creek	<100	<100	108	108	105	112	108	<100	110
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 5.1-2. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at TWG habitat and extant localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Honda Creek	-	6	-	9.5	-	9.5
Santa Ynez River	-	4-5	-	2.5	-	2.5
Jalama Creek	-	2-3	-	3	-	3
San Antonio Creek	-	2.2	-	1-2	-	1-2

Exceptionally little sound is transmitted between the air-water interface (Godin 2008). Therefore, in-air sound during launches, landings, and static fire events is not expected to cause more than a temporary behavioral response in fish, if present, in Honda Creek, and a similar response to TWG in the Santa Ynez River and Jalama Creek. Since TWG have not been detected during regular survey efforts in Honda Creek dating back to 2008 (MSRS 2009a, 2016, 2018a), they are unlikely to be present during the proposed launch, landing, and static fire activities where the loudest noises would occur; however, TWG could potentially recolonize Honda Creek in the future.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Because there is exceptionally little sound transmitted between the air-water interface (Godin 2008) and the low level of ascent sonic booms impacting Eastern Santa Barbara, Ventura, and Los Angeles Counties, ascent sonic booms caused during missions with easterly trajectories are not expected to have an effect on TWG in these areas.

5.1.1.3 Water Use

As described in Section 0, the Proposed Action would use up to 21.1 million gallons (65.6 ac-ft) of water per year. Annual VSFB water use from 2019 through 2021 has averaged 910,500,000 gallons (2,794 ac-ft) per year. The current water source for VSFB, including SLC-4, is via an existing connection between State Water and the VSFB water supply system. VSFB primarily relies on State Water; however, during annual maintenance that lasts two to three weeks, VSFB utilizes four water wells in the San Antonio Creek Basin.

TWG in San Antonio Creek would be negatively impacted if the water used for the Proposed Action reduced flow rates, hydration periods, or water levels in San Antonio Creek. SpaceX's proposed use of up to 21.1 million gallons (65.6 ac-ft) of water per year would represent

approximately 2.3% of the total annual water usage on VSFB. VSFB primarily relies on State Water. But even if pumping this entire 65.6 ac-ft volume of water from the San Antonio Creek groundwater basin, it would have an undetectable effect of water levels and flow rates in the creek (G. Cromwell, USGS, pers. comm.). Since VSFB only relies on water from the San Antonio Creek groundwater basin during up to three weeks per year, SpaceX would only require pumping approximately 5.3 million gallons (16.4 ac-ft) from the groundwater basin, which would have substantially less impact on San Antonio Creek. The Proposed Action's water usage would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek. Therefore, any potential effects on the TWG are expected to be insignificant.

5.1.1.4 Conclusion

Because of the low likelihood of TWG presence in Honda Creek, the minimal transfer of in-air noise into underwater noise, and the increase in water extraction from the San Antonio Creek Basin, the anticipated level of disturbance from the Proposed Action would be discountable. Therefore, the DAF has determined that the Proposed Action may affect but is not likely to adversely affect the TWG.

5.1.2 Unarmored Threespine Stickleback

5.1.2.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on UTS.

5.1.2.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

As discussed in Section 4.1, the UTS was introduced into Honda Creek, south of SLC-5, in 1984 (MSRS 2009a). Extensive surveys conducted in 2008, 2016, and 2017 did not detect any fish in the creek (MSRS 2009a, 2016a, 2018a). Between 2008 and 2022, Honda Creek has gone through multiple cycles of drying and rehydration, which would preclude occupancy by and persistence of fish. The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at UTS localities in San Antonio Creek are presented in Table 5.1-3 and Table 5.1-4 and Figure 4.4-1 through Figure 4.4-5. The estimated levels for engine noise are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.) and most measurements have been below the levels predicted by modeling (Appendix B). However, engine noise levels have not been measured at San Antonio Creek during Falcon 9 launches from SLC-4.. Sonic boom levels have not been measured at San Antonio Creek. As of 24 January 2024, sonic booms have been measured at 5 monitoring locations on VSFB during 22 Falcon 9 first stage events at SLC-4W, resulting in 50 measurements (Appendix B). All but 8 of the 50 measurements were within the range of predicted psf levels. Therefore, the sonic boom levels in Table 5.1-4, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact San Antonio Creek.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at San Antonio Creek compared to sonic booms created during landing events (see Figure 2.2-3).

Table 5.1-3. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at UTS localities at San Antonio Creek.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 5.1-4. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at UTS localities at San Antonio Creek.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
San Antonio Creek	-	2.2	-	1-2	-	1-2

Exceptionally little sound is transmitted between the air-water interface (Godin 2008). Therefore, in-air sound during launches, landings, and static fire events is not expected to cause more than a brief behavioral response, if any reaction, to UTS.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Because there is exceptionally little sound transmitted between the air-water interface (Godin 2008) and the low level of ascent sonic booms impacting Eastern Santa Barbara, Ventura, and Los Angeles Counties, ascent sonic booms caused during missions with easterly trajectories is not expected to have an effect on UTS in these areas.

5.1.2.3 Water Use

As described in Section 5.1.2, at maximum cadence, the Proposed Action would use up to 21.1 million gallons (65.6 ac-ft) of water per year. Annual VSFB water use from 2019 through 2021 has averaged 910,500,000 gallons (2,794 ac-ft) per year. The current water source for VSFB, including SLC-4, is via an existing connection between State Water and the VSFB water supply system. VSFB primarily relies on State Water; however, during annual maintenance that lasts two to three weeks, VSFB utilizes four water wells in the San Antonio Creek Basin.

UTS in San Antonio Creek would be negatively impacted if the water used for the Proposed Action reduced flow rates, hydration periods, or water levels in San Antonio Creek. SpaceX's proposed use of up to 21.1 million gallons (65.6 ac-ft) per year would represent an increase of approximately 2.3% of the total annual water usage on VSFB. VSFB primarily relies on State Water and even if pumping this entire 65.6 ac-ft volume of water from the San Antonio Creek groundwater basin, it would have an undetectable effect of water levels and flow rates in the creek (G. Cromwell, USGS, pers. comm.). Since VSFB only relies on water from the San Antonio Creek groundwater basin during up to three weeks per year, SpaceX would only require pumping approximately 5.3 million gallons (16.4 ac-ft) from the groundwater basin, which would have substantially less impact on San Antonio Creek. The Proposed Action's water usage would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek. Therefore, any potential effects on the UTS are expected to be insignificant.

5.1.2.4 Conclusion

Because of the minimal transfer of in-air noise into underwater noise and that the increase in water extraction from the San Antonio Creek Basin under the Proposed Action would be discountable, the DAF has determined that the Proposed Action may affect but is not likely to adversely affect the UTS.

5.1.3 California Tiger Salamander

5.1.3.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on CTS.

5.1.3.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at CTS habitat and localities in the Santa Rita Hills and Santa Maria Valley are presented in Table 5.1-5 and Table 5.1-6 and Figure 4.3-1 through Figure 4.3-5. The estimated levels for engine noise are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.) and most measurements have been below the levels predicted by modeling (Appendix B). However, engine noise levels have not been measured at either of these locations during Falcon 9 launches from SLC-4.

Sonic boom levels have not been measured at the Santa Rita Hills or Santa Maria Valley. As of 24 January 2024, sonic booms have been measured at 5 monitoring locations on VSFb during 22 Falcon 9 first stage events at SLC-4W, resulting in 50 measurements (Appendix B). All but 8 of the 50 measurements were within the range of predicted psf levels. Therefore, the sonic boom levels in Table 5.1-6, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact these areas. The single explosive event during demolition would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Table 5.1-5. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at CTS localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Santa Rita Hills	<100	<100	105	100	<100	106	110	106	116
Santa Maria Valley	<100	<100	100	<100	<100	105	103	<100	108

Table 5.1-6. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at CTS localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Santa Rita Hills	-	1-2	-	1.5	-	1.5
Santa Maria Valley	-	1-1.5	-	1	-	1

There is very little information regarding the hearing of salamanders. The hearing ability of this group is rudimentary and likely limited to physical vibrations, although tiger salamanders have been shown to detect air-borne sound (Weaver 1985), but with low sensitivity (Christensen et al. 2015). Salamanders do not have an inner ear cavity and likely only hear bone-conducted sound. Therefore, it is more likely that urodeles hear sound primarily through substrate, rather than in-air sound (Stebbens 1983; Christensen et al. 2015). The CTS spends the majority of their life underground, coming out once a year to migrate to and breed in temporary bodies of water. Exceptionally little sound is transmitted between the air-water interface (Godin 2008); thus, in-air sound is not likely to have an effect on submerged CTS. Likewise, exceptionally little sound is transferred underground. There is no known research on salamander's sensitivity to noise underground. However, due to the reflection from the ground, the intensity of the sonic boom would be greatly diminished at ground level (Ventre et al. 2002) and below ground level the overpressures would decrease approximately 30% for every centimeter, depending on the type of soil (Oelze et al. 2002). Since CTS are typically in burrows at depths between 0.2 m and 1.36 m underground (Barry & Shaffer 1994), essentially all noise energy would be attenuated before reaching subterranean CTS. Therefore, the sonic boom would not likely affect the CTS when underground.

Emergence from burrows and migration to breeding pools is strongly tied to the onset of significant rainfall (Loredo & Van Vuren 1996; Trenham et al. 2000; Cook et al. 2006; USFWS 2016). Literature searches failed to find any information on noise, either natural or human-caused, causing pre-mature emergence from burrows. It is unlikely that CTS use noise as a cue to emerge for the following reasons: 1: CTS tend to be deeper underground than surface noises would be able to reach (Barry & Shaffer 1994; Ventre et al. 2002); 2: Lightning (and therefore thunder) is rarely associated with winter rainstorms in Santa Barbara County (Meier & Thompson 2009); 3: CTS are not observed moving to breeding ponds until substantial rainfall events that have greater potential to fill pools are underway, suggesting that CTS may be primarily responding to inundation of their burrows with water (J. LaBonte, pers. obs.). Therefore, noise associated with the Proposed Action is unlikely to have any effect on CTS when below ground.

In the unlikely event that a CTS was above ground and exposed to a 1- to 1.5-psf overpressure or rocket engine noise, the noise could potentially cause a minor temporary behavioral reaction, if any. However, CTS are aboveground very infrequently and for short durations (at most several nights per year during transit between breeding ponds and upland habitat). Therefore, the action is very unlikely to cause disruption of normal behavior.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

There are no records of CTS in eastern Santa Barbara, Ventura, and Los Angeles Counties and there would be no noise impacts on this species in this area as a result of the Proposed Action.

5.1.3.3 Conclusion

Any potential impact on CTS from noise associated with the Proposed Action would be very unlikely to occur given the attenuation of noise due to landforms between SLC-4, SLC-6, and the nearest localities 14 mi to the east, as well as the low likelihood that CTS would be above ground

during a launch event. Therefore, the Proposed Action may affect, but is not likely to adversely affect the CTS.

5.1.4 California Red-Legged Frog

5.1.4.1 Physical Impacts

Direct impacts on post-metamorphic CRLF, including injury and mortality, may inadvertently occur during removal of vegetation, site grading and contouring, construction, firebreak and fire establishment, and site maintenance from the operation of heavy equipment, machinery, and vehicles at SLC-6. CRLF that may disperse through the project area could become entrapped in any holes or trenches left open overnight. However, open holes and trenches would be covered overnight and the risk of impacts on CRLF will be reduced because biologists will monitor construction activities and search for animals trapped in open holes and trenches. Any CRLF detected within the construction area would be captured and relocated to nearby suitable habitat. In addition, when any demolition, contouring, or construction occurs at SLC-6, the active construction areas would be surrounded by exclusion fence (see Section 2.3.2). A USFWS approved biologist would be present to monitor vegetation-clearing activities and move any CRLF encountered to the nearest suitable habitat out of harm's way. Regardless, post-metamorphic frogs may be injured or killed during construction and vegetation clearing activities if they are not detected before or during construction. The risk of introducing or spreading chytrid fungus would be reduced by requiring implementation of the DAPTF Fieldwork Code of Practice (USFWS 2002a).

5.1.4.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

Construction noise during day and night hours would potentially disrupt CRLF if present within the area affected by these noise sources. Standard types of construction equipment would be employed that have well-known noise profiles. Noise during construction greater than 80 dB is not expected to extend more than 320 ft from the construction site (Table 2.2-1). There are no current extant CRLF populations or suitable breeding habitat within this distance; Semi-aquatic habitat exists at both the northern and southern drainages and the Industrial Wastewater Treatment Ponds where transitory CRLF could occur (Figure 4.4-6). However, any CRLF transiting through the area would be unlikely to remain at these locations for extended periods of time. In addition, transiting CRLF could be drawn to the vault structure and the flame trench. CRLF would be unlikely to spend extensive time in the flame trench due to the lack of aquatic vegetation and cover. Although CRLF could potentially be trapped in the vault structure, qualified biologists would survey the area while establishing a wildlife exclusion zone and capture and relocate any CRLF found in the vault, thus minimizing the risk that they would be exposed to loud noises at SLC-6. The nearest suitable CRLF breeding habitat and extant records is approximately 1.4 mi north at Honda Creek, well outside the typical dispersal distance of CRLF (210 meters). Therefore, construction noise is unlikely to have an effect on any CRLF. In the event that a CRLF is transiting through SLC-6 or upland habitat near the construction areas during construction activities, it could conceivably be exposed to noise levels of 80 dB or above. However, implementation of the avoidance and minimization measures during construction listed in Section 2.3.1 would greatly

reduce the likelihood of CRLF being within this area since a wildlife exclusion zone would be established prior to construction which would be surveyed and monitored by a qualified biologist who would capture and relocate any CRLF encountered. Therefore, the likelihood of CRLF being disturbed by construction noise in upland habitat is very low.

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at CRLF localities are presented in Table 5.1-7 and Table 5.1-8 and Figure 4.4-1 through Figure 4.4-5. The estimated engine noise levels are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). Actual measurements at Honda Creek during Falcon 9 missions from SLC-4 had an average launch noise level of 115.6 dB L_{max} (n=13), although in one instance (Starlink G8-1) launch a noise level of 127.9 dB L_{max} was measured, exceeding the modeled estimate of 125 dB L_{max} . The average landing noise level measured at Honda Creek is 104.3 dB L_{max} (n=3), substantially below the estimated level of 120 dB L_{max} . Appendix B includes all noise levels measured during Falcon 9 launches as of 24 January 2025.

Table 5.1-7. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at CRLF localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Honda Creek	118	120	125	122	119	125	129	120	130
Santa Ynez River	110	105	118	118	108	112	112	106	116
Jalama Creek	<100	<100	108	108	105	112	108	<100	110
San Antonio Creek	100	<100	108	100	<100	106	110	106	116

Table 5.1-8. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at CRLF localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Honda Creek	-	6	-	9.5	-	9.5
Santa Ynez River	-	4-5	-	2.5	-	2.5
Jalama Creek	-	2-3	-	3	-	3
San Antonio Creek	-	2.2	-	1-2	-	1-2

Sonic boom modeling is performed for each SpaceX mission.

Table 5.1-8 presents sonic boom levels predicted from the model produced for the Falcon 9 Bandwagon-2 mission in December 2024, which had a relatively large geographic impact area and relatively higher levels predicted than for other missions and therefore was used for this BA to represent a potential worst-case scenario (see Appendix A for variability). The mission-specific model results for landing events that have required CRLF monitoring have predicted sonic booms ranging from 1 to 5.5 psf at Honda Creek for Falcon 9 landing events at SLC-4 (Appendix B). Measured sonic boom levels at Honda Creek for these missions have averaged 5.04 psf (n=7) and ranged from 2.42 to 9.86 psf (Transporter 10; Appendix B). Sonic booms haven't been measured at the Santa Ynez River, Jalama Creek, or San Antonio Creek. However, as discussed previously, all but 8 of 50 sonic boom measurements during Falcon 9 first stage landing events at SLC-4W were within the range of predicted psf levels (Appendix B). Therefore, the sonic boom levels in Table 5.1-8, which represents a potential worst-case scenario, and the potential variation in

boom model results presented in Appendix A, should be representative of the levels that would impact the Santa Ynez River, Jalama Creek, or San Antonio Creek.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Under the worst case scenario, modeled engine noise is predicted to reach as high as 150 dB L_{max} with sonic booms have been predicted up to 8.5 psf in upland CRLF dispersal habitat on SLC-4 (Figure 4.4-2), however, as noted above, acoustic monitoring during the Transporter 10 mission measured a 9.86 psf at Honda Creek, 2.1 mi south of SLC-4 which shows that levels can exceed predicted values (Appendix B). Modeling for landings at SLC-6 predict sonic booms potentially as high as 13 psf (Figure 4.4-5 **Error! Reference source not found.**). However, vegetation management within and around SLC-4 and SLC-6 would make CRLF presence above ground within the SLCs unlikely during typical dry conditions.

There are no studies in the literature on the effects of noise on CRLF. Simmons et al. (2014) found that American bullfrogs, which are within the same Family as the CRLF (Ranidae), required long exposure (20 to 24 hours) to sound levels greater than 150 dB L_{max} (approximately equivalent to 13 psf) to consistently cause morphological damage of hair cells in the hearing structures. Even after such hearing damage, bullfrogs showed full functional recovery within 3 to 4 days; thus, the hearing damage was temporary (Simmons et al. 2014). CRLF in terrestrial environments may be exposed to engine noise levels of 150 dB L_{max} and sonic booms up to 8.5 psf; therefore, inferring from this study of the bullfrog, the most closely related species for which science is currently available, even temporary hearing damage would be unlikely for CRLF that may be present. Additionally, due to vegetation management around the proposed launch vehicle sites, the likelihood of CRLF being present in terrestrial environments exposed to these noise levels would be very low and few individuals would be impacted.

There are no CRLF-specific hearing curves (i.e., audiograms) or other data on this species' hearing sensitivity. However, there are published hearing curves for several species in the same family that are similar in size and have similar call frequency spectra. Fay (1988) presents hearing curves for the pool frog (*Pelophylax lessonae*, Family Ranidae), the marsh frog (*P. ridibunda*, Family Ranidae), and the edible frog (*P. esculentus*, Family Ranidae). These data were used to create a mean "Ranidae" hearing curve (Figure 5.1-1), and the mean curve was processed following methods established in Southall et al. (2019) to produce a weighting function that would be appropriate for CRLF hearing sensitivity (Figure 5.1-2). Slopes beyond the lower and upper frequency cutoffs surrounding the range of best hearing (in dB/decade) were measured to estimate the amount of weighting to be applied at each frequency (Figure 5.1-2).

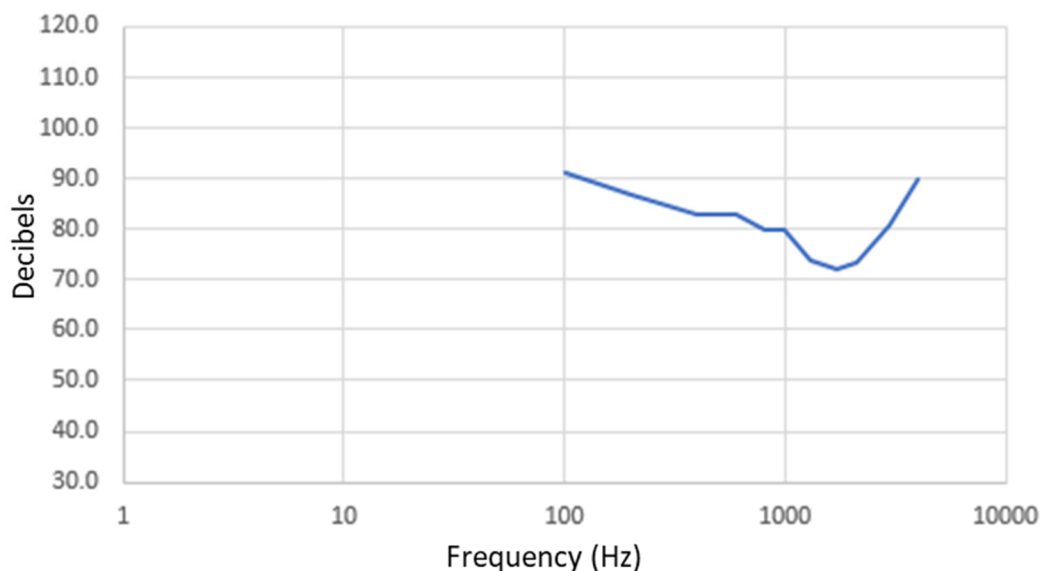


Figure 5.1-1. Mean Ranidae hearing sensitivity curve.

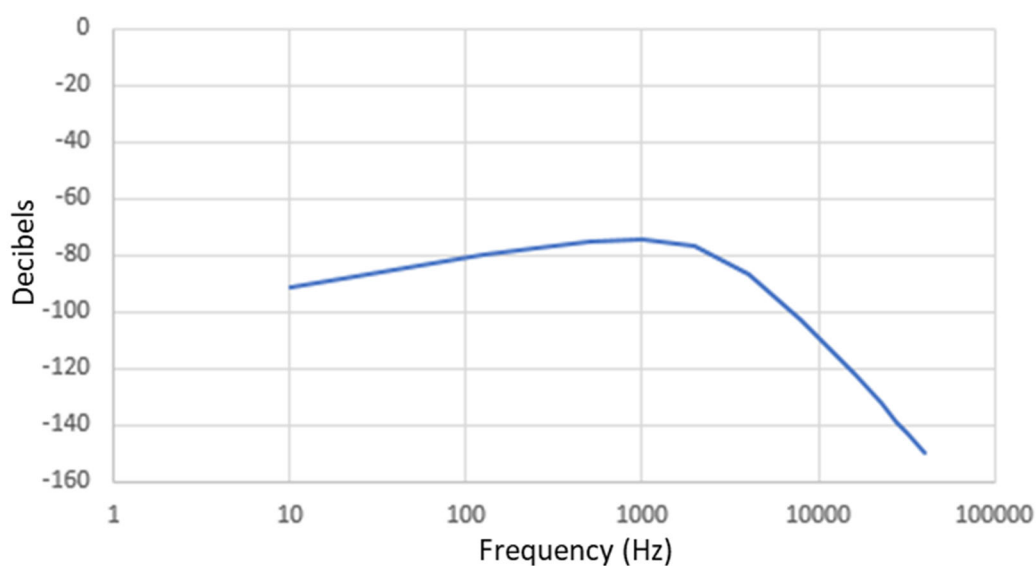


Figure 5.1-2. Ranidae weighting function.

