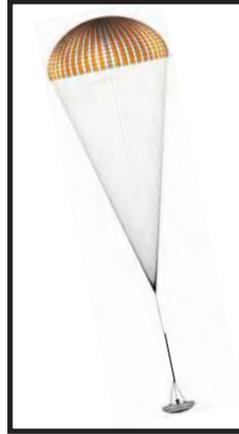


**National Aeronautics and Space Administration  
Low Density Supersonic Decelerator  
Technology Demonstration Mission  
Pacific Missile Range Facility**



**Supplemental Environmental Assessment**  
Draft

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# **Executive Summary**

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# EXECUTIVE SUMMARY

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## Introduction

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. The 2013 Final EA addressed the first demonstration test which was successfully conducted in June 2014, as well as the campaigns planned in 2015 consisting of three additional demonstration tests. Based on information gleaned from the first test, the purpose of this Supplemental Environmental Assessment (SEA) is to evaluate the potential environmental consequences (environmental impacts) of changes planned for future campaigns. These changes consist of the No-action Alternative, Alternative 1, and Alternative 2:

- **No-action Alternative:** Under the No-action Alternative, NASA would conduct the Proposed Action as detailed in the 2013 LDSD Final EA and with the clarification that some recovery aids discussed in that EA may or may not be employed. This proposed test campaign would consist of launch, operation, and recovery of up to four missions from a designated location on PMRF. The Supersonic Flight Dynamics Test (SFDT) campaign would consist of up to four flights from approximately June to July 2014 and June to August 2015. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.2.2.1 (Operational Facilities) and 2.4.2 (Launch Operation) of this SEA would apply.
- **Alternative 1 (Preferred Alternative):** Consists of using additional open ocean splashdown area within and outside of Papahānaumokuākea Marine National Monument (PMNM) and additional launch years. For Alternative 1 (Preferred Alternative), these changes consist of (1) permit authorization from NOAA for flight hardware to potentially fly over, splashdown, and be recovered within the easternmost part of PMNM (except balloon flight train which would rapidly sink in the open ocean); and (2) perform up to two LDSD TDM test flights annually over the next 5 years, starting in June 2015 and ending in August 2019. Issuance of the permit is contingent upon final approval of this SEA and associated FONSI.
- **Alternative 2:** Consists of adding additional launch years to the 2013 Final EA with the clarification that some recovery aids discussed in that EA may or may not be employed. For Alternative 2, these changes consist of additional test flights of up to two missions per year over the next 5 years (June 2015–August 2019) from a designated location on PMRF using the flight trajectory outlined in the 2013 LDSD Final EA. For future testing, the full open ocean recovery of the expended flight hardware, including balloon carcass, Test

1 Vehicle, and supersonic parachute, will take place within a pre-coordinated  
2 operational area located west by northwest of PMRF. Under Alternative 2,  
3 Sections 2.2.2.1 (Operational Facilities) and 2.4.2 (Launch Operation) of this  
4 SEA would apply.

5 This SEA is in compliance with the following statutes, regulations, and procedures:

- 6 • National Environmental Policy Act (NEPA) of 1969, as amended (42 United  
7 States Code [U.S.C.] 4321 et seq.)
- 8 • Council on Environmental Quality (CEQ) Regulations for Implementing the  
9 Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts  
10 1500-1508)
- 11 • NASA NEPA Implementing Regulation (Subpart 1216.3)
- 12 • NASA Procedural Requirement 8580.1, NASA National Environmental Policy  
13 Act Management Requirements
- 14 • Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal  
15 Actions
- 16 • Presidential Proclamation, 8031 Establishment of the Northwestern Hawaiian  
17 Islands Marine National Monument
- 18 • 50 CFR Part 404, Northwestern Hawaiian Islands Marine National Monument

## 19 **Background**

20 In May 2013, NASA completed the *Low Density Supersonic Decelerator Technology*  
21 *Demonstration Mission (TDM) Pacific Missile Range Facility (PMRF) Final*  
22 *Environmental Assessment (LDSD Final EA)* and issued its FONSI on 10 May 2013.  
23 Subsequent to issuing the FONSI, NASA continued its mission planning and ultimately  
24 conducted the first LDSD flight in June 2014. Lessons learned from this initial LDSD  
25 flight indicated that changes to the Proposed Action as described in the LDSD Final EA  
26 could be warranted.

27 Accordingly, NASA has prepared this SEA as a supplement to the 2013 LDSD Final EA  
28 to evaluate the environmental consequences of operational changes it proposes for  
29 future LDSD test flights.

30 The following three sections of the Executive Summary provide (1) a summary of the  
31 June 2014 LDSD test flight; (2) a summary of the lessons learned that prompted NASA  
32 to consider modifying its Proposed Action; and (3) a summary of the Federal  
33 authorization needed to undertake the proposed changes.

### 34 **1. 2014 LDSD SFDT Flight Summary**

35 The LDSD Project's first Supersonic Flight Dynamics Test (SFDT) on 28 June 2014  
36 from the U.S. Navy's PMRF represented the culmination of years of planning,

1 development, and ingenuity by multiple NASA centers. The focus of this first SFDT was  
2 to determine if the devised test architecture and Concept of Operations (ConOps)  
3 achieved engineering and technology conditions to push the limits of the decelerators  
4 being developed. The SFDT had to be accomplished within established requirements  
5 outlined in the LDSD project's EA, NASA's Safety policies defined in the Wallops Flight  
6 Facility Range Safety Manual, and the U.S. Navy's Safety policies defined in the Range  
7 Safety Operational Plan.

8 Although the initial 2-week launch window opened on 2 June 2014, the LDSD project  
9 experienced daily upper wind conditions that preempted all launch attempts during that  
10 window. The LDSD project and the U.S. Navy's Management coordinated a second  
11 launch window at the end of June 2014 requiring redeployment of project personnel and  
12 support assets. The first day of the second launch window opened on 28 June 2014  
13 and provided a valid opportunity for launch. The predicted balloon trajectory was along  
14 a path north of Niihau. This particular balloon trajectory only afforded an approximate  
15 30-minute decision window whether to drop the Test Vehicle based on any inflight  
16 anomalies (i.e., unplanned scenarios) that might occur. The LDSD project accepted the  
17 risks associated with this northern trajectory and moved forward with a launch attempt.  
18 After numerous decision meetings, all Go/No Go criteria were green and the balloon  
19 was released from the launch site at PMRF.

20 The balloon ascent progressed in accordance to plan except for slightly higher upper air  
21 wind speeds than predicted and the balloon's ascent being slightly slower than  
22 predicted. Each of these slight changes to the timeline narrowed the overall margin in  
23 the decision window for Test Vehicle drop before initiation of the SFDT. Had there been  
24 any significant delay in the mission (e.g., non-participating vessels in the range,  
25 hardware issue, etc.), then the U.S. Navy Range Safety Organization would have  
26 issued a mission termination order, resulting in an immediate drop of the balloon and  
27 Test Vehicle into the ocean to prevent potential PMNM infringement, resulting in the  
28 likely full loss of the vehicle due to impact damage.

## 29 **2. 2014 Lessons Learned That Prompted This SEA**

30 A significant accomplishment of the LDSD project's 2014 campaign was demonstrating  
31 the ability to accurately predict the balloon's climb-out trajectory and to recover the  
32 balloon carcass and Test Vehicle. Figure 1-3 of the SEA captures recovery operations  
33 of the balloon, and Figure 1-4 shows recovery operations at the Test Vehicle recovery  
34 site. The hard lesson learned was that there is the possibility of going weeks without  
35 acceptable conditions for launch. Another lesson learned is that the northern  
36 trajectories represent significant risk of early termination unless mitigated. Based on the  
37 results of the 28 June 2014 test flight, the LDSD project decided to investigate the  
38 possibility of potentially dropping and recovering expended flight hardware, with the  
39 exception of the balloon flight train, in the eastern part of PMNM during future  
40 demonstration missions, as part of any additional flight option. This would be conducted  
41 within the boundary of PMNM as measured from PMRF, but outside of the 5.6-kilometer  
42 (km) (3-nautical-mile [nm]) Special Management Area surrounding Nihoa Island.

1 Section 1.1.3 of the SEA summarizes the request for authorization to operate within  
2 PMNM.

### 3 **3. Papahānaumokuākea Marine National Monument Permit and Authorization** 4 **Request Process**

5 In January 2015, NASA submitted to the permit coordinator an application seeking  
6 authorization to include the eastern part of PMNM surrounding Nihoa Island as part of  
7 its splashdown area for the SFDTs. NASA requests authorization under Permit  
8 Category—Conservation and Management per recommendation of the PMNM Permit  
9 Coordinator. The activity for potential entry into the monument would occur on the day  
10 of the launches beginning with the 2015 test flights scheduled for 1 June through 31  
11 August 2015. Test flights are anticipated to occur annually during the June–August time  
12 frame beginning in 2015 and ending in 2019. A launch window would be based on wind  
13 studies conducted at PMRF.

14 The LDSD project requested authorization to potentially drop and recover expended  
15 flight hardware, with the exception of the balloon flight train which would sink to the  
16 seafloor, from up to two scheduled SFDTs in 2015 (with the potential for up to two  
17 additional flights per year through 31 August 2019) in the Open Ocean Area within the  
18 boundary of PMNM, but outside of the 5.6-km (3-nm) boundary surrounding Nihoa  
19 Island. This operations area excludes the 70 hectares (170 acres) of Nihoa Island and  
20 the Special Management Area within the 5.6 km (3 nm) surrounding Nihoa Island. This  
21 permit would also allow NASA to enter PMNM for recovery purposes if the flight  
22 hardware is dropped outside PMNM and carried into PMNM by ocean currents.

23 There are two factors that determine whether entering into PMNM would be required.  
24 The presence of these factors cannot be definitively determined until after the balloon  
25 has been launched. The first factor is the progress of the balloon's ascent on its  
26 predicted trajectory. If the balloon is ascending along its predicted trajectory, then it  
27 would most likely reach float altitude well to the east of PMNM. The balloon in some  
28 cases is allowed to float westerly, providing it does not overfly Niihau. The Test Vehicle  
29 is eventually dropped, initiating the SFDT along a northeasterly trajectory and avoiding  
30 PMNM altogether. Once the Test Vehicle has been released, the balloon flight is  
31 terminated and the balloon carcass falls to the ocean for recovery.

32 The second factor in determining PMNM entry is the latitude at which the balloon is  
33 moving westerly. Under the planned (nominal) scenario, the upper level winds carry the  
34 balloon nearly due west. The possibility of the balloon entering into PMNM decreases  
35 as the point where the float altitude is reached.

36 Under unplanned (i.e., anomalous) scenarios, the winds at a given altitude may or may  
37 not be as predictable. If it is predicted that the balloon will not reach its planned  
38 (nominal) float altitude, then a decision would be made whether to continue with an  
39 SFDT attempt or terminate the flight depending on altitude reached and the predicted  
40 path the balloon is traveling. Depending on the nature and timing of the anomaly

1 (unplanned scenario), the flight system could float westerly long enough for PMNM  
2 entry.

3 In either unplanned scenario (i.e., anomalous), NASA would enter PMNM and recover  
4 all floating expended flight hardware as demonstrated in the 2014 SFDT mission.  
5 NASA would deploy three recovery vessels to Test Support Positions within the  
6 operational area outside PMNM. Immediately upon splashdown of the expended flight  
7 hardware, the vessels would be directed to the different floating hardware locations to  
8 begin recovery. During the 2014 mission, it took the respective vessels approximately 5  
9 hours to reach and recover the ring-sail parachute, 6.5 hours to reach and recover the  
10 balloon carcass, and 4 hours to reach and recover the Test Vehicle. All items  
11 designated for recovery were recovered.

12 Issuance of a PMNM permit is contingent upon final approval of this SEA and its  
13 associated signed FONSI. Access into PMNM would not occur prior to issuance of a  
14 PMNM permit. NASA anticipates receiving the PMNM Research Permit prior to the  
15 opening of the launch window on 1 June 2015. The Permit Application is attached as  
16 Appendix C of this SEA. If the permit is not received prior to 2015 launch attempts,  
17 NASA would accept the mission risks of operating as in the 2014 LDSD campaign  
18 without the possibility of entering into PMNM as described in the No-action Alternative  
19 (the Proposed Action of the 2013 Final LDSD EA).

## 20 **Purpose and Need**

21 The Proposed Action is needed to increase the number of testing opportunities and the  
22 probability of successful test flights while decreasing the risk of a scenario for an  
23 unplanned (i.e., anomalous) termination of the test flight. To execute the Proposed  
24 Action, NASA has requested authorization for entry into PMNM through a Research  
25 permit.

26 NASA could have up to two technology testing launches each year for the next 5 years  
27 (June 2015 through August 2019). The SEA is needed to present the potential  
28 environmental impacts to PMNM. The overall goals of NASA's LDSD TDM as detailed  
29 in the 2013 LDSD Final EA continue to apply to the future test flights.

## 30 **No-action Alternative**

31 Under the No-action Alternative, NASA would conduct the Proposed Action as detailed  
32 in the 2013 LDSD Final EA and with the clarification that some recovery aids discussed  
33 in that EA may or may not be employed. This proposed test campaign would consist of  
34 launch, operation, and recovery of up to four missions from a designated location on  
35 PMRF. The SFDT campaign would consist of up to four flights from approximately June  
36 to July 2014 and June to August 2015. One flight was conducted in 2014, and up to  
37 three could be conducted in 2015. Under the No-action Alternative, Sections 2.2.2.1  
38 (Operational Facilities) and 2.4.2 (Launch Operation) of this SEA would apply.

1 **Alternative 1—Proposed Action (Preferred Alternative)**

2 The Proposed Action is for NASA to be allowed access to an additional 37,600 square  
3 kilometers (km<sup>2</sup>) (10,950 square nautical miles [nm<sup>2</sup>]) of splashdown area for future  
4 SFDT test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730  
5 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within PMNM and the other approximately 8,875  
6 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM (Figure 2-2). The Proposed  
7 Action would require authorized entry into the easternmost part of the PMNM Open  
8 Ocean Area, which would consist of the splashdown, and recovery of expended flight  
9 hardware, with the exception of the balloon flight train which would sink quickly to the  
10 seafloor, from scheduled SFDTs beginning in 2015. The Proposed Action excludes the  
11 70 hectares (170 acres) of Nihoa Island and the approximately 128.5 km<sup>2</sup> (37.5 nm<sup>2</sup>)  
12 Special Management Area within 5.5 km (3 nm) surrounding Nihoa Island. NASA could  
13 have up to two technology testing launches each year for the next 5 years (June 2015  
14 through August 2019).

15 **Alternative 2—Additional Launch Years**

16 Under Alternative 2, NASA would conduct the Proposed Action as detailed in the 2013  
17 LDSD Final EA with the clarification that some recovery aids discussed in that EA may  
18 or may not be employed. The proposed test campaign for Alternative 2 would consist of  
19 launch, operation, and recovery of up to two missions per year over the next 5 years  
20 (June 2015–August 2019) from a designated location on PMRF using the flight  
21 trajectory outlined in the 2013 LDSD Final EA. Under Alternative 2, Sections 2.1.1.1.2.1  
22 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

23 **Environmental Impact Assessment Methodology**

24 *Resources Carried Forward for Detailed Analysis*

25 Table ES-1 presents the results of the process of identifying resources to be analyzed in  
26 this SEA for Alternative 1, which are air quality, biological resources and cultural  
27 resources for Open Ocean; and biological resources, cultural resources, and health and  
28 safety for Nihoa Island. The general organization of resource areas is consistent with  
29 the Final 2013 LDSD EA; however, some have been incorporated by reference in the  
30 SEA and are detailed in Table ES-1.

31 *Resources Considered but Eliminated from Detailed Analysis*

32 Fourteen areas of environmental consideration were initially evaluated to provide a  
33 context for understanding the potential effects of the Alternative 1—Proposed Action  
34 (Preferred Alternative) and to provide a basis for assessing the severity of potential  
35 environmental impacts. These areas included air quality, airspace, biological resources,  
36 cultural resource, geology and soils, hazardous materials and waste, health and safety,  
37 land use, noise, socioeconomics, transportation, utilities, visual aesthetics, and water  
38 resources. Ultimately, 3 of the 14 areas of environmental consideration were addressed  
39 for the Open Ocean Area (air quality, biological resources and cultural resources) and 2  
40 of the 14 areas of environmental consideration were addressed for Nihoa Island  
41 (biological and cultural resources), and the results are listed in Table ES-1. The

1 remaining resource areas were not analyzed in such a manner. Those resources not  
2 warranting further discussion are also presented in Table ES-1. The No-action  
3 Alternative headings of Table ES-1 refer to the analysis in the 2013 LDSD Final EA  
4 applicable to the Proposed Action in that document. For Alternative 2, analyses for the  
5 affected environment were detailed in the 2013 Final LDSD EA, and results are  
6 incorporated by reference. Table ES-2 is a summary of the cumulative effects  
7 associated with an additional 4 years of SFDT launches from PMRF.

DRAFT

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action Alternative
<b>Air Quality</b>	<p>The ballast of the balloon system provides stability and control of the balloon during ascent. The Low Density Supersonic Decelerator (LDSD) balloon system carries approximately 110 kilograms (250 pounds) of ballast consisting of very fine steel shot (grain size 0.3 to 0.5 millimeters [mm] [0.01 to 0.02 inch]), which would be released to adjust the float altitude of the balloon system. In the United States, the U.S. Environmental Protection Agency (EPA) regulates particulate matter of size 2.5 and 10 microns (1 micron is equal to 0.001 mm), as these sizes can be easily breathed into the lungs of humans or animals. However, as the particle size of the ballast exceeds 10 microns, the ballast material is not regulated by EPA. The released ballast would travel in the upper atmospheric winds and be dispersed over hundreds of kilometers. Therefore, under the Proposed Action, the emissions from Supersonic Flight Dynamics Test (SFDT) would have no significant adverse effect on existing air quality within PMNM.</p>	<p>Hawaii’s air quality standards (Hawaii Revised Statutes [HRS], Chapter 342B, Air Pollution Control and Hawaii Administrative Rules [HAR] Chapters 11-59 and 11-60.1) are broadly based and adhere to all federal emission standards for hazardous air pollutants. Due to the remote location and low level of human activities, the air of PMNM (Northwestern Hawaiian Islands) is relatively pristine.</p>	<p>Based on the Proposed Action from the 2013 LDSD Final Environmental Assessment (EA) (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.</p>
<b>Airspace</b>	<p>No incremental, additive adverse cumulative impacts to airspace were identified for the Broad Ocean Area within PMNM. The detailed analysis presented in the 2013 LDSD Final EA applies to the airspace over PMNM which includes Nihoa Island, and is therefore added by reference. NASA will comply with all applicable Federal Aviation Administration (FAA) requirements.</p>	<p>No incremental, additive adverse cumulative impacts to airspace were identified for Nihoa Island within PMNM. The detailed analysis presented in the 2013 LDSD Final EA applies to the airspace over PMNM which includes Nihoa Island, and is therefore added by reference. NASA will comply with all applicable FAA requirements.</p>	<p>Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.</p>

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

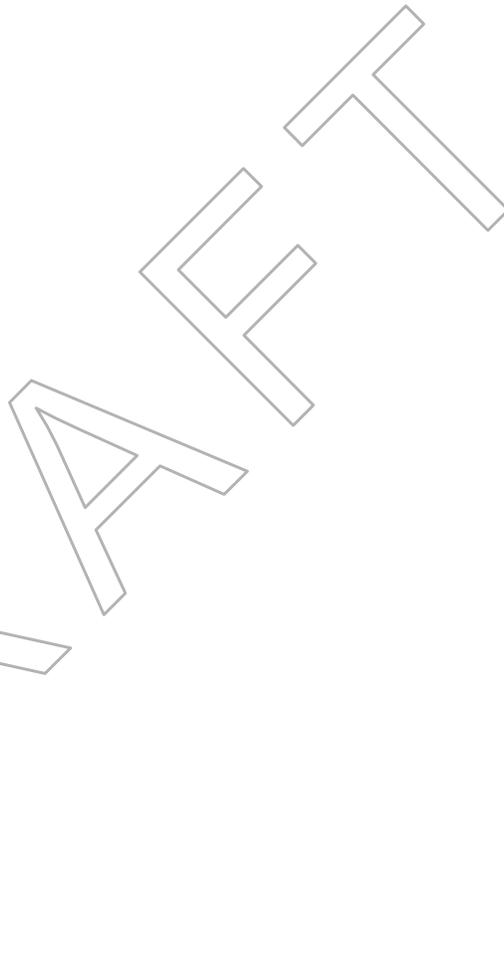
Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Biological Resources</b>	<p>The proposed activities of concern for analysis are (1) expended flight hardware, (2) unrecovered sinkable hardware, and (3) sea vessels and airplanes.</p> <p><b>Expended Flight Hardware:</b> The threatened and endangered species (cetaceans, pinnipeds, and sea turtles) and critical habitat (Hawaiian monk seal) listed in Table 3-2 of the Supplemental Environmental Assessment (SEA) have been observed and designated in the region of influence. Based on the Biological Evaluation, the Proposed Action is likely to produce stressors (i.e., 1. supersonic flight, 2. direct or proximate strike, 3. entanglement, 4. ingestion, 5. aircraft overflight, and 6. recovery vessel operations) to which listed individuals would respond if exposed. However, the likelihood of such exposures has been determined to be highly unlikely/extremely remote/very low. Based on the low density of whales during the summer, the distance from shorelines where sea turtles and Hawaiian monk seals are more likely to be encountered, the prompt recovery of all floating expended flight hardware, and the small number of overall launch attempts (up to 10 over the next 5 years), the draft determination is that the Proposed Action may affect but is not likely to adversely affect ESA-listed Hawaiian monk seals, sea turtles, whales, and Hawaiian monk seal critical habitat. There are no known endangered corals or bottomfish in the action area, and therefore no environmental impact is anticipated.</p>	<p><b>Expended Flight Hardware (Including Balloon Flight Train):</b></p> <p><b>Terrestrial</b>—The primary concern regarding terrestrial resources would be the potential for SFDT hardware to crash, burn, and/or bury an individual endangered plant and/or animal (Nihoa fan palm, `Ohai, <i>Amaranthus brownii</i>, Nihoa millerbird, Nihoa finch—see Table 3-1 in the SEA). To mitigate (reduce) the potential for environmental impact to Nihoa Island and the Special Management Area, one of two scenarios would occur: (1) the LDS Program would initiate the SFDT in such a manner that expended flight hardware would be recovered before drifting into the excluded area; or (2) the flight system would overfly the excluded area, and the Test Vehicle would be dropped outside 5.5 kilometers (km) (3 nautical miles [nm]) from Nihoa Island.</p> <p><b>Marine</b>—The endangered Hawaiian monk seal has been observed at Nihoa Island. Potential adverse environmental effects would be associated with an unplanned scenario (anomalies) which would allow SFDT hardware to encounter a Hawaiian monk seal. However, one of two scenarios listed above would occur, and the same probability assumption applied to terrestrial resources is applicable to the unexpected adverse environmental impacts to the Hawaiian monk seal. There are no endangered corals, fish, or other invertebrates found within the region of influence.</p>	<p>Based on the Proposed Action from the 2013 LDS Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.</p>

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Biological Resources (Continued)</b>	<p>For federally listed seabirds, it would be expected that the splashdown of the expended flight hardware would be likely to produce short-term stressors (i.e., 1. supersonic flight, 2. direct or proximate strike, 3. entanglement, 4. ingestion, 5. aircraft overflight, and 6. recovery vessel operations). These short-term stressors would have the potential to cause seabirds to leave the immediate area for a short time or permanently.</p> <p><b>Unrecovered Sinkable Hardware:</b> The balloon flight train would rapidly sink in the Open Ocean Area and/or PMNM and would be almost impossible to locate, which may cause environmental impacts to biological/marine wildlife in the form of stressors (i.e., 1. supersonic flight, 2. direct or proximate strike, 3. entanglement, 4. ingestion, 5. aircraft overflight, and 6. recovery vessel operations) to which listed individuals would respond if exposed. However, based on the occurrence of the species in the splashdown area being directly under the flight train as it sinks (i.e., descends to the ocean floor) during the SFDT launch season (June–August), the likelihood of such exposure has been determined to be highly unlikely/extremely remote.</p> <p>It is conceivable that the balloon train could settle on deep-sea coral as it reaches the ocean floor. However, review of NOAA and United Nations Environment Programme surveys of coral reefs in the NHI and NWHI indicate that coral reefs are not expected in the splashdown area and, therefore, significant impacts to corals from the balloon flight train are not anticipated.</p>	<p><b>Seaborne Vessel and Aircraft:</b> Based on the planned (nominal) trajectory, the test flights would not overfly Nihoa, which would mitigate the need for the seaborne vessel are aircraft to sail near or fly over Nihoa Island. However, if overflight of Nihoa Island is needed, one of two scenarios would occur: (1) the LDSD Program would initiate the SFDT in such a manner that expended flight hardware would be recovered before drifting into the excluded area; or (2) the flight system would overfly the excluded area, and the Test Vehicle would be dropped outside 5.5 km (3 nm) from Nihoa Island.</p> <p><b>ESA Section 7 Consultation:</b> In accordance with Section 7 of the ESA, NASA initiated informal consultation for the SEA with the U.S. Fish and Wildlife Service (USFWS) on 15 January 2015.</p>	

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Biological Resources (Continued)</b>	<p>It is conceivable that the balloon train could come in contact with bottomfish and marine mammals as it reaches the ocean floor. Based on natural behavior (e.g. startled by noise, vibrations), it is anticipated that bottomfish and marine mammals would leave the immediate area as the balloon flight train is descending to the ocean floor.</p> <p><b>Seaborne Vessels and Aircraft:</b> Endangered species including whales, monk seals and sea turtles may be seen during vessel operation activities within PMNM. However, due to the rare to unlikely occurrence of these species within the operating area during the SFDT test flight season (June-August) the seaborne vessels may strike, but the seaborne vessels are not likely to encounter an ESA species. The vessels are not anticipated to come in contact with deep-sea coral, bottomfish, or seabirds. The deep-sea coral and bottomfish are located at depths beyond the natural hull reach of the vessels. It is anticipated that seabirds would depart the immediate area. The three seaborne vessels would not anchor during the recovery process. Aircraft currently operate on an FAA approved flight plan throughout the PMNM. It is not anticipated that the aircraft would have an adverse environmental impact on marine mammals, turtles, deep-sea corals, bottomfish, marine mammals, and seabirds.</p> <p><b>ESA Section 7 Consultation:</b> In accordance with Section 7 of the ESA, NASA initiated informal consultation for the SEA with NMFS on 9 January 2015.</p>		



**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Cultural Resources</b>	As PMNM is considered in Hawaiian traditions as a sacred place from which life springs and to which spirits return, unavoidable cultural impacts may occur if either of the up to 10 balloon flight trains (up to two per year over 5 years) should sink to the PMNM sea floor. However, given the unlikely probability of splashdown occurring in PMNM and that the balloon flight train is most likely to sink outside PMNM, the risk of impact is small. No Section 106 Consultation was required for this Proposed Action.	All identified cultural properties on Nihoa Island are situated some distance from the planned (nominal) trajectory of the Proposed Action. In the highly unlikely probability that an unplanned scenario occurs (e.g., crash, fire) and indication of a culturally or historically significant site is adversely impacted, NASA would contact the Monument Permit Coordinator as soon as reasonably possible. NASA understands that if an archaeological activity needs to occur in PMNM, the activity must be permitted and undergo a National Historic Preservation Act consultation prior to issuance of a PMNM permit. No Section 106 Consultation was required for this Proposed Action.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
<b>Geology and Soil</b>	N/A*	The LDSD Program proposes no ground activities on Nihoa Island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

1 \*N/A — Resource not applicable and not analyzed for this location.

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Hazardous Materials and Waste</b>	<p>The detailed analysis presented in the 2013 LDSD Final EA applies to hazardous materials and waste for the Open Ocean Area within and north of PMNM and is therefore incorporated by reference.</p> <p>All hazardous materials are fully integrated into either the balloon system or the Test Vehicle. Immediately post-landing, vessels would transit from the test support locations beyond the launch hazard arc to intercept and salvage the floating systems-balloon and Test Vehicle. Whether or not either of these systems enter PMNM, they would be recovered as quickly as possible. Under nominal conditions, all pyrotechnic systems are fired during flight and land spent (as part of the balloon system or Test Vehicle) in the ocean.</p>	<p>The detailed analysis presented in the 2013 LDSD Final EA applies to hazardous materials and waste for the On-shore Area and is therefore added by reference.</p> <p>NASA would exclude a splashdown near the 70 hectares (170 acres) of Nihoa Island and the approximately 128.5 km<sup>2</sup> (37.5 nm<sup>2</sup>) Special Management Area surrounding Nihoa Island. In the highly unlikely probability that an unplanned scenario occurs (e.g., crash, fire), NASA would contact the PMNM Permit Coordinator immediately.</p>	<p>Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.</p>
<b>Health and Safety</b>	<p>The detailed analysis presented in the 2013 LDSD Final EA applies to the health and safety for the Open Ocean Area within and north of PMNM and is therefore added by reference.</p>	<p>Undeveloped and unpopulated island</p>	<p>Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.</p>

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

<b>Resource Category</b>	<b>Open Ocean Area (PMNM and Outside Area)</b>	<b>Nihoa Island (Including Special Management Area)</b>	<b>No-action</b>
<b>Land Use</b>	N/A*	Undeveloped and unpopulated island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
<b>Noise</b>	Any change in noise levels is expected to be short-term and temporary and would not adversely affect marine animals.	Any change in noise levels is expected to be short-term and temporary and would not adversely affect terrestrial or marine animals.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
<b>Socioeconomics</b>	Post launch activities are not anticipated to affect any commercial or private commerce on the open seas. Commercial and private sea vessels and aircraft would be notified in advance of launch activities by PMRF as part of their routine operations through Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs).	Undeveloped and unpopulated island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

1 \*N/A — Resource not applicable and not analyzed for this location.

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Transportation</b>	<p>Post launch activities are not anticipated to adversely affect any commercial or private sea vessels or aircraft that could be present in the area. Commercial and private sea vessels and aircraft would be notified in advance of launch activities by PMRF as part of their routine operations through NOTAMs and NOTMARs.</p> <p>Federal regulations (50 CFR Part 404) define specific vessel traffic reporting rules for areas within PMNM, a designated Particularly Sensitive Sea Area (PSSA). All domestic vessels, foreign vessels greater than 300 gross tons that are either going to or coming from a U.S. port or place, and foreign vessels of any size that are heading to or coming from a U.S. port or place must provide entry notification within 72 hours of entering the PSSA and provide exit notification within 12 hours of exiting the PSSA. Notification to PMNM via telephone, fax, or email (<a href="http://www.papahanaumokuakea.gov/resource/ship_reporting.html">http://www.papahanaumokuakea.gov/resource/ship_reporting.html</a>). All other vessels are encouraged to participate, but are not required. Passage without interruption is highest during the winter months (October–February) due to bad weather north of PMNM. In general, due to the area’s remote location, vessel traffic is minimal throughout the year.</p>	Undeveloped and unpopulated island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

**Table ES-1. Summary of Environmental Impacts for Alternative 1—Proposed Action (Continued)**

Resource Category	Open Ocean Area (PMNM and Outside Area)	Nihoa Island (Including Special Management Area)	No-action
<b>Utilities</b>	N/A*	Undeveloped and unpopulated island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
<b>Visual Aesthetics</b>	Although the balloon and parachute may be visible for a brief time, there are no known receptors that would suffer adverse environmental impacts to “scenic views” in the Open Ocean Area.	Undeveloped and unpopulated island.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
<b>Water</b>	The detailed analysis presented in the 2013 LDSD Final EA applies to water resources for the Open Ocean Area within and north of PMNM and is therefore added by reference.	The detailed analysis presented in the 2013 LDSD Final EA applies to water resources for the Open Ocean Area within and north of the PMNM and is therefore added by reference.	Based on the Proposed Action from the 2013 LDSD Final EA (those results are incorporated by reference) and with the clarification that some recovery aids discussed in that EA may or may not be employed. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

1 \*N/A — Resource not applicable and not analyzed for this location.

1 Under Alternative 2, NASA would conduct the Proposed Action as detailed in the 2013  
 2 LDSD Final EA and with clarification of recovery aides that may or may not be  
 3 employed. The proposed test campaign for Alternative 2 would consist of launch,  
 4 operation, and recovery of up to two missions per year over the next 5 years (June  
 5 2015–August 2019) from a designated location on PMRF using the flight trajectory  
 6 outlined in the 2013 LDSD Final EA. Under Alternative 2, Sections 2.2.2.1 (Operational  
 7 Facilities) and 2.4.2 (Launch Operation) of this SEA would apply. Analyses for the  
 8 affected environments were detailed in the 2013 LDSD Final EA, and results are  
 9 incorporated by reference. The corresponding 2013 Final EA section numbers are  
 10 denoted in parentheses after each heading. Table ES-2 is a summary of the cumulative  
 11 effects associated with 5 additional years of SFDT launches from PMRF.

**Table ES-2. Summary of Environmental Impacts for Alternative 2—  
 Additional Launch Years**

Affected Environment	Cumulative Effects
<b>Pacific Missile Range Facility</b>	<p><b>No-action:</b> Based on the Proposed Action from the 2013 Final Low Density Supersonic Decelerator Environmental Assessment (LDSD Final EA); those results are incorporated by reference.</p> <p><b>Proposed Action:</b> Based on the analysis of resources analyzed and presented in the 2013 LDSD Final EA for the Pacific Missile Range Facility (PMRF) (air quality [4.1.1], airspace [4.1.2], biological resources [4.1.3], hazardous materials and waste [4.1.4], health and safety [4.1.5], socioeconomics [4.1.6], and water resources [4.1.7]), the following conclusions can be made. Negligible temporary increases would occur in emissions, and activities would be minor and transitory. Airspace would continue to be coordinated through the Federal Aviation Administration (FAA). The addition of eight flights over 4 years and other activities combined would be performed at varying times and locations on PMRF and should have negligible adverse cumulative environmental impacts on biological resources. Pre-launch and launch activities represent routine types of hazardous material and waste as well as health and safety activities at PMRF, as a result, no substantial adverse environmental impacts from the management of Supersonic Flight Dynamics Test (SFDT) project related hazardous materials and waste and routinely provided safety support are anticipated. There would continue to be no negative environmental impacts on the permanent population size, employment characteristics, schools, and type of housing available on-island. The amount of exhaust products from the SFDT that could potentially be deposited due to the launch activity would be small, and no cumulative impacts are expected. The Test Vehicle hardware, debris, and propellants that could fall into the ocean are expected to have only a localized, short-term effect on water quality.</p>

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**Table ES-2. Summary of Environmental Impacts for Alternative 2—  
Additional Launch Years (Continued)**

Affected Environment	Cumulative Effects
<b>Niihau</b>	<p><b>No-action:</b> Based on the Proposed Action from the 2013 LDSD Final EA; those results are incorporated by reference.</p> <p><b>Proposed Action:</b> Based on the analysis of resources analyzed and presented in the 2013 LDSD Final EA for Niihau (airspace [4.2.1], biological resources [4.2.2], cultural resources [4.2.3], and health and safety [4.2.4]), the additional LDSD launches may still require overflight of Niihau. The overflight is not anticipated to result in adverse environmental impacts to the airspace over Niihau; is not anticipated to environmentally impact biological and cultural resources on the island, and all missions or projects are closely reviewed and analyzed to ensure that there are no unacceptable risks to the public, Government and military personnel, and contractors.</p>
<b>Open Ocean Area</b>	<p><b>No-action Alternative:</b> Based on the Proposed Action from the 2013 LDSD Final EA; those results are incorporated by reference.</p> <p><b>Proposed Action:</b> Based on the analysis of resources analyzed and presented in the 2013 LDSD Final EA for the Open Ocean Area (airspace [4.3.1], biological [4.3.2], cultural [4.3.3], hazardous materials and waste [4.3.4], health and safety [4.3.5], and water resources [4.3.6]), the launch activity will continue the use of the required scheduling and coordination process for area airspace, and adherence to applicable Department of Defense directives and FAA regulations. The activities proposed may affect but is not likely to adversely affect federally-listed marine mammals and sea turtles in the operational area. The proposed activities would not result in any direct environmental impacts on corals or degradation of water/sediment quality in the vicinity of corals. Any submerged features that might be within this area are at considerable depth, and the potential for disturbance is extremely remote. The implementation of Alternative 2 would not introduce new types of hazardous materials and waste into the Open Ocean Area, and only small increases in quantities of previously introduced types of hazardous wastes are expected. For health and safety, rocket launches are short-term, discrete events that are actively managed by PMRF range safety. The launch activities would not be scheduled to occur at the same time as other launch programs. The effect of any rocket motor emission products deposited in the open ocean would be very transient due to the buffering capacity of sea water and dilution by current ocean mixing and would not be expected to result in any cumulative adverse effects.</p>
<b>Global Environment</b>	<p><b>No-action Alternative:</b> Based on the Proposed Action from the 2013 LDSD Final EA; those results are incorporated by reference.</p> <p><b>Proposed Action:</b> Because the LDSD launches would release little or no ozone depleting substance, there would be no adverse cumulative environmental impacts on the stratospheric ozone layer.</p>

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# **Acronyms and Abbreviations**

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# ACRONYMS AND ABBREVIATIONS

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1		
2	AGL	Above Ground Level
3	ATK	Alliant Techsystems Incorporated
4	CEQ	Council on Environmental Quality
5	CFR	Code of Federal Regulations
6	ConOps	Concept of Operations
7	DoD	Department of Defense
8	DPS	Distinct Population Segment
9	EA	Environmental Assessment
10	EFH	Essential Fish Habitat
11	EGSE	Electronic Ground Support Equipment
12	EO	Executive Order
13	EPA	United States Environmental Protection Agency
14	ESA	Endangered Species Act
15	FAA	Federal Aviation Administration
16	FONSI	Finding of No Significant Impact
17	ft	Feet
18	kg	Kilogram(s)
19	km	Kilometer(s)
20	km <sup>2</sup>	Square Kilometer(s)
21	km/hr	Kilometers per Hour
22	lb	Pound(s)
23	LDSD	Low Density Supersonic Decelerators
24	LEO	Low Earth Orbit
25	m	Meter(s)
26	mcf	Million Cubic Feet
27	MET	Meteorological
28	MHI	Main Hawaiian Islands
29	mi	Mile(s)
30	mi <sup>2</sup>	Square Mile(s)
31	N/A	Not Applicable
32	NASA	National Aeronautics and Space Administration
33	NEPA	National Environmental Policy Act

1	NHPA	National Historic Preservation Act
2	nm	Nautical Mile(s)
3	nm <sup>2</sup>	Square Nautical Mile
4	NMFS	National Marine Fisheries Service
5	NOAA	National Oceanic and Atmospheric Administration
6	NOTAM	Notice to Airmen
7	NOTMAR	Notice to Mariners
8	NWHI	Northwestern Hawaiian Islands
9	PMNM	Papahānaumokuākea Marine National Monument
10	PMRF	Pacific Missile Range Facility
11	PSSA	Particularly Sensitive Sea Area
12	ROBIN	Rocket Balloon Instruments
13	RSOP	Range Safety Operational Plan
14	SEA	Supplemental Environmental Assessment
15	SFDT	Supersonic Flight Dynamics Test
16	SIAD	Supersonic Inflatable Aerodynamic Decelerator
17	SSRS	Supersonic Ring-Sail
18	STMD	Space Technology Mission Directorate
19	TDM	Technology Demonstration Mission
20	TSP	Test Support Positions
21	U.S.C.	United States Code
22	USFWS	United States Fish and Wildlife Service
23	WPRFMC	Western Pacific Regional Fishery Management Council
24		

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### UNIT CONVERSION TABLE

Metric Unit		Conversion Factor		Imperial (English) Unit
meter	Multiply by:	3.28084	To convert to:	foot
kilometer		0.539957		nautical mile*
kilometer		0.621371		mile
square kilometer		0.291181		square nautical mile
hectare		2.47105		acre
kilogram		2.20462		pound

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\*Note: To convert miles into nautical miles multiply by 0.86897.

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## **1.0 Purpose and Need for Proposed Action**

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# 1.0 PURPOSE AND NEED FOR PROPOSED ACTION

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The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii (Figure 1-1). The 2013 Final EA addressed the first demonstration test which was successfully conducted in June 2014, as well as the campaigns planned in 2015 consisting of three additional demonstration tests. Based on information gleaned from the first test, the purpose of this Supplemental Environmental Assessment (SEA) is to evaluate the potential environmental consequences (environmental impacts) of changes planned for future campaigns. These changes consist of the No-action Alternative, Alternative 1, and Alternative 2:

- **No-action Alternative:** Under the No-action Alternative, NASA would conduct the Proposed Action as detailed in the 2013 LDSD Final EA and with the clarification that some recovery aids discussed in that EA may or may not be employed. This proposed test campaign would consist of launch, operation, and recovery of up to four missions from a designated location on PMRF. The Supersonic Flight Dynamics Test (SFDT) campaign would consist of up to four flights from approximately June to July 2014 and June to August 2015. One flight was conducted in 2014, and up to three could be conducted in 2015. Under the No-action Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.
- **Alternative 1 (Preferred Alternative):** Consists of using additional open ocean splashdown area within and outside of Papahānaumokuākea Marine National Monument (PMNM) and additional launch years. For Alternative 1 (Preferred Alternative), these changes consist of (1) permit authorization from the National Oceanic and Atmospheric Administration (NOAA) (issuance of which is contingent upon final approval of this SEA and associated FONSI) for flight hardware to potentially fly over, splashdown, and be recovered (except the balloon flight train, which would rapidly sink in the open ocean) within the easternmost part of PMNM; and (2) perform up to two LDSD TDM test flights annually over the next 5 years, starting in June 2015 and ending in August 2019.
- **Alternative 2:** Consists of adding additional launch years to the 2013 Final EA and with the clarification that some recovery aids discussed in that EA may or may not be employed. For Alternative 2, these changes consist of additional test flights of up to two missions per year over the next 5 years (June 2015–August 2019) from a designated location on PMRF using the flight trajectory outlined in the 2013 LDSD Final EA. For future testing, the



**EXPLANATION**

-  Proposed Launch Area (not to scale)
-  Red Label Area (not to scale)

**Overview of PMRF and the Western Shore of Kauai**

Kauai, Hawaii

**Figure 1-1**

11\_overview\_2/20/2015



NORTH

1 full open ocean recovery of the expended flight hardware, including balloon  
2 carcass, Test Vehicle, and supersonic parachute, will take place within a pre-  
3 coordinated operational area located west by northwest of PMRF (Figure 1-  
4 2). Under Alternative 2, Sections 2.1.1.1.2.1 (Operational Facilities) and  
5 2.1.1.3 (Launch Operation) of this SEA would apply.

6 This SEA is in compliance with the following statutes, regulations, and procedures:

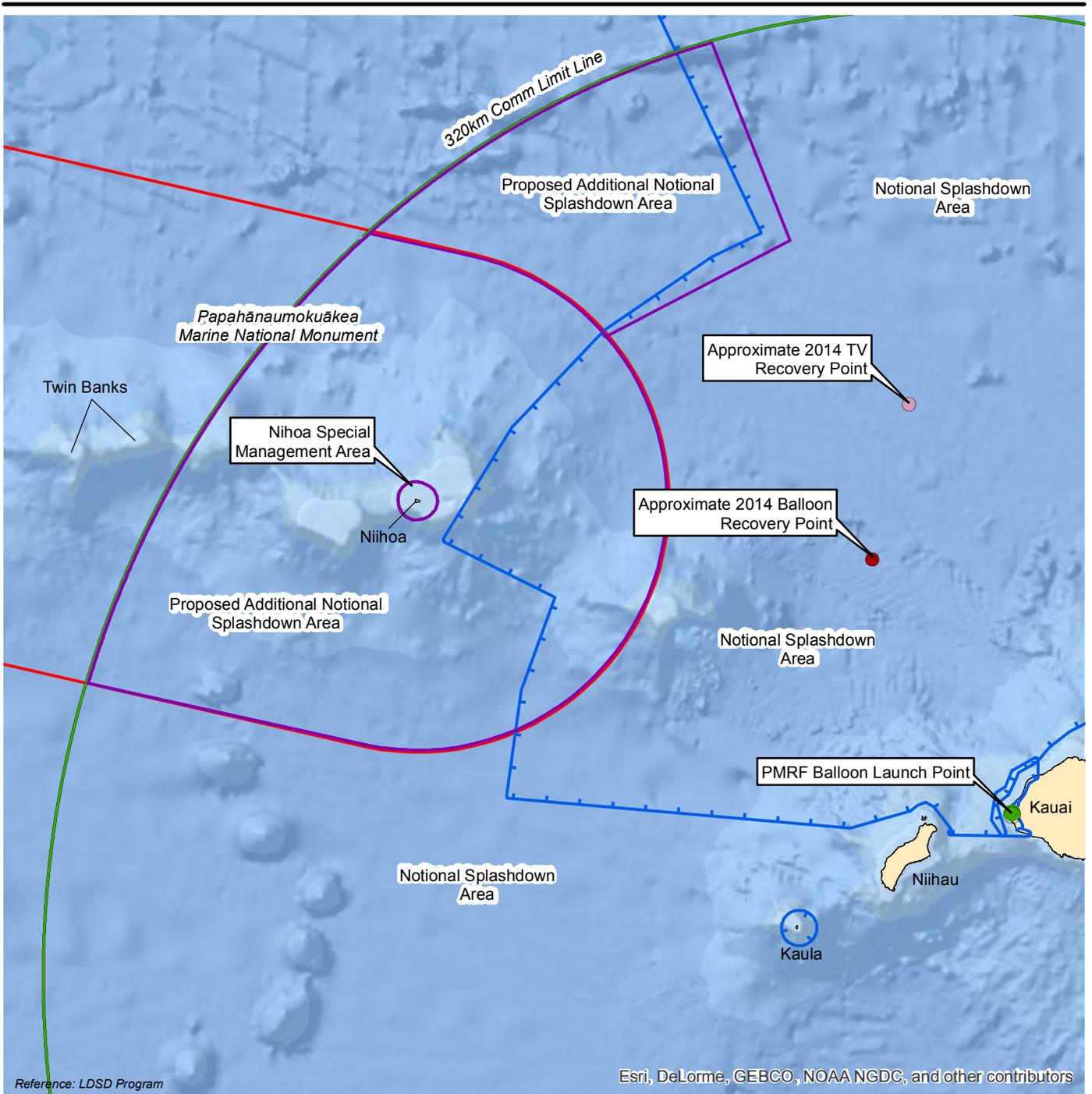
- 7 • National Environmental Policy Act (NEPA) of 1969, as amended (42 United  
8 States Code [U.S.C.] 4321 et seq.)
- 9 • Council on Environmental Quality (CEQ) Regulations for Implementing the  
10 Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts  
11 1500-1508)
- 12 • NASA NEPA Implementing Regulation (Subpart 1216.3)
- 13 • NASA Procedural Requirement 8580.1, NASA National Environmental Policy  
14 Act Management Requirements
- 15 • Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal  
16 Actions
- 17 • Presidential Proclamation, 8031 Establishment of the Northwestern Hawaiian  
18 Islands Marine National Monument
- 19 • 50 CFR Part 404, Northwestern Hawaiian Islands Marine National Monument

## 20 **1.1 BACKGROUND**

21 Section 1.1 of the 2013 LDSD Final EA provides a detailed background for NASA's  
22 LDSD mission directive, and Chapter 4 of the 2013 LDSD Final EA analyzes the  
23 environmental consequences of conducting the series of LDSD tests from PMRF, and  
24 also potential impacts on Niihau and the Open Ocean Area. The 2013 LDSD Final EA  
25 can be found at [http://www.sites.wff.nasa.gov/Code250/LDSD\\_Final\\_EA\\_May2013.pdf](http://www.sites.wff.nasa.gov/Code250/LDSD_Final_EA_May2013.pdf).

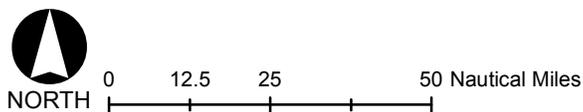
26 Subsequent to issuing a FONSI for the LDSD Final EA on 10 May 2013, NASA  
27 continued its mission planning and ultimately conducted the first LDSD flight in June  
28 2014. Lessons learned from this initial LDSD flight indicated that changes to the  
29 Proposed Action as described in the LDSD Final EA could be warranted.

30



**EXPLANATION**

- PMRF Balloon Launch Point
- Approximate 2014 Balloon Recovery Point
- Approximate 2014 TV Recovery Point
- Proposed Additional Notional Splashdown Area
- 320-km Communications Limit Line
- Special Use Airspace
- Papahānaumokuākea Marine National Monument



**2014 SFDT Test Flight Recovery Points for Flight Hardware**

PMRF, Niihau, and Open Ocean

**Figure 1-2**

12 hardware recovery, 2/24/2015

1 Under NEPA, Federal agencies have a continuing duty to evaluate the environmental  
2 consequences of their actions. Under certain circumstances, agencies must  
3 supplement their existing environmental analyses should they propose changes to  
4 those actions that could have a bearing on environmental consequences.

5 Accordingly, NASA has prepared this SEA as a supplement to the 2013 LDSD Final EA  
6 to evaluate the environmental consequences of operational changes it proposes for the  
7 additional LDSD test flights scheduled to be conducted in the summers of 2015 through  
8 2019.

9 The following three sections of the SEA provide (1) a summary of the June 2014 LDSD  
10 test flight; (2) the lessons learned which prompted NASA to consider modifying its  
11 Proposed Action; and (3) the Federal authorization needed to undertake the proposed  
12 changes.

### 13 **1.1.1 2014 LDSD SFDT FLIGHT SUMMARY**

14 The LDSD project's first Supersonic Flight Dynamics Test (SFDT), executed on 28 June  
15 2014 from the U.S. Navy's PMRF, represented the culmination of years of planning,  
16 development, and ingenuity by multiple NASA centers. The focus of this first SFDT was  
17 to determine if the devised test architecture and Concept of Operations (ConOps)  
18 achieved engineering and technology conditions to push the limits of the decelerators  
19 being developed. The SFDT had to be accomplished within established requirements  
20 outlined in the LDSD project's EA, NASA's policies defined in the Wallops Flight Facility  
21 Range Safety Manual, and the U.S. Navy's Safety policies defined in the Range Safety  
22 Operational Plan (RSOP).

23 Although the initial 2-week launch window opened on 2 June 2014, the LDSD project  
24 experienced daily upper wind conditions that preempted all launch attempts during that  
25 window. The LDSD project and the U.S. Navy's Management coordinated a second  
26 launch window at the end of June 2014 requiring redeployment of project personnel and  
27 support assets. The first day of the second launch window opened on 28 June 2014  
28 and provided a valid opportunity for launch. The predicted balloon trajectory was along  
29 a path north of Niihau. This particular balloon trajectory only afforded an approximate  
30 30-minute decision window for Test Vehicle drop to reaction to any inflight anomalies  
31 (i.e., unplanned scenarios) that might occur. The LDSD project accepted the risks  
32 associated with this northern trajectory and moved forward with a launch attempt. After  
33 numerous decision meetings, all Go/No Go criteria were green and the balloon was  
34 released from the launch site at PMRF.

35 The SFDT consisted of releasing a 1 million cubic meter (34 million cubic foot [mcf])  
36 scientific balloon that carried the Test Vehicle to the minimum desired float altitude of  
37 37,000 meters (m) (120,000 feet [ft]). The Test Vehicle was then released, initiating the  
38 mission sequence. After the Test Vehicle dropped, small solid-fueled rocket motors  
39 ignited and stabilized the Test Vehicle prior to the main motor ignition. The main motor  
40 ignited propelling the Test Vehicle upwards to an altitude of approximately 55,000 m

1 (180,000 ft) at a speed of approximately Mach 4. The Test Vehicle then deployed a  
2 torus (doughnut-shaped) tube called the Supersonic Inflatable Aerodynamic Decelerator  
3 (SIAD) to slow its velocity to approximately Mach 2. The Test Vehicle then deployed  
4 the 30.5-m (100-ft) diameter supersonic parachute, designed to carry the Test Vehicle  
5 safely to a controlled oceanic impact in a pre-coordinated operational area off the west  
6 coast of the island of Kauai, Hawaii.

7 The combined flight system (balloon and Test Vehicle) was continually tracked by  
8 PMRF ground instrumentation providing positional data to the U.S. Navy Range Safety  
9 Organization. The position of the flight system along with individual splashdown  
10 dispersions (variable, maximum 26 kilometers [km] [14 nautical miles [nm]]) for the  
11 balloon, detached balloon flight train on recovery parachute, and Test Vehicle were  
12 overlaid onto a display system. The splashdown dispersions (for each item) were  
13 compared to restrictions imposed on the LDSD project due to Niihau and Kauai islands  
14 (public safety criteria), Federal Aviation Administration (FAA) boundaries (public safety  
15 criteria), and PMNM (environmental safety criteria).

16 The balloon ascent progressed in accordance to plan except for slightly higher upper air  
17 wind speeds than predicted and the balloon's ascent being slightly slower than  
18 predicted. Each of these slight changes to the timeline narrowed the overall margin in  
19 the decision window for Test Vehicle drop for initiation of the SFDT. The LDSD project  
20 estimates that the 26-km (14-nm) splashdown dispersion circle was between 8 to 15  
21 minutes from violating the outer boundary of PMNM. Had there been any significant  
22 delay in the mission (e.g., non-participating vessels in the range, hardware issue, etc.),  
23 then the U.S. Navy Range Safety Organization would have issued a mission termination  
24 order, resulting in an immediate drop of the balloon and Test Vehicle into the ocean to  
25 prevent potential PMNM infringement, resulting in the likely full loss of the vehicle due to  
26 impact damage.

27 Almost all expended flight hardware was then recovered from the open ocean, with the  
28 exception of the balloon flight train. This flight train connects the Test Vehicle to the  
29 balloon. Once the Test Vehicle dropped, a signal was sent that separated the flight  
30 train from the balloon. The flight train consisted of a burst parachute (a safety  
31 instrument), sensors, connections, and Kevlar® cabling. This system sank rapidly in the  
32 ocean and was impossible to locate.

### 33 **1.1.2 2014 LESSONS LEARNED THAT PROMPTED THIS SEA**

34 A significant accomplishment of the LDSD project's 2014 campaign was demonstrating  
35 the ability to accurately predict the balloon's climb-out trajectory and to recover the  
36 balloon carcass and Test Vehicle. Figure 1-3 captures recovery operations of the  
37 balloon, and Figure 1-4 shows recovery operations at the Test Vehicle recovery site.  
38 The hard lesson learned was that there is the possibility of going weeks without  
39 acceptable conditions for launch. Another lesson learned is that the northern  
40 trajectories represent significant risk of early termination unless mitigated.



**2014 SFDT Test Flight  
Recovery Operations of  
the Scientific Balloon**

**Figure 1-3**

13\_balloon\_recovery, 2/20/2015



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**2014 SFDT Test Flight  
Operations at the Test  
Vehicle Recovery Site**

---

**Figure 1-4**

14\_TV\_recovery, 2/20/2015

1 Based on the results of the 28 June 2014 test flight, the LDSD project decided to  
2 investigate the possibility of potentially dropping and recovering expended flight  
3 hardware, with the exception of the balloon flight train, in the eastern part of PMNM  
4 during future demonstration missions, as part of any additional flight option. This flight  
5 option would be conducted within the boundary of PMNM, but outside of the 5.6-km (3-  
6 nm) Special Management Area surrounding Nihoa Island. Section 1.1.3 summarizes  
7 the request for authorization to splashdown within PMNM (Figure 1-5).

### 8 **1.1.3 PAPAĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT PERMIT AND** 9 **APPLICATION PROCESS**

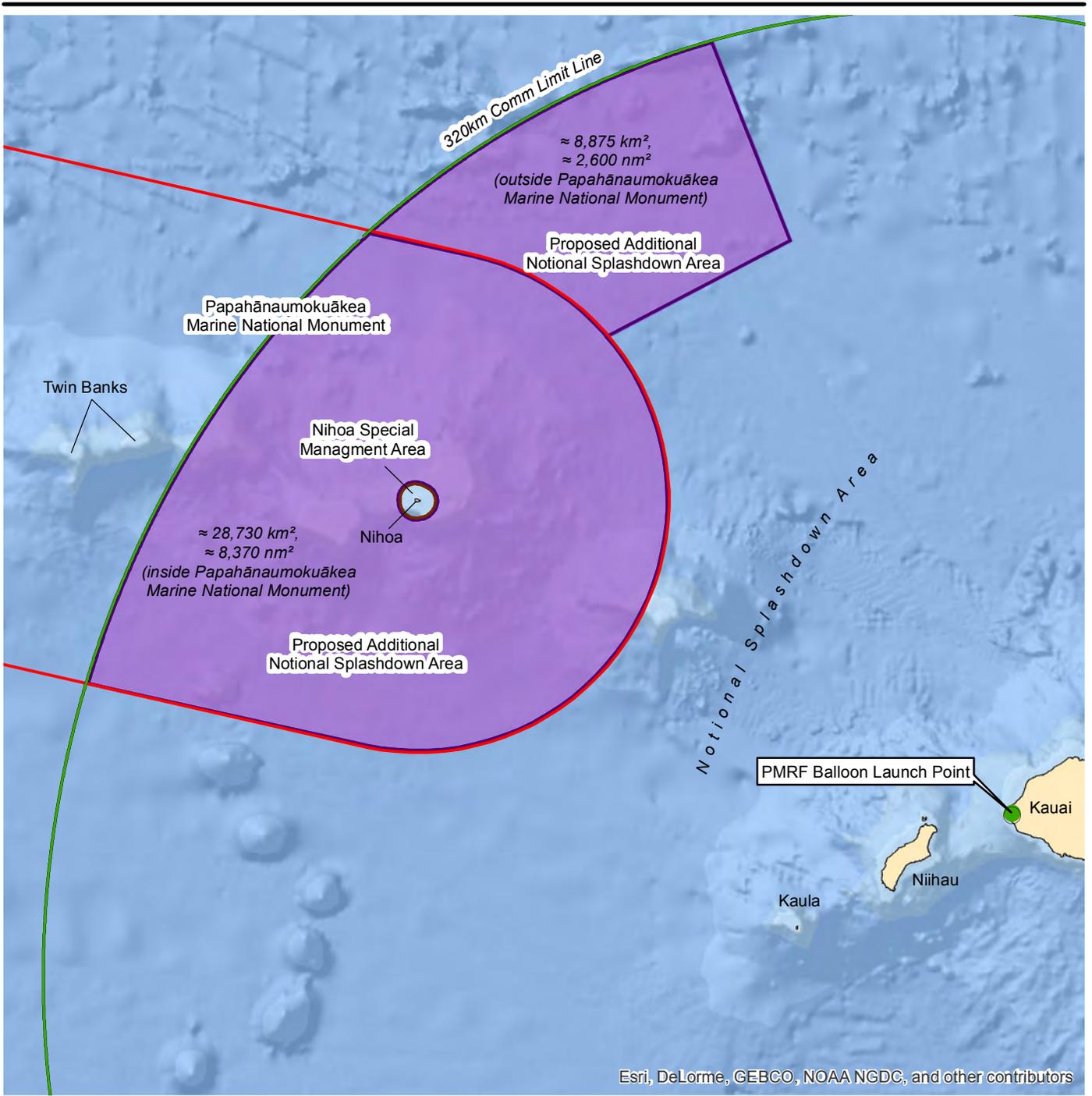
10 In January 2015, NASA submitted to the PMNM permit coordinator an application  
11 seeking authorization to include the eastern part of PMNM surrounding Nihoa Island as  
12 part of its splashdown and recovery area for the SFDTs. NASA is seeking authorization  
13 to conduct activities within PMNM via the established permitting process defined in  
14 Presidential Proclamation 8031 and codifying regulations in 50 CFR Part 404. PMNM  
15 issues permits in six categories (Research, Education, Conservation and Management,  
16 Native Hawaiian Practices, Special Ocean Use, and Recreation). Issuance of a PMNM  
17 permit is contingent upon final approval of this SEA and its associated signed FONSI.  
18 Access into PMNM would not occur prior to issuance of a PMNM permit. NASA  
19 requests authorization under Permit Category—Conservation and Management per  
20 recommendation of the PMNM permit coordinator. The activity for potential entry into  
21 PMNM would occur on the day of the launches beginning with the 2015 test flights  
22 scheduled for 1 June through 31 August 2015. Test flights are anticipated to occur  
23 during the June–August time frame beginning in 2015 and ending in 2019. A launch  
24 window would be based on wind studies conducted at PMRF.

