Draft Environmental Assessment
for the
Aerial Herbicide Application Research Study
Guadalupe-Nipomo Dunes National Wildlife Refuge
San Luis Obispo County, California

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Section I: PURPOSE AND NEED FOR ACTION

A. Proposed Action

The U.S. Fish and Wildlife Service (USFWS) proposes to participate in a research study to evaluate the efficacy of aerial herbicide application as a management strategy to control invasive perennial veldt grass (*Ehrharta calycina*) on the Guadalupe-Nipomo Dunes National Wildlife Refuge (Refuge). In this research study, a helicopter equipped with a spray boom would apply a clethodim or sethoxydim herbicide on up to 20 acres of Refuge land. Also, herbicide drift beyond the spray zone would be assessed to establish appropriate buffers for future treatments that may be in proximity to sensitive ecological areas.

This research study would be conducted as a joint operation with neighboring land managers, environmental organizations, and educational organizations, starting as soon as November 2014. Depending on available funding and the effectiveness of treatments, aerial herbicide applications would continue for at least two seasons and up to five seasons. Depending on weather conditions and perennial veldt grass growth stages, the herbicide application season could possibly extend from November through April. Administration of this project would be conducted by the Dunes Center (a non-profit environmental education, outreach, and research organization based in Guadalupe, California). Management of this project would be conducted by the Land Conservancy of San Luis Obispo County (a non-profit environmental conservation organization based in San Luis Obispo, California; hereafter referred to as Land Conservancy) or another qualified organization. The Biological Science Department at California Polytechnic State University, San Luis Obispo, California, and Padre Associates, Inc. (an environmental consulting firm), San Luis Obispo, California would provide technical assistance. The USFWS would prepare environmental documents, prepare and review federal permits, and provide technical assistance to the project administrators and managers during the course of this Proposed Action. The Proposed Action would occur in central coast dune scrub habitat located in the central and south-central portion of the Refuge (Fig. 1).

B. Purpose of the Action

The primary goal of the proposed action is to evaluate the efficacy of aerial herbicide application as a method for controlling perennial veldt grass. If proven efficacious, aerial herbicide application may be utilized on additional areas of the Refuge and also on neighboring lands in the Guadalupe-Nipomo Dunes Complex. A secondary goal of the proposed action is to determine the extent of herbicide drift from aerial application. The information from drift monitoring would help establish appropriate buffer zones around wetland and other sensitive areas, so that the treatment of additional areas could be planned appropriately.

The past and current treatment measures used on the Refuge and neighboring lands to control perennial veldt grass have consisted of applying herbicides with backpack sprayer and/or mowing. While successful on a small, localized scale, these treatment measures have proved to be too time-consuming and too costly to successfully control the spread of perennial veldt grass on a larger, landscape scale.

If successful, aerial herbicide application would be the first treatment measure to be established on the Refuge and neighboring lands for the effective control of perennial veldt grass on a landscape level. Such an event would provide an opportunity for desirable native vegetation or natural bare-sand dunes to become re-established, and native habitats to become restored. The restoration of native habitats would encourage the recovery of native plant and animal species.

C. Need for Proposed Action

The primary environmental threat to the Refuge and neighboring lands is invasive plants. The ecological functioning and survival of several rare and declining native Refuge wildlife habitats and their plant and animal inhabitants are being seriously threatened by the invasion of numerous invasive pest plants species, including perennial veldt grass, European beach grass (*Ammophila arenaria*), sea fig (*Carpobrotus chilensis*), freeway ice-plant (*Carpobrotus edulis*), slender leaf ice-plant (*Conicosia pugioniformis*), bull thistle (*Cirsium vulgare*), jubata grass (*Cortaderia jubata*), and purple ragwort (*Senecio elegans*). During 14 years of land management activities conducted on the Refuge by the USFWS, the most difficult plant species to control has been perennial veldt grass. Perennial veldt grass has also been the most difficult plant species to control on lands neighboring the Refuge by other land managers.

Currently, perennial veldt grass has invaded more than an estimated 450 acres (about 18%) of the 2,553-acre land area of the Refuge. If left uncontrolled, this highly invasive species would continue to invade native habitats on the Refuge where it would outcompete and overgrow native plant species. Such an event would ultimately lead to the conversion of nearly all of the natural sand dune and central coast dune scrub habitats on the Refuge to large monocultures of perennial veldt grass. This would result in a catastrophic loss of both rare habitats and imperiled species, including designated critical habitat units, federally listed species, and state listed species.

Perennial veldt grass is a non-native invasive grass from South Africa that is currently invading many habitats in the United States. Where it has been introduced, perennial veldt grass often invades habitats with sandy soils, and in California it is known to occur along many portions of the Central Coast and Western Transverse Range (Smith 2012). Perennial veldt grass is present as a dominant plant species in the central coast dune scrub habitat of the Guadalupe-Nipomo Dunes Complex. Once established, perennial veldt grass typically inhibits or prevents germination and establishment of native coastal dune plant species. In locations it becomes established, perennial veldt grass can outcompete and reduce the population sizes of sensitive plant species, can alter ecosystem processes such as sand dune dynamics, and can impact all native species occurring in the central coast dune scrub community. Typically, the invasion of perennial veldt grass into native scrub communities, such as central coast dune scrub, causes a rapid shift towards monoculture grassland. This ongoing growth and spread of perennial veldt grass threatens the existence of central coast dune scrub plant communities and all the plant and animal species that rely upon central coast dune scrub plant communities throughout the Guadalupe-Nipomo Dunes Complex, and other portions of the Central California Coast.