This weighting function was applied to the time waveform recording of a June 2022 launch at VSFB (Falcon 9 SARah-1). The unfiltered time waveform had frequency spectra with an unweighted peak level of approximately 110 dB Lmax (Figure 5.1-3). After applying the Ranidae weighting function, the peak level is approximately 22 dB Lmax (Figure 5.1-3). In humans, 20 dBA is equivalent to whispering. Given the high falloff rates outside the range of best hearing, as well as a much higher hearing threshold relative to most mammals, the perceived rocket engine noise in CRLF is very likely to be negligible.

Despite CRLF's low hearing sensitivity to rocket engine noise and sonic boom, it is assumed that the sonic boom and engine noise would likely trigger a startle response in CRLF if above water and near the launch site, potentially due to minor vibrations of the substrate underneath them

caused by the noise and potential visual disturbance if under the path of the rocket. Straam Group (2025) performed a study of vibrations caused during Falcon 9 launch and landing events at SLC-4. Vibrations in soil were detected during engine noise and sonic boom events during this effort. At Spring Canyon, 0.27 mi from the launch site, mild vibrations were detected at a maximum peak particle velocity (PPV) of 0.96 inches per second, roughly equivalent to a magnitude 3-4 earthquake at a distance of several mi from the epicenter (Winant, T., pers. comm.). Those levels declined exponentially with distance from SLC-4. At Bear Creek, 1.4 mi from SLC-4, the maximum PPV measured was 0.04 inches per second, which is unlikely to be perceptible to humans and roughly equivalent to a magnitude 2 or less earthquake at 2 mi from the epicenter (Winant, T., pers. comm.). Ground vibrations as a result of earthquakes of this level are common. For instance, between 5 February 2025 and 7 March 2025, of the 3,387 earthquakes recorded in California, 41% of them were at levels between 1 and 2 (USGS 2025). It is unlikely that this level of vibration would disturb a CRLF. At the San Antonio Creek Oxbow site the peak acceleration during launch was approximately 0.01% of the acceleration measured at the Bear Creek (Straam Group 2025). Thus, CRLF near the launch site would be expected to experience a temporary behavioral disruption due to vibration, but further away, any effect due to vibration is unlikely.

Bioacoustic monitoring was performed during the CRLF breeding season during the NROL-87 mission on 2 February 2022 and the SWOT mission on 16 December 2022. MSRS performed bioacoustic monitoring during NROL-87 at two locations within the predicted boom impact area (MSRS 2022e), following the monitoring requirements of the 2017 BO (USFWS 2017a). Though the landing occurred during daylight hours, CRLF were detected calling at both monitoring locations, a drainage near the VSFb Recreation Center and lower Honda Creek. The sonic boom did not cause a measurable reduction in CRLF calling frequency at either of the two locations where the received overpressures were between 1 psf (VSFB Recreation Center, 6.8 mi northeast of SLC-4) and 2.4 psf (lower Honda Creek, 2.1 mi southwest of SLC-4). At both sites, CRLF calls were detected within 20 to 30 minutes after the sonic boom was received and the average number of calls per hour during the two nights following the sonic boom were greater than the night prior to the boom, suggesting that the noise disturbance did not prompt reduced calling behavior (MSRS 2022e). At the Recreation Center Drainage, three CRLF calls were detected during the hour prior to the sonic boom (1100–1200), and three were detected during the hour period when the sonic boom occurred (1200–1300). One of the three calls detected during the period when the boom was received was 30 minutes prior to the boom with the other two calls 23 and 24 minutes after the boom. At lower Honda Creek, no CRLF calls were detected during the hour period prior to the sonic boom (1100–1200), and four calls were detected during the hour when the boom occurred (1200–1300). Of the four calls that occurred during the hour period when the boom occurred, all four were detected after the boom, at 32, 37, 47, and 48 minutes post boom (MSRS 2022e).

During the SWOT mission in December 2022, no CRLF were detected calling at Honda Creek in the days prior to or during the launch. CRLF were calling at a Recreation Center Drainage approximately 6.8 mi northeast of SLC-4 and were monitored for the launch. There was no evidence that the noise from the launch or sonic boom negatively affected breeding behavior based on calls per hour. CRLF calling rates increased during the 5-hour period after the sonic

boom; however, the increase did not appear to be in response to the sonic boom. During the hour immediately prior and following the sonic boom, CRLF calls were not detected prior and only one call was detected after. Call rate then steadily increased for the next several hours, peaking at or near sunrise (MSRS 2023b).

Lewis and Narins (1985) determined that white-lipped frogs (*Leptodactylus albilabris*) can detect seismic signals and use them in communication. This species is not closely related to CRLF; however, it may be reasonable to assume that the strongest reaction to engine noise and sonic booms may be the result of minor physical vibrations of water or the ground caused by the low frequency portion of the noise energy in combination with visual disturbance, rather than the noises themselves. In CRLF, this could translate to a startle response to noise, minor vibrations, and visual disturbance during launch, landing, and static fire, causing them to flee to water or attempt to hide in place. Because landing engine noise occurs approximately 5 to 7 minutes after launch noise and is typically slightly (seconds) before the sonic boom is received, individuals that flee into water because of launch disturbance would have a reduced likelihood of being exposed to the landing engine noise and sonic boom due to the attenuation of sound in water (Godin 2008). It is likely that any reaction would be dependent on the sensitivity of the individual, the behavior in which it is engaged when it experiences the noise, and past exposure to similar noise. Regardless, the reaction is expected to be the same—the frog’s behavior would likely be disrupted, and it may flee to cover in a similar reaction to that of a frog reacting to a predator. As a result, there could be a temporary disruption of CRLF behaviors including foraging, calling, and mating (during the breeding season). However, frogs tend to return to normal behavior quickly after being disturbed.

Rodriguez-Prieto and Fernandez-Juricic (2005) examined the responses in the Iberian frog (*Rana iberica*) to repeated human disturbance and found that the resumption of normal behavior after three repeated human approaches occurred after less than four minutes. Sun and Narins (2005) examined the effects of airplane and motorcycle noise on anuran calling in a mixed-species assemblage, including the sapgreen stream frog (*Rana nigrovittata*). Sun and Narins found that frogs reduced calling rate during the stimulus but increased calling rate immediately after cessation of the stimuli, likely in response to the subsequent lull in ambient sound levels. Similarly, Kruger and Du Preez (2016) found that male Pickersgill’s reed frog (*Hyperolius pickersgilli*) exposed to routine airplane overflights increased call rates immediately after the noise but resumed their normal call-rest patterns within a few minutes of absence of plane noise. USFWS permitted biologists working on VSFB and elsewhere in CRLF occupied habitat have also routinely observed a similar response in this species after disrupting individuals while conducting frog surveys (A. Abela, M. Ball, and J. LaBonte, pers. obs.). CRLF would, therefore, be expected to resume normal activities quickly once the disturbance from the noise event has ended and any behavioral response to individual noise events would be short term.



Figure 5.1-3. Launch peak noise level comparison of unweighted (green) versus Ranidae-weighted (brown) decibels (note: time waveform recording from the June 2022 Falcon 9 SARah-1 launch).

Whether a result of minor physical vibrations caused by noise or overlap of some noise stimuli with various species hearing sensitivity range, there is a growing body of literature on the effects of anthropogenic noise disturbance on anurans. These studies have typically examined the impact of sustained vehicle noise associated with roads near breeding ponds and have generally shown negative effects on individual frog behavior and physiology which potentially have consequences for populations (see examples in Parris et al. 2009 and Tennessen et al. 2014). For instance, a variety of anurans have been shown to alter call signal structure in response to chronic exposure to traffic noise (Bee & Swanson 2007; Lengagne 2008; Cunningham & Fahrig 2010; Kaiser et al. 2011; Hanna et al. 2014) and airplane noise (Sun & Narins 2005, Kruger & Du Preez 2016). Researchers studying chronic exposure to sustained anthropogenic noise in anurans have also found higher levels of stress hormones, lowered immunity, and impacts to reproductive physiology and behavior, all of which may have negative consequences for populations. Tennessen et al. (2014) showed that prolonged exposure to traffic noise increased corticosterone and impaired mate attraction in wood frogs (*Lithobates sylvaticus*). Tennesen et al. (2014) also showed that populations of wood frogs in high traffic noise locations have undergone evolutionary adaptation to avoid physiological costs of the noise to fitness, suggesting that at least some species may be able to adapt to sustained noise. In an experiment where European tree frogs (*Hyla arborea*) were exposed to four hours of continuous recorded traffic noise nightly, Troïanowski et al. (2017) found increased stress hormone level that induced an immunosuppressive effect in the subjects. Similarly, White's treefrogs (*Litoria caerulea*) exposed to continuous, sustained noise (one week of recorded traffic noise) had higher levels of corticosterone and decreased sperm count and sperm viability (Kaiser et al. 2015). In chronic high-noise habitats adjacent to a busy highway (average 30,000 vehicles per day), the time and distance over which male Pacific chorus frogs (*Pseudacris regilla*) calls could be perceived for was significantly reduced, potentially having implications for the reproductive success of this species (Nelson et al. 2017). Japanese tree frogs (*Dryophytes japonicus*) exposed to persistent, low frequency noise caused by wind turbines had faster call rates, increased salivary concentrations of corticosterone, and lower innate immunity (Park & Do 2022). Eastern sedge frogs (*Litoria fallax*) tended to choose less attractive male calls significantly more often when experimentally exposed to background traffic noise, potentially having evolutionary and population level implications over the long term (Schou et al. 2021). There are no thresholds in the literature that quantify what level of noise or frequency of disturbance would elicit stress hormone responses, impacts to breeding and reproduction, or negative population level effects. While these studies show effects on behavior and physiology that could have impacts on fitness and populations, none of them present direct evidence of population impacts, so the long-term effects of chronic exposure to anthropogenic noise on populations is unknown for these species.

None of the preceding studies are directly comparable to the noise impacts of the Proposed Action, which is likely to be minimally perceptible in the hearing range of CRLF and infrequent. While the Proposed Action may cause vibrations that would be sensed, the noise and vibrations would be of short duration and infrequent (up to 100 events per year) compared to the available literature, which examines sustained traffic noise and multiple daily airplane flights, and therefore are likely to result in minimal disturbance on CRLF.

Monitoring survey data from 2024 shows that CRLF populations in Honda Creek and Bear Creek have increased significantly despite the increased cadence in 2024. Table 5.1-9 shows the established baseline CRLF night survey results for a set survey stretch in lower Honda Creek that has been surveyed repeatedly since 2013 using the same methods. During 2024, both the total number of adult CRLF and CRLF detected per survey hour are approximately twice as high as pre-project implementation.

Table 5.1-9. Baseline and post-project implementation CRLF night survey results for lower Honda Creek*.

Survey Date	Adults Detected	Total Survey Time	CRLF per Survey hour
Pre-Project Baseline (annual high number of adults detected)			
7/17/2013	9	2:18	3.9
5/3/2016	9	5:19	1.7
6/23/2017	1	1:46	0.6
8/18/2020	10	1:36	6.3
1/25/2022	7	1:36	4.4
Pre-Project Baseline Average	7.2	2:31	2.9
Post-Project Implementation Monitoring Surveys			
4/30/2024	15	3:40	4.1
5/22/2024	14	2:35	5.4
8/28/2024	13	1:49	7.2
Post-Project Average	14	2:41	5.2
* Lower Honda Creek survey stretch begins downstream at estuary (34.608208°, -120.637200°) and ends at a waterfall (34.605609, -120.628571).			

The most recent thorough pre-project baseline night survey efforts of Bear Creek were performed in 2013. A total of 12 post-metamorphic CRLF were observed within the creek across two night surveys in March 2013 (MSRS 2014a). Drought conditions persisted from 2013 through 2022, which impacted CRLF habitat quality in Bear Creek during this period. In 2023, above average rainfall levels rehydrated portions of Bear Creek, including the basin at the western terminus of the creek. Biologists performed a night survey of this basin in April 2023, but only detected Baja California tree frogs despite suitable CRLF habitat. Rainfall during the 2023-2024 wet season was again above average. Extensive vegetation which had overgrown the creek during the drought from 2013 through 2022 required a large trail cutting effort in order to access the creek which delayed entry to the upper portions of the creek until later in the season. Additionally, the increase in hydrated portions of the creek required it to be surveyed across four separate set stretches to obtain a full survey of the creek each quarter. Table 5.1-10

Table 5.1-10 shows the results of these survey efforts with the baseline from 2013 for comparison. Because of the differences in survey stretches surveyed in 2013 and 2024 and missing survey lengths for 2013, they are not directly comparable; however, the numbers of CRLF observed in 2024 are clearly greater than 2023, suggesting that available habitat (i.e., hydrated portions of the stream) is the driving factor in CRLF presence.

Table 5.1-10. Baseline and post-project implementation CRLF night survey results for Bear Creek.

Survey Date		Adults Detected	Total Survey Time	CRLF per Survey hour
Pre-Project Baseline*				
Lagoon + Lower	3/14/2013	11	*	*
Upper 1 + Upper 2	3/20/2013	1	*	*
Post-Project Implementation Monitoring Surveys				
Lagoon	2/27/2024	23	2:39	8.7
Lagoon	3/11/2024	4	2:18	1.7
Lagoon	5/23/2024	16	4:14	3.8
Lagoon	7/2/2024	15	2:20	6.4
Lagoon	8/13/2024	15	1:12	12.5
Lower	5/23/2024	0	1:47	0.0
Lower	7/2/2024	0	1:36	0.0
Lower	8/13/2024	1	1:01	1.0
Upper 1	4/29/2024	0	3:04	0.0
Upper 1	7/8/2024	0	2:30	0.0
Upper 1	8/14/2024	1	1:05	0.9
Upper 2	6/12/2024	3	2:47	1.1
Upper 2	7/1/2024	1	1:42	0.6
Upper 2	8/15/2024	1	2:43	0.4
* In 2013, CRLF night surveys of the entire hydrated portions of Bear Creek required two night survey efforts, however survey data was not available to provide the survey length for each date and CRLF per survey hour.				

Quarterly protocol night surveys of the Santa Ynez River at the 13th Street Bridge on VSFB, performed from winter 2014 through fall 2015, documented between 4 and 13 adult CRLF per survey, with an average of 8.5 adult CRLF per survey. The majority of these observations were within an agricultural runoff channel on the southeastern side of the 13th Street Bridge (MSRS 2016a). Upstream of the bridge, only one adult CRLF was detected in the stretch of the Santa Ynez River extending from approximately 200 meters east of the bridge to the base boundary during survey efforts in 2008 and 2015 (MSRS 2009b, 2016a). The 13th Street Bridge was replaced during a two-year construction effort from August 2016 to October 2017. During this project, the agricultural runoff channel was almost entirely removed. The channel was reconstructed at the end of the project, with efforts made to recreate the deep pools the channel had included prior to construction. Sedimentation of the drainage from off-base agricultural fields quickly decreased the depth of these pools to approximately 6 inches on average. During monthly night surveys of the area impacted by bridge replacement project from November 2017 through October 2018, between 0 and 5 adult (average 1.25) CRLF were observed per survey, with an overall average of 0.47 adult CRLF per surveyor-hour (MSRS 2018b). Most CRLF were observed in the main channel of the Santa Ynez River, with very low numbers within the agricultural runoff channel. Although up to 5 CRLF were detected calling in 2018, no tadpoles were observed during seine surveys in July 2018 (MSRS 2018b). The lower number of observations and detection rates suggests that the loss of the agricultural channel impacted the CRLF population in the area surrounding the bridge.

As of 2022, the habitat in the agricultural channel remained shallow and completely filled with emergent vegetation (A. Abela, pers. comm.). Therefore, the pre-project baseline was estimated to be 5 adult CRLF at the 13th Street Bridge (including the agricultural channel). High flow events during 2024 delayed monitoring surveys of the river due to safety concerns; however, 8 adult CRLF were detected during a night survey of the 13th Street bridge stretch on 20 March 2024, 4 adults on 30 May 2024, and 1 adult on 20 August 2024. Although robust baseline data are not available for the lower Santa Ynez River (west of the 13th Street Bridge), a night survey on 26 August 2024 detected 77 adult CRLF on this stretch. These data are still being analyzed to compare to environmental variables, but overall, CRLF on the Santa Ynez River appear to shift occurrence based on changes in habitat quality in this highly dynamic system, and there is no indication that launch noise is causing declines in this system.

Because noise and vibrations would be minimally perceptible, of short duration and infrequent, and monitoring data collected to date does not indicate declines in populations, the Proposed Action is likely to result in minimal disturbance and effects on CRLF on VSFB and nearby areas. The DAF will continue to implement a monitoring program (see Section 2.3.2) to track CRLF habitat occupancy, breeding behaviors, and tadpole densities in Lower Honda Creek (the area to receive the highest noise levels), Bear Creek, the Santa Ynez River, and will add monitoring in Jalama Creek as the launch cadence increases under the Proposed Action. The DAF will also continue to use passive bioacoustic recorders and analyze these data to assess any associated impacts on the CRLF population. As required under the 2024 BO, the DAF is offsetting potential effects to CRLF by creating CRLF breeding habitat at the San Antonio Creek Oxbow Restoration Area.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Approximately 65% of missions with easterly trajectories are predicted to create sonic booms that will overlap at least one CRLF population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these ascent sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of CRLF localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.4-9. Figure 5.1-4 and Table 5.1-11 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of CRLF localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that ascent sonic booms greater than 1.0 psf would impact CRLF populations in these areas infrequently and the lack of any coupled visual stimuli, which can heighten the perception of a threat in animals (Partan & Marler 2005; Stevens 2013), ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on CRLF.

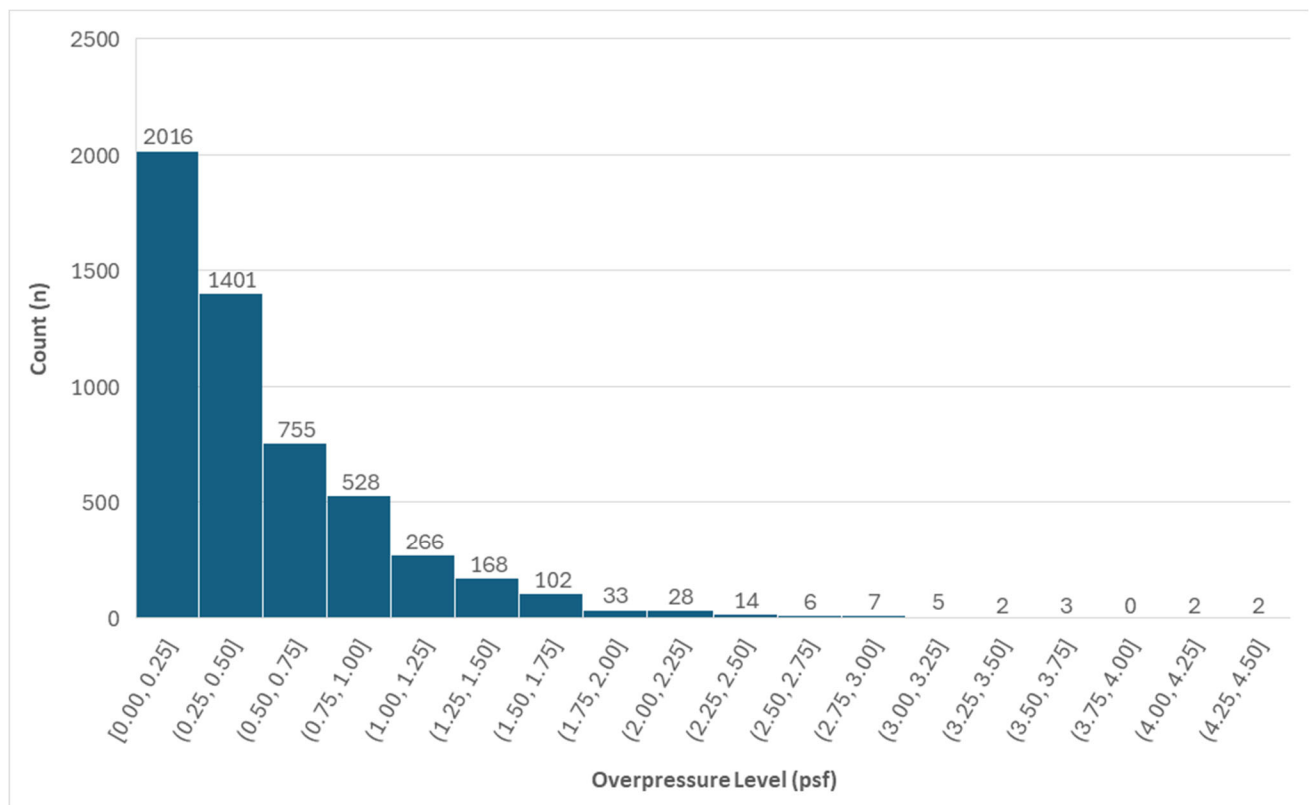


Figure 5.1-4. Distribution of PCBoom ascent sonic boom modeling results within 10 km of CRLF localities shown in Figure 4.4-9.