25 The LDSD project requested authorization to potentially drop and recover expended  
26 flight hardware, with the exception of the balloon flight train which would sink to the  
27 seafloor, from up to two scheduled SFDTs in 2015 (with the potential for up to two  
28 additional flights per year through 31 August 2019) in the Open Ocean area within the  
29 boundary of PMNM. This operations area excludes the 70 hectares (170 acres) of  
30 Nihoa Island and the Special Management Area within the 5.6 km (3 nm) surrounding  
31 Nihoa Island. This permit would also allow NASA to enter PMNM if the flight hardware  
32 is dropped outside PMNM and carried into PMNM by ocean currents.

33 This overlay of the hardware splashdown area was derived from negotiations among  
34 the LDSD project, U.S. Navy Range Management, and the FAA and also considered  
35 the 320-km (170-nm) telecommunications limitation arc from the Test Vehicle to PMRF.

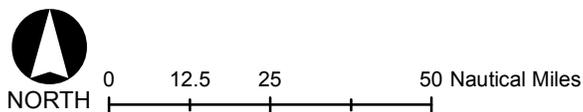
36 Two factors determine whether entering into PMNM would be required. The presence  
37 of these factors cannot be definitively determined until after the balloon has been  
38 launched. The first factor is the progress of the balloon's ascent on its predicted

39



**EXPLANATION**

- PMRF Balloon Launch Point
- 320-km Communications Limit Line
- Proposed Additional Notional Splashdown Area
- Nihoa 3-nautical mile Special Management Area
- Papahānaumokuākea Marine National Monument



**Proposed Additional Splashdown Area**

PMRF, Niihau, and Open Ocean

**Figure 1-5**

15\_proposed\_splashdown, 2/20/2015

1 trajectory. If the balloon is ascending along its predicted trajectory, then it would most  
2 likely reach float altitude well to the east of PMNM. The balloon in some cases is  
3 allowed to float westerly, providing it does not overfly Niihau. The Test Vehicle is  
4 eventually dropped, initiating the SFDT along a northeasterly trajectory and avoiding  
5 PMNM altogether. Once the Test Vehicle has been released, the balloon flight is  
6 terminated and the balloon carcass falls to the ocean for recovery.

7 During the ascent and float stage of the balloon, unplanned scenarios (i.e., anomalies)  
8 in the following elements could result in actions being taken leading to the flight system  
9 moving into PMNM:

- 10 • Determination that the sun will interfere with on-board camera systems
- 11 • System failure involving one or more of the recovery assets (sea vessels and  
12 aircraft)
- 13 • System failure involving the balloon and/or Test Vehicle
- 14 • Non-participating sea vessel and/or aircraft in the mission related hazard areas
- 15 • System failure involving one or more of the ground telecommunications systems

16 Once aloft (in flight/airborne), NASA has no control over the balloon's direction of travel.  
17 All the anomalies (unplanned scenarios) listed above could result in one of two possible  
18 outcomes:

- 19 • A delay until the flight system is deemed flight ready and the SFDT is initiated
- 20 • A delay until the flight system is deemed unsafe and terminated

21 The second factor in determining PMNM entry is the latitude at which the balloon is  
22 moving westerly. Under the planned (i.e., nominal) scenario, the upper level winds  
23 carry the balloon nearly due west. The southeasterly point of PMNM is at roughly 22  
24 degrees 13 minutes north latitude. The possibility of the balloon entering into PMNM  
25 decreases as the point where the float altitude is reached moves southward of 22  
26 degrees 13 minutes north latitude.

27 Under unplanned (anomalous) scenarios, the winds at a given altitude may or may not  
28 be as predictable as those at approximately 37,000 meters (m) (120,000-feet [ft]). If it is  
29 predicted that the balloon will not reach its planned (i.e., nominal) float altitude, then a  
30 decision is made whether to continue with an SFDT attempt or terminate the flight  
31 depending on altitude reached and where it predicted the balloon is traveling.  
32 Depending on the nature and timing of the anomaly (i.e., unplanned scenario), the flight  
33 system could float westerly long enough for PMNM entry.

34 In either unplanned (i.e., anomalous) scenario, NASA would enter PMNM and recover  
35 all floating expended flight hardware as demonstrated in the 2014 SFDT mission  
36 (Figures 1-3 and 1-4). NASA would deploy up to two aircraft to fly surveillance tracks

1 between approximately 460 and 7,300 m (1,500 and 24,000 ft) above ground level  
2 (AGL) and to aid in recovery and up to three recovery vessels to Test Support Positions  
3 (TSPs) within the operational area outside PMNM. Immediately upon splashdown of  
4 the expended flight hardware, the spotter aircraft would be directed to the different  
5 floating hardware locations to begin recovery. During the 2014 mission, it took the  
6 respective vessels approximately 5 hours to reach and recover the ring-sail parachute,  
7 6.5 hours to reach and recover the balloon carcass, and 4 hours to reach and recover  
8 the Test Vehicle.

9 Almost all expended flight hardware is then recovered from the ocean, with the  
10 exception of the balloon flight train. This flight train connects the Test Vehicle to the  
11 balloon. Once the Test Vehicle is dropped, a signal is sent that separates the flight train  
12 from the balloon and in the process, rips the balloon to allow descent. The flight train  
13 weighs approximately 375 kilograms [kg] (830 pounds [lb]); is approximately 300 m (990  
14 ft) long; and consists of a burst parachute (a safety instrument), sensors, connections,  
15 and Kevlar® cabling. This system would sink rapidly in the ocean and would be almost  
16 impossible to locate.

17 NASA anticipates receiving the PMNM Research Permit prior to the opening of the  
18 launch window on 1 June 2015. The Permit Application is attached as Appendix C of  
19 this SEA. If the Permit is not received prior to 2015 launch attempts, NASA would  
20 accept the mission risks of operating as in the 2014 LDSD campaign without entering  
21 into PMNM, as described in the No-action Alternative.

## 22 **1.2 SCOPE OF SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT**

23 This SEA is prepared in compliance with the statutes and regulations previously listed  
24 that direct NASA officials to consider potential environmental consequences when  
25 authorizing or approving Federal actions. This SEA evaluates the potential  
26 environmental impacts over 5 years of up to two per year of the potential fly-over,  
27 splashdown, and recovery of the LDSD balloon and Test Vehicle in the eastern part of  
28 PMNM, which includes the 28,723 square kilometers [km<sup>2</sup>] (8,364 square nautical miles  
29 [nm<sup>2</sup>]) of Open Ocean Area in the easternmost part of PMNM and the approximately  
30 8,874 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area north of PMNM and recovery of the balloon  
31 carcass, Test Vehicle, and supersonic parachute. This SEA also evaluates the potential  
32 environmental impacts of the balloon flight train remaining on the open ocean seafloor.  
33 Alternative 2 of this SEA assesses expanding the No-action Alternative for 4 additional  
34 years with up to two SFDTs per year. The No-action Alternative of this SEA is the  
35 Proposed Action in the 2013 LDSD Final EA, and with the clarification that some  
36 recovery aids discussed in that EA may or may not be employed, is not reassessed as  
37 there is no change in the Proposed Action. For the No-action Alternative, one flight was  
38 conducted in 2014, and up to three could be conducted in 2015 (National Aeronautics  
39 and Space Administration, 2013).

40 This SEA addresses all of the reasonably foreseeable activities in the particular  
41 geographical areas of the eastern part of PMNM (Open Ocean) potentially affected by

1 the Proposed Action and focuses on those activities ready for Federal and resource  
2 agency decisions. The majority of activities would use existing facilities and/or be on  
3 previously disturbed land (located on PMRF).

4 Consistent with the CEQ regulations, the scope of the analysis presented in this SEA  
5 was defined by the range of potential environmental impacts that would result from  
6 implementation of the Proposed Action. Resources that may be impacted are  
7 considered in the SEA analysis to provide the decision makers with sufficient evidence  
8 and analysis for evaluation of the potential effects of the action. For this SEA, the  
9 environment is discussed in terms of two resource areas (biological resources and  
10 cultural resources) associated with Open Ocean Area within and outside PMNM.

### 11 **1.3 PURPOSE AND NEED OF THE PROPOSED ACTION**

12 The Proposed Action (Alternative 1–Preferred Alternative) is to provide for additional  
13 splashdown area and test opportunities for the SFDT. This would require approved  
14 entry into the easternmost part of the Open Ocean Area of PMNM; therefore, NASA has  
15 requested authorization for entry into PMNM through a Conservation and Management  
16 permit. This entry would consist of the splashdown and recovery of expended flight  
17 hardware and potential fly-over of Nihoa Island and its surrounding Special  
18 Management Area from scheduled SFDTs beginning in 2015. NASA could have up to  
19 two technology testing launches each year for the next 5 years (June 2015 through  
20 August 2019). These additional test opportunities would increase the probability of  
21 successful test flights and lower the risk of a scenario for an unplanned (i.e.,  
22 anomalous) termination of the test flight.

### 23 **1.4 COOPERATING AND COORDINATING AGENCY**

24 In accordance with 40 CFR 1508.5, a *Cooperating Agency* means any Federal agency  
25 other than a Lead Agency that has jurisdiction by law or special expertise with respect  
26 to any environmental impact involved in a proposal (or a reasonable alternative) for  
27 major Federal action significantly affecting the quality of the human environment. The  
28 selection and responsibilities of a Cooperating Agency are described in 40 CFR 1501.6.  
29 NASA is the Lead Agency for preparation of this SEA. NASA considers the Co-trustees  
30 of PMNM as Cooperating Agencies, as any approved permit would be a joint permit  
31 signed by all the agencies (NOAA, U.S. Fish and Wildlife Service [USFWS], and State  
32 of Hawaii as noted in 40 CFR 1508.5 and 40 CFR 1508.6). This permit would grant  
33 authorization for the splashdown and recovery activities of future SDFT flight tests to  
34 take place in the easternmost part of PMNM. The SEA must be finalized before the  
35 permit is approved. As the Cooperating Agencies have a joint action in issuing the  
36 Conservation and Management Permit to NASA, this SEA also serves to fulfill the  
37 NEPA obligations for the PMNM Co-Trustees. NASA, as the project proponent, is the  
38 Lead Agency and is responsible for ensuring overall compliance with applicable  
39 environmental statutes, including NEPA.

1 A Coordinating Agency refers to an agency that was instrumental in the preparation of  
2 this SEA. NASA considers the U.S. Navy to be a Coordinating Agency since the PMRF  
3 facilities and range have been selected as the baselined location for the LDSD SFDT  
4 campaigns.

5 The LDSD is being developed under the NASA Space Technology Mission Directorate  
6 (STMD) and is neither associated with any Department of Defense (DoD) program nor  
7 using any repurposed weapons technology. The LDSD project is not regulated by any  
8 of the following treaties: Strategic Arms Reduction Treaty, Intermediate-Range Nuclear  
9 Forces Treaty, Open Skies Treaty, Anti-ballistic Missile Treaty, or Chemical Weapons  
10 Convention.

## 11 **1.5 PUBLIC NOTIFICATION AND REVIEW**

12 In accordance with the CEQ, and NASA regulations for implementing NEPA, NASA is  
13 soliciting comments on this Draft SEA from interested and affected parties. A Notice of  
14 Availability for the Draft SEA has been published in the newspapers identified in Table  
15 1-1.

16 **Table 1-1. Local Newspapers**

Country or State	City/Town	Newspaper
Hawaii	Kauai	<i>The Garden Island</i>
	Honolulu	<i>Star Advertiser</i>
	Honolulu	<i>Environmental Notice, Office of Environmental Quality Control</i>

17

18 Copies of the Draft SEA have been placed in local libraries and are available over the  
19 Internet at [http://sites.wff.nasa.gov/code250/docs/NASA\\_LDSD\\_DSEA.pdf](http://sites.wff.nasa.gov/code250/docs/NASA_LDSD_DSEA.pdf). Appendix A  
20 lists agencies, organizations, and libraries that have been sent a copy of the Draft SEA.

## 21 **1.6 DECISION(S) TO BE MADE**

22 The decision(s) to be made are based in part on the analysis presented in the SEA.  
23 Following the public review period (as specified in the newspaper notices), NASA will  
24 consider public and agency comments received to decide whether to (1) issue a Final  
25 SEA and a Finding of No Significant Impact, which would allow the Proposed Action to  
26 proceed; or (2) conduct additional environmental analysis (if needed); or (3) select the  
27 Alternative 2 or the No-action Alternative; or (4) prepare a Notice of Intent to prepare an  
28 Environmental Impact Statement. The PMNM Co-Trustees will make the decision  
29 whether to issue the NASA LDSD project a Conservation and Management Permit  
30 authorizing entrance into PMNM.

1 **1.7 RELATED ENVIRONMENTAL DOCUMENTATION**

2 Environmental documents for some of the programs, projects, and installations within  
3 the geographical scope of this SEA that have undergone environmental review to  
4 ensure compliance with the NEPA and EO 12114, Environmental Effects Abroad of  
5 Major Federal Actions, include the following:

- 6 • Hawaii–Southern California Training and Testing EIS/OEIS, August 2013, and  
7 Record of Decision, December 2013
- 8 • *National Aeronautics and Space Administration Low Density Supersonic*  
9 *Decelerator Technology Demonstration Mission Pacific Missile Range Facility,*  
10 *Environmental Assessment, May 2013*
- 11 • *Hawaii Range Complex Environmental Impact Statement/Overseas*  
12 *Environmental Impact Statement, May 2008, and Record of Decision, June 2008*

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## **2.0 Description of Proposed Action and Alternatives**

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# 2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

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This chapter describes the modifications made to the 2013 Final LDSD EA Proposed Action (Section 2.1), Test Description and Procedures (Section 2.2), Launch Trajectory (Section 2.3), Launch Operation (Section 2.4), and the No-action Alternative (Section 2.5). These changes describe the No-action Alternative for this SEA and are incorporated into Alternatives 1 and 2. The topics in Sections 2.1.2 (Proposed Additional Splashdown Area) and Section 2.5 (Alternative 2) in this SEA are new and were not in the 2013 Final LDSD EA.

## 2.1 NO-ACTION ALTERNATIVE

Under the No-action Alternative, NASA would conduct the Proposed Action as detailed in the 2013 LDSD Final EA with the clarification that some recovery aids discussed in the EA may or may not be employed. This proposed test campaign would consist of launch, operation, and recovery of up to four missions from a designated location on PMRF. The SFDT campaign would consist of up to four flights from approximately June to July 2014 and June to August 2015. One flight was conducted in 2014, and up to three flights could be conducted in 2015. Under the No-action Alternative, Sections 2.2.2.1 (Operational Facilities) and 2.4.2 (Launch Operation) of this SEA would apply.

### 2.1.1 TECHNOLOGY DEVELOPMENT

NASA's STMD established the LDSD project as a test architecture for the development and full-scale testing of decelerator technologies at representative conditions to those found on the planet Mars. The current decelerator technologies were developed in the 1970s as part of NASA's Viking Program, which sent two probes to the Martian surface. Since these early Mars landers, the main focus on technology development has been on the landing phase of orbital insertion.

The decelerator technologies that could be developed through the LDSD project enable the following:

- Put more mass on the Martian surface in a single landing
  - Increase cost effectiveness of missions
  - Open up possibilities for future human exploration of Mars
  - Enable NASA to take advances of new rocket systems being developed
    - Current (United Launch Alliance): Delta IV-H, approximate capacity 27,569-kilograms (kg) (60,779-pounds [lb]) to Low Earth Orbit (LEO)
    - Future (Space Exploration Technologies Corporation): Falcon 9 Heavy, approximate capacity 53,000 kg (116,845 lb) to LEO

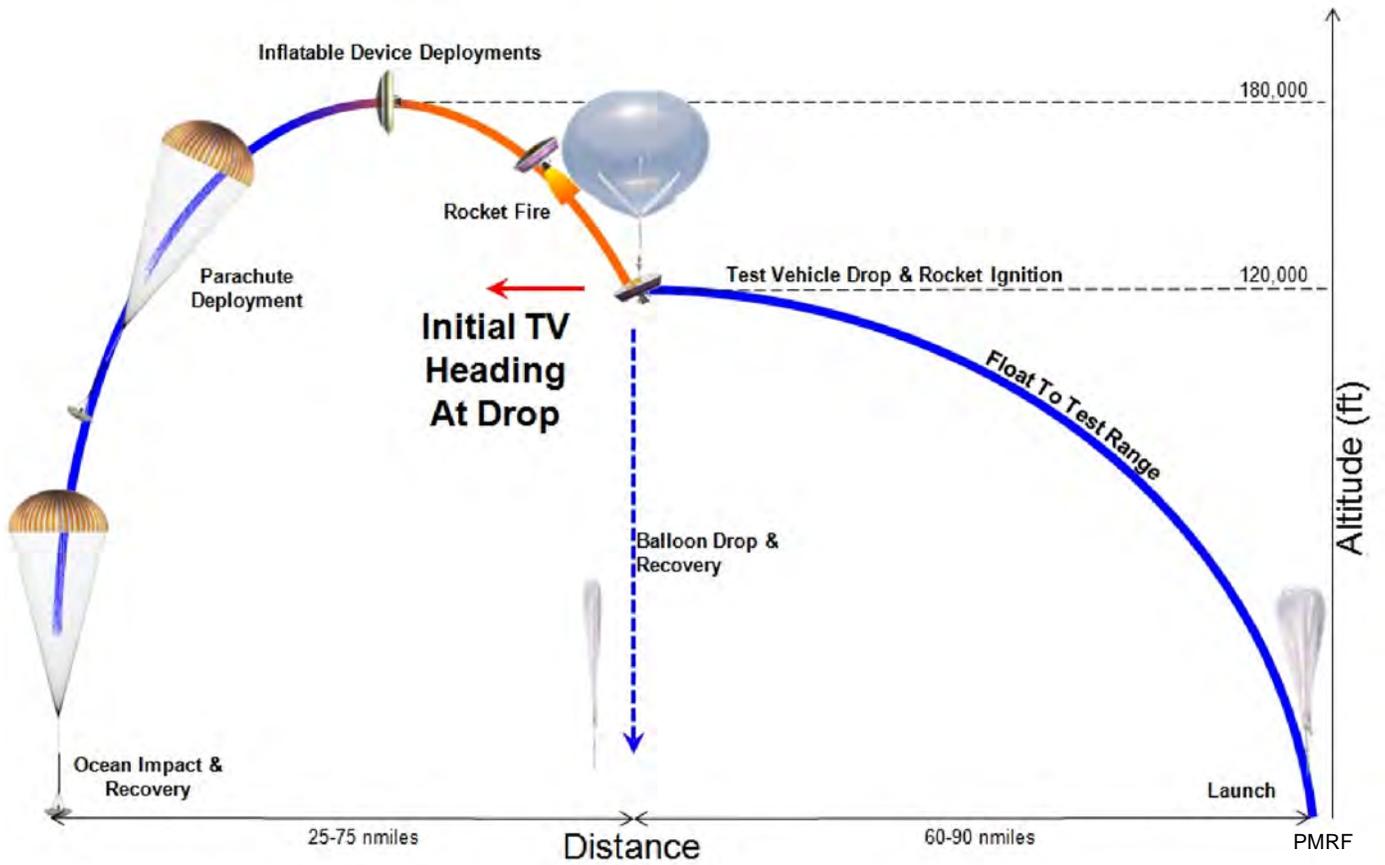
- 1 • Open up more of the Martian surface for landing
- 2 – Current decelerators require a lot of atmosphere to slow descent, restricting
- 3 landings to only the lowest points on Martian surface
- 4 – New decelerators open up Martian plateau and mountains for direct landings
- 5 • Increase the probability of landing at a desired location on the Martian surface
- 6 – Parachute drift is a significant contributor to inaccuracy
- 7 – Less atmosphere on descent potentially opens up delaying parachute
- 8 deployment until closer to the surface

9

10 Under this broad project scope, the LDSD project could execute up to two SFDTs per  
11 year for the next 5 years (June 2015–August 2019) at the U.S. Navy’s PMRF on Kauai,  
12 Hawaii. The focus of the LDSD project’s 2014 campaign was to validate the test  
13 architecture itself, build confidence in the test ConOps, and closeout many lingering  
14 unknowns related to first use hardware and techniques. An added benefit was the  
15 certification of the Supersonic Inflatable Aerodynamic Decelerator (SIAD), specifically  
16 the Robotic class design (denoted SIAD-R). NASA has scheduled two SFDTs to  
17 validate the design of a supersonic parachute design to be flown in conjunction with the  
18 validated SIAD-R decelerator.

19 With each SFDT, the NASA Jet Propulsion Laboratory (JPL) designed Test Vehicle is  
20 dropped from the 1 million cubic meter (34 mcf) scientific balloon at approximately  
21 37,000 m (120,000 ft). After the Test Vehicle drop, small solid-fuel rocket motors ignite  
22 to spin-stabilize the Test Vehicle ahead of the main motor ignition. The main motor for  
23 all SFDTs is an Orbital Alliant Techsystems (ATK), Incorporated manufactured Star 48B  
24 long nozzle solid-fueled rocket engine. The Star 48 is ignited, propelling the Test  
25 Vehicle upwards to a maximum altitude of approximately 54,000 m (180,000 ft) and at a  
26 speed of approximately Mach 3.8. The Test Vehicle then deploys its SIAD to slow its  
27 velocity to approximately Mach 2. The Test Vehicle’s main supersonic parachute then  
28 deploys, carrying the Test Vehicle safely for a controlled splashdown within a pre-  
29 coordinated operational area located west by northwest of PMRF. Starting with the  
30 2015 campaign, NASA is seeking authorization from the PMNM Co-Trustees to  
31 potentially fly over, splashdown, and recover floating expended flight hardware within  
32 the boundary of PMNM, but outside of the 5.6-km (3-nm) Special Management Area  
33 surrounding Nihoa Island. Figure 2-1 illustrates the LDSD test operational sequence at  
34 PMRF, which would include the planned (nominal) landing operations of the balloon and  
35 Test Vehicle within the operational area. The environmental impacts for this operational  
36 area were assessed in the 2013 LDSD Final EA (results are hereby included by  
37 reference).

38



**LDSD Supersonic  
Flight Dynamics Test  
Operational Sequence**

Kauai, Hawaii

**Figure 2-1**

21\_sfdt\_2/20/2015

1 **2.1.1.1 Test Description and Procedures**

2 *2.1.1.1.1 Unmodified Sections of Test Description and Procedures*

3 The following Test Description and Procedures sections will remain as outlined and  
4 detailed in the 2013 LDSD Final EA. These sections describe the No-action Alternative  
5 for this SEA and are incorporated into Alternatives 1 and 2. The 2013 EA section  
6 numbers are denoted in parenthesis after each section heading bullet.

- 7 • Supersonic Flight Dynamic Test (2.2.1.1)
- 8 • Test Vehicle System Information (2.2.1.2)
- 9 • Balloon Launch Platform (2.2.2)
- 10 • SFDT Test Vehicle (2.2.3)
- 11 • Test Vehicle System Ordnance Items and Storage (2.2.5)
- 12 • Test Vehicle Instrumentation System (2.2.6)
- 13 • Test Vehicle Global Positioning System (2.2.7)
- 14 • Test Vehicle Command Systems (2.2.8)
- 15 • Test Vehicle Flight Termination System (2.2.9)

16 *2.1.1.1.2 Modified Sections of Test Description and Procedures*

17 The following sections have been modified from what is stated in the 2013 LDSD Final  
18 EA. These sections describe the No-action Alternative for this SEA and are  
19 incorporated into Alternatives 1 and 2. The 2013 EA section numbers are denoted in  
20 parentheses after each heading.

21 2.1.1.1.2.1 Operational Facilities (2.2.4)

22 Any appropriate and available operational facility at PMRF could be used for the  
23 proposed SFDT. These modifications would also apply to Alternative 2 and the No-  
24 action Alternative. In addition to the facilities identified in the 2013 LDSD Final EA, the  
25 following facilities have been added:

26 **Building 360—Administrative Offices**

27 NASA would use Building 360 to provide office space and a dedicated conference room  
28 for project use during deployment to PMRF. The building would be equipped with  
29 printers, copiers, projections screens, and white boards. Communication interfaces are  
30 needed throughout the facility.

31 **Building 384—Aircraft Hangar**

32 NASA requires the use of Building 384 as a “Day of Launch Media Center.” A  
33 Transportable Satellite Ground Station would be located outside on the north side of  
34 Building 384.

1 **Building 560—Balloon/Test Vehicle Operations Center**

2 NASA would use Building 560 as the operations center for both NASA Balloon and Test  
3 Vehicle teams during launch operations. This facility is the location of the Balloon and  
4 Test Vehicle Electronic Ground Support Equipment (EGSE). The majority of the  
5 commands during the mission would be initiated from this location; the only exception  
6 would be the UHF commands associated with the Test Vehicle drop circuit. The drop  
7 circuit commands would be initiated from Building 105 by the U.S. Navy's Range Safety  
8 Organization.

9 **2.1.1.2 Launch Trajectory**

10 *2.1.1.2.1 Unmodified Sections of Launch Trajectory*

11 The following Launch Trajectory sections will remain as outlined and detailed in the  
12 2013 LDSD Final EA. These sections describe the No-action Alternative for this SEA  
13 and are incorporated into Alternatives 1 and 2. The 2013 EA section numbers are  
14 denoted in parenthesis after each section heading bullet.

- 15 • SFDT Test Vehicle Nominal Trajectory Information (2.3.2)

16  
17 *2.1.1.2.2 Modified Sections of Test Description and Procedures*

18 The following sections have been modified from what is stated in the 2013 LDSD Final  
19 EA. These sections describe the No-action Alternative for this SEA and are  
20 incorporated into Alternatives 1 and 2. The 2013 EA section numbers are denoted in  
21 parenthesis after each heading.

22 2.1.1.2.2.1 Balloon Launch Platform Notional Trajectory (2.3.1)

23 The notional predicted trajectories of the balloon from PMRF include possible over-flight  
24 of Nihoa Island, the Special Management Area around Nihoa Island, and the  
25 easternmost part of PMNM.

26 Launch decisions for the SFDT are tied directly to suitability of winds from ground level  
27 to a height of approximately 55,000 m (180,000 ft). Meteorological (MET) soundings  
28 are used to gauge mid- and upper level wind conditions. Two sizes of latex MET  
29 balloons (2,000 grams [g] [70.5 ounces] and 30 g [1 ounce]), would be released to  
30 measure lower- and mid-level wind conditions from ground up to a height of  
31 approximately 33,500 m (110,000 ft) while Super Loki sounding rocket-deployed Rocket  
32 Balloon Instruments (ROBINs) are used to calculate upper level wind conditions to a  
33 height of approximately 90,000 m (295,000 ft). Two 2,000-g (70.5-ounce) MET balloons  
34 would be released the day of launch (one 1.5 hours prior to launch and the other 1.5  
35 hours after launch). Each 2,000-g (70.5-ounce) MET balloon would be equipped with a  
36 radiosonde that contains instruments capable of making direct in-situ measurements  
37 of air temperature, humidity, and pressure. These observed data are transmitted  
38 immediately to the ground station by a radio transmitter located within the instrument  
39 package. The Super Loki is a two-stage rocket system used to obtain density,

1 temperature, ozone, and wind data at altitudes ranging from 85,000 to 110,000 m  
2 (279,000 to 361,000 ft) to ground level. The first stage is a solid propellant rocket, 0.1  
3 m (0.3 ft) in diameter and 2.0 m (6.6 ft) long. The second stage is an inert instrumented  
4 Dart, 0.054 m (0.177 ft) in diameter and 1.26 m (4.13 ft) long. Both stages consist of an  
5 aluminum case with an internally burning cast-in-the-case solid propellant. The  
6 propellant fuel is a polysulfide polymer, and the oxidizer is ammonium perchlorate.  
7 Each Super Loki rocket would deploy a ROBIN, (a metalized 0.5-mil thick Mylar sphere,  
8 1.0 m [3.3 ft] in diameter, inflated to 12 hectopascal pressure), to a height of  
9 approximately 89,900 m (295,000 ft. Since the ROBIN sphere's mass and spherical  
10 diameter is known, as the sphere falls from this initial deployment height to a minimum  
11 height of approximately 30,500 m (100,000 ft), where the higher external pressure  
12 causes the sphere to collapse, radar tracking information can be used to calculate wind  
13 direction, wind velocity, temperature, density, and pressure.

14 The balloon's pressure and altitude would remain at a fairly constant float level  
15 (constant pressure altitude), oscillating  $\pm 200$  m (650 ft) with ballast commands. The  
16 balloon's internal pressure and altitude could be controlled via radio commands sent  
17 from the command station. If the balloon pressure needs to be lowered, a command is  
18 sent to vent helium until the correct pressure is achieved. Should the internal pressure  
19 need to be raised, flight controllers can send a command to slowly release a portion of  
20 the ballast material until the correct pressure and a slightly higher float altitude is again  
21 achieved. The LDSB balloon system carries approximately 113 kg (250 lb) of 0.3 to 0.5  
22 mm (0.01 to 0.02 inches) steel shot ballast that has been designed to be slowly and  
23 completely released during the ascent phase. It should be noted that while such fine-  
24 tune control of the balloon flight is possible by releasing ballast material, gross trajectory  
25 control (i.e., steering) cannot be achieved with the balloon system; the balloon system  
26 would follow the prevailing wind patterns encountered during its flight. These wind  
27 patterns were part of the computational algorithms used during the Monte Carlo  
28 simulations utilized to project flight trajectories.

29 The Monte Carlo method is a problem solving technique which approximates the  
30 probability of certain outcomes by running multiple trial runs, called simulations, using  
31 random variables. Monte Carlo simulations were employed to take an identified set of  
32 variables (e.g., wind patterns) representing real world conditions that could affect the  
33 LDSB flight and used computational algorithms to find potential outcomes (flight  
34 trajectories) of "what-if" scenarios. These scenarios were not screened against the  
35 safety and mission success criteria, so several of these trajectories would not be  
36 executed under the project's established Go/No Go criteria.

37 Under the assumption that all possible trajectories were allowed to fly, NASA estimates  
38 the balloon has approximately a 0.4% chance of reaching float altitude within PMNM  
39 and a 20% chance of entering PMNM after reaching float altitude. These probabilities  
40 are reduced when NASA and the U.S. Navy apply the project's established Go/No Go  
41 criteria (e.g., safety restrictions, proper weather conditions, operational status of all  
42 LDSB subsystems, telemetry checks, and readiness of recovery systems). These test  
43 rules eliminate trajectories that are predicted to fly out directly over large populated

1 areas or follow a trajectory outside boundaries set by NASA, the U.S. Navy, and the  
2 FAA. (Combs, 2014) Figure 2-2 depicts notional test footprints for a balloon supersonic  
3 flight test launch trajectory.

#### 4 **2.1.1.3 Launch Operation**

##### 5 *2.1.1.3.1 Unmodified Sections of Launch Operation*

6 The following Launch Operation sections will remain as outlined and detailed in the  
7 2013 LDSD Final EA. These sections describe the No-action Alternative for this SEA  
8 and are incorporated into Alternatives 1 and 2. The 2013 EA section numbers are  
9 denoted in parenthesis after each section heading bullet.

- 10 • Pre-Launch Activities (2.4.1)
  - 11 – Launch Preparation Activities (2.4.1.2)
  - 12 – Transportation and Storage (2.4.1.1)
  - 13 – Personnel, Utility and Equipment Requirement (2.4.1.3)
  - 14 – Safety Hazard Issues (2.4.1.4)
- 15 • Launch Activities (2.4.2)
  - 16 – Launch Control (2.4.2.2)
  - 17 – Telemetry Data (2.4.2.4)

##### 18 19 *2.1.1.3.2 Modified Sections of Launch Operation*

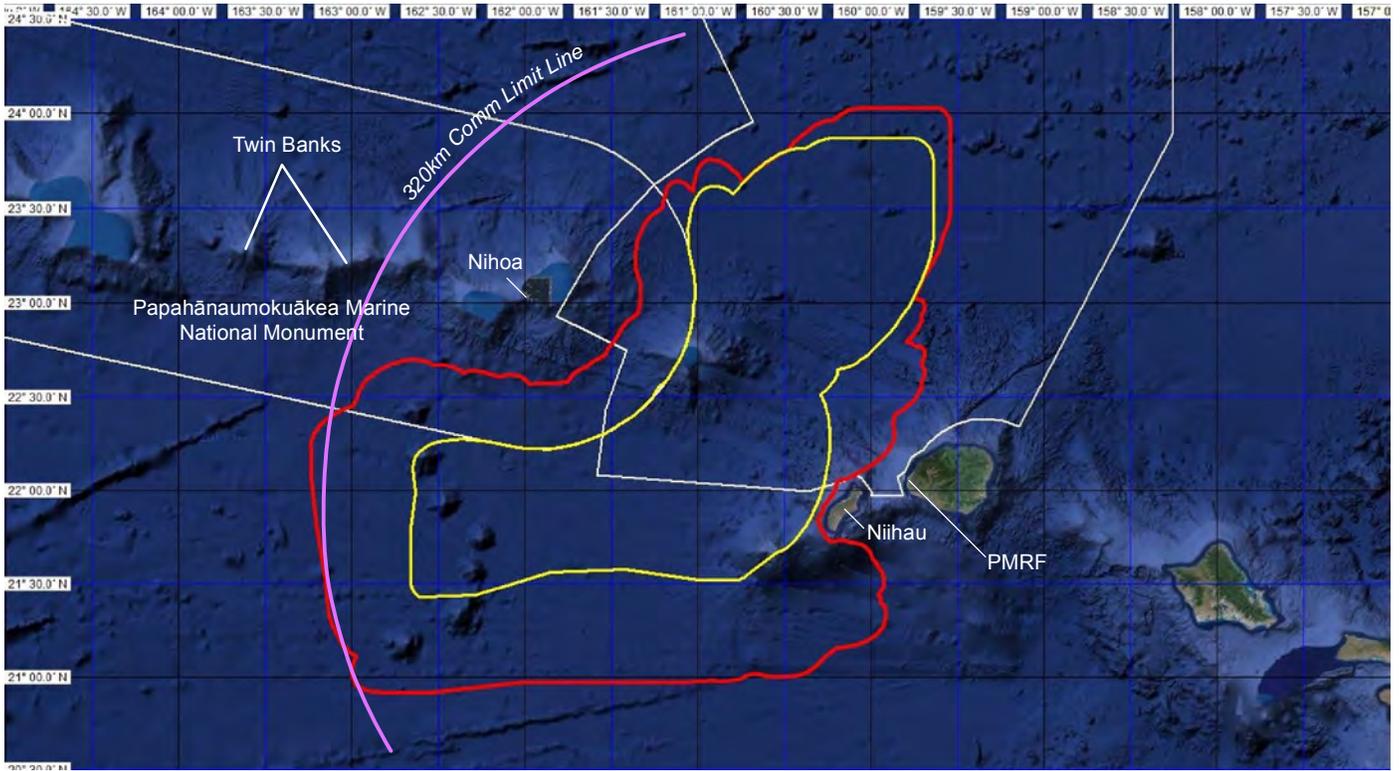
20 The following Launch Operation sections have been modified from what is stated in the  
21 2013 LDSD Final EA. These sections describe the No-action Alternative for this SEA  
22 and are incorporated into Alternatives 1 and 2. These modifications would also apply to  
23 Alternative 2 and the No-action Alternative. The 2013 EA section numbers are denoted  
24 in parenthesis after each heading.

##### 25 2.1.1.3.2.1 Day of Launch Timeline (2.4.2.1—Table 2-3)

26 For the +2.5 hours [Time (T-Minus)] event description, a balloon spotter aircraft could be  
27 deployed.

##### 28 2.1.1.3.2.2 Metric Data (2.4.2.3)

29 It is critical to the success of the LDSD project that accurate tracking information be  
30 captured and analyzed in real-time starting at launch of the balloon, during execution of  
31 the SFDT, and through splashdown of expended flight hardware to aid in recovery.  
32 NASA and the U.S. Navy would work cooperatively to develop a comprehensive and  
33 robust radar tracking plan for both the balloon Launch Platform and the Test Vehicle  
34 based on the available radar tracking assets at PMRF. High speed and high resolution  
35 memory data storage devices for each flight would be onboard the Test Vehicle and



**EXPLANATION**

-  320-km Communications Limit Line Approximation
-  Nominal Highlighted Trajectory
-  Off-Nominal Trajectory



**Examples of Potential Test Footprints for a Balloon Supersonic Flight Dynamics Test Launch Trajectory**

PMRF, Niihau, Open Ocean, and PMNM

**Figure 2-2**

22\_sigma.2/23/2015

1 must be recovered. Part of the flight reconstruction process would be physical  
2 examination of the actual decelerators, so those too must be recovered.

3 During the 2014 campaign, the NASA and U.S. Navy team demonstrated the ability to  
4 precisely predict and track the scientific balloon, Test Vehicle, and other associated  
5 flight hardware through splash down. Lessons learned from the 2014 campaign would  
6 be leveraged in future flights (beginning in June 2015) to improve the project's  
7 prediction, tracking, and recovery performance.

8 2.1.1.3.2.3 Other Support Activities (2.4.2.5)

9 Other launch support activities could be required to execute the Proposed Action. Table  
10 2-1 lists and summarizes those other support activities that have been modified from the  
11 2013 LDSD Final EA and describe the No-action Alternative for this SEA and are  
12 incorporated into Alternatives 1 and 2.

**Table 2-1. Summary of Other Support Activities (Table 2-5)**

<b>Support Activity</b>	<b>Support Activities</b>
Command System	<ul style="list-style-type: none"><li>• No modification</li></ul>
Timing Signals	<ul style="list-style-type: none"><li>• No modification</li></ul>
Visual Countdown	<ul style="list-style-type: none"><li>• No modification</li></ul>
Communications (Air/Ground/Video/ Network/Telephone/ Frequencies)	<ul style="list-style-type: none"><li>• NASA could use a recovery spotter aircraft and if used, would require voice communications with the recovery spotter aircraft and PMRF's surveillance aircraft that may be supporting recovery efforts.</li></ul>
Real Time Data Display/ Control	<ul style="list-style-type: none"><li>• No modification</li></ul>
Photographic	<ul style="list-style-type: none"><li>• No modification</li></ul>

13

14 2.1.1.3.2.4 Recovery and Recovery Support (2.4.3.1)

15 NASA and the U.S. Navy have evaluated multiple contingent flight scenarios and  
16 terminate conditions in addition to the planned (nominal) test plans. The combined flight  
17 system (balloon and Test Vehicle) would be continually tracked by PMRF ground  
18 instrumentation providing positional data to the U.S. Navy Range Safety Organization.  
19 The present position of the flight system along with individual impact dispersions (which  
20 is a variable circle with a maximum radius 26 km [14 nm]) for the balloon carcass, flight  
21 train system, and Test Vehicle would be overlaid onto a series of decisional safety  
22 displays. The splashdown dispersions would be compared to boundaries designed to  
23 protect the general public on Niihau and Kauai islands along with safety criteria  
24 established to protect non-participating ships and aircraft. During the 2014 campaign,  
25 the NASA and U.S. Navy team demonstrated the ability to precisely predict and track  
26 the balloon, Test Vehicle, and other associated flight hardware through splashdown.

1 Lessons learned from the 2014 campaign would be leveraged in future campaigns to  
2 improve the project's prediction, tracking, and recovery performance.

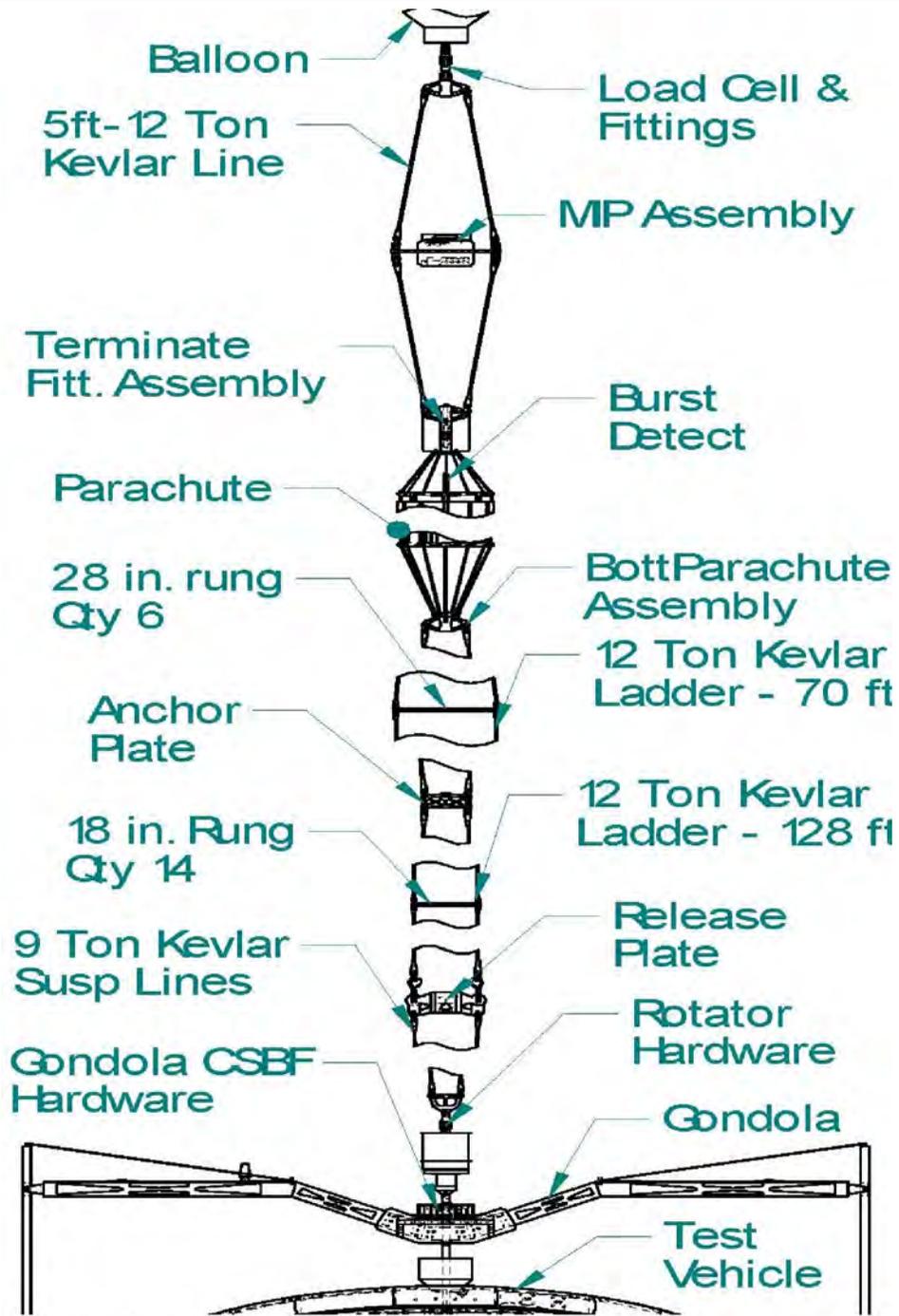
3 The LDSD project would maintain continuous communications with the supporting  
4 seaborne vessels and aircraft to ensure situational awareness during the test. The  
5 NASA Recovery Director serves as the responsible Point of Contact for execution of the  
6 NASA Recovery Plan once the combined flight system (balloon and Test Vehicle) is  
7 over ocean. The NASA Recovery Plan address both planned (i.e., nominal) and  
8 contingent procedures associated with the SFDT, early termination, and inflight  
9 unplanned scenarios (anomalies) over water. All procedures would be executed in  
10 compliance with established NASA and U.S. Navy NEPA requirements for the LDSD  
11 project and PMRF.

12 NASA would utilize up to three seaborne vessels and up to two U.S. Navy aircraft  
13 during the future campaigns to execute recovery operations immediately following each  
14 SFDT. The recovery operations would be to deploy the seaborne vessels prior to SFDT  
15 initiation to Test Support Positions (TSP) based on the predicted Test Vehicle drop  
16 location for the following day. The time of the deployment for seaborne vessels would  
17 depend on the location of the TSPs and the transit speed of the particular vessels  
18 assigned to those TSPs. A TSP flight path would also be assigned for any supporting  
19 recovery aircraft along with a test specific timeline. These supporting aircraft would be  
20 deployed according to their timeline.

21 After the SFDT, the NASA Recovery Director would receive confirmation of balloon  
22 termination, deployment of decelerators, status of ordnance items, and best estimate of  
23 splashdown locations for each item to be recovered. This information would be  
24 provided by multiple project elements including the balloon team, Test Vehicle team,  
25 and PMRF ground instrumentation. This information would be passed on to supporting  
26 recovery assets for verification. When recovery assets encounter expended flight  
27 hardware, it would be rendered safe by onboard safety personnel before being brought  
28 aboard the appropriate seaborne vessel.

29 Almost all expended flight hardware is then recovered from the ocean, with the  
30 exception of the balloon flight train (Figure 2-3). This flight train connects the Test  
31 Vehicle to the balloon. The flight train weighs approximately 376 kg (830 lb); is  
32 approximately 302 m (990 feet) long; and consists of a burst parachute (a safety  
33 instrument), sensors, connections, and Kevlar® cabling. This system would sink rapidly  
34 in the ocean and would be almost impossible to locate. Once the Test Vehicle is  
35 dropped, a signal is sent that separates the flight train from the balloon and in the  
36 process, rips the balloon to allow descent.

37 Identified recoverable items would be returned to Port Allen, Kauai, Hawaii and off-  
38 loaded to NASA and U.S. Navy personnel. The recovered items would be sorted by  
39 destination at Port Allen, then relocated per a coordinated disposition plan.



**Flight Train Assembly**

**Figure 2-3**

23\_flight\_train\_2/20/2015

1 Table 2-2 lists and summarizes these other potential recovery activities that have been  
 2 modified from the 2013 LDSD Final EA and describe the No-action Alternative for this  
 3 SEA and are incorporated into Alternatives 1 and 2.

**Table 2-2. Overview of Recovery Aids (Table 2-6)**

Flight Hardware	Recovery Aids
Balloon Launch Platform	<ul style="list-style-type: none"> <li>• Recovery aids such as Global Positioning System (GPS) beacons or other similar transmitting systems could be used on the balloon.</li> <li>• The notional concept of operations (ConOps) for recovering the balloon could be a spotter plane within visual range as the balloon falls and that reports its position once in the water.</li> </ul>
Test Vehicle	<ul style="list-style-type: none"> <li>• Could be equipped with two different types of GPS locators</li> <li>• One GPS locator system could relay data over the Argos satellite network.</li> <li>• One GPS locator system could relay data over the Iridium satellite network.</li> <li>• The GPS locators could be situated on the Test Vehicle such that one or the other could function despite the orientation of the Test Vehicle in the water.</li> </ul>
Flight Image Recorder	<ul style="list-style-type: none"> <li>• Could be equipped with a ruggedized GPS locator developed by the U.S. Army</li> <li>• Could be equipped with a water activated audible pinger developed by Teledyne Benthos</li> <li>• The notional ConOps is that the Flight Image Recorder would stay with the Test Vehicle and, if used, any water activated recovery aids do not engage. In the event of an anomaly, the Flight Image Recorder is designed to separate from the Test Vehicle. Depending on the circumstances of the anomaly, if used, the water activated recovery aids on the Flight Image Recorder may help locate the Test Vehicle.</li> </ul>

4

5 2.1.1.3.2.5 Potential Test Vehicle Recovery Aids (2.4.3.2)

6 In addition to recovery aids required by the Range and the LDSD program, other  
 7 potential test vehicle recovery aids could be used.

8 2.1.1.3.2.5.1 Flotation Duration (2.4.3.2.1)

9 All recovery aids may be required to remain active for a minimum of 4 days.

10 2.1.1.3.2.5.2 Electronic Aids (2.4.3.2.2)

11 The balloon and the Test Vehicle could use two different types of electronic recovery  
 12 aids. The first could be Trident’s Iridium GPS beacon, which could be used by the

1 balloon and the Test Vehicle. The second system of the balloon could be a Telonics  
2 marine Argos/GPS beacon. The balloon could also be equipped with two audible  
3 beacons; one of each could be mounted in the same locations as the other recovery  
4 aids (top and bottom of the balloon). The recovery vessel could have an underwater  
5 hydrophone designed specifically to listen for these if they are activated.

6 The Test Vehicle would contain water-tight data enclosures that are intended to stay  
7 with the vehicle upon water impact. In the event that these enclosures separate from  
8 the vehicle upon impact, they could be equipped with audible beacons for water  
9 recovery. The Test Vehicle could also be equipped with three audible beacons  
10 mounted on the rear camera boxes in the event the camera boxes become dislodged  
11 from the vehicle during impact with the water. The Test Vehicle would utilize the Iridium  
12 system to account for either of two possible float orientations in the water.

#### 13 2.1.1.3.2.5.3 Visual Aids (2.4.3.2.3)

14 As currently planned, the balloon visual aids could include two strobe lights to aid the  
15 spotter planes in the initial location. The units would be located in the same locations  
16 as the Iridium and Argos beacons and would be salt water activated.

17 The Test Vehicle visual aids could also include two strobe lights to aid the spotter  
18 planes. The units would be located in the shoulder region of the Test Vehicle and would  
19 be salt water activated.

## 20 **2.2 ALTERNATIVE 1—PREFERRED ALTERNATIVE**

21 The Proposed Action (Alternative 1—Preferred Alternative) incorporates all activities  
22 described in the No-action Alternative, with clarification that some recovery aids  
23 discussed in the 2013 EA may or may not be employed and provides for additional  
24 splashdown area and test opportunities for the SFDT. This would require approved  
25 entry into the easternmost part of the Open Ocean Area of PMNM; therefore, NASA has  
26 requested authorization for entry into PMNM through a Conservation and Management  
27 permit. This entry would consist of the splashdown and recovery of expended flight  
28 hardware and potential fly-over of Nihoa Island and its surrounding Special  
29 Management Area from scheduled SFDTs beginning in 2015. NASA could have up to  
30 two technology testing launches each year for the next 5 years (June 2015 through  
31 August 2019). These additional test opportunities would increase the probability of  
32 successful test flights and lower the risk of a scenario for an unplanned (i.e.,  
33 anomalous) termination of the test flight.

### 34 **2.2.1 PROPOSED ADDITIONAL SPLASHDOWN AREA**

35 NASA proposes to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for  
36 future SDFT test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately  
37 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within PMNM and the other approximately  
38 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM (see Figure 1-5).

1 NASA submitted a Conservation and Management Permit requesting authorization for  
2 use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the  
3 PMNM Conservation and Management Permit would authorize entry, splashdown, and  
4 recovery of expended flight hardware within PMNM.

5 This additional splashdown area excludes the 70 hectares (170 acres) of Nihoa Island  
6 and the approximately 128.5 km<sup>2</sup> (37.5 nm<sup>2</sup>) Special Management Area within 5.5 km (3  
7 nm) surrounding Nihoa Island. To ensure the excluded area waters and/or island will  
8 not be entered, one of two scenarios would occur: (1) the LDSD Program would initiate  
9 the SFDT in such a manner that expended flight hardware would be recovered before  
10 drifting into the excluded area; or (2) the flight system would overfly the excluded area,  
11 and the Test Vehicle would be dropped outside 5.5 km (3 nm) from Nihoa Island.  
12 Therefore, expended flight hardware would not be deposited on Nihoa Island or within  
13 the Special Management Area surrounding the island (see Figure 1-5).

### 14 **2.3 ALTERNATIVE 2—ADDITIONAL LAUNCH YEARS**

15 Under Alternative 2, NASA would conduct the No-action Alternative as described in this  
16 SEA, which is the Proposed Action as detailed in the 2013 LDSD Final EA with  
17 clarification that some recovery aids discussed in the 2013 EA may or may not be  
18 employed. The proposed test campaign for Alternative 2 would consist of launch,  
19 operation, and recovery of up to two missions per year over the next 5 years (June  
20 2015–August 2019) from a designated location on PMRF using the flight trajectory  
21 outlined in the 2013 LDSD Final EA. Under Alternative 2, Sections 2.1.1.1.2.1  
22 (Operational Facilities) and 2.1.1.3 (Launch Operation) of this SEA would apply.

23

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## **3.0 Affected Environment and Environmental Consequences**

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# 3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

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1  
2

3 This chapter describes the No-action Alternative, Alternative 1, and Alternative 2. This  
4 chapter discusses and analyzes (1) the environmental characteristics that may be  
5 affected by the Proposed Action and (2) the environmental impacts to these  
6 characteristics. This information serves as a baseline from which to identify and  
7 evaluate environmental changes resulting from the LDSD operations that would occur in  
8 approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within the easternmost part  
9 of PMNM and approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area north of  
10 PMNM. To provide a baseline point of reference for understanding any potential  
11 environmental effects, the affected environment is briefly described; any components of  
12 greater concern are described in greater detail. CEQ regulations for implementing  
13 NEPA also require the discussion of environmental impacts in proportion to their  
14 significance, with only enough discussion of non-significant issues to show why more  
15 study is not warranted. The analysis in this SEA considers the current conditions of the  
16 affected environment and compares those to conditions that might occur should NASA  
17 implement the Proposed Action.

18 The Pacific region of PMRF, the island of Niihau, the Open Ocean Area, and the Global  
19 Environment were detailed and analyzed in the 2013 LDSD Final EA and are  
20 incorporated by reference. All analyses presented in the 2013 LDSD Final EA for these  
21 locations apply for all future flight tests.

22 Available reference materials, including natural resources management plans and EAs,  
23 were reviewed. To fill data gaps (questions that could not be answered from the  
24 literature) and to verify and update available information, subject matter experts and  
25 program personnel were contacted.

26 Table 3-1 presents the results of the process of identifying resources to be analyzed in  
27 this SEA.

1

**Table 3-1. Resources Considered for Analysis in this SEA**

Resource	Open Ocean Area (Within and Outside of PMNM)		Nihoa Island	
	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination
<b>Air Quality</b>	Yes	Section 3.2.1.1	No	No incremental or cumulative adverse environmental impacts to air quality were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA (which is hereby incorporated by reference) and in Section 3.2.1.1 of this SEA.
<b>Airspace</b>	No	No incremental or cumulative adverse environmental impacts to airspace were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	No incremental or cumulative adverse environmental impacts to airspace were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.
<b>Biological Resources</b>				
Coral	Yes	Section 3.2.1.2.2.1	Yes	Section 3.1.2.1.2.2
Bottomfish	Yes	Section 3.2.1.2.2.2	No	N/A*
Seabirds	Yes	Section 3.2.1.2.2.3	Yes	Section 3.2.2.1.2.4
Terrestrial	No	N/A*	Yes	Section 3.2.2.1.2.1
Marine Mammals	Yes	Section 3.2.1.2.2.4	Yes	Section 3.2.2.1.2.2
Threatened and Endangered Species	Yes	Section 3.2.1.2.2.5 (Cetaceans, Pinnipeds, Sea Turtles)	Yes	Section 3.1.2.1.2.1 and 3.1.2.1.2.2
Environmentally Sensitive Habitat Area	Yes	3.1.1.2.2.5	Yes	Section 3.2.2.1.2.3
Endangered Species Act Section 7 Consultation	Yes	Section 3.2.1.2.3	Yes	Section 3.2.2.1.3

2 \*N/A — Resource not applicable and not analyzed for this location.

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**Table 3-1. Resources Considered for Analysis in this SEA (Continued)**

Resource	Open Ocean Area (Within and Outside of PMNM)		Nihoa Island	
	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination
<b>Cultural Resources</b>				
PMNM	Yes	Section 3.2.1.2.8.1	No	
Open Ocean Area	Yes	Section 3.2.1.2.8.2	N/A*	
Historic Buildings and Structures	N/A*		Yes	Section 3.2.2.1.2.1
Traditional Resources (including burials)	No		Yes	Section 3.2.2.1.2.2
<b>Geology and Soil</b>	No	N/A*	No	The LDSD Program proposes no ground activities on Nihoa Island.
<b>Hazardous Materials and Waste</b>	No	No incremental or cumulative adverse environmental impacts from hazardous material and waste were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	No incremental or cumulative adverse environmental impacts from hazardous material and waste were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.
<b>Health and Safety</b>	No	No incremental or cumulative adverse environmental impacts relating to Health and safety were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	Undeveloped and unpopulated island
<b>Land Use</b>	No	N/A*	No	Undeveloped and unpopulated island

2 \*N/A — Resource not applicable and not analyzed for this location.

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**Table 3-1. Resources Considered for Analysis in this SEA (Continued)**

Resource	Open Ocean Area (Within and Outside of PMNM)		Nihoa Island	
	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination
Noise	No	No incremental or cumulative adverse environmental impacts to noise were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	No incremental or cumulative adverse environmental impacts to noise were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.
Socioeconomics	No	No incremental or cumulative adverse environmental impacts to socioeconomics characteristics were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	Undeveloped and unpopulated island
Transportation	No	No incremental or cumulative adverse environmental impacts to transportation were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	Undeveloped and unpopulated island
Utilities	No	N/A*	No	Undeveloped and unpopulated island
Visual Aesthetics	No	No incremental or cumulative adverse environmental impacts to visual aesthetics were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	Undeveloped and unpopulated island

2 \*N/A — Resource not applicable and not analyzed for this location.

3

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**Table 3-1. Resources Considered for Analysis in this SEA (Continued)**

Resource	Open Ocean Area (Within and Outside of PMNM)		Nihoa Island	
	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination	Analyzed in Detail in this SEA	If Yes, SEA Section If No, Rationale for Elimination
Water	No	No incremental or cumulative adverse environmental impacts to water resources were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.	No	No incremental or cumulative adverse environmental impacts to water resources were identified beyond those identified in the detailed analysis presented in the 2013 LDSD Final EA, which is hereby incorporated by reference.

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DRAFT

1 **3.1 NO-ACTION ALTERNATIVE**

2 Under the No-action Alternative, the SFDTs would follow the planned (i.e., nominal)  
3 launch trajectory path outlined in the 2013 LDSD Final EA and with the clarification that  
4 some recovery aids discussed in that EA may or may not be employed. Except as  
5 described in Section 2.1.1, the No-action Alternative would be identical to the Proposed  
6 Action in the 2013 LDSD Final EA and, as such, would have the same environmental  
7 consequences as analyzed in that document, which are hereby incorporated by  
8 reference. This proposed test campaign would consist of launch, operation, and  
9 recovery of up to four missions from a designated location on PMRF. The purpose of  
10 the SFDT campaign is to demonstrate and evaluate development of new SIAD and  
11 SSRS parachute technologies. The SFDT campaign would consist of up to four flights  
12 from approximately June to July 2014 and June to August 2015. One flight was  
13 conducted in 2014, and up to three could be conducted in 2015. Under the No-action  
14 Alternative, Sections 2.1.1.1.2.1 (Operational Facilities) and 2.1.1.3 (Launch Operation)  
15 of this SEA would apply. Any potential environmental impacts are discussed and  
16 analyzed in the 2013 LDSD Final EA.