Table 5.1-11. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of CRLF localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	199	308	64.6%
1-2	84	308	27.3%
2-3	35	308	11.4%
3-4	8	308	2.6%
4-5	4 (4.5 psf)	308	1.3%

5.1.4.3 Water Use

As described above, at maximum cadence, the Proposed Action would use up to 21.1 million gallons (65.6 ac-ft) of water per year. Annual VSFB water use from 2019 through 2021 has averaged 910,500,000 gallons (2,794 ac-ft) per year. The current water source for VSFB, including SLC-4, is via an existing connection between State Water and the VSFB water supply system. VSFB primarily relies on State Water; however, during annual maintenance that lasts two to three weeks, VSFB utilizes four water wells in the San Antonio Creek Basin.

CRLF in San Antonio Creek would be negatively impacted if the water used for the Proposed Action reduced flow rates, hydration periods, or water levels in San Antonio Creek. SpaceX's proposed use of up to 21.1 million gallons (65.6 ac-ft) per year would represent approximately 2.3% of the total annual water usage on VSFB. VSFB primarily relies on State Water and even with pumping this entire 65.6 ac-ft volume of water from the San Antonio Creek groundwater basin, it would have an undetectable effect of water levels and flow rates in the creek (G. Cromwell, pers. comm.). Since VSFB only relies on water from the San Antonio Creek groundwater basin during up to three weeks per year, SpaceX would only require pumping approximately 5.3 million gallons (16.4 ac-ft) from the groundwater basin, which would have substantially less impact on San Antonio Creek. The Proposed Action's water usage would not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek. Therefore, any potential effects on the CRLF are expected to be insignificant.

5.1.4.4 Conclusion

The DAF has determined that, although it is highly unlikely that CRLF may be encountered while performing construction activities at SLC-6, if a CRLF is encountered, capture and relocation may affect, and is likely to adversely affect, CRLF on VSFB. Launch noise, sonic booms, and visual disturbance within the action area may induce minor behavioral responses in individual CRLF. Although monitoring data from 2024 does not suggest that there is population-level decline in areas impacted by existing launch noise, which is of short duration and occurs only intermittently, further monitoring will help determine if behavioral responses may result in any population declines within the area affected by noise. Therefore, the DAF has determined that noise as a result of the Proposed Action may affect, and is likely to adversely affect the CRLF.

5.1.5 Arroyo Toad

5.1.5.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on ARTO.

5.1.5.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

There would be no noise impacts to ARTO in the VSFB area.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Approximately 45% of missions with easterly trajectories are predicted to create ascent sonic booms that overlap an ARTO population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of ARTO localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.5-1. Figure 5.1-5 and Table 5.1-12 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of ARTO localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that ascent sonic booms greater than 1.0 psf would be very unlikely to impact ARTO populations and the lack of any coupled visual stimuli, which can heighten the perception of a threat in animals (Partan & Marler 2005; Stevens 2013), ascent sonic booms

created during missions with easterly trajectories are not expected to have an adverse effect on ARTO.

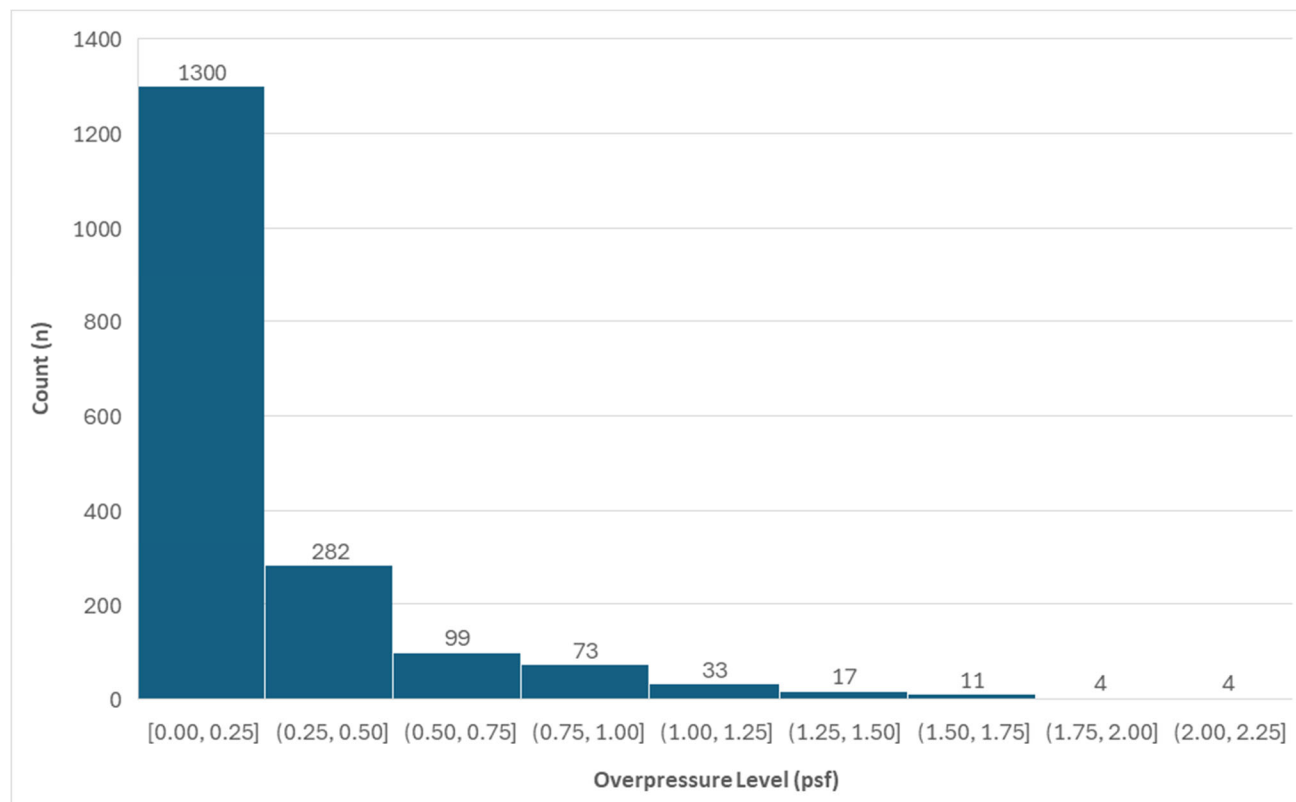


Figure 5.1-5. Distribution of PCBoom ascent sonic boom modeling results within 10 km of ARTO localities shown in Figure 4.5-1.

Table 5.1-12. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of ARTO localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	140	308	45.5%
1-2	18	308	5.8%
2-3	4 (2.1 psf)	308	1.3%
3-4	0	308	0%
4-5	0	308	0%

5.1.5.3 Conclusion

Given that ascent sonic booms greater than 1.0 psf would be very unlikely to impact ARTO populations and the lack of any coupled visual stimuli, the DAF has determined that noise as a result of the Proposed Action is discountable and may affect, but is not likely to adversely affect, ARTO.

5.1.6 Marbled Murrelet

5.1.6.1 Physical Impacts

No ground disturbing activities would occur within or near MAMU habitat; therefore, the Proposed Action would have no direct physical impacts on MAMU or MAMU habitat.

5.1.6.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

MAMU do not nest on VSFB, so exposure to noise impacts would be limited to foraging adults that have occasionally been observed between the late summer through winter off the coast of south VSFB (eBird 2024).

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at the nearest coastline location to each SLC are presented in Table 5.1-13 and Table 5.1-14 and Figure 4.6-1 through Figure 4.6-5. Engine noise levels have not been measured at these locations during Falcon 9 launches from SLC-4. However, the estimated engine noise levels are likely to be conservatively high because the models do not consider attenuation due to land forms (e.g., mountains, hills, valleys, etc.) and most measurements have been below the levels predicted by modeling (Appendix B). Additionally, the majority of MAMU are found in a band about 984 to 6,561 ft from shore (Strachan et al. 1995) where noise levels would be much lower because of the distance of individuals from the source of the noise.

Table 5.1-13. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at the nearest coastline to each launch facility.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Nearest Coastline	122	130	140	130	120	140	130	120	130

Table 5.1-14. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at the nearest coastline to each launch facility.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Nearest Coastline	-	7-8	-	10	-	10

Sonic boom levels have not been measured at the coastline nearest to SLC-4 during Falcon 9 launches from SLC-4. However, as of 24 January 2024, sonic booms have been measured at 5 monitoring locations on VSFB during 22 Falcon 9 first stage events at SLC-4W, resulting in 50 measurements (Appendix B). All but 8 of the 50 measurements were within the range of predicted psf levels. Therefore, the sonic boom levels in Table 5.1-14, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact these areas.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Very little data are available regarding MAMU's response to noise and visual disturbances; however, Bellefleur et al. (2009) examined the response of MAMU to boat traffic. MAMU response was found to depend on the age of the birds, the distance and speed of the boats encountered, and the season. MAMU either showed no reaction, flew, or dove in response. Late in the season (July through August), some MAMU were found to fly completely out of feeding areas when approached by boats traveling in excess of 17.9 mi per hour. The dominant response of MAMU to approach by boats was, however, for birds to dive and resurface a short distance away. MAMU are, therefore, expected to exhibit a startle response that would cause birds to dive and resurface, but they are expected to return to normal behavior soon after each launch or static fire event has been completed.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

There are no records of MAMU in eastern Santa Barbara, Ventura, and Los Angeles Counties, and there would be no noise impacts on this species in this area as a result of the Proposed Action.

5.1.6.3 Conclusion

Because MAMU would be unlikely to be present during a launch, landing, or static fire event, and the expected impact would be a temporary behavioral reaction in response to noise, the Proposed Action would have a discountable effect on MAMU. Therefore, the DAF has determined that the Proposed Action may affect, but is not likely to adversely affect, the MAMU.

5.1.7 Southwestern Willow Flycatcher

5.1.7.1 Physical and Habitat Impacts

No ground disturbing activities or vegetation management activities would occur within SWFL habitat and avoidance and minimization measures discussed in Section 2.3.1 would ensure that there are no SWFL near the construction area. Therefore, these actions would have no effect on SWFL.

5.1.7.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at historic and extant SWFL localities at the 13th Street Bridge area at the Santa Ynez River and Buellton are presented in Table 5.1-15 and Table 5.1-16 and Figure 4.7-1 through Figure 4.7-5. The estimated levels for engine noise are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.) and most measurements have been below the levels predicted by modeling (Appendix B). However, engine noise levels have not been measured at either of these locations during Falcon 9 launches from SLC-4.

Table 5.1-15. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at historic and extant SWFL localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
13 th Street Bridge	110	105	118	118	108	112	112	106	116
Buellton	<100	<100	102	<100	<100	102	100	<100	107

Table 5.1-16. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at historic and extant SWFL localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
13 th Street Bridge	-	4-5	-	2.5	-	2.5
Buellton	-	1-1.5	-	1-1.5	-	1-1.5

Sonic boom levels have not been measured at the 13th Street Bridge at the Santa Ynez River or at Buellton. However, as of 24 January 2024, sonic booms have been measured at 5 monitoring locations on VSFB during 22 Falcon 9 first stage events at SLC-4W, resulting in 50 measurements (Appendix B). All but 8 of the 50 measurements were within the range of predicted psf levels. Therefore, the sonic boom levels in Table 5.1-16, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact these areas.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Although there are no SWFL-specific audiograms or other data on this species' hearing sensitivity available, most bird species' greatest sensitivity to sounds is within a relatively narrow range from 1 kHz - 4 kHz (Konishi 1970). Most of the noise energy produced by rocket engines is less than 200 Hz (Figure 5.1-6). In addition, noise energy in higher frequencies ranges attenuates more quickly while traveling through the atmosphere; therefore, the maximum noise levels within bird's hearing sensitivity range that would reach SWFL sites near Buellton, approximately 22 mi from SLC-6, would have reduced significantly as noise travels through the atmosphere. Finally, the predicted noise levels based on modeling are conservative since the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). It is therefore reasonable to conclude that perceived noise levels for SWFL at this location would be substantially less than 105 dB and very little of the noise energy perceivable by SWFL would reach these sites.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Approximately 48% of missions with easterly trajectories are predicted to impact a SWFL population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these ascent sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of SWFL localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.7-6. Figure 5.1-6 and Table 5.1-17 present the proportion of the sonic booms levels of model results that overlapped the 10 km

buffer of SWFL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that ascent sonic booms greater than 1.0 psf would be very unlikely to impact SWFL populations and the lack of any coupled visual stimuli, sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on SWFL.

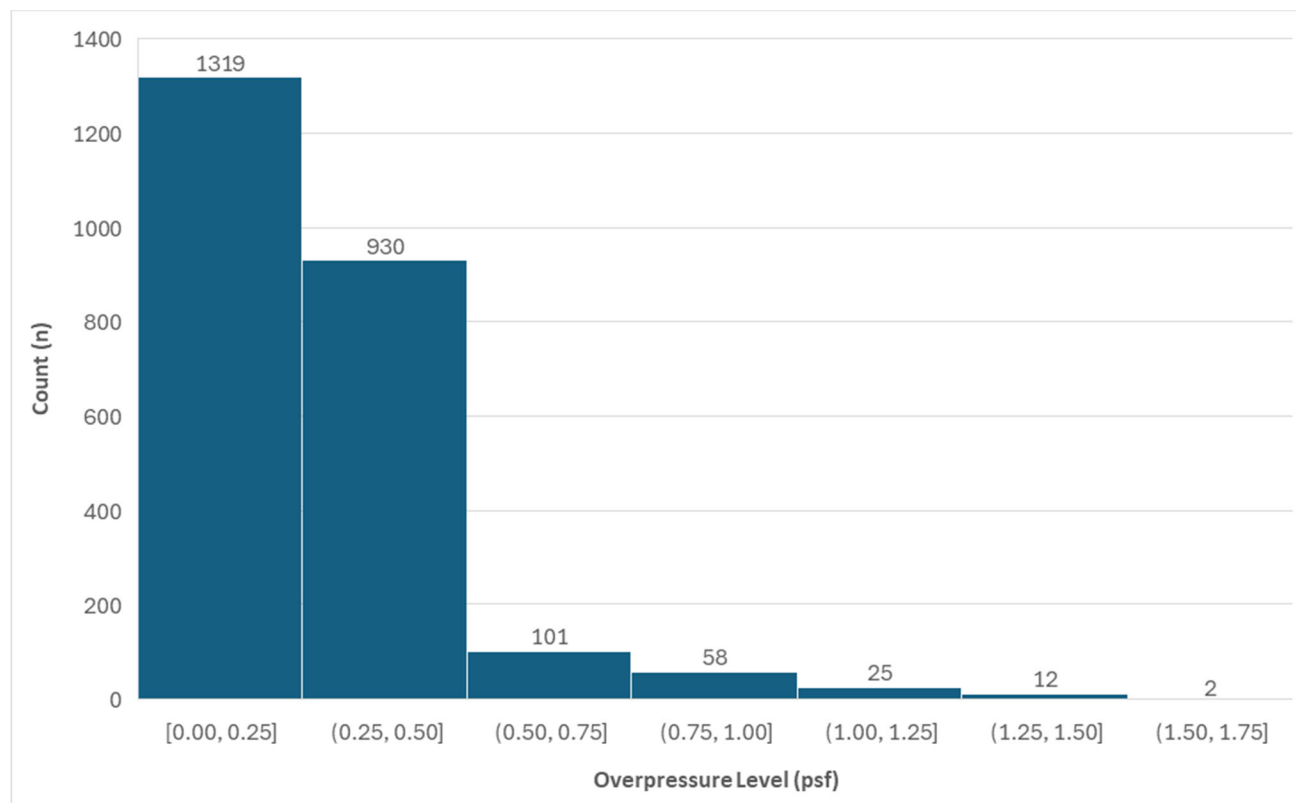


Figure 5.1-6. Distribution of PCBoom ascent sonic boom modeling results within 10 km of SWFL localities shown in Figure 4.7-6.

Table 5.1-17. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of SWFL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	146	308	47.4%
1-2	14 (1.7 psf)	308	4.5%
2-3	0	308	0.0%
3-4	0	308	0.0%
4-5	0	308	0.0%

5.1.7.3 Conclusion

Given the lack of an extant SWFL breeding population on VSFB, SWFL presence on VSFB is likely limited to migrants. Recent observations of SWFL at the Santa Ynez River in Buellton were limited to one territorial male with suspected, but unconfirmed, pairing. SWFL occurrence and breeding

activity within the Action Area during a launch event is, therefore, rare. Additionally, attenuation of noise over 22 mi from SLC-6 to SWLF sites would reduce noise levels within the sensitivity range of birds. Finally, ascent sonic booms greater than 1.0 psf at SWFL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties would be very rare. For these reasons, the DAF has determined that the Proposed Action would have a discountable effect and may affect, but is not likely to adversely affect the SWFL.

5.1.8 Least Bell's Vireo

5.1.8.1 Physical and Habitat Impacts

No ground disturbing activities or vegetation management activities would occur within LBVI habitat and avoidance and minimization measures discussed in Section 2.3.1 would ensure that there are no LBVI near the construction area. Therefore, these actions would have no effect on LBVI. The potential effects of noise are discussed below.

5.1.8.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at historic and extant LBVI localities at the 13th Street Bridge area at the Santa Ynez River and Buellton are presented in

Table 5.1-18 and Table 5.1-19 and Figure 4.8-1 through Figure 4.8-5. The estimated levels for engine noise are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.) and most measurements have been below the levels predicted by modeling (Appendix B). However, engine noise levels have not been measured at either of these locations during Falcon 9 launches from SLC-4.

Table 5.1-18. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at historic and extant LBVI localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Santa Ynez River	110	105	118	118	108	112	112	106	116
Buellton	<100	<100	102	<100	<100	102	100	<100	107

Table 5.1-19. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at historic and extant LBVI localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
13 th Street Bridge	-	4-5	-	2.5	-	2.5
Buellton	-	1-1.5	-	1-1.5	-	1-1.5

Sonic boom levels have not been measured at the 13th Street Bridge at the Santa Ynez River or at Buellton. However, as of 24 January 2024, sonic booms have been measured at 5 monitoring locations on VSFB during 22 Falcon 9 first stage events at SLC-4W, resulting in 50 measurements (Appendix B). All but 8 of the 50 measurements were within the range of predicted psf levels. Therefore, the sonic boom levels in Table 5.1-19, which represents a potential worst-case

scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact these areas.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Although there are no LBVI-specific audiograms or other data on this species' hearing sensitivity available, most bird species' greatest sensitivity to sounds is within a relatively narrow range from 1 kHz - 4 kHz (Konishi 1970). Most of the noise energy produced by rocket engines is less than 200 Hz (Figure 5.1-7). In addition, noise energy in higher frequencies ranges attenuates more quickly while traveling through the atmosphere; therefore, the maximum noise levels within bird's hearing sensitivity range that would reach LBVI sites near Buellton, approximately 22 mi from SLC-6, and Santa Maria, approximately 30 mi from SLC-6, would have reduced significantly as they travel through the atmosphere. Finally, the predicted noise levels based on modeling are conservative since the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). It is therefore reasonable to conclude that perceived noise levels for LBVI at this location would be substantially less than 105 dB at Buellton and less than 102 dB in the Santa Maria Valley and very little of the noise energy perceivable by LBVI would reach these sites.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

Approximately 88% of missions with easterly trajectories are predicted to impact a LBVI population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these ascent sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of LBVI localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.8-6. Figure 5.1-7 and Table 5.1-20 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of LBVI localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that sonic booms greater than 1.0 psf would be very unlikely to impact LBVI populations and the lack of any coupled visual stimuli, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on LBVI.

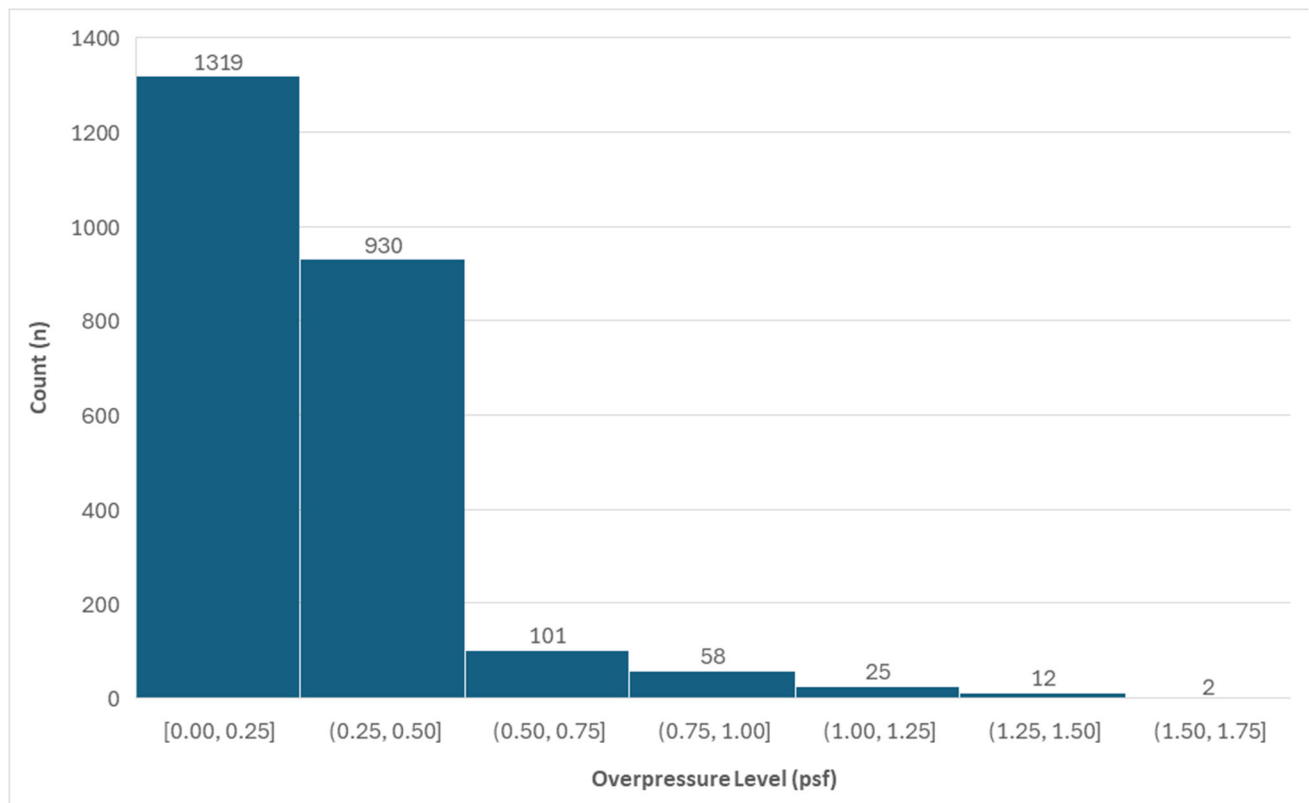


Figure 5.1-7. Distribution of PCBoom ascent sonic boom modeling results within 10 km of LBVI localities shown in Figure 4.8-6.