17 Under the No-action Alternative, flight activities (expended hardware, vessels and  
18 aircraft, and unrecoverable sinkable items) associated with the SFDT would not enter or  
19 have an adverse effect on Nihoa Island, the Special Management Area around Nihoa  
20 Island, or PMNM as a whole.

21 **3.2 ALTERNATIVE 1—PROPOSED ACTION (PREFERRED**  
22 **ALTERNATIVE)**

23 **3.2.1 OPEN OCEAN**

24 **Resources Carried Forward for Detailed Analysis for the Open Ocean Area**

25 Table 3-1 presents the results of the process of identifying resources to be analyzed in  
26 this SEA, which are air quality, biological resources, and cultural resources. The  
27 general organization of resource areas is consistent with the 2013 LDSD Final EA;  
28 however, many have been eliminated from the SEA and are detailed in Table 3-1.

29 **Resources Considered but Eliminated from Detailed Analysis for the Open Ocean**  
30 **Area**

31 Fourteen areas of environmental consideration were initially evaluated for the Open  
32 Ocean Area to provide a context for understanding the potential effects of the Proposed  
33 Action and to provide a basis for assessing the severity of potential environmental  
34 effects. These areas included air quality, airspace, biological resources, cultural  
35 resources, geology and soils, hazardous materials and waste, health and safety, land  
36 use, noise, socioeconomics, transportation, utilities, visual aesthetics, and water  
37 resources. Ultimately 3 of the 14 areas of environmental consideration were addressed  
38 for the Open Ocean Area (air quality, biological resources, and cultural resources). The

1 remaining resource areas were not analyzed in such a manner. Those resources not  
2 warranting further discussion are presented in Table 3-1.

### 3 **Papahānaumokuākea Marine National Monument**

4 President George W. Bush established PMNM on 15 June 2006 to protect the  
5 resources of the Northwestern Hawaiian Islands (NWHI) (Figure 3-1). The purposes  
6 and management regime for PMNM, as well as restrictions and prohibitions regarding  
7 activities in PMNM, are set forth in Proclamation 8031 (71 Federal Register 36443, 26  
8 June 2006) (Proclamation).

9 PMNM is situated in the Pacific Ocean northwest of the Main Hawaiian Islands (MHI).  
10 PMNM includes the NWHI Coral Reef Ecosystem Reserve, the Hawaiian Islands  
11 National Wildlife Refuge, the Midway Atoll National Wildlife Refuge, and the Battle of  
12 Midway National Memorial.

13 Dedicated to the conservation of the NWHI, PMNM encompasses an area northwest of  
14 the MHI from Nihoa Island to Kure Atoll. It is a nearly 362,600-km<sup>2</sup> (140,000-square-  
15 mile [mi<sup>2</sup>]) area, 160-km (100 miles [mi]) wide and was established to protect marine  
16 resources in the area including coral reefs, the endangered Hawaiian monk seal  
17 (*Monachus schauinslandi*), the threatened Hawaiian green turtle (*Chelonia mydas*), and  
18 the endangered leatherback and hawksbill turtles (*Dermochelys coriacea* and  
19 *Eretmochelys imbricata*). PMNM is an approximately 2,220-km (1,200-nm) stretch of  
20 coral islands, seamounts, banks, and shoals. (National Oceanic and Atmospheric  
21 Administration, 2006).

#### 22 **3.2.1.1 Air Quality—Open Ocean (Alternative 1—Proposed Action)**

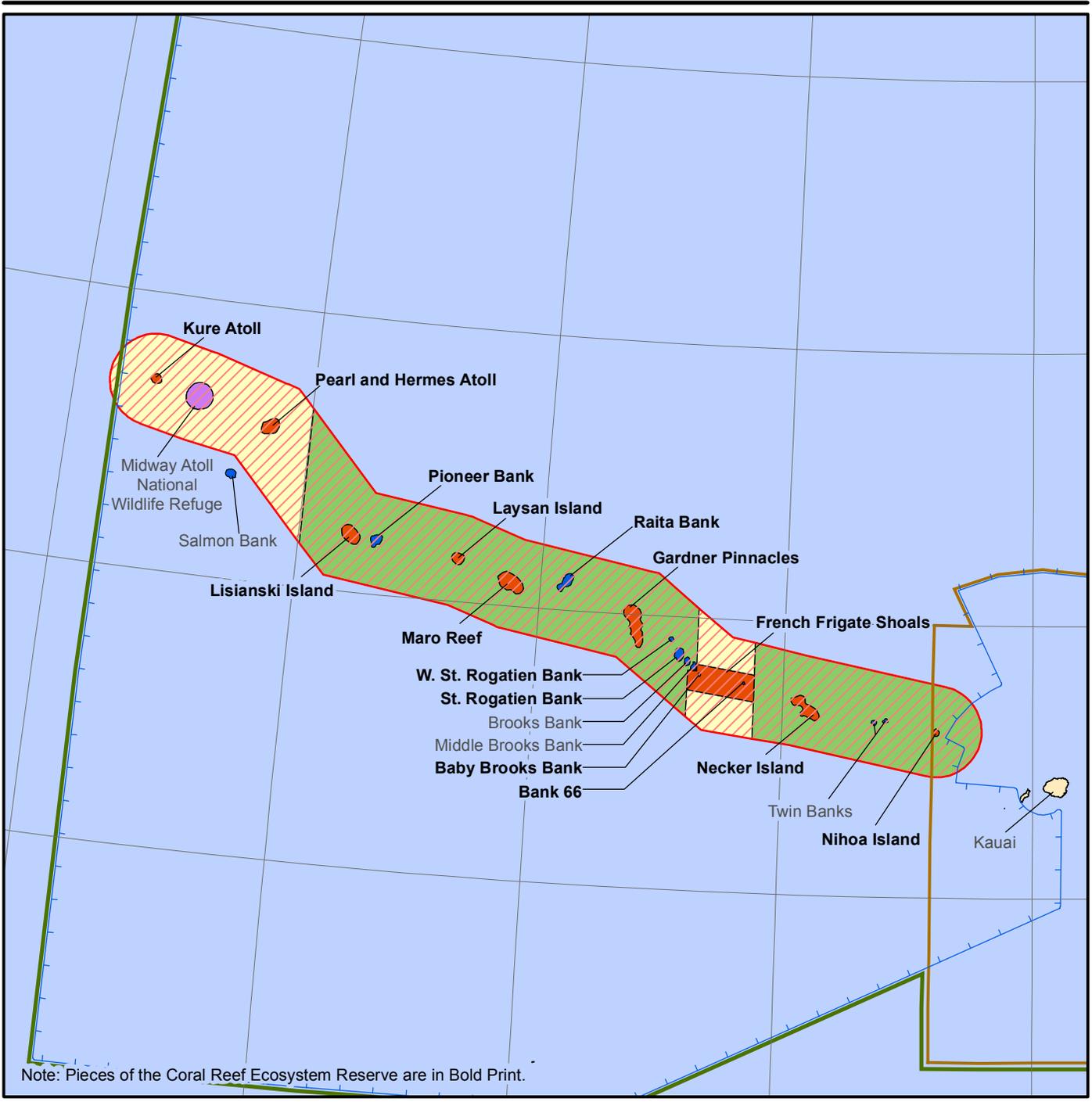
##### 23 **3.2.1.1.1 Region of Influence**

24 The region of influence includes the entire SFDT operations area. The operations area  
25 would include the additional splashdown area in the Open Ocean Area, which is  
26 approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), and all operational areas discussed in the  
27 2013 Final LDSD EA. This additional splashdown area includes approximately 28,730  
28 km<sup>2</sup> (8,370 nm<sup>2</sup>) within the easternmost part of PMNM and approximately 8,875 km<sup>2</sup>  
29 (2,600 nm<sup>2</sup>) north of PMNM. Figure 1-5 is an overview of the region of influence.

##### 30 **3.2.1.1.2 Affected Environment**

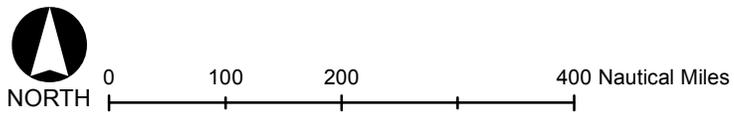
31 Hawaii's air quality standards (HRS, Chapter 342B, Air Pollution Control and HAR  
32 Chapters 11-59 and 11-60.1) are broadly based and adhere to all federal emission  
33 standards for hazardous air pollutants. Due to the remote location and low level of  
34 human activities, the air of PMNM (NWHI) is relatively pristine. (National Oceanic and  
35 Atmospheric Administration, 2014)

36



**EXPLANATION**

- Temporary Operating Area
- Hawaii Range Complex
- Hawaiian Operating Area
- Papahānaumokuākea Marine National Monument
- Bank
- Commercial Fishing Phase-Out Area
- Ecological Reserve
- Hawaiian Islands National Wildlife Refuge
- Midway Atoll National Wildlife Refuge



**Papahānaumokuākea Marine National Monument**

Northwestern Hawaiian Islands

**Figure 3-1**

31\_monument\_2/20/2015

1 **3.2.1.1.3 Environmental Consequences**

2 The ballast of the balloon system provides stability and control of the balloon during  
3 ascent. The LDSD balloon system carries approximately 110 kilograms (kg) (250  
4 pounds [lb]) of ballast consisting of very fine steel shot (grain size 0.3 to 0.5 mm [0.01 to  
5 0.02 inch]), which would be released to adjust the float altitude of the balloon system. In  
6 the United States, the U.S. Environmental Protection Agency (EPA) regulates  
7 particulate matter of size 2.5 and 10 microns (1 micron is equal to 0.001 mm), as these  
8 sizes can be easily breathed into the lungs of humans or animals. However, as the  
9 particle size of the ballast exceeds 10 microns, the ballast material is not regulated by  
10 EPA. The released ballast would travel in the upper atmospheric winds and be  
11 dispersed over hundreds of kilometers. Therefore, under the Proposed Action, the  
12 emissions from SFDT would have no significant adverse effect on existing air quality  
13 within PMNM.

14 **3.2.1.2 Biological Resources—Open Ocean (Alternative 1—Proposed Action)**

15 **3.2.1.2.1 Region of Influence**

16 The region of influence for the Open Ocean Area includes approximately 37,600 km<sup>2</sup>  
17 (10,950 nm<sup>2</sup>) of additional splashdown area. Of the approximately 37,600 km<sup>2</sup> (10,950  
18 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within the  
19 easternmost part of PMNM and approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean  
20 Area north of PMNM. Figure 1-5 is an overview of the region of influence. The  
21 following sections provide a summary of biological resources typically located in the  
22 region of influence.

23 **3.2.1.2.2 Affected Environment**

24 The affected environment biological resources environment in the Open Ocean Area of  
25 influence is described below. Additionally, this area is considered as the same Open  
26 Ocean Area described in the 2013 LDSD Final EA and is therefore incorporated by  
27 reference. The following sections will remain as outlined and detailed in the 2013 LDSD  
28 Final EA. The 2013 EA section numbers are noted in parenthesis after each section  
29 heading bullet.

- 30 • Fish (3.3.2.1; page 3-48)
- 31 • Essential Fish Habitat (3.3.2.1; page 3-49)

32  
33 The following sections have been modified from what is stated in the 2013 LDSD Final  
34 EA. The corresponding 2013 EA section numbers are denoted in parentheses after  
35 each heading.

36 **3.2.1.2.2.1 Coral (3.3.2.2; page 3-47)**

37 Corals play a critical role in maintaining the reef ecosystem by providing a framework for  
38 the ecological community. The Hawaiian Islands have 17,520 km<sup>2</sup> (6,764.5 mi<sup>2</sup>) of coral

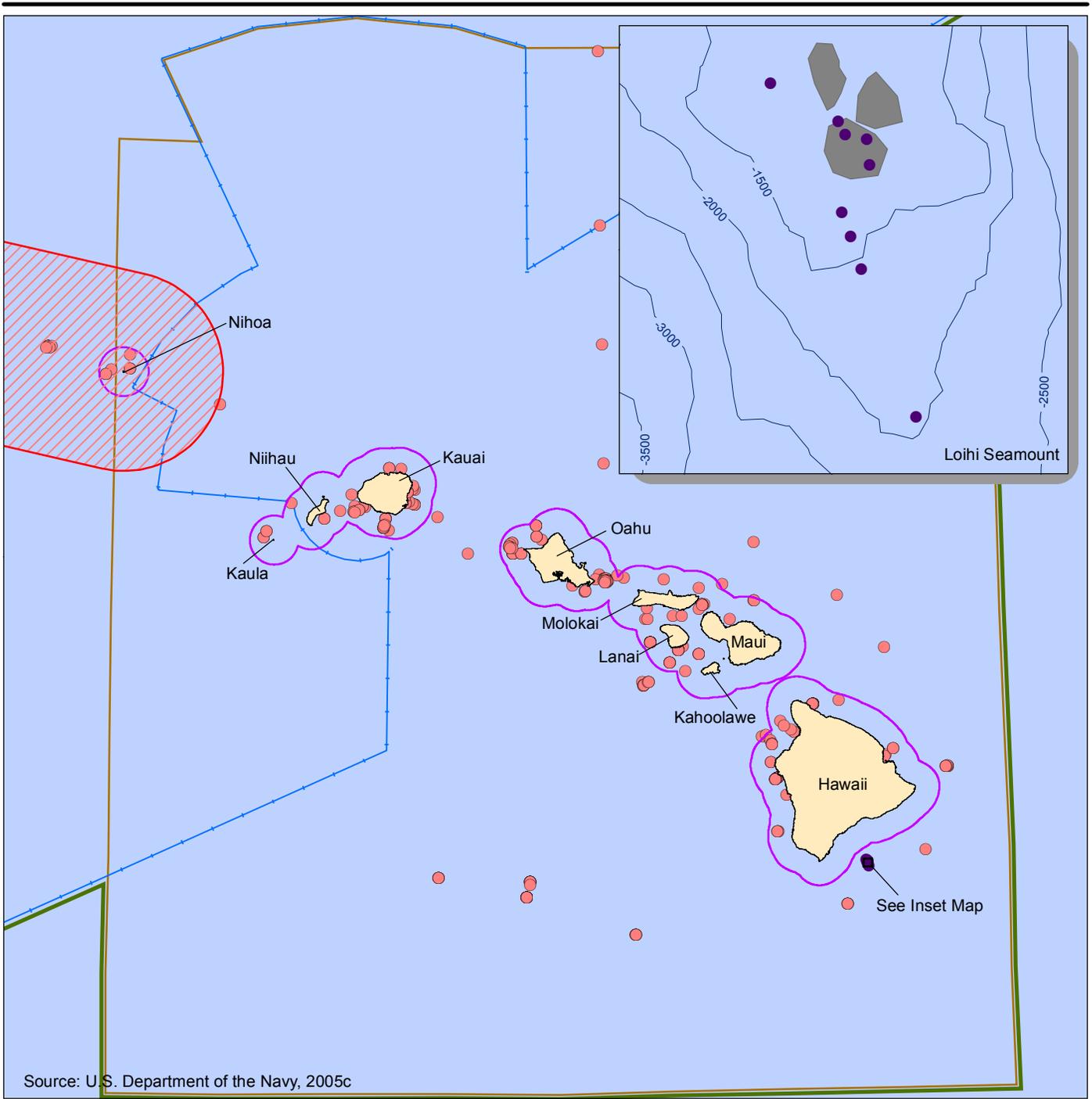
1 reef area, representing 84 percent of the coral reef area in the United States (Maragos,  
2 1977). Due to the motion of the Pacific Plate, the Hawaiian Islands have been  
3 transported in a north to northwest direction away from their original location of  
4 formation over the hot spot at a rate of about 10 cm (4 inches) per year (Grigg, 1988;  
5 1997). The youngest island in the archipelago is Hawaii, where the youngest fringing  
6 reefs and barrier reefs are found. Fringing reefs on the western coast of Hawaii are  
7 from 100 to 1,000 years old.

8 Coral reefs in PMNM are relatively isolated from human impacts. There are 57 stony  
9 coral species known in the shallow subtropical waters of PMNM (National Oceanic and  
10 Atmospheric Administration, 2005). They are found across the world's oceans, in both  
11 shallow and deep water, but reef-building corals are only found in shallow subtropical  
12 waters such as those surrounding the MHI and NWHI. The algae found in the tissues of  
13 shallow water corals need light for photosynthesis and water temperatures between 22-  
14 29 degrees Celsius (70-85 degrees Fahrenheit) (Smithsonian, n.d.). Conversely, deep-  
15 sea corals, which do not have the same algae and do not need sunlight or warm water  
16 to survive, thrive in cold, dark water. NWHI and MHI deep water coral reefs are typically  
17 found at depths between 350 to 600 m (1,150 to 2,000 ft), with some species continuing  
18 below 1,800 m (6,000 ft) (Parrish and Baco, 2007).

19 Deep-sea coral communities are prevalent throughout the Hawaiian archipelago (Figure  
20 3-2). They often form offshore reefs that surround all of the MHI at depths between 49  
21 and 199 m (27 and 109 fathoms) (Maragos, 1998). Although light penetrates to these  
22 depths, it is normally insufficient for photosynthesis. The term "deep-sea corals" may be  
23 misleading because substrate (surface for growth), currents, temperature, salinity, and  
24 nutrient supply are more important factors in determining the distribution of growth  
25 rather than depth (Chave and Malahoff, 1998).

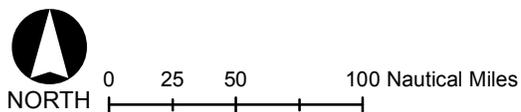
26 Shallow and deep-sea coral reef habitats harbor a diversity of macro and micro algae.  
27 In addition, deep-sea corals support habitat for a diverse array of species, serve as a  
28 hotspot of biological diversity, as well as serve as indicators of past climates. Currently,  
29 a total of 355 algal species have been recorded from shallow water coral reef habitats of  
30 the NWHI. The NWHI contains a large number of Indo-Pacific algal species not found  
31 in the MHI, such as the green calcareous alga (*Halimeda velasquezii*). Unlike the MHI  
32 where invasive species (e.g. invasive algae, *Kappaphycus alvarezii*) have overgrown  
33 many coral reefs, the reefs of the NWHI are largely free of invasive species.  
34 Approximately 98 percent of PMNM's area is deeper than 100 m (330 ft); therefore,  
35 deep-sea research is important to understand what is being protected within PMNM.

36



**EXPLANATION**

- Deep-Sea Coral
- Hydrothermal Vent
- Hawaii Range Complex
- - - Temporary Operating Area
- 12-Nautical Mile Limit
- Crater
- Hawaii Operating Area
- ▨ Papahānaumokuākea Marine National Monument



**Distribution of Deep-Sea Corals and Hydrothermal Vents**

Hawaiian Islands

**Figure 3-2**

32\_hydrothermal, 2/20/2015

1 Deep-sea corals can form large communities in PMNM ranging in size from patches of  
2 small solitary colonies to massive reef structures (mounds, banks, and forests) spanning  
3 an estimated total spatial coverage of about 2,000 km<sup>2</sup> (800 mi<sup>2</sup>) (Cairns, 1994; Freiwald  
4 et al., 2004). Much like shallow-water corals, deep-sea corals are fragile, slow growing,  
5 and can survive for hundreds of years (Roberts and Hirshfield, 2003). Deep-sea corals  
6 can be of two basic types: (1) the hard or stony corals, which are related to those found  
7 on tropical coral reefs; and (2) the soft corals, which include the familiar gorgonians of  
8 tropical shallow seas, as well as a broad diversity of other fleshy or tree-like forms.  
9 Some of the stony corals are small, but they can grow to be very massive. The soft  
10 corals may be small and delicate or very large and tree-like (Watling, 2003). Potential  
11 threats to deep-sea corals include fishing (e.g., bottom trawling), oil- and gas-related  
12 activities, cable laying, seabed aggregate extraction, shipping activities, the disposal of  
13 waste in deep waters, coral exploitation, other mineral exploration, and increased  
14 atmospheric carbon dioxide (Gass, 2003; Freiwald et al., 2004).

#### 15 3.2.1.2.2 *Bottomfish*

16 Prior to the establishment of PMNM, commercial bottomfishing had been conducted in  
17 the NWHI for over 60 years. Bottomfish are found concentrated on the steep slopes of  
18 deepwater banks of the NWHI. Descriptions of bottomfish habitats in the NWHI indicate  
19 that the distribution and abundance of bottomfish are patchy, and appear to be  
20 associated with cavities or oceanic current patterns that serve as prey attractants (Kelly  
21 et al. 2004). The fishery included 13 species of snapper and carangid and one species  
22 of grouper that was commonly caught at depths between 60 to 350 m (200 to 1,150 ft)  
23 (National Oceanic and Atmospheric Administration, 2007). Common bottomfish species  
24 include onaga (*Etelis coruscans*), ehu (*E. carbunculus*), opakapaka (*Pristipomoides*  
25 *filamentosus*), kalekale (*P. sieboldii*), lehi (*Aphareus rutilans*), gindai (*P. zonatus*), and  
26 hapuupuu (*Epinephelus quernus*). In addition, species of Hawaii bottomfish that are  
27 federally regulated include uku (*Aprion virescens*), white ulua (*Caranx ignobilis*), black  
28 ulua (*C. lugubris*), butaguchi (*Pseudocaranx dentex*), taape (*Lutjanus kasmira*), yellow  
29 tail kalekale (*Pristipomoides auricilla*) and kahala (*Seriola dumerilii*). With the  
30 establishment of PMNM, commercial bottomfishing was phased out and the fishery  
31 closed on 15 June 15 2011 (Monument Proclamation 8031).

#### 32 3.2.1.2.3 *Seabirds*

33 Seabird colonies in the NWHI constitute one of the largest and most important  
34 assemblages of seabirds in the world, with approximately 14 million birds representing  
35 20 breeding species (Naughton and Flint, 2004). Birds that live at sea and migratory  
36 birds are also part of the ecosystem. The NWHI contain over 95 percent of the world's  
37 black-footed and Laysan albatrosses. The greatest threats to seabirds in the NWHI are  
38 introduced mammals and other invasive species, fishery interactions, contaminants, oil  
39 pollution, and climate change.

1 3.2.1.2.2.4 *Marine Mammals (3.3.2.2-page 3-52)*

2 A total of 24 different species of marine mammals have been recorded by research  
3 cruises within the U.S. Exclusive Economic Zone in waters surrounding PMNM (NWHI)  
4 and are afforded protection under the Marine Mammal Protection Act (Barlow, 2003).  
5 Marine mammals observed in PMNM (NWHI) include whales, dolphins, and Hawaiian  
6 monk seals.

7 3.2.1.2.2.5 *Threatened and Endangered Species*

8 According to the Endangered Species Act (ESA) of 1973, endangered species are  
9 those currently facing extinction. Threatened species are those likely to become  
10 endangered within the foreseeable future. Twenty-three species of plants and animals  
11 known to occur in PMNM (NWHI) are listed under ESA. Of those listed species that  
12 occur in the marine ecosystem, the following 13 ESA-listed marine species are further  
13 discussed based on occurrence within the region of influence, or may be affected by the  
14 Proposed Action. Table 3-2 is a summary of ESA determination species occurring in  
15 the region of influence.

16 **Cetaceans**

17 *North Pacific Right Whale*

18 The North Pacific right whale, *Eubalaena japonica*, is ESA-listed as endangered  
19 throughout its range (73 FR 12024). Right whale adults typically are 13 to 16 m (43 to  
20 52 ft) in length, but North Pacific individuals may measure up to 18 m (59 ft) and weigh  
21 up to 100 metric tons (Kenney, 2009). The North Pacific right whale is composed of two  
22 populations—western and eastern—that are considered isolated from each other  
23 (Brownell et al., 2001). The population of the eastern North Pacific is considered to be  
24 the smallest whale population in the world for which an abundance estimate is known,  
25 at approximately 30 animals (Wade et al., 2010). No reliable population estimate  
26 presently exists for the species in the western North Pacific; however, it may number at  
27 least in the low hundreds (Brownell et al., 2001; Clapham et al., 2004).

28 Right whales migrate annually between high-latitude feeding grounds and low-latitude  
29 calving and breeding grounds (Kenney, 2009). Feeding takes place in spring, summer,  
30 and fall in higher-latitude feeding grounds, where ocean temperatures are cooler and  
31 overall biological productivity is much higher (Kenney, 2009). The specific locations of  
32 such feeding grounds are poorly known. Based on historical whaling records and the  
33 few recent sightings, Clapham et al. (2004) found that the principal feeding grounds  
34 were most likely in the Sea of Okhotsk, central and eastern Bering Sea, and Gulf of  
35 Alaska, all of which are more oceanic (offshore) habitats than those utilized by their  
36 well-studied North Atlantic counterparts. Breeding and calving both occur during the  
37 winter months, however the locations of such habitats for North Pacific right whales are  
38 unknown (Kenney, 2009).

39 The primary food source for North Pacific right whales is zooplankton (e.g., copepods).  
40 Right whales are skim-feeders: they feed by removing prey from the water using baleen

1 while moving with their mouth open through a patch of zooplankton, typically within the  
2 upper 10 to 20 m (33 to 66 ft) of the water column (Watkins and Schevill, 1976;  
3 Woodward et al., 2006; Parks et al., 2011).

4 Occurrence of this species within the Hawaiian Islands, and furthermore, the action  
5 area, would be considered rare based on historical sightings data. For example, in April  
6 1996, a right whale was sighted off of Maui (Salden and Mickelsen, 1999). This was the  
7 first documented sighting of a right whale in Hawaiian waters since 1979 (Herman et al.,  
8 1980; Rowntree et al., 1980). Further supporting this conclusion is earlier work by  
9 Scarff (1986), who reviewed information from the mid-1800s and that from Rowntree et  
10 al. (1980) and Herman et al. (1980), concluding that individuals in the waters off Hawaii,  
11 particularly during the time when the proposed action would occur (i.e., June-July),  
12 represented stragglers, not concentrations of wintering right whales. Although Kennedy  
13 et al. (2012) recently documented a high- to low-latitude migration of the individual  
14 sighted in April 1996, confirming that right whales at least occasionally travel across the  
15 North Pacific between Hawaii and Alaska, the authors caution that it is still premature to  
16 call the present record definitive proof of an annual migration.

#### 17 *Blue Whale*

18 The blue whale (*Balaenoptera musculus*) is ESA-listed as endangered throughout its  
19 range (35 FR 18319). It is the largest of the baleen whales, with lengths exceeding  
20 30 m (100 ft) (Sears and Perrin, 2009). The North Pacific blue whale is composed of  
21 two stocks—western and eastern. NMFS considers blue whales found in Hawaii as part  
22 of the Western North Pacific stock (Carretta et al., 2005). Blue whales typically migrate  
23 between high-latitude feeding grounds and low-latitude wintering areas (Sears and  
24 Perrin, 2009); however, some individuals have been observed to remain in the same  
25 region year-round (e.g., Watkins et al., 2000). The western stock feeds in summer in  
26 the southwest of Kamchatka, south of the Aleutian Islands, and in the Gulf of Alaska  
27 (Stafford, 2003; Watkins et al., 2000). In winter, they migrate to lower latitudes in the  
28 western Pacific and, much less frequently, in the central Pacific, including Hawaii  
29 (Thompson and Friedl, 1982).

30 Blue whales are “lunge feeders” targeting dense patches of euphausiids and other  
31 crustacean meso-zooplankton (Sears and Perrin, 2009) in the upper 150 to 200 m (492  
32 to 256 ft) of the water column (Croll et al. 2001, 2005).

33 The presence of blue whales in the action area would be considered rare. With the  
34 exception of occasional encounters (Oahu: Thompson and Friedl, 1982), there are few  
35 records of blue whales in Hawaiian waters. This conclusion is especially true during the  
36 time of year when the proposed action would occur, as individuals would be expected to  
37 be at higher latitudes in summer foraging grounds.

1 *Fin Whale*

2 The fin whale (*Balaenoptera physalus*) is ESA-listed as endangered throughout its  
3 range (35 FR 18319). The second largest of the whales in the family Balaenopteridae,  
4 fin whales range in length up to approximately 26 m (85 ft), with females slightly larger  
5 than males (Aguilar, 2009). Fin whales are considered a cosmopolitan species and  
6 occur from polar to tropical waters, with the greatest concentrations usually outside of  
7 the continental slope (Aguilar, 2009). Fin whales engage in north-south movements  
8 from wintering grounds to summer feeding areas (Aguilar, 2009). The locations where  
9 breeding and calving occur remain largely unknown (Rice, 1998) because, unlike other  
10 mysticetes, calving does not appear to take place in distinct inshore areas (Reeves et  
11 al., 2002; Mizroch et al., 2009). Reviewing historic catch, acoustic, and observation  
12 data, Mizroch et al. (2009) found that during summer, fin whales range from the Chukchi  
13 Sea south to 35°N on the Sanriku coast of Honshu, to the Subarctic Boundary  
14 (approximately 42°N) in the western and central Pacific. During winter months, Pacific  
15 fin whales have been documented over a wide area from 60°N south to 23°N (Mizroch  
16 et al., 2009).

17 A 2002 shipboard line-transect survey of the entire Hawaiian Islands Exclusive  
18 Economic Zone resulted in an abundance estimate of 174 fin whales (Barlow, 2003).  
19 However, Barlow (2006) did not provide a density estimate for fin whales in Hawaii  
20 because the survey (originally analyzed in Barlow 2003) was not conducted during the  
21 peak period of abundance (i.e., winter).

22 Fin whales are “lunge feeders,” feeding at similar depths and prey as blue whales  
23 (Goldbogen et al., 2007). Southern Hemisphere fin whales feed almost exclusively on  
24 euphausiids (Aguilar, 2009).

25 Occurrence of this species within the action area, particularly during the time of year  
26 when the action would occur, would be highly unlikely. Summarizing observations of fin  
27 whales in the Hawaiian Islands, Mizroch et al. (2009) found that while several sightings  
28 from the 1970s were during the month of May, no recent reports (e.g., Oahu: Thompson  
29 and Friedl, 1982, McDonald and Fox; Kauai: Mobley et al., 1996) were between May  
30 and July. As with the other mysticetes potentially within the action area, fin whales  
31 would typically be at higher latitude foraging grounds during the summer months.

32 *Sei Whale*

33 The sei whale (*Balaenoptera borealis*) is ESA-listed as endangered throughout its range  
34 (35 FR 18319). Individuals range in length up to approximately 20 m (66 ft), which  
35 makes it the third largest whale in the family Balaenopteridae (Horwood, 2009). Like  
36 most balaenopterids, sei whales are found in all oceans and migrate long distances  
37 north-south from high-latitude summer feeding grounds to lower-latitude winter areas.  
38 They range even farther offshore than fin whales and tend to be nomadic (Mizroch et  
39 al., 1984). In the North Pacific Ocean, their summer distribution extends from California  
40 westward to Japan and northward to the Aleutian Islands. In the eastern North Pacific,  
41 their winter distribution is known to range from Piedras Blancas in California to the

1 Revillagigedo Islands off Mexico; however, in the central and western North Pacific their  
2 winter distribution is largely unknown (Rankin and Barlow, 2007).

3 NMFS divides Pacific Ocean sei whales into three stocks, one of which inhabits the  
4 waters around Hawaii. A 2002 shipboard line-transect survey of the entire Hawaiian  
5 Islands Exclusive Economic Zone located groups of sei whales northeast of Maui (late  
6 November) and east of Hawaii, resulting in a summer/fall abundance estimate of 77 sei  
7 whales (Barlow, 2003). Barlow (2006) did not provide a density estimate for sei whales  
8 in Hawaii because the survey (originally analyzed in Barlow 2003) was not conducted  
9 during the peak period of abundance (i.e., winter).

10 Sei whales are primarily skimmers rather than lunge swallows, feeding on patches of  
11 copepods (their preferred forage), euphausiids, fish, and squid, if available (Horwood,  
12 2009).

### 13 *Humpback Whale*

14 The humpback whale (*Megaptera novaeangliae*) is ESA-listed as endangered  
15 throughout its range (35 FR 18319). Humpback whales are shorter and stouter than  
16 most other balaenopterids; at maturity, individuals are typically between 14 and 15 m  
17 (46 and 49 ft) (Clapham, 2009). In the North Pacific, there are three separate  
18 humpback whale populations, the Central North Pacific stock occurring within Hawaiian  
19 waters (Allen and Angliss, 2014). Employing the most recent survey data from the  
20 SPLASH study (Calambokidis et al., 2008), Allen and Angliss (2014) conservatively  
21 estimated the minimum abundance for the Central West Pacific stock to be  
22 approximately 5,800 individuals.

23 Humpbacks are typically found in coastal or shelf waters in summer and close to islands  
24 or reef systems in winter (Clapham, 2009). The species is highly migratory, moving  
25 seasonally between low-latitude winter breeding areas and high-latitude summer  
26 feeding grounds (Clapham and Mead, 1999). In summer, the majority of whales from  
27 the Central North Pacific stock are found in the Aleutian Islands, Bering Sea, Gulf of  
28 Alaska, and Southeast Alaska/northern British Columbia (Calambokidis et al., 2001).  
29 Humpback whales use Hawaiian waters as a major breeding ground during winter and  
30 spring (November through April) (Baker et al., 1986). Calambokidis et al. (1997)  
31 estimated that up to half of the North Pacific populations of humpback whales migrate to  
32 the Hawaiian Islands during the winter. Peak abundance around the Hawaiian Islands is  
33 from late February through early April (Mobley et al., 2001; Carretta et al., 2005).  
34 During the fall–winter period, primary occurrence is generally within 92.6 kilometers (50  
35 nm) offshore, which takes into consideration both the available sighting data and the  
36 preferred breeding habitat (shallow [ $< 200$  m (656 ft)] waters) (Herman and Antinaja,  
37 1977; Mobley et al., 1999). The greatest densities of humpback whales (including  
38 calves) are in the four-island region consisting of Maui, Molokai, Kahoolawe, and Lanai,  
39 as well as Penguin Bank (Mobley et al., 1999, 2001) and around Kauai (Mobley, 2005).  
40 However, coupling spatial modeling with observation data, Johnston et al. (2007) also

1 identified extensive areas of suitable wintering habitat within the Northwestern  
2 Hawaiian Islands.

3 Humpbacks have shorter and coarser baleen bristles than other baleen whales and  
4 feed on both euphausiids and schooling fish (Clapham 2009). Primarily classified as  
5 “swallowers” rather than “skimmers,” feeding primarily occurs in the upper 150 m (492  
6 ft) of the water column (Goldbogen et al., 2008; Ware et al., 2011).

7 Of the mysticetes potentially within the action area, the humpback whale is the species  
8 most likely to occur. Its presence during the time the action is conducted (i.e., June–  
9 July) would be unlikely, as it would be in northern foraging grounds, returning to the  
10 nearshore waters of the action area in late fall.

### 11 *False Killer Whale*

12 Three stocks of false killer whales, *Pseudorca crasidens*, are recognized within  
13 Hawaiian waters: the Hawaii pelagic stock, the MHI insular stock, and the Northwestern  
14 Hawaiian Islands insular stock (Carretta et al., 2014). The MHI insular Distinct  
15 Population Segment is ESA-listed as endangered throughout its range (77 FR 70915).  
16 A member of the dolphin family, females reach lengths of almost 5 m (16 ft), while  
17 males are almost 6 m (20 ft) (Baird, 2009). In adulthood, false killer whales can weigh  
18 approximately 680 kg (1,500 lb). False killer whales are considered to be very social  
19 animals, usually traveling in groups of 20 to 100 individuals (Baird, 2009).

20 Forney et al. (2010) defined the general boundaries of the MHI insular stock to include a  
21 “core” use area extending 40 km (22 nm) from shore and an “extended” offshore  
22 boundary ranging from the outer boundary of the “core” area out to 140 km (76 nm)  
23 from the MHI. Baird et al. (2012) found three areas of frequent use by the MHI insular  
24 population: the north side of the island of Hawaii (both east and west sides), a large  
25 area extending from north of Maui to northwest of Molokai, and a small area to the  
26 southwest of Lanai. The depth distribution for high-use areas was mean depth of 623 m  
27 (2,070 ft), relative to an overall median depth of 1,679 m (5,500 ft; Baird et al., 2012).  
28 Tracks from tagged individuals provided documentation that individuals from the central  
29 and eastern MHI use the area around Kauai and Niihau (Baird et al. 2010, 2011).  
30 Knowledge of seasonal movements of this species is still evolving. Baird et al. (2012)  
31 provided satellite tracking data for a large number of individuals; however, their data did  
32 not cover the timeframe between March and June. Although the authors acknowledge  
33 that the species does use some of the same areas during these months, as in the  
34 months for which data is available, more information is needed to determine whether  
35 additional areas outside of their identified high use areas are frequented (Baird et al.,  
36 2012).

37 In Hawaii, false killer whales have been documented feeding on a wide variety of large  
38 fish, including wahoo (*Acanthocybium solandri*), tunas (*Thunnus* spp.), and broadbill  
39 swordfish (*Xiphias gladius*) (Baird et al., 2008). Little is known about the diving behavior  
40 of this species in Hawaii (Baird et al., 2012). However, a recent tracking study by Baird

1 et al. (2014) off the coast of Kauai has contributed to the knowledge base. The single  
2 tagged individual in the study was observed to dive to median depths of approximately  
3 138 m (453 ft) with a maximum recorded dive of 928 m (3,040 ft). As the median  
4 depth of the waters within which the individual was monitored was 710 m (2,330 ft),  
5 some of the deepest dives were likely at, or near, the sea floor (Baird et al., 2014).

## 6 *Sperm Whale*

7 The sperm whale (*Physeter macrocephalus*) is ESA-listed as endangered throughout its  
8 range (35 FR 18319). The largest odontocete, male sperm whales are 18.5 m (61 ft) in  
9 length, females 12.5 m (41 ft) (Rice, 1989). Sperm whales are typically found in deep  
10 oceanic waters, with females almost always inhabiting water deeper than 1,000 m  
11 (3,300 ft) (Whitehead, 2009). Baird et al. (2013) most commonly encountered sperm  
12 whales in Hawaiian waters deeper than 3,000 m (9,842 ft). Sperm whales are widely  
13 distributed throughout the Hawaiian Islands year-round (Au et al. 2014; Baird et al.,  
14 2013; Barlow, 2006; Mobley et al., 2000), and have been found to be the most abundant  
15 large whale in Hawaiian waters during summer and fall months (Barlow, 2006). Barlow  
16 (2006) estimated there to be approximately 6,900 sperm whales in Hawaiian waters  
17 based on his survey work conducted between August and November 2002. A recent  
18 yearlong acoustic monitoring study conducted by Au et al. (2014) within and adjacent to  
19 the action area most frequently identified sperm whales on the southwest side of Kauai  
20 between the months of March and June.

21 In comparison to the other cetacean species in the action area, sperm whales forage at  
22 deeper water depths. Maximum-recorded dive depths differ across regions, with values  
23 of 644 and 985 m (2,113 and 3,230 ft) for the Gulf of Mexico and Atlantic Ocean,  
24 respectively (Watwood et al., 2006); 1,400 m (4,600 ft) in the north Pacific Ocean (Aoki  
25 et al., 2012); and up to nearly 1,900 m (6,230 ft) off the coast of Norway (Teloni et al.,  
26 2008). Though individuals do forage at the ocean floor, the majority of foraging  
27 observed occurred higher in the water column (Aoki et al., 2012; Mathias et al., 2012;  
28 Miller et al., 2013; Teloni et al., 2008; Wahlberg, 2002).

29 Sperm whales spend about 70 to 80 percent of their time at depths of several hundred  
30 meters (Amano and Yoshioka, 2003; Watkins et al., 1993), and most of their diet  
31 consists of mesopelagic and bathypelagic cephalopods (Clarke, 1980; Clarke et al.,  
32 1993; Kawakami, 1980). Multiple hypotheses exist regarding the means sperm whales  
33 locate prey; however, it is generally accepted that foraging individuals rely heavily on  
34 emitting acoustic “clicks” during dives to echolocate prey items (Madsen et al., 2002;  
35 Miller et al., 2004).

## 36 **Pinnipeds**

### 37 *Hawaiian Monk Seal*

38 The Hawaiian monk seal, *Neomonachus schauinslandi* (formerly *Monachus*  
39 *schauinslandi*), is ESA-listed as endangered throughout its range (41 FR 51611).  
40 Adults range in length from 2.1 to 2.4 m (6.9 to 7.9 ft) and weights are between 170 and

1 240 kg (375 and 529 lb), with females slightly larger than males (Gilmartin and Forcada,  
2 2009). The species occurs only in the central North Pacific and are managed as a  
3 single stock, although there are six main reproductive subpopulations at French Frigate  
4 Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure  
5 Atoll (Ragen and Lavigne, 1999), all of which are outside the action area. The vast  
6 majority of the population is present in the NWHI. Monk seal births in Hawaii usually  
7 occur from February to August, peaking in April–June, but births are known in all  
8 months (Gilmartin and Forcada, 2009).

9 Until recently, this species occurred almost exclusively at remote atolls in the NWHI. In  
10 the last decade, however, sightings of Hawaiian monk seals in the MHI have increased  
11 considerably (Baker and Johanos, 2004). Most monk seal haulout events in the MHI  
12 have been on the western islands of Niihau and Kauai (Baker and Johanos, 2004). The  
13 best estimate of the total population size is approximately 1,060 individuals in the  
14 Hawaiian Islands Archipelago, of which at least 150 are in the MHI (Baker et al., 2011)  
15 and the remaining 910 in the NWHI. Recent population trends indicate that the  
16 population in the MHI is growing, whereas that in the NWHI is decreasing (Baker et al.,  
17 2011). A recent analysis of range-wide movements by Johanos et al. (2013)  
18 demonstrates connectivity (albeit rare; 10 seals in 30 years of observations) between  
19 the NWHI and MHI subpopulations and highlighted an approximately 2,400 km (1,300  
20 nm) transit by a female spanning the entire Hawaiian archipelago. Intra-region  
21 movements were more common (Johanos et al., 2013).

22 Hawaiian monk seals have a diverse prey base, including demersal fish, squid, octopus,  
23 eels, and crustaceans (Parrish et al., 2000; Cahoon et al., 2013), with little observed  
24 difference between those of the NWHI and MHI subpopulations (Cahoon et al., 2013).  
25 They mostly forage within their resident atolls and along the barrier reefs, but may also  
26 forage at distant seamounts and submerged reefs hundreds of kilometers from their  
27 colonies (Gilmartin and Forcada, 2009; Stewart et al., 2006). Stewart et al. (2006)  
28 found most (75 percent) core foraging areas to occur within 20 km (11 nm) of the  
29 respective colony. Although individuals have been observed diving to depths  
30 approximating 500 m (1,640 ft) (summarized by Stewart et al., 2006), the majority of  
31 foraging activity typically occurs at depths less than 100 m (330 ft) (Parrish et al., 2000,  
32 2005, 2008; Stewart et al., 2006).

33 Hawaiian monk seal critical habitat has been designated under the ESA to include all  
34 beach areas, sand spits and islets, including all beach vegetation to its deepest extent  
35 inland, and lagoon waters out to a depth of 37 m (120 ft or 20 fathoms) in designated  
36 areas of use (53 FR 18988).

37 Essential features of critical habitat for Hawaiian monk seals include the following:  
38 terrestrial coastal areas with characteristics preferred for pupping and nursing; shallow,  
39 sheltered aquatic areas adjacent to coastal locations preferred for pupping and nursing;  
40 marine areas preferred for foraging; areas with low levels of anthropogenic disturbance;

1 marine areas with adequate prey quantity and quality; and areas used for hauling out,  
2 resting, or molting.

3 NMFS has proposed to extend critical habitat in the NWHI out to the 500-m (1,640-ft)  
4 depth contour and to include Sand Island at Midway Islands; and by designating six new  
5 areas in MHI. Specific areas proposed for the MHI include terrestrial and marine habitat  
6 from 5 m (16.4 ft) inland from the shoreline extending seaward to the 500-m (1,640-ft)  
7 depth contour around Kaula Island, Niihau, Kauai, Oahu, Maui Nui (including  
8 Kahoolawe, Lanai, Maui, and Molokai), and Hawaii (76 FR 32026). Several zones  
9 within the action area (e.g., PMRF offshore areas) have been excluded from  
10 designation in the proposed rule due to national security reasons (76 FR 32026).

## 11 **Sea Turtles**

### 12 *Green Turtle*

13 The Hawaiian population of green sea turtle (*Chelonia mydas*) is ESA-listed as  
14 threatened throughout its range (43 FR 32800). On 16 February 2012, NMFS received  
15 a petition to classify the species in Hawaii as a DPS and to delist that DPS under the  
16 ESA. On 1 August 2012, NMFS made a positive 90-day finding (77 FR 45571),  
17 determining that the petitioned action may be warranted. A comprehensive status  
18 review is underway to inform the 12-month finding.

19 Green sea turtles are the largest of all the hard-shelled sea turtles, but have a  
20 comparatively small head. While hatchlings are just 50 millimeters (2 inches) long,  
21 adults can grow to more than 1.2 m (4 ft) long and weigh 136 to 159 kg (300 to 350 lb).  
22 The green sea turtle is the most common sea turtle species occurring in the waters  
23 around the Hawaiian Islands. Green turtles live in nearshore coastal habitats, with high  
24 fidelity to specific reef, rock, bay, or lagoon feeding locations. The species' breeding  
25 and nesting season ranges between mid-April and mid-August of each year (Balazs,  
26 1976). During the breeding season males and females swim 800 to 1,290 km (500 to  
27 800 mi) from their feeding grounds in the MHI to their nesting beaches. More than 90  
28 percent of all green sea turtle breeding and nesting activity in Hawaiian waters occurs at  
29 French Frigate Shoals (Balazs, 1980), with the main rookery on East Island (Tiwari et  
30 al., 2010). Upon nesting, most adults migrate to the coastal waters surrounding the MHI  
31 (especially around Maui and Kauai) (Balazs, 1976). Hatchling green turtles emerge  
32 from their nests and enter the ocean, a time after which little is known until they enter  
33 neritic foraging grounds approximately 5 to 10 years later (Reich et al., 2007).  
34 Consequently, post-hatchling green sea turtles in this oceanic phase can occur  
35 hundreds of kilometers from landmasses in water depths at least kilometers deep  
36 (Parker et al., 2011).

37 Adult green sea turtles are unique among sea turtles in that they are primarily  
38 herbivorous, feeding on seagrasses, sea lettuce, and algae, and to a lesser extent,  
39 jellyfish, salps, and sponges (Bjorndal, 1997). During the oceanic phase of life, young  
40 green turtles are primarily carnivorous, foraging on prey items commonly found within  
41 the first 100 m (330 ft) of the water column, including zooplankton, crustaceans, and

1 mollusks (Parker et al., 2011). Most of the adults' time is spent at depths less than 30  
2 m (100 ft) when on the foraging grounds but they can dive to depths of over 100 m (330  
3 ft) when migrating, although the majority of their migratory dives are usually much  
4 shallower (1 to 4 m [3 to 13 ft] diurnal; 35 to 55 m [115 to 180 ft] nocturnal) (Rice and  
5 Balazs, 2008).

#### 6 *Hawksbill Turtle*

7 The hawksbill sea turtle, *Eretmochelys imbricata*, is ESA-listed as endangered  
8 throughout its range (35 FR 8491). Hawksbill sea turtles are the second most common  
9 species in the offshore waters of the Hawaiian Islands, yet they are far less abundant  
10 than green sea turtles. In Hawaii, hawksbills nest on MHI beaches, primarily along the  
11 east coast of the island of Hawaii and to a much lesser extent Maui, Oahu, and Molokai  
12 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998a). Peak  
13 nesting activity occurs from late July to early September (Katahira et al. 1994). Similar  
14 to other species of sea turtles, upon hatching young hawksbills inhabit an oceanic  
15 habitat, returning years later to neritic habitats as larger juveniles (Musick and Limpus,  
16 1997).

17 In a study of satellite-tracked females, Parker et al. (2009) found post-nesting  
18 movements of adult Hawaiian hawksbills to be relatively short-range (90 to 345 km [49  
19 to 186 nm] from nesting beaches), and largely confined to coastal waters (depths less  
20 than 30 m [100 ft]) within the MHI. The west coast of Oahu was the farthest west that  
21 the individuals tracked in the Parker et al. (2009) study traveled when foraging.  
22 Previous sightings of immature Hawaiian hawksbills (e.g., Keuper-Bennett and Bennett,  
23 2002) have also been in very shallow areas of the MHI.

24 Sightings of hawksbills in the NWHI are even rarer (National Marine Fisheries Service  
25 and U.S. Fish and Wildlife Service, 1998a). Summarizing historic and contemporary  
26 sightings of hawksbill sea turtles in the NWHI, Van Houten et al. (2012) identified six  
27 definitive observations and three potential nesting records. Based on this information,  
28 the authors conclude that hawksbills currently occur within the NWHI (albeit in low  
29 numbers), with a lack of regular monitoring within this geographic area likely  
30 contributing to the infrequency of documented observations (Van Houten et al., 2012).

31 Studies of hawksbill diet have identified sponges (Caribbean: Meylan, 1988) and to a  
32 lesser extent, tunicates (eastern Pacific: Carrión-Cortez et al., 2013) as primary forage  
33 items. In a study of Eastern Pacific hawksbills, Gaos et al. (2012) rarely observed adult  
34 hawksbills diving deeper than 20 m (66 ft) in the water column.

#### 35 *North Pacific Loggerhead Turtle*

36 The North Pacific DPS of the loggerhead sea turtle, *Caretta caretta*, is ESA-listed as  
37 endangered throughout its range (75 FR 58868). This reddish-brown turtle averages  
38 approximately 0.9 m (3 ft) in length and 136 kg (300 lb) in weight. Nesting in the Pacific  
39 basin is restricted to the western region (primarily Japan and Australia), with those in

1 U.S. waters likely originating from Japanese beaches (National Marine Fisheries  
2 Service and U.S. Fish and Wildlife Service, 1998c). There is no loggerhead nesting on  
3 the western seaboard of the United States or in Hawaii (Balazs, 1982); however,  
4 southern California and western Mexico serve as important coastal foraging areas  
5 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998c). Only  
6 four records of occurrence exist for Hawaii, all of which were juveniles and most likely  
7 drifted over from Mexico or Japan (National Marine Fisheries Service and U.S. Fish and  
8 Wildlife Service, 1998c).

9 Central North Pacific loggerheads in oceanic habitats have been shown to forage  
10 primarily on floating organisms, including gastropods, pelagic crabs, barnacles and, to a  
11 lesser extent, pyrosomas, among others (Parker et al., 2002). In a study of tagged  
12 North Pacific loggerheads within the open ocean, Polovina et al. (2004) found  
13 individuals to associate with oceanic eddies and fronts, most frequently occupying the  
14 uppermost stratum of the water column, spending approximately 90 percent of their time  
15 at depths less than 40 m (130 ft) (40 percent of time at the surface), with occasional  
16 dives to depths in excess of 100 m (330 ft).

#### 17 *Olive Ridley Turtle*

18 The olive ridley sea turtle, *Lepidochelys olivacea*, is ESA-listed as threatened  
19 throughout its range (43 FR 32800). They are regarded as the most abundant sea  
20 turtles in the world, with nesting occurring primarily on beaches of India, southern  
21 Mexico, and northern Costa Rica (National Marine Fisheries Service and U.S. Fish and  
22 Wildlife Service, 1998). Balazs and Hau (1986) reported a single Hawaiian nesting  
23 event on the island of Maui in September 1985. In-water sightings are also rare, with  
24 the majority of those observed as takes within the Hawaiian-based longline fishery (e.g.,  
25 Work and Balazs, 2010).

26 An analysis of stomach contents from eight olive ridleys caught in the Hawaii-based  
27 longline fishery indicates that while olive ridleys do forage on some organisms at the  
28 ocean's surface, their most common prey are pyrosomas and salps which are found at  
29 deeper depths (Polovina et al., 2004). In this same study, Polovina et al. (2004) found  
30 olive ridleys to most frequently occupying the epipelagic stratum of the water column  
31 (albeit deeper than loggerheads), spending approximately 60 percent of their time at  
32 depths less than 40 m (130 ft) (20 percent of time at the surface), with occasional dives  
33 to depths in excess of 150 m (490 ft). Swimmer et al. (2006) recorded an olive ridley in  
34 the eastern Pacific Ocean diving in excess of 400 m (1,310 ft); however, most dives  
35 were less than 100 m (330 ft).

#### 36 *Leatherback Turtle*

37 The leatherback sea turtle, *Dermochelys coriacea*, is ESA-listed as endangered  
38 throughout its range (35 FR 8491). Leatherbacks are the largest marine turtle, with a  
39 curved carapace length often exceeding 1.5 m (5 ft) and front flippers that can span 2.7  
40 m (9 ft) (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998b).  
41 Leatherback sea turtles are a highly oceanic species and undertake long journeys of

1 over 2,800 km (1,510 nm), in some cases reaching cold seas far from their tropical  
2 nesting grounds (Hughes et al., 1998).

3 Two populations of leatherbacks occur in the Pacific Ocean – eastern and western.  
4 Eastern Pacific leatherback turtles nest in Mexico and Costa Rica during the boreal  
5 winter (October–March) (Eckert et al., 2012). In contrast, western Pacific leatherback  
6 turtles nest year-round at beaches across Australia, Malaysia, Indonesia, and Papua  
7 New Guinea (Eckert et al., 2012). Once leatherback hatchlings enter the oceanic  
8 environment, little is known about this portion of their life until they recruit to neritic  
9 habitats as juveniles; it is hypothesized that areas of upwelling and/or convergence  
10 zones may serve as nursery grounds (Musick and Limpus, 1997).

11 Migratory routes of adult leatherbacks are not entirely known. However, recent satellite  
12 telemetry studies have documented transoceanic migrations between nesting beaches  
13 and foraging areas in the Pacific Ocean basin (Bailey et al., 2012) and have  
14 characterized the post-nesting movements of summer and winter nesters (Benson et al.  
15 2011). The oceanic areas visited by foraging turtles are mainly characterized by sea  
16 currents and related features, which can influence leatherback feeding-related  
17 movements. In particular, convergence zones and eddies may concentrate nutrients  
18 and organisms, and thus represent patches of high prey abundance targeted by  
19 foraging turtles (Carr, 1987). Recent research by Seminoff et al. (2012) demonstrates  
20 that most adult Pacific leatherbacks demonstrate fidelity to foraging areas between  
21 nesting events. Leatherbacks are regularly observed in the offshore waters at the  
22 southern end of the Hawaiian archipelago, potentially during their movement from one  
23 area of the Pacific Ocean to another (National Marine Fisheries Service and U.S. Fish  
24 and Wildlife Service, 1998b).

25 Leatherbacks primarily forage gelatinous zooplankton, including cnidarians (jellyfish and  
26 siphonophores) and, to a lesser extent, tunicates (pyrosomes and salps) at or just below  
27 the sea surface (Bjørndal, 1997). Leatherback sea turtles are the deepest reptilian  
28 divers: maximum dives ranging from 630 m (2,070 ft) (Hays et al., 2004) up to 1,280 m  
29 (4,200 ft) (Doyle et al. 2008) have been observed in the oceanic Atlantic. However,  
30 dives are typically much shallower (generally < 300 m [980 ft]) (Houghton et al., 2008).

### 31 **3.2.1.2.3 Endangered Species Act Section 7 Consultation for Open Ocean** 32 **Regulatory Context**

33 Section 7 of the ESA requires Federal agencies to evaluate the effects of their actions  
34 on listed species and consult with either USFWS or NMFS if the agency determines that  
35 its action “may affect” an individual or critical habitat of the respective species. Federal  
36 agencies are directed, under Section 7(a)(1) of the ESA, to utilize their authorities to  
37 carry out programs for the conservation of threatened and endangered species.  
38 Therefore, the SFDT program will be completed prior to NASA issuing a FONSI for the  
39 Proposed Action.

1 *U.S. Fish and Wildlife Service*

2 Under Section 7, Federal agencies must consult with USFWS when any action the  
3 agency carries out, funds, or authorizes (such as through a permit) *may affect* a listed  
4 endangered or threatened species. This process usually begins as informal  
5 consultation. A Federal agency, in the early stages of project planning, approaches  
6 USFWS and requests informal consultation. Discussions between the two agencies  
7 may include what types of listed species may occur in the Proposed Action area, and  
8 what effect the Proposed Action may have on those species. If the Federal agency,  
9 after discussions with USFWS, determines that the Proposed Action is not likely to  
10 affect any listed species in the project area, and if USFWS concurs, the informal  
11 consultation is complete and the proposed project moves ahead. If it appears that the  
12 agency's action may affect a listed species, that agency may then prepare a biological  
13 assessment to assist in its determination of the project's effect on a species. (U.S. Fish  
14 and Wildlife Service, 2014)

15 *National Oceanic and Atmospheric Administration/National Marine Fisheries Service*

16 Federal agencies must also consult with NMFS, under section 7(a)(2) of the ESA, on  
17 activities that may affect a listed marine species. These interagency consultations, or  
18 Section 7 consultations, are designed to assist Federal agencies in fulfilling their duty to  
19 ensure Federal actions do not jeopardize the continued existence of a species or  
20 destroy or adversely modify critical habitat. Should an action be determined by NMFS,  
21 to jeopardize a species or adversely modify critical habitat, NMFS may authorize an  
22 Incidental Take and suggest corresponding Reasonable and Prudent Alternatives.  
23 (National Oceanic and Atmospheric Administration, 2014)

24 As indicated in Table 3-3, threatened and endangered marine species could be found in  
25 the region of influence.

26 **3.2.1.2.4 Environmental Consequences**

27 The analytical approach for biological resources involved evaluating the degree to which  
28 the proposed activities could environmentally impact threatened or endangered species,  
29 and sensitive habitat within the affected area. Criteria for assessing potential  
30 environmental impacts to biological resources are based on the number or amount of  
31 the resource that would be environmentally impacted relative to its occurrence at the  
32 project site, the sensitivity of the resource to proposed activities, and the duration of the  
33 environmental impact. Species impacts are considered substantial if they have the  
34 potential to result in reduction of the population size of federally listed threatened or  
35 endangered species, degradation of biologically important unique habitats, substantial  
36 long-term loss of vegetation, or reduction in capacity of a habitat to support wildlife. The  
37 proposed activities of concern for analysis are (1) expended flight hardware,  
38 (2) unrecovered sinkable hardware, and (3) sea vessels and airplanes.

1 3.2.1.2.4.1 Section 7 Consultation

2 In 2013 NASA submitted a Coordinating Draft LDSD EA and a public Draft LDSD EA to  
3 NMFS and USFWS for review and concurrence. Both agencies provided comments on  
4 the Coordinating Draft LDSD EA, and NMFS provided comments on the public Draft  
5 LDSD EA.

6 In accordance with Section 7 of the ESA, NASA initiated informal consultation for the  
7 SEA with NMFS on 9 January 2015 and with USFWS on 15 January 2015. Following  
8 ESA consultation guidance developed by NMFS (2013a), NASA applied the following  
9 rationale to arrive at its final determinations of effect on listed species in the LDSD  
10 splashdown (operating) area:

11 First, based on the analysis in the Biological Evaluation, the Proposed Action is likely to  
12 produce stressors to which listed individuals would respond if exposed. However, the  
13 likelihood of such exposure has been determined to be extremely remote. Therefore,  
14 NASA's determination process is based on "Proposition B" in the NMFS guidance  
15 document, which is:

16 *The action is likely to produce potential stressors..., endangered or*  
17 *threatened individuals are not likely to be exposed to one or more of those*  
18 *potential stressors or subsidies or one or more of the Action's direct or*  
19 *indirect consequences on the environment;*

20  
21 Next, once NASA accepted Proposition B as true, NASA identified the first of four  
22 potential determination outcomes (identified as outcome 3.1 in the NMFS guidance  
23 document) as being applicable to the action considered in the Biological Evaluation,  
24 which is:

25 *If an agency ... accepts Proposition B as true (the action produces*  
26 *stressor or subsidies, but the probability of exposing listed individuals to*  
27 *those stressors is so small that it would not be reasonable to expect them*  
28 *to occur) and can defend that acceptance based on all of the relevant*  
29 *evidence available and the appropriate background, the agency is justified*  
30 *in a "may affect, but not likely to adversely affect" determination (because*  
31 *the probability of effects would be discountable).*

32  
33 As such, NASA concludes that the Proposed Action "may affect, not likely to adversely  
34 affect," all listed species in the action area. Table 3-2 summarizes the determinations  
35 for each species potentially affected by NASA's action.