Table 5.1-20. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of LBVI localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	272	308	88.3%
1-2	93	308	30.2%
2-3	20	308	6.5%
3-4	3 (3.7 psf)	308	1.0%
4-5	0	308	0.0%

5.1.8.3 Conclusion

Given the lack of an extant LBVI breeding population on VSFB, LBVI presence on VSFB is likely limited to migrants. Recent observations of LBVI at the Santa Ynez River in Buellton were limited to one territorial male with suspected, but unconfirmed, pairing. LBVI occurrence and breeding activity within the Action Area during a launch event is, therefore, rare. Additionally, attenuation of noise over the 22 mi from SLC-6 to LBVI sites at Buellton and 30 mi to LBVI sites in the Santa Maria Valley would reduce noise levels within the sensitivity range of birds. Finally, ascent sonic booms greater than 1.0 psf at LBVI localities in eastern Santa Barbara, Ventura, and Los Angeles Counties would be very rare. For these reasons, the DAF has determined that the Proposed

Action would have a discountable effect and may affect, but is not likely to adversely affect the LBVI.

5.1.9 Western Snowy Plover

5.1.9.1 Physical Impacts

No ground disturbing activities would occur within or near SNPL habitat; therefore, the Proposed Action would have no direct physical impacts on SNPL or SNPL habitat.

5.1.9.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at SNPL localities are presented in Table 5.1-21 and Table 5.1-22 and Figure 4.9-1 through Figure 4.9-5. As discussed previously, the estimated engine noise levels are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). Noise measurements have not been collected at the nearest area of Surf Beach to SLC-4 which was the location evaluated to produce the estimated levels in Table 5.1-21; however, measurements collected during Falcon 9 missions from SLC-4 at a location used for SNPL monitoring, approximately 1.6 mi north, had an average launch noise level of 117.4 dB L_{max} (n=15), less than the modeled estimate of 122 dB L_{max} for the monitoring location (Appendix B). The average landing noise level measured at the monitoring location is 109.0 dB L_{max} (n=5), below the estimated level of 110 dB L_{max} , with one measurement of 113.8 dB L_{max} (Transporter 7) exceeding the estimated level. Appendix B includes all noise levels measured during Falcon 9 launches as of 24 January 2025.

Table 5.1-21. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at SNPL localities.

South Surf Beach	122	130	130	115	111	118	119	111	123
Guadalupe Dunes	<100	<100	<100	<100	<100	<100	<100	<100	103
Jalama Beach	<100	<100	107	105	102	108	110	102	112

Table 5.1-22. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at SNPL localities.

					Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
South Surf Beach	-	7-8	-	4	-	4
Guadalupe Dunes	-	1	-	<1	-	<1
Jalama Beach	-	2	-	3	-	3

Sonic boom modeling is performed for each SpaceX mission. Table 5.1-22 presents sonic boom levels predicted from the model produced for the Falcon 9 Bandwagon-2 mission in December 2024, which had a relatively large geographic impact area and relatively higher levels predicted than for other missions and therefore was used for this BA to represent a potential worst-case scenario (see Appendix A for variability). The mission-specific model results for landing events that have required SNPL monitoring have predicted sonic booms ranging from 1 to 7 psf at a

South Surf Beach monitoring location for Falcon 9 landing events at SLC-4 (Appendix B). Measured sonic boom levels at the South Surf monitoring location for these missions have averaged 3.51 psf (n=10) and ranged from 1.95 to 4.54 psf (Appendix B). Sonic booms haven't been measured at the Guadalupe Dunes or Jalama Beach. However, as discussed previously, all but 8 of 50 sonic boom measurements during Falcon 9 first stage landing events at SLC-4W were within the range of predicted psf levels (Appendix B). Therefore, the sonic boom levels in Table 5.1-22, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact the Guadalupe Dunes or Jalama Beach.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Launch and landing noise events would last less than one minute and static fire noise would last less than 7 seconds. Launch engine noise and, to a lesser extent, landing engine noise would be coupled with the visual disturbance of the rocket engines firing during lift off and landing. When animals perceive both auditory and visual disturbances, the combined stimuli often lead to a stronger perception of danger (Partan & Marler 2005; Stevens 2013).

There are no SNPL-specific audiograms or other data on this species' hearing sensitivity available. A weighted noise function for SNPL was deduced from the budgerigar (*Melopsittacus undulatus*), which has a similar vocal spectrum, size, and body mass, and thus may be used as a surrogate species. There is a strong correlation between the range of hearing in birds and the frequency spectrum of bird vocalizations (Dooling & Popper 2007). That is, except for some nocturnal predators, birds hear best in the spectral region of their species-specific vocalizations. Typical frequency components of SNPL call and song were identified using field recordings from California. As presented in Figure 5.1-8, the highest energy in a plover call falls between 1.2 and 4 kHz, equating to a best hearing range between 1.2 and 4 kHz. This range was used to review several avian hearing curves (i.e., audiograms) to identify an approximate match for the SNPL that could be used in developing a weighting filter. In addition, the mass of bird species is significantly correlated with the size of the basilar papilla while the noise frequency sensitivity for bird species is inversely correlated to body mass and the length of the basilar papilla (Gleich et al. 2005). After conferring with Dr. Robert Dooling, the hearing curve for the budgerigar (Figure 5.1-9; Dooling 2002) was used as surrogate data for the SNPL (Dooling 2024, personal communication).

This budgerigar hearing curve was processed following methods established in Southall et al. (2019), to derive an auditory weighting function serving as a frequency-specific filter to quantify how noise would be perceived by SNPL (Figure 5.1-10) and how that would relate to the spectral characteristics of a SNPL's potential susceptibility to noise. Weighting functions are used to de-emphasize noise at frequencies where susceptibility is lower and emphasize noise at frequencies where sensitivity is greater. The high and low frequency cutoffs of the audiogram were noted as were the "fall-offs" outside of the range of best hearing. The slopes of the lower and upper frequency cutoffs were measured (dB/decade) and used to estimate the amount of weighting to be applied at each frequency (Figure 5.1-10).

Finally, this weighting function was applied to the timewave form recording of the June 2022 Falcon 9 SARah-1 launch. The unfiltered time waveform had frequency spectra with an unweighted peak level of approximately 110 dB Lmax (Figure 5.1-11). Given the high falloff rates outside the range of best hearing, both the low- and high-frequency component of the rocket launch noise were notably reduced. After applying the SNPL weighting function, the peak level was approximately 104 dB Lmax (Figure 5.1-11). In comparison to human hearing sensitivity, 104 dBA is equivalent to the noise level of a typical musical concert. For SNPL on VSFB, the level of impact expected from this level of noise and the coupled visual stimuli is consistent with the minor behavioral reactions observed in SNPL during video monitoring for launch and landing events.



Figure 5.1-8. Western snowy plover call frequency.

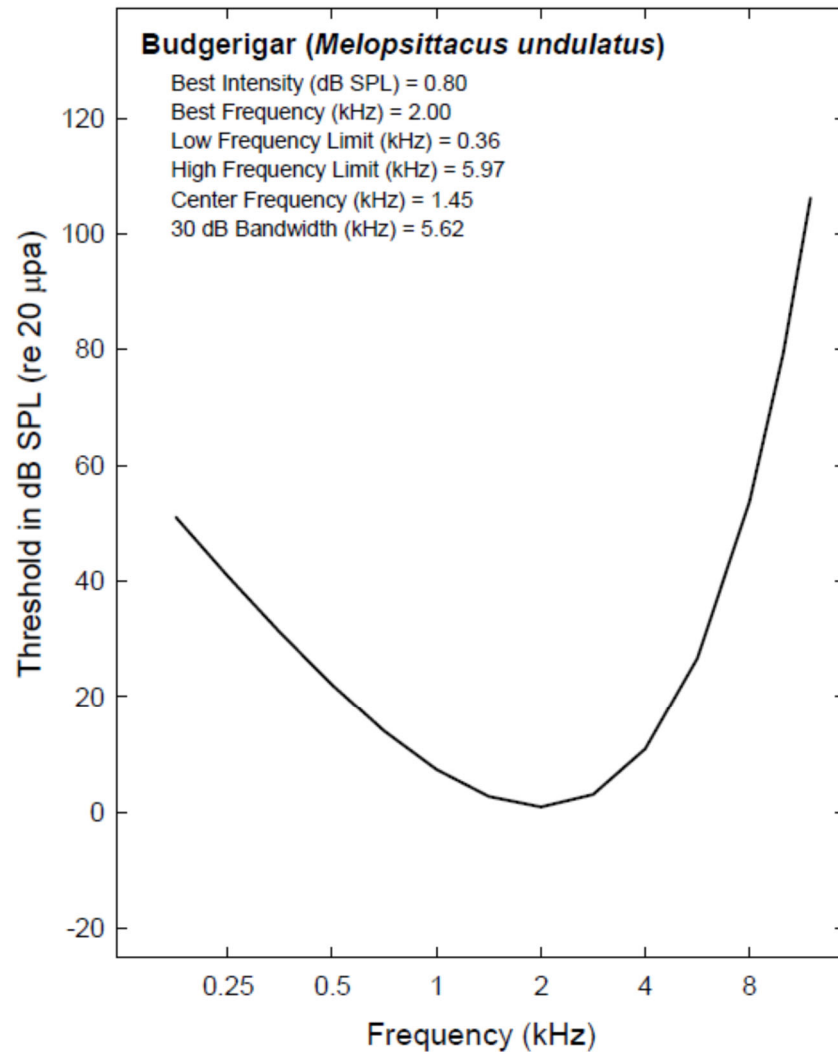


Figure 5.1-9. Budgerigar hearing sensitivity curve (Dooling 2002).

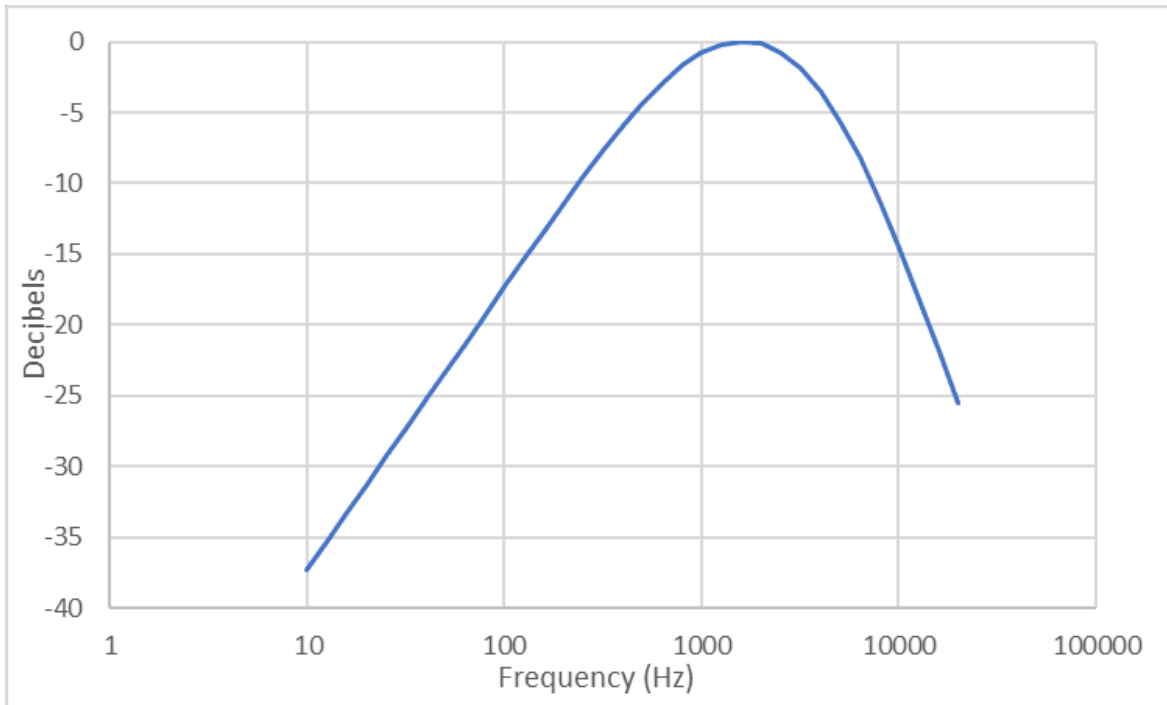


Figure 5.1-10. Budgerigar weighting function.

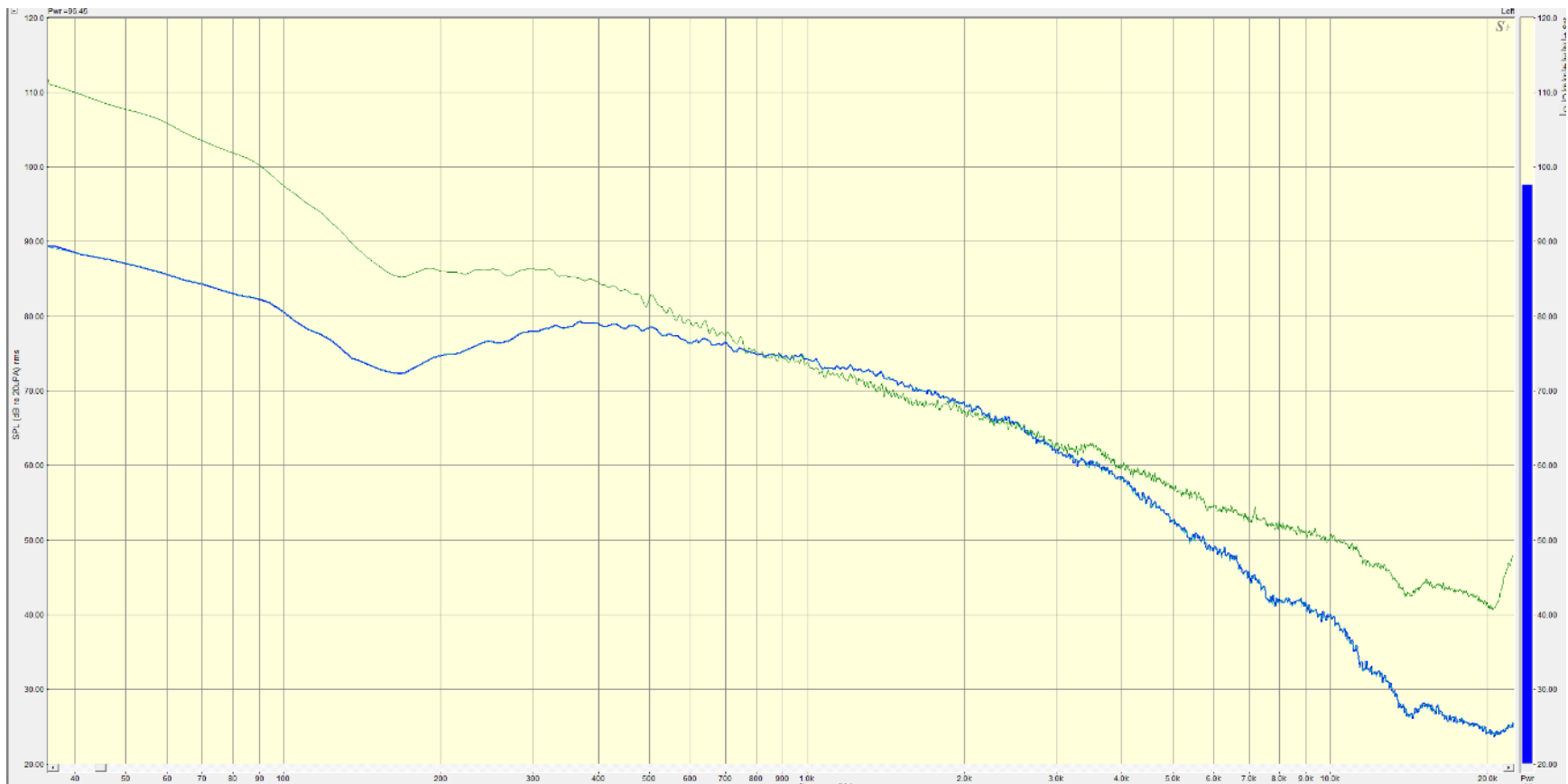


Figure 5.1-11. Launch peak noise level comparison of unweighted (green) versus SNPL-weighted (blue) decibels (note: time waveform recording from the June 2022 Falcon 9 SARah-1 launch).

The DAF has monitored SNPL during the breeding and non-breeding seasons on VSFB during numerous launches over the past 24 years, including 10 Falcon 9 missions with boostback and landing at SLC-4W. The monitoring has routinely demonstrated that launch noise only has a minor effect on SNPL behavior, and no incidents of injury or mortality to adults, young, or eggs attributable to launch activities have been documented (SRS Technologies, Inc. 2001, 2006a, 2006b, 2006c, 2006f, 2006g, 2006h, 2006i, 2006j, 2006k; MSRS 2007a, 2008a, 2008b, 2008c, 2009c, 2010a, 2010b, 2013; Robinette & Ball 2013; Robinette & Miller 2017a, 2017b; Robinette & Rice 2019; Robinette & Rice 2022a, 2022b; Robinette et al. 2024a, 2024b).

Incubating SNPLs were captured on video during two Falcon 9 launches with first stage landing in 2022, eleven Falcon 9 launch events, some with first stage landing, in 2023, and thirteen Falcon 9 launch events, some with first stage landing, in 2024. The majority of these SNPL's only exhibited alerting behavior involving minor head movements; a smaller proportion showed a startle effect, where the bird was observed to physically jolt, often accompanied by quick head movements; and an even smaller proportion "hunkered down" on the nest (Robinette & Rice 2022a, 2022b; Robinette et al. 2024a, 2024b). In 2023, these videos showed that 92% of observed individuals had minor alerting, 11% startled, 7 % hunkered, and 0% flushed off nests during launch noise events (n=26; Robinette et al. 2024a). In response to sonic booms during first stage SLC-4 landings in 2023, 100% exhibited minor alerting, 43% startled, 14% hunkered, and 0% flushed off nests during sonic booms (n=7; Robinette et al. 2024a). In 2024, SNPL video nest monitoring during launches showed that 95% had minor alerting, 69% startled, 35% hunkered, and 5% flushed off nests during launch noise events (n=77; Robinette et al. 2024b). Video monitoring of nests for sonic booms during first stage SLC-4 landings showed that 91% startled, 54% hunkered, and 0% flushed (n=24; Robinette et al. 2024b). In 2022, 2023, and 2024, there were no significant changes in incubation rates, overall plover abundance, or nest attendance before and after the launches and boost-back events. Rates of nest abandonment were lower in 2024 compared to 2023 when a high abandonment rate was documented for the Surf South beach section closest to SLC-4, which was likely attributed to many high surf and wind events during 2023 (Robinette et al. 2024a, 2024b). Additionally, both hatch rates and abandonment rates were similar among north and south VSFB beaches in 2024 (Robinette et al. 2024).

From 2019 through 2024, there have been five cases of failed eggs being found within areas that are exposed to launch and landing noise that may have been damaged on or around the date of the launch. During 2019, one SNPL egg that failed to hatch was found on north Surf Beach with signs of potential damage (a slight crack). This egg was part of a three-egg clutch in which the other two eggs successfully hatched. Based on inspection of the failed egg, the embryo may have stopped developing around the time of monitoring for the 12 June 2019 Falcon 9 Radarsat launch (Robinette and Rice 2019). Similarly, one failed SNPL egg was found at north Wall Beach in 2022 that had a long crack. The damaged egg had an approximately three-week-old embryo that may have stopped developing around the time of the 18 June 2022 Falcon 9 SARah-1 mission (Robinette & Rice 2022b). During 2023, two failed eggs were found: one a dented egg with an embryo at Wall Beach that would have stopped developing around 16 May 2023, near the 20 May 2023 Falcon Iridium mission; and a second undamaged egg at Wall Beach that stopped developing around 22 June 2023, the date of the Falcon 9 Starlink G5-7 mission (Robinette et al. 2024a). During 2024, one damaged egg was found in a SNPL nest located south of the Santa Ynez

River mouth, west of Ocean Park, in an area of high human impact with an embryo that stopped developing close to the timing of the 18 June 2024 Starlink G9-1 mission (Robinette et al. 2024b).

In all five cases, there was no evidence of what caused the damage to the eggs or chicks to stop developing. The sonic booms produced during first stage landing are of vastly insufficient levels to break avian eggs (Ting et al. 1997). Bowles et al. (1994) found that sonic boom forces up to 30 psf were not sufficient to damage chicken eggs or embryos. While chicken eggs are larger than snowy plover and least tern eggs, Bowles et al. (1994) argued that chicken eggs were more susceptible to damage than smaller eggs because larger eggs will resonate more with the low frequencies produced by a sonic boom. Furthermore, Bowles et al. (1991) found that sonic boom forces up to 200 – 400 psf were not sufficient to damage intact eggs or further damage eggs with pre-existing cracks. Finally, Ting and Bowles (2002) predicted that a sonic boom would need to create a minimum force of 250 psf before damage to an egg would occur.

There are many natural events that can damage plover eggs, including tide events that destroy nests, high wind events that cover nests in sand, and predation events where not all eggs are taken by the predator (Robinette et al. 2024b). It is unknown whether the damaged eggs are related to launch impacts, other human-related impacts, or a natural event that we were unable to detect. One hypothesis for why an egg would be damaged in the absence of natural damaging events is that the hunker down or flushing behaviors can lead to damage. However, none of the 33 launch noise events monitored in 2023 showed any SNPL flushing off nests and only 4 SNPL were observed to flush during 77 SNPL responses to noise events video recorded in 2024, making this explanation unlikely. Although VSFB does not yet have data on how often eggs are damaged under normal (i.e., non-launch) circumstances, it is common that one or more eggs from a successful nest do not hatch (Robinette and Rice 2019; Robinette & Rice 2022b). Overall, all the monitoring that has been performed has shown there are no changes in bird abundance, nest attendance, or hatching rates, before and after launches.

In 2024, video/in-person monitoring of non-nesting SNPL was performed, as required under the 2024 BO for the first time during two launch events. During the OneWeb-4 mission on 19 October 2024, thermal scopes were used to attempt to film reactions to the launch and subsequent landing at SLC-4. Although challenges were encountered with this first attempt at obtaining video footage during a nighttime launch, a small number of SNPL were observed to have brief behavioral reactions to the launch and subsequent sonic boom but appeared to return to normal behavior quickly. For the 24 October 2024 NROL-167 mission, video monitoring was not performed, but two monitors observed a flock of 78 SNPL during the launch. The flock responded to the launch by tilting their head, appearing to look at the rocket as it took off. This response was observed prior to the noise of the rocket heard on the beach by the monitors. No other movement or response by the plovers was observed. No birds flushed; all remained roosting in the same area.

Despite an increase in launch cadence (16 launches in 2024 breeding season and 11 launches in 2023 breeding season) and the associated minor behavioral responses, the number of adult SNPL observed on all VSFB beaches combined during the nesting season was 309 in 2024, a 31% increase from that observed in 2023 (235; Robinette et al. 2024c). In recent years, the number of adult plovers on South Beaches has shown a curvilinear trend, increasing from 2009 through 2017

and then decreasing through 2024. Adult numbers on North Beaches have shown the opposite trend, with numbers increasing since 2017. These trends are suspected to be primarily driven by restoration efforts on South Beaches in 2013 and 2014. Vegetation removal on Surf North in 2013 and Wall in 2014 increased the amount of nesting habitat for SNPL, and adult numbers quickly responded to both restoration efforts. However, vegetation has since grown in these areas, reducing the amount of available nesting habitat on South Beaches which has likely led to adult SNPL moving to North Beaches (Robinette et al. 2024c). Nesting habitat availability, predation, and nest destruction by wind and tides are the primary factors of nesting locations, hatch success, and fledging success on VSFB (Robinette et al. 2024c). Overall, the breeding population and number of nests on VSFB has been relatively stable since 2011, although year to year fluctuations are observed (Robinette et al. 2024d).

The scientific literature shows that the effects of frequent noise disturbance on bird species varies greatly. Reviewed in Francis and Barber (2013), response to noise disturbances in wildlife depends on how frequent and predictable the noise is, acuteness, overlap with biologically relevant sounds, and overlap with animals' hearing sensitivity range. Chronic (i.e., sustained) noise generally causes acoustic cue masking, which can impact a variety of behaviors important to reproduction and fitness (Francis & Barber 2013). On the opposite side of the spectrum, infrequent, acute noise tends to cause startle responses (Francis & Barber 2013). In birds, sustained, chronic noise, such as that produced by traffic, wind turbines, and gas/oil fields, has been shown to correlate to a variety of negative effects, including changes in levels of stress hormones and stress physiology (Kleist et al. 2018; Zollinger et al. 2019), acoustic cue masking (Francis et al. 2011a; Francis & Barber 2013), changes in breeding behavior (Goudie & Jones 2004; Swaddle & Page 2007; Alquezar et al. 2020), changes in territorial behavior and aggression (Goudie & Jones 2004; Mockford & Marshall 2009; Wolfenden et al. 2019; Passos et al. 2020), impacts on reproduction and nest success (Halfwerk et al. 2011; Kleist et al. 2018; Zollinger et al. 2019), and declines in bird abundance (Francis et al. 2011b; McClure et al. 2013; Mejia et al. 2019; Rosa & Koper 2022), all of which have implications for survival and fitness (Francis & Barber 2013).

In many species, however, research has shown a lack of effect of chronic noise and evidence of habituation. It should, therefore, not be assumed that chronic noise exposure in birds is necessarily associated with the negative impacts listed above or that closely related species, or even individuals, will respond similarly. Yorzinski and Hermann (2016) found that peafowl (*Pavo cristatus*) exposed to continuous white noise showed no preference for roosting near or away from the noise source. Walthers and Barber (2020) found that traffic noise was not associated with stress indicators in nestling European starlings (*Sturnus vulgaris*). Similarly, stress physiology and immune function in nestling tree swallows (*Tachycineta bicolor*) were not altered when exposed to continuous white noise. Although Meillere et al. (2015) found differences in predator vigilance in house sparrows (*Passer domesticus*) exposed to traffic noise, they found no effect of the chronic exposure on reproductive performance. In response to loud, frequent, but non-sustained aircraft noise, a study of domestic turkeys (*Meleagris gallopavo domesticus*) showed they quickly acclimated to the noise (Bradley et al. 1990). Conomy et al. (1998) found that black duck (*Anas rubripes*) reactions to jet noise declined with exposure, but wood duck (*Aix*

sponsa) reactions did not change. Aircraft noise was also shown not to have a significant effect on physiological stress in nestling tree sparrows (*Passer montanus*; Redondo et al. 2021).

The effect of increasing noise disturbances on SNPL populations is uncertain based on scientific literature. However, none of the scientific literature studies are directly comparable to the noise impacts of the Proposed Action. Launch engine noise and sonic booms are acute, non-sustained, and unpredictable. It is most similar to aircraft noise disturbance yet would be much less frequent. Due to this uncertainty, the DAF has determined that launch and landing noise as a result of the Proposed Action may affect and is likely to adversely affect the SNPL on VSFB.

Noise Impacts at the NCI

Since 2017 and as of 20 October 2024, of the launches that produced sonic booms that impacted the surface of the earth, approximately 67% have impacted the NCI, with approximately 50% of those impacting Santa Rosa Island where SNPL is considered a permanent resident. However, conservatively, it is assumed that up to 100 Falcon missions each year may result in a 1 psf sonic boom or greater, impacting SNPL at Santa Rosa Island. Depending on mission trajectories, ascent sonic boom may occasionally reach approximately 8 psf. Sonic boom footprints vary by mission-specific trajectories and weather conditions and the actual number of impacts above 1 psf would likely be less than 100 per year. As established through monitoring on VSFB (discussed above), SNPL would be expected to have a startle reaction to a sonic boom on Santa Rosa Island. However, there would not be any exposure to associated visual stimuli, which can heighten the perception of threats, as discussed above. Since the sonic boom would be disassociated from these other stimuli, SNPL on Santa Rosa Island would likely have less intensity than on VSFB but would still be expected to have a brief startle reaction. Reactions would likely be short term and be unlikely to cause any long-term consequences for individuals or populations. However, the effect of increasing noise disturbances on SNPL populations is uncertain based on scientific literature. Due to this uncertainty, the DAF has determined that launch and landing noise as a result of the Proposed Action may affect and is likely to adversely affect the SNPL on the NCI.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

An estimated 89% of missions with easterly trajectories are predicted to result in ascent sonic booms that overlap SNPL population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of SNPL localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.9-8. Figure 5.1-12 and Table 5.1-23 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of SNPL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that ascent sonic booms greater than 1.0 psf would be very unlikely to impact SNPL populations and the lack of any coupled visual stimuli which can increase the perception of danger, as discussed above, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on SNPL.

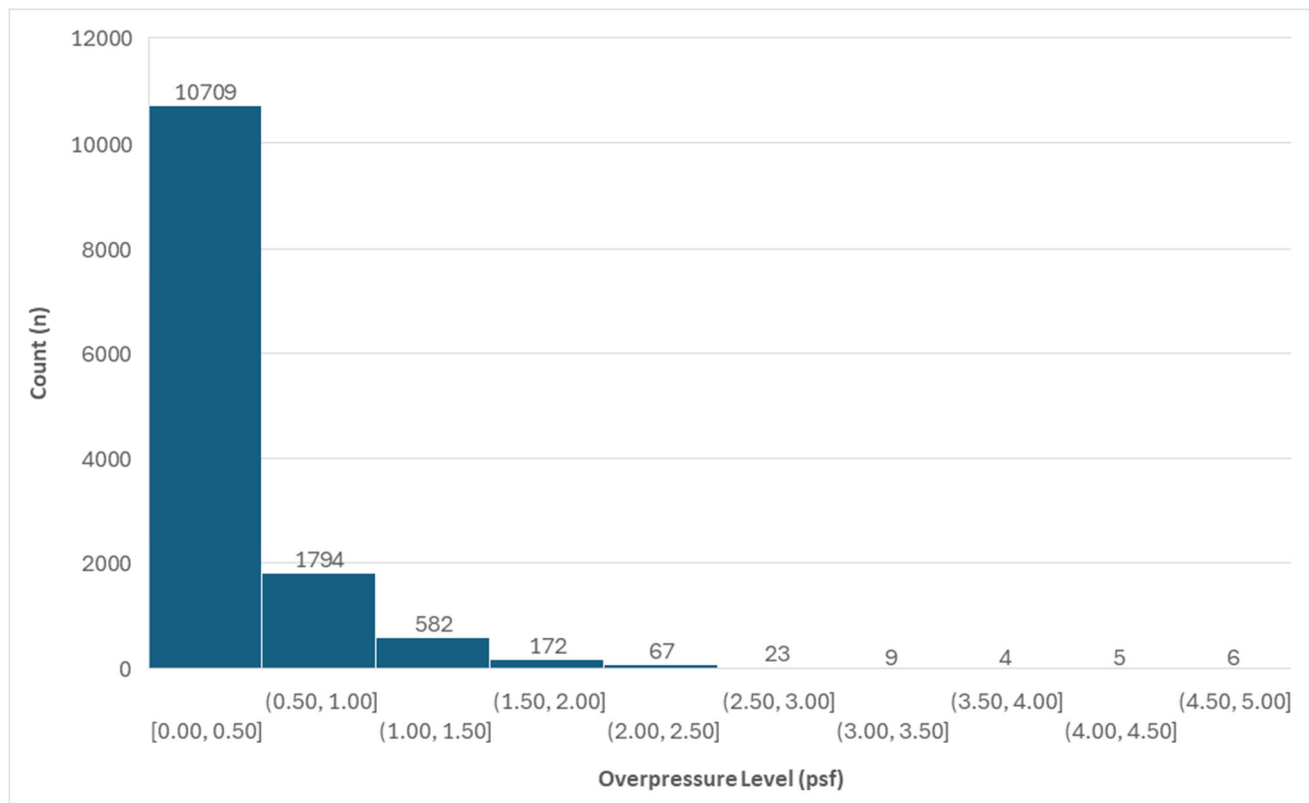


Figure 5.1-12. Distribution of PCBoom ascent sonic boom modeling results within 10 km of SNPL localities shown in Figure 4.11-8.

Table 5.1-23. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of SNPL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	275	308	89.3%
1-2	127	308	41.2%
2-3	53	308	17.2%
3-4	12	308	3.9%
4-5	8 (5.0 psf)	308	2.6%

5.1.9.3 Conclusion

The DAF has determined that the Proposed Action may affect, and is likely to adversely affect, the SNPL on VSFB. Individuals nesting, roosting, and foraging in the action area on VSFB are likely to be disturbed by visual cues and noise from launch and landing activities. These disturbances may startle SNPL and temporarily disrupt foraging or breeding activities. If launch and landing occur during the breeding season (approximately March through September), brooding birds may startle and flush which could potentially damage eggs or leave eggs or chicks unattended. Unattended eggs and chicks may become vulnerable to exposure or predation. Noise exposure

may cause effects that are not immediately evident and may cause reduced numbers of nesting adults or reduced productivity in the action area over time.

5.1.10 California Least Tern

5.1.10.1 Physical Impacts

No ground disturbing activities would occur within or near LETE habitat; therefore, the Proposed Action would have no direct physical impacts on LETE or LETE habitat.

5.1.10.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at the LETE Purisima colony and the Santa Ynez River estuary roosting site are presented in Table 5.1-24 and Table 5.1-25 and Figure 4.10-1 through Figure 4.10-5. As discussed previously, the estimated engine noise levels are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). Noise measurements collected at the Purisima colony during Falcon 9 launches from SLC-4 have averaged 104.5 dB L_{max} (n=5), less than the modeled estimate of 112 dB L_{max} at this location (Appendix B).

Table 5.1-24. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at LETE localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Purisima Point	102	<100	112	105	102	108	110	102	113
Santa Ynez River	110	105	118	118	108	112	112	106	116

Table 5.1-25. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at LETE localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Purisima Point	-	3	-	1-2	-	1-2
Santa Ynez River	-	4-5	-	2.5	-	2.5

Sonic boom modeling is performed for each SpaceX mission. Table 5.1-25 presents sonic boom levels predicted from the model produced for the Falcon 9 Bandwagon-2 mission in December 2024, which had a relatively large geographic impact area and relatively higher levels predicted than for other missions and therefore was used for this BA to represent a potential worst-case scenario (see Appendix A for variability). The mission-specific model results for landing events that have required LETE monitoring have predicted sonic booms ranging from 0.5 to 4 psf at the Purisima colony monitoring location for Falcon 9 landing events at SLC-4 (Appendix B). Measured sonic boom levels at the Purisima colony for these missions have averaged 1.62 psf (n=3) and ranged from 1.07 to 2.66 psf (Appendix B).

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Based on the extensive monitoring observations detailed below, the audible and visual components of the Proposed Action (i.e., launch, landing, sonic boom, and vehicle lift off) could cause LETS to respond behaviorally. This stimulus could trigger a startle response that alerts predators to nest locations and causes adults to temporarily (minutes) flush off of nests. The proposed environmental protection measures would be employed to characterize impacts on LETS as a result of launch-related noise events.

At VSFB, LETS monitoring has been conducted for five Delta II launches from SLC-2 on north VSFB. SLC-2 is 0.4 mi from the Purisima Point nesting colony. LETS responses to launch noise have varied. Pre- and post-launch monitoring of non-breeding LETS for the 7 June 2007 Delta II COSMO-1 launch and monitoring of nesting LETS during the 20 June 2008 Delta II OSTM and 10 June 2011 Delta II AQUARIUS launches did not document any mortality of adults, young, or eggs, or any abnormal behavior resulting from launches (MSRS 2007a, 2008b, 2011). However, Delta II launches from SLC-2 in 2002 and 2005, when terns were arriving at the colony, may have caused temporary or permanent emigration from the colony because there was decreased attendance following the launches (Robinette et al. 2003; Robinette & Rogan 2005). These data imply that LETS response to noise relates to timing with the nesting cycle. For instance, at the beginning of the nesting season when LETS are arriving at the breeding colony, the adults seem to be more sensitive, but once courtship and nest-tending begins, the adults are more resilient.

On 12 June 2019, LETS response was documented during a SpaceX Falcon 9 launch with first stage landing at SLC-4 on VSFB. The landing produced a 2.7 psf sonic boom, as measured at the Purisima LETS colony. LETS response to the launch and boost-back landing was documented via pre- and post-launch monitoring and video recording during the launch event. LETS response during the launch was difficult to determine since the birds flushed before sonic boom impact. All LETS returned to their nests minutes after the launch event. One LETS egg was found to be damaged. The damaged LETS egg was from a one egg clutch and was inspected when it was a week past hatch date. The cause and timing of the damage to the egg was inconclusive (Robinette & Rice 2019).

Monitoring of the LETS colony was also performed for the 12 June 2022 SpaceX Falcon 9 launch with first stage landing at SLC-4W. A 1.1 psf sonic boom was recorded at the colony. There were no differences in overall bird abundance or nest attendance before and after the launch and landing. Video monitoring showed the reaction of incubating LETS ranged from alert and minor looking around to a startle effect (i.e., calm before the boom, with a jolt and quick head movements looking around when the boom hit; Robinette & Rice 2022b), in a similar manner to how an LETS would react to a potential predator or other unfamiliar cues.

In 2023, monitoring over the entire season showed no significant difference in incubation rates before and after launches (Robinette, et al. 2024a). Video footage of incubating LETS during Falcon 9 launches in 2023 (n=7) showed that 100% of LETS reacted, 43% flushed off nests, and all flushed birds returned to nest within 45 seconds (Robinette, et al. 2024a). Video footage of incubating LETS for Falcon 9 launches with SLC-4 landings during the LETS nesting season in 2023 (n=5) showed that 100% reacted, 100% startled, 40% hunkered, 40% flushed, and all returned to nest within 45 seconds. In 2024, video footage of incubating LETS during Falcon 9 launches (n=21)

found that 90% of the adults alerted, 50% were startled, less than 20% hunkered or shifted on their nests, and less than 10% flushed off their nests (Robinette et al. 2024b).

In 2024, there were no Falcon 9 launches with SLC-4 landings during the LETE breeding season. However, there were active LETE nests during five Falcon 9 launches with downrange barge landings in 2024 (Starlink G8-8, Starlink G9-1, Starlink G9-2, NROL-186, and Starlink G9-3). During these launches, video cameras were used to record 21 LETE acute responses to initial launch noise. The video footage showed that the majority (~90%) of incubating adults reacted to initial launch noise, were startled during almost 50% of launches, hunkered or shifted on their nests during <20% of events, and flushed off their nests during <10% of events (Robinette et al. 2024d). There was no difference in incubation rates before and after launches and LETE reproductive success at VSFB was well above the long-term average for the first time since 2016 (Robinette et al. 2024d). There was only one LETE nest abandoned in 2024, and this was due to one of the breeding adults being depredated by an owl. Thus, aside from increased disturbance resulting in a short-term response, we have no direct evidence that launches from SLC-4 had an impact on nesting LETE at VSFB in 2024 (Robinette et al. 2024d).

In contrast to infrequent, acute noise which tends to cause a startle response in animals (Francis & Barber 2013), the scientific literature shows that the effects of frequent noise disturbance on bird species vary greatly. Reviewed in Francis and Barber (2013), response to noise disturbances in wildlife depends on how frequent and predictable the noise is, acuteness, overlap with biologically relevant sounds, and overlap with animals hearing sensitivity range. Chronic (i.e., sustained) noise can impact a variety of behaviors important to reproduction and fitness (Francis & Barber 2013). In birds, sustained, chronic noise, such as that produced by traffic, wind turbines, and gas/oil fields, has been shown to correlate to a variety of negative effects, including changes in levels of stress hormones and stress physiology (Kleist et al. 2018; Zollinger et al 2019), acoustic cue masking (Francis et al. 2011a; Francis & Barber 2013), changes in breeding behavior (Goudie & Jones 2004; Swaddle & Page 2007; Alquezar et al. 2020), changes in territorial behavior and aggression (Goudie & Jones 2004; Mockford & Marshall 2009; Wolfenden et al. 2019; Passos et al. 2020), impacts on reproduction and nest success (Halfwerk et al. 2011; Kleist et al. 2018; Zollinger et al. 2019), and declines in bird abundance (Francis et al. 2011b; McClure et al. 2013; Mejia et al. 2019; Rosa & Koper 2022), all of which have implications for survival and fitness (Francis & Barber 2013).

In many species, however, research has shown a lack of effect of chronic noise and evidence of habituation. It should, therefore, not be assumed that chronic noise exposure in birds is necessarily associated with the negative impacts listed above or that closely related species, or even individuals, will respond similarly. Yorzinski and Hermann (2016) found that peafowl (*Pavo cristatus*) exposed to continuous white noise showed no preference for roosting near or away from the noise source. Walther and Barber (2020) found that traffic noise was not associated with stress indicators in nestling European starlings (*Sturnus vulgaris*). Similarly, stress physiology and immune function in nestling tree swallows (*Tachycineta bicolor*) were not altered when exposed to continuous white noise. Although Meillere et al. (2015) found differences in predator vigilance in house sparrows (*Passer domesticus*) exposed to traffic noise, they found no effect of the chronic exposure on reproductive performance. In response to loud, frequent, but non-sustained aircraft noise, a study of domestic turkeys (*Meleagris gallopavo domesticus*)

showed they quickly acclimated to the noise (Bradley et al. 1990). Conomy et al. (1998) found that black duck (*Anas rubripes*) reactions to jet noise declined with exposure, but wood duck (*Aix sponsa*) reactions did not change. Aircraft noise was also shown not to have a significant effect on physiological stress in nestling tree sparrows (*Passer montanus*; Redondo et al. 2021).