1 **(1) Expended Flight Hardware (Including Flight Train)**

2 **Threatened and Endangered Species**

3 The threatened and endangered species (cetaceans, pinnipeds, and sea turtles) and  
4 critical habitat (Hawaiian monk seal) listed on Table 3-3 (located at the end of this  
5 section) have been observed and designated in the region of influence. Post-launch  
6 activities could involve an unplanned (i.e., anomalies) test execution which would  
7 produce expended flight hardware within PMNM.

8 The balloon and Test Vehicle would be recovered from the open ocean. Under the  
9 assumption that all possible trajectories were allowed to fly, NASA estimates the balloon  
10 has approximately a 0.4 percent chance of reaching float altitude within PMNM and a 20  
11 percent chance of entering PMNM after reaching float altitude. These probabilities are  
12 reduced when NASA and the U.S. Navy apply the project's established Go/No Go  
13 criteria. (Combs, 2014)

14 The term "stress" is often used ambiguously to describe a broad range of conditions that  
15 threaten the well-being of an organism (National Oceanic and Atmospheric  
16 Administration, 1999). Based on the Biological Evaluation, the Proposed Action is likely  
17 to produce stressors (i.e., 1. supersonic flight, 2. direct or proximate strike, 3.  
18 entanglement, 4. ingestion, 5. aircraft overflight, and 6. recovery vessel operations) to  
19 which listed individuals would respond if exposed.

20 **1. Supersonic Flight:** Individuals exposed to a sonic boom could potentially change  
21 their behavior, such as becoming alert, diving, or swimming laterally. The shock waves  
22 from the supersonic flight process at the ocean's surface would be minor. As such, the  
23 most probable exposure route would be if an individual were at the surface.

24 *Cetaceans:* For cetaceans, when considered in conjunction with the infrequent nature of  
25 the testing, it may be concluded that the potential for exposing an individual to a weak  
26 sonic boom would be highly unlikely. Even if it were to occur, it is doubtful that even a  
27 behavioral response would be evoked.

28 *Pinnipeds:* For monk seals and their Critical Habitat, in consideration of the relatively  
29 lower sonic boom profile generated by the Proposed Action, and its infrequent nature, it  
30 may be reasoned that if an individual were exposed to a sonic boom created by the  
31 LDS Test Vehicle, the resultant physiological or behavior effects would be negligible.  
32 Sonic booms would have only a negligible effect on either designated or proposed  
33 Hawaiian monk seal critical habitat. Although it is possible that some sound could enter  
34 the aquatic habitat, particularly during rough sea conditions (Richardson et al., 1995), it  
35 would be small in intensity (given the flight altitudes and limited potential for air-to-water  
36 sound transmission [Richardson et al., 1995]) and transient in nature. Likewise, aside  
37 from the transient low pressure sound from a sonic boom, terrestrial critical habitat  
38 would be unaffected.

1 *Sea Turtles*: With the exception of green sea turtles, and to a much lesser extent,  
2 hawksbills, the potential for exposing other species of sea turtles to the Test Vehicle-  
3 generated sonic boom would be unlikely based on historic sightings data. However,  
4 should a sea turtle be exposed to a sonic boom, it is unlikely to evoke much, if any, of a  
5 physiological or behavioral response at the levels and frequencies which would be  
6 propagated to the ocean's surface.

7 **2. Direct or Proximate Strike**: During the oceanic landing of flight hardware, there  
8 would be only a remote likelihood of the Test Vehicle, balloon, or MET rocket stages  
9 striking or landing near a listed species.

10 *Cetaceans*: The occurrence of either mysticete species within the action area at the  
11 time of either flight termination or test execution and subsequent descent of flight  
12 hardware would be rare, as all species are known to migrate to northern waters outside  
13 the action area during the summer months. Furthermore, the infrequent nature of the  
14 action (up to twice per year over a 5-year term) renders a direct or proximate strike a  
15 highly unlikely event.

16 Although sperm whales would be within the action area during the time when the action  
17 would occur, they spend about 70 to 80 percent of their time at depths of several  
18 hundred meters (Amano and Yoshioka, 2003; Watkins et al., 1993). When coupled with  
19 the infrequent nature of the testing, and low density of individuals within the action area,  
20 the chance of a direct or proximate strike would also be very low.

21 *Pinnipeds*: Hawaiian monk seals would occur within the action area during the time of  
22 test execution; however, the probability of a direct or proximate strike would be very low  
23 for the following reasons. First, the core locations of all six reproductive subpopulations  
24 are outside the action area. Second, while some individuals have been shown to  
25 undergo long distance movements from their "home" colonies (Johanos et al., 2014),  
26 the majority of Hawaiian monk seals tend to remain within 50 km (30 mi) of these areas  
27 (Curtice et al., 2011), which, again for most, would be outside the action area. Third,  
28 although birthing and nursing would be spread over a much wider window than just the  
29 June to August timeframe, during this time a portion of the adult females and young of  
30 the year would be on land (largely outside the action area), further reducing the number  
31 of individuals potentially within the action area. Finally, the infrequent nature of the  
32 Proposed Action supports the conclusion that a direct strike would be unlikely.

33 Should either the Test Vehicle, balloon, or MET rocket stage land within aquatic  
34 Hawaiian monk seal critical habitat, it would temporarily occupy a small portion of the  
35 epipelagic portion of the water column that would have otherwise been available for use  
36 as foraging grounds for the species. However, in consideration of the mandatory  
37 recovery of all major hardware items, the resultant effects would be only transient in  
38 nature. Should unrecoverable flight hardware (i.e., the flight train or MET rocket stages)  
39 enter critical habitat upon descent, it would only occupy the water column for a very  
40 short time, and upon landing on the ocean floor, would represent a very small portion of

1 the overall habitat available for the species. It is possible over time that the material  
2 would either trap, or otherwise become covered with sediment, further reducing the  
3 detraction from habitat value. The occurrence of floating expended hardware entering  
4 aqueous critical habitat would be possible; however, unlikely due to the low number of  
5 these items being flown per year and the very large areal extent of the action area.

6 *Sea Turtles:* All sea turtles could be in the action area during the summer months when  
7 the action would occur. However, with the exception of green, and to a much lesser  
8 extent, hawksbill sea turtles, their occurrence would be rare based on historic sightings  
9 data. Even in the case of green sea turtles, the most populous species within the action  
10 area, when considering the infrequent nature of the action, the low density of individuals  
11 within the action area, and the fact that sea turtles spend a significant portion of their  
12 time below the sea surface (Lutcavage and Lutz, 1997); the probability of a direct or  
13 proximate strike would be very low.

14 **3. Entanglement:** According to the literature (major reviews by Laist, 1987, 1997;  
15 Derraik, 2002), entanglement of marine species can lead to injury, compromised health,  
16 or mortality.

17 *Cetacean:* For either cetacean species, the relative size difference between the  
18 (comparatively small) floating MET balloons and Rocket Balloon Instruments (ROBIN)  
19 spheres and a (much larger) individual of either species renders the probability of  
20 entanglement negligible. Being hollow aluminum columns, MET rocket stages do not  
21 pose a risk of entanglement. For mysticetes, traveling or feeding baleen whales could  
22 potentially become entangled in the floating Test Vehicle or balloon or sinking balloon  
23 flight train once they enter the water column. However, multiple factors render this  
24 potential stressor highly unlikely. First, the occurrence of either mysticete species within  
25 the action area at the time when the action is conducted (and, therefore, when the  
26 majority of flight hardware would be in-water) would be rare. Second, the rapid  
27 recovery of the larger Test Vehicle and balloon system from the water column would  
28 further reduce the risk of potential entanglement with the largest flight hardware items.  
29 For odontocetes, although false killer whales have not been definitively reported as  
30 becoming entangled in marine debris (Baulch and Perry 2014), the potential exists for  
31 such a stressor to occur should flight hardware land within the species' range.  
32 However, multiple factors render this outcome highly unlikely. First, the greatest  
33 concentrations of the species are farther east in the MHI, outside the action area (Baird  
34 et al., 2012). Second, the species generally forages on prey that is typically found in the  
35 uppermost water column. Because the floating balloon system and Test Vehicle would  
36 be recovered after landing in the water, the potential for this stressor would be short in  
37 duration. Furthermore, the rapid descent of the unrecoverable flight hardware to depths  
38 beyond which false killer whales typically forage render the chance of encountering the  
39 item remote. Finally, the infrequent nature of the action and the low density of the  
40 species (when compared to the size of its range within the action area) render this event  
41 highly improbable. Sperm whales may feed at greater depths than mysticetes (e.g., 400  
42 to 600 m [1,310 to 1970 ft]) and sometimes at or near the benthos (Mathias et al., 2012;  
43 Miller et al., 2013; Teloni et al., 2008), potentially putting them at higher risk for

1 entanglement with the unrecovered materials once they are on the seafloor. However,  
2 dive depth data from studies of sperm whales indicate that, while individuals  
3 occasionally forage at the seafloor, typical feeding is at lesser water depths. The  
4 analysis indicated that approximately 96 percent of the waters in the action are deeper  
5 than 2,000 m (6,560 ft), which is more than the deepest recorded high-latitude sperm  
6 whale foraging dive (1,900 m [6,230 ft]; Teloni et al., 2008). Therefore, in summary,  
7 while a sperm whale undertaking a deeper (greater than 2,000 m [6,560 ft]) foraging  
8 dive to the ocean floor (where the unrecovered flight hardware would remain) is  
9 possible, when considered in conjunction with the fact that most recorded foraging has  
10 occurred at shallower depths, the low density of individuals in the action area, and the  
11 infrequent nature of the action, it may be concluded that the probability of a foraging  
12 sperm whale becoming entangled in the items on the sea floor would be very low.  
13 Likewise, given the sink rate of the unrecovered flight hardware, it is expected that the  
14 items would be below the stratum of the water column most commonly used for sperm  
15 whale foraging in approximately 1 to 2 hours, rendering the potential for entanglement  
16 negligible.

17 *Pinnipeds:* Hawaiian monk seals are particularly susceptible to entanglement with  
18 marine debris, with pups and juveniles the most vulnerable life stage (Henderson, 1990;  
19 Henderson, 2001). Entanglement most often involves derelict fishing gear including  
20 nets, fish line, and associated hardware. As discussed under *Direct or Proximate*  
21 *Strike*, the majority of seal colonies are outside the action area, with most individuals  
22 remaining in close proximity to the islands. Furthermore, the rapid recovery of floating  
23 materials from the water column and rapid sinking of unrecovered materials renders the  
24 chance of entanglement unlikely. Although the unrecovered material theoretically could  
25 present an entanglement hazard if it were to land in shallow nearshore depths, the vast  
26 majority (greater than 99 percent) of waters in the action area are deeper than the  
27 maximum recorded dive depths of Hawaiian monk seals, below which there would be  
28 no potential for interaction. Finally, the historic reports of entanglement support the  
29 conclusion that the potential for entanglement with unrecovered items under the  
30 proposed action is negligible. There are no known cases of Hawaiian monk seals being  
31 entangled in military expended material (National Marine Fisheries Service 2014), which  
32 is analogous to the MET balloons and ROBIN spheres. The entanglement stressor is  
33 not applicable to either designated or proposed Hawaiian monk seal critical habitat.

34 *Sea Turtles:* It is possible that sea turtles might encounter or approach the floating MET  
35 balloons or ROBIN spheres. Likewise, in-water turtles could encounter the floating Test  
36 Vehicle or balloon and subsequently become entangled (Carr, 1987), as sea turtles  
37 have been observed to feed under floating debris. However, multiple factors render this  
38 potential stressor highly unlikely. First, SFDT flights from PMRF would be infrequent,  
39 not exceeding two per year over a 5-year term. Second, the majority of buoyant  
40 materials (i.e., balloon, Test Vehicle) would be recovered. The unrecovered flight train's  
41 expected sink rate would effectively remove it from the water column stratum most  
42 commonly frequented by migrating and foraging sea turtles in less than 1 hour. Though  
43 it is possible that the ultimate location of the flight train on the seafloor could be within  
44 the range of depths observed for diving sea turtles, particularly leatherbacks (maximum

1 recorded dive depths to 1,280 m [4,200 ft] [Doyle et al., 2008]), it has recently been  
2 determined from satellite telemetry that very deep dives (>300 m [984 ft]) are rare  
3 (Houghton et al., 2008). Finally, the low density of sea turtles in the action area makes  
4 the likelihood of an individual becoming entangled in the descending or seafloor-resting  
5 flight hardware highly unlikely.

6 **4. Ingestion:** Foraging individuals at or near the sea surface could ingest portions of the  
7 expended flight hardware, particularly the floating MET balloons or ROBIN spheres.

8 *Cetaceans:* The likelihood of mysticete whales encountering large pieces of floating or  
9 descending flight hardware (i.e., Test Vehicle, balloon, or flight train) would be negligible  
10 because of (1) their absence from the action area during testing; (2) the recovery of the  
11 balloon and Test Vehicle shortly after landing on the ocean's surface; and (3) and the  
12 rapid descent of the unrecovered flight train to the seafloor. For false killer whales, in  
13 consideration of the infrequency of the Proposed Action, the low density of individuals  
14 within the action area, the large size of most floating materials (rendering ingestion  
15 unlikely), and their recovery upon landing in the water, the probability of an individual  
16 encountering the floating material is very low; and for sperm whales, given the large  
17 proportion (96 percent) of deep water (greater than 2,000 m [6,562 ft]) in the action  
18 area, and shallower "typical" foraging depths (400 to 800 m [1,312 to 2,625 ft]) observed  
19 in sperm whales, the likelihood of a foraging sperm whale encountering the descended  
20 flight hardware would be remote. In the long term, the possibility of the MET balloons or  
21 ROBIN spheres fragmenting into smaller pieces, which would be more readily ingested  
22 by foraging individuals, could occur. However, when considered over the entire pelagic  
23 portion of the action area and the distributed/dilute nature of the degraded particles, the  
24 probability of an individual encountering a concentration of plastic items from the  
25 degraded balloon system years into the future is very low. Finally, the low density of  
26 sperm whales in the action area makes the likelihood of an individual interacting with  
27 the expended materials at any point during their presence in the water column or on the  
28 seafloor highly unlikely.

29 *Pinnipeds:* Although Hawaiian monk seals have not been definitively reported ingesting  
30 marine debris (Baulch and Perry, 2014), the potential exists for such a stressor to occur  
31 should flight hardware land within the species' range. However, in consideration of the  
32 infrequency of the Proposed Action, the low density of individuals within the action area,  
33 the large size of most floating materials (rendering ingestion unlikely), and their recovery  
34 upon landing in the water, the probability of an individual encountering the floating  
35 material is very low. The entanglement stressor is not applicable to either designated or  
36 proposed Hawaiian monk seal critical habitat.

37 *Sea Turtles:* In a comprehensive review of 37 sea turtle/debris ingestion studies  
38 undertaken since Balazs (1985), Schuyler et al. (2014) found that while all species  
39 potentially within the action area had been reported as ingesting debris, leatherbacks  
40 and green sea turtles were the most susceptible to plastic ingestion, likely due to their  
41 feeding preferences. However, multiple factors render the potential of an individual sea

1 turtle encountering either of the floating items unlikely. First, with the exception of green  
2 sea turtles, the potential for other species to occur within the action area would be low,  
3 and likely only when transiting between other areas in the Pacific Ocean. Second, the  
4 infrequent nature of the action makes the likelihood of an individual interacting with the  
5 expended materials at any point during their presence in the water column or on the  
6 seafloor highly unlikely. Finally, when considered over the entire pelagic portion of the  
7 action area and the distributed/dilute nature of the degraded particles, the probability of  
8 an individual encountering a concentration of plastic items from the degraded balloon  
9 system years into the future is very low.

10 **5. Aircraft Overflight:** Transmission of noise from aircraft into the water would be  
11 possible; however, individuals would have to be at or near the surface at the time of an  
12 overflight to be exposed to elevated sound levels. Likewise, a visual stimulus could also  
13 lead to a change in behavior, although likely temporary.

14 *Cetaceans:* Consideration of the facts that (1) mysticete species would not likely be  
15 within the action area during the time when aircraft surveillance and recovery flights  
16 would occur, and (2) the flights are infrequent in nature, support the conclusion that  
17 exposing a mysticete to this stressor would be highly unlikely. Although sperm whales  
18 would be within the action area during the time when the action would occur, they spend  
19 about 70 to 80 percent of their time at depths of several hundred meters (Amano and  
20 Yoshioka, 2003; Watkins et al., 1993), at which they would not likely be exposed to  
21 aircraft-induced stressors (i.e., visual and/or acoustic cues). Furthermore, in  
22 consideration of the infrequent nature and short duration of aircraft flights, the relatively  
23 high altitude (above 457 m [284 ft] AGL) at which they would surveil, and limited  
24 behavioral responses documented in available research, it is expected that potential  
25 effects on marine mammals, should they even occur, would be negligible.

26 *Pinnipeds:* Based on the responses of other pinniped species to aircraft overflight, it is  
27 expected that Hawaiian monk seals would be most responsive to aircraft-induced visual  
28 or acoustic stimuli when hauled out for pupping or molting (Richardson et al., 1995).  
29 Observed reactions would vary in severity, and could range from becoming alert to  
30 rushing into the water. While not specific to the Hawaiian monk seal, Richardson et al.  
31 (1995) presented available research at the time, which in summary supports the  
32 conclusion that the surveillance and recovery aircraft under the proposed action would  
33 have limited, if any, potential for disturbance at the altitudes at which they would fly.  
34 Aircraft overflight would have only a negligible effect on either designated or proposed  
35 Hawaiian monk seal critical habitat. Although it is possible that some aircraft-induced  
36 sound could enter the water column, particularly during rough sea conditions  
37 (Richardson et al., 1995), it would be small in intensity (given the flight altitudes and  
38 limited potential for air-to-water sound transmission [Richardson et al., 1995]) and  
39 transient in nature. Likewise, aside from the transient sound transmitted at ground level  
40 by aircraft overflight, the terrestrial critical habitat would be otherwise unaffected.

1 *Sea Turtles*: Based on sea turtle sensory biology (Bartol and Musick, 2003), sound from  
2 low flying aircraft could likely be heard by a sea turtle at or near the surface. Turtles  
3 might also detect low flying aircraft via visual cues such as the aircraft's shadow (similar  
4 to the findings of Hazel et al. [2007] regarding watercraft), potentially eliciting a brief  
5 startle reaction such as a dive or lateral movement. However, in consideration of (1) the  
6 fact that sea turtles spend a significant portion of their time below the sea surface  
7 (Lutcavage and Lutz, 1997); (2) with the exception of green sea turtles, the rarity of  
8 other species within the action area; and (3) the infrequent nature of the surveillance  
9 flights, the probability of exposing an individual to an acoustically- or visually-induced  
10 stressor from aircraft overflight would be very low. Furthermore, because the  
11 surveillance and recovery aircraft would be flown at altitudes (i.e., above 457 m [1,500  
12 ft] AGL) well above those which are employed by wildlife agencies when performing  
13 aerial surveys of in-water sea turtles (e.g., 152 m (500 ft): Epperly et al. 1995), it can be  
14 reasoned that potential effects on an individual, even should it be overflown, would be  
15 insignificant.

16 **6. Recovery Vessel Operation**: Collisions with vessels could result in either non-lethal  
17 (blunt trauma, lacerations) or lethal injuries, depending on a number of factors, including  
18 vessel speed. In the case of a proximate approach, the acoustic or visual stimulus (or  
19 combination of the two) from recovery vessels could result in exposed individuals  
20 changing their behavior, including diving or swimming laterally to avoid the oncoming  
21 vessel. Additionally, to ensure that in-water species are not exposed to ship-induced  
22 stressors (e.g., ship strike), vessel operators would employ all vessel operating  
23 protocols stipulated in Section 2.4.2 of the Biological Evaluation (Appendix D).

24 *Cetaceans*: Collisions with ships have been a stressor imparted upon large whale  
25 species for many years, particularly since vessels began to attain speeds in excess of  
26 24 km/hr (13 knots) (Laist et al., 2001). In the event that a vessel strikes a whale,  
27 studies have found that the probability of its lethality increases with ship speed (Gende  
28 et al., 2011; Vanderlaan and Taggart, 2007). However, several factors render this  
29 stressor highly unlikely. First, with the exception of sperm whales, the other species of  
30 cetaceans would occur in very low numbers, if at all, within the action area during the  
31 time when ship-based recovery operations would be conducted. Although sperm  
32 whales could be in the action area during this time, they spend about 70 to 80 percent  
33 of their time at depths of several hundred meters (Amano and Yoshioka, 2003; Watkins,  
34 et al., 1993), at which there would be no possibility of an individual encountering a  
35 project vessel. Coupled with the infrequent nature of the action, the small number of  
36 recovery vessels employed in support of the activity, and the employment of vessel  
37 operating protocols, the probability of striking a listed cetacean would be very low. In  
38 the event of a proximate approach, the potential reactions of cetaceans to various types  
39 of vessels vary considerably among populations, locations, and time of year (Scheidat  
40 et al., 2004). However, as discussed in the Biological Evaluation (Appendix D)  
41 regarding ship strike, the probability of a project vessel encountering a listed whale  
42 species would be unlikely, and even if it were to occur, the temporary behavioral  
43 reaction (e.g., humpback increase in speed: Scheidat et al., 2004; change in sperm

1 whale ventilation rate: Richter et al., 2006) associated with a proximate approach would  
2 not measurably affect an individual's fitness.

3 *Pinnipeds:* In general, very little data (largely anecdotal) exists regarding the reactions  
4 of seals to vessels; however, available information suggests that seals are rather  
5 tolerant of them (Richardson et al., 1995). Likewise, little data is available regarding the  
6 potential for (and effects of) ship strikes. However, given that the flight hardware would  
7 only land within or adjacent to terrestrial areas in the event of an off-nominal flight  
8 termination scenario, the probability of the need for ship use in shallow waters around  
9 terrestrial areas (where seals would be hauled out) would be low. Additionally, because  
10 the terrestrial areas within the action area (e.g., Nihoa Island) are only home to a small  
11 number of monk seals and since vessel operating protocols would be employed to avoid  
12 monk seals, the possibility of exposing an individual to a vessel-induced stressor such  
13 that a behavioral response is evoked is also considered very low. It is unlikely that  
14 vessels would enter, and therefore affect, designated or proposed Hawaiian monk seal  
15 critical habitat. Should entry into critical habitat occur, the resultant effects would be  
16 transient and infrequent, and limited to the propagation of vessel noise into the water  
17 column and the physical movement of waters in the epipelagic stratum of the water  
18 column due to the ships' wake. NASA would require its vessel operators to prepare for  
19 and take all necessary precautions to prevent discharges of oil and releases of waste or  
20 hazardous materials that may impair water quality. In the event of such an occurrence,  
21 notification and response would be in accordance with applicable requirements of 40  
22 CFR Part 300. Additionally, to prevent the introduction of marine alien species, all  
23 submerged and waterline vessel surfaces would be cleaned of algae or other organisms  
24 prior to vessel use, and ballast water would be managed in accordance with U.S. Coast  
25 Guard Regulations (33 CFR Part 151). As such, the Proposed Action would only have  
26 negligible effects on the water column comprising either the designated or proposed  
27 Hawaiian monk seal critical habitat.

28 *Sea Turtles:* The potential exists for a project recovery vessel to strike a sea turtle.  
29 However, several factors render this stressor highly unlikely. First, with the exception of  
30 green sea turtles, the other species of sea turtles occur in very low numbers within the  
31 action area. Coupled with the infrequent nature of the action, the small number of  
32 recovery vessels employed in support of the proposed activity, and the employment of  
33 vessel operating protocols, the probability of striking a listed sea turtle would be very low.

34 Therefore, based on the data presented above, NASA concludes that the Proposed  
35 Action may affect, but is not likely to adversely affect, all listed species and critical  
36 habitat in the action area. Table 3-2 lists the possibility for presence of the species in  
37 the LDSD operating area during the launch season (June–August) and Table 3-3 is a  
38 summary of NASA's ESA determinations.

### 39 *Deep-sea Corals, Bottomfish, and Seabirds*

40 The balloon and Test Vehicle would be recovered from the Open Ocean Area and  
41 therefore not anticipated to have an adverse environmental impact on deep-sea corals

1 or bottomfish. As was demonstrated during the 2014 mission, it took the respective  
 2 vessels approximately 5 hours to reach and recover the ring-sail parachute, 6.5 hours to  
 3 reach and recover the balloon carcass, and 4 hours to reach and recover the Test  
 4 Vehicle. Therefore, it is anticipated that the LDSD program would be able to locate and  
 5 recover the balloon and Test Vehicle.

6 For seabirds, it would be expected that the splashdown of the expended flight hardware  
 7 would be likely to produce short-term stressors (i.e., supersonic flight, direct or  
 8 proximate strike, entanglement, ingestion, aircraft overflight, and recovery vessel  
 9 operations). Seaborne vessels and spotter aircraft, directed to locate and remove the  
 10 floating expended hardware, would also cause stressors to seabirds. However, vessel  
 11 operating protocols employed to reduce risks to marine mammals and sea turtles would  
 12 ensure a reduction in the stressors to seabirds. Therefore, these short-term stressors  
 13 would have the potential to cause seabirds to leave the immediate area for a short-time  
 14 or permanently.

15 **Table 3-2. ESA Species Occurrence in the Region of Influence During Launch**

Order	Species	Scientific Name	Present in Splashdown (Operating) Area during June–August
<b>Cetaceans</b>			
Mysticetes	North Pacific right whale	<i>Eubalaena japonica</i>	Rare
	Blue whale	<i>Balaenoptera musculus</i>	Rare
	Fin whale	<i>Balaenoptera physalus</i>	Highly Unlikely
	Sei whale	<i>Balaenoptera borealis</i>	Not Known
	Humpback whale	<i>Megaptera novaeangliae</i>	Unlikely
Odontocetes	False killer whale (MHI Insular)	<i>Pseudorca crasidens</i>	Undeterminable for Splashdown Timeframe
	Sperm whale	<i>Physeter macrocephalus</i>	Undeterminable for Splashdown Timeframe
<b>Pinnipeds</b>			
	Hawaiian Monk Seal	<i>Neomonachus schauinslandi</i>	Likely
	Hawaiian Monk Seal Critical Habitat	N/A	Unlikely
<b>Sea Turtles</b>			
	Green sea turtle	<i>Chelonia mydas</i>	Unlikely (Breeding season at French Frigate Shoals)
	Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Rare
	Loggerhead sea turtle	<i>Caretta caretta</i>	Highly Unlikely
	Olive ridley sea turtle	<i>Lepidochelys olivacea</i>	Unlikely
	Leatherback sea turtle	<i>Dermochelys coriacea</i>	Rare

16

1

**Table 3-3. Summary of ESA Species to Occur in the Region of Influence**

Order	Species	Scientific Name	ESA Status	NASA Inclusion in 2013 Final LDSD EA*	NASA ESA Determination 2015
<b>Cetaceans</b>					
Mysticetes	North Pacific right whale	<i>Eubalaena japonica</i>	E	Yes (Page 3-54)	NLAA
	Blue whale	<i>Balaenoptera musculus</i>	E	Yes (Page 3-55)	NLAA
	Fin whale	<i>Balaenoptera physalus</i>	E	Yes (Page 3-54)	NLAA
	Sei whale	<i>Balaenoptera borealis</i>	E	Yes (Page 3-54)	NLAA
	Humpback whale	<i>Megaptera novaeangliae</i>	E	Yes (Page 3-54)	NLAA
Odontocetes	False killer whale (MHI Insular)	<i>Pseudorca crasidens</i>		Yes (Page 3-24)	NLAA
	Sperm whale	<i>Physeter macrocephalus</i>	E	Yes (Page 3-55)	NLAA
<b>Pinnipeds</b>					
	Hawaiian monk seal	<i>Neomonachus schauinslandi</i>	E	Yes (Page 3-55)	NLAA
	Hawaiian monk seal critical habitat	N/A	D	No	NLAA
<b>Sea Turtles</b>					
	Green sea turtle	<i>Chelonia mydas</i>	T	Yes (Page 3-51)	NLAA
	Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	E	Yes (Page 3-51)	NLAA
	Loggerhead sea turtle	<i>Caretta caretta</i>	E	Yes (Page 3-50)	NLAA
	Olive ridley sea turtle	<i>Lepidochelys olivacea</i>	T	Yes (Page 3-50)	NLAA
	Leatherback sea turtle	<i>Dermochelys coriacea</i>	E	Yes (Page 3-50)	NLAA

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Key:

NLAA = May affect, not likely to adversely affect.

E=Endangered

D=Designated

T=Threatened

N/A=Not Applicable

\*NMFS did not require formal Section 7 Consultation for the 2013 LDSD EA

10

1 **(2) Unrecovered Sinkable Hardware**

2 The balloon flight train would rapidly sink in the Open Ocean Area and/or PMNM and  
3 would be almost impossible to locate.

4 **Threatened and Endangered Species**

5 The balloon flight train would be left in the open ocean and/or PMNM, and the sinking of  
6 the balloon flight train may cause environmental impacts to biological/marine wildlife in  
7 the form of stressors (i.e. supersonic flight, direct or proximate strike, entanglement,  
8 ingestion, aircraft overflight, and recovery vessel operations) to which listed individuals  
9 would respond if exposed. Potential impacts from stressors caused by the discarded  
10 balloon flight train on ESA species have been analyzed in the Biological Evaluation  
11 (Appendix D) and are discussed above under Threatened and Endangered Species-  
12 Expended Flight Hardware (including Flight Train).

13 *Deep-sea Corals, Bottomfish, and Marine Mammals*

14 It is conceivable that the balloon train could settle on deep-sea coral as it reaches the  
15 ocean floor. NASA would not recover the balloon train from the ocean floor because it  
16 would be almost impossible to locate. However, review of NOAA and United Nations  
17 Environment Programme surveys of coral reefs in the NHI and NWHI indicate that coral  
18 reefs are not expected in the splashdown area and, therefore, significant impacts to  
19 corals from the balloon flight train are not anticipated.

20 It is conceivable that the balloon train could come in contact with bottomfish as it  
21 reaches the ocean floor. Based on the natural behavior of fish and marine mammals  
22 (e.g. startled by noise, vibrations), it is anticipated that bottomfish and marine mammals  
23 would leave the immediate area as the balloon flight train is descending to the ocean  
24 floor.

25 To ensure that in-water species are not exposed to ship-induced stressors (e.g., ship  
26 strike) constant vigilance would be maintained for the presence of ESA-listed marine  
27 mammals and sea turtles. Vessels would remain at least 92 m (300 ft) from Hawai'ian  
28 monk seals and humpback whales and at least 46 m (150 ft) from all other marine  
29 mammals and sea turtles. Vessel speeds would be reduced to 18.5 kilometers per hour  
30 (km/hr) (10 knots) or less when piloting in proximity of marine mammals and further  
31 reduced to 9.25 km/hr (5 knots) or less when piloting in areas of known or suspected  
32 sea turtle activity. If marine mammals or sea turtle approach a vessel, activity would  
33 stop, allowing the animal to safely depart the immediate area prior to resuming  
34 operation. Additionally, to prevent the introduction of marine alien species, all  
35 submerged and waterline surfaces would be cleaned of algae or other organisms prior  
36 to vessel use, and ballast water would be managed in accordance with U.S. Coast  
37 Guard Regulations (33 CFR Part 151).

1 **(3) Seaborne Vessels and Aircraft**

2 NASA would utilize up to three seaborne vessels and up to two U.S. Navy aircraft  
3 during future campaigns to execute recovery operations immediately following each  
4 SFDT (Table 3-4). The proposed activities of concern for seaborne vessels are  
5 (1) vessel strike and (2) vessel anchoring.

6 **Table 3-4. Proposed Seaborne Vessels and Aircraft for Proposed Action**

<b>Seaborne Vessels</b>			
<b>Name/Type</b>	<b>Length</b>	<b>Max Speed</b>	<b>Cruise Speed</b>
M/V Kahana	56 m (185 ft)	22 km/hr (12 knots)	15-18.5 km/hr (8-10 knots)
M/V Honua	45.7 m (150 ft)	20 km/hr (11 knots)	15 km/hr (8 knots)
MV Manao II	19.5 (64 ft)	28 km/hr (15 knots)	22 km/hr (12 knots)

<b>Aircraft</b>			
<b>Name</b>	<b>Type</b>	<b>Purpose</b>	<b>Flight Altitude</b>
U.S. Navy G-2/3	G-2/3	Spotter Aircraft/Safety Surveillance	15,000-24,000
U.S. Navy C-12/26	C-12/26	Spotter Aircraft/Safety Surveillance	15,000-24,000

7

8 **Vessel Strike**

9 *Threatened and Endangered Species*

10 Potential impacts from the recovery vessel operation may cause stress to ESA species.  
11 This potential has been analyzed in the Biological Evaluation (Appendix D) and is  
12 discussed above under Threatened and Endangered Species—Expendable Flight  
13 Hardware (Including Flight Train)—Recovery Vessel Operation.

14 *Deep-sea Corals, Bottomfish, and Seabirds*

15 The vessels are not anticipated to come in contact with deep-sea coral, bottomfish, or  
16 seabirds. The deep-sea coral and bottomfish are located at depths beyond the natural  
17 hull reach of the vessels. It is anticipated that seabirds would depart the immediate  
18 area.

19 *Vessel Anchoring*

20 The three seaborne vessels would not anchor during the recovery process.

1           **Aircraft**

2           *Threatened and Endangered Species*

3 Potential impacts from the Aircraft Overflight may cause stress to ESA species. This  
4 potential stress has been analyzed in the Biological Evaluation (Appendix D) and is  
5 discussed above under Threatened and Endangered Species- Expanded Flight  
6 Hardware (including Flight Train)-Aircraft Overflight.

7           *Deep-sea Corals, Bottomfish, Marine Mammals, Turtles and Seabirds*

8 The operators of LDSA search and recovery aircraft are required to operate at an  
9 altitude greater than 457 m (1,500 ft), at which the effects of overflight (e.g., startle)  
10 would be minimal. Furthermore, should aircraft operators observe sea birds, marine  
11 mammals, or sea turtles, they would not undertake potentially harassing (e.g., repeated  
12 circling) patterns until the individuals are no longer under the aircraft's flight path. It is  
13 not anticipated that the aircraft would have an adverse environmental impact on corals  
14 or bottomfish.

15 **3.2.1.2.5 Cultural Resources—Open Ocean Area (Alternative 1—Proposed**  
16 **Action/Preferred Alternative)**

17 **3.2.1.2.6 Regulatory Content**

18 The National Historic Preservation Act (NHPA) of 1966, as amended, outlines Federal  
19 policy to protect historic properties and promote historic preservation in cooperation with  
20 other nations, Tribal governments, States, and local governments. Section 106 of the  
21 NHPA and its implementing regulations outline the procedures for Federal agencies to  
22 follow to take into account their actions on historic properties. Under Section 106,  
23 Federal agencies are responsible for identifying historic properties within the Area of  
24 Potential Effects for an undertaking, assessing the effects of the undertaking on those  
25 historic properties, if present, and considering ways to avoid, minimize, and mitigate any  
26 adverse effects.

27 **3.2.1.2.7 Region of Influence**

28 The region of influence for Open Ocean Area cultural resources includes approximately  
29 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area encompasses locations where the Test  
30 Vehicle system equipment splashdown and debris might affect submerged sites,  
31 features, wrecks, or ruins. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>),  
32 approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within the easternmost part  
33 of PMNM and approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) is Open Ocean Area north of  
34 PMNM. Figure 1-5 is an overview of the affected area.

35 **3.2.1.2.8 Affected Environment**

36 The affected environment is discussed for PMNM and the Open Ocean Area outside of  
37 PMNM.

1 3.2.1.2.8.1 *Papahānaumokuākea Marine National Monument*

2 Papahānaumokuākea is the name given to a vast and isolated linear cluster of small, low  
3 lying islands and atolls, with their surrounding ocean, extending some 1,931 km (1,200  
4 mi) to the northwest of the main Hawaiian Archipelago, located in the north-central  
5 Pacific Ocean. The property comprises PMNM, which extends almost 2,000 km (1,080  
6 nm) from southeast to northwest. The property includes a significant portion of the  
7 Hawaii-Emperor hotspot trail, constituting an outstanding example of island hotspot  
8 progression. Much of the property is made up of pelagic and deepwater habitats, with  
9 notable features such as seamounts and submerged banks, extensive coral reefs,  
10 lagoons, and 14 km<sup>2</sup> (5.4 mi<sup>2</sup>) of emergent lands distributed between a number of eroded  
11 high islands, pinnacles, atoll islands, and cays. With a total area of around 362,075 km<sup>2</sup>  
12 (105,564 nm<sup>2</sup>), it is one of the largest marine protected areas in the world. The  
13 geomorphological history and isolation of the archipelago have led to the development of  
14 an extraordinary range of habitats and features, including an extremely high degree of  
15 endemism (i.e., unique to a specific place). Largely as a result of its isolation, marine  
16 ecosystems and ecological processes are virtually intact, leading to exceptional biomass  
17 accumulated in large apex predators. Island environments have, however, been altered  
18 through human use, and although some change is irreversible, there are also examples  
19 of successful restoration. The area is host to numerous endangered or threatened  
20 species, both terrestrial and marine, some of which depend solely on  
21 Papahānaumokuākea for their survival. All the cultural attributes that reflect Outstanding  
22 Universal Value are within the boundaries of the property. The archaeological sites  
23 remain relatively undisturbed by cultural factors. Although none of the attributes are  
24 under severe threat, some of the archaeological sites need further conservation and  
25 protection against damage from plants and wildlife. (World Heritage Convention, 2015)

26 In Hawaiian traditions, Papahānaumokuākea (NWHI) is considered a sacred place, a  
27 region of primordial darkness from which life springs and spirits return after death  
28 (Kikiloi, 2006). Much of the information about Papahānaumokuākea (NWHI) has been  
29 passed down in oral and written histories, genealogies, songs, dance, and  
30 archaeological resources. Through these sources, Native Hawaiians are able to  
31 recount the travels of seafaring ancestors between the NWHI and the MHI. Hawaiian  
32 language archival resources have played an important role in providing this  
33 documentation, through a large body of information published over a hundred years ago  
34 in local newspapers (e.g., Kaunamano 1862 in *Hōkū o ka Pakipika*; Manu 1899 in *Ka*  
35 *Lōea Kalai'āina*; Wise 1924 in *Nūpepa Kuoko'a*). More recent ethnological studies  
36 (Maly, 2003) highlight the continuity of Native Hawaiian traditional practices and  
37 histories in PMNM (NWHI). Only a fraction of these have been recorded, and many  
38 more exist in the memories and life histories of kupuna. (National Oceanic and  
39 Atmospheric Administration, 2015)

40 Today, Native Hawaiians remain deeply connected to the NWHI on genealogical,  
41 cultural, and spiritual levels. Kauai and Niihau families voyaged to these islands,  
42 indicating that they played a role in a larger network for subsistence practices into the  
43 20th century (Tava and Keale, 1989; Maly, 2003). In recent years, Native Hawaiian

1 cultural practitioners voyaged to the NWHI to honor their ancestors and perpetuate  
2 traditional practices. (National Oceanic and Atmospheric Administration, 2015)

3 Maritime archaeologists conduct archaeological surveys to characterize the maritime  
4 heritage resources on the seafloor as a pivotal part of the effort to develop an inventory  
5 and a better understanding of the resource base in PMNM. Characterization begins  
6 with a historical inventory of the potential resources and proceeds to the field research  
7 component: physically locating and documenting these sites. Field research to date has  
8 resulted in the documentation of 20 maritime heritage sites. These sites have been  
9 documented at both Phase 1 (general site description) and Phase 2 (thorough site  
10 documentation and evaluation of a site for eligibility for inclusion in the National Register  
11 of Historic Places) levels. (Papahānaumokuākea Marine National Monument, 2011)

#### 12 3.2.1.2.8.2 *Open Ocean Area*

13 In the waters surrounding the Hawaiian Islands, there are thousands of submerged  
14 cultural resources. The types of wrecks most likely to occur are 19th century cargo  
15 ships, submarines, old whaling and merchant ships, fishing boats, or 20th century U.S.  
16 warships, aircraft, recreational craft, and land vehicles. There is no definitive count of  
17 the number of wrecks surrounding the Hawaiian Islands, as they are located at depths  
18 that make them difficult to locate and record. Pacific Ocean currents and storms are  
19 also quick to destroy these types of submerged resources.

20 The State of Hawaii's Geographic Information System and the Marine Resources  
21 Assessment for the Hawaiian Islands Operating Area, Final Report (U.S. Department of  
22 the Navy, 2005a) were reviewed to determine the potential for submerged cultural  
23 resources within the Area of Potential Effects; none were noted.

#### 24 3.2.1.2.9 **Environmental Consequences**

25 NASA would conduct up to two SFDT test flight per year over the next 5 years (2016–  
26 2019). If expended flight hardware should splashdown or drift into PMNM, NASA would  
27 recover all floating hardware as quickly as possible, thereby avoiding adverse impacts to  
28 cultural resources. As PMNM is considered in Hawaiian traditions as a sacred place  
29 from which life springs and to which spirits return, unavoidable cultural impacts may  
30 occur, if either of the up to 10 balloon flight trains (up to two per year, over 5 years)  
31 should sink to the PMNM sea floor. However, given the unlikely probability of  
32 splashdown occurring in PMNM and that the balloon flight train is most likely to sink  
33 outside PMNM, the risk of impact is small. No Section 106 Consultation was required for  
34 this Proposed Action.

35

1 **3.2.2 NIHOA ISLAND (INCLUDING THE SPECIAL MANAGEMENT AREA)**

2 **Resources Carried Forward for Detailed Analysis for Nihoa Island**

3 The LDSD project has the potential for overflight of Nihoa Island and the Special  
4 Management Area, and only in the event of a catastrophic failure of the flight system  
5 would flight hardware descend into these areas. Therefore, 2 of the 14 areas of  
6 environmental consideration have been addressed in detail in this SEA. Table 3-5  
7 presents the results of the process of identifying resources to be analyzed in this SEA,  
8 which are biological resources, cultural resources and health and safety. The general  
9 organization of resource areas is consistent with the 2013 LDSD Final EA; however,  
10 many have been eliminated from the SEA and are detailed in Table 3-1.

11 **Resources Considered but Eliminated from Detailed Analysis for Nihoa Island**

12 Fourteen areas of environmental consideration were initially evaluated for Nihoa Island  
13 to provide a context for understanding the potential effects of the Proposed Action and  
14 to provide a basis for assessing the severity of potential environmental effects. These  
15 areas included air quality, airspace, biological resources, cultural resources, geology  
16 and soils, hazardous materials and waste, health and safety, land use, noise,  
17 socioeconomics, transportation, utilities, visual aesthetics, and water resources.  
18 Ultimately 2 of the 14 areas of environmental consideration were addressed for Nihoa  
19 Island and the Special Management Area surrounding the island (biological and cultural  
20 resources). The remaining resource areas were not analyzed in such a manner. Those  
21 resources not warranting further discussion are presented in Table 3-1.

22 **3.2.2.1 Biological Resources—Nihoa Island (Alternative 1—Proposed Action)**

23 **3.2.2.1.1 Region of Influence**

24 The region of influence for biological resources includes the area within the Nihoa Island  
25 boundary that could be affected by the proposed activities. Figure 3-3 is an overview of  
26 the biological resources surrounding Nihoa Island.

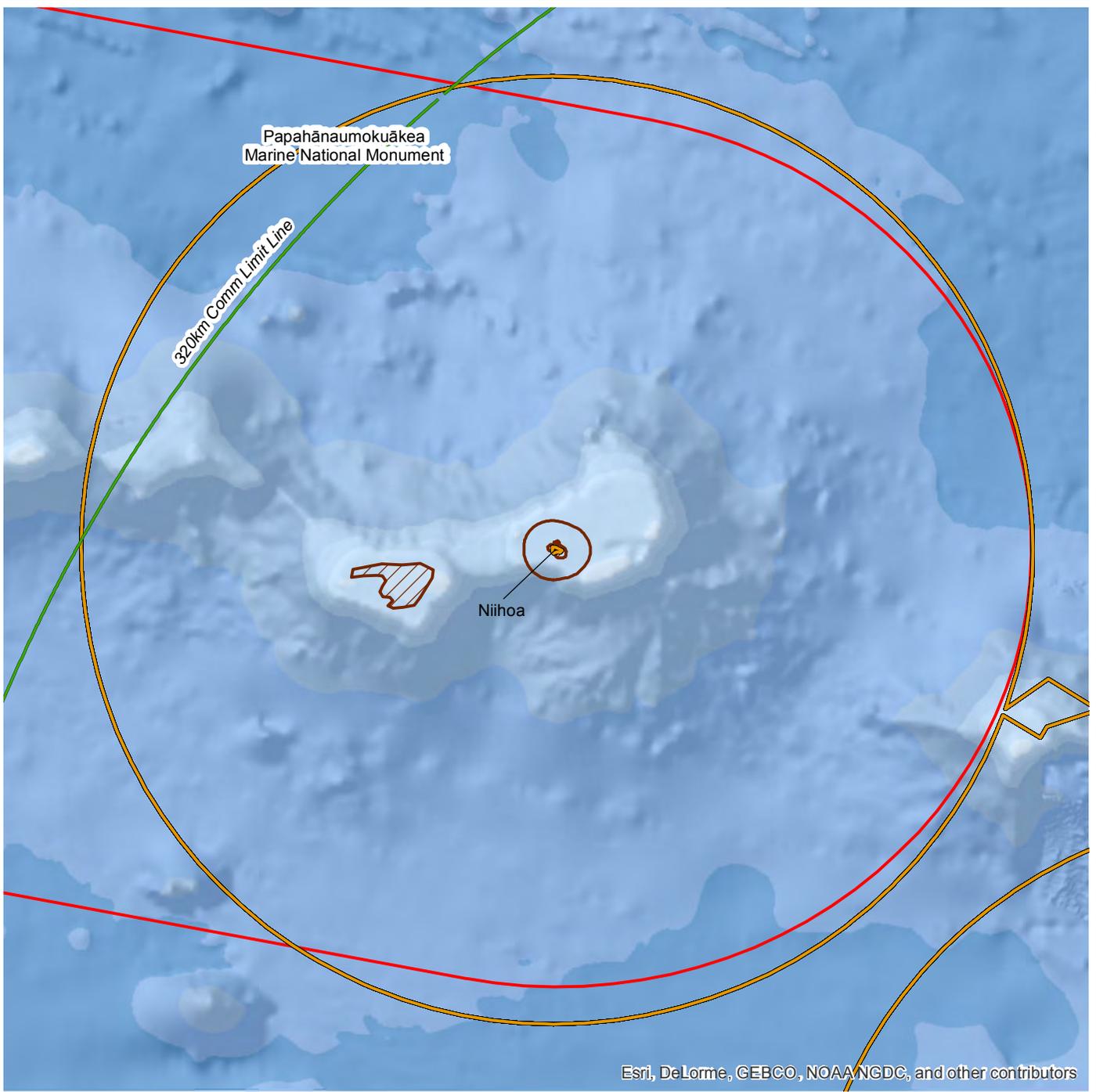
27 **3.2.2.1.2 Affected Environment**

28 *3.2.2.1.2.1 Terrestrial*

29 **Vegetation**

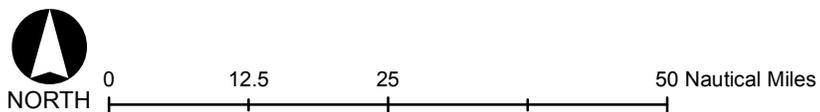
30 Endemic endangered plants on Nihoa Island include the Nihoa fan palm (*Pritchardia*  
31 *remota*), the only species of tree on the island, and the leguminous 'ohai shrub  
32 (*Sesbania tomentosa*). Most of the ridges are covered with two species of grass, and  
33 the valleys are densely covered with shrubs and bushes. (National Oceanic and  
34 Atmospheric Administration, 2013)

35



**EXPLANATION**

-  320-km Communications Limit Line
-  Papahānaumokuākea Marine National Monument
-  Coral
-  Monk Seal Critical Habitat
-  Nihoa 3-nautical mile Special Management Area



**Biological Resources Surrounding Nihoa Island**

Nihoa

**Figure 3-3**

33\_nihoa\_coral\_2/20/2015

## 1 **Threatened and Endangered Terrestrial Vegetation**

### 2 *Nihoa Fan Palm (Pritchardia remota)*

3 The Nihoa fan palm (*Pritchardia remota*) is one of the endemic Hawaiian species that  
4 has a very narrow geographic distribution. It is one of only four *Pritchardia* species that  
5 are found in low-elevation dryland vegetation as all the other species are found in mesic  
6 or wet vegetation. This species is found on Nihoa Island at the base of cliffs and on  
7 high cliff terraces ranging from an elevation of 200 to 800 m (656 to 2,625 ft) in East and  
8 West Palm valleys. *Nihoa pritchardia* grows to only 4 to 5 m (13 to 16 ft) in height with a  
9 narrow trunk that is less than 15 cm (6 inches) in diameter. This species may also be  
10 present on Laysan Island, northwest of Nihoa Island. (National Tropical Botanical  
11 Garden, 2015)

12 A 1996 survey found a total of four plant populations of 680 palms on the island.  
13 Groves of Nihoa fan palms grow in coastal mesic valley depressions in two valleys on  
14 Nihoa Island: The largest population grows in the West Palm Valley, while the three  
15 smaller populations are found in the East Palm Valley. (Gemmill, 1998)

### 16 *Leguminous 'Ohai Shrub (Sesbania tomentosa)*

17 'Ohai (*Sesbania tomentosa*) is a variable species. It is usually a low, spreading shrub  
18 with horizontal or arching branches; it can also have a treelike habit up to  
19 approximately 5 m (15 ft) tall. In the wild, a single plant can cover a large area, but in  
20 cultivation it will tend to be under approximately 3 m (10 ft) in diameter. It is an  
21 endangered, endemic Hawaiian plant. It used to grow in dry areas at elevations below  
22 762 m (2,500 ft) on all of the main islands. However, destruction of these habitats has  
23 greatly diminished its natural occurrence within its former range. (Hawaiian Native Plant  
24 Propagation Database, 2001)

25 Ohai are naturally found on sandy beaches, dunes, soil pockets on lava, and along  
26 pond margins (only Mānā, Kauai). In the NWHI 'ohai is a rather common component in  
27 the shrubland on Nihoa (Moku Manu) and is also found on Necker (Mokumanamana).  
28 Formerly widespread, 'ohai is now extinct on Niihau and rare and restricted to relict  
29 populations elsewhere in the MHI. On Oahu, it is restricted to a few locations such as  
30 Ka'ena, Moku'auia, and Kāohikaipua; on Kaho'olawe it is only found on Pu'ukoaia Islet.  
31 (Native Plants Hawaii, 2009)

### 32 *Amaranthus brownii*

33 *Amaranthus brownii* is endemic to the island of Nihoa in the NWHI. Nihoa is part of the  
34 Hawaiian Islands National Wildlife Refuge, and has an area of only 0.65 km<sup>2</sup>.  
35 *Amaranthus brownii*, a member of the amaranth family (Amaranthaceae), is an annual  
36 herb with leafy upright or ascending stems, 1 to 3 ft (30 to 90 cm) long. The slightly  
37 hairy, alternate leaves are long and narrow, 1.6 to 2.8 in (4 to 7 cm) long, 0.06 to 0.16 in  
38 (1.5 to 4 mm) wide, and more or less folded in half lengthwise. Flowers are either male  
39 or female, and both sexes are found on the same plant. The green flowers are  
40 subtended by two oval, bristle-tipped bracts about 0.04 in (1 mm) long and 0.03 in (0.7

1 mm) wide. The flattened, oval fruit, which does not split open at maturity, is 0.03 to 0.04  
2 in (0.8 to 1 mm) long and 0.02 to 0.03 in (0.6 to 0.8 mm) wide and contains one shiny,  
3 lens-shaped, reddish black seed. This species can be distinguished from other  
4 Hawaiian members of the genus by its spineless leaf axils, its linear leaves, and its fruit  
5 which does not split open when mature. (Department of Land and Natural Resources,  
6 2005)

7 When *Amaranthus brownii* was first collected in 1923, it was recorded as “most  
8 common on the ridge leading to Millers Peak, but abundant also on the ridges to the  
9 east.” The two known populations are separated by a distance of 0.4 km (0.25 mi) and  
10 contain approximately 35 plants: about 23 plants near Millers Peak and about 12 plants  
11 in Middle Valley. Threats include competition from invasive alien plant species,  
12 landslides, fire, possible hybridization with non-native amaranth species, small number  
13 of populations and individuals and limited distribution that increase threats by stochastic  
14 extinction, and reduced reproductive vigor. (Department of Land and Natural  
15 Resources, 2005)

## 16 **Terrestrial Wildlife (Animal)**

17 The terrestrial fauna includes monk seals (*Monachus schauinslandi*), 72 species of  
18 arthropods including giant crickets and earwigs, 2 species of endemic land birds—the  
19 endangered Nihoa finch (*Telespyza ultima*) and the endangered Nihoa millerbird  
20 (*Acrocephalus familiaris kingi*)—and several species of seabirds, such as terns,  
21 shearwaters, petrels, boobies, albatrosses, tropic birds, and frigate birds. (National  
22 Oceanic and Atmospheric Administration, 2013)

## 23 **Threatened and Endangered Terrestrial Wildlife**

### 24 *Nihoa Finch (Telespyza ultima)*

25 Nihoa finch is an endemic species that lives only on Nihoa Island. It prefers open but  
26 vegetated habitat, nesting in small holes in rock outcrops 30.5 to 244 m (100 to 800 ft)  
27 above sea level. (National Oceanic and Atmospheric Administration, 2013) The  
28 species occurs on more than two-thirds of the island, but its entire range is still less than  
29 0.5 km<sup>2</sup> (0.2 mi<sup>2</sup>) (BirdLife International, 2014). Threats to the Nihoa finch include  
30 introduced plants and animals, and fire.