The effect of increased launch and landing noise on LETE is uncertain based on scientific literature. None of these studies in scientific literature are directly comparable to the noise impacts of the Proposed Action. Launch engine noise and sonic booms are acute, non-sustained, and unpredictable. It is more similar to aircraft noise disturbances studied in the literature, but would occur much less frequently. In 2024, despite the minor behavioral disruptions recorded during launch events, DAF monitoring found that LETE reproductive success at VSFB was well above the long-term average for the first time since 2016 (Robinette et al. 2024a, 2024b). There was only one LETE nest abandoned in 2024 and that was due to one of the breeding adults being depredated by an owl, not due to a launch event. Predation and food availability, rather than launch noise, appear to be the primary drivers acting on these populations (Robinette et al. 2024a, 2024b). Due to this uncertainty, the DAF has determined that launch and landing noise as a result of the Proposed Action may affect and is likely to adversely affect the LETE on VSFB.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

An estimated 89% of missions with easterly trajectories are predicted to impact a LETE population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these ascent sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of LETE localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.10-6. Figure 5.1-13 and Table 5.1-26 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of LETE localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that sonic booms greater than 1.0 psf would be very unlikely to impact LETE populations and the lack of any coupled visual stimuli, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on LETE.

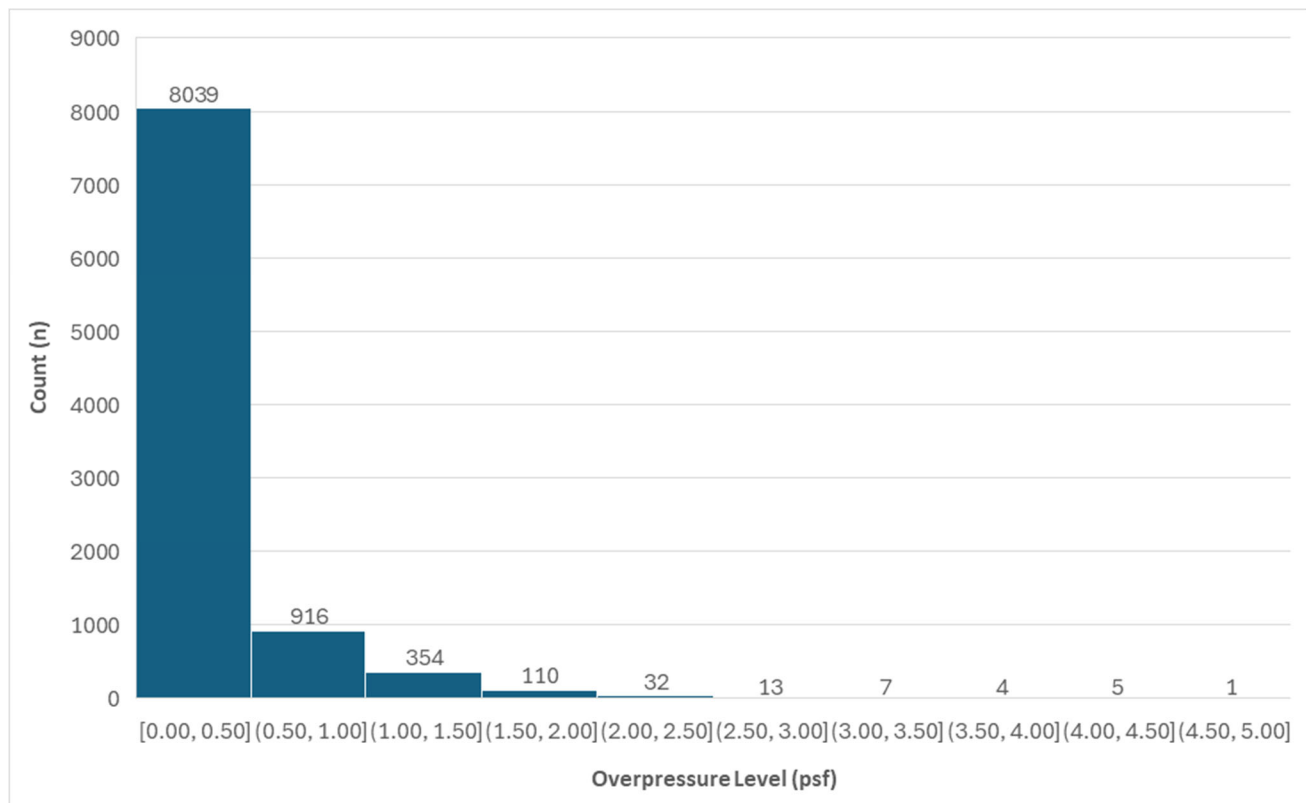


Figure 5.1-13. Distribution of PCBoom ascent sonic boom modeling results within 10 km of LETÉ localities shown in Figure 4.10-6.

Table 5.1-26. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of LETÉ localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	274	308	89.0%
1-2	87	308	28.2%
2-3	30	308	9.7%
3-4	10	308	3.2%
4-5	5 (5.0 psf)	308	1.6%

5.1.10.3 Conclusion

As of November 2024, many launch and landing events have occurred and been monitored during the LETÉ breeding season. Although a proportion of brooding birds may startle and a smaller proportion may flush, there is no evidence that exposure to rocket engine sound and sonic booms from Falcon launches has caused reduced numbers of nesting adults or reduced productivity of the nesting colony over the past several years, as evident from 2024 reproductive success exceeding the long-term average for the first time since 2016 (Robinette et al. 2024a, 2024b, 2024d). LETÉ have been observed to be more sensitive to disturbance while initiating nesting. Analysis of monitoring data will help determine if population declines occur. As a result,

the DAF has determined that the Proposed Action may affect, and is likely to adversely affect, the LETE.

5.1.11 California Condor

5.1.11.1 Physical Impacts

No ground disturbing activities would occur within or near California condor habitat; therefore, the Proposed Action would have no direct physical impacts on California condor or condor habitat.

5.1.11.2 Noise and Visual Disturbance

Noise Impacts in Western Santa Barbara County

It has been difficult to analyze the effect human disturbance could have on California condors. Generally, California condors are less tolerant of human disturbances near nesting sites than at roosting sites. The species is described as being “keenly aware of intruders” and may be alarmed by loud noises from distances greater than 1.6 mi. In addition, the greater the disturbance in either noise level or frequency, the less likely the condor would be to nest nearby. As such, USFWS typically requires isolating roosting and nesting sites from human intrusion (USFWS 1996). Noise from a launch coupled with visual disturbance could cause a startle response and disrupt behavior if a condor is within the Action Area.

Although launch noise, sonic booms, and visual disturbance may cause a startle response and disrupt behavior, the likelihood of a condor being present during these activities is extremely low and, therefore, the effect of the Proposed Action would be discountable.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

An estimated 24% of missions with easterly trajectories are predicted to cause ascent sonic booms that would overlap a California condor population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of California condor localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.11-1. Figure 5.1-14 and Table 5.1-27 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of California condor localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that ascent sonic booms greater than 1.0 psf would be very unlikely to impact California condor populations and the lack of any coupled visual stimuli, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on California condors.

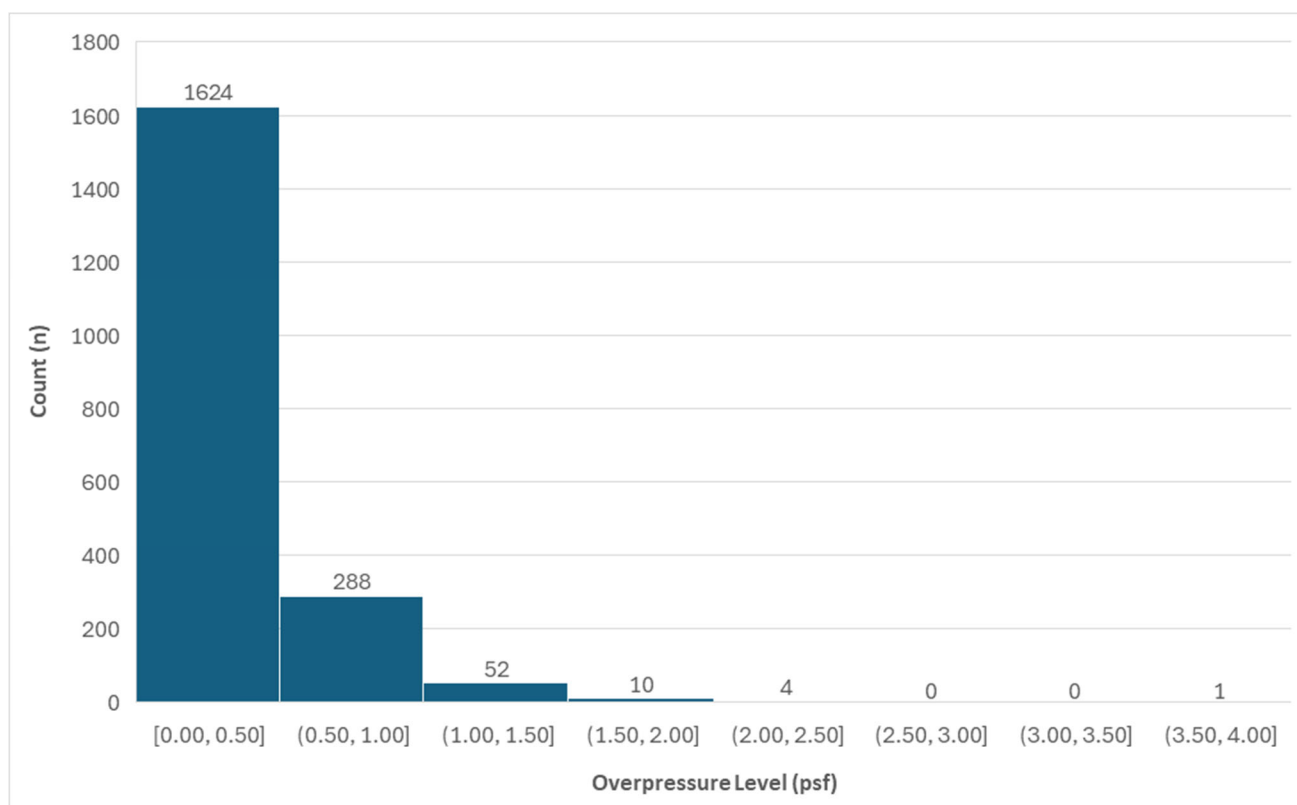


Figure 5.1-14. Distribution of PCBoom ascent sonic boom modeling results within 10 km of California condor localities shown in Figure 4.11-1.

Table 5.1-27. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of California condor localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	74	308	24.0%
1-2	19	308	6.2%
2-3	3	308	1.0%
3-4	1 (3.5 psf)	308	0.3%
4-5	0	308	0.0%

5.1.11.3 Conclusion

The overall likelihood of a California condor occurring at VSFB during a launch, landing, or static fire event is extremely unlikely, hence, discountable. Additionally, the likelihood that missions with an easterly trajectory generate an ascent sonic boom greater than 1.0 psf that would overlap California condor localities is very low. Therefore, the DAF has determined that Proposed Action may affect, but is not likely to adversely affect, the California condor. The DAF will continue to coordinate with the USFWS and Ventana Wildlife Society to monitor condor presence at VSFB prior to launches.

5.1.12 Coastal California Gnatcatcher

5.1.12.1 Physical Impacts

No ground disturbing activities would occur within or near CAGN habitat; therefore, the Proposed Action would have no direct physical impacts on CAGN or CAGN habitat.

5.1.12.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

There would be no noise impacts to CAGN in the Western Santa Barbara County.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

An estimated 84% of missions with easterly trajectories are predicted to create an ascent sonic boom that would overlap a CAGN population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of CAGN localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.12-1. Figure 5.1-15 and Table 5.1-28 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of SNPL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that sonic booms greater than 1.0 psf would be very unlikely to impact CAGN populations and the lack of any coupled visual stimuli, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on CAGN.

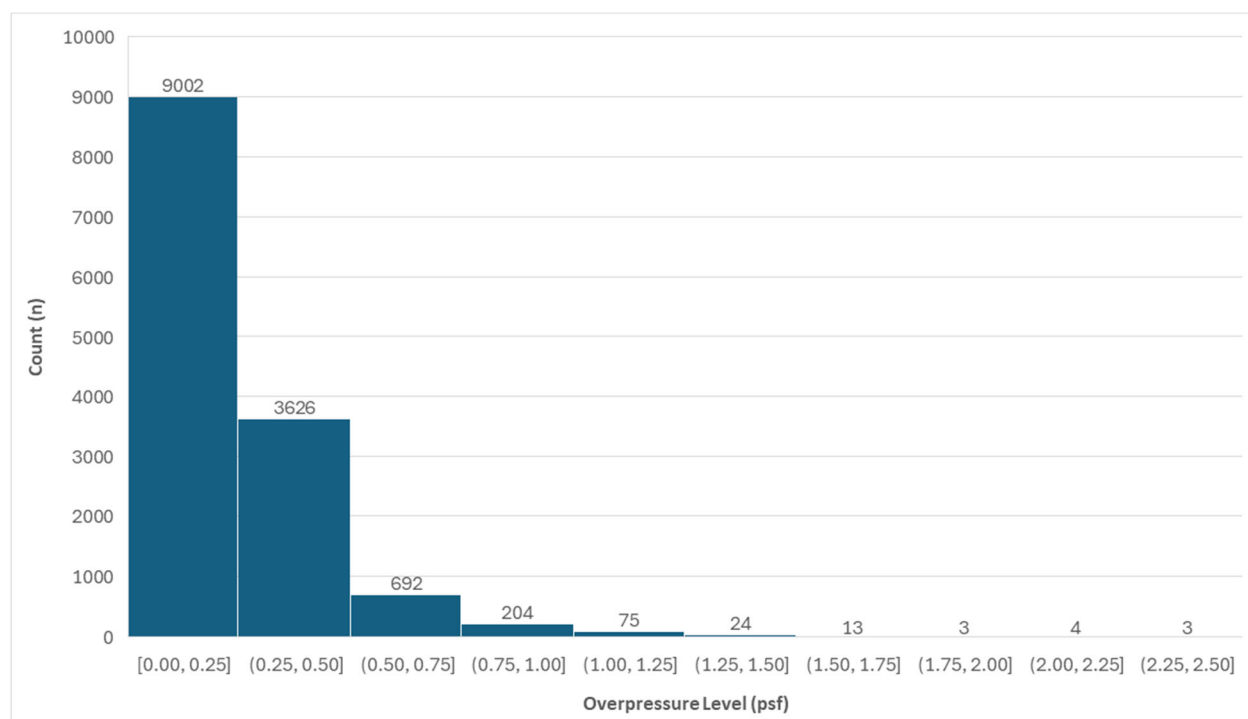


Figure 5.1-15. Distribution of PCBoom ascent sonic boom modeling results within 10 km of CAGN localities shown in Figure 4.12-1.

Table 5.1-28. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of CAGN localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	259	308	84.1%
1-2	50	308	16.2%
2-3	6	308	1.9%
3-4	0	308	0.0%
4-5	0	308	0.0%

5.1.12.3 Conclusion

The likelihood that missions with an easterly trajectory generate an ascent sonic boom greater than 1.0 psf that would impact CAGN localities is very low. Therefore, the DAF has determined that Proposed Action may affect, but is not likely to adversely affect, CAGN.

5.1.13 Light-footed Ridgeway's Rail

5.1.13.1 Physical Impacts

No ground disturbing activities would occur within or near RIRA habitat; therefore, the Proposed Action would have no direct physical impacts on RIRA or RIRA habitat.

5.1.13.2 Noise Impacts

Noise Impacts in Western Santa Barbara County

There would be no noise impacts to RIRA in Western Santa Barbara County.

Noise Impacts in Eastern Santa Barbara, Ventura, and Los Angeles Counties

An estimated 98% of missions with easterly trajectories are predicted to create an ascent sonic boom that would overlap a RIRA population in eastern Santa Barbara, Ventura, and Los Angeles Counties. To estimate the potential levels of these sonic booms, a frequency distribution of potential sonic boom levels was constructed by overlaying a 10-km buffer of RIRA localities onto the PCBoom model output described in Section 2.2.6 and as depicted in Figure 4.13-1. Figure 5.1-16 and Table 5.1-29 present the proportion of the sonic booms levels of model results that overlapped the 10 km buffer of SNPL localities in eastern Santa Barbara, Ventura, and Los Angeles Counties. Given that sonic booms greater than 1.0 psf would be very unlikely to impact RIRA populations and the lack of any coupled visual stimuli, ascent sonic booms created during missions with easterly trajectories are not expected to have an adverse effect on RIRA.

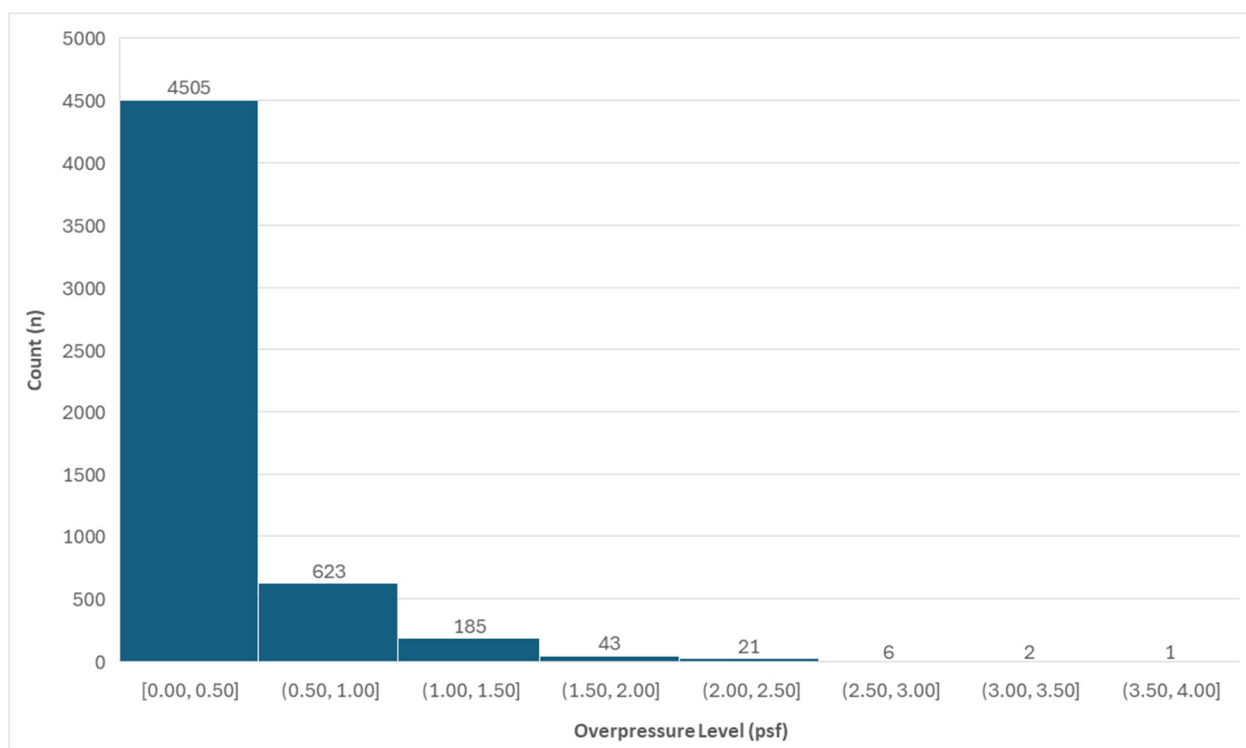


Figure 5.1-16. Distribution of PCBoom ascent sonic boom modeling results within 10 km of RIRA localities shown in Figure 4.13-1.

Table 5.1-29. Proportion of the sonic booms levels of model results that overlapped the 10 km buffer of RIRA localities in eastern Santa Barbara, Ventura, and Los Angeles Counties (Note: largest sonic boom level in parentheses).

Sonic Boom Levels (psf)	# Model Runs Overlapping Buffer	Total # Model Runs	% of Sonic Boom Levels Overlapping Buffer
0-1	272	308	88.3%
1-2	73	308	23.7%
2-3	19	308	6.2%
3-4	3 (3.7 psf)	308	1.0%
4-5	0	308	0.0%

5.1.13.3 Conclusion

The likelihood that missions with an easterly trajectory generate a sonic boom greater than 1.0 psf that would impact RIRA localities is very low. Therefore, the DAF has determined that Proposed Action may affect, but is not likely to adversely affect, RIRA.

5.1.14 Short-tailed Albatross

5.1.14.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on short-tailed albatross.

5.1.14.2 Noise Impacts

While above the water surface, short-tailed albatross may be exposed to landing engine noise and sonic boom within the recovery area if within the vicinity of the barge during a landing event. While diving, birds would not be exposed to these noises. The hearing capabilities of short-tailed albatross have not been measured; therefore, their hearing capabilities are inferred from other species. The majority of the published literature on bird hearing focuses on terrestrial birds and their ability to hear in air. A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kHz (Beason 2004; Dooling 2002). Very few can hear below 20 Hz, most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 15 kHz (Dooling 2002). Hearing capabilities have been studied for only a few seabirds (Beason 2004; Beuter et al. 1986; Crowell et al. 2015; Johansen et al. 2016; Maxwell et al. 2017; Mooney et al. 2019; Thiessen 1958; Wever et al. 1969); these studies show that seabird hearing ranges and sensitivity in air are consistent with what is known about bird hearing in general.

Landing engine noise and sonic boom may cause temporary physiological or behavioral disturbances to short-tailed albatross. These disturbances would be short in duration and may startle individuals, causing minor behavioral disruptions. The potential effects would vary among individuals due to temperament, sex, age, and prior experience with noise, as well as the distance to the noise source. Due to the short-term, transient nature of engine noise and sonic boom and low densities of this species within the Action Area, the potential effects are only anticipated to be behavioral and temporary. These behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations.