31 Identification. Nihoa finches are medium-sized finches (17 cm ([6.7 inches]) with heavy,  
32 silver-colored bills. Adult males have yellow heads, yellow underparts, grayish backs  
33 with a yellow patch in the middle, and yellowish wings. Females and juveniles have a  
34 very different appearance; they too have yellow breasts, but their underparts, heads,  
35 and backs are all heavily streaked with brown and black. (BirdLife International, 2014)

36 Distribution and Population Trends. *Telespiza ultima* once occurred at least on the  
37 island of Molokai in the MHI, but was extirpated in prehistory probably by a combination  
38 of predation by introduced mammals and habitat loss (Morin and Conant, 2002).  
39 Today, this species is restricted to the steep, rocky island of Nihoa in the NWHI (Berger,

1 1972, Morin et al., 1997). Numbers fluctuate (James and Olson, 1991; Morin and  
2 Conant 2002), although some variation may be due to differences in survey methods  
3 and time of year. Numbers on Nihoa have ranged from 6,686 in 1968 to 946 in 1987  
4 (James and Olson, 1991; Morin and Conant, 2002). The most recent population  
5 estimate based on surveys in 2012 is 4,475 individuals (VanderWerf, 2012), which  
6 roughly equates to 3,000 (2,400–3,600) mature individuals. (BirdLife International  
7 (2015)

8 Between 1967 and 1996, population estimates for Nihoa finches ranged from a high of  
9 6,686 in 1968 to a low of 946 in 1987. This species' numbers are thought to naturally  
10 fluctuate somewhat, but some of the variation in annual population estimates might be  
11 the result of different survey protocols (including time of year). (BirdLife International,  
12 2014)

13 Ecology. Nihoa island is a steep, rocky island largely covered by low shrubs and  
14 grasses. Nihoa finches are omnivorous, feeding on seabird eggs, seeds, flowers, and  
15 insects. These birds nest in rock crevices. As with other Hawaiian finches, Nihoa  
16 finches are loud singers with complex, canary-like songs. (Audubon, 2014). Egg laying  
17 begins in February and may extend to early July, with an average clutch of three eggs.  
18 (U.S. Fish and Wildlife Service, 2012a)

19 The Nihoa finch whistles, trills, and warbles loudly and melodiously. Males are showy  
20 when singing, holding their wings horizontally away from their bodies and sometimes  
21 swaying back and forth. The distress call is a loud, harsh chip. (U.S. Fish and Wildlife  
22 Service, 2012a)

23 Threats. The major threats to Nihoa finches are the introduction of non-native plant and  
24 insect species, and large catastrophic events, such as hurricanes, droughts, and major  
25 storms. Nihoa finches' extremely limited range makes them extremely susceptible to  
26 extinction from a single major catastrophe. (BirdLife International, 2014)

27 Conservation. Nihoa finches were listed as Endangered by USFWS in March 1967.  
28 Nihoa Island is part of the Hawaiian Islands National Wildlife Refuge, thereby providing  
29 protection for the species' habitat. Nihoa is not a populated island, and access to it is  
30 strictly controlled. Biologists and other researchers who are permitted access to the  
31 island are carefully inspected to ensure that they do not accidentally introduce seeds,  
32 eggs, or insects to Nihoa Island via their clothes or equipment. In addition, researchers  
33 visiting the island regularly perform hand weeding of introduced plants to control their  
34 growth. To establish another population of Nihoa finches, and thereby reduce the risk  
35 of complete extinction via one cataclysmic event, a group of birds was introduced to  
36 French Frigate Shoals (also in the Hawaiian Islands National Wildlife Refuge), but those  
37 birds did not survive. (BirdLife International, 2014)

1 *Nihoa Millerbird (Acrocephalus familiaris kingi)*

2 The Nihoa millerbird is an endemic bird found only on Nihoa Island. The population size  
3 of the Nihoa millerbird has fluctuated between 300 and 700 individuals in the last 30  
4 years. Threats to the Nihoa millerbird include introduced plants and animals, and fire.  
5 (National Oceanic and Atmospheric Administration, 2013)

6 Biologists are considering the translocation of sufficient millerbirds to create a second  
7 population on another Hawaiian island to reduce the risk of extinction. A ranking of  
8 potential translocation sites for the millerbird indicated that Laysan Island is the first  
9 choice for a translocation effort. Planning is underway for this project. (U.S. Fish and  
10 Wildlife Service, 2012b)

11 Identification. The Nihoa millerbird is a tiny land bird measuring approximately 12.7 cm  
12 (5 inches) in length that was discovered on the Nihoa Island in 1923. It has dark gray-  
13 brown feathers above, a buffy-white belly, and a thin dark colored bill. This bird got its  
14 name because its favorite food is the miller moth. Male and female birds are similar  
15 looking. (U.S. Fish and Wildlife Service, 2012)

16 Distribution and Population Trends. The millerbird is known only from two islands within  
17 the Hawaiian Archipelago. The Laysan Island population was considered abundant  
18 prior to the introduction of rabbits around 1903. Somewhere between 1916 and 1923  
19 the Laysan population disappeared as rabbits consumed all living plants that provided  
20 food, shelter, and nest sites for this little warbler. Another population was discovered on  
21 Nihoa Island in 1923, the same year that the Laysan population was confirmed extinct.  
22 The logistics of accessing Nihoa Island and conducting accurate surveys have made it  
23 difficult to track population changes or dynamics, but it seems that the population has  
24 remained stable within its extremely small range (40 hectares [99 acres] of vegetation  
25 on a 63-hectare [156-acre] island). Over the last 30 years of annual surveys, estimates  
26 of population sizes have ranged from 31 to 731 birds, while the carrying capacity of the  
27 island has been estimated at around 600 birds. (Audubon, 2014)

28 Ecology. Very little is known about the Laysan millerbird, while limited and difficult  
29 access to Nihoa Island has significantly reduced opportunities to learn about the  
30 species from its extant population. Birds on Laysan Island were characterized as  
31 energetic and confiding, often seen around buildings or camps searching in crannies for  
32 insects or even hopping around and landing on visitors. On Nihoa Island, millerbirds  
33 are known to prefer dense cover near the ground, where they search for insects and  
34 larvae and build nests in dense shrubs. The first nest on Nihoa Island was discovered  
35 in 1962, and the nesting season is now suspected to run from January to September.  
36 Their food consists entirely of insects and larvae, especially moths and caterpillars.  
37 (Audubon, 2014)

38 Threats. As with any limited population, random events could have catastrophic effects.  
39 The tiny exposed island of Nihoa is especially susceptible to weather events, and  
40 weather events probably account in part for changes in millerbird population estimates

1 over the past 30 years. The fragile nature of this tiny ecosystem and the chance that  
2 human visitors could introduce an alien species are an ongoing cause for concern. At  
3 this time only three alien plants are thought to be established on Nihoa Island, and  
4 disease-bearing mosquitoes that have decimated other Hawaiian endemic birds have  
5 not become established on the island. Rats, mosquitoes, or new plants are all possible  
6 threats. (Audubon, 2014)

7 Conservation. The species was federally listed as Endangered in 1967. Nihoa Island is  
8 part of the Hawaiian Islands National Wildlife Refuge, and access is strictly controlled  
9 through a permitting process. While visiting scientists make an effort to pull invasive  
10 weeds, no other substantive efforts on behalf of the millerbird have been undertaken.  
11 The option of translocating millerbirds to other islands (including Laysan, Necker, and  
12 Kaho'olawe) has been seriously considered, with the option of returning millerbirds to  
13 Laysan receiving the most serious attention. Computer models show that the current  
14 population has an unacceptably high probability for extinction unless efforts are made to  
15 establish supplemental populations either on other islands or in captivity. (Audubon,  
16 2014)

17 In 2011 and 2012, a small number of ulūlu were translocated from Nihoa Island to  
18 Laysan Island to improve the long-term survival of the species and to fill a gap in  
19 Laysan's ecosystem that was once filled by the now-extinct Laysan millerbird. (National  
20 Oceanic and Atmospheric Administration, 2014)

#### 21 3.2.2.1.2.2 *Marine*

##### 22 **Corals**

23 Nihoa Island's submerged coral reef habitat totals approximately 570 km<sup>2</sup> (141,000  
24 acres) and is the remnant of a former volcanic cone. The northern edge of the reef is a  
25 steep cliff made up of successive layers of lava through which numerous volcanic  
26 extrusion (dikes) are visible. Nihoa Island supports coral communities with very limited  
27 total habitat, most of which is protected from the heavy and chronic wave action that  
28 strikes this small island from all directions. These habitats consist of the submerged  
29 portions of sea cliffs close to shore, caves and lava tubes, ledges, overhangs, basalt  
30 pinnacles, boulders, cobbles, sand deposits, basalt benches and slopes, trenches and  
31 shelves. All of these features have been shaped by and are constantly eroded by the  
32 pounding waves. The rigorous environment and isolated nature of Nihoa Island has  
33 limited the number of corals that have successfully colonized the shallow habitats  
34 encircling the island. Due to the scouring effects of sand and turbulent waves, most of  
35 the 20 species of corals only survive at depths greater than 9 m (30 ft), and nowhere is  
36 coral cover greater than 25 percent. (National Ocean Service, 2012)

37 Seventeen species of scleractinian (stony) coral were found at Nihoa Island. Small  
38 encrusting forms of the lobe coral, *Porites lobata*, and rose coral colonies (*Pocillopora*  
39 *meandrina*) were the most common. Encrusting pink coralline algae covered many  
40 rocky surfaces in very shallow water. Some red, brown, and green algae were common  
41 around the island. The red alga, *Asparagopsis taxiformis*, is an edible species that is no

1 longer common in the MHI. (National Oceanic and Atmospheric Administration, 2013)  
2 Stony corals are also less abundant and diverse off the exposed basalt islands to the  
3 southeast (Nihoa, Necker, La Perouse, Gardner), where soft corals (Sinularia, Palythoa)  
4 are more abundant. Exposure to severe wave action appears to limit coral development  
5 off these small islands and surrounding deep platforms. The lowest live coral values  
6 were concentrated at ocean facing reefs off Nihoa, Necker, Gardner, and Laysan  
7 Islands, which are more exposed to large waves and swells from any direction.  
8 (National Oceanic and Atmospheric Administration, 2005)

## 9 **Other Marine Life (Nihoa Island)**

10 Reef fish, sharks, jacks, and other predators are common to Nihoa Island. Due to a  
11 limited number of habitat types, however, species diversity of reef fishes is low when  
12 compared to other atolls and islands in the PMNM chain. Although Nihoa Island was  
13 populated during the 16<sup>th</sup> century, human disturbances have been minimal in the near  
14 shore waters around the island in recent times. (Papahānaumokuākea Marine National  
15 Monument, 2008)

16 The most common invertebrates found (excluding corals and other cnidarians) are the  
17 smaller encrusting species, such as sponges, ectoprocts (*bryozoans*), and tunicates.  
18 Large invertebrates are uncommon, except for a couple of species of rock-boring sea  
19 urchins and a starfish, shark, jack, monks seals, and other apex predators (predatory  
20 animals which are at the top of their food chain and are not normally preyed upon by  
21 other predators) that are common to the island. However, due to the limited number of  
22 habitat types, species diversity of reef fishes is low when compared to other atolls and  
23 islands in the NWHI (PMNM). (National Ocean Service, 2012)

## 24 **Threatened and Endangered Marine Wildlife Species**

### 25 *Hawaiian Monk Seal (Monachus schauinslandi)*

26 Nihoa Island supports a small population of endangered Hawaiian monk seals  
27 (*Monachus schauinslandi*) with limited reproduction, probably maintained by  
28 immigration from other breeding colonies. The endangered Hawaiian monk seal is an  
29 indigenous mammal that has been observed at Nihoa Island. Nihoa Island supports a  
30 small population of endangered Hawaiian monk seals with limited reproduction,  
31 probably maintained by immigration from other breeding colonies. (National Oceanic  
32 and Atmospheric Administration, 2013) The primary occurrence of Hawaiian monk  
33 seals within the region of influence is expected to be in a continuous band between  
34 Nihoa Island, Kaula, Niihau, and Kauai.

35 In PMNM (NWHI), there are eight discrete monk seal subpopulations from Nihoa Island  
36 to Kure Atoll (excluding Gardner Pinnacles and Maro Reef), a distance of 2,000 km  
37 (1,080 nm). (National Oceanic and Atmospheric Administration, undated).

38 Despite the fact that Hawaiian monk seals are one contiguous species, the  
39 subpopulations in PMNM (NWHI) and MHI face different threats. In PMNM (NWHI),

1 primary threats include food limitation for juveniles, shark predation on juveniles,  
 2 entanglement in marine debris, male seal aggression on females and juveniles, and  
 3 shoreline habitat loss. Threats in the MHI include disease and various types of human-  
 4 induced impacts, such as disturbance at haul-out areas, fishery interactions, feeding  
 5 and other interactions that cause habituation to humans, and most recently, intentional  
 6 killings. (National Oceanic and Atmospheric Administration, 2011) Table 3-5 lists the  
 7 threatened and/or endangered species known/expected to occur on Nihoa Island.

8 **Table 3-5. Listed Species Known/Expected to Occur On and Around Nihoa Island**

Scientific Name	Common Name	Federal Status
<b>Terrestrial</b>		
<b>Plants<sup>1</sup></b>		
<i>Pritchardia remota</i>	Loulu (Nihoa fan palm)	E
<i>Sesbania tomentosa</i>	`Ohai	E
<i>Amaranthus brownii</i>	No common name	E
<b>Birds</b>		
<i>Acrocephalus familiaris kingi</i>	Nihoa millerbird	E
<i>Telespyza ultima</i>	Nihoa finch	E
<b>Marine*</b>		
<b>Mammals</b>		
<i>Monachus schauinslandi</i>	Hawaiian monk seal	E

9 Source: U.S. Fish and Wildlife Service, 20003; National Oceanic and Atmospheric  
 10 Administration, 2006

11 1 Note: The entire island of Nihoa other than manmade features has been designated as  
 12 critical habitat for these plants.

13 Key to Federal Status:

14 \*See Table 3-2 for Cetacean, Pinnipeds, and Sea Turtles

15 E = Endangered

16

17 **3.2.2.1.2.3 Environmentally Sensitive Habitat Area**

18 An environmentally sensitive habitat area can be defined as a designated protective  
 19 area within the zone of a specific area (e.g., wetlands). The entire island of Nihoa other  
 20 than manmade features has been designated as critical habitat for the endangered  
 21 plants *Pritchardia remota*, *Sesbania tomentosa* and *Amaranthus brownii*. The 10 km<sup>2</sup>  
 22 (3 nm<sup>2</sup>) surrounding Nihoa is designated as a Special Management Area; the boundary  
 23 extends 5.5 km (3 nm) from shore.

24 **3.2.2.1.2.4 Seabirds**

25 Nihoa's seabird colony boasts one of the largest populations of Tristram's storm-petrel.  
 26 Bulwer's petrel, and blue noddies in the Hawaiian Islands, and very possibly the world.  
 27 The island is a unique example of a lowland native community, resembling those

1 lowland communities that once occurred on the MHI but are now almost completely  
2 gone (Wagner et al., 1990).

### 3 **3.2.2.1.3 Section 7 Consultation for Nihoa Island**

4 *U.S. Fish and Wildlife Service*

5 In accordance with Section 7 of the ESA, NASA initiated informal consultation *for the*  
6 *SEA* with NMFS on 9 January 2015 and with USFWS on 15 January 2015.

### 7 **3.2.2.1.4 Environmental Consequences**

#### 8 **Proposed Action**

9 The analytical approach for biological resources involved evaluating the degree to which  
10 the proposed activities could impact vegetation, wildlife, threatened or endangered  
11 species, and sensitive habitat within the affected area. Criteria for assessing potential  
12 impacts to biological resources are based on the following: the number or amount of the  
13 resource that would be impacted relative to its occurrence at the project site, the  
14 sensitivity of the resource to proposed activities, and the duration of the impact.  
15 Impacts are considered substantial if they have the potential to result in reduction of the  
16 population size of federally listed threatened or endangered species, degradation of  
17 biologically important unique habitats, substantial long-term loss of vegetation, or  
18 reduction in capacity of a habitat to support wildlife. The proposed activities of concern  
19 for analysis are ((1) expended flight hardware and (2) sea vessels and airplanes.

#### 20 **(1) Expended Flight Hardware (Including the Flight Train)**

##### 21 *Terrestrial Resources*

22 The primary concern regarding terrestrial resources would be the potential for SFDT  
23 hardware to crash, burn, and/or bury an individual endangered animals (Nihoa millerbird  
24 [*Acrocephalus familiaris kingi*], the Nihoa finch [*Telespyza ultima*]), Amaranthus brownii  
25 and endangered plants (Nihoa fan palm [*Pritchardia remota*] and Ohai [*Sesbania*  
26 *tomentosa*]) on Nihoa Island. The Nihoa finch's egg laying begins in February and may  
27 extend to early July, and the nesting season for the Nihoa millerbird is suspected to run  
28 from January to September. Up to two annual SFDT test flights would occur between  
29 June and August of each year, which could have an adverse environmental impact on  
30 the nesting season of both birds if the expended flight hardware landed on island.

31 To mitigate (reduce) the potential for environmental impact to Nihoa Island and the  
32 Special Management Area, one of two scenarios would occur: (1) the flight system  
33 would overfly the excluded area, and the Test Vehicle would be dropped outside 5.5 km  
34 (3 nm) from Nihoa Island; or (2) the LDSD Program would initiate the SFDT in such a  
35 manner that expended flight hardware would be recovered before drifting into the  
36 excluded area. Additionally, under the assumption that all possible trajectories were  
37 allowed to fly, NASA estimates that the balloon has approximately a 20 percent chance  
38 of entering PMNM after reaching float altitude and a 0.4 percent chance of reaching

1 float altitude within PMNM. These probabilities are further reduced when NASA and the  
2 U.S. Navy apply the project's established Go/No Go criteria.

3 If an unplanned scenario occurs (e.g., crash, fire) and there is indication of an adverse  
4 environmental impact, NASA would contact the Monument Permit Coordinator as soon  
5 as reasonably possible.

### 6 *Marine Resources*

7 The endangered Hawaiian monk seal has been observed at Nihoa Island. Nihoa Island  
8 supports a small population with limited reproduction. Potential adverse environmental  
9 effect would be associated with an unplanned scenario (anomalies) which would allow  
10 SFDT hardware to encounter a Hawaiian monk seal. However, one of two scenarios  
11 listed above would occur and the same probability assumption applied to terrestrial  
12 resources is applicable to the unexpected adverse environmental impacts to the  
13 Hawaiian monk seal. Therefore, based on the planned (nominal) trajectory, no potential  
14 adverse environmental impacts marine resources are expected. If an unplanned  
15 scenario occurs (e.g., crash, fire) and there is indication of an adverse environmental  
16 impact, NASA would contact the Monument Permit Coordinator as soon as reasonably  
17 possible.

18 Should either the Test Vehicle, balloon, or MET rockets land within terrestrial Hawaiian  
19 monk seal critical habitat, it would occupy a small portion of habitat that would have  
20 otherwise been available for pupping, basking, or resting. The physical impact of the  
21 descending items could crush shoreline vegetation or penetrate the surface of the  
22 beach (i.e., create a "divot"). However, such effects would be transient as all materials  
23 would be located and removed by the project as soon as practicable. Likewise, any  
24 physical disturbance created would be remediated to pre-project conditions.

25 Nonetheless, the potential for this stressor to occur would be highly unlikely. As  
26 discussed in Section 2.5 of the Biological Evaluation (Appendix D), Nihoa Island and its  
27 5.6-km (3-nm) buffer would be categorically avoided when conducting each SFDT.  
28 Under normal conditions, these areas would be overflown. It would only be in the case  
29 of a catastrophic failure of the flight system that flight hardware would descend into  
30 designated terrestrial critical habitat.

31  
32 The rigorous environment and isolated nature of Nihoa Island have limited the number  
33 of corals that have colonized in the shallow habitats encircling the island. Stony corals  
34 are less abundant and diverse and are not anticipated to be adversely affect by the  
35 Proposed Action. There are no endangered corals, fish, or other invertebrates found  
36 within the region of influence, and due to the limited habitat types, the diversity of fish  
37 and other invertebrates is also limited.

## 1 **(2) Seaborne Vessels and Aircraft**

2 NASA would utilize up to three seaborne vessels and up to two aircraft (see Table 3-4)  
3 during future campaigns to execute recovery operations immediately following each  
4 SFDT.

### 5 **Seaborne Vessels**

6 In general, very little data (largely anecdotal) exists regarding the reactions of seals to  
7 vessels; however available information suggests that seals are rather tolerant of them  
8 **(Richardson, et al., 1995)**. Based on the planned (nominal) trajectory, the test flights  
9 would not overfly Nihoa which would mitigate the need for the seaborne vessel or  
10 aircraft to sail near or fly over Nihoa Island. Given that the flight hardware would only  
11 land within or adjacent to terrestrial areas in the event of an unplanned flight termination  
12 scenario, the probability of the need for ship use in shallow waters around terrestrial  
13 areas (where seals would be hauled out) would be low. Additionally, because the  
14 terrestrial areas within the action area (e.g., Nihoa Island) are only home to a small  
15 number of monk seals, and since vessel operating protocols would be employed to  
16 avoid monk seals, the possibility of exposing an individual to a vessel-induced stressor  
17 such that a behavioral response is evoked is also considered very low.

### 18 **Aircraft**

19 If overflight of Nihoa Island is needed, one of two scenarios would occur: (1) the LDSD  
20 Program would initiate the SFDT in such a manner that expended flight hardware would  
21 be recovered before drifting into the excluded area; or (2) the flight system would overfly  
22 the excluded area, and the Test Vehicle would be dropped outside 5.5 km (3 nm) from  
23 Nihoa Island. With either scenario, the LDSD Program would mitigate the need to place  
24 seaborne vessel and aircraft inside or above the Special management Area.  
25 Additionally, given that the flight hardware would only land within or adjacent to  
26 terrestrial areas in the event of an off-nominal flight termination scenario, the probability  
27 of the need for repeated flights around terrestrial areas (where seals would be hauled  
28 out) would be low. Furthermore, because the terrestrial areas within the action area  
29 (e.g., Nihoa Island) are only home to a small number of monk seals, the possibility of  
30 exposing an individual to an aircraft-induced stressor such that a behavioral response is  
31 evoked is also considered very low. If an unplanned scenario occurs (e.g., plane crash,  
32 vessel run aground) and there is indication of an adverse environmental impact, NASA  
33 would contact the Monument Permit Coordinator as soon as reasonably possible.

34 Therefore, no potential adverse impacts to terrestrial and marine resources are  
35 expected from the utilization of the seaborne vessels and aircraft.

## 36 **3.2.2.2 Cultural Resources—Nihoa Island (Alternative 1—Proposed Action)**

### 37 **3.2.2.2.1 Regulatory Content**

38 The National Historic Preservation Act (NHPA) of 1966, as amended, outlines Federal  
39 policy to protect historic properties and promote historic preservation in cooperation with

1 other nations, Tribal governments, States, and local governments. Section 106 of the  
2 NHPA and its implementing regulations outline the procedures for Federal agencies to  
3 follow to take into account their actions on historic properties. Under Section 106,  
4 Federal agencies are responsible for identifying historic properties within the Area of  
5 Potential Effects for an undertaking, assessing the effects of the undertaking on those  
6 historic properties, if present, and considering ways to avoid, minimize, and mitigate any  
7 adverse effects.

#### 8 **3.2.2.2 Region of Influence**

9 The region of influence for cultural resources would be the approximately 70 hectares  
10 (170 acres) of land that constitute Nihoa Island. This island is the closest to the MHI.

#### 11 **3.2.2.3 Affected Environment**

12 A sacred place in the history and cosmology of Native Hawaiian people, Nihoa Island  
13 especially, is considered exceptional for its numerous and intact ritual sites (heiau—  
14 shrines) and its connection to living cultural traditions (National Park Service, n.d.). This  
15 remote land of rugged cliffs and steep valleys provided a home for Hawaiians between  
16 A.D. 1000 and A.D. 1700. (National Oceanic and Atmospheric Administration, 2014a)

17 In 1822, Queen Ka'ahumanu organized and participated in an expedition to locate and  
18 claim Nihoa under the Kamehameha Monarchy. Nihoa was reaffirmed as part of the  
19 existing territory of Hawai'i in 1856 by authority of Alexander Liholiho, Kamehameha IV  
20 (March 16, 1856, Circular of the Kingdom of Hawai'i). (PMNM, 2008) In 1997, the  
21 Native Hawaiian group Hui Mälama I Nä Kūpuna O Hawai'i Nei returned ancestral  
22 bones to Nihoa that had been removed from the island decades earlier. (National  
23 Oceanic and Atmospheric Administration, 2014a)

24 Nihoa also has a rich cultural heritage, with at least 88 known wahi kupuna (ancestral  
25 sites) constructed by the precontact Hawaiians who inhabited the island for 700 years  
26 (until 1700 A.D.), and is listed on the National Register of Historic Places.  
27 (Papahānaumokuākea Marine National Monument, 2008) The impressions left by  
28 ancient Hawaiians can be seen through the distinctive archaeology of Nihoa Island and  
29 Mokumanamana. The ceremonial terraces and platform foundations with upright stones  
30 found on both Nihoa Island and Mokumanamana are not only amazing examples of  
31 unique traditional Hawaiian architectural forms of stone masonry work, but they also  
32 show similarities to samples from inland Tahiti (Emory, 1928). The structures are some  
33 of the best preserved early temple designs in Hawai'i and have played a critical role in  
34 understanding Hawaii's strong cultural affiliation with the rest of Polynesia, and the  
35 significant role of Native Hawaiians in the migratory history and human colonization of  
36 the Pacific (Cleghorn, 1988).

37 The sites date from before the 13th century and include 25 to 35 house terraces, 15  
38 ceremonial structures, burial caves, bluff shelters, and agricultural terraces. As many  
39 as 175 people are estimated to have lived there during prehistoric times. Numerous

1 artifacts found on Nihoa establish a close relationship with Native Hawaiian culture in  
2 the MHI, and to the first settlers of Hawaii who sailed through the Pacific on large  
3 voyaging canoes. Because the island had sufficient soil and water for limited  
4 agriculture, Nihoa Island was a good place for voyagers to stop and resupply their  
5 canoes. This is evidenced by the remains of stone terraces that suggest an investment  
6 in agricultural food production (U.S. Department of Commerce, The Under Secretary of  
7 Commerce for Oceans and Atmosphere, 2007; Bishop Museum Fact Sheet, n.d).

#### 8 3.2.2.2.3.1 *Historic Buildings and Structures*

9 There are no modern historic buildings or structures on Nihoa Island; however, there  
10 are a number of pre-contact stone structures representing habitation, agricultural, and  
11 ceremonial features (Emory, 1928).

#### 12 3.2.2.2.3.2 *Traditional Resources (Including Burials)*

13 Among the recorded sites on Nihoa Island are religious and ceremonial features (cairns,  
14 terraces, stone platforms, upright stones, and burial sites) (Emory, 1928;  
15 TenBruggencate, 2005; U.S. Department of Commerce, The Under Secretary of  
16 Commerce for Oceans and Atmosphere, 2007).

17 There are no maritime heritage resources associated with Nihoa Island (National  
18 Oceanic and Atmospheric Administration (Graphic, 2014).

#### 19 **3.2.2.2.4 Environmental Consequences**

20 All identified cultural properties on Nihoa Island are situated some distance from the  
21 planned (nominal) trajectory of the Proposed Action. NASA estimates that the balloon  
22 has approximately a 0.4 percent chance of reaching float altitude within PMNM and a 20  
23 percent chance of entering PMNM after reaching float altitude. These probabilities are  
24 further reduced when NASA and the U.S. Navy apply the project's established Go/No  
25 Go criteria. Additionally, to further mitigate (reduce) the potential for environmental  
26 impact, Nihoa Island and the Special Management Area would be excluded and one of  
27 two scenarios would occur: one of two scenarios would occur: (1) the LDS Program  
28 would initiate the SFDT in such a manner that expended flight hardware would be  
29 recovered before drifting into the excluded area; or (2) the flight system would overfly  
30 the excluded area, and the Test Vehicle would be dropped outside 5.5 km (3 nm) from  
31 Nihoa Island.

32 Under unplanned (i.e., anomalous) scenarios, the Proposed Action has the potential for  
33 overflight of the Balloon and Test Vehicle over Nihoa Island and the Special  
34 Management Area [70 hectares (170 acres) of Nihoa Island and the approximately  
35 128.5 km<sup>2</sup> (37.5 nm<sup>2</sup>) Special Management Area within 5.5 km (3 nm) surrounding  
36 Nihoa Island]. In the highly unlikely probability that an unplanned scenario occurs (e.g.,  
37 crash, fire) and indication of a culturally or historically significant site is adversely  
38 impacted, NASA would contact the Monument Permit Coordinator as soon as  
39 reasonably possible. NASA understands that if an archeological activity needs to occur

1 in PMNM, it must be permitted and undergo a National Historic Preservation Act  
2 consultation prior to issuance of a PMNM permit. No Section 106 Consultation was  
3 required for this Proposed Action.

### 4 **3.3 ALTERNATIVE 2—ADDITIONAL LAUNCH YEARS**

#### 5 **3.3.1 REGION OF INFLUENCE**

6 The region of influence would be the same as that discussed in detailed the 2013 Final  
7 LDSD EA. This includes the Pacific region of PMRF (Section 3.1), Niihau (Section 3.2),  
8 the Open Ocean Area (Section 3.3) and the Global Environment (3.4).

#### 9 **3.3.2 AFFECTED ENVIRONMENT**

10 The corresponding 2013 EA section numbers are denoted in parentheses after each  
11 heading.

##### 12 **3.3.2.1 Pacific Missile Range Facility (Section 3.1: Page 3-1)**

13 The majority of PMRF's facilities and equipment are at the Main Base, which occupies a  
14 land area of 779 hectares (1,925 acres) and lies just south of Polihale State Park.  
15 PMRF/Main Base is generally flat and is approximately 0.8 km (0.5 mi) wide and 10.5  
16 km (6.5 mi) long with a nominal elevation of 4.6 m (15 ft) above mean sea level. PMRF  
17 is a multi-environment range capable of supporting surface, subsurface, air, and space  
18 events and activities simultaneously. (U.S. Department of the Navy, 2008)

##### 19 **3.3.2.2 Niihau (Section 3.2: Page 3-40)**

20 The only element of the LDSD Program with the potential to affect the island of Niihau is  
21 the possible overflight of the balloon and Test Vehicle and any effects of equipment or  
22 debris unexpectedly impacting the island. Although that potential is extremely unlikely,  
23 4 of the 14 areas of environmental consideration have been addressed in detail in this  
24 SEA.

##### 25 **3.3.2.3 Open Ocean Area (Section 3.3: Page 3-44)**

26 The Open Ocean Area for PMRF is the area that is greater than 22.2 kilometers (12 nm)  
27 offshore of the Hawaiian Islands. The Open Ocean Area also includes PMRF Warning  
28 Areas, Oahu Warning Areas, and the Temporary Operating Area (TOA). The Open  
29 Ocean Area, as part of the high seas (outside 22.2 km [12 nm] from land), is subject to  
30 Executive Order 12114. Both sea and air operations are covered in this section.

##### 31 **3.3.2.4 Global Environment (Section 3.4: Page 3-58)**

32 In addition to actions at PMRF, Niihau, and the Open Ocean, this SEA considered the  
33 environmental effects on the global environment in accordance with the requirements of  
34 EO 12114. Specifically, potential impacts on the global atmosphere are discussed.

1 **3.3.3 ENVIRONMENTAL CONSEQUENCES (CHAPTER 4: PAGES 4-1 THROUGH**  
2 **4-26)**

3 The environmental consequences for all affected environments are discussed and  
4 analyzed in detail in the 2013 Final EA and therefore incorporated by reference. The  
5 environmental consequences have been summarized under cumulative effects in  
6 Section 3.6.2 of this SEA.

7 **3.4 FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN**  
8 **MINORITY POPULATIONS AND LOW-INCOME POPULATIONS**  
9 **(EXECUTIVE ORDER 12898)**

10 An Environmental Justice analysis is included in this document to comply with the intent  
11 of EO 12898 and DoD guidance. The EO states that “each Federal agency shall make  
12 achieving environmental justice part of its mission by identifying and addressing, as  
13 appropriate, disproportionately high and adverse human health or environmental effects  
14 of its programs, policies, and activities on minority populations and low-income  
15 populations.” In addition, the EO requires that minority and low-income populations be  
16 given access to information and opportunities to provide input to decision-making on  
17 Federal actions.

18 Proposed activities would be conducted in a manner that would not substantially affect  
19 human health and the environment. This SEA has identified no human health or  
20 environmental effects that would result in disproportionately high or adverse effects on  
21 minority or low-income populations in the area.

22 The activities would also be conducted in a manner that would not exclude persons  
23 from participating in, deny persons the benefits of, or subject persons to discrimination  
24 because of their race, color, national origin, or socioeconomic status.

25 **3.5 FEDERAL ACTIONS TO ADDRESS PROTECTION OF CHILDREN**  
26 **FROM ENVIRONMENTAL HEALTH RISKS AND SAFETY RISKS**  
27 **(EXECUTIVE ORDER 13045, AS AMENDED BY EXECUTIVE ORDER**  
28 **13229)**

29 This SEA has not identified any environmental health and safety risks that may  
30 disproportionately affect children, in compliance with EO 13045, as amended by EO  
31 13229.

32 **3.6 CUMULATIVE EFFECTS**

33 The CEQ defines cumulative effects as “the impacts on the environment which result  
34 from the incremental impact of the actions(s) when added to other past, present, and  
35 reasonably foreseeable future actions regardless of what agency (Federal or non-  
36 Federal) or person undertakes such other actions” (40 CFR 1508.7). Cumulative

1 impacts result when the effects of an action are added to or interact with other effects in  
 2 a particular place and within a particular time. It is a combination of these effects and  
 3 the resulting environmental degradation that should be the focus of the cumulative  
 4 effects analysis (U.S. Environmental Protection Agency, 1999). The Proposed Action,  
 5 to be implemented over approximately the next 5 years, includes all of the projects  
 6 associated with additional projects at or associated with PMNM and PMRF. While a  
 7 single project may individually have minor impacts, when it is considered together with  
 8 other projects on a regional scale, the effect may be collectively significant. A  
 9 cumulative impact is the additive effect of all projects in the geographic area. Other  
 10 projects for PMNM and PMRF that are likely to result in cumulative impacts over the  
 11 next 3 years are provided in Table 3-6.

12 **Table 3-6. Past and Proposed Projects**

Project	Related Project Location	Project Sponsor	Project Description	Project Completion Date	Relevance to LDS Program
Pending Permits	PMNM		Projects may allow additional peoples and boats in the area	Ongoing	Additive
AUV Sentry & Sikuliaq Vessel Entry	PMNM	Florida State University University of Alaska-Fairbanks	Research using an Autonomous Unmanned Vehicle within PMNM	2016	Additive
Air Traffic	PMNM Open Ocean Area	FAA	N/A	Continuous	Additive
Commercial Shipping	Open Ocean Area	PMNM/DOT/ Dept. of Commerce	N/A	Continuous	Additive
ORS-Super Strypi Proof-of-Principle Satellite Launches	PMRF	Operationally Responsive Space (ORS)	Launching two proof-of-principle launch vehicles from PMRF, Kauai, Hawaii. The Proposed Action would reestablish a rail launcher at Kokole Point to support the development of a sun-synchronous and/or polar orbit launch site, establish and demonstrate space launch capabilities in Hawaii with the flights for the Super Strypi Project.	2015	Additive

13

1 **Cumulative Impact Analysis**

2 This section addresses the additive effects of the Proposed Action in combination with  
3 the projects identified in Table 3-6. Since environmental analyses for some of the  
4 projects listed are not complete or do not include quantitative data, cumulative  
5 environmental impacts are addressed qualitatively and are described below.

6 **3.6.1 ALTERNATIVE 1**

7 **Air Quality**

8 No significant adverse impacts to air quality are anticipated as a result of the Proposed  
9 Action. The location of PMNM is remote and vast, and access is regulated resulting in  
10 minimal accesses per year. On average 17 vessel entries and exits occur each year  
11 and 50 flights per year. Two runways were operational within PMNM (Midway Atoll and  
12 Tern Island, French Frigate Shoals) until 2011. In 2011 the runway on Tern Island was  
13 closed, leaving only one operational runway within PMNM (located on Midway Atoll).  
14 As a result, the number of flights drastically decreased starting in 2012 and is expected  
15 to either remain the same or decrease in future years. In addition, emissions resulting  
16 from vessel operations are minimal and result in no known cumulative impacts to the  
17 environment, especially given the remote location and relatively pristine environment.  
18 Therefore, the Proposed Action would not result in cumulative impacts.

19 **Biological Resources**

20 NASA does not anticipate direct, indirect, secondary, or cumulative effects to biological  
21 or cultural resources within the affected environment. Up to two LDSD vehicles test  
22 flights would be launched annually from PMRF beginning with the June to August 2015  
23 timeframe through the June to August 2019 timeframe. Entry into the eastern part of  
24 PMNM would be on an as-needed basis only. If entered, NASA would make every  
25 effort to limit the time spent within the easternmost part of PMNM. Analogous to the  
26 2014 demonstration mission, NASA would deploy three recovery vessels immediately  
27 upon splashdown of the scientific balloon and Test Vehicle; the vessels would be  
28 directed to the different floating hardware locations to begin recovery. During the 2014  
29 mission, it took the respective vessels approximately 5 hours to reach and recover the  
30 ring-sail parachute, 6.5 hours to reach and recover the balloon, and 4 hours to reach  
31 and recover the Test Vehicle.

32 In the short and long term, NASA would continue to follow the terms and conditions of  
33 its Conservation and Management permit, the 2013 LDSD Final EA, and this SEA.  
34 When considered collectively, no cumulative effects are anticipated as a result of the  
35 Proposed Action.

36 **Cultural Resources**

37 When reviewed against past, present, and reasonably foreseeable projects at PMNM,  
38 this project would not have an appreciable cumulative effect. There are no known  
39 submerged features that might be within this effected environment. For those areas  
40 identified under this Proposed Action (crash, fire) that have the potential to adversely

1 impact cultural material on Nihoa Island due to an extremely unlikely overflight of the  
2 island, NASA would contact the Monument Permit Coordinator as soon as reasonably  
3 possible. NASA understands that Nihoa Island is a sacred place in the history and  
4 cosmology of Native Hawaiian people; Nihoa Island, especially, is considered  
5 exceptional for its numerous and intact ritual sites (heiau—shrines) and its connection to  
6 living cultural traditions.

### 7 **3.6.2 ALTERNATIVE 2**

8 Under Alternative 2, NASA would conduct the Proposed Action as detailed in the 2013  
9 LDSF Final EA and with the clarification that some recovery aids discussed in that EA  
10 may or may not be employed. The proposed test campaign for Alternative 2 would  
11 consist of launch, operation, and recovery of up to two missions per year over the next 5  
12 years (June 2015–August 2019) from a designated location on PMRF using the flight  
13 trajectory outlined in the 2013 LDSF Final EA. Under Alternative 2, Sections 2.2.2.1  
14 (Operational Facilities) and 2.4.2 (Launch Operation) of this SEA would apply.  
15 Analyses for the affected environments were detailed in the 2013 LDSF Final EA, and  
16 results are incorporated by reference. The corresponding 2013 Final EA section  
17 numbers are denoted in parentheses after each heading. Table ES-2 is a summary of  
18 the cumulative effects associated with 5 additional years of SFDT launches from PMRF.

### 19 **Pacific Missile Range Facility (Pages 4-1 through 4-15)**

20 Based on the analysis of resources analyzed and presented in the 2013 LDSF Final EA  
21 for PMRF (air quality [4.1.1], airspace [4.1.2], biological resources [4.1.3], hazardous  
22 materials and waste [4.1.4], health and safety [4.1.5], socioeconomics [4.1.6], and water  
23 resources [4.1.7]), negligible temporary increases would occur in emissions, and  
24 activities would be minor and transitory; airspace would continue to be coordinated  
25 through the FAA; the addition of 10 flights over 5 years and other activities combined  
26 would be performed at varying times and locations on PMRF and should have negligible  
27 adverse cumulative environmental impacts on biological resources; pre-launch and  
28 launch activities represent routine types of hazardous material and waste as well as  
29 health and safety activities at PMRF, and as a result, no substantial adverse  
30 environmental impacts from the management of SFDT project related hazardous  
31 materials and waste and routinely provided safety support are anticipated. There would  
32 continue to be no negative environmental impacts on the permanent population size,  
33 employment characteristics, schools, and type of housing available on island. The  
34 amount of exhaust products from the SFDT that could potentially be deposited due to  
35 the launch activity would be small, and no cumulative impacts are expected. The Test  
36 Vehicle hardware, debris, and propellants that could fall into the ocean are expected to  
37 have only a localized, short-term effect on water quality.

### 38 **Niihau (Pages 4-16 through 4-18)**

39 Based on the analysis of resources analyzed and presented in the 2013 LDSF Final EA  
40 for Niihau (airspace [4.2.1], biological resources [4.2.2], cultural resources [4.2.3], and  
41 health and safety [4.2.4]), the additional LDSF launches may still require overflight of

1 Niihau. The overflight is not anticipated to result in adverse environmental impacts to  
2 the airspace over Niihau; is not anticipated to environmentally impact biological and  
3 cultural resources on the island; and all missions or projects are closely reviewed and  
4 analyzed to ensure that there are no unacceptable risks to the public, Government and  
5 military personnel, and contractors.

#### 6 **Open Ocean Area (Pages 4-18 through 4-18)**

7 Based on the analysis of resources analyzed and presented in the 2013 LDSD Final EA  
8 for the Open Ocean Area (airspace [4.3.1], biological [4.3.2], cultural [4.3.3], hazardous  
9 materials and waste [4.3.4], health and safety [4.3.5], and water resources [4.3.6]), the  
10 launch activity will continue the use of the required scheduling and coordination process  
11 for area airspace, and adherence to applicable DoD directives and FAA regulations.  
12 The proposed activities would not result in any direct environmental impacts on coral or  
13 degradation of water/sediment quality in the vicinity of corals. Any submerged features  
14 that might be within this area are at considerable depth, and the potential for  
15 disturbance is extremely remote. The implementation of Alternative 2 would not  
16 introduce new types of hazardous materials and waste into the Open Ocean Area, and  
17 only small increases in quantities of previously introduced types of hazardous wastes  
18 are expected. For health and safety, rocket launches are short-term, discrete events  
19 that are actively managed by PMRF range safety. The launch activities would not be  
20 scheduled to occur at the same time as other launch programs. The effect of any rocket  
21 motor emission products deposited in the open ocean would be very transient due to  
22 the buffering capacity of sea water and dilution by current ocean mixing and would not  
23 be expected to result in any cumulative adverse effects.

#### 24 **Global Environment**

25 Because the LDSD launches would release little or no ozone depleting substance, there  
26 would be no adverse cumulative environmental impacts on the stratospheric ozone  
27 layer.

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## **5.0 List of Preparers**

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# 5.0 LIST OF PREPARERS

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Years of Experience: 25

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B.S., 1976 Geology, Northern Arizona University  
Years of Experience: 38

1 **KFS, LLC**

2

3 Edd V. Joy, Senior Environmental Program Manager, KFS, LLC

4 B.A., 1974, Geography, California State University, Northridge

5 Years of Experience: 41

DRAFT

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## **6.0 Agencies and Individuals Contacted**

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# 6.0 AGENCIES AND INDIVIDUALS CONTACTED

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2

3 NEPA regulations require that Federal, State, and local agencies with jurisdiction or  
4 special expertise regarding environmental impacts be consulted and involved in the  
5 NEPA process. Agencies involved include those with authority to issue permits,  
6 licenses, and other regulatory approvals. Other agencies include those responsible for  
7 protecting significant resources such as endangered species or wetlands. The  
8 agencies listed below were contacted during the preparation of this SEA.

## 9 **Federal**

10 Federal Aviation Administration  
11 Honolulu Control Facility

12 U.S. Fish and Wildlife Service  
13 Pacific Islands Office

14 National Marine Fisheries Service  
15 Pacific Islands Office

16 United States Navy, Pacific Missile Range Facility  
17 Kauai, HI

18 National Oceanic and Atmospheric Administration Office of National Marine  
19 Sanctuaries, Permit and Policy Office  
20 Honolulu, HI

## 21 **State**

22 The Office of Hawaiian Affairs  
23 Honolulu Headquarters

24 State Historic Preservation Division  
25 Department of Land and Natural Resources

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# **Appendix A Distribution List**

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# APPENDIX A DISTRIBUTION LIST

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## **Federal**

Federal Aviation Administration  
Honolulu Control Facility  
760 Worchester Ave  
Honolulu, HI 96818

U.S. Fish and Wildlife Service  
Pacific Islands Office  
300 Ala Moana Blvd.  
P.O. Box 500888  
Honolulu, HI 96850

National Marine Fisheries Service  
Pacific Islands Office  
1601 Kapiolani Blvd, Suite 1110  
Honolulu, HI 96814-4700

## **State**

The Office of Hawaiian Affairs  
Honolulu Headquarters  
711 Kapiolani Blvd, Suite 500  
Honolulu, HI 96813

State Historic Preservation Division  
Department of Land and Natural Resources  
601 Kamokila Blvd, Suite 555  
Kapolei, HI 96707

## **Libraries**

Waimea Public Library  
9750 Kaumualii Highway  
Waimea, Kauai, HI 96796

1 Hawaii State Library  
2 Hawaii and Pacific Section Document Unit  
3 478 South King Street  
4 Honolulu, Oahu, HI 96813-2994

5 Lihue Public Library  
6 4344 Hardy Street  
7 Lihue, Kauai, HI 96766

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## **Appendix B Correspondence**

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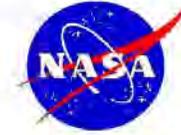
# APPENDIX B

## CORRESPONDENCE

National Aeronautics and  
Space Administration  
Mission Support Directorate

**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to AltN of AI020

February 27, 2015

Mr. Neil Okuna  
Federal Aviation Administration  
Honolulu Control Facility  
760 Worcester Ave  
Honolulu, HI 96818

**SUBJECT:** National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment

Dear Mr. Okuna:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA). Because the proposed launch requires routine coordination between PMRF and the Federal Aviation Administration (FAA) for established area airspace, NASA is providing the enclosed Draft SEA (DSEA).

NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDI) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM) and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on previously disturbed land.

The balloon, Test Vehicle, and parachute would be recovered. The DSEA identifies and evaluates the potential for environmental impacts to the Open Ocean Area of PMNM and Nihoa Island. Because of the established coordination process between PMRF and the FAA for area airspace, and adherence to applicable Department of Defense (DoD) directives and FAA regulations concerning issuance of Notices to Airmen (NOTAMs) and selection of launch areas and trajectories, the potential for any environmental impacts is minimal.

To ensure that any concerns you might have about our efforts to identify issues and assess potential environmental impacts are fully addressed, please review the DSEA and provide any written comments on the enclosed comment form by March 27, 2015. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (Hard Copy and CD)

cc:

HDLNR\Mr. W. Aila  
NMFS\Dr. S. Kolinski  
NMS\Ms. T. Brown  
OHA\Ms. C. Machado  
USFWS\Dr. D. Polhemus

National Aeronautics and  
Space Administration  
Mission Support Directorate

**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to ATM of: AI020

February 27, 2015

Dr. Steven Kolinski  
National Marine Fisheries Service  
Pacific Islands Region Office  
1601 Kapiolani Blvd, Suite 1110  
Honolulu, HI 96814-4700

**SUBJECT:** National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment

Dear Dr. Kolinski:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA). Because the proposed LDSD activities would occur in the Pacific Ocean, the enclosed Draft SEA (DSEA) is being distributed to your office for review and comment.

NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDI) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM) and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on previously disturbed land.

The balloon, Test Vehicle, and parachute would be recovered. The DSEA identifies and evaluates the potential for environmental impacts to the Open Ocean Area of PMNM and Nihoa Island. The affected area for any potential biological resource impacts includes the open ocean area within and outside of PMNM that could be affected by proposed activities, possible expended flight hardware, seaborne vessel and aircraft and over-flight of Nihoa Island.

No impacts on sensitive marine species protected by the Marine Mammal Protection Act are planned. No impacts on listed threatened or endangered marine species or critical habitat protected by the Endangered Species Act are planned. Balloon over-flight of Nihoa Island is not expected to affect marine species or the Hawaiian monk seal.

Although a direct hit from a LDSD balloon, Test Vehicle, or parachute would affect a sea turtle or marine mammal, or marine species at the surface, it is extremely unlikely that this would occur due to the relatively low density of marine species present, the limited number of test events, and the size of the ocean area that would be potentially affected. By the time the spent rocket motors impact in the open ocean, generally all of the propellants in them have burned. Any residual aluminum oxide, burned hydrocarbons, or propellant materials are not expected to present toxicity concerns. The Proposed Action would not result in any impacts on coral, degradation of water/sediment quality near the corals, or essential fish habitat.

NASA has determined that the proposed action would not jeopardize any listed threatened or endangered species or critical habitat. Also NASA has determined that the proposed action for the reasons mentioned above would be extremely unlikely to result in the take of a marine mammal protected under the Marine Mammal Protection Act. Therefore, an incidental take permit would not be required.

To ensure that any concerns you might have about our efforts to identify issues and assess potential environmental impacts are fully addressed, please review the DSEA and provide any written comments on the enclosed comment form by March 27, 2015. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (hardcopy and CD)

cc:

FAA\Mr. N. Okuna  
HDLNR\Mr. W. Aila  
NMS\Ms. T. Brown  
OHA\Ms. C. Machado  
USFWS\Dr. D. Polhemus

National Aeronautics and  
Space Administration  
Mission Support Directorate

**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to Attn of AI020

February 27, 2015

Ms. Colette Machado, Chairperson  
The Office of Hawaiian Affairs, Honolulu Headquarters  
711 Kapiolani Blvd., Suite 500  
Honolulu, HI 96813

**SUBJECT:** National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment

Dear Ms. Machado:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA). Because the DSEA considers the potential for impacts on archaeological, historical, and traditional Native Hawaiian resources, and in accordance with the National Historic Preservation Act and its implementing regulations 36 Code of Federal Regulations (CFR) 800, NASA is providing the enclosed Draft SEA (DSEA) for your review.

NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDT) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM), and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on previously disturbed land. The Area of Potential Effects (APE) for cultural resources encompasses the over-flight of Nihoa Island.

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Based on a review of cultural resources surveys, NASA has determined that no archaeological/traditional Native Hawaiian sites or historic properties will be affected by the proposed LDSD activities. There are also no ground disturbing activities associated with this Proposed Action.

To ensure that any concerns you might have about our efforts to identify issues and assess potential environmental impacts are fully addressed, please review the DSEA and provide any written comments on the enclosed comment form by March 27, 2015. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (hardcopy and CD)

cc:

FAA\Mr. N. Okuna  
HDLNR\Mr. W. Aila  
NMPF\Dr. S. Kolinski  
NMS\Ms. T. Brown  
USFWS\Dr. D. Polhemus

National Aeronautics and  
Space Administration  
Mission Support Directorate

**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to Attn of AI020

February 27, 2015

Mr. William J. Aila, Jr.  
State Historic Preservation Division  
Department of Land and Natural Resources  
601 Kamokila Boulevard, Suite 555  
Kapolei, HI 96707

**SUBJECT:** National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment

Dear Mr. Aila:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA).

In accordance with Section 106 of the National Historic Preservation Act and its implementing regulations 36 CFR 800, NASA seeks your concurrence and comments on the proposed launch, operation, and recovery of the LDSD test campaign at PMRF on Nihoa Island and the Open Ocean Area. NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDT) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM), and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on

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previously disturbed land. The 2013 Final LDSD was submitted to your office for review and comment that addressed the existing facilities and/or previously disturbed land.

NASA has prepared the attached Draft Supplemental Environmental Assessment (DSEA) in compliance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 4321 et seq.). The DSEA outlines the proposed action and its potential environmental effects. The proposed undertaking is similar to other launches by the Navy and other entities at PMRF.

The purpose of the SFDT campaign of LDSD is to demonstrate and evaluate development of new supersonic inflatable aerodynamic decelerator (SIAD) and supersonic ringsail (SSRS) parachute technologies. These tests would allow the SIAD and SSRS parachute to fly in the Earth's stratosphere at supersonic speed to simulate operation in the thin atmosphere of Mars or other similar planets.

The Area of Potential Effects (APE) encompasses the Open Ocean Area and possible balloon over-flight of Nihoa Island (please see attached figure). Based on a review of cultural resources surveys, NASA has determined that no archaeological/traditional Native Hawaiian sites or historic properties will be affected by the proposed LDSD activities. There are also no ground disturbing activities associated with this Proposed Action.

NASA's proposed LDSD mission will support ambitious new robotic missions to Mars and other planetary bodies and will lay the groundwork for even more complex human and science explorations in the future. NASA has continuously used a parachute-based deceleration system since the Viking Program, which put two landers on Mars in 1977. New technology beyond the current parachute-based deceleration systems is needed to slow even larger, heavier landers from the supersonic speeds of atmospheric entry to subsonic surface-approach speeds for these other planetary bodies. The LDSD will test new parachute technology to further space exploration.

NASA's LDSD DSEA addresses all of the reasonably foreseeable activities in the particular geographical areas affected by the Proposed Action and the No-action Alternative and focuses on those activities ready for Federal and resource agency decisions. NASA anticipates no land disturbance activities that might affect cultural resources and intends to carry out its activities much the same way PMRF regularly conducts launch tests. The Department of the Navy (DON) and PMRF previously conducted the Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (HRC EIS/OEIS) (May 2008) outlining the use of the Hawaii Range, which was concurred on by your office.

Based on the analysis in the DSEA and coordination with the DON/PMRF, NASA has determined that there will be no historic properties affected by the proposed undertaking and seeks your concurrence. If NASA does not receive any further comment from your office on the proposed undertaking within 30 days, we will assume concurrence with our determination. The Draft SEA (DSEA) is enclosed for your review. Please provide any written comments on the DSEA by March 27, 2015, using the enclosed comment form. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,

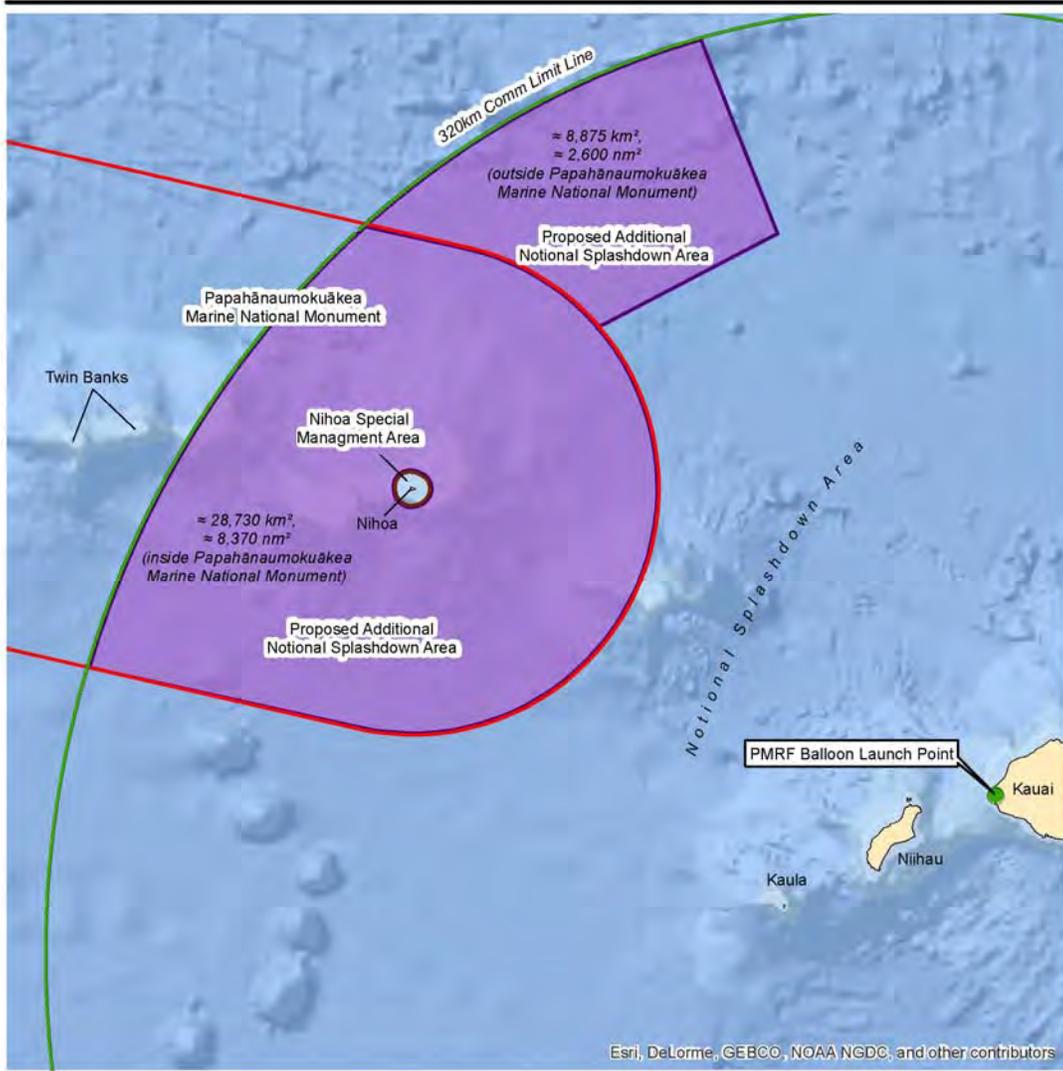


Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (hardcopy and CD)

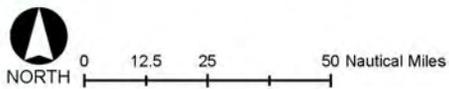
cc:

FAA\Mr. N. Okuna  
NMFS\Dr. S. Kolinski  
NMS\Ms. T. Brown  
OHA\Ms. C. Machado  
USFWS\Dr. D. Polhemus



**EXPLANATION**

- PMRF Balloon Launch Point
- 320-km Communications Limit Line
- Proposed Additional Notional Splashdown Area
- Nihoa 3-nautical mile Special Management Area
- Papahānaumokuākea Marine National Monument



**Proposed Additional  
Splashdown Area**

PMRF, Niihau, and Open Ocean

**Figure 1-5**

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National Aeronautics and  
Space Administration  
Mission Support Directorate



**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099

Reply to Attn of: AI020

February 27, 2015

Dr. Dan Polhemus  
U.S. Fish and Wildlife Service  
Pacific Islands Fish and Wildlife Office  
P.O. Box 500888  
Honolulu, HI 96850

**SUBJECT: National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment**

Dear Dr. Polhemus:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA). Because the proposed LDSD activities have the potential for over-flight of Nihoa Island, the enclosed Draft SEA (DSEA) is being distributed to your office for review and comment.

NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDT) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM), and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on previously disturbed land.

1  
2

The DSEA identifies and evaluates the potential for environmental impacts to the Open Ocean and Nihoa Island. As described in the DSEA, the affected area for any potential biological resource impacts includes the area within the property boundary that could be affected by possible balloon over-flight of Nihoa Island, and areas of the Pacific Ocean.

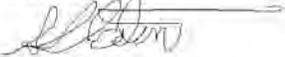
The potential impacts of the proposed activities on Nihoa Island terrestrial and marine biological resources are expected to be minimal. Balloon over-flight of Nihoa Island is not expected to affect plant or wildlife species on the island. The activities would incorporate procedures to avoid threatened or endangered wildlife that are foraging, resting, or hauled out, such as the endangered Hawaiian monk seal. NASA has determined that the proposed action will not jeopardize any listed threatened or endangered species or critical habitat. In conjunction with the DSEA, NASA is currently preparing a Biological Evaluation for your review and concurrence.

To ensure that any concerns you might have about our efforts to identify issues and assess potential environmental impacts are fully addressed, please review the DSEA and provide any written comments on the enclosed comment form by March 27, 2015. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (hardcopy and CD)

cc:

FAA\Mr. N. Okuna  
HDLNR\Mr. W. Aila  
NMFS\Dr. S. Kolinski  
NMS\Ms. T. Brown  
OHA\Ms. C. Machado

National Aeronautics and  
Space Administration  
Mission Support Directorate



**NASA Management Office**

4800 Oak Grove Drive  
Pasadena, CA 91109-8099

Reply to Ath of: AI020

February 27, 2015

Ms. Tia Brown  
Permit and Policy Coordinator  
NOAA Office of National Marine Sanctuaries  
Papahānaumokuākea Marine National Monument  
1845 Wasp Blvd. Building 176  
Honolulu, HI 96818

**SUBJECT: National Aeronautics and Space Administration Low-Density Supersonic  
Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental  
Assessment**

Dear Ms. Brown:

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA). Because the proposed LDSD activities have the potential for over-flight of Nihoa Island, the enclosed Draft SEA (DSEA) is being distributed to your office for review and comment.

NASA is proposing to use an additional 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>) of splashdown area for future supersonic flight dynamic tests (SFDI) test flights. Of the approximately 37,600 km<sup>2</sup> (10,950 nm<sup>2</sup>), approximately 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) is Open Ocean Area within Papahānaumokuākea Marine National Monument (PMNM), and the other approximately 8,875 km<sup>2</sup> (2,600 nm<sup>2</sup>) of Open Ocean Area is north of PMNM. NASA submitted a Conservation and Management Permit requesting authorization for use of the 28,730 km<sup>2</sup> (8,370 nm<sup>2</sup>) of Open Ocean Area within PMNM. If granted, the PMNM Conservation and Management Permit would authorize entry, splashdown, and recovery of expended flight hardware within PMNM.

This proposed test campaign would consist of launch, operation, and recovery of up to two missions per year for the next 5 years from a designated location on PMRF. The Test Vehicle with its small solid rocket motor would be launched on a high altitude balloon from PMRF. The majority of activities would use existing facilities and/or be on previously disturbed land. The DSEA identifies and evaluates the potential for

environmental impacts to the Open Ocean (air quality, biological resource, and cultural resources) and Nihoa Island (biological resource, cultural resources, and health and safety).

No impacts on sensitive marine species protected by the Marine Mammal Protection Act are planned in the Open Ocean Area. No impacts on listed threatened or endangered marine species or critical habitat protected by the Endangered Species Act are planned in the Open Ocean Area. The potential impacts of the proposed activities on Nihoa Island terrestrial and marine biological resources are expected to be minimal. Balloon over-flight of Nihoa Island is not expected to affect plant or wildlife species on the island. The activities would incorporate procedures to avoid threatened or endangered wildlife that are foraging, resting, or hauled out, such as the endangered Hawaiian monk seal. NASA has determined that the proposed action will not jeopardize any listed threatened or endangered species or critical habitat.

To ensure that any concerns you might have about our efforts to identify issues and assess potential environmental impacts are fully addressed, please review the DSEA and provide any written comments on the enclosed comment form by March 27, 2015. Comments can be e-mailed to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

If you or any other staff have questions on the DSEA, please contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Sincerely,



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosure: DSEA and Comment Form (hardcopy and CD)

cc:

FAA\Mr. N. Okuna  
HDLNR\Mr. W. Aila  
NMFS\Dr. S. Kolinski  
OHA\Ms. C. Machado  
USFWS\Dr. D. Polhemus

National Aeronautics and  
Space Administration  
Mission Support Directorate

NASA Management Office  
180-801  
4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to Attn of: AI020

DATE: February 27, 2015

**SUBJECT:** NASA Supplemental Environmental Assessment for the Low Density Supersonic  
Decelerator (LDSD) Project

To Whom It May Concern:

Please provide space in your library or offices for public access to the enclosed National Aeronautics and Space Administration Low Density Supersonic Decelerator Test – Pacific Missile Range Facility Draft Supplemental Environmental Assessment (DSEA). The DSEA will be available for public access and review through **March 27, 2015**.

The document and a blank comment form are also available on the internet at  
<https://www.govsupport.us/nasaldsdsea>

Anyone wishing to provide comments can do so in one of three ways:

1. E-mail comments to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).
2. Mail comments to:

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109

Comments should be received no later than **March 27, 2015**. Questions and comments regarding the DSEA, or requests for additional copies, can be sent to [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

A handwritten signature in black ink, appearing to read "Steve Slaten".

Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosures: One hardcopy and 1 CD of DSEA and Comment Form

National Aeronautics and  
Space Administration  
Mission Support Directorate

NASA Management Office  
180-801  
4800 Oak Grove Drive  
Pasadena, CA 91109-8099



Reply to Attn. of: A1020

DATE: February 27, 2015

**SUBJECT:** NASA Draft Supplemental Environmental Assessment for the Low Density Supersonic Decelerator (LDSD) Project

The National Aeronautics and Space Administration (NASA) prepared a Final Environmental Assessment (EA) and issued a Finding of No Significant Impact (FONSI) in May 2013 which evaluated and addressed the potential environmental consequences of conducting the proposed launch, operation, and recovery of the Low Density Supersonic Decelerator (LDSD) Technology Demonstration Mission (TDM) test flights at the U.S. Navy's Pacific Missile Range Facility (PMRF) on Kauai, Hawaii. Based on information gleaned from the first test, NASA is preparing a Supplemental Environmental Assessment (SEA), in accordance with the following statutes, regulations, and procedures:

- National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 4321 et seq.);
- Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508);
- NASA NEPA Implementing Regulation (Subpart 1216.3);
- NASA Procedural Requirement 8580.1, NASA National Environmental Policy Act Management Requirements;
- Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions;
- Presidential Proclamation, 8031 Establishment of the Northwestern Hawaiian Islands Marine National Monument; and
- 50 CFR Part 404, Northwestern Hawaiian Islands Marine National Monument.

The NASA LDSD SEA analyzes potential environmental consequences (environmental impacts) of changes planned for future campaigns. These changes consist of two alternatives. Alternative 1 consists of using an additional open ocean splashdown area within and outside of Papahānaumokuākea Marine National Monument (PMNM), and Alternative 2 consists of adding additional launch years to the 2013 Final EA. For Alternative 1 (preferred alternative), these changes consist of (1) permit authorization (issuance of which is contingent upon final approval of this SEA and associated FONSI) for flight hardware to potentially fly over, splashdown, and be recovered (except the balloon flight train, which would rapidly sink in the open ocean) within the easternmost part of PMNM; and (2) perform up to two LDSD TDM test flights annually over the next 5 years, starting in June 2015 and ending in August 2019. For Alternative 2, these changes consist of additional testing of up to two missions per year over the next 4 years (June 2016–August 2019) from a designated location on

1  
2  
3

PMRF using the flight trajectory outlined in the 2013 LDSD Final EA. This document and a blank comment form are also available online at:  
[http://sites.vff.nasa.gov/code250/docs/NASA\\_LDSD\\_DSEA.pdf](http://sites.vff.nasa.gov/code250/docs/NASA_LDSD_DSEA.pdf).

Please provide your written comments on this Draft SEA (DSEA) by March 27, 2015, using the enclosed comment form. Comments may be submitted contact Steve Slaten, Jet Propulsion Laboratory Facilities and Environmental Manager at the following address or by calling (818) 393-6683, or by email at [sslaten@nasa.gov](mailto:sslaten@nasa.gov).

Mr. Steven W. Slaten  
NASA Management Office Environment and Facilities Manager  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
MS 180-801  
Pasadena, CA 91109



Steve Slaten  
Environmental and Facilities Manager  
NASA Management Office

Enclosures: One hardcopy and 1 CD of DSEA and Comment Form

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**Appendix C**  
**PMNM Conservation and Management**  
**Permit Application**

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**Papahānaumokuākea Marine National Monument**  
CONSERVATION AND MANAGEMENT Permit Application

**NOTE:** *This Permit Application (and associated Instructions) are to propose activities to be conducted in the Papahānaumokuākea Marine National Monument. The Co-Trustees are required to determine that issuing the requested permit is compatible with the findings of Presidential Proclamation 8031. Within this Application, provide all information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Papahānaumokuākea Marine National Monument (Monument).*

**ADDITIONAL IMPORTANT INFORMATION:**

- Any or all of the information within this application may be posted to the Monument website informing the public on projects proposed to occur in the Monument.
- In addition to the permit application, the Applicant must either download the Monument Compliance Information Sheet from the Monument website OR request a hard copy from the Monument Permit Coordinator (contact information below). The Monument Compliance Information Sheet must be submitted to the Monument Permit Coordinator after initial application consultation.
- Issuance of a Monument permit is dependent upon the completion and review of the application and Compliance Information Sheet.

**INCOMPLETE APPLICATIONS WILL NOT BE CONSIDERED**

Send Permit Applications to:

NOAA/Inouye Regional Center

NOS/ONMS/PMNM/Attn: Permit Coordinator

1845 Wasp Blvd, Building 176

Honolulu, HI 96818

nwhipermit@noaa.gov

PHONE: (808) 725-5800      FAX: (808) 455-3093

**SUBMITTAL VIA ELECTRONIC MAIL IS PREFERRED BUT NOT REQUIRED. FOR ADDITIONAL SUBMITTAL INSTRUCTIONS, SEE THE LAST PAGE.**

## **Papahānaumokuākea Marine National Monument Permit Application Cover Sheet**

This Permit Application Cover Sheet is intended to provide summary information and status to the public on permit applications for activities proposed to be conducted in the Papahānaumokuākea Marine National Monument. While a permit application has been received, it has not been fully reviewed nor approved by the Monument Management Board to date. The Monument permit process also ensures that all environmental reviews are conducted prior to the issuance of a Monument permit.

### **Summary Information**

**Applicant Name:** David Wilcox

**Affiliation:** National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF) Range and Mission Management Office (RMMO), Low Density Supersonic Decelerators (LDSD) Project, Project Manager (GS15)

**Permit Category:** Conservation and Management

**Proposed Activity Dates:** every June 1 through August 31, 2015 - 2019

**Proposed Method of Entry (Vessel/Plane):** up to 3 commercial vessels & 2 Navy aircraft

**Proposed Locations:** within a 320 kilometer (approximately 200 mile) arc centered on Makaha Ridge, Kauai

**Estimated number of individuals (including Applicant) to be covered under this permit:**  
35

**Estimated number of days in the Monument:** 8

**Description of proposed activities:** (complete these sentences):

a.) The proposed activity would...  
allow for PMNM access to recover decelerator technologies flight hardware in the event the decelerator enters and lands in PMNM waters. This activity supports full scale testing of decelerator technologies at representative conditions to those found on the planet Mars. The decelerator technologies developed as part of the Low Density Supersonic Decelerator (LDSD) project could enable the following on future missions to Mars:

- Placement of more mass on the Martian surface in a single landing
- Make more of the Martian surface accessible for exploration
- Increase landing accuracy on the Martian surface

The focus of the LDSD project's campaign is to validate a 100 feet (ft.) diameter Supersonic Ring Sail (SSRS) parachute behind a 19 ft. 8 inches (in.) attached torus Supersonic Inflatable Aerodynamic Decelerator (SIAD).

b.) To accomplish this activity we would ....

The LDSD Project seeks, as a contingency condition, to potentially drop and recover floating expended flight hardware from up to two scheduled SFDTs in 2015 (with the possibility for up to 2 additional flights per summer [June through August] through 2019) in the Open Ocean area within the boundary of PMNM, but outside of the 3 NM Special Management Area surrounding Nihoa Island. This operations area would not include the 170 acres of Nihoa Island and the Special Management Area within the 3 NM surrounding Nihoa Island. In order to circumvent this area, one of two scenarios would occur: (1) the LDSD Program would initiate the Supersonic Flight Dynamic Test (SFDT) in such a manner that expended flight hardware would be recovered or sink before drifting into the Special Management Area or (2) the flight system would overfly Nihoa and the Special Management Area and the Test Vehicle would be dropped outside the Special Management Area surrounding Nihoa Island. Therefore, expended flight hardware would not be deposited on Nihoa Island or within the Special Management Area surrounding the Island. Enclosure 1A highlights the area within PMNM in which the LDSD Project is requesting permission to potentially drop and recover floating expended flight hardware within the boundary of PMNM during the months of June, July, and August 2015 through 2019. This overlay of the hardware splashdown area was derived from negotiations between LDSD Project, U.S. Navy (USN) Range Management, and the Federal Aviation Administration (FAA) within the 170 NM arc defining the TV to PMRF telecommunications limit plus and additional 6 NM buffer to account for a conservative estimate of the distance the floating hardware could drift with surface currents for the 12 hours it would take for recovery vessels to reach them.

In accordance in with the National Environmental Policy Act (NEPA), in May 2013 NASA prepared an Environmental Assessment (EA) for the proposed LDSD Technology Demonstration Mission (TDM) (<http://www.govsupport.us/nasaldsdea/default.aspx>). Based on the EA, NASA issued a Finding of No Significant Impact (FONSI) on 29 May 2013. Section 2.6.2 of the May 2013 LDSD EA, details the site selection process for the LDSD Project. NASA began evaluating sites for the LDSD Program in 2011; originally analyzing twelve global candidate test sites. The USN Pacific Missile Range Facility (PMRF) in Kauai, Hawaii was considered the most viable launch range and, therefore, was selected as the host test range for the execution of the SFDT portion of the LDSD Project. Additionally, please refer to the enclosed PMNM Advisory Council White Paper for more details (Enclosure 1).

Each nominal SFDT flight would consist of releasing from PMRF a 34 million cubic foot (mcf) scientific balloon that carries the TV to the minimum desired float altitude of 120,000 ft (Figure 1 of Enclosure 1). At float altitude, the balloon fully inflates to approximately 400 ft tall and 450 ft in diameter. The TV is then released, initiating the

mission sequence. Once the TV is dropped, a signal is sent that separates the flight train from the balloon and in the process, ripping the balloon to allow descent. After the TV drops, small solid-fueled rocket motors ignite and stabilize the TV prior to the main motor ignition. The main motor is an Orbital Alliant Techsystems, Incorporated manufactured Star 48B, a long nozzle solid-fueled rocket engine. The Star 48B ignites propelling the TV upwards to an altitude of approximately 180,000 ft at a speed of approximately Mach 4. The TV then deploys a torus (doughnut-shaped) tube called the Supersonic Inflatable Aerodynamic Decelerator (SIAD) to slow its velocity to approximately Mach 2. The TV then deploys the 100-ft diameter supersonic parachute, which carries the TV safely to a controlled oceanic impact in a pre-coordinated operational area off the west coast of the Island of Kauai, Hawaii.

Almost all expended flight hardware is then recovered from the ocean, with the exception of the balloon flight train (Enclosure 2, "Balloon Flight Train Assembly, Summary"). This flight train connects the TV to the balloon. The flight train, that separates from the balloon and the TV, weighs approximately 830 pounds; is approximately 990 feet long; and consists of a burst parachute (a safety instrument), sensors, connections, and Kevlar® cabling. This system would sink rapidly in the ocean and would be almost impossible to locate.

The balloon system carries approximately 250 pounds of 0.3 to 0.5 mm steel shot ballast (roughly the diameter of beach sand) that would be slowly and completely released during the ascent phase. Ballast released during ascent would travel in the upper atmospheric winds and be dispersed over hundreds of miles. It is, therefore, highly unlikely that ballast material would enter PMNM. If, in the unlikely event that all ballast is not released during ascent, the leak proof container would be recovered with the balloon system.

Whether the SFDT is nominal or off nominal, the intention is to drop the TV and scientific balloon within an approximately 170 NM arc centered on the PMRF instrumentation site located on Makaha Ridge, Kauai. This arc distance is defined by the TV to PMRF telecommunications limitation. A 6 NM buffer would be added to telecommunications limit (resulting in a 176 NM arc) to account for a conservative estimate of the distance the floating hardware could drift with surface currents for the 12 hours it would take for recovery vessels to reach them.

c.) This activity would help the Monument by ...

In the event the LDSO enters and lands in the Monument, recovery activities would ensure protection of Monument resources. In addition, NASA is willing to discuss potential avenues to partner with the Monument in support of outreach and/or education activities that would mutually benefit both the Monument's and NASA's mission goals.

**Other information or background:**

The focus of the successful 2014 LDSO Project campaign was to validate the SFDT test architecture itself. The SFDT executed on 28 June 2014 from the USN's PMRF was accomplished within existing constraints outlined in the LDSO project's EA and USN's Range Safety Operational Plan (RSOP). However, there were several lessons learned during this first campaign.

Although the initial two week launch window opened on 2 June 2014, the LDSO project experienced daily upper wind conditions that preempted all launch attempts during window. The LDSO project and USN Range Management scheduled a second launch window at the end of June 2014 requiring redeployment of project personnel and support assets. The first day of the second launch window opened on 28 June 2014 and provided a valid opportunity for launch. The predicted scientific balloon trajectory was along a path north of Niihau Island (Figure 3 of Enclosure 1). The trajectories north of Niihau provide much less time at float and thereby less time for reaction to unknowns. The LDSO project accepted the risks associated with this northern trajectory and moved forward with a launch attempt. The LDSO project and USN Range Safety identified a nominal TV drop location from the scientific balloon for the execution of the SFDT. After numerous decision meetings, all Go / No Go criteria were green and the scientific balloon was released from the launch site at PMRF.

The combined flight system (TV and scientific balloon) is continually tracked by PMRF ground instrumentation providing positional data to the USN Range Safety Organization. The present position of the flight system along with individual impact dispersions (which is a variable circle with a maximum radius of 14 NM) for the scientific balloon, detached flight train on recovery parachute, and TV are overlaid onto a display system. The impact dispersions are compared to restrictions imposed on the LDSO project due to Niihau and Kauai Islands (public safety criteria), FAA boundaries (public safety criteria), and PMNM (environmental safety criteria).

The 2014 SFDT was nominal except for slightly higher upper air winds speeds than predicted and the scientific balloon's ascent being slightly slower than predicted. The combination of the northern trajectory, higher than predicted winds, and slower than predicted ascent shortened the available decision window for initiation of the SFDT. Had there been any significant delay in the mission countdown (e.g. non-participating vessels in the range, hardware issue, etc.), then the USN Range Safety Organization would have issued a mission termination order, resulting in an immediate drop of the TV into the ocean in order to prevent the trajectory from crossing into PMNM.

The LDSO project demonstrated the ability to accurately predict the scientific balloon's climb out trajectory and to recover all floating expended flight hardware (see Figures 4 and 5 of Enclosure 1). The hard lessons learned from the 2014 campaign was that there is the possibility of going weeks without acceptable conditions for launch. The northern trajectories represents significant risk of early termination unless mitigated. One potential path of mitigating the risk is seeking a PMNM entry permit for the SFDT campaigns.

## **Section A - Applicant Information**

### **1. Applicant**

Name (last, first, middle initial): Wilcox, David A.

Title: NASA GSFC/WFF LDSD Project Manager

#### **1a. Intended field Principal Investigator (See instructions for more information):**

Mr. Eric Littleton  
LDSD Project Recovery Director  
NASA Wallops Flight Facility  
34200 Fulton Street  
Wallops Island, VA 23337  
office (757) 824-2049  
cell (410) 430-3310  
eric.a.littleton@nasa.gov

#### **2. Mailing address (street/P.O. box, city, state, country, zip):**

34200 Street, Wallops Island, Virginia 23337

Phone: (757) 824-1314

Fax:

Email: David.A.Wilcox@nasa.gov

For students, major professor's name, telephone and email address:

#### **3. Affiliation (institution/agency/organization directly related to the proposed project):**

NASA GSFC/WFF, Range and Mission Mangement Office

**4. Additional persons to be covered by permit. List all personnel roles and names (if known at time of application) here (e.g. John Doe, Research Diver; Jane Doe, Field Technician):**

Each of the three vessels listed below either already has a PMNM-approved VMS system installed and operational or has a system on order that will be installed and operational prior to entering the Monument:

Vessel Kahana

4 – 6 Ship Crew from Hawaii Resources Group

3 – 4 Explosive Ordnance Disposal (EOD) Technicians from Naval Station Pearl Harbor

2 – 3 Flight Hardware Subject Matter Experts from NASA Jet Propulsion Laboratory

Total not to exceed 11 passengers

VMS System:

Sailor Inmarsat 150 communication unit

Sailor 3026D VMS Gold tracking unit

(already installed and operational)

Vessel Honua

4 – 6 Ship Crew from Hawaii Resources Group

VMS System:

Sailor Inmarsat 150 communication unit

Sailor VMS 3027D Gold tracking unit

(on order)

Vessel Manao II

3 Ship Crew from Hawaii Resources Group

VMS System:

Sailor Inmarsat 150 communication unit

Sailor VMS 3027D Gold tracking unit

(on order)

**Section B: Project Information**

**5a. Project location(s):**

- |                                                       |                                     |                                        |                                                |
|-------------------------------------------------------|-------------------------------------|----------------------------------------|------------------------------------------------|
| <input checked="" type="checkbox"/> Nihoa Island      | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input checked="" type="checkbox"/> Deep water |
| <input type="checkbox"/> Necker Island (Mokumanamana) | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> French Frigate Shoals        | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Gardner Pinnacles            | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Maro Reef                    |                                     |                                        |                                                |
| <input type="checkbox"/> Laysan Island                | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Lisianski Island, Neva Shoal | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Pearl and Hermes Atoll       | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Midway Atoll                 | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Kure Atoll                   | <input type="checkbox"/> Land-based | <input type="checkbox"/> Shallow water | <input type="checkbox"/> Deep water            |
| <input type="checkbox"/> Other                        |                                     |                                        |                                                |

**Ocean Based**

Remaining ashore on any island or atoll (with the exception of Midway & Kure Atolls and Field Camp staff on other islands/atolls) between sunset and sunrise.

NOTE: There is a fee schedule for people visiting Midway Atoll National Wildlife Refuge via vessel and aircraft.

Location Description:

Project could occur within a 320 km arc centered at Makaha Ridge, Kauai, excluding all State waters.

**5b. Check all applicable regulated activities proposed to be conducted in the Monument:**

- Removing, moving, taking, harvesting, possessing, injuring, disturbing, or damaging any living or nonliving Monument resource
- Drilling into, dredging, or otherwise altering the submerged lands other than by anchoring a vessel; or constructing, placing, or abandoning any structure, material, or other matter on the submerged lands
- Anchoring a vessel
- Deserting a vessel aground, at anchor, or adrift
- Discharging or depositing any material or matter into the Monument
- Touching coral, living or dead
- Possessing fishing gear except when stowed and not available for immediate use during passage without interruption through the Monument
- Attracting any living Monument resource
- Sustenance fishing (Federal waters only, outside of Special Preservation Areas, Ecological Reserves and Special Management Areas)
- Subsistence fishing (State waters only)
- Swimming, snorkeling, or closed or open circuit SCUBA diving within any Special Preservation Area or Midway Atoll Special Management Area

**6. Purpose/Need/Scope *State purpose of proposed activities:***

In the event the TV and/or scientific balloon lands or drifts into the PMNM boundary as a result of the SFDT, NASA is requesting access to PMNM to recover floating expended flight hardware (see Enclosure 2 for description of flight hardware not to be recovered and Enclosure 3 for descriptions of flight hardware to be recovered). The LDSD Project seeks to potentially drop and recover floating expended flight hardware from up to two scheduled SFDTs in 2015 (with the potential for up to 2 additional flights per sum [June to August] through 2019) in the Open Ocean area within the boundary of PMNM, but outside of the 3 NM Special Management Area surrounding Nihoa Island. Enclosure 1A highlights the area within PMNM in which the LDSD project is requesting permission to operate. This overlay of the hardware splashdown area was derived from negotiations between LDSD Project, U.S. Navy (USN) Range Management, and the Federal Aviation Administration (FAA) within the 170 NM arc defining the TV to PMRF telecommunications limit plus and additional 6 NM buffer to account for a conservative estimate of the distance the floating hardware could drift with surface currents for the 12 hours it would take for recovery vessels to reach them.

The purpose of the LDSD Project is to support full-scale testing of decelerator technologies at representative conditions to those found on the planet Mars. The decelerator technologies developed as part of the LDSD project could enable the following on future missions to Mars:

- Placement of more mass on the Martian surface in a single landing
- Make more of the Martian surface accessible for exploration
- Increase landing accuracy on the Martian surface

The focus of the LDSD project's campaign is to validate a 100 ft. diameter supersonic parachute behind a 19 ft. 8 in. attached torus-shaped SIAD. The validation of the supersonic parachute requires execution of a SFDT from the USN PMRF in a pre-coordinated operational area off the west coast of the Island of Kauai, Hawaii.

Each nominal SFDT would consist of releasing from PMRF a 34 mcf scientific balloon that carries a TV to the minimum desired float altitude of 120,000 ft. (Figure 1 of Enclosure 1). At float altitude, the balloon fully inflates to approximately 400 ft. tall and 450 ft. in diameter. The TV is then released, initiating the mission sequence. Separate sets of solid-fueled rocket motors first stabilize the TV, and then propel the TV upwards to an altitude of approximately 180,000 ft. at a speed of approximately Mach 4. The TV then deploys a doughnut-shaped tube called the SIAD to slow its velocity to approximately Mach 2. The TV then deploys the 100 ft. diameter supersonic parachute, which carries the TV safely to a controlled oceanic impact, while the balloon and balloon flight train separate and splashdown.

\*Considering the purpose of the proposed activities, do you intend to film / photograph federally protected species? Yes  No

For a list of terrestrial species protected under the Endangered Species Act visit:

<http://www.fws.gov/angered/>

For a list of marine species protected under the Endangered Species Act visit:

<http://www.nmfs.noaa.gov/pr/species/esa/>

For information about species protected under the Marine Mammal Protection Act visit:

<http://www.nmfs.noaa.gov/pr/laws/mmpa/>

**7. Answer the Findings below by providing information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Monument:**

The Findings are as follows:

a. How can the activity be conducted with adequate safeguards for the cultural, natural and historic resources and ecological integrity of the Monument?

The proposed activities would be carried out with strict safeguards for the natural, cultural and historic resources of the Monument as required by Presidential Proclamation 8031, other applicable laws, and agency policies and standard operating procedures. Early and ongoing coordination of proposed activities would occur between NASA, the USN, Monument managers and all other relevant partners. NASA will ensure full participation in all pre-access permit and cultural briefings required each year prior to access to the Monument as well as strict adherence to all relevant Monument Best Management Practices (BMPs).

The notional predicted trajectories of the balloon from PMRF include possible over-flight of Nihoa Island, the Special Management Area around Nihoa Island, and the eastern-most part of PMNM. Although, fine control of the balloon's altitude is possible by releasing ballast material or venting helium, trajectory control (i.e., steering) cannot be achieved; the balloon system would follow the prevailing wind patterns encountered during its flight. These wind patterns were part of the computational algorithms used during the Monte Carlo simulations utilized to project flight trajectories.

The Monte Carlo method is a problem solving technique which approximates the probability of certain outcomes by running multiple trial runs, called simulations, using random variables. Monte Carlo simulations were employed to take an identified set of variables (e.g., wind patterns) representing real world conditions that could affect the LDSD flight and used computational algorithms to find potential outcomes (i.e., flight trajectories) of "what-if" scenarios. These scenarios were not screened against the safety and mission success criteria, so several of these trajectories would not be executed under the project's established Go/No Go criteria (e.g., safety restrictions,

proper weather conditions, operational status of all LDSB subsystems, telemetry checks, and readiness of recovery systems).

Under the assumption that all possible trajectories were allowed to fly, NASA estimates the balloon system has approximately a 0.4% chance of reaching float altitude within PMNM and a 20% chance of overflying PMNM after reaching float altitude (e.g., 110,000 ft). These probabilities are reduced when NASA and the U.S. Navy apply the project's established Go/No Go criteria. These Go/No Go test rules eliminate trajectories that are predicted to fly out directly over large populated areas or follow a trajectory outside boundaries set by NASA, the U.S. Navy, and the FAA.

NASA has a vested interest in recovering the floating expended flight hardware including the scientific balloon, the TV, the flight imagery recorder, and the SIAD. Enclosure 3, "Flight Hardware to be Recovered" gives a detailed description of each of these systems. High speed and high resolution memory data storage devices for each flight are onboard the TV and must be recovered. Part of the flight reconstruction process is physical examination of the actual decelerators, so those too must be recovered. Therefore, accurate tracking information is captured and analyzed in real-time starting at launch of the scientific balloon, during execution of the SFDT, through splash down.

The recovery concept of operations has been demonstrated. During the 2014 campaign, the NASA and USN team demonstrated the ability to precisely predict and track the scientific balloon, TV, and other associated flight hardware through splash down. Lessons learned from the 2014 campaign will be leveraged in the remaining demonstration tests to improve the project's prediction, tracking, and recovery performance. The process improvements being implemented for the 2015 through 2019 campaigns represent the adequate safeguards being submitted for consideration.

Almost all expended flight hardware is recovered from the ocean, with the exception of the balloon flight train (Enclosure 2, "Balloon Flight Train Assembly, Summary"). This flight train connects the TV to the balloon. Once the TV is dropped, a signal is sent that separates the flight train from the balloon and in the process, ripping the balloon to allow descent. The flight train weighs approximately 830 pounds; is approximately 990 feet long; and consists of a burst parachute (a safety instrument), sensors, connections, and Kevlar® cabling. This system would sink rapidly in the ocean and would be almost impossible to locate.

In August 2014, NASA, in consultation with the National Science Foundation and the National Marine Fisheries Service, finalized an Initial Environmental Evaluation/Environmental Assessment of Southern Hemisphere Ultra Long Duration Ballooning Operations Expansion (accessible online at <http://sites.wff.nasa.gov/code250/docs/ULDB/ULDB%20Southern%20Hemi%20IEE-EA%20FINAL.pdf>) which found no significant impact to environmental resources from

scientific balloons designed to sink after performing in the southern hemisphere (between the 29°S and 65°S latitude bands).

b. How will the activity be conducted in a manner compatible with the management direction of this proclamation, considering the extent to which the conduct of the activity may diminish or enhance Monument cultural, natural and historic resources, qualities, and ecological integrity, any indirect, secondary, or cumulative effects of the activity, and the duration of such effects?

As assessed in the 2013 LDSD EA, NASA does not anticipate direct, indirect, secondary, or cumulative effects (either beneficial or detrimental) to Monument cultural, natural, and historic resources, qualities, or ecological integrity. Section 4.3.2.5 of the EA stated that "...activities would not result in any direct impacts on the coral or degradation of water/sediment quality in the vicinity of the corals. PMRF strictly controls launches and does not permit an exercise to proceed until the range is determined clear after consideration of inputs from ships' sensors, visual surveillance of the range from aircraft and range safety boats, radar data, acoustic information from a comprehensive system of sensors, and surveillance from shore. Implementation of these controls minimizes the potential for cumulative impacts to marine species. No substantial adverse cumulative impacts are anticipated from the planned LDSD launches. Implementation of the Proposed Action in conjunction with other past, present, and reasonably foreseeable future actions will not result in cumulative effects on cultural resources within the Open Ocean Area. Any submerged features that might be within this area are at considerable depth, and the potential for disturbance is extremely remote."

In addition, NASA is willing to discuss potential avenues to partner with the Monument in support of outreach and/or education activities that would mutually benefit both the Monument's and NASA's mission goals. NASA staff have reached out to NOAA ONMS staff in efforts to begin discussions regarding potential support for education and/or outreach activities and hope to continue discussions with the broader Monument managing agencies.

c. Is there a practicable alternative to conducting the activity within the Monument? If not, explain why your activities must be conducted in the Monument.

There is no practicable alternative to allowing for this proposed action to occur within the Monument. Once at float altitude, there are common wind conditions that could push the scientific balloon into PMNM before attaining the altitude needed to execute an SFDT. Allowing Monument access to the LDSD project team would ensure timely and safe recovery of any floating flight hardware that entered the Monument as well as would allow NASA to conduct a full-test of the decelerator technologies under development.

As previously mentioned, there are common wind conditions that could push the scientific balloon into PMNM before attaining the altitude needed to execute an SFDT. Allowing balloon flights over the Monument would give the LDSD Project additional flight

opportunities based on predicted balloon trajectories and avoid terminating a healthy flight vehicle in the event that contingencies preclude a timely TV drop (e.g., non-participating vessels in the range, stratospheric wind speeds are under predicted). Additionally, the TV is notionally launched in a northeasterly to easterly direction from the scientific balloon which may put mission-critical cameras at risk of pointing into the sun. The TV's on-board high-speed and high-resolution cameras are used to measure parachute shape versus flight time. The proposed splashdown area within the Monument would allow the TV to be launched in a more eastward or potentially southeastwardly direction such that the cameras' field of view would not be exposed to sun glare. Without the option of splashdown and recovery in the Monument, the probability that the SFDT would fail to meet mission objectives, due to an absence of proper imaging, is higher.

d. How does the end value of the activity outweigh its adverse impacts on Monument cultural, natural and historic resources, qualities, and ecological integrity?

NASA does not anticipate adverse impacts on Monument cultural, natural, or historic resources, qualities, or ecological integrity. On the contrary, NASA's ability to quickly and safely recover floating flight hardware after splashdown would ensure minimal if any impact to Monument resources and could be considered an appropriate management action to safeguard Monument resources in the event of a landing within PMNM boundaries. In addition, participants will ensure that all Monument BMPs are followed to ensure safety and protection of Monument natural and cultural resources. NASA will also work with the USN to establish appropriate mission rules of engagement to further ensure safety and protection of Monument natural and cultural resources.

In addition, as expressed by the Space Studies Board's Committee on the Planetary Science Decadal Survey in "Vision and Voyages for Planetary Science in the Decade 2013-2022", a technology development program is considered one of the highest priority activities for the upcoming decade in support of the Mars Exploration Program. The report emphasized the need for a focused technology program that includes the development of new and improved capabilities for entry, descent, and landing in a variety of surfaces and atmospheres including Venus and Mars. The Space Studies Board further elaborates that the continued success of NASA planetary exploration is dependent on a "robust, stable technology development program" emphasizing key investment technologies that do not currently exist. (Space Studies Board, 2011; [http://www.nap.edu/openbook.php?record\\_id=13329](http://www.nap.edu/openbook.php?record_id=13329)).

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.

NASA would only enter the Monument to recover floating expended flight hardware as demonstrated in the 2014 SFDT mission (see Figures 4 and 5 of Enclosure 1). NASA would deploy three recovery vessels to anchor at Test Support Positions (TSPs) selected to minimize the recovery operations timeline. Immediately upon splashdown of

the floating expended flight hardware, the vessels would be directed to the different floating hardware locations to begin recovery. Swimmers, with snorkeling gear, may enter the water to assist in recovery of the floating hardware. As the LDSD project is limited by the 170 NM arc from Makaha Ridge, Kauai, swimmers would not enter the water within a Special Preservation Area or the Midway Atoll Special Management Area. During the 2014 mission, it took the respective vessels approximately 5 hours to reach and recover the parachute, 6.5 hours to reach and recover the balloon carcass, and 4 hours to reach and recover the TV.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.

NASA, in partnership with the USN, demonstrated the ability to conduct and complete the SFDT during the successful LDSD 2014 campaign at PMRF.

g. Provide information demonstrating that you have adequate financial resources available to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.

NASA, as with all Federal agencies, is subject to appropriations from Congress and both the mission and the recovery operations for the 2015 have been fully funded. Appropriations would occur annually prior to the 2016 through 2019 LDSD campaigns. Additionally, given NASA's strong commitment to stewardship, the Agency would advocate for any necessary mitigation funding from impacts resulting from the LDSD Program.

h. Explain how your methods and procedures are appropriate to achieve the proposed activity's goals in relation to their impacts to Monument cultural, natural and historic resources, qualities, and ecological integrity.

NASA will make every effort to limit the time spent within the Monument. Analogous to the 2014 demonstration mission, NASA would deploy three recovery vessels to anchor at TSPs, selected to minimize the recovery operations timeline. Immediately upon splashdown of the scientific balloon and TV, the vessels would be directed to the different floating hardware locations to begin recovery. During the 2014 mission, it took the respective vessels approximately 5 hours to reach and recover the parachute, 6.5 hours to reach and recover the balloon and flight train, and 4 hours to reach and recover the TV.

i. Has your vessel been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?

Yes

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.

No other foreseeable factors exist that would make the issuance of a permit for this activity inappropriate.

#### **8. Procedures/Methods:**

Sections 2.2, 2.3, and 2.4 of the May 2013 NASA LDS Technology Demonstration Mission EA, (<http://www.govsupport.us/nasaldsdea/default.aspx>) detail the procedures and methods used for the LDS missions. Prior to launch, the LDS Project and USN Range Management conduct a series of launch decision meetings to determine whether a launch attempt can be made within a pre-determined set of public safety (e.g., non-participant vessel risks), environmental safety (e.g., potential to encroach on the PMNM), and mission success criteria (e.g., weather/winds conditions, critical hardware success). Each of these criteria imposes separate restrictions on the impact dispersion of both the scientific balloon and the TV. When the separate dispersion patterns are combined, the resulting pattern serves as the primary aid for these decision meetings.

If all range safety criteria are met, the SFDT is allowed to proceed and the 3 vessels are sent to their respective TSPs. Each SFDT consists of a 34 mcf scientific balloon that carries the SFDT TV to the minimum desired float altitude of 120,000 ft then releases the TV to initiate the mission sequence. Once the TV is dropped, a signal is sent that separates the flight train from the balloon and in the process, ripping the balloon to allow descent. After the TV drops, small solid-fueled rocket motors ignite and stabilize the TV prior to the main motor ignition. The main motor is an Orbital Alliant Techsystems, Incorporated manufactured Star 48B, a long nozzle solid-fueled rocket engine. The Star 48B ignites propelling the TV upwards to an altitude of approximately 180,000 ft at a speed of approximately Mach 4. The TV then deploys a doughnut-shaped tube called the SIAD to slow its velocity to approximately Mach 2. The TV then deploys a 100-ft diameter supersonic parachute, which carries the TV safely to a controlled oceanic impact. After splashdown, the three vessels transit to the locations of the floating expended flight hardware (balloon and TV) for recovery. The flight train, that separates from the balloon and the TV, would sink rapidly in the ocean and would be almost impossible to locate.

All launch activities would occur during daylight and all trajectories would direct splashdown into deep water, beyond 3 nautical miles of any island (vessels may be transiting to TSPs overnight). No Monument staff or volunteers would be required by NASA or its affiliate contractors, in conducting the mission.

**NOTE: If land or marine archeological activities are involved, contact the Monument Permit Coordinator at the address on the general application form before proceeding.**

**9a. Collection of specimens - collecting activities (would apply to any activity): organisms or objects (List of species, if applicable, attach additional sheets if necessary):**

Common name:

Scientific name:

# & size of specimens:

Collection location:

Whole Organism  Partial Organism

**9b. What will be done with the specimens after the project has ended?**

**9c. Will the organisms be kept alive after collection?**  Yes  No

• General site/location for collections:

• Is it an open or closed system?  Open  Closed

• Is there an outfall?  Yes  No

• Will these organisms be housed with other organisms? If so, what are the other organisms?

• Will organisms be released?

**10. If applicable, how will the collected samples or specimens be transported out of the Monument?**

**11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:**

**12. List all specialized gear and materials to be used in this activity:**

Sections 2.2.2 and 2.2.3 of the 2013 LDSA EA and Enclosure 5 "Equipment and Materials Description" detail the balloon launch platform and the SFDT Test Vehicle. The following is a breakdown of main components on each system:

5,100-pound, 34 mcf scientific balloon flight train assembly composed of thin sheets (0.8 mil) of polyethylene film (much like a typical trash bag) sealed together with enclosed polyester fibers.

830-pound balloon flight train including:

- Kevlar cable ladder made of ½" Zylon/PBO Synthetic
- FAA Air Traffic Control Radar Beacon System
- Micro Instrumentation Package (including global positioning system, uplink and downlink telemetry (TM), line of sight ultra-high frequency (UHF) transceiver and an Iridium unit for over the horizon commanding and TM)
  - 90-pound, 72-foot balloon burst parachute and cabling
  - Ballast (very fine fine steel shot [0.3 to 0.5 mm] - released during balloon ascent)
  - Small, self-contained pyrotechnic device for balloon termination - ignited in flight, spent prior to landing

6,600-pound Test Vehicle (15 feet in diameter by 7 feet in height)

- TV core structure is constructed of composite sandwich panel, with carbon facesheets and closed-cell (foam) to provide bouyancy
  - Orbital Alliant Techsystems, Incorporated manufactured Star 48B, a long nozzle solid-fueled rocket engine - ignited in flight, spent prior to landing
  - Heat shield segments
  - C-band beacon for radar tracking
  - Two TM downlink systems operating in the S-band frequency range of 2,200-2,300 megahertz (MHz).
    - o Frequency Modulation (FM) transmitter and two circularly polarized slot antennas
    - o National Television System Committee (NTSC) standard video FM transmitter and two circularly polarized slot antennas
  - Small solid-fueled rocket motors that ignite and stabilize the TV prior to the main motor ignition - ignited in flight, spent prior to landing

Supersonic Inflatable Aerodynamic Decelerator (SIAD) uses automotive gas generators (air bag propellant) and a custom designed gas diffuser for inflation

- 100-foot diameter Supersonic Ringsail (SSRS) parachute with a mortar fired pilot ballute (to provide extraction force for the main parachute deployment) and rigging (deployment bags, braided riser bridle, and bridle rigidizers)
  - Flight image recorder and Go-Pro® cameras
  - Electronics control platform with two subsystems battery packs:
    - o Electrical power subsystem contains 5 battery packs in parallel consisting of 11 lithium manganese dioxide (M62) cells in series per pack
    - o Drop subsystem contains a 24 cell nickel cadmium (NiCad) "D" pack

**13. List all Hazardous Materials you propose to take to and use within the Monument:**

Refer to Enclosure 5. "Equipment and Materials Descriptions" for full descriptions of each hazardous system and corresponding safety data sheets.

All hazardous materials are fully integrated into either the balloon system or the TV.

Immediately post-landing, vessels will transit from test support locations beyond the launch hazard arc to intercept and salvage the floating systems - balloon and TV.

Whether or not either of these systems enter PMNM, they will be recovered as quickly as possible. Under nominal conditions, all pyrotechnic systems are fired during flight and land spent (as part of the balloon system or TV) in the ocean.

**14. Describe any fixed installations and instrumentation proposed to be set in the Monument:**

NA

**15. Provide a time line for sample analysis, data analysis, write-up and publication of information:**

Feb – Web Video – China Lake Rocket Sled testing

Feb/March – media day at JPL (include press release and video file)

April 1 – image release

April – feature story

May – web video

May – press release

May - Image release

June 1 – televised news briefing, video file, press release, web video, press kit

June 2 – commentary, press release

June 3 – media telecon, web video, video file and press release

June 4 – web video

June 17 – web video

D=0: Day of Test (to be determined in June, July, or August)

D+2 days: Flash Report on estimated trajectory conditions

D+30 days: Status Update on Trajectory Reconstruction

D+60 days: Test Summary Report Issued

D+90 - D+365 days: Publication and Presentation of Conference Papers

**16. List all Applicant's publications directly related to the proposed project:**

May 2013. National Aeronautics and Space Administration Low Density Supersonic Decelerator Technology Demonstration Mission Pacific Missile Range Facility, Environmental Assessment (<http://www.govsupport.us/nasaldsdea/default.aspx>)

June 2013. Low Density Supersonic Decelerators Fact Sheet (JPL 400-1530) ([http://www.nasa.gov/pdf/737628main\\_Final\\_LDSD\\_Fact\\_Sheet\\_3-26-13.pdf](http://www.nasa.gov/pdf/737628main_Final_LDSD_Fact_Sheet_3-26-13.pdf))

May 2014. Low-Density Supersonic Decelerator (LDSD) Press Kit ([http://www.jpl.nasa.gov/news/press\\_kits/ldsd.pdf](http://www.jpl.nasa.gov/news/press_kits/ldsd.pdf))

June 2014. NASA's Low-Density Supersonic Decelerator Set to Lift Off. NASA Jet Propulsion Laboratory News (<http://www.jpl.nasa.gov/news/news.php?release=2014-207>)

June 2014. NASA's Low-Density Supersonic Decelerator Lifts Off. NASA Jet Propulsion Laboratory News (<http://www.jpl.nasa.gov/news/news.php?release=2014-208>)

June 2014. First LDSD Test Flight a Success. NASA Jet Propulsion Laboratory News (<http://www.jpl.nasa.gov/news/news.php?release=2014-210>)

August 2014. High-Def Video of NASA's 'Flying Saucer' Test. NASA Jet Propulsion Laboratory Videos (<http://www.jpl.nasa.gov/video/details.php?id=1321>)

August 2014. Fishing LDSD out of the Water. NASA Jet Propulsion Laboratory Images (<http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA18465>)

November 2014. NASA Saucer Named 'Best of What's New'. NASA Jet Propulsion Laboratory News (<http://www.jpl.nasa.gov/news/news.php?feature=4385>)

With knowledge of the penalties for false or incomplete statements, as provided by 18 U.S.C. 1001, and for perjury, as provided by 18 U.S.C. 1621, I hereby certify to the best of my abilities under penalty of perjury of that the information I have provided on this application form is true and correct. I agree that the Co-Trustees may post this application in its entirety on the Internet. I understand that the Co-Trustees will consider deleting all information that I have identified as “confidential” prior to posting the application.

---

Signature

Date

**SEND ONE SIGNED APPLICATION VIA MAIL TO THE MONUMENT OFFICE BELOW:**

NOAA/Inouye Regional Center  
NOS/ONMS/PMNM/Attn: Permit Coordinator  
1845 Wasp Blvd, Building 176  
Honolulu, HI 96818  
FAX: (808) 455-3093

**DID YOU INCLUDE THESE?**

- Applicant CV/Resume/Biography
- Intended field Principal Investigator CV/Resume/Biography
- Electronic and Hard Copy of Application with Signature

- Statement of information you wish to be kept confidential
- Material Safety Data Sheets for Hazardous Materials

- 11km Drift Buffer
- LDSD Operational Area
- PMNM Boundary
- Special Management Area

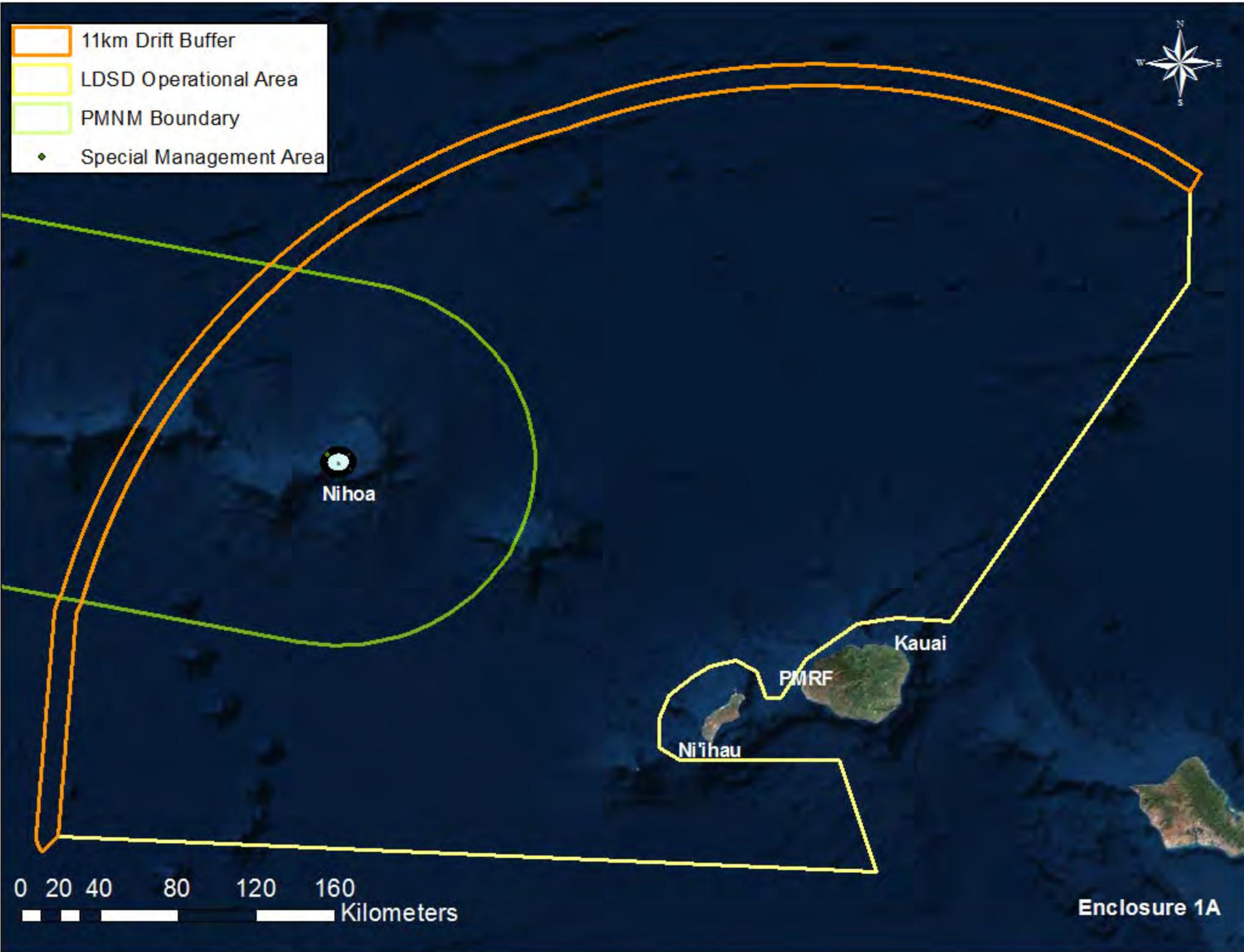


Nihoa

Ni'ihau  
PMRF  
Kauai

0 20 40 80 120 160 Kilometers

Enclosure 1A



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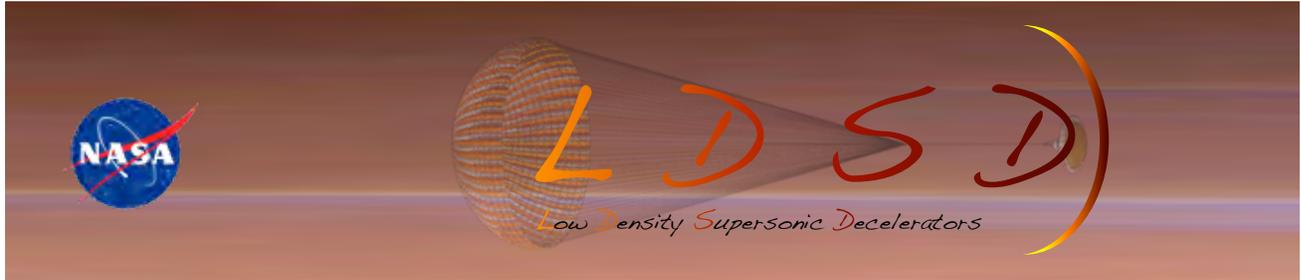
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**Appendix D**  
**LDSD Technology Demonstration Mission**  
**Biological Evaluation**

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# **BIOLOGICAL EVALUATION**

## **LOW DENSITY SUPERSONIC DECELERATORS TECHNOLOGY DEMONSTRATION MISSION**



*Prepared for:*

**Low Density Supersonic Decelerators Project  
Jet Propulsion Laboratory  
Pasadena, CA**

*Prepared by:*

**Wallops Flight Facility Environmental Office  
NASA Wallops Flight Facility  
Wallops Island, VA**

*Submitted to:*

**National Marine Fisheries Service  
Pacific Islands Regional Office Protected Resources Division  
Honolulu, HI**

**February 2015**

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## 1.0 Background/History

This Biological Evaluation (BE) has been prepared to address the effects of the National Aeronautics and Space Administration’s (NASA) Low Density Supersonic Decelerators (LDS) Technology Demonstration Mission (TDM) on species listed as endangered or threatened under the Endangered Species Act (ESA) of 1973, or their designated critical habitat. Section 7 of the ESA assures that, through consultation (or conferencing for proposed species) with the National Marine Fisheries Service (NMFS) and/or the U.S. Fish and Wildlife Service (USFWS), federal actions do not jeopardize the continued existence of any threatened, endangered or proposed species, or result in the destruction or adverse modification of critical habitat.

The primary action considered herein is NASA’s funding of up to two Supersonic Flight Dynamics Tests (SFDT) per summer (June through August) from 2015 through 2019, from the U.S. Navy’s (USN’s) Pacific Missile Range Facility (PMRF) on Kaua‘i, Hawai‘i. Also considered in this BE are the connected actions of the National Oceanic and Atmospheric Administration (NOAA) and the USFWS. In accordance with the authorities granted to them under Presidential Proclamation 8031 and 50 CFR Part 404, NASA has requested that they, along with the State of Hawai‘i, issue the LDS Project a permit to enter the Papahānaumokuākea Marine National Monument (PMNM). If NASA’s permit application were to be approved, their action of issuing the permit would be subject to ESA consultation requirements. As such, NASA has assumed the role as Lead Agency (50 CFR § 402.07) and prepared this BE to fulfill the ESA obligations of all three federal action agencies.

Because the action would occur over (during flight) and within (upon landing) the open ocean, it has the potential to impact ESA-listed marine species that may occur in the area, shown in **Table 1**.

**Table 1: Summary of Species & Critical Habitat Potentially within the LDS Action Area**

Common Name	Scientific Name	ESA Status
<b>Cetaceans</b>		
North Pacific right whale	<i>Eubalaena japonica</i>	Endangered
Blue whale	<i>Balaenoptera musculus</i>	Endangered
Fin whale	<i>Balaenoptera physalus</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
False killer whale (MHI Insular)	<i>Pseudorca crasidens</i>	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	Endangered
<b>Pinnipeds</b>		
Hawai‘ian Monk Seal	<i>Neomonachus schauinslandi</i>	Endangered
Hawai‘ian Monk Seal Critical Habitat	N/A	Designated & Proposed
<b>Sea Turtles</b>		
Green sea turtle	<i>Chelonia mydas</i>	Threatened
Hawksbill sea turtle	<i>Eretmochelys imbricate</i>	Endangered
North Pacific loggerhead sea turtle	<i>Caretta caretta</i>	Endangered
Olive ridley sea turtle	<i>Lepidochelys olivacea</i>	Threatened
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered

Early coordination and pre-consultation with NMFS was conducted during a series of document reviews and telephone conversations including:

- December 2012 and March 2013: NASA completed the *Low Density Supersonic Decelerator Technology Demonstration Mission Pacific Missile Range Facility Final Environmental Assessment* (“LDSA EA;” **NASA 2013**) and issued a Finding of No Significant Impact on May 10, 2013. During the preparation of the LDSA EA, NMFS was provided copies of both the Coordinating Draft and Public Draft EA. Although it appears that NMFS reviewed the EA, no ESA consultation was conducted (**P. Opay, NMFS, personal communication, 2015**).
- January 20, 2015: NASA participated in a telephone conversation with Mr. Patrick Opay, NMFS Pacific Islands Region, Office of Protected Resources, to discuss the previous coordination on the 2013 LDSA EA and steps forward for completing ESA consultation for future tests. It was mutually agreed upon that NASA would prepare a BE and submit it to NMFS, and, pending NASA’s determinations of effect, request either a Letter of Concurrence (informal consultation) or enter into formal consultation, should conditions warrant.
- January 28, 2015: NASA and NMFS held a brief teleconference to discuss the status of the BE and to confirm the necessity of NASA’s providing a summary (rather than a detailed assessment) of the environmental baseline within the action area.

### **1.1 Purpose of the Proposed Action**

NASA’s TDMs are used to bridge the gap between need and means, between scientific and engineering challenges and the technological innovations needed to overcome them, and between laboratory development and demonstration in space.

Once a technology is proven in the laboratory environment, the program becomes a bridge from ground to flight testing. System-level technology solutions are given the opportunity to operate in the actual space environment, where they gain operational heritage, reduce risks to future missions by eliminating the need to fly unproven hardware, and continue NASA’s long history as a technological innovator. These cutting-edge technologies allow future NASA missions to pursue bolder and more sophisticated science, enable safe and rewarding human missions beyond low-Earth orbit, and enable entirely new approaches to United States space operations.

NASA seeks to use atmospheric drag as a solution to the limitations of parachute-only deceleration systems in thin exoatmospheric environments, saving rocket engines and fuel for final maneuvers and landing procedures. The heavier planetary landers of tomorrow, however, would require much larger drag devices than those currently employed to slow them. The next-generation drag devices would also need to be deployed at higher supersonic speeds to safely land vehicle, crew, and cargo. NASA’s LDSA TDM, led by the California Institute of Technology’s Jet Propulsion Laboratory (JPL) in Pasadena, California, would conduct full-scale, stratospheric tests of these technologies in the Earth’s stratosphere (which mimics Mars’s thin atmosphere), to prove their value for future missions to Mars and potentially other solar system bodies.

NASA's Space Technology Mission Directorate (STMD) established the LDSD Project as a test architecture for the development and full-scale testing of decelerator technologies at representative conditions to those found on the planet Mars. The current decelerator technologies were developed in the 1970s as part of NASA's Viking Program, which sent two probes to the Martian surface. Since these early Mars landers, the main focus on technology development has been on the landing phase of planetary missions. The decelerator technologies that could be developed through the LDSD project enable the following on future missions to Mars:

- Placement of more mass on the Martian surface in a single landing
- Making more of the Martian surface accessible for exploration
- Increasing landing accuracy on the Martian surface

The primary focus of the LDSD Project's campaign in Hawai'i is to validate a 30 meter (m; 100 feet [ft]) diameter Supersonic Ring Sail (SSRS) parachute behind a 6 m (20 ft) attached torus Supersonic Inflatable Aerodynamic Decelerator (SIAD).

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## 2.0 Description of the Action and Action Area

The LDSD Project seeks to conduct up to two SFDT campaigns in the summer of 2015, with the possibility for up to two additional flights per summer (i.e., June through August) through year 2019, from the USN's PMRF on Kaua'i, Hawai'i.

### 2.1 Supersonic Flight Dynamics Test Overview

Each SFDT flight (**Figure 1**) would consist of releasing from PMRF a 34 million cubic foot (1 million cubic meter [ $m^3$ ]) helium-filled scientific balloon that carries a Test Vehicle (TV) to a minimum desired float altitude of 37,600 m (120,000 ft). At float altitude, the balloon fully inflates to approximately 122 m (400 ft) tall and 137 m (450 ft) in diameter. The TV is then released, initiating the mission sequence. Once the TV is dropped, a signal is sent that separates the flight train from the balloon and, in the process, rips the balloon to allow for its descent. After the TV drops, small solid-fueled rocket motors ignite and stabilize the TV prior to the main motor ignition. The main motor is a Star 48B, a long nozzle solid-fueled rocket engine. The Star 48B ignites, propelling the TV upwards to an altitude of approximately 55,000 m (180,000 ft) at a speed of approximately Mach 4. The TV then deploys a torus (doughnut-shaped) tube called the SIAD to slow its velocity to approximately Mach 2. The TV then deploys the 30-m (100-ft) diameter SSRS parachute, which carries the TV safely to a controlled oceanic impact in a pre-coordinated operational area off the west coast of Kaua'i.

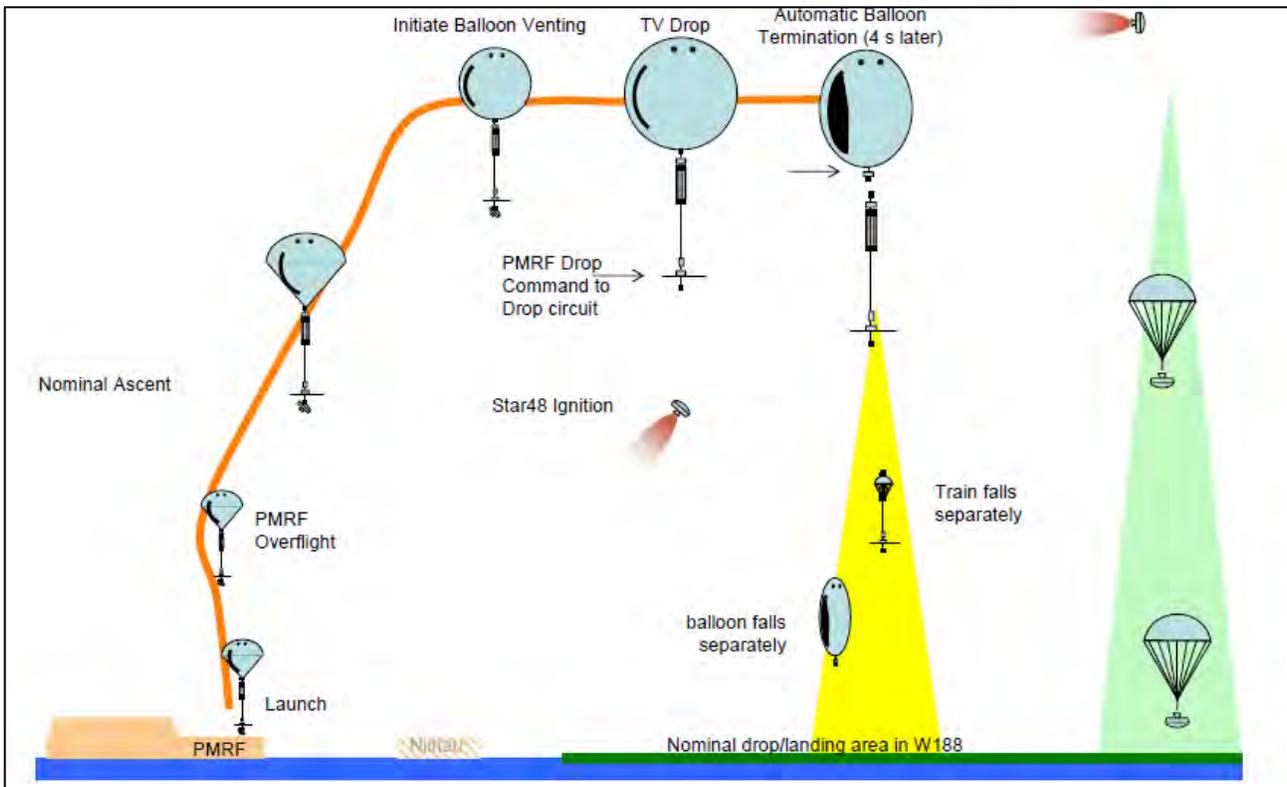


Figure 1: Supersonic Flight Dynamics Test Sequence

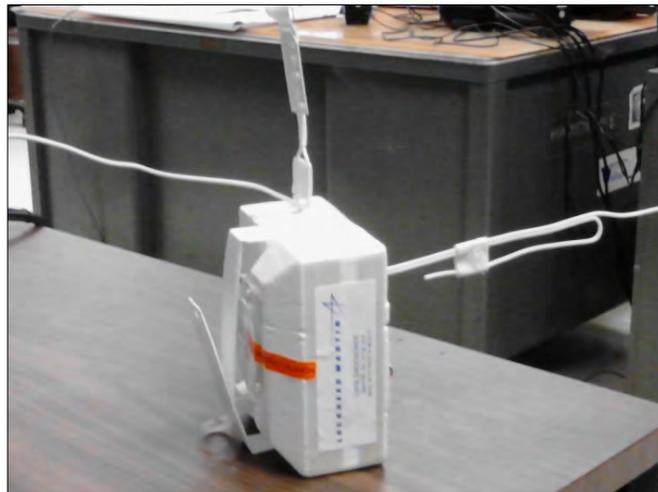
## 2.2 Pre-launch Activities

Launch decisions for the SFDT are tied directly to suitability of winds from ground level to a height of approximately 55,000 m (180,000 ft). Meteorological (MET) soundings are used to gauge mid- and upper level wind conditions. Two sizes of latex MET balloons (“2,000 grams” [g] and “30 g”), would be released to measure lower- and mid-level wind conditions from ground up to a height of approximately 33,500 m (110,000 ft) while Super Loki sounding rocket-deployed Rocket Balloon Instruments (ROBINs) are used to calculate upper level wind conditions to a height of approximately 90,000 m (295,000 ft). Each is described in more detail below.

### 2.2.1 Latex Meteorological Balloons

#### Radiosondes

During each LDSO campaign, a dress rehearsal is held prior to the first launch attempt of the campaign. This dress rehearsal is used to ensure that all telemetry, command systems, radar tracking, and other systems are functioning properly before the launch attempt. One 2,000 g MET balloon would be released as part of the dress rehearsal. Two 2,000 g MET balloons would be released the day of launch (one 1.5 hours prior to launch and the other 1.5 hours after launch). Each 2,000 g MET balloon would be equipped with a radiosonde that contains instruments capable of making direct in-situ measurements of air temperature, humidity, and pressure (**Figure 2**). These observed data are transmitted immediately to the ground station by a radio transmitter located within the instrument package.



**Figure 2: Polystyrene Radiosonde Box with Internal Electronics**

The 2,000 g MET balloons are inflated with helium gas and free-fly from the release point on PMRF to a bursting elevation of approximately 35,000 m (115,000 ft). Parachutes then deploy and prevailing winds carry the instrument package over the Pacific. Battery operated (9 volt) radiosondes are not recovered from the ocean. However, they are packed in floating polystyrene containers with waterproof pre-paid labels for return to NASA’s scientific balloon contractor. Over the remaining five-year time frame of the LDSO Project, a maximum of 25 radiosonde balloons would be released, burst, and descend to the Pacific Ocean. Based on wind conditions, these radiosonde balloons should land in the Pacific Ocean approximately 16 to 32 kilometers (km; 9 to 17 nautical miles [nm]) downrange or between Kaua’i and Ni’ihau (**D. Gregory, NASA Balloon Program Office, personal communication, 2015**).

## Pilot Balloons

Pilot balloons (30 g MET balloons) are launched to determine wind speed and wind direction (**Figure 3**). They are filled with helium, released to free-fly, and visually tracked with optical instrumentation. Using height and angular direction information from a theodolite to the balloon, wind direction or horizontal movement of the balloon is tracked, calculated, and graphed. For 30 g latex pilot balloons, wind speed and direction can be tracked at altitudes up to 4,500 m (14,800 ft). These balloons do not carry instrumentation on them, rather, they are only balloons.

Starting 25 days before each of the up to two, 10-day launch windows (two work weeks), 30 g latex MET balloons would be released at the rate of one every 30 minutes for two hours before and two hours after sunrise every day. Each balloon would be filled with approximately 0.16 m<sup>3</sup> (5.7 cubic feet [ft<sup>3</sup>]) of gaseous helium to a diameter of 64 centimeters (cm; 25 inches [in]). As the balloon rises in altitude, the gaseous helium expands until the balloon bursts completely at about 102 cm (40 in) in diameter.



**Figure 3: 30 gram Pilot Balloon and Observation Equipment**

If an LDSO launch attempt is not made until the last day of each window, a maximum of 630 pilot balloons could be released per year. For the entire five-year Project, a maximum of 3,150 pilot latex balloons could be released, burst, and land in the Pacific Ocean. Based on wind conditions, approximately 30 to 40 percent of these pilot balloons, equating to between 945 and 1,260 balloons during the remaining five-year term of the LDSO Project, would land in the Pacific Ocean approximately 8 km (4 nm) downrange from Kaua'i (**D. Gregory, NASA Balloon Program Office, personal communication, 2015**).

### **2.2.2 Super Loki Sounding Rockets**

The Super Loki is a two-stage rocket system used to obtain density, temperature, ozone, and wind data at altitudes ranging from 85,000 to 110,000 m (279,000 to 361,000 ft) to ground level. The first stage is a solid propellant rocket, 0.1 m (0.3 ft) in diameter and 2.0 m (6.6 ft) long. The second stage is an inert instrumented Dart, 0.054 m (0.177 ft) in diameter and 1.26 m (4.13 ft) long. Both stages consist of an aluminum case with an internally burning cast-in-the-case solid propellant. The propellant fuel is a

polysulfide polymer and the oxidizer is ammonium perchlorate. The entire rocket is approximately 3.25 m (10.7 ft) long and weighs approximately 30 kilograms (kg; 66 pounds [lb]) with propellants. After ignition, the first stage travels approximately 18,000 m (59,000 ft) in altitude before expending its fuel. The spent first stage rocket then separates from the Dart and follows a trajectory to an ocean impact approximately 5 km (3 nm) downrange. After separation, the second stage Dart ignites and reaches an altitude of approximately 80,000 m (262,000 ft), at which point the motor expends its fuel, the payload is released, and the Dart follows a ballistic trajectory to an ocean impact approximately 31 km (17 nm) downrange.

Each Super Loki rocket would deploy a ROBIN, (a metalized 0.5-mil thick Mylar sphere, 1.0 m [3.3 ft] in diameter, inflated to 12 hectopascal pressure), to a height of approximately 89,900 m (295,000 ft) (**Figure 4**). Since the ROBIN sphere's mass and spherical diameter is known, as the sphere falls from this initial deployment height to a minimum height of approximately 30,500 m (100,000 ft), where the higher external pressure causes the sphere to collapse, radar tracking information can be used to calculate wind direction, wind velocity, temperature, density, and pressure.



**Figure 4: ROBIN Sphere Pre- (left) and Post- (right) Inflation**

Super Loki MET rockets would be launched in conjunction with the 2,000 g radiosonde balloons. Therefore, over the remaining five-year time frame of the LDSO Project, a maximum of 25 Super Loki first stage motors, 25 Dart second stage motors, and 25 ROBIN spheres would land in the Pacific Ocean west of Kaua'i.

## **2.3 Post-launch Activities**

### **2.3.1 Recovery**

NASA has a vested interest in recovering the floating expended flight hardware including the scientific balloon, the TV, the flight imagery recorder, and the SIAD. High speed and high resolution memory data storage devices for each flight are onboard the TV and must be recovered. Part of the flight reconstruction process is physical examination of the actual decelerators, so those too must be recovered. Therefore, accurate tracking information is captured and analyzed in real-time starting at launch of the scientific balloon, during execution of the SFDT, through splash down.

The recovery concept of operations has been demonstrated (**Figures 5 and 6**). During the 2014 campaign, the NASA and USN team demonstrated the ability to precisely predict and track the scientific balloon, TV, and other associated flight hardware through splashdown.

To recover floating expended flight hardware, NASA would deploy three recovery vessels to anchor at positions selected to minimize the recovery operations timeline. The maximum cruise speed of the three vessels would be 22 km per hr [km/hr; 12 knots (kt)] with an average cruising speed of 10 kt. Up to two USN aircraft (either G-2/3 and/or C-12/26) would be flown to perform safety surveillance of the operational area and to assist with locating expended flight hardware for recovery. These aircraft would fly at altitudes between 460 and 7,300 m (1,500 and 24,000 ft) above the ocean surface and would help direct the vessels to the different recovery positions immediately upon splashdown of the floating expended flight hardware. During the 2014 mission, it took the respective vessels approximately 5 hours to reach and recover the supersonic parachute, 6.5 hours to reach and recover the balloon carcass (**Figure 5**), and 4 hours to reach and recover the TV (**Figure 6**). Swimmers, with snorkeling gear, may enter the water to assist in recovery of the floating hardware. As the LDSD project is limited by the 315 km (170 nm) arc centered at Mākaha Ridge, Kaua‘i, swimmers would not enter the water within a Special Preservation Area or the Midway Atoll Special Management Area.



**Figure 5: Scientific Balloon Recovery Operations on 2014 SFDT**



**Figure 6: TV Recovery Operations on 2014 SFDT**

### **2.3.2 Items Not Recovered**

Nearly all LDSO expended flight hardware (i.e., TV, balloon) would be recovered from the open ocean, with the exception of the balloon flight train (items 2-17 depicted in **Figure 7**). This flight train connects the TV to the balloon, and consists of a burst parachute (a safety instrument), sensors, connections, and Kevlar® cabling. This system would sink rapidly in the ocean, as described in more detail below.

#### **2.3.2.1 Detailed Description of Flight Train**

The balloon flight train weighs approximately 375 kg (827 lb) and is approximately 300 m (1,000 ft) long from the connection to the balloon through the connection to the TV. Stainless steel connectors, an electronic balloon burst detector for sensing a sudden drop in balloon altitude, a Micro Instrumentation Package (comprised of global positioning system, uplink and downlink telemetry, line of sight ultra-high frequency transceiver and an Iridium unit for over the horizon commanding and telemetry, electronic controlling units for venting the balloon, and small electrically-actuated charges for separating the balloon flight train from the balloon), and 1.5 m (5 ft) of Kevlar® line, connect the balloon to a 22 m (72 ft) diameter (canopy) nylon parachute. Parachute suspension cables connect to interface rings at both the top and bottom of the parachute. Three sections of Kevlar® cable “ladders” interspaced with aluminum anchor plates connect the parachute to the TV’s rotator, electronics deck, and release hardware. Each strand of Kevlar® is approximately 1.27 cm (0.5 in) diameter with 0.5 m (1.6 ft) long strands attached perpendicularly between two parallel strands. The three ladder sections are 21, 39, and 4.5 m (69, 128, and 15 ft) long. The TV’s electronics deck carries the leak-proof ballast hopper containing approximately 110 kg (243 lb) of 0.3 to 0.5 millimeter (mm; 0.01 to 0.02 inch) steel shot ballast (roughly the diameter of beach sand), and controls the slow, complete release of ballast during the ascent phase of LDSO. The TV release hardware contains additional small, electrically-actuated charges for separation of the TV from the balloon flight train.

#### **2.3.2.2 Materials of Interest in Flight Train**

##### Pyrotechnics

During each SFDT, two distinct separation events must occur: 1) release of the TV and 2) release of the balloon flight train with burst parachute. To enable such separations, the LDSO system contains a series of small explosive charges that are used to sever mechanical connections. To provide perspective on size, the largest charge currently employed is just less than 180 milligrams (0.0004 lb).

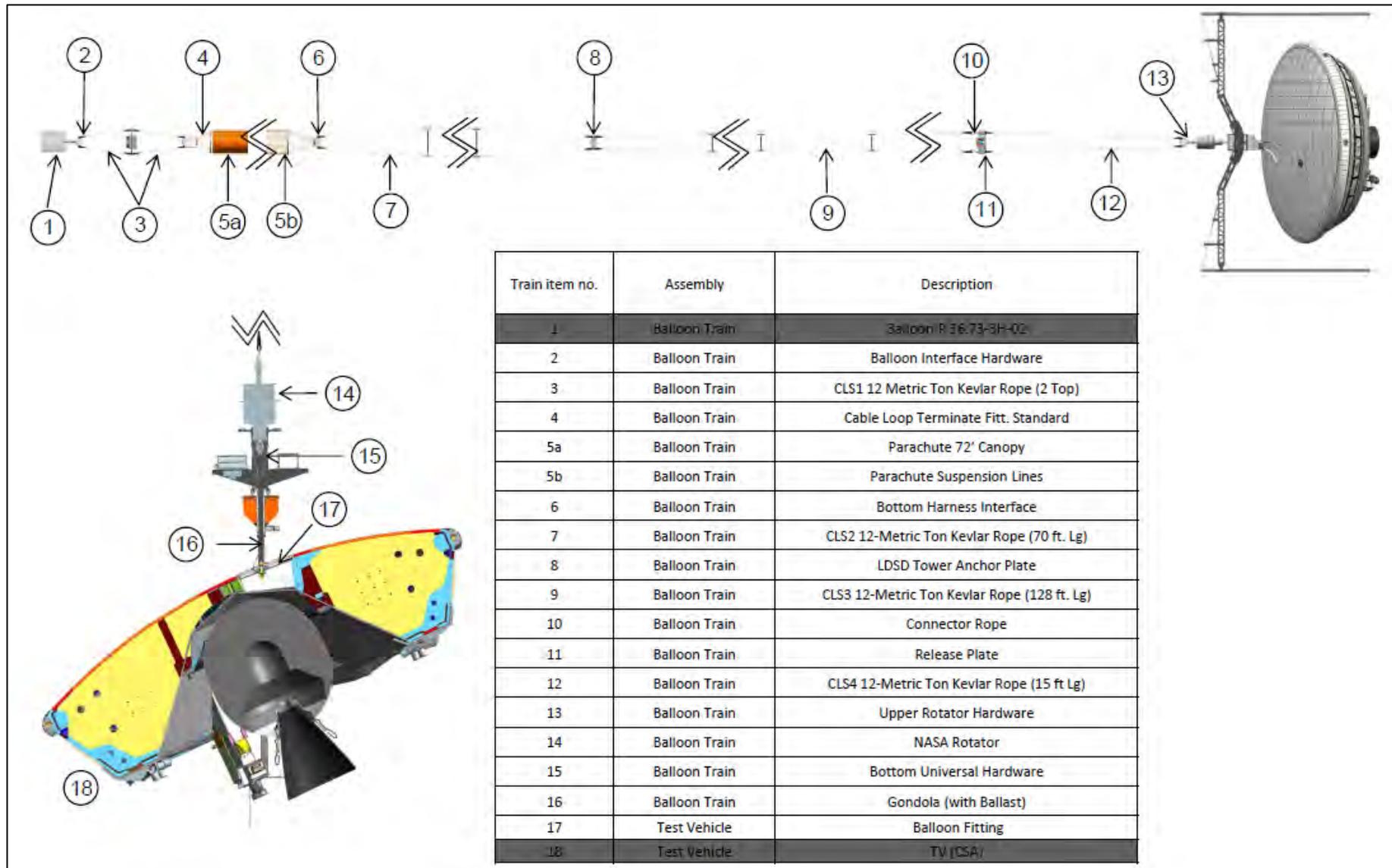


Figure 7: Balloon Flight Train

Each separation event uses two charges. Under normal flight conditions, all charges would be expended during flight. In an off-nominal flight condition (anomaly event), the charges for separation would not be expended; however, upon water impact, all unexpended charges would short out in the “safe” position, effectively eliminating the possibility of an in-water ignition.

### Electrical System Components

Small electrical systems are required on the flight train to enable the separation functions described above and to power scientific instruments and flight tracking systems. The entire flight train contains approximately 23 kg (50 lb) of lithium sulfur dioxide (LiSO<sub>2</sub>) batteries (comparable to approximately 710 “CR-V3” lithium cells typically used in consumer photographic and electronic devices: **Energizer Holdings, Incorporated n.d.**).

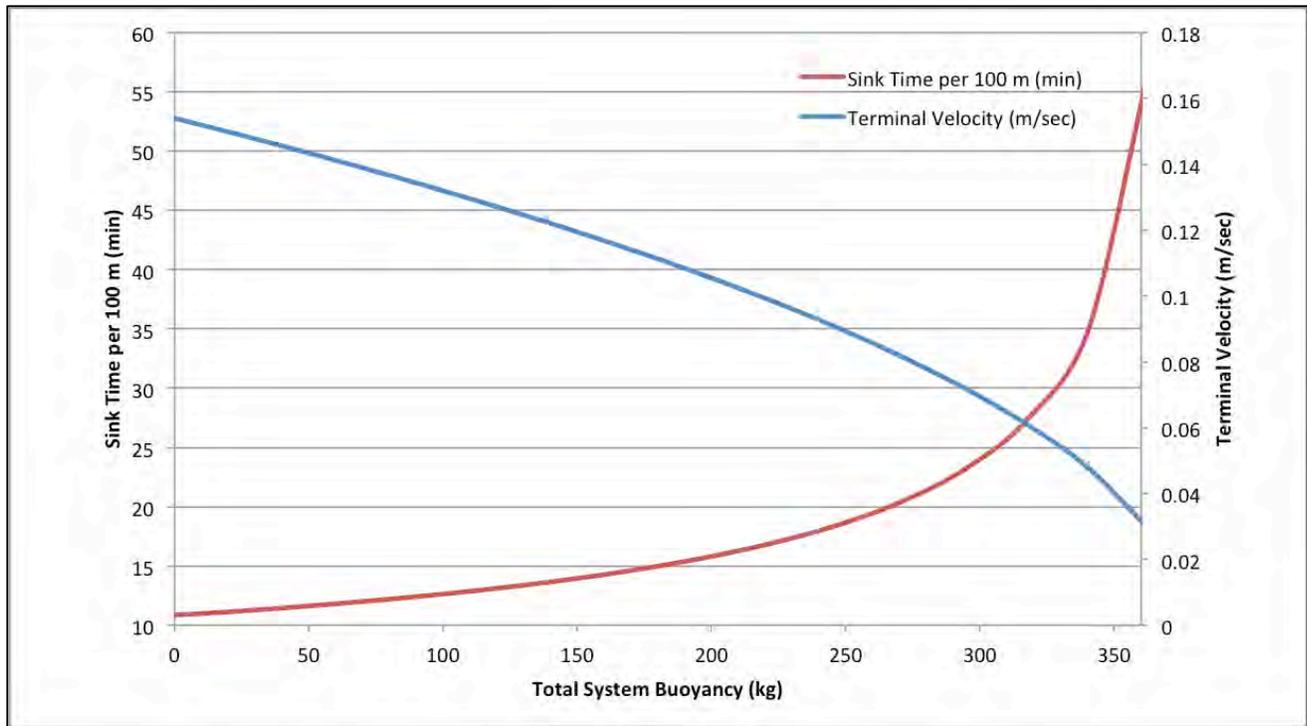
Very small quantities of lead-containing solder are used on other parts of the LDSD electrical systems. Although the majority of electrical systems are connected with crimps, some soldered connections are still employed, including those in the battery packs. Approximately 100 g (0.22 lb) of solder would be used on a balloon’s entire electrical system, with 40 percent (40 g [0.09 lb]) of this solder consisting of lead. This quantity of lead is slightly more than what is contained in one 12-gauge shotgun shell used for small-game hunting. Therefore, in summary, there would be approximately 40 g (0.09 lb) of lead on each SFDT flight.

#### **2.3.2.3 Estimated Flight Train Sink Rate**

To estimate the sink rate of the unrecoverable flight train once in the water, a conservative assessment was performed that included the following assumptions:

- The parachute remained open during the entire in-water descent, slowing the descent velocity, when, in actuality, the parachute could either collapse or become entangled in the other flight train components;
- The density of seawater remained constant at a value expected at 6,000 m (19,685 ft) depth (1.05 g per cubic cm [65.5 lb per cubic ft]), increasing both the drag and the buoyant forces acting upon the entire system, when, in actuality, the density of seawater would be less at shallower depths; and
- The effect of horizontal currents (which would generate a negligible amount of lift) on the system’s descent were zero, given that the effects would likely be outweighed by the previous two assumptions.

Based on this assessment, and assuming 170 kg (375 lb) of buoyant force, the flight train would sink at a rate between about 0.10 and 0.12 m per second (0.33 to 0.39 ft per second), equating to approximately 375 to 420 m (1,230 to 1,380 ft) per hour (**Figure 8**).



**Figure 8: Estimated Sink Rates of Unrecoverable Flight Train**

The time required to reach the ocean floor would depend on the depth of the ultimate landing location. However, based on the most commonly encountered depth “bins” within the action area (3,000 to 5,000 m [9,800 to 16,400 ft]: **IOC et al. 2003**), the descending flight train assembly would likely take between approximately 7.5 and 12.5 hours to reach such depths.

### 2.3.3 Fate of Unrecovered Materials

#### 2.3.3.1 Meteorological Equipment

##### Latex Balloons

When a latex balloon is released, the helium gas inside it expands as the balloon rises. Depending on the weight of the balloon and the thickness of the latex, the helium will expand the latex until the balloon bursts. Commonly cited research (**Burchette 1989**) asserts that nearly all latex balloons at burst altitude rupture into small, ribbon-like fragments. However, **Foley (1990)** demonstrated that 80 percent of latex balloons studied burst into 2 to 3 mm shreds but, of those, 60 percent (48 percent of the total) remained intact (all or most parts still connected together) and 20 percent burst without shredding at all. Similarly, more recent research (**Irwin 2012**) noted that only 12 percent of balloons in a trial burst into small pieces and 81 percent were recovered with half the balloon mass intact. As such, from these studies, it is assumed that a portion of the MET balloons used in support of SFDT launch operations would land in the Pacific Ocean in small shreds, but most would likely land deflated and fully intact. These balloon pieces would be positively buoyant, float on the surface, and begin to photo-oxidize due to ultraviolet light

exposure. However, degradation would occur at a slower rate than on land due to less heat buildup and the biofouling. Numerous studies show that latex in water will degrade, losing tensile strength and integrity, though this process can require multiple months of exposure time (**Pegram & Andrady 1989; Andrady 1990; Irwin 2012**).

As the latex balloon fragments float on the surface, they would become a substrate for microflora such as algae and eventually become weighted down with heavy-bodied epifauna such as tunicates (**Foley 1990**). In addition to further degradation of the latex material, the embedded organisms would cause the material to become negatively buoyant, making it slowly sink to the ocean floor.

The degree to which such colonization would occur would correspond to the amount of time the balloon would remain at or near the ocean's surface. Additionally, an area's geographic latitude (and corresponding climatic conditions) has been shown to have a marked effect on the degree of biofouling on marine debris. Studies in temperate waters have shown that fouling can result in positively buoyant materials (e.g., plastics) becoming neutrally buoyant, sinking below the surface into the water column after only several weeks of exposure (**Ye & Andrady 1991; Lobelle & Cunliffe 2011**), or descending farther to rest on the seafloor (**Thompson et al. 2004**).

#### Polystyrene Radiosonde Box

Foamed polystyrene is a lightweight, positively buoyant polymer that is degraded by exposure to sunlight, high temperatures, moisture, abrasion, and fouling by microorganisms. According to weathering studies in the marine environment (**Andrady 1990**), foamed polystyrene sheets rapidly undergo yellowing, algal fouling, and embrittlement of the exposed surface. Over a twelve-month exposure period evaluated by **Andrady (1990)**, a surface layer of up to half the original thickness became brittle enough to crumble on handling. As the polystyrene became more brittle, wind and rain exposure scoured the surface, sloughing off fragments and decreasing the thickness of the material. **Andrady (1990)** also determined that the tensile strength of the remaining (non-yellowed) material decreases with the duration of exposure, as the deeper layers become accessible to the free radicals generated during the photoreaction. Foamed polystyrene degraded more quickly in seawater than on land, losing over 60 percent of tensile strength in 4 months and rapidly fragmenting.

As such, it is expected that the radiosonde boxes would remain afloat for a period time following oceanic impact, likely less than a year, during which a combination of fouling (**Wahl 1989**) and photodegradation would cause the material to break into smaller pieces and eventually sink into the water column. As each box would have "return to sender" information on it, the possibility exists for an inestimable portion of these items to be recovered prior to their ultimate degradation and/or descent below the water's surface.

### Super Loki Rockets

Comprised of aluminum, these negatively buoyant items would sink and slowly corrode on the ocean floor. Small amounts of residual unconsumed solid propellant could be present inside them. However, effects on water quality would be negligible due to the extremely small amount of residual fuel and the effective dilution and buffering capacity of the ocean.

Corrosion of hardware and spent rocket stages into toxic concentrations of metal ions would be localized and temporary because corrosion rates of aluminum are very slow in seawater (**Godard 1960; Ezuber et al. 2008**) and do not change with immersion depth (**Vargel 2004**). Miscellaneous materials such as battery electrolytes are in such small quantities that only temporary, highly localized effects on water quality would be expected.

### ROBIN Spheres

The degradation mechanisms for the plastic component (polyethylene terephthalate) of the Mylar ROBIN spheres would be similar to other polymers previously discussed. Studies have demonstrated (**Edge et al. 1991; Allen et al. 1994**) that the breakdown of these films is enhanced by increasing temperature, relative humidity, and ultraviolet (UV) irradiation, with high humidity causing the greatest degradation. However, due to the aluminized outer surface, photo-oxidation of the plastic material would be substantially reduced. As such, it is expected that biofouling (**Wahl 1989**) would occur before notable loss of structural integrity, with these items descending to the ocean floor where they would likely remain for many years.

#### **2.3.3.2 Flight Train**

##### Nylon Burst Parachute

The parachute's primary material, nylon, is in the family of high molecular weight polymers known as polyamides (**Hegde et al. 2004**), which are not easily degraded by abiotic (physical or chemical) or biotic processes (**Haines & Alexander 1974**). More specifically, LDSD parachutes are made of "ripstop" nylon that is woven with a double or extra-thick thread at regular intervals, creating a pattern of small squares. This structure keeps small tears from spreading (**Hall 2015**).

Photo-oxidative degradation, the process of decomposition of the material by light (most effectively by near-UV and UV wavelengths), would be the most effective source of damage exerted on the nylon parachute. Once initiated by exposure to sunlight, the degradation can continue thermo-oxidatively for some time without the need for further UV exposure as long as oxygen is available (**Andrady 2011**). However, upon entering the water column, the entire balloon flight train system would rapidly sink below the depths to which UV radiation in clear Pacific Ocean waters has been reported to penetrate (50 to 60 m [160 to 200 ft]: **Ahmad et al. 2003**), eventually resting on the ocean floor where exposure to UV light would also not occur (**Gregory & Andrady 2003**), making photo-oxidation improbable. Once on the ocean floor, the relatively constant temperatures (lacking diurnal cycling) and the lower oxygen concentration (as compared to the atmosphere) would slow any resultant degradation (**Andrady 1990; Andrady 2011**).

Polymers can fragment in the environment as a consequence of prolonged exposure to UV light and physical abrasion (**Andrady et al. 2003; Thompson et al. 2004**). This is particularly evident on shorelines where photodegradation, elevated temperatures, and abrasion through wave action make plastic items brittle, increasing their potential for fragmentation (**Andrady 2011; Barnes et al. 2009**). In consideration of the fact that the nylon parachute would not undergo substantial chemical or physical degradation prior to or following landing in the ocean, and the depth at which it would ultimately rest would not be subjected to abrasive physical processes (which could cause a “mass” release of particles), it is expected that any resultant fragmentation into smaller pieces, while inevitable over an indeterminate period of time, would be at a very slow, gradual rate.

Even when the nylon fragments into smaller pieces in the long term, it is likely that not all pieces would be positively buoyant due to fouling and/or sediment deposition. Furthermore, once in the water column, the particles could again return to the seafloor. **Van Cauwenberghe et al. (2013)** suggest that, once in the water column, small pieces of plastic could reach the sea floor as marine snow, which is produced as a biologically enhanced aggregation of small organic and inorganic particles (**Allredge & Silver 1988**). Sinking rates of marine snow are estimated to range from 1 to 368 m (3 to 1,200 ft) per day (**Allredge & Silver 1988**). Therefore, considering this sink rate, the return of the smaller plastic particles to the seafloor once at the surface could take as little as several months to more than decades.

While polymers will eventually biodegrade in the marine environment, the rate of this process, even in the benthic sediment, is several orders of magnitude slower compared to light-induced oxidative degradation (**Andrady 2011**). The ultimate degradation endpoint for polymers is when all organic carbon is converted into carbon dioxide, water and biomass by microorganisms (referred to as complete mineralization [**Andrady 1994**]), the kinetics of which are not well understood (**Andrady 2011**). Estimates regarding the amount of time required for such a fate in the marine environment are highly variable, spanning several orders of magnitude from hundreds (**Derraik 2002**) to even thousands of years (**Barnes et al. 2009**), particularly in deep, cold, dark oceans (**Barnes et al. 2009; Bergmann & Klages 2012**).

Because of the expected rapid descent toward the light-deficient ocean floor (**Wahl 1989**), fouling of a nylon burst parachute by photosynthetic organisms would be minimal. However, once on the seafloor, the parachute may provide hard substrata for the attachment of opportunistic sessile biota, increasing local diversity (**Mordecai et al. 2011; Moret-Ferguson et al. 2010**), though at the cost of replacing existing species and leading to non-natural alterations of community composition (**Bergmann & Klages 2012**). The epibionts of benthic polymer (i.e., plastic) debris are not as well-known as those of pelagic items. Accounts are limited (e.g., **Hollström 1975**), but indicate a hard ground biota dominated by brozoans.

## Kevlar® Ladder

Kevlar® is a negatively buoyant material that is highly resistant to mechanical degradation by abrasion or stretching (Terry & Slater 1999). Although studies have shown immersion in seawater causes fibers to swell and consequently lose tensile strength (Fowler & Reiniger 1979; Riewald et al. 1986; Gopalan et al. 1989), it is not expected that the material would be exposed to extreme mechanical loading once on the seafloor. As such, the material is expected to remain intact for the foreseeable future.

## Metallic Components

Once the balloon flight train system is in contact with seawater, structural metallic components (i.e., aluminum and steel alloys) would corrode. Likewise, based on research conducted by Rosak (1985), the LiSO<sub>2</sub> batteries would corrode, releasing their electrolytes (e.g., SO<sub>2</sub>, acetonitrile, and lithium salt) into the water column and expose the internal lithium metal strips to seawater.

As corrosion rates in seawater are from the cumulative effect of multiple site-specific factors, including temperature, pH, dissolved oxygen, currents, and extent of biofouling (Guedes Soares et al. 2011), absolute corrosion rates of metallic balloon flight train hardware cannot be accurately estimated. However, some general observations can be made about the fate of these materials. When comparing potential corrosion rates of the balloon flight train system metals, due to the relatively high dissolved oxygen concentrations of the Pacific Ocean water at depth (Joos et al. 2003), ferrous materials would undergo corrosion more rapidly (Melchers 2005) than the aluminum components, which tend to form a protective oxide coating that can preserve the material (Reinhart 1969). Similarly, items containing lead (e.g., solder), a metal often regarded as highly resistant to corrosion in the marine environment (Tylecote 1977), would form a protective inorganic coating on their surfaces, slowing dissolution. Finally, given lithium metal's highly reactive nature in water, some of the corroded LiSO<sub>2</sub> batteries (i.e., those not fully discharged) could exhibit characteristic, short-duration lithium-water exothermic burning and popping, forming lithium chloride and releasing hydrogen gas (Rosak 1985). In the instance of fully discharged batteries, they would be unreactive due to the lithium metal being converted to a lithium oxide (Aral & Vecchio-Sadus 2008).

## ***2.4 Measures to Reduce Potential for Adverse Effects on Listed Species***

To reduce the potential for adverse effects on listed species, NASA has included the following measures as integral components of its proposed action.

### **2.4.1 Recovery of Expended Flight Hardware**

As discussed in Section 2.3.1 of this BE, NASA requires that all major flight hardware components be tracked during flight until splashdown, at which point surface vessels (i.e., propeller-driven ships) will be deployed to recover the balloon and TV. The rapid recovery of

such items would limit the timeframe within which listed species could interact with (and therefore be exposed to stressors from) the expended flight hardware.

#### **2.4.2 Employment of Vessel Operating Protocols**

To ensure that in-water species are not exposed to ship-induced stressors (e.g., ship strike), constant vigilance would be maintained for the presence of ESA-listed marine mammals and sea turtles. Vessels would remain at least 92 m (300 ft) from Hawai‘ian monk seals and humpback whales and at least 46 m (150 ft) from all other marine mammals and sea turtles. Vessel speeds would be reduced to 18.5 km/hr (10 kt) or less when piloting in the proximity of marine mammals and further reduced to 9.25 km/hr (5 kt) or less when piloting in areas of known or suspected sea turtle activity. If marine mammals or sea turtle approach a vessel, activity would stop, allowing the animal to safely depart the immediate area prior to resuming operation. Additionally, to prevent the introduction of marine alien species, all submerged and waterline surfaces would be cleaned of algae or other organisms prior to vessel use and ballast water would be managed in accordance with U.S. Coast Guard Regulations (33 CFR Part 151).

Likewise, the operators of LDSO search and recovery aircraft are required to operate at an altitude greater than 457 m (1,500 ft), at which the effects of overflight (e.g., startle) would be minimal. Furthermore, should aircraft operators observe marine mammals or sea turtles, they would not undertake potentially harassing (e.g., repeated circling) patterns until the individuals are no longer under the aircraft’s flight path.

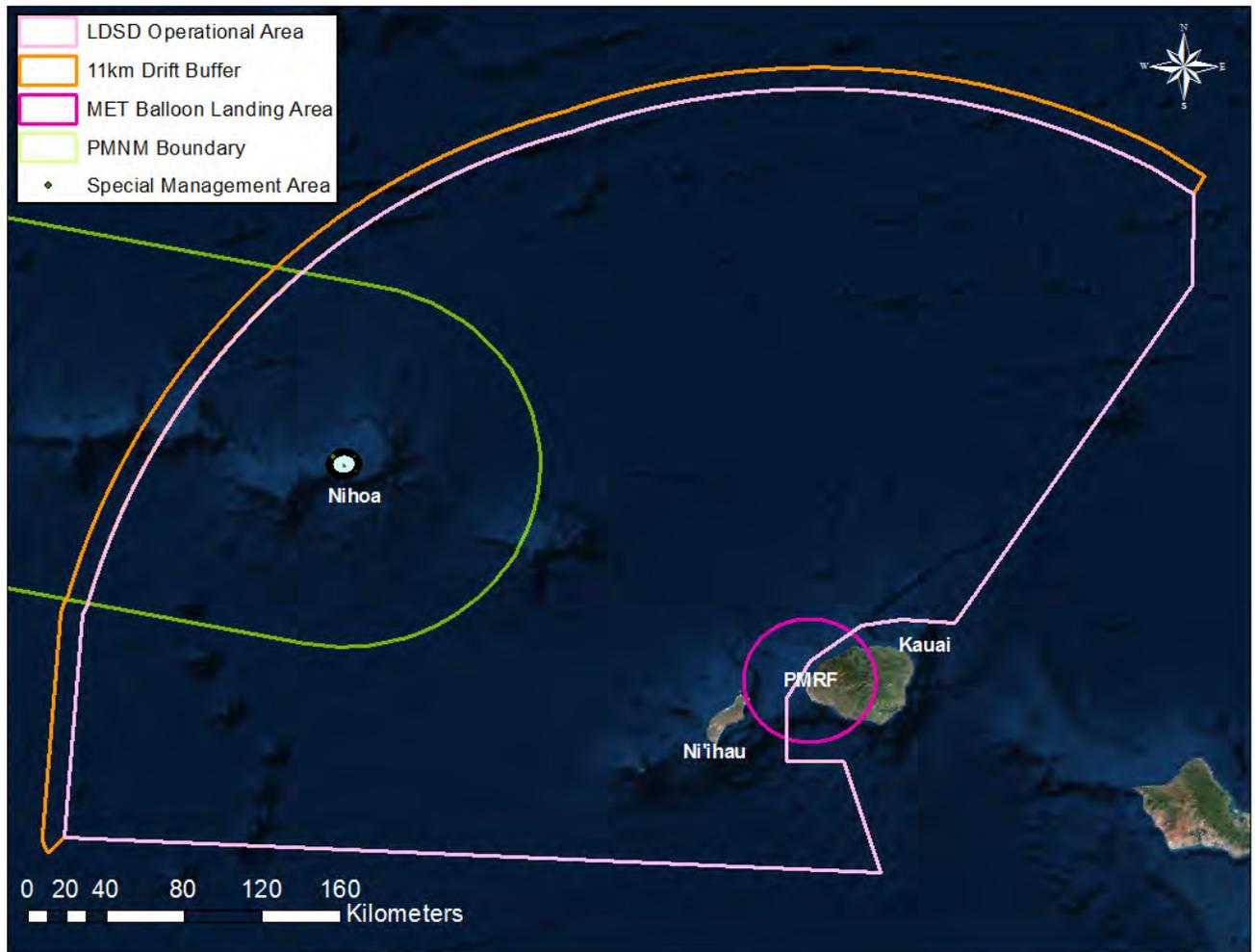
#### **2.4.3 Reporting**

Under the ESA (and the PMNM Permit General Terms and Conditions), NASA has a continuing duty to monitor the effects of its ongoing actions on listed species. As such, by December 31 of each year between the years 2015 and 2019, NASA will submit to NMFS a report on the outcomes of its proposed action. Annual reports will include the following: (a) the dates of all SFDT launches; (b) locations (GPS coordinates) of all SFDT flight terminations and resultant recoveries; (c) any available information on the fate of expended flight hardware after flight termination, including sink rate, evidence that components failed to sink, or evidence that components later reappeared on the surface; (d) information on attempts to recover hardware after flight termination; and (e) any evidence that listed species were adversely affected by the action.

### **2.5 Action Area**

The action area is defined in 50 CFR 402.02 as “all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action.” **Figure 9** depicts the action area for the proposed SFDTs, which includes the airspace, land, water column, and seabed within which the balloon and TV could fly and expended flight hardware could land and ultimately come to rest. The action area also accounts for where the flight and deposition of meteorological support equipment (i.e., MET balloons, Super Loki rockets, ROBIN spheres) could occur.

The action area is defined by the addition of three shapes. The basic shape, depicted in light pink in **Figure 9**, is the LDSO operations area defined by a 315 km (170 nm) arc centered on Mākaha Ridge, Kaua‘i, which is the TV to PMRF telecommunications limit. This operations area is wholly inside the USN Hawai‘ian Range Complex, and is where the balloon would loft the TV, the TV would perform the SFDT, and expended flight hardware would land. The second orange shape is an approximately 11 km (6 nm) buffer along the western and northern PMRF to TV telecommunications arc. If the TV and balloon were to land at the northern or western boundary of the telecommunications limit, this buffer accounts for a conservative estimate of the distance floating hardware could drift with westerly flowing surface currents (**Flament 1996**) for the 12 hours it could take for recovery vessels to reach them. This buffer also includes a conservative estimate of potential lateral drift of the unrecovered flight train as it descends to the ocean floor. The third shape is a dark pink circle, having a 17 km (9 nm) radius centered at the MET balloon release location on PMRF, within which 2,000 gram and 30 gram MET balloons would land upon bursting at altitude.



**Figure 9: LDSO SFDT Action Area**

It should be noted that under nominal flight conditions, the action area would not include the terrestrial or marine areas comprising Ni‘ihau, Nihoa Island, and the Special Management Area within 5.6 km (3.0 nm) surrounding Nihoa Island. To ensure that flight hardware does not land within these areas, one of two scenarios would occur: (1) the LDSD Project would initiate the SFDT in such a manner that expended flight hardware would be recovered or sink before drifting into either area or (2) the flight system would overfly these areas and the TV would be dropped outside either area. Therefore, with the exception of an in-flight system failure, expended flight hardware would not be deposited on Ni‘ihau, Nihoa Island, or within the Special Management Area surrounding Nihoa Island.

## ***2.6 Connected Federal Action Also Considered in This BE***

As the action area would include a portion of the PMNM, on January 27, 2015, NASA submitted to the PMNM permit coordinator an application seeking authorization to allow for access to PMNM waters. NASA is seeking this authorization via the established permitting process defined in Presidential Proclamation 8031 and codifying regulations in 50 CFR Part 404. PMNM issues permits in six categories (Research, Education, Conservation and Management, Native Hawai‘ian Practices, Special Ocean Use, and Recreation). Per recommendation of the PMNM permit coordinator, NASA is requesting authorization under Permit Category-Conservation and Management. The permit application seeks the ability to potentially drop and recover floating expended flight hardware from five years of future flights beginning with two scheduled SFDTs in 2015 within the boundary of PMNM, but outside of the Special Management Area surrounding Nihoa Island (**Figure 9**). This permit would also allow NASA to enter the PMNM for recovery purposes if the flight hardware is dropped outside the PMNM but carried into the PMNM by ocean currents.

Under the assumption that all possible trajectories were allowed to fly, NASA estimates the balloon has approximately a 0.4 percent chance of reaching float altitude within PMNM and a 20 percent chance of entering PMNM after reaching float altitude. These probabilities are reduced when NASA and the USN apply the project’s established Go/No Go criteria (e.g., safety restrictions, proper weather conditions, operational status of all LDSD subsystems, telemetry checks, and readiness of recovery systems). These test rules eliminate trajectories that are predicted to fly out directly over large populated areas or follow a trajectory outside boundaries established by NASA, the USN and the Federal Aviation Administration.

### 3.0 Listed Species & Critical Habitat in the Action Area

The following ESA-listed marine species and critical could occur within the action area, or may be affected by the proposed action.

#### 3.1 *Mysticetes*

Mysticetes are one of the two suborders of cetaceans and are characterized by having baleen plates for filter feeding (**Bannister 2009**). Two types of mysticetes occur in the action area: balaenids and rorquals (a family and a group, respectively).

##### 3.1.1 Balaenids

Balaenids include the bowhead whales and right whales (**Bannister 2009**). One right whale species has the potential to occur in the action area.

###### 3.1.1.1 *North Pacific Right Whale*

The North Pacific right whale (*Eubalaena japonica*) is ESA-listed as endangered throughout its range (**35 FR 18319**). Right whale adults typically are 13 to 16 m (43 to 52 ft) in length but North Pacific individuals may measure up to 18 m (59 ft) and weigh up to 100 metric tons (110 tons: **Kenney 2009**). The North Pacific right whale is comprised of two populations – western and eastern – that are considered isolated from each other (**Brownell et al. 2001**). The population of the eastern North Pacific is considered to be the smallest whale population in the world for which an abundance estimate is known, at approximately 30 animals (**Wade et al. 2010**). No reliable population estimate presently exists for the species in the western North Pacific, however it may number at least in the low hundreds (**Brownell et al. 2001; Clapham et al. 2004**).

Right whales migrate annually between high-latitude feeding grounds and low-latitude calving and breeding grounds (**Kenney 2009**). Feeding takes place in spring, summer, and fall in higher-latitude feeding grounds, where ocean temperatures are cooler and overall biological productivity is much higher (**Kenney 2009**). The specific locations of such feeding grounds are not well-known. Based on historical whaling records and the few recent sightings, **Clapham et al. (2004)** found that the principal feeding grounds were most likely in the Sea of Okhotsk, central and eastern Bering Sea, and Gulf of Alaska, all of which are more oceanic (offshore) habitats than those utilized by their well-studied North Atlantic counterparts. Breeding and calving both occur during the winter months, but the locations of such habitats for North Pacific right whales are unknown (**Kenney 2009**).

The primary food source for North Pacific right whales is zooplankton (e.g., copepods). Right whales are skim-feeders: they feed by removing prey from the water using baleen while moving with their mouth open through a patch of zooplankton, typically within the upper 10 to 20 m (33

to 66 ft) of the water column (Watkins & Schevill 1976; Woodward et al. 2006; Parks et al. 2011).

Occurrence of this species within the Hawai‘ian Islands, and, furthermore, the action area, would be considered rare based upon historical sightings data. For example, in April 1996, a right whale was sighted off of Maui (Salden & Mickelsen 1999). This was the first documented sighting of a right whale in Hawai‘ian waters since 1979 (Herman et al. 1980; Rowntree et al. 1980). Further supporting this conclusion is earlier work by Scarff (1986), who reviewed information from the mid-1800s and that from Rowntree et al. (1980) and Herman et al. (1980), concluding that individuals in the waters off Hawai‘i, particularly during the time when the proposed action would occur (i.e., June-July), represented stragglers, not concentrations of wintering right whales. Although Kennedy et al. (2012) recently documented a high- to low-latitude migration of the individual sighted in April 1996, confirming that right whales at least occasionally travel across the North Pacific between Hawai‘i and Alaska, the authors caution that it is still premature to call the present record definitive proof of an annual migration.

### 3.1.2 Rorquals

Rorquals, of the family Balaenopterida, are the largest group of baleen whales, and include the blue, fin, sei, and humpbacks (Bannister 2009).

#### 3.1.2.1 Blue Whale

The blue whale (*Balaenoptera musculus*) is ESA-listed as endangered throughout its range (35 FR 18319). It is the largest of the baleen whales, with lengths exceeding 30 m (100 ft: Sears & Perrin 2009). The North Pacific blue whale is comprised of two stocks – western and eastern. NMFS considers blue whales found in Hawai‘i as part of the western North Pacific stock (Carretta et al. 2005). Blue whales typically migrate between high-latitude feeding grounds and low-latitude wintering areas (Sears & Perrin 2009). However, some individuals have been observed to remain in the same region year-round (e.g., Watkins et al. 2000). The western stock feeds in summer in the southwest of Kamchatka, south of the Aleutian Islands, and in the Gulf of Alaska (Stafford 2003; Watkins et al. 2000). In winter, they migrate to lower latitudes in the western Pacific and, much less frequently, in the central Pacific, including Hawai‘i (Thompson & Friedl 1982).

Blue whales are “lunge feeders” targeting dense patches of euphausiids and other crustacean meso-zooplankton (Sears & Perrin 2009) in the upper 150 to 200 m (490 660 ft) of the water column (Croll et al. 2001, 2005).

The presence of blue whales in the action area would be considered rare. With the exception of occasional encounters (e.g., O‘ahu: Thompson & Friedl 1982), there are few records of blue whales in Hawai‘ian waters. This conclusion is especially true during the time of year when the proposed action would occur, as individuals would be expected to be at higher latitudes in summer foraging grounds.

### 3.1.2.2 *Fin Whale*

The fin whale (*Balaenoptera physalus*) is ESA-listed as endangered throughout its range (**35 FR 18319**). The second largest of the whales in the family Balaenopteridae, fin whales range in length up to approximately 26 m (85 ft), with females slightly larger than males (**Aguilar 2009**). Fin whales are considered a cosmopolitan species and occur from polar to tropical waters, with the greatest concentrations usually outside of the continental slope (**Aguilar 2009**). Fin whales engage in north-south movements from wintering grounds to summer feeding areas (**Aguilar 2009**). The locations where breeding and calving occur remain largely unknown (**Rice 1998**) because, unlike other mysticetes, calving does not appear to take place in distinct inshore areas (**Reeves et al. 2002; Mizroch et al. 2009**). Reviewing historic catch, acoustic, and observation data, **Mizroch et al. (2009)** found that, during summer, fin whales range from the Chukchi Sea south to 35° N on the Sanriku coast of Honshu (Japan), to the Subarctic Boundary (approximately 42° N) in the western and central Pacific. During winter months, Pacific fin whales have been documented over a wide area from 60° N south to 23° N (**Mizroch et al. 2009**).

A 2002 shipboard line-transect survey of the entire Hawai‘ian Islands Economic Exclusion Zone (EEZ) resulted in an abundance estimate of 174 fin whales (**Barlow 2003**). However, **Barlow (2006)** did not provide a density estimate for fin whales in Hawai‘i because the survey (originally analyzed in **Barlow 2003**) was not conducted during the peak period of abundance (i.e., winter).

Fin whales are “lunge feeders,” feeding at similar depths and prey as blue whales (**Goldbogen et al. 2007**). Fin whales feed almost exclusively on euphausiids (**Aguilar 2009**).

Occurrence of this species within the action area, particularly during the time of year when the action would occur, would be highly unlikely. Summarizing observations of fin whales in the Hawai‘ian Islands, **Mizroch et al. (2009)** found that, while several sightings from the 1970s were during the month of May, no recent reports (e.g., O‘ahu: **Thompson & Friedl 1982, McDonald & Fox 1999**; Kaua‘i: **Mobley et al. 1996**) were between May and July. As with the other mysticetes potentially within the action area, fin whales would typically be at higher latitude foraging grounds during the summer months.

### 3.1.2.3 *Sei Whale*

The sei whale (*Balaenoptera borealis*) is ESA-listed as endangered throughout its range (**35 FR 18319**). Individuals range in length up to approximately 20 m (66 ft), which makes it the third largest whale in the family Balaenopteridae (**Horwood 2009**). Like most balaenopterids, sei whales are found in all oceans and migrate long distances north-south from high-latitude summer feeding grounds to lower-latitude winter areas. They range even farther offshore than fin whales and tend to be nomadic (**Mizroch et al. 1984**). In the North Pacific Ocean, their summer distribution extends from California westward to Japan and northward to the Aleutian Islands. In the eastern North Pacific, their winter distribution ranges from Piedras Blancas in California to

the Revillagigedo Islands off Mexico. However, in the central and western North Pacific, their winter distribution is largely unknown (**Rankin & Barlow 2007**).

The NMFS divides Pacific Ocean sei whales into three stocks, one of which inhabits the waters around Hawai‘i. A 2002 shipboard line-transect survey of the entire Hawai‘ian Islands EEZ located groups of sei whales northeast of Maui (late November) and east of Hawai‘i, resulting in a summer and fall abundance estimate of 77 sei whales (**Barlow 2003**). **Barlow (2006)** did not provide a density estimate for sei whales in Hawai‘i because the survey (originally analyzed in **Barlow 2003**) was not conducted during the peak period of abundance (i.e., winter).

Sei whales are primarily skimmers rather than lunge swallows, feeding on patches of copepods (their preferred prey), euphausiids, fish, and squid, if available (**Horwood 2009**).

#### **3.1.2.4 Humpback Whale**

The humpback whale (*Megaptera novaeangliae*) is ESA-listed as endangered throughout its range (**35 FR 18319**). Humpback whales are shorter and stouter than most other balaenopterids. At maturity, individuals are typically between 14 and 15 m (46 and 49 ft: **Clapham 2009**). In the North Pacific, there are three separate humpback whale populations with the Central North Pacific stock occurring within Hawai‘ian waters (**Allen & Angliss 2014**). Employing the most recent survey data from the SPLASH study (**Calambokidis et al. 2008**), **Allen & Angliss (2014)** conservatively estimated the minimum abundance for the Central West Pacific stock to be approximately 5,800 individuals.

Humpbacks are typically found in coastal or shelf waters in summer and close to islands or reef systems in winter (**Clapham 2009**). The species is highly migratory, moving seasonally between low-latitude winter breeding areas and high-latitude summer feeding grounds (**Clapham & Mead 1999**). In summer, the majority of whales from the Central North Pacific stock are found in the Aleutian Islands, Bering Sea, Gulf of Alaska, and Southeast Alaska and northern British Columbia (**Calambokidis et al. 2001**). Humpback whales use Hawai‘ian waters as a major breeding ground during winter and spring (November through April: **Baker et al. 1986**). **Calambokidis et al. (1997)** estimated that up to half of the North Pacific populations of humpback whales migrate to the Hawai‘ian Islands during the winter. Peak abundance around the Hawai‘ian Islands is from late February through early April (**Mobley et al. 2001**; **Carretta et al. 2005**). During the fall–winter period, primary occurrence is generally within approximately 90 kilometers (50 nm) offshore, which takes into consideration both the available sighting data and the preferred breeding habitat (shallow [ $< 200$  m (660 ft)] waters: **Herman & Antinaja 1977**; **Mobley et al. 1999**). The greatest densities of humpback whales (including calves) are in the four-island region consisting of Maui, Moloka‘i, Kaho‘olawe, and Lana‘i, as well as Penguin Bank (**Mobley et al. 1999, 2001**) and around Kaua‘i (**Mobley 2005**). However, coupling spatial modeling with observation data, **Johnston et al. (2007)** also identified extensive areas of suitable wintering habitat within the Northwestern Hawai‘ian Islands (NWHI).

Humpbacks have shorter and coarser baleen bristles than other baleen whales and feed on both euphausiids and schooling fish (**Clapham 2009**). Primarily classified as “swallowers” rather than “skimmers,” feeding primarily occurs in the upper 150 m (490 ft) of the water column (**Goldbogen et al. 2008; Ware et al. 2011**).

Of the mysticetes potentially within the action area, the humpback whale is the species most likely to occur. Its presence during the time the action is conducted (i.e., June-August) would be unlikely, as it would be in northern foraging grounds, returning to the nearshore waters of the action area in late fall.

## **3.2 Odontocetes**

Odontocetes are the second suborder of cetaceans and are characterized by having teeth (**Hooker 2009**).

### **3.2.1 False Killer Whale**

Three stocks of false killer whales (*Pseudorca crasidens*) are recognized within Hawai‘ian waters: the Hawai‘i pelagic stock, the Main Hawai‘ian Islands (MHI) insular stock, and the NWHI insular stock (**Carretta et al. 2014**). The MHI insular Distinct Population Segment (DPS) is ESA-listed as endangered throughout its range (**77 FR 70915**). A member of the dolphin family, females reach lengths of almost 5 m (16 ft), while males are almost 6 m (20 ft: **Baird 2009**). In adulthood, false killer whales can weigh approximately 680 kilograms (1,500 pounds). False killer whales are considered to be very social animals, usually traveling in groups of 20 to 100 individuals (**Baird 2009**).

**Forney et al. (2010)** defined the general boundaries of the MHI insular stock to include a “core” use area extending 40 km (22 nm) from shore and an “extended” offshore boundary ranging from the outer boundary of the “core” area out to 140 km (76 nm) from the MHI. **Baird et al. (2012)** found three areas of frequent use by the MHI insular population: the north side of the island of Hawai‘i (both east and west sides), a large area extending from north of Maui to northwest of Moloka‘i, and a small area to the southwest of Lana‘i. The depth distribution for high-use areas was mean depth of 623 m (2,070 ft), relative to an overall median depth of 1,679 m (5,500 ft: **Baird et al. 2012**). Tracks from tagged individuals provided documentation that individuals from the central and eastern MHI use the area around Kaua‘i and Ni‘ihau (**Baird et al. 2010, 2011**). Knowledge of seasonal movements of this species is still evolving. **Baird et al. (2012)** provided satellite tracking data for a large number of individuals, however their data did not cover the timeframe between March and June. Although the authors acknowledge that the species does use some of the same areas during these months, as in the months for which data is available, more information is needed to determine whether additional areas outside of their identified high use areas are frequented (**Baird et al. 2012**).

In Hawai‘i, false killer whales have been documented feeding on a wide variety of large fish, including wahoo (*Acanthocybium solandri*), tunas (*Thunnus* spp.), and broadbill swordfish

(*Xiphias gladius*) (**Baird et al. 2008**). Little is known about the diving behavior of this species in Hawai‘i (**Baird et al. 2012**). However, a recent tracking study by **Baird et al. (2014)** off the coast of Kaua‘i has contributed to the knowledge base. The single tagged individual in the study was observed to dive to median depths of approximately 138 m (453 ft) with a maximum recorded dive of 928 m (3,040 ft). As the median depth of the waters within which the individual was monitored was 710 m (2,330 ft), some of the deepest dives were likely at, or near, the sea floor (**Baird et al. 2014**).

### 3.2.2 Sperm Whale

The sperm whale (*Physeter macrocephalus*) is ESA-listed as endangered throughout its range (**35 FR 18319**). The largest odontocete, male sperm whales are 18.5 m (60 ft) in length, females 12.5 m (41 ft: **Rice 1989**). Sperm whales are typically found in deep oceanic waters, with females almost always inhabiting water deeper than 1,000 m (3,300 ft: **Whitehead 2009**). **Baird et al. (2013)** most commonly encountered sperm whales in Hawai‘ian waters deeper than 3,000 m (10,000 ft). Sperm whales are widely distributed throughout the Hawai‘ian Islands year-round (**Au et al. 2014; Baird et al. 2013; Barlow 2006; Mobley et al. 2000**), and have been found to be the most abundant large whale in Hawai‘ian waters during summer and fall months (**Barlow 2006**). **Barlow (2006)** estimated there to be approximately 6,900 sperm whales in Hawai‘ian waters based on his survey work conducted between August and November 2002. A recent yearlong acoustic monitoring study conducted by **Au et al. (2014)** within and adjacent to the action area most frequently identified sperm whales on the southwest side of Kaua‘i between the months of March and June.

In comparison to the other cetacean species in the action area, sperm whales forage at deeper water depths. Maximum-recorded dive depths differ across regions, with values of 644 and 985 m (2,110 and 3,230 ft) for the Gulf of Mexico and Atlantic Ocean, respectively (**Watwood et al. 2006**), 1,400 m (4,600 ft) in the north Pacific Ocean (**Aoki et al. 2012**), and up to nearly 1,900 m (6,230 ft) off the coast of Norway (**Teloni et al. 2008**). Though individuals do forage at the ocean floor, the majority of foraging observed occurred higher in the water column (**Aoki et al. 2012; Mathias et al. 2012; Miller et al. 2013; Teloni et al. 2008; Wahlberg 2002**).

Sperm whales spend about 70 to 80 percent of their time at depths of several hundred meters (**Amano & Yoshioka 2003; Watkins et al. 1993**), and most of their diet consists of mesopelagic and bathypelagic cephalopods (**Clarke 1980; Clarke et al. 1993; Kawakami 1980**). Multiple hypotheses exist regarding the means sperm whales locate prey. However, it is generally accepted that foraging individuals rely heavily on emitting acoustic “clicks” during dives to echolocate prey items (**Madsen et al. 2002; Miller et al. 2004**).

### 3.3 *Pinnipeds*

One species of phocid (true seal), the Hawai‘ian monk seal, is known to inhabit the action area. Additionally, designated and proposed Hawai‘ian monk seal critical habitat is within the action area.

#### 3.3.1 Hawai‘ian Monk Seal

The Hawai‘ian monk seal (*Neomonachus schauinslandi*; formerly *Monachus schauinslandi*) is ESA-listed as endangered throughout its range (**41 FR 51611**). Adults range in length from 2.1 to 2.4 m (7 to 8 fr) and weights are between 170 and 240 kg (375 and 529 lb), with females slightly larger than males (**Gilmartin & Forcada 2009**). The species occurs only in the central North Pacific and are managed as a single stock, although there are six main reproductive subpopulations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll (**Ragen & Lavigne 1999**), all of which are outside the action area. The vast majority of the population is present in the NWHI. Monk seal births in Hawai‘i usually occur from February to August, peaking in April to June, but births are known in all months (**Gilmartin & Forcada 2009**).

Until recently, this species occurred almost exclusively at remote atolls in the NWHI. In the last decade, however, sightings of Hawai‘ian monk seals in the MHI have increased considerably (**Baker & Johanos 2004**). Most monk seal haulout events in the MHI have been on the western islands of Ni‘ihau and Kaua‘i (**Baker & Johanos 2004**), including the PMRF Main Base beach. The best estimate of the total population size is approximately 1,060 individuals in the Hawai‘ian Islands Archipelago, of which at least 150 are in the MHI (**Baker et al. 2011**) and the remaining 910 in the NWHI. Recent population trends indicate that the population in the MHI is growing whereas that in the NWHI is decreasing (**Baker et al. 2011**). A recent analysis of range-wide movements by **Johanos et al. (2013)** demonstrates connectivity (albeit rare; 10 seals in 30 years of observations) between the NWHI and MHI subpopulations and highlighted an approximately 2,400 km (1,300 nm) transit by a female spanning the entire Hawai‘ian archipelago. Intra-region movements were more common (**Johanos et al. 2013**).

Hawai‘ian monk seals have a diverse prey base, including demersal fish, squid, octopus, eels, and crustaceans (**Parrish et al. 2000; Cahoon et al. 2013**), with little observed difference between those of the NWHI and MHI subpopulations (**Cahoon et al. 2013**). They mostly forage within their resident atolls and along the barrier reefs, but may also forage at distant seamounts and submerged reefs hundreds of kilometers from their colonies (**Gilmartin & Forcada 2009; Stewart et al. 2006**). **Stewart et al. (2006)** found most (75 percent) core foraging areas to occur within 20 km (11 nm) of the respective colony. Although individuals have been observed diving to depths of approximately 500 m (1,640 ft: summarized by **Stewart et al. 2006**), the majority of foraging activity typically occurs at depths less than 100 m (330 ft: **Parrish et al. 2000, 2005, 2008; Stewart et al. 2006**).

### **3.3.2 Hawai‘ian Monk Seal Critical Habitat**

Hawai‘ian monk seal critical habitat has been designated under the ESA to include all beach areas, sand spits and islets, including all beach vegetation to its deepest extent inland, and lagoon waters out to a depth of 37 m (120 ft [or 20 fathoms]) in designated areas of use (**53 FR 18988**).

Essential features of critical habitat for Hawai‘ian monk seals include the following: terrestrial coastal areas with characteristics preferred for pupping and nursing; shallow, sheltered aquatic areas adjacent to coastal locations preferred for pupping and nursing; marine areas preferred for foraging; areas with low levels of anthropogenic disturbance; marine areas with adequate prey quantity and quality; and areas used for hauling out, resting, or molting.