5.1.14.3 Conclusion

Given the low densities of short-tailed albatross in the Action Area any exposure to sonic boom or landing engine noise would be unlikely and only cause short-term disturbances. Therefore, the DAF has determined that Proposed Action may affect, but is not likely to adversely affect, the short-tailed albatross.

5.1.15 Hawaiian Petrel

5.1.15.1 Physical Impacts

No aspects of the Proposed Action would have potential physical impacts on Hawaiian petrel.

5.1.15.2 Noise Impacts

The hearing capabilities of Hawaiian petrels have not been measured; therefore, their hearing capabilities are inferred from other species. The majority of the published literature on bird hearing focuses on terrestrial birds and their ability to hear in air. A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kHz (Beason 2004; Dooling 2002). Very few can hear below 20 Hz, most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 15 kHz (Dooling 2002). Hearing capabilities have been studied for only a few seabirds (Beason 2004; Beuter et al. 1986; Crowell et al. 2015; Johansen et al. 2016; Maxwell et al. 2017; Mooney et al. 2019; Thiessen

1958; Wever et al. 1969); these studies show that seabird hearing ranges and sensitivity in air are consistent with what is known about bird hearing in general.

Landing engine noise and sonic boom may cause temporary physiological or behavioral disturbances to Hawaiian petrels. These disturbances would be short in duration and may startle individuals, causing minor behavioral disruptions. The potential effects would vary among individuals due to temperament, sex, age, and prior experience with noise, as well as the distance to the noise source. Due to the short-term, transient nature of engine noise and sonic boom and low densities of this species within the Action Area, the potential effects are only anticipated to be behavioral and temporary. These behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations.

5.1.15.3 Conclusion

Given the low densities of Hawaiian petrels in the Action Area any exposure to sonic boom or landing engine noise would be unlikely and only cause short-term disturbances. Therefore, the DAF has determined that Proposed Action may affect, but is not likely to adversely affect, the Hawaiian petrel.

5.1.16 Southern Sea Otter

5.1.16.1 Physical Impacts

No ground disturbing activities would occur within or near SSO habitat; therefore, the Proposed Action would have no direct physical impacts on SSO or SSO habitat.

5.1.16.2 Noise and Visual Disturbance

Historically, at least one SSO was consistently observed at Purisima Point; however, SSO are currently only occasionally observed along the coast between Purisima Point and Point Arguello transiting through the area between suitable habitat to the north and south. Beginning at the VSFB harbor and continuing south along Sudden Flats, the inshore habitat supports expansive kelp beds and a relatively high density of SSO. The estimated Falcon rocket engine noise (produced by RNoise) and sonic boom (produced by PCBoom) exposures at these areas are presented in

Table **5.1-30** and Table 5.1-31 and Figure 4.16-1 through Figure 4.16-5. As discussed previously, the estimated engine noise levels are likely to be conservatively high because the models do not take into account attenuation due to land forms (e.g., mountains, hills, valleys, etc.). Launch engine noise measurement collected at Sudden Ranch during Falcon 9 missions from SLC-4 have averaged 109.8 dB L_{max} (n=13), less than the modeled estimate of 116 dB L_{max} at this location (Appendix B). Landing engine noise has averaged 96.5 dB L_{max} , less than the modeled estimate of 108 dB L_{max} . Appendix B includes all noise levels measured during Falcon 9 launches as of 24 January 2025.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Table 5.1-30. Estimated maximum Falcon rocket engine noise levels (dB L_{max}) at SSO localities.

Location	Falcon 9 at SLC-4			Falcon 9 at SLC-6			Falcon Heavy at SLC-6		
	Static Fire	Landing	Launch	Static Fire	Landing	Launch	Static Fire	Landing	Launch
Nearest Coastline	122	130	140	130	120	130	130	110	135
VSFB Harbor	108	108	116	120	119	125	128	118	129
Sudden Ranch	108	108	116	120	119	125	128	118	129

Table 5.1-31. Estimated maximum Falcon sonic boom levels (psf) during launches and landings at SSO localities.

Location	Falcon 9 at SLC-4		Falcon 9 at SLC-6		Falcon Heavy at SLC-6	
	Launch	Landing	Launch	Landing	Launch	Landing
Nearest Coastline	-	7-8	-	10	-	10
VSFB Harbor	-	3.5-4	-	5-8	-	5-8
Sudden Ranch	-	2-3	-	3	-	3

Sonic boom modeling is performed for each SpaceX mission. Table 5.1-31 presents sonic boom levels predicted from the model produced for the Falcon 9 Bandwagon-2 mission in December 2024, which had a relatively large geographic impact area and relatively higher levels predicted than for other missions and therefore was used for this BA to represent a potential worst-case scenario (see Appendix A for variability). The mission-specific model results for landing events that have required SSO monitoring have predicted sonic booms ranging from 2 to 6 psf at a Sudden Ranch monitoring location for Falcon 9 landing events at SLC-4 (Appendix B). Measured sonic boom levels at the monitoring location for these missions have averaged 2.72 psf (n=16) and ranged from 0.71 to 5.57 psf (Appendix B). Sonic booms haven't been measured at the coastline nearest to SLC-4. However, as discussed previously, all but 8 of 50 sonic boom measurements during Falcon 9 first stage landing events at SLC-4W were within the range of predicted psf levels (Appendix B). Therefore, the sonic boom levels in Table 5.1-31, which represents a potential worst-case scenario, and the potential variation in boom model results presented in Appendix A, should be representative of the levels that would impact these areas.

The single explosive event during demolition activities at SLC-6, as discussed in Section 2.2.3, would result in substantially lower impulsive noise impacts at these locations compared to sonic booms created during landing events (see Figure 2.2-3).

Exceptionally little sound is transmitted between the air-water interface; thus, in-air sound, whether from launch, landing, or sonic boom, would not have a significant effect on submerged animals (Godin 2008). In addition, according to Ghoul and Reichmuth (2014), "[u]nder water, hearing sensitivity [of SSO] was significantly reduced when compared to sea lions and other pinniped species, demonstrating that sea otter hearing is primarily adapted to receive airborne sounds." This study suggested that SSO are less efficient than other marine carnivores at perceiving specific noise sources from ambient noise (Ghoul & Reichmuth 2014). Therefore, the potential impact of underwater noise caused by in-air sound would be discountable.

SSO in the nearshore environment of south VSFB that are not submerged during a launch or return landing may experience non-impulsive noise from rocket engines during liftoff and impulsive noise from a sonic boom during first stage landings. Specific noise exposure thresholds for temporary and permanent hearing damage in SSO have not been established. However,

similarities in the biology and hearing sensitivity between otariid pinnipeds and SSO make otariid thresholds a suitable proxy for SSO (Ghoul & Reichmuth 2014; Southall et al. 2019). The National Marine Fisheries Service established noise exposure thresholds for in-air impulsive noise for temporary threshold shift [TTS] in hearing sensitivity and for permanent threshold shifts [PTS] in hearing sensitivity for otariid and phocid pinnipeds (NMFS 2021) based on species' audiograms and the results of studies measuring threshold shifts and behavioral responses (Table 5.1-32). NMFS has not established thresholds for PTS or TTS due to in-air non-impulsive noise for pinnipeds; however, Southall et al. (2019) estimated the lower limit for TTS as a result of in-air non-impulsive noise for otariids and "other marine carnivores" (OCA) is 157 dB M-weighted Sound Exposure Level (SEL), and the lower limit for PTS is 177 dB M-weighted SEL (Table 5.1-33). M-weighting is adjusted for the hearing sensitivity of otariids and OCA per Southall et al. 2019. Applying M-weighted thresholds to unweighted exposure levels is a conservative approach to determining if thresholds are exceeded (i.e., unweighted dB would be greater than the same levels with an M-weighted filter applied and therefore overestimate an individuals perceived noise exposure).

Table 5.1-32. In-air impulsive noise thresholds for TTS and PTS in otariid pinnipeds in peak decibels and equivalent pounds per square foot.

TTS (unweighted; re 20 μPa)	PTS (unweighted; re 20 μPa)
170 dB L_{max} (132.1 psf)	176 dB L_{max} (263.6 psf)

Source: NMFS 2021

L_{max} = maximum sound pressure level; dB = decibels; dB re 20 μ Pa = decibels related to 20 micropascals

Table 5.1-33. In-air non-impulsive noise thresholds for TTS and PTS in otariid pinnipeds.

TTS (M-weighted*; re 20 μPa)	PTS (M-unweighted; re 20 μPa)
157 dB SEL	177 dB SEL

Source: Southall et al. 2019

SEL = sound exposure level; dB = decibels; dB re 20 μ Pa = decibels related to 20 micropascals

* M-weighted is based on a filter applying otariid hearing sensitivity presented in Southall et al. 2019.

The DAF applied these thresholds, modeling results, and ground measurements as the best available science to estimate the effects of in-air impulsive and non-impulsive noise exposures presented herein. PCBoom estimated that the loudest potential sonic booms (impulsive noise) may occur during double booster landings at SLC-6. The levels predicted at the nearest coastline location, where transiting SSO are rarely observed, is 0.6 mi from the proposed landing zones and are predicted to be up to approximately 10.0 psf (Figure 4.16-5). The highest level measured during a Falcon Heavy double booster landing at the Kennedy Space Center during the Arabsat 6A mission on 11 April 2019 was 7.7 psf at 0.3 mi from the landing pads (National Academies of Sciences, Engineering, and Medicine 2020). Both the maximum sonic boom level estimated by PCBoom and measured at 0.3 mi during the Arabsat 6A mission are an order of magnitude less

than the TTS-onset threshold for in-air impulsive noise (132 psf; Table 5.1-32). The landing zone at SLC-4 is a similar distance (0.6 mi) from coastline where transiting SSO are rarely observed and much further (5.5 mi) from areas where SSO are regularly observed near the Boat Dock. Therefore, no SSO would be exposed to impulsive noise levels that would cause TTS or PTS as a result of Falcon 9 launches from SLC-4 or SLC-6 or Falcon Heavy launches from SLC-6.

Models for rocket engine noise do not currently produce M-weighted estimates of noise metrics to directly compare to the in-air non-impulsive thresholds presented in **Table 5.1-33** developed by Southall et al. 2019. However, unweighted measurements of SEL were collected during the Falcon Heavy Arabsat 6A mission at varying distances from the launch pad and, as noted above, comparing M-weighted thresholds to unweighted received levels is a conservative approach in determining if thresholds would be exceeded. During the Arabsat 6A launch, the nearest recording station to the launch pad, 0.3 mi, measured 152 dB unweighted SEL, less than the 157 dB M-weighted SEL threshold (Table 5.1-33; National Academies of Sciences, Engineering, and Medicine 2020). The nearest coastline to the launch pad where transiting SSO are rarely observed is at SLC-6 is 0.9 mi, and the nearest location where SSO are routinely observed is near the Boat Dock at 2.2 mi from SLC-6 (Figure 4.16-1 through Figure 4.16-5). During the Arabsat 6A launch, one recording station was 2.0 mi from the launch pad and measured 141.9 dB unweighted SEL, substantially below the threshold of 157 dB M-weighted SEL. The Falcon 9, with only one first stage compared to the equivalent of three first stages on the Falcon Heavy, is a quieter vehicle. In addition, SLC-6 and the proposed landing zones are closer to potential SSO locations than SLC-4. Therefore, no SSO would be exposed to in-air non-impulsive noise that would cause TTS or PTS as a result of Falcon 9 from SLC-4 or SLC-6 or Falcon Heavy launches from SLC-6.

Extensive launch monitoring has been conducted for SSO on both north and south VSFb, with pre- and post-launch counts and observations conducted at rafting sites immediately south of Purisima Point for numerous Delta II launches from SLC-2 and one Taurus launch from Launch Facility-576E and at the rafting sites off of Sudden Flats for two Delta IV launches from SLC-6. No abnormal behavior, mortality, or injury of effects on the population has ever been documented for SSO as a result of launch-related noise and visual disturbance (SRS Technologies, Inc. 2006b, 2006d, 2006e, 2006f, 2006g, 2006i, 2006k, 2006l; MSRS 2007a, 2007b, 2007c, 2008a, 2008b, 2009d; 2021c). More recently, for the SpaceX Falcon 9 SAOCOM launch and landing on 7 October 2018, SSO were monitored during pre- and post-launch surveys on south VSFb (MSRS 2018d). The sonic boom received at the SSO monitoring location was estimated at 0.71 psf and the maximum landing engine noise at this location was estimated at 99.5 dB L_{max} . Count totals of both pups and adults were similar before and after the launch and there was no discernable impact on SSO on south VSFb. Additionally, SSO were monitored during 2 Falcon 9 launches with SLC-4 landings during 2022 and 4 launches with SLC-4 landings during 2023. For each of these missions SSO totals during post-launch counts were either similar to pre-launch counts or were lower because of factors other than the sonic boom (e.g., high winds, high swell, and rain) that impacted the south VSFb rafting sites (U.S. Space Force 2024). None of the sonic booms produced during any of the first stage landings had discernible impacts on overall SSO numbers at the monitoring sites (MSRS 2024b).

Launches and landings and accompanying noise and visual disturbance would be expected to result in minor behavioral response. This has been confirmed by monitoring and recording groups

of SSO during two Falcon 9 missions which included first stage landing at SLC-4: Transporter 11 and OneWeb-4. During the Transporter 11 mission during the day on 16 August 2024, SSO reacted to the launch by alerting and diving and had a similar reaction during the landing and sonic boom with the SSO resurfacing within minutes and the entire group completely resettled at approximately 30 minutes after the launch (MSRS 2024c). During the OneWeb-4 mission during the night of 19 October 2024, all SSO reacted to the launch by diving, which corresponded to peak visual disturbance and launch noise, but had no reaction to the sonic boom during landing. Individuals began resurfacing within one to two minutes, with all SSO resettled within approximately 9 minutes of the launch (MSRS 2024d).

If disturbed, SSO typically dive under the water and therefore minimize potential noise exposure anyway. As noted in Section 2.2.4, landing noise follows launch by approximately 5 to 7 minutes and typically occurs slightly before the sonic boom impacts land. Therefore, any individuals that flee into water as a result of launch disturbance would reduce their likelihood of being exposed to the landing engine noise and sonic boom due to the attenuation of sound in water (Godin 2008). As a result, there would not be an opportunity for chronic noise exposure in SSO. However, SSO are the smallest marine mammal and lack some of the thermoregulatory adaptations that are seen in cetaceans and pinnipeds, which results in elevated thermal energetic costs for SSO (Costa & Kooyman 1984; Yeates et al. 2007). As a result, if resting SSO are disrupted frequently, there may be energetic consequences that could affect fitness and survival of individuals. Yeates et al. (2007) found that mean metabolic rate for single dives (non-foraging dives), typically lasting 1 to 3 minutes, were only 1.3 times as great as resting metabolic rate in the SSO. Most of the reactions documented during the Transporter 11 and OneWeb-4 missions were short dives; however, some individuals swam for approximately nine minutes in addition to diving. Swimming is approximately 2 times as great as resting metabolic rate (Yeates et al. 2007). Using the metabolic rates, activity budget, and energetic costs for male SSO reported in Yeates et al. (2007), the energetic cost of a male SSO disturbed from rest and swimming for 10 minutes was estimated to be an increase of approximately 1% in energetic cost over one day (Table 5.1-34). Because there would only be approximately two launch events per week and not all SSO are expected to react to this degree (most resume normal behavior within 2 to 3 minutes), the effect on energetic expenditure would be insignificant.

Table 5.1-34. Activity budget and energetic expenditure for “normal” and “disturbed” male southern sea otter, adapted from Yeates et al. 2007. (Note: values in red reflect assumed changes in energetic expenditure due to a 10-minute disturbance from resting to swimming. Total MJ per day calculated assuming a mean body mass of adult male sea otters is 27.7 kg)

Behavior	Proportion of 24-hr day normal	Minutes day ⁻¹ normal	Proportion of 24-hr day disturbed	Minutes day ⁻¹ disturbed	MJ day ⁻¹ kg ⁻¹ normal	MJ day ⁻¹ kg ⁻¹ disturbed	Total MJ day ⁻¹ normal	Total MJ day ⁻¹ disturbed
Resting	0.402	579	0.395	569	0.156	0.154	4.33	4.27
Feeding	0.363	522	0.363	522	0.224	0.224	6.22	6.22
Grooming	0.091	131	0.091	131	0.077	0.077	2.21	2.21
Swimming	0.085	122	0.092	132	0.072	0.078	1.94	2.16
Other	0.073	105	0.073	105	0.051	0.051	1.39	1.39
						Total MJ	16.09	16.25

MJ = megajoule, kg = kilogram

For a lactating female SSO with a large post-molt pup, an average swimming metabolic rate (0.49 KJ/min/kg) and average resting rate (0.27 KJ/min/kg) were used after applying a correction factor of 51.8% (Thometz et al. 2016). The resulting adjusted rates for lactating females were 0.744 KJ/min/kg for swimming and 0.41 KJ/min/kg for resting. The same approach was applied as above for male SSO to estimate the metabolic cost of a 10 minute disruption in rest caused by a rocket launch, with the assumption that lactating females behaviors were spent in the same proportions to male behaviors throughout a day. The energetic cost of a lactating female SSO disturbed from rest and swimming for 10 minutes was estimated to be an increase of less than 1% in energetic cost over one day (0.07 MJ increase). Following an approach used in Barrett et al. (2025) the additional feeding requirements needed to meet this cost was evaluated by converting MJ to kilocalories (kcal) using a conversion factor of 1 MJ = 239 kcal (Ofstedal et al. 2007); therefore, the total additional caloric intake to meet this cost is 17 kcal. Ofstedal et al. (2007) provided estimates of caloric values of various prey. A female otter foraging on purple urchin (*Strongylocentrotus purpuratus*; 0.393 kcal/gram; average mass 14.43 gram), which are a relatively low value, low mass prey present in the waters off of sudden ranch, approximately 3 extra urchins would need to be consumed to meet the cost of disturbance. As noted above, there would only be approximately two launch events per week and not all SSO are expected to react to this degree. Therefore, the effect of the disturbance on energetic expenditure would be insignificant.

Table 5.1-35. Activity budget and energetic expenditure for “normal” and “disturbed” lactating female southern sea otter, adapted from Yeates et al. 2007. (Note: values in red reflect assumed changes in energetic expenditure due to a 10-minute disturbance from resting to swimming. Total MJ per day calculated assuming a mean body mass of a lactating female sea otters is 21.3 kg)

Behavior	Proportion of 24-hr day normal	Minutes day ⁻¹ normal	Proportion of 24-hr day disturbed	Minutes day ⁻¹ disturbed	MJ day ⁻¹ kg ⁻¹ normal	MJ day ⁻¹ kg ⁻¹ disturbed	Total MJ day ⁻¹ normal	Total MJ day ⁻¹ disturbed
Resting	0.402	579	0.395	569	0.237	0.233	5.05	4.97
Feeding	0.363	522	0.363	522	0.388	0.388	8.27	8.27
Grooming	0.091	131	0.091	131	0.097	0.097	2.08	2.08
Swimming	0.085	122	0.092	132	0.091	0.098	1.93	2.09
Other	0.073	105	0.073	105	0.078	0.078	1.66	1.66
MJ = megajoule, kg = kilogram						Total MJ	19.00	19.07

The lack of any demonstrated impact from launches on populations off the coast of Sudden Ranch and minimal behavioral reactions observed is likely because there is little overlap in the hearing sensitivity of SSO (primarily 2 to 22 kHz) and launch engine noise, which is primarily below 250 Hz, with moderate energy to 2 kHz range, and little energy above 2 kHz, as discussed below. While a 2-psf sonic boom is approximately 135 dB (unweighted) L_{max} , it is likely that most of that acoustic energy from the sonic boom is not heard by SSO anyway. Similarly, the frequency spectrum of a 1.5-psf sonic boom (recorded at San Nicolas Island on 12 December 2014) has little overlap with the hearing curve of a SSO (Ghoul & Reichmuth 2014; Figure 5.1-17). Most of the sonic boom energy is less than 250 Hz, well below the region of best sensitivity of the SSO (2–22.6 kHz; Figure 5.1-17). While the SSO would likely hear the sonic boom, it would only be

responding to acoustic energy that is above 250 Hz and total sound levels much less than 135 dB unweighted $L_{\max}$. As the sonic boom increases in pressure, it is likely that more energy would be detected by the SSO, most notably in frequencies higher than 250 Hz.

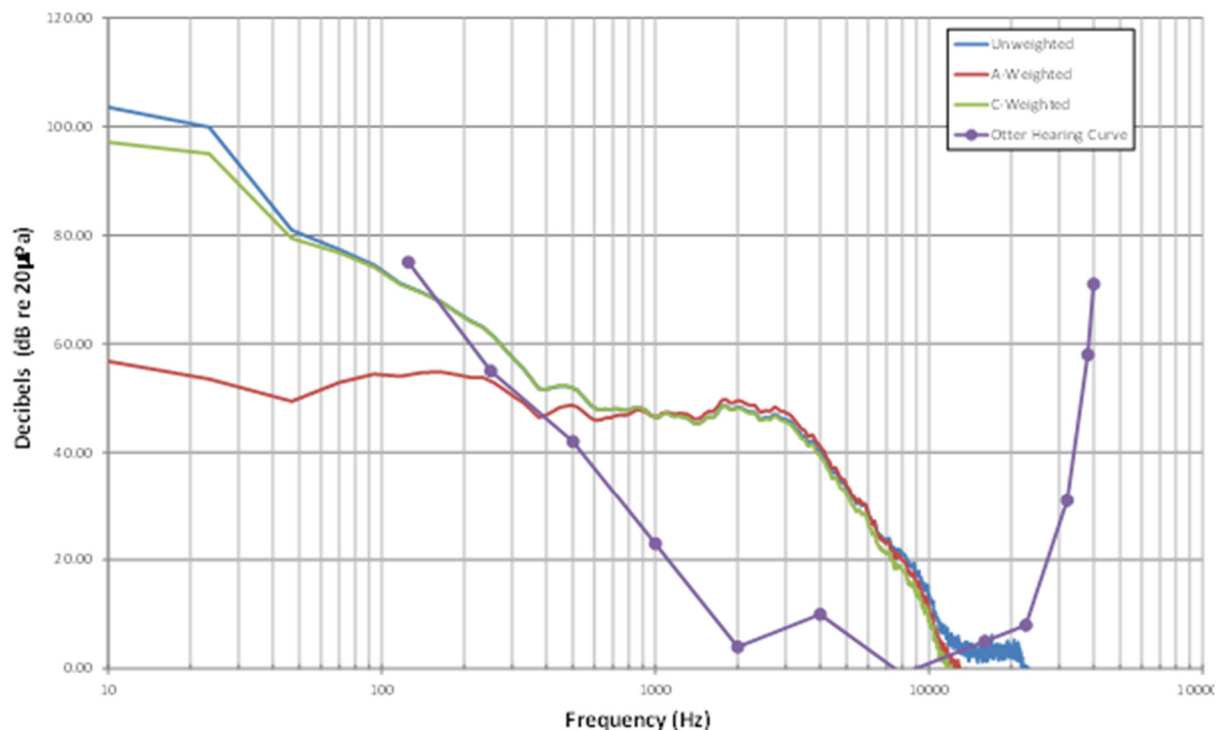


Figure 5.1-17. Sonic boom spectrum and sea otter hearing sensitivity curve.

To determine how much rocket engine noise SSO would be able to sense, a frequency-weighting filter was developed for SSO. Ghouli & Reichmuth (2014) developed an audiogram for the northern sea otter (*Enhydra lutris kenyoni*; Figure 5.1-18). Following methods established in Southall et al. (2019), this audiogram was used to derive an auditory weighting function to serve as a frequency-specific filter to quantify how noise may be perceived by SSO, given its spectral content (Figure 5.1-19), and how that would relate to the spectral characteristics of an otter's potential susceptibility to noise. Weighting functions are used to de-emphasize noise at frequencies where susceptibility is lower and emphasize noise at frequencies where sensitivity is greater.

To determine the resultant level of in-air noise that is potentially perceived by a SSO during launch, the otter weighting function was applied to the timewave form recording of the June 2022 Falcon 9 SARah-1 launch. The unfiltered time waveform had a frequency spectra with an unweighted peak level of approximately 110 dB $L_{\max}$ (Figure 5.1-20). After applying the otter weighting function, the peak level was approximately 70 dB $L_{\max}$ (Figure 5.1-20), which by comparison to human hearing sensitivity is equivalent to the sound level of a household washing machine. Therefore, the perceived noise during rocket launches under the Proposed Action would be significantly less than the unweighted modeling results of between 100 and 110 dB $L_{\max}$ at Sudden Ranch would suggest.

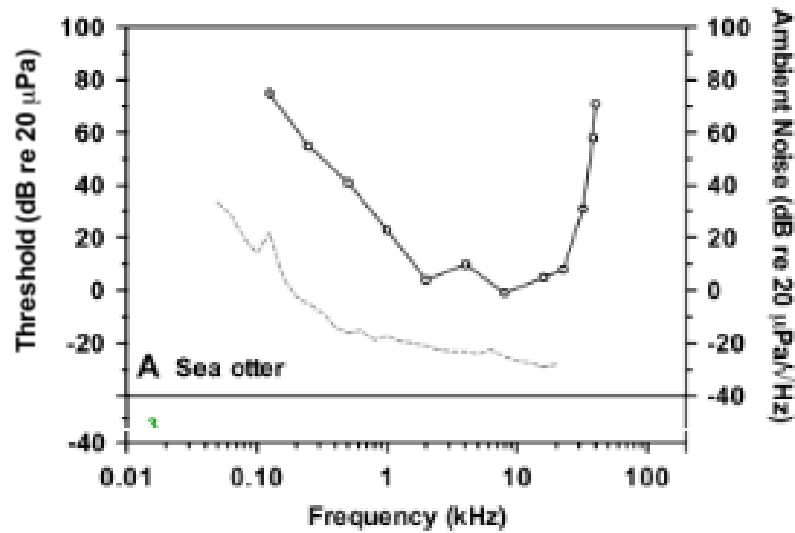


Figure 5.1-18. Northern sea otter audiogram (solid dotted line; source: Ghoul & Reichmuth 2014).

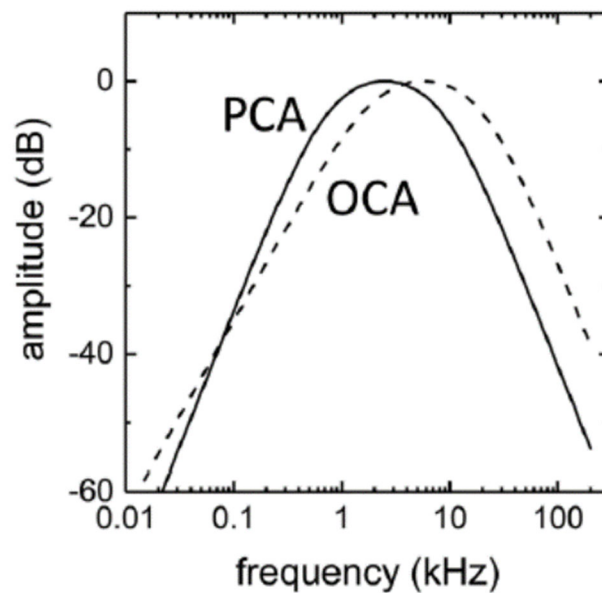


Figure 5.1-19. Sea otter derived auditory weighting function (dotted line; OCA = other carnivores in-air and is appropriate for otters; PCA = phocids in-air; Source: Southall et al. 2019).

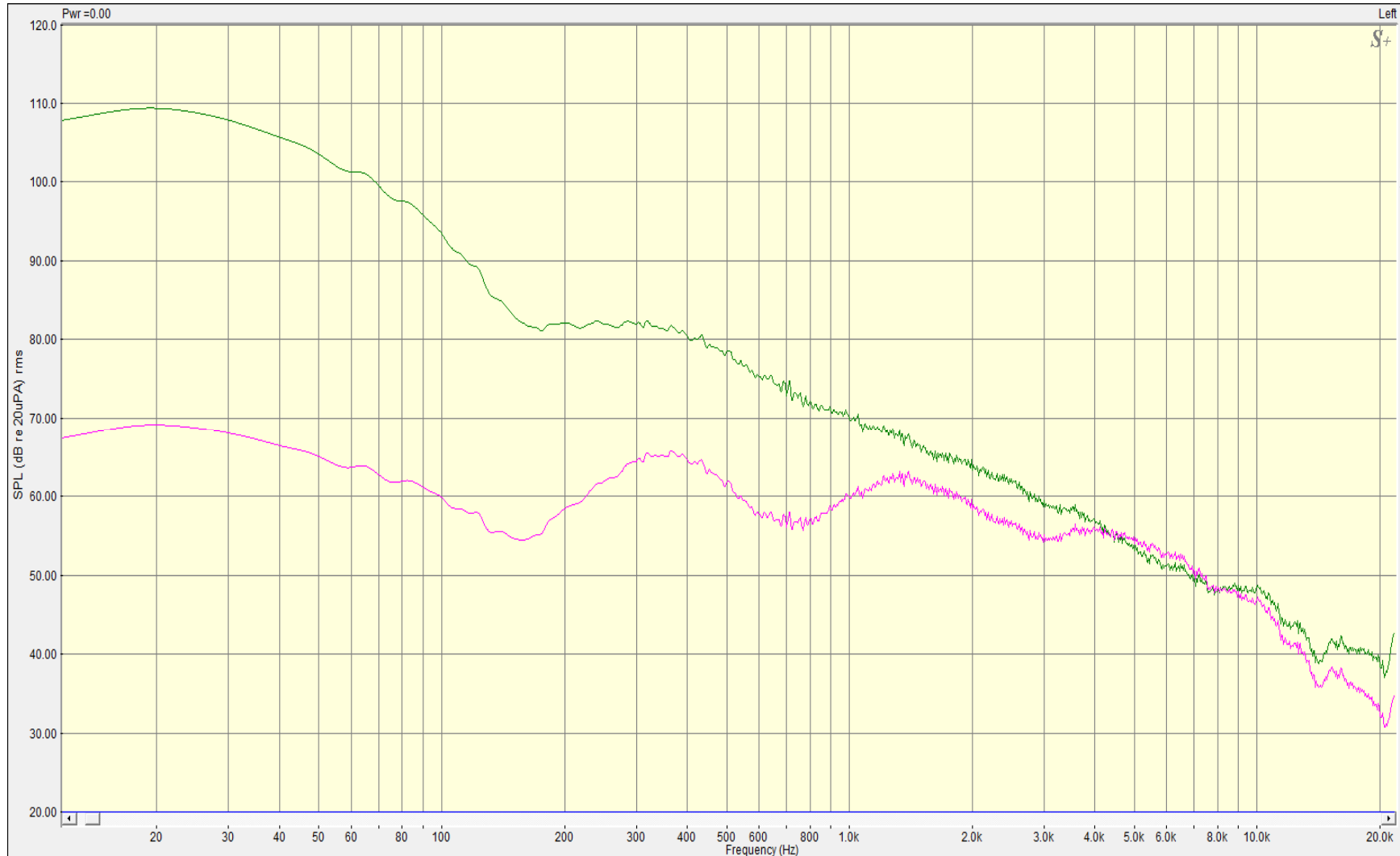


Figure 5.1-20. Launch peak noise level comparison of unweighted (green) versus otter-weighted (purple) decibels (note: time waveform recording from the June 2022 Falcon 9 SARah-1 launch).

Finally, northern sea otters have also been shown to quickly acclimate to disturbances from boats, people, and harassment devices (air horns). Davis et al. (1988) conducted a study of northern sea otter's reactions to various underwater and in-air acoustic stimuli. The purpose of the study was to identify a means to move northern sea otters away from a location in the event of an oil spill. Anthropogenic sound sources used in this behavioral response study included truck air horns and an acoustic harassment device (10 to 20 kHz at 190 dB) designed to keep dolphins and pinnipeds from being caught in fishing nets. The authors found that the northern sea otters often remained undisturbed and quickly became tolerant of the various sounds. When a fleeing response occurred as a result of the harassing sound, northern sea otters generally moved only a short distance (328 to 656 ft [100 to 200 m]) before resuming normal activity (Davis et al. 1988).

Curland (1997), studying the SSO, also found that they may acclimate to disturbance. The author compared otter behavior in areas with and without human-related disturbance (e.g., kayaks, boats, divers, planes, sonic booms, and military testing at Fort Ord) near Monterey, California. SSO spent more time traveling in areas with disturbance compared to those without disturbance; however, there was no significant differences in the amount of time spent resting, foraging, grooming, and interacting, suggesting that the SSO were becoming acclimated to regular disturbances from a variety of sources (Curland 1997). Extensive launch monitoring of SSO on VSFB has shown that disturbance from rockets is not a primary driver of SSO behavior or use of the habitat along Sudden Flats and has not had any apparent long-term consequences on populations. Therefore, any impacts as a result of noise (launch, landing, and sonic boom) or visual disturbance are expected to be limited to minor behavioral disruption.

5.1.16.3 Conclusion

Because there is very little overlap in the hearing sensitivity of SSO and noise produced during rocket launches and landings, SSO would perceive very little noise during launch activities. Additionally, if SSO do react to the launch and landing, the disturbance, if at rest, would result in an increase of approximately only 1% of daily energy expenditure. However, because such potential disturbance would be more frequent under the Proposed Action, the DAF has determined that impacts on SSO under the Proposed Action may affect, and is likely to adversely affect, the SSO off the coast of VSFB.

5.2 Direct and Indirect Effects on Critical Habitat

5.2.1 Tidewater Goby

The potential ascent sonic boom footprint from missions with easterly trajectories overlaps Critical Habitat Units SB-8, 9, 10, 11, and 12, VEN-1, 2, 3, and 4, and LA-1, 2, 3, and 4 (Figure 4.1-2). Sonic booms would not affect any of the PCEs for Critical Habitat (i.e., substrates, submerged and emergent aquatic vegetation, or the presence of sandbars at lagoons or estuaries; see Section 4.1.4). Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.2 California Tiger Salamander

The Action Area includes designated Critical Habitat Units 1, 2, 3, 4, 5, and 6 for the Santa Barbara DPS of the CTS (Figure 4.3-1 through Figure 4.3-5). The Proposed Action would have no ground

disturbing activities or impacts on any of the PCEs for Critical Habitat (i.e., standing bodies of fresh water, upland habitats adjacent to breeding ponds, or upland dispersal habitat; see Section 4.3.4). Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.3 California Red-Legged Frog

The Action Area includes the following designated Critical Habitat units for the CRLF: STB-2, STB-4, STB-5, and STB-6 (Figure 4.4-1 through Figure 4.4-5). The potential ascent sonic boom footprint from missions with easterly trajectories overlaps STB-7, VEN-1, VEN-2, VEN-3, and LOS-1 (Figure 4.4-9). The Proposed Action would have no ground disturbing activities or impacts on water quality within Critical Habitat. Therefore, the Proposed Action would not affect any of the PCEs for Critical Habitat (i.e., space for individuals and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding; and habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distribution of the species). Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.4 Southwestern Willow Flycatcher

The Action Area includes the designated Critical Habitat along the Santa Ynez River east of Lompoc (Figure 4.7-1 through Figure 4.7-5). Additionally, in the region potentially impacted by ascent sonic booms during missions with easterly trajectories, Critical Habitat has been designated in the upper Santa Ynez River, the Ventura River, and the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.7-6). The Proposed Action would have no ground disturbing activities within SWFL Critical Habitat and would not affect any of the PCEs (i.e., riparian vegetation or prey populations; see Section 4.7.4). Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.5 Least Bell's Vireo

In the region potentially impacted by ascent sonic booms during missions with easterly trajectories, Critical Habitat has been designated in the upper Santa Ynez River in eastern Santa Barbara County and the Santa Clara River drainage in Ventura and Los Angeles Counties (Figure 4.8-6). There are no activities under the Proposed Action that would impact physically impact LBVI Critical Habitat. Subsequently the Proposed Action would not affect any of the PCEs (i.e., "riparian woodland vegetation that generally contains both canopy and shrub layers, and includes some associated upland habitats"; 59 FR 4845-4867).. Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.6 Western Snowy Plover

The Action Area includes portions of Santa Rosa Island which are designated Critical Habitat for the SNPL (Figure 4.9-6 and Figure 4.9-7). These areas would receive ascent sonic booms greater than 1 psf during up to 100 Falcon missions each year. Depending on mission trajectories, ascent sonic boom may occasionally reach approximately 8 psf. Sonic boom footprints vary by mission-specific trajectories and weather conditions and the actual number of impacts above 1 psf would likely be less than 100 per year. Additionally, in the region potentially impacted by sonic booms during missions with easterly trajectories, the Action Area includes various Critical Habitat units

along the coast of eastern Santa Barbara, Ventura, and Los Angeles Counties (Figure 4.9-9). The Proposed Action does not include any ground disturbance within Critical Habitat nor would it appreciably diminish the species' prey base or effect any other PCEs.

The DAF interprets the designation of Critical Habitat and development of PCEs (78 FR 344-534) as clearly focused on the physical presence of humans, pets, and off-highway vehicles (OHVs), not noise. The definition of “undisturbed areas” points to physical presences of humans, pets, and off-highway vehicles (OHVs) rather than noise, for example *“humans or pets approach too closely”*, *“dogs may also deliberately chase plovers and inadvertently trample nests, while vehicles may directly crush adults, chicks, or nests, separate chicks from brooding adults, and interfere with foraging and mating activities”*, *“use of OHVs has been documented to crush plover nests and strike plover adults”*, and the potential for *“repeated flushing of incubating plovers”*. In evaluation of the status of subunits, the analysis repeatedly focused on physically present threats, for example: *“The physical or biological features essential to the conservation of the species may require special management considerations or protection to address the main threats from nonnative vegetation, predators, OHVs, and disturbance from equestrians and humans with pets”*. Areas without noise disturbance were not included in the PCEs. Therefore, because the Proposed Action would have no physical impact on Critical Habitat, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.7 California Condor

The potential ascent sonic boom footprint from missions with easterly trajectories overlaps the Sisquoc-San Rafael, Matilija, and Sespe-Piru Critical Habitat units (Figure 4.11-1). The Critical Habitat designation for California condor did not include a description of Physical and Biological Features; however, no ground disturbing activities under the Proposed Action would occur in designated Critical Habitat for this species and sonic booms greater than 1.0 psf would be very rare. Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.2.8 California Gnatcatcher

The potential ascent sonic boom footprint from missions with easterly trajectories overlaps Unit 13 in western Los Angeles and Ventura Counties (Figure 4.12-1). There are no ground disturbing activities within CAGN Critical Habitat; subsequently, the Proposed Action would not have any impacts on the Critical Habitat PCEs for CAGN (i.e., dynamic and successional sage scrub habitats or non-sage habitats in proximity to sage scrub; see Section 4.12.1). Therefore, the Proposed Action would have no effect on Critical Habitat for this species.

5.3 Cumulative Effects

Cumulative effects are defined in 50 C.F.R. § 402.02 as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area of the Federal action subject to consultation.” Reasonable, foreseeable, future federal actions, and potential future federal actions, that are unrelated to the Proposed Action, are not considered in the analysis of cumulative effects because they would require separate

consultation pursuant to Section 7 of the ESA. There are no activities within the Action Area that would contribute to cumulative effects related to the Proposed Action.

5.4 Potentially Related Activities

There are no other activities with a “but for” relationship to the Proposed Action and reasonably certain to occur that would contribute to effects of the action.

6 Conclusion

SpaceX proposes to increase the Falcon annual launch cadence at VSFB to 100 per year cumulatively between SLC-4 and SLC-6, including up to 5 Falcon Heavy mission per year at SLC-6. SpaceX will continue to land up to 12 first stage recoveries per year at SLC-4W, proposes to land up to 17 first stages/boosters per year at SLC-6, as described in Section 2.2.6, and will continue to recover first stages downrange on offshore landing locations in the Pacific Ocean. SpaceX will also redevelop SLC-6 to accommodate the Falcon program and a new landing zone. This Proposed Action would result in increases in airborne noise and visual disturbance during launches, static fire, and landing events within the Action Area, as well as potential physical impacts during construction.

After reviewing the Proposed Action, including the proposed avoidance, minimization, monitoring, and mitigation measures (Section 2.3), the DAF has come to the conclusions which are summarized in Tables 6.0-1 and 6.0-2.

Table 6.0-1. Federally listed species with potential to occur in the Action Area and summary of effects determinations.

Common Name	Scientific Name	Federal Listing	Effects Determinations for the Proposed Action
Tidewater Goby	<i>Eucyclogobius newberryi</i>	Endangered	May affect, not likely to adversely affect.
Unarmored Threespine Stickleback	<i>Gasterosteus aculeatus williamsoni</i>	Endangered	May affect, not likely to adversely affect.
California Tiger Salamander Santa Barbara DPS	<i>Ambystoma californiense</i>	Endangered	May affect, not likely to adversely affect.
California Red-legged Frog	<i>Rana draytonii</i>	Threatened	May affect, likely to adversely affect.
Arroyo Toad	<i>Anaxyrus californicus</i>	Endangered	May affect, not likely to adversely affect.
Marbled Murrelet	<i>Brachyramphus marmoratus</i>	Threatened	May affect, not likely to adversely affect.
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	Endangered	May affect, not likely to adversely affect.
Least Bell's Vireo	<i>Vireo bellii pusillus</i>	Endangered	May affect, not likely to adversely affect.
Western Snowy Plover	<i>Charadrius nivosus</i>	Threatened	May affect, likely to adversely affect.
California Least Tern	<i>Sternula antillarum browni</i>	Endangered	May affect, likely to adversely affect.
California Condor	<i>Gymnogyps californianus</i>	Endangered	May affect, not likely to adversely affect.
California Gnatcatcher	<i>Poliophtila californica californica</i>	Threatened	May affect, not likely to adversely affect.

Common Name	Scientific Name	Federal Listing	Effects Determinations for the Proposed Action
Light-footed Clapper Rail	<i>Rallus obsoletus levipes</i>	Endangered	May affect, not likely to adversely affect.
Short-tailed Albatross	<i>Phoebastria (=Diomedea) albatrus</i>	Endangered	May affect, not likely to adversely affect.
Hawaiian Petrel	<i>Pterodroma sandwichensis</i>	Endangered	May affect, not likely to adversely affect.
Southern Sea Otter	<i>Enhydra lutris nereis</i>	Threatened	May affect, likely to adversely affect.

Table 6.0-2. Designated critical habitat within the Action Area and effects determinations.

Common Name	Scientific Name	Federal Listing	Effects Determinations for the Proposed Action
Tidewater Goby	<i>Eucyclogobius newberryi</i>	Endangered	No Effect
California Tiger Salamander	<i>Ambystoma californiense</i>	Endangered	No Effect
California Red-legged Frog	<i>Rana draytonii</i>	Threatened	No Effect
Arroyo Toad	<i>Anaxyrus californicus</i>	Endangered	No Effect
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	Endangered	No Effect
Least Bell's Vireo	<i>Vireo bellii pusillus</i>	Endangered	No Effect
Western Snowy Plover	<i>Charadrius nivosus</i>	Threatened	No Effect
California Condor	<i>Gymnogyps californianus</i>	Endangered	No Effect
California Gnatcatcher	<i>Poliophtila californica californica</i>	Threatened	No Effect

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