NMFS has proposed to extend critical habitat in the NWHI out to the 500 m (1,640 ft) depth contour and to include Sand Island at Midway Islands; and by designating six new areas in MHI. Specific areas proposed for the MHI include terrestrial and marine habitat from 5 m (16 ft) inland from the shoreline extending seaward to the 500 m (1,640 ft) depth contour around Ka‘ula Island, Ni‘ihau, Kaua‘i, O‘ahu, Maui Nui (including Kaho‘olawe, Lana‘i, Maui, and Moloka‘i), and Hawai‘i (**76 FR 32026**). Several zones within the action area (e.g., PMRF offshore areas) have been excluded from designation in the proposed rule due to national security reasons (**76 FR 32026**).

## **3.4 Sea Turtles**

There are two families of sea turtles (**Wynne & Schwartz 1999**). The Cheloniidae family contains six genera and six distinct species. These species are loggerhead, green, flatback, hawksbill, Kemp’s ridley, and olive ridley. The family Dermochelyidae is comprised of only one genus and species, commonly referred to as the leatherback sea turtle. Five species of federally-listed sea turtles could potentially occur within the action area.

### **3.4.1 Cheloniids**

#### **3.4.1.1 Green Turtle**

The Hawai‘ian population of green sea turtle (*Chelonia mydas*) is ESA-listed as threatened throughout its range (**43 FR 32800**). On February 16, 2012, NMFS received a petition to classify the species in Hawai‘i as a DPS and to delist that DPS under the ESA. On August 1, 2012, NMFS made a positive 90-day finding (**77 FR 45571**), determining that the petitioned action may be warranted. A comprehensive status review is underway to inform the 12-month finding.

Green sea turtles are the largest of all the hard-shelled sea turtles, but have a comparatively small head. While hatchlings are just 50 mm (2 in) long, adults can grow to more than 1.2 m (4 ft) long and weigh 136 to 159 kg (300 to 350 lb). The green sea turtle is the most common sea turtle species occurring in the waters around the Hawai‘ian Islands. Green turtles live in nearshore coastal habitats, with high fidelity to specific reef, rock, bay, or lagoon feeding

locations. The species' breeding and nesting season ranges between mid-April and mid-August of each year (**Balazs 1976**). During the breeding season males and females swim 800 to 1,300 km (430 to 700 nm) from their feeding grounds in the MHI to their nesting beaches. More than 90 percent of all green sea turtle breeding and nesting activity in Hawai'ian waters occurs at French Frigate Shoals (**Balazs 1980**), with the main rookery on East Island (**Tiwari et al. 2010**). Occasional nesting activity has been observed within the action area at the PMRF beach, however most individuals observed at PMRF are basking. Upon nesting, most adults migrate to the coastal waters surrounding the MHI (especially around Maui and Kaua'i) (**Balazs 1976**). Hatchling green turtles emerge from their nests and enter the ocean, a time after which little is known until they enter neritic foraging grounds approximately five to ten years later (**Reich et al. 2007**). Consequently, post-hatchling green sea turtles in this oceanic phase can occur hundreds of kilometers from landmasses in water depths at least kilometers deep (**Parker et al. 2011**).

Adult green sea turtles are unique among sea turtles in that they are primarily herbivorous, feeding on seagrasses, sea lettuce, and algae, and to a lesser extent, jellyfish, salps, and sponges (**Bjorndal 1997**). During the oceanic phase of life, young green turtles are primarily carnivorous, foraging on prey items commonly found within the first 100 m (330 ft) of the water column, including zooplankton, crustaceans, and mollusks (**Parker et al. 2011**). Most of the adults' time is spent at depths less than 30 m (100 ft) when on the foraging grounds but they can dive to depths of over 100 m (330 ft) when migrating, although the majority of their migratory dives are usually much shallower (1 to 4 m [3 to 13 ft] diurnal; 35 to 55 m [115 to 180 ft] nocturnal: **Rice & Balazs 2008**).

#### **3.4.1.2 Hawksbill Turtle**

The hawksbill sea turtle (*Eretmochelys imbricate*) is ESA-listed as endangered throughout its range (**35 FR 8491**). Hawksbill sea turtles are the second most common species in the offshore waters of the Hawai'ian Islands, although they are far less abundant than green sea turtles. In Hawai'i, hawksbills nest on MHI beaches, primarily along the east coast of the island of Hawai'i and, to a much lesser extent, Maui, O'ahu, and Moloka'i (**NMFS & USFWS 1998a**). Peak nesting activity occurs from late July to early September (**Katahira et al. 1994**). Similar to other species of sea turtles, upon hatching, young hawksbills inhabit an oceanic habitat, returning years later to neritic habitats as larger juveniles (**Musick & Limpus 1997**).

In a study of satellite-tracked females, **Parker et al. (2009)** found post-nesting movements of adult Hawai'ian hawksbills to be relatively short-range (90 to 345 km [49 to 186 nm] from nesting beaches), and largely confined to coastal waters (depths less than 30 m [100 ft]) within the MHI. The west coast of O'ahu was the farthest west that the individuals tracked in the **Parker et al. (2009)** study traveled when foraging. Previous sightings of immature Hawai'ian hawksbills (e.g., **Keuper-Bennett & Bennett 2002**) have also been in very shallow areas of the MHI.

Sightings of hawksbills in the NWHI are even more rare (NMFS & USFWS 1998a). Summarizing historic and contemporary sightings of hawksbill sea turtles in the NWHI, Van Houten et al. (2012) identified six definitive observations and three potential nesting records. Based on this information, the authors conclude that hawksbills currently occur within the NWHI (albeit in low numbers), with a lack of regular monitoring within this geographic area likely contributing to the infrequency of documented observations (Van Houten et al. 2012).

Studies of hawksbill diet have identified sponges (Caribbean: Meylan 1988) and, to a lesser extent, tunicates (eastern Pacific: Carrión-Cortez et al. 2013) as primary forage items. In a study of Eastern Pacific hawksbills, Gaos et al. (2012) rarely observed adult hawksbills diving deeper than 20 m (66 ft) in the water column.

#### **3.4.1.3 North Pacific Loggerhead Turtle**

The North Pacific DPS of the loggerhead sea turtle (*Caretta caretta*) is ESA-listed as endangered throughout its range (75 FR 58868). This reddish-brown turtle averages approximately 0.9 m (3 ft) in length and 136 kg (300 lb) in weight. Nesting in the Pacific basin is restricted to the western region (primarily Japan and Australia), with those in U.S. waters likely originating from Japanese beaches (NMFS & USFWS 1998c). There is no loggerhead nesting on the western seaboard of the United States or in Hawai‘i (Balazs 1982). However, southern California and western Mexico serve as important coastal foraging areas (NMFS & USFWS 1998c). Only four records of occurrence exist for Hawai‘i, all of which were juveniles and most likely drifted over from Mexico or Japan (NMFS & USFWS 1998c).

Central North Pacific loggerheads in oceanic habitats have been shown to forage primarily on floating organisms, including gastropods, pelagic crabs, barnacles and, to a lesser extent, pyrosomas, among others (Parker et al. 2002). In a study of tagged North Pacific loggerheads within the open ocean, Polovina et al. (2004) found individuals to associate with oceanic eddies and fronts, most frequently occupying the uppermost stratum of the water column, spending approximately 90 percent of their time at depths less than 40 m (130 ft; 40 percent of time at the surface), with occasional dives to depths in excess of 100 m (330 ft).

#### **3.4.1.4 Olive Ridley Turtle**

The olive ridley sea turtle (*Lepidochelys olivacea*) is ESA-listed as threatened throughout its range (43 FR 32800). They are regarded as the most abundant sea turtles in the world, with nesting occurring primarily on beaches of India, southern Mexico, and northern Costa Rica (NMFS & USFWS 1998d). Balazs & Hau (1986) reported a single Hawai‘ian nesting event on the island of Maui in September 1985. In-water sightings are also rare, with the majority of those observed as takes within the Hawai‘ian-based longline fishery (e.g., Work & Balazs 2010).

An analysis of stomach contents from eight olive ridleys caught in the Hawai‘i-based longline fishery indicates that, while olive ridleys do forage on some organisms at the ocean’s surface, their most common prey are pyrosomas and salps which are found at deeper depths (Polovina et

al. 2004). In this same study, **Polovina et al. (2004)** found olive ridleys to most frequently occupying the epipelagic stratum of the water column, spending approximately 60 percent of their time at depths less than 40 m (130 ft; 20 percent of time at the surface), with occasional dives to depths in excess of 150 m (490 ft). **Swimmer et al. (2006)** recorded an olive ridley in the eastern Pacific Ocean diving in excess of 400 m (1,310 ft). However, most dives were less than 100 m (330 ft).

### 3.4.2 Dermochelyids

#### 3.4.2.1 *Leatherback Turtle*

The leatherback sea turtle (*Dermochelys coriacea*) is ESA-listed as endangered throughout its range (**35 FR 8491**). Leatherbacks are the largest marine turtle, with a curved carapace length often exceeding 1.5 m (5 ft) and front flippers that can span 2.7 m (9 ft: **NMFS & USFWS 1998b**). Leatherback sea turtles are a highly oceanic species and undertake long journeys of over 2,800 km (1,510 nm), in some cases reaching cold seas far from their tropical nesting grounds (**Hughes et al. 1998**).

Two populations of leatherbacks occur in the Pacific Ocean – eastern and western. Eastern Pacific leatherback turtles nest in Mexico and Costa Rica during the boreal winter (October through March: **Eckert et al. 2012**). In contrast, western Pacific leatherback turtles nest year-round at beaches across Australia, Malaysia, Indonesia, and Papua New Guinea (**Eckert et al. 2012**). Once leatherback hatchlings enter the oceanic environment, little is known about this portion of their life until they recruit to neritic habitats as juveniles. It is hypothesized that areas of upwelling and/or convergence zones may serve as nursery grounds (**Musick & Limpus 1997**).

Migratory routes of adult leatherbacks are not well-known. However, recent satellite telemetry studies have documented transoceanic migrations between nesting beaches and foraging areas in the Pacific Ocean basin (**Bailey et al. 2012**) and have characterized the post-nesting movements of summer and winter nesters (**Benson et al. 2011**). The oceanic areas visited by foraging turtles are mainly characterized by sea currents and related features, which can influence leatherback feeding-related movements. In particular, convergence zones and eddies may concentrate nutrients and organisms, and thus represent patches of high prey abundance targeted by foraging turtles (**Carr 1987**). Recent research by **Seminoff et al. (2012)** demonstrates that most adult Pacific leatherbacks demonstrate fidelity to foraging areas between nesting events. Leatherbacks are regularly observed in the offshore waters at the southern end of the Hawai'ian archipelago, potentially during their movement from one area of the Pacific Ocean to another (**NMFS & USFWS 1998b**).

Leatherbacks primarily forage on gelatinous zooplankton, including cnidarians (jellyfish and siphonophores) and, to a lesser extent, tunicates (pyrosomes and salps) at or just below the sea surface (**Bjorndal 1997**). Leatherback sea turtles are the deepest reptilian divers: maximum dives ranging from 630 m (2,070 ft: **Hays et al. 2004**) up to 1,280 m (4,200 ft: **Doyle et al. 2008**) have been observed in the oceanic Atlantic. However, dives are typically much shallower (generally < 300 m [980 ft]: **Houghton et al. 2008**).

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## 4.0 Environmental Baseline Conditions

This section identifies and describes known human-induced sources of impact to the listed species in the action area, except those caused by the proposed action. A recent, comprehensive environmental baseline of the action area is provided in the *Biological Opinion and Conference Report on U.S. Navy Hawai'i-Southern California Training and Testing (NMFS 2014)*. As such, this section provides a summary of conditions as described in that document.

The listed species within the action area are exposed to a host of anthropogenic stressors, including:

- Intentional killing
- Commercial and subsistence harvesting
- Interaction with commercial fishing gear
- Vessel strikes
- Habitat degradation
- Invasive species
- Disease
- Interaction with marine debris
- U.S. Navy training and testing activities
- Ambient noise
- Commercial and private whale watching
- Scientific research

Of the above listed stressors, intentional killing and commercial and subsistence harvesting are (in relative terms) the least likely to affect the species on an ongoing basis while the proposed action is occurring. For example, while there have been several documented Hawai'ian monk seal killings, the numbers of these incidents is relatively low (**Carretta et al. 2014**). Likewise, while historic whaling practices in the action area may be having latent effects on species in the action area, this practice is now outlawed. Vessel strikes, most commonly considered a threat to large whale species, but also a potential threat to sea turtles, occur within the action area but at an unknown extent. Habitat degradation, owing to the introduction of toxins into the aquatic environment, and the transmission of anthropogenic noise into the water column are also occurring, again with adverse, albeit unquantifiable effects at the species level. Both disease (resulting from anthropogenically-introduced pathogens) and invasive species are to some degree affecting species within the action area.

Due to oceanic transport patterns in the Pacific Ocean, marine debris is commonly encountered within the action area (**Kubota 1994**), at times to the detriment of nearly all listed species within the action area (cetaceans: **Baulch & Perry 2014**; sea turtles: **Schuyler et al. 2014**; all species: **Laist 1997**). The U.S. Navy frequently conducts testing and training activities with the action area, including mid- and low frequency active sonar, high frequency active acoustic monitoring,

and sink exercises. Naval operations also introduce military expendable materials into the water column, a potential ingestion or entanglement stressor. While it is probable that multiple listed species are unavoidably exposed to elevated underwater sound levels during Naval activities within the action area, the strict mitigation and monitoring undertaken during these exercise has proven to be effective in ensuring that exposures are not lethal.

Unrelated to Naval activities, listed species are also exposed to regular anthropogenic noise in both deep and shallow water habitats (**Urlick 1983**). Scientific research also results in lethal (i.e., Hawai‘ian monk seal males) and non-lethal take of all species potentially within the action area. Finally, entrapment and entanglement in commercial fishing gear is one of the most frequently documented sources of human-caused mortality in both large whale and sea turtle species.

As concluded in **NMFS 2014**, despite the persistent adverse effects of the environmental baseline, blue, fin, humpback, and sperm whale populations appear to be increasing, or at least not declining, within the action area. Likewise, Hawai‘ian monk seals in the MHI appear to be increasing in numbers (**Baker et al. 2011**). Conversely, MHI false killer whales and Hawai‘ian monk seals in the NWHI continue to decline in numbers, as do sea turtle species, including green, hawksbill, leatherback, and loggerheads, exposed to the combined threats of entanglements in fishing gear, overharvests, and loss of their nesting habitat.

## **5.0 Effects of the Action**

This section addresses potential impacts on listed species and critical habitat that NMFS has identified as having the potential to occur within the action area. In preparing this analysis, the proposed action is divided by the stressors it could impart upon listed species and critical habitat. Species are grouped, when possible, under each stressor instead of providing a repeated analysis of effects for each species. Despite this “grouping” analytical approach, species-specific considerations are elucidated when they could have a bearing on either the likelihood or significance of the stressor.

### **5.1 *Supersonic Flight***

Once a MET rocket is launch and again when the TV is released from the scientific balloon, they would be accelerated to a velocity beyond the sound barrier, at which point they would create sonic booms. When heard at the ground, a sonic boom consists of two shock waves of approximately equal strength. The complete ground pattern of a sonic boom depends on the size, shape, speed, and trajectory of the vehicle creating it. Since typical aircraft fly supersonically with relatively low horizontal angles, the boom is directed toward the ground. However, for the TV ascent trajectory, which would have a much higher horizontal angle (i.e., between 60 and 72 degrees), the boom would be directed laterally. This causes the sonic boom to propagate much further downrange when compared to typical aircraft sonic booms. Extended propagation usually results in very shallow propagation angles, relatively lower sonic boom levels, and negligible energy being transmitted to the earth’s surface.

Of all factors affecting the intensity of sonic booms, altitude has the most significant influence. The magnitude of the sonic boom will decrease with increasing altitude of the vehicle, as this requires the boom to travel further through the atmosphere. Given that the TV’s flight would become supersonic at altitudes in excess of 3,500 m (115,000 ft), and, when considered in conjunction with the high angle of attack during ascent, the resultant energy transferred to the water’s surface would be negligible. Comparatively, given the MET rocket’s small mass, aerodynamic shape, and high launch and steep descent angles, the resultant energy transfer would be less than that of the TV. Therefore, the remainder of the discussion focuses on the sonic boom created by the TV.

Atmospheric reentry of an object can also generate a sonic boom on the ground as the body falls back to Earth. For this case, the propagation is directed toward the ground, so the boom is more concentrated around the impact site. As the descent of the TV would also be at supersonic speeds (yet still above 30,500 m [100,000 ft] above ground level [AGL]), this portion of flight would create a more intense (in terms relative to the ascent phase) sonic boom. However, in absolute terms, the potential overpressure felt at the ocean’s surface would also be minor for the following reasons.

**Herron (2007)** modeled the re-entry of NASA's Crew Exploration Vehicle, also a "blunt body vehicle", although substantially heavier (6,700 kg [14,800 lb]) than the TV (3,040 kg [6,700 lb] at drop; 1,300 kg [2,900 lb] when solid propellant is consumed). The results of her work predicted maximum overpressure values ranging from 15.8 to 20.6 pascals (Pa; 0.33 up to 0.43 pounds per square foot [psf]). Similarly, **Hilton & Henderson (1974)** measured the overpressures created by the reentry of the 5,800-kg (12,800-lb) Apollo 15 capsule into the Pacific Ocean, recording values ranging from approximately 9.6 to 38.3 Pa (0.2 to 0.8 psf), depending on lateral distance from the impact location and altitude of the descending spacecraft. By comparison, the NASA Space Shuttle generated maximum overpressures in excess of 59.9 Pa (1.25 psf: **NASA 1989**) and typical supersonic aircraft generate maximum overpressures in the range of 47.9 to 143.6 Pa (1 to 3 psf: **Richardson et al. 1995**). In an unrelated study of sonic booms of similar magnitude (i.e., 9.6 Pa [0.2 psf]) to those presented in **Herron (2007)** and **Hilton & Henderson (1974)**, observers on the ground who were operating the sonic boom recording equipment within the predicted footprint of the sounding rocket boom "heard the boom but felt that they would not have noticed it had they been engaged in an unrelated activity" (**Plotkin et al. 2006**).

It is expected that the overpressure values generated by the TV reentry would be even less than those predicted by **Herron (2007)** or recorded by **Hilton & Henderson (1974)**, as larger and heavier objects must displace more air and create more lift to sustain flight, thereby creating sonic booms stronger than those of smaller, lighter items. In summary, all other variables being equal, the larger and heavier the object in flight, the stronger the shock waves will be. Therefore, given that both studies indicated only minor overpressures from substantially heavier vehicles of generally the same geometry, it is reasonable to conclude that the TV's overpressures at the ocean's surface would also be minor.

Furthermore, little, if any, of the energy received at the ocean's surface would be expected to propagate into the water (**Richardson et al. 1995**). Although a surface sound wave is produced, it would be transient and diminish rapidly with depth (**Richardson et al. 1995**). As such, the most probable exposure route would be if an individual were at the surface.

### **5.1.1 Aspects of Stressor Common to All Species**

Individuals exposed to a sonic boom could potentially change their behavior, such as becoming alert, diving, or swimming laterally.

### **5.1.2 Considerations Specific to Cetaceans**

Given that nearly all cetacean species would be outside the action area during each test campaign, those potentially within the action area (i.e., sperm whales) would be at depths of several hundred meters for a majority of the time (**Amano & Yoshioka 2003; Watkins et al. 1993**). When considered in conjunction with the infrequent nature of the testing, it may be concluded that the potential for exposing an individual to a weak sonic boom would be highly unlikely. Even if it were to occur, it is doubtful that a behavioral response would even be evoked.

### 5.1.3 Considerations Specific to Hawai’ian Monk Seal and Critical Habitat

#### Species

The potential exists for exposing Hawai’ian monk seals to the TV sonic boom, especially when individuals are hauled out of the water. A primary concern of sound exposure on pinnipeds is whether the source would result in either temporary or permanent hearing loss. **Southall et al. (2007)** proposed a 149 decibel (dB) exposure criterion for assessing the potential injury to pinnipeds in air exposed to a single sound pulse. Therefore, when considered within the context of these criteria, the expected reentry sonic boom under the proposed action (within the range of 114 dB at 9.6 Pa [0.2 psf] to 126 dB at 38.3 Pa [0.8 psf]) would cause no temporary or permanent hearing damage to Hawai’ian monk seals.

Adverse behavioral effects on pinnipeds exposed to sonic booms could include leaving the beach to enter the water, increased aggression, reduced maternal care, and prolongation of molting (**Perry et al. 2002**). However, research conducted by **Perry et al. (2002)** exposed two species of seals (gray and harbor seals) to more intense sonic booms than those predicted for the proposed action, concluded that, while several individuals demonstrated elevated heart rates and increased vigilance, the sonic boom exposure did not notably affect the breeding or molting behavior of these animals. **Holst et al. (2011)** reported similar results when evaluating the effects of sonic boom on harbor seals and elephant seals. Despite the sonic booms generated by the rockets studied by **Holst et al. (2011)** being greater than those expected under the proposed action, the authors did not observe the booms to result in greater responses by the studied animals than in control groups, summarizing the effects as minor and localized. **Southall et al. (2007)** proposed a 109 dB criterion for single pulse sound behavioral disturbance of pinnipeds in air, though the authors noted that it is likely conservative and based upon observation of strong responses (e.g., stampeding behavior) of some species, especially harbor seals, to sonic booms from aircraft and missile launches under certain conditions. Furthermore, supported by the more recent work by **Holst et al. (2011)**, and the fact that nearly all of the sound energy of the TV’s sonic boom would be below 75 hertz (Hz; the minimum estimated range of hearing as presented in **Southall et al. [2007]**), it is questionable whether seals would react to sonic booms at such low overpressures.

In conclusion, although the referenced studies were conducted on different seal species than those potentially within the action area, in consideration of the relatively lower sonic boom profile generated by the proposed action, and its infrequent nature, it may be reasoned that, if an individual were exposed to a sonic boom created by the LDS TV, the resultant physiological or behavior effects would be negligible.

## Critical Habitat

Sonic booms would have only a negligible effect on either designated or proposed Hawai‘ian monk seal critical habitat. Although it is possible that some sound could enter the aquatic habitat, particularly during rough sea conditions (**Richardson et al. 1995**), it would be small in intensity (given the flight altitudes and limited potential for air-to-water sound transmission [**Richardson et al. 1995**]) and transient in nature. Likewise, aside from the transient low pressure sound from a sonic boom, terrestrial critical habitat would be unaffected.

### **5.1.4 Considerations Specific to Sea Turtles**

With the exception of green sea turtles, and to a much lesser extent, hawksbills, the potential for exposing other species of sea turtles to the TV-generated sonic boom would be unlikely based on historic sightings data. However, should a sea turtle be exposed to a sonic boom, it is unlikely to evoke much, if any, of a physiological or behavioral response at the levels and frequencies which would be propagated to the ocean’s surface.

Physiologically, although not specific to sea turtles, but using the best proxy available, **Bowles et al. (1999)** exposed desert tortoises to single and repeated simulated sonic booms. None of the eight individuals experienced temporary hearing loss after exposure to single or paired sonic booms (143 dB peak; greater than that expected under the proposed action). As such, in consideration of the low magnitude and infrequent occurrence of the sonic booms under the proposed action, it may be reasoned that exposed sea turtle species would not be subjected to measurable physiologic effects.

Likewise, behaviorally, the majority of energy in a sonic boom is less than 100 Hz. Early research on the hearing of green sea turtles by **Ridgway et al. (1969)** identified their maximum hearing sensitivity to be between 300 and 400 Hz. Consequently, while the potential for a sea turtle detecting the audible stimulus, should it be exposed to it, cannot be completely ruled out, it may be concluded that the resultant behavioral effect, if one even were to occur, would be minor. The sea turtles in more recent studies which demonstrated notable behavioral responses (e.g., diving) to impulsive sounds (e.g., airguns: **DeRuiter & Doukara 2012**) were exposed to far more intense stimuli than would be anticipated under the proposed action.

## **5.2 Direct or Proximate Strike**

### **5.2.1 Aspects of Stressor Common to All Species**

During the oceanic landing of flight hardware, there would be only a remote likelihood of the TV, balloon, or MET rocket stages striking or landing near a listed species. Even if a strike were to occur, it is not possible to predict the exact consequence and outcome. However, several general conclusions can be drawn. The likelihood for injurious effects would be greatest if the individual were at the surface breathing or foraging, with the potential for injury decreasing substantially with depth. In the event that the TV, balloon, or MET rocket stage were to land near a surfacing individual, the extent of effects would likely be limited to a short-term startle reaction.

### 5.2.2 Considerations Specific to Cetaceans

The occurrence of either mysticete species within the action area at the time of either flight termination or test execution and subsequent descent of flight hardware would be rare, as all species are known to migrate to northern waters outside the action area during the summer months. Furthermore, the infrequent nature of the action (up to twice per year over a five-year term) renders a direct or proximate strike a highly unlikely event.

Although odontocete species would be within the action area during the time when the action would occur, both species spend about 70 to 80 percent of their time at depths of several hundred meters (**Amano & Yoshioka 2003; Watkins et al. 1993**). When coupled with the infrequent nature of the testing, and low density of individuals within the action area, the chance of a direct or proximate strike would also be very low.

### 5.2.3 Considerations Specific to Hawai‘ian Monk Seal and Critical Habitat

#### Species

Hawai‘ian monk seals would occur within the action area during the time of test execution. However, the probability of a direct or proximate strike would be very low for the following reasons. First, the core locations of all six reproductive subpopulations are outside the action area. Second, while some individuals have been shown to undergo long distance movements from their “home” colonies (**Johanos et al. 2014**), the majority of Hawai‘ian monk seals tend to remain within 50 km (27 nm) of these areas (**Curtice et al. 2011**), which, again, for most, would be outside the action area. Third, although birthing and nursing would be spread over a much wider window than just the June to August timeframe, during this time a portion of the adult females and young of the year would be on land (largely outside the action area), further reducing the number of individuals potentially within the action area. Finally, the infrequent nature of the proposed action supports the conclusion that a direct strike would be unlikely.

#### Critical Habitat

**Aquatic:** Should either the TV, or balloon land within aquatic Hawai‘ian monk seal critical habitat, it would temporarily occupy a small portion of the epipelagic portion of the water column that would have otherwise been available for use as foraging grounds for the species. However, in consideration of the mandatory recovery of all major hardware items, the resultant effects would be only transient in nature. Should unrecoverable flight hardware (i.e., the flight train or MET rocket stages) enter critical habitat upon descent, it would only occupy the water column for a very short time, and, upon landing on the ocean floor, would represent a very small portion of the overall habitat available for the species. It is possible that, over time, the material would either trap, or otherwise become covered with sediment, further reducing the detraction from habitat value. The occurrence of floating expended hardware entering aqueous critical habitat would be possible, though unlikely due to the low number of these items being flown per year and the very large areal extent of the action area.

***Terrestrial:*** Should either the TV, balloon, or MET rocket stages land within terrestrial Hawai‘ian monk seal critical habitat, it would occupy a small portion of habitat that would have otherwise been available for pupping, basking, or resting. The physical impact of the descending items could crush shoreline vegetation or penetrate the surface of the beach (i.e., create a “divot”). However, such effects would be transient as all materials would be located and removed by the project as soon as practicable. Likewise, any physical disturbance created would be remediated to pre-project conditions.

Nonetheless, the potential for this stressor to occur would be highly unlikely. As discussed in Section 2.5 of this BE, the island of Nihoa and its 5.6 km (3.0 nm) buffer would be categorically avoided when conducting each SFDT. Under normal conditions, these areas would be overflowed. It would only be in the case of a catastrophic failure of the flight system that flight hardware would descend into designated terrestrial critical habitat.

#### **5.2.4 Considerations Specific to Sea Turtles**

All sea turtles could be in the action area during the summer months when the proposed action would occur. However, with the exception of green, and, to a much lesser extent, hawksbill sea turtles, their occurrence would be rare, based on historic sightings data. Even in the case of green sea turtles, the most populous species within the action area, when considering the infrequent nature of the action, the low density of individuals within the action area, and the fact that sea turtles spend a significant portion of their time below the sea surface (**Lutcavage & Lutz 1997**), the probability of a direct or proximate strike would be very low.

### **5.3 Entanglement**

#### **5.3.1 Aspects of Stressor Common to All Species**

According to the literature (major reviews by **Laist 1987, 1997; Derraik 2002**), entanglement of marine species can lead to injury, compromised health, or mortality. Entanglement could disadvantage an individual animal by limiting its ability to open and close its jaw when feeding or by restricting its ability to travel through the water for feeding, reproductive, or migratory purposes. Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual’s health. Such a compromised individual is less likely to be able to escape predation and would be less likely to be reproductively successful.

#### **5.3.2 Considerations Specific to Cetaceans**

For either cetacean species, the relative size difference between the (comparatively small) floating MET balloons and ROBIN spheres and a (much larger) individual of either species renders the probability of entanglement negligible. Being hollow aluminum columns, MET rocket stages do not pose a risk of entanglement. As such, they will not be discussed further and this Section will focus on the larger TV, balloon, and balloon flight train.

## Mysticetes

Traveling or feeding baleen whales could potentially become entangled in the floating TV or balloon or sinking balloon flight train once they enter the water column. Should feeding whales encounter the floating or descending flight hardware, the debris could enter the buccal cavity, wrap around and damage baleens, lodge within the esophagus, or become wrapped around the tongue or rostrum. Entanglement of pectoral or caudal fins may result from an encounter between traveling whales and the floating or descending flight hardware. While fishing gear has been the primary type of debris observed on entangled cetaceans (e.g., humpbacks: **García-Godos et al. 2013**), entanglement in other types of plastic-based materials has also been reported (e.g., fin whales: **Sadove & Morreale 1990**) (**Baulch & Perry 2014**).

However, multiple factors render this potential stressor highly unlikely. First, the occurrence of either mysticete species within the action area at the time when the proposed action would be conducted (and, therefore, when the majority of flight hardware would be in-water) would be rare as all species are known to migrate to northern waters outside the action area during the summer months. Moreover, with the exception of humpback whales, the occurrence of any mysticete species within the action area at any time would be rare based upon historical sightings data.

Second, the rapid recovery of the larger TV and balloon system from the water column would further reduce the risk of potential entanglement with the largest flight hardware items. Furthermore, since the unrecovered flight hardware would sink rapidly following water impact, the material would not be available for entanglement except but for a brief period of time (less than an hour) during its descent to the ocean floor. Upon reaching the sea floor, none of the mysticetes potentially within the action area are likely to interact with the flight hardware as they would not likely be engaged in foraging behaviors at that depth, and, consequently, would be located higher in the water column.

Finally, the infrequent nature of the action (twice per year over a five-year term) renders the probability of a mysticete encountering any flight hardware, whether within the water column or on the seafloor, a highly unlikely event.

## Odontocetes

**False Killer Whale:** Although false killer whales have not been definitively reported as becoming entangled in marine debris (**Baulch & Perry 2014**), the potential exists for such a stressor to occur should flight hardware land within the species' range. However, multiple factors render this outcome highly unlikely. First, the greatest concentrations of the species are farther east in the MHIs, outside the action area (**Baird et al. 2012**). Second, the species generally forages on prey that is typically found in the uppermost portion of the water column. Because the floating balloon system and TV would be recovered soon after landing in the water, the potential for this stressor would be short in duration. Furthermore, the rapid descent of

unrecoverable flight hardware to depths beyond which false killer whales typically forage renders the chance of this species encountering these objects remote. Finally, the infrequent nature of the action and the low density of the species (when compared to the size of its range within the action area) render this event highly improbable.

***Sperm Whale:*** Both lethal and non-lethal entanglements in marine debris have been reported for sperm whales (**Haase & Felix 1994; Kock et al. 2006; Pace et al. 2008**). Sperm whales have been found with bands and strands of plastic, polypropylene rope, cables, and other plastic materials wrapped around the mandible (**Arbelo et al. 2013**). Typically, these types of entanglements result in necrotic tissues, extremely poor body condition (due to limited ability to feed successfully), and have even been cited as contributing to an animal's ultimate death (**Jacobsen et al. 2010**).

Sperm whales feed at greater depths than mysticetes (e.g., 400 to 600 m [1,310 to 1,970 ft]) and sometimes at or near the benthos (**Mathias et al. 2012; Miller et al. 2013; Teloni et al. 2008**), potentially putting them at higher risk for entanglement with the unrecovered materials once they are on the seafloor. However, dive depth data from studies of sperm whales indicate that, while individuals occasionally forage at the seafloor, typical feeding is at lesser water depths. For example, **Teloni et al. (2008)** recorded over 72 percent of sperm whale dives at depths shallower than 400 m (1,310 ft) in a Norwegian canyon approximately 2,000 m (6,560 ft) deep. Similarly, half of the sperm whales observed by **Wahlberg (2002)** undertook dives of maximum depths of 700 to 800 m (2,300 to 2,620 ft) in water depths of approximately 1,500 m (4,920 ft). A study conducted by **Miller et al. (2013)** indicated typical dive depths of 400 m (1,310 ft) in the Kaikoura Canyon of coastal New Zealand, with bottom depths between 600 and 1,000 m (1,970 and 3,280 ft). **Mathias et al. (2012)** found that sperm whales typically foraged at depths of approximately 400 m (1,310 ft) in a study area with water depths of approximately 800 m (2,620 ft). **Papastavrou et al. (1989)** recorded average dive depths in tropical latitudes of approximately 400 m (1,310 ft) in waters 2,000 to 4,000 m (6,560 to 13,100 ft) deep. As such, while it is possible that a foraging sperm whale could encounter the flight train once on the seafloor, the likelihood of entanglement is remote given their tendency to more frequently forage higher in the water column.

To further support this conclusion, a Geographic Information System (GIS) (**Environmental Systems Research Institute 2010**) – based bathymetry analysis was conducted (using data from **IOC et al. 2003**) to determine the distribution of water depths in the action area. The analysis indicated that approximately 96 percent of the waters in the action are deeper than 2,000 m (6,560 ft), which is more than the deepest reported sperm whale foraging dive (“possibly to 2,000 m”; **Watkins et al. [1993]**). Therefore, in summary, while a sperm whale undertaking a deeper (greater than 2,000 m [6,560 ft]) foraging dive to the ocean floor (where the unrecovered flight hardware would remain) is possible, when considered in conjunction with the fact that most recorded foraging has occurred at shallower depths, the low density of individuals in the action area, and the infrequent nature of the proposed action, it may be concluded that the

probability of a foraging sperm whale becoming entangled in the items on the sea floor would be very low. Likewise, given the sink rate of the unrecovered flight hardware, it is expected that the items would be below the stratum of the water column most commonly used for sperm whale foraging in approximately one to two hours, rendering the potential for entanglement negligible.

### **5.3.3 Considerations Specific to Hawai‘ian Monk Seal and Critical Habitat**

#### Species

Hawai‘ian monk seals are particularly susceptible to entanglement with marine debris, with pups and juveniles the most vulnerable life stage (**Henderson 1990; Henderson 2001**). Entanglement most often involves derelict fishing gear including nets, fish line, and associated hardware. As discussed under *Direct or Proximate Strike*, the majority of seal colonies are outside the action area with most individuals remaining in close proximity to the islands. Furthermore, the rapid recovery of floating materials from the water column and rapid sinking of unrecovered materials renders the chance of entanglement unlikely. Although the unrecovered material theoretically could present an entanglement hazard if it were to land in shallow nearshore depths, the vast majority (greater than 99 percent) of waters in the action area are deeper than the maximum recorded dive depths of Hawai‘ian monk seals, below which there would be no potential for interaction. Finally, historic reports of entanglement support the conclusion that the potential for entanglement with unrecovered items under the proposed action is negligible. There are no known cases of Hawai‘ian monk seal being entangled in military expended material (**NMFS 2014**), which is analogous to the MET balloons and ROBIN spheres.

#### Critical Habitat

The entanglement stressor is not applicable to either designated or proposed Hawai‘ian monk seal critical habitat.

### **5.3.4 Considerations Specific to Sea Turtles**

It is possible that sea turtles might encounter or approach the floating MET balloons or ROBIN spheres. Likewise, in-water turtles could encounter the floating TV or balloon and subsequently become entangled (**Carr 1987**), as sea turtles have been observed to feed under floating debris. **Balazs (1985)** reported sea turtle entanglements involving monofilament line, ropes, netting, cloth debris, tar, and plastic bands around the neck.

However, multiple factors render this potential stressor highly unlikely. First, SFDT flights from PMRF would be infrequent, not exceeding two per year over a five-year term. Second, the majority of buoyant materials (i.e., balloon, TV) would be recovered. The unrecovered flight train’s expected sink rate would effectively remove it from the water column stratum most commonly frequented by migrating and foraging sea turtles in less than one hour. Though it is possible that the ultimate location of the flight hardware on the seafloor could be within the range of depths observed for diving sea turtles, particularly leatherbacks (maximum recorded

dive depths to 1,280 m [4,200 ft: **Doyle et al. 2008**]), it has recently been determined from satellite telemetry that very deep dives (>300 m [980 ft]) are rare (**Houghton et al. 2008**). Finally, the low density of sea turtles in the action area makes the likelihood of an individual becoming entangled in the descending or seafloor-resting flight hardware highly unlikely.

## **5.4 Ingestion**

### **5.4.1 Aspects of Stressor Common to All Species**

Foraging individuals at or near the sea surface could ingest portions of the expended flight hardware, particularly the floating MET balloons or ROBIN spheres. Ingestion of debris may cause a physical blockage in the digestive system to the point of starvation or that results in ulceration or rupture, cause the animal to feel satiated and reduce its foraging effort and overall fitness, or to introduce toxic chemicals into the tissues of animals, causing adverse health or reproductive consequences (**Laist 1997; Derraik 2002**).

### **5.4.2 Considerations Specific to Cetaceans**

Compared to entanglement, ingestion of debris, particularly plastics, has been reported more frequently for cetacean species (**Baulch & Perry 2014**). There are numerous reports in the literature (e.g., **Arbelo et al. 2013; Sadove & Morreale 1990**) documenting a range of consequences to large whales resulting from ingestion of plastic materials. Such consequences may be subtle, as when debris builds up over time in an animal's stomach, giving it the feeling of satiation with no nutritional value, consequently reducing appetite and feeding, the result being an animal in poor body condition and compromised fitness (**Secchi & Zarzur 1999**).

#### Mysticetes

Based on research conducted by **Irwin (2012)**, it is possible that degraded or intact latex MET balloons would remain afloat for months following their landing in the ocean. Likewise, the Mylar ROBIN spheres would not be expected to degrade at the surface, descending through the water column under the weight of fouling organisms. However, when considered over the entire pelagic portion of the action area and the distributed or dilute nature of these relatively small items, the probability of an individual of either species encountering an item is very low. Furthermore, in the unlikely instance that a large mysticete were to ingest a small item from a degraded balloon, interference with alimentary processes would not necessarily occur. This is due to the fact that, if the material is weak enough to break away from the larger item, it would likely be too weak to cause an obstruction of the gut once ingested (**Andrady 1990**).

Moreover, as discussed in this document under *Entanglement*, the likelihood of mysticete whales encountering large pieces of floating or descending flight hardware (i.e., TV, balloon, or flight train) would be negligible because of 1) their absence from the action area during testing; 2) the recovery of the balloon and TV shortly after landing on the ocean's surface; and 3) the rapid descent of the unrecovered flight train to the seafloor.

## Odontocetes

***False Killer Whale:*** With the exception of a single report of a false killer whale ingesting a plastic jug in Florida (**Barros et al. 1990**), there are no definitive reports of the species ingesting marine debris (**Baulch & Perry 2014**). Regardless, the potential exists for such a stressor to occur should flight hardware land within the species' range. However, in consideration of the infrequency of the proposed action, the low density of individuals within the action area, the large size of most floating materials (rendering ingestion unlikely), and their recovery upon landing in the water, the probability of an individual encountering floating material from the proposed action is very low.

***Sperm Whale:*** Sperm whales may be more susceptible than other whale species to ingestion of debris, as they feed within a wide range of the water column (**de Stephanis et al. 2013**). Fatalities associated with ingestion of plastic bags and other materials have been reported in sperm whales. In one case, the variability in size and age of the pieces suggested the material was ingested from the surface rather than bitten off from active fishing gear (**Jacobsen et al. 2010**), while, in another case (**Walker & Coe 1990**), ingestion was thought to occur incidentally while feeding on benthic prey. However, as also discussed in this document under *Entanglement*, given the large proportion (96 percent) of deep water (greater than 2,000 m [6,560 ft]) in the action area, and shallower “typical” foraging depths (400 to 800 m [1,310 to 2,620 ft]) observed in sperm whales, the likelihood of a foraging sperm whale encountering the descended flight hardware would be remote. Additionally, **de Stephanis et al. (2013)** summarized 17 sperm whale plastic ingestion incidents reported worldwide, finding that the mass of ingested debris ranged from approximately 20 grams to 2.5 kilograms (0.04 to 5.5 lb) while surface areas ranged from under 1.0 square meter (m<sup>2</sup> [10.8 square feet (ft<sup>2</sup>)]) to approximately 30 m<sup>2</sup> [323 ft<sup>2</sup>]. Based on squid morphometric data from **Bolstad (2007)** and **Semmens & Jackson (2005)**, this range of debris sizes generally corresponds with the size and mass of the forage resources most commonly identified (oceanic squids, *Moroteuthis* spp.) in the stomachs of sperm whales (**Kawakami 1980**). As such, the data from these studies further support the conclusion that, with the exception of the MET balloons and ROBIN spheres, ingestion would be unlikely, as both the most commonly ingested prey and reported debris items are significantly smaller than the items entering the water under the proposed action.

Even so, when considered over the entire pelagic portion of the action area and the distributed or dilute nature of the temporarily floating items, the probability of an individual encountering a concentration of positively- or neutrally-buoyant MET balloons or ROBIN spheres years into the future is very low. Finally, the low density of sperm whales in the action area makes the likelihood of an individual interacting with the expended materials at any point during their presence in the water column or on the seafloor highly unlikely.

### 5.4.3 Considerations Specific to Hawai‘ian Monk Seal and Critical Habitat

#### Species

Although Hawai‘ian monk seals have not been definitively reported to ingest marine debris (**Baulch & Perry 2014**), the potential exists for such a stressor to occur should flight hardware land within the species’ range. However, in consideration of the infrequency of the proposed action, the low density of individuals within the action area, the large size of most floating materials (rendering ingestion unlikely), and their recovery upon landing in the water, the probability of an individual encountering the floating material would be very low.

#### Critical Habitat

The ingestion stressor is not applicable to either designated or proposed Hawai‘ian critical habitat.

### 5.4.4 Considerations Specific to Sea Turtles

In a comprehensive review of 37 sea turtle debris ingestion studies undertaken since **Balazs (1985)**, **Schuyler et al. (2014)** found that, while all species potentially within the action area had been reported to ingest debris, leatherbacks and greens were the most susceptible to plastic ingestion, likely due to their feeding preferences. Of the multiple stages in a sea turtle’s life, the oceanic phase appears to be at greatest risk (**Schuyler et al. 2014**). Earlier research by **Schuyler et al. (2012)** on greens and hawksbills found the majority of materials (including rubber balloons) ingested by sea turtles were positively buoyant, resulting in the presence of these items in the portion of the water column occupied by oceanic post-hatchling sea turtles.

**Parker et al. (2011)** summarized the diets of oceanic Hawai‘ian green sea turtles, documenting that these individuals mostly foraged on *Pyrosoma* spp., which can grow up to 60 cm (2 ft) in length and 2 - 4 cm (1 - 1.5 in) wide. Likewise, in a study of leatherbacks foraging in the northern Atlantic Ocean, **Heaslip et al. (2012)** found that the diameters of gelatinous prey ingested by the observed individuals ranged between 3.0 and 22.0 cm (1.2 to 8.9 in; the larger being roughly the diameter of a soccer ball). These findings strongly suggest that, with the exception of the MET balloons and ROBIN spheres, the substantially larger flight hardware (i.e., balloon, TV, flight train) would not be within the size range of (or resemble) prey typically encountered and ingested by foraging sea turtles. However, in the longer term, the possibility of the MET balloons fragmenting into smaller buoyant pieces, which would be more readily ingested by sea turtles, could occur.

Regardless, multiple factors render the potential of an individual sea turtle encountering either of the floating items unlikely. First, with the exception of green sea turtles, the potential for other species to occur within the action area would be low, and likely only when transiting between other areas in the Pacific Ocean. Second, the infrequent nature of the proposed action makes the likelihood of an individual interacting with the expended materials at any point during their

presence in the water column or on the seafloor highly unlikely. Finally, when considered over the entire pelagic portion of the action area and the distributed or dilute nature of the degraded particles, the probability of an individual encountering a concentration of floating items from the proposed action years into the future would be very low. Even in the highly unlikely scenario that an individual were to ingest a small piece of a MET balloon, for example, it is possible that adverse physiological effects would not result (e.g., **Parker et al. 2011**).

## **5.5 Aircraft Overflight**

### **5.5.1 Aspects of Stressor Common to All Species**

Transmission of noise from aircraft into the water would be possible. However, individuals would have to be at or near the surface at the time of an overflight in order to be exposed to elevated sound levels. Likewise, a visual stimulus from overflight could also lead to a change in behavior, although this would likely be temporary.

### **5.5.2 Considerations Specific to Cetaceans**

Responses to aircraft overflight have been shown to vary by species. For example, smaller delphinids have been shown to react to fixed-wing aircraft overflights either neutrally or with a startle response whereas more “cryptic” species (e.g., ziphiids) tend to react more overtly, often diving when overflown (**Wursig et al. 1998**). It has also been reported that dolphins generally show no reaction to the overflight of aircraft unless the aircraft’s shadow passes directly over them (**Richardson et al. 1995**). **Patenaude et al. (2002)** observed mysticetes (bowhead whales [*Balaena mysticetes*]) during spring migration in Alaska and recorded their short-term responses to fixed-wing aircraft activity. Few (approximately 2 percent) of the observed bowheads reacted to overflights (between 60 and 457 m [200 and 1,500 ft] AGL), with the most common behavioral responses being abrupt dives, short surfacing episodes, breaching, and tail slaps (**Patenaude et al. 2002**). The majority of these responses occurred when the aircraft was below altitudes of 182 m (600 ft) and lateral distances of 250 m (820 ft: **Patenaude et al. 2002**), which is below the range of altitudes (i.e., above 457 m [1,500]) which would be flown during surveillance under the proposed action. Of note is that the authors state “there was little if any reaction by bowheads when the aircraft circled at altitude 460 m...” (1,500 ft: **Patenaude et al. 2002**). Regarding odontocetes, **Wursig et al. (1998)** found in their study that most Gulf of Mexico sperm whales dive when overflown by fixed wing aircraft. **Richter et al. (2006)** documented only minor behavioral effects (i.e., both longer surface time and time to first vocalization) of whale-watching aircraft on New Zealand sperm whales. However, details on flight altitude and airspeed were not provided. **Smultea et al. (2008)** studied sperm whales in Hawai‘i, documenting that diving responses to fixed winged overflights occurred at approximately 250 m (820 ft) AGL.

As mysticete species would not likely be within the action area during the time when aircraft surveillance and recovery flights would occur, and the flights would be infrequent in nature, it

may be concluded that exposing a mysticete to this stressor would be highly unlikely. Although sperm whales would be within the action area during the time when the action would occur, they spend about 70 to 80 percent of their time at depths of several hundred meters (**Amano & Yoshioka 2003; Watkins et al. 1993**), where it is unlikely that they would be exposed to aircraft-induced stressors (i.e., visual and/or acoustic cues). Furthermore, in consideration of the infrequent nature and short duration of aircraft flights, the relatively high altitude (above 457 m [1,500 ft] AGL) at which they would surveil, and limited behavioral responses documented in available research, it is expected that potential effects on marine mammals, should they even occur, would be negligible. This conclusion is further supported by **Richardson et al. (1995)**, who summarized available information at the time of their publication and stated that research does not indicate that the occasional overflight would cause long-term displacement of whales.

### **5.5.3 Considerations Specific to Hawai‘ian Monk Seal and Critical Habitat**

#### Species

Based on the responses of other pinniped species to aircraft overflight, it is expected that Hawai‘ian monk seals would be most responsive to aircraft-induced visual or acoustic stimuli when hauled out for pupping or molting (**Richardson et al. 1995**). Observed reactions would vary in severity, and could range from becoming alert to rushing into the water. While not specific to Hawai‘ian monk seal, **Richardson et al. (1995)** presented available research at the time, which, in summary, supports the conclusion that the surveillance and recovery aircraft proposed under the proposed action would have limited, if any, potential for disturbance at the altitudes at which they would fly. Furthermore, given that the flight hardware would only land within or adjacent to terrestrial areas in the event of an off-nominal flight termination scenario, the probability of the need for repeated flights around terrestrial areas where seals would be hauled out would be low. Furthermore, because the terrestrial areas within the action area (e.g., Nihoa) are only home to a small number of monk seals, the possibility of exposing an individual to an aircraft-induced stressor such that a behavioral response is evoked is also considered to be very low.

There are few specific data on the reactions of in-water pinnipeds to aircraft overflight (**Richardson et al. 1995**). Based on observations when conducting aerial surveys of pinniped populations, it is likely that Hawai‘ian monk seals would dive if overflown by fixed wing aircraft at low altitude. However, in consideration of the facts that 1) the aircraft would be operated at least 457 m (1,500 ft) AGL; 2) the SFDT flights would be infrequent in nature; and 3) the low density of individuals within the action area, the probability of exposing an in-water individual to an aircraft-induced stressor would be very low. Even if a seal were to be overflown, the resultant effect is unlikely to reduce the individual’s fitness.

## Critical Habitat

Aircraft overflight would have only a negligible effect on either designated or proposed Hawai‘ian monk seal critical habitat. Although it is possible that some aircraft-induced sound could enter the water column, particularly during rough sea conditions (**Richardson et al. 1995**), it would be low in intensity (given the flight altitudes and limited potential for air-to-water sound transmission [**Richardson et al. 1995**]) and transient in nature. Likewise, aside from the transient sound transmitted at ground level by aircraft overflight, the terrestrial critical habitat would be otherwise unaffected.

### **5.5.4 Considerations Specific to Sea Turtles**

Species-specific studies on the reaction of sea turtles to fixed wing aircraft overflight are lacking. Based on sea turtle sensory biology (**Bartol & Musick 2003**), sound from low flying aircraft could likely be heard by a sea turtle at or near the ocean surface. Turtles might also detect low flying aircraft via visual cues such as the aircraft's shadow (similar to the findings of **Hazel et al. [2007]** regarding watercraft), potentially eliciting a brief startle reaction such as a dive or lateral movement. However, in consideration of 1) the fact that sea turtles spend a significant portion of their time below the sea surface (**Lutcavage & Lutz 1997**); 2) with the exception of green sea turtles, the rarity of other species within the action area; and 3) the infrequent nature of the surveillance flights, the probability of exposing an individual to an acoustically- or visually-induced stressor from aircraft overflight would be very low. Furthermore, because the surveillance and recovery aircraft would be flown at altitudes (i.e., above 457 m [1,500 ft] AGL), well above those which are employed by wildlife agencies when performing aerial surveys of in-water sea turtles (e.g., 152 m [500 ft]: **Epperly et al. 1995**), it can be reasoned that potential effects on an in-water individual, even should it be overflown, would be insignificant.

## **5.6 Recovery Vessel Operation**

### **5.6.1 Aspects of Stressor Common to All Species**

Collisions with vessels could result in either non-lethal (e.g., blunt trauma, lacerations) or lethal injuries, depending on a number of factors, including vessel speed. In the case of a proximate approach, the acoustic or visual stimuli (or combination of the two) from recovery vessels could cause exposed individuals to change their behavior, including diving or swimming laterally to avoid the oncoming vessel. To ensure that in-water species are not exposed to ship-induced stressors (e.g., ship strike), vessel operators would employ all vessel operating protocols stipulated in Section 2.4.2 of this BE.

### **5.6.2 Considerations Specific to Cetaceans**

Collisions with ships have been a stressor inflicted upon large whale species for many years, particularly since vessels began to attain speeds in excess of 24 km/hr (13 kt: **Laist et al. 2001**). Mysticetes, and in particular, fin and right whales, have been the most frequently reported

species affected by ship strikes (**Jensen & Silber 2003; Laist et al. 2001**). **Lammers et al. (2013)** summarized records of collisions between vessels and North Pacific humpback whales in Hawai'ian waters, concluding that collisions were most frequently reported outside the action area (i.e., the waters between Maui, Moloka'i, Lana'i, and Kaho'olawe), and that their observed rise in frequency of collision was likely due to the continued recovery of humpbacks in Hawai'i, increases in vessel traffic, and improved reporting practices.

In the event that a vessel strikes a whale, studies have found that the probability of its lethality increase with ship speed (**Gende et al. 2011; Vanderlaan & Taggart 2007**). For example, **Vanderlaan & Taggart (2007)** found the probability of a lethal strike increased from 20 percent to 100 percent at speeds between 17 and 37 km/hr (9 and 20 kt), and that lethality from ship strike increased most rapidly between 19 and 26 km/hr (10 and 14 kt). As project recovery vessels would cruise at speeds between approximately 15 and 26 km/hr (8 and 14 kt), the potential exists for an injurious, even lethal, ship strike.

However, several factors render this stressor highly unlikely. First, with the exception of sperm whales, the other species of cetaceans would occur in very low numbers, if at all, within the action area during the time when ship-based recovery operations would be conducted. Although sperm whales could be in the action area during this time, they spend about 70 to 80 percent of their time at depths of several hundred meters (**Amano & Yoshioka 2003; Watkins et al. 1993**), at which there would be no possibility of an individual encountering a project vessel. Coupled with the infrequent nature of the action, the small number of recovery vessels employed in support of the activity, and the employment of vessel operating protocols, the probability of striking a listed cetacean would be very low.

In the event of a proximate approach, the potential reactions of cetaceans to various types of vessels vary considerably among populations, locations and time of year (**Scheidat et al. 2004**). However, as discussed previously in this section regarding ship strike, the probability of a project vessel encountering a listed whale species would be unlikely, and, even if it were to occur, the temporary behavioral reaction (e.g., humpback increase in speed: **Scheidat et al. 2004**; change in sperm whale ventilation rate: **Richter et al. 2006**) associated with a proximate approach would not measurably affect an individual's fitness. This conclusion is further supported by research in Hawai'i by **Bauer et al. (1993)**, who noted obvious short-term reactions of wintering humpbacks to vessel traffic but concluded that longer-term effects were not apparent. Similarly, after studying the reactions of male sperm whales to whale-watching vessels in the waters off New Zealand, **Richter et al. (2006)** concluded that the minor behavioral changes they observed were not likely of biological significance.

### **5.6.3 Considerations Specific to Hawai‘ian Monk Seal and Critical Habitat**

#### Species

In general, very little data (and that largely anecdotal) exists regarding the reactions of seals to vessels. However, available information suggests that seals are rather tolerant of vessels (**Richardson et al. 1995**). Likewise, little data is available regarding the potential for (and effects of) ship strikes.

However, given that the flight hardware would only land within or adjacent to terrestrial areas in the event of an off-nominal flight termination scenario, the probability of the need for ship use in shallow waters around terrestrial areas (where seals would be hauled out) would be low. Additionally, because the terrestrial areas within the action area (e.g., Nihoa) are only home to a small number of monk seals, and since vessel operating protocols would be employed to avoid monk seals, the possibility of exposing an individual to a vessel-induced stressor such that a behavioral response is evoked is also considered to be very low.

#### Critical Habitat

Consistent with the above discussion regarding the effects of vessels on the species, it is unlikely that vessels would enter, and therefore affect, designated or proposed Hawai‘ian monk seal critical habitat. Should entry into critical habitat occur, the resultant effects would be transient and infrequent, and limited to the propagation of vessel noise into the water column and the physical movement of waters in the epipelagic stratum of the water column due to the ships’ wake. NASA would require its vessel operators to prepare for and take all necessary precautions to prevent discharges of oil and releases of waste or hazardous materials that may impair water quality. In the event of such an occurrence, notification and response would be in accordance with applicable requirements of 40 CFR Part 300. Additionally, to prevent the introduction of marine alien species, all submerged and waterline vessel surfaces would be cleaned of algae or other organisms prior to vessel use and ballast water would be managed in accordance with U.S. Coast Guard Regulations (33 CFR Part 151). As such, the proposed action would only have negligible effects on the water column comprising either the designated or proposed Hawai‘ian monk seal critical habitat.

### **5.6.4 Considerations Specific to Sea Turtles**

The potential exists for a project recovery vessel to strike a sea turtle. All sea turtles must surface to breathe and several species are known to bask at the surface. Although sea turtles can move either horizontally or vertically to avoid an incoming vessel, **Hazel et al. (2007)** found that green sea turtles may not be able to move out of the way of vessels cruising at more than 4 km/hr (2 kt). Furthermore, these same researchers suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases (**Hazel et al. 2007**). Project recovery vessels would travel faster than this in open water between port and the recovery site. However, several factors render sea

turtle strike highly unlikely. First, with the exception of green sea turtles, the other species of sea turtles occur in very low numbers within the action area. Coupled with the infrequent nature of the action, and small number of recovery vessels employed in support of the proposed activity, as well as the employment of vessel operating protocols, the probability of striking a listed sea turtle would be very low.

## 6.0 Conclusions

Following ESA consultation guidance developed by NMFS (2013), NASA applied the following rationale to arrive at its final determinations of effect on listed species in the LDSF SFDT action area:

First, based on the analysis in this BE, the proposed action is likely to produce stressors to which listed individuals would respond if exposed. However, the likelihood of such exposure has been determined to be extremely remote. Therefore, NASA's determination process is based on "Proposition B" in the NMFS guidance document, which is:

*The action is likely to produce potential stressors..., endangered or threatened individuals are not likely to be exposed to one or more of those potential stressors or subsidies or one or more of the Action's direct or indirect consequences on the environment;*

Next, once NASA accepted Proposition B as true, NASA identified the first of four potential determination outcomes (identified as outcome 3.1 in the NMFS guidance document) as being applicable to the action considered in this BE, which is:

*If an agency ... accepts Proposition B as true (the action produces stressor or subsidies, but the probability of exposing listed individuals to those stressors is so small that it would not be reasonable to expect them to occur) and can defend that acceptance based on all of the relevant evidence available and the appropriate background, the agency is justified in a "may affect, but not likely to adversely affect" determination (because the probability of effects would be discountable).*

As such, NASA concludes that the proposed action "may affect, not likely to adversely affect," all listed species and critical habitat in the action area. **Table 2** on the following page presents a summary of determinations for each species and critical habitat potentially affected by NASA's action:

**Table 2: Summary of Endangered Species Act Determinations**

Species	ESA Status	NASA ESA Determination
<b>Cetaceans</b>		
North Pacific right whale	Endangered	NLAA
Blue whale	Endangered	NLAA
Fin whale	Endangered	NLAA
Sei whale	Endangered	NLAA
Humpback whale	Endangered	NLAA
False killer whale (MHI Insular)	Endangered	NLAA
Sperm whale	Endangered	NLAA
<b>Pinnipeds</b>		
Hawai‘ian Monk Seal	Endangered	NLAA
Hawai‘ian Monk Seal Critical Habitat	Designated / Proposed	NLAA / NLAM
<b>Sea Turtles</b>		
Green sea turtle	Threatened	NLAA
Hawksbill sea turtle	Endangered	NLAA
North Pacific loggerhead sea turtle	Endangered	NLAA
Olive ridley sea turtle	Threatened	NLAA
Leatherback sea turtle	Endangered	NLAA

Key: NLAA = May affect, not likely to adversely affect (for listed species and designated critical habitat)  
 NLAM = Not likely to adversely modify (for proposed critical habitat)

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