In an effort to provide protection and restoration for wildlife habitats and to provide protection and recovery for wildlife species, it is necessary to implement a treatment method for control of perennial veldt grass that is both environmentally safe and efficient, and is also effective on a landscape level.

During the last 20 years, invasive species control efforts have been conducted by most of the land managers located in the Dunes Complex. Past and current control methods for perennial veldt grass in the Dunes Complex have included backpack sprayer application of herbicides, hand-pulling, and grazing. All three of these control methods are resource intensive and have been implemented with very limited success when applied on a large scale, and perennial veldt grass presence has been increasing in recent years.

D. Background

The Refuge is located along the Central Coast of California within the Guadalupe-Nipomo Dunes Complex (Dunes Complex), an 18-mile long coastal dunes landscape that occupies approximately 20,000 acres of southwestern San Luis Obispo County and northwestern Santa Barbara County (Fig. 1). The Dunes Complex is one of the largest coastal dune landscapes along the west coast of North America, and it contains some of the rarest wildlife habitats and species on the continent.

The 2,553-acre Refuge was created in 2000 as a satellite of the Hopper Mountain National Wildlife Refuge Complex (Refuge Complex), which is headquartered in Ventura, California. The main purpose for creation of the Refuge was to conserve Central California coastal dune and associated wetlands habitats and assist in the recovery of native plants and animals that are federally listed as threatened or endangered. Specific Refuge goals include protecting federally listed species and critical habitat, protecting and restoring biodiversity, creating and leading conservation partnerships, and providing safe and high-quality opportunities for compatible wildlife-dependent educational and recreational activities (USFWS 2000). Refuge lands consist of six native plant communities and one non-native plant community. The six native communities are all considered to be rare and declining, and include coastal strand and active dunes, central coast foredunes, central coast dune scrub and active interior dunes, coastal dune swale, coastal dune freshwater marshes and ponds, and coastal dune riparian woodland (Holland et al. 1995). The non-native plant community is classified as agrestal (habitat previously disturbed by cultivation) (Holland and Keil 1989).

The Refuge was established to conserve imperiled wildlife habitats and species. Several specific Refuge goals include the recovery of the federally endangered La Graciosa thistle (*Cirsium scariosum* var. *loncholepis* [*Cirsium loncholepis*]*)*, California least tern (*Sternula antillarum browni*), and the federally threatened California red-legged frog (*Rana draytonii*) and western snowy plover (*Charadrius nivosus nivosus*). Further, the Refuge serves to protect designated critical habitat units for the La Graciosa thistle and western snowy plover.

At least 26 imperiled plant species and at least 118 imperiled animal species occur in the Dunes Complex, for a combined minimum total of 144 imperiled species (Blecha et al.

2007). Many of these 144 imperiled species inhabit central coast dunes scrub communities and natural bare-sand dune habitats, such as those that occur on the Refuge. If aerial spraying proves to be effective, removal of perennial veldt grass would provide an opportunity for desirable native central coast dune scrub communities and natural bare-sand dune habitats to become re-established, and corresponding native wildlife habitats to become naturally restored in the up-to-20-acre treatment area. The restoration of these native wildlife habitats would encourage the presence and continued existence of native plant and animal species, including many of the 144 imperiled species that have been documented to occur in the Dunes Complex.

E. Decision to be Made by the Responsible Official

Based on the analysis documented in this Environmental Assessment (EA), the USFWS must decide if implementing the Proposed Action would have a significant effect upon the quality of the human environment. Further, the USFWS must also decide whether any potential environmental degradation or risk is reasonably avoidable or acceptable in comparison to the benefits provided by the Proposed Action. If the USFWS concludes that the Proposed Action does not have a significant impact to the human environment, then a Finding of No Significant Impact (FONSI) will be prepared and signed, and project implementation would commence as soon as all other applicable permits and documents have been completed.

F. Issues Identified During Project Planning

Issues identified during project planning included the following:

1) Non-target desirable plants could also be sprayed and harmed or killed by herbicides;

2) The Morro blue butterfly (*Plebejus icarioides moroensis*), and other animals could be accidentally sprayed by herbicides. Animals could also eat plants and other animals that were sprayed with herbicides;

3) Birds could potentially have air strikes with the spray helicopter. Noise, vibrations, and rotor wash from the spray helicopter could harass wildlife;

4) Potential spillage of herbicides could contaminate upland habitats;

5) The California legless lizard (*Anniella pulchra*) and other wildlife species could possibly be crushed by the vehicles used for transportation of project staff members to project sites; and

6) Field crews could trample plants and animals. The presence of field crews could also cause harassment to wildlife and disrupt their daily activities.

Section II: ALTERNATIVES, INCLUDING THE PROPOSED ACTION

A. Alternative 1: No Action

Implementation of Alternative 1, the No Action Alternative, would not allow for evaluation of the efficiency of aerial herbicide treatment with clethodim or sethoxydim, one of the most promising proposed methods reviewed to date as a means to control perennial veldt grass in the 20,000-acre Dunes Complex. Also, no evaluation of the potential extent of herbicide drift from aerial herbicide application would be made under the No Action Alternative.

Implementation of the No Action Alternative would prevent the treatment of up to 20 acres of invaded coastal dune scrub habitat for perennial veldt grass control. Therefore, perennial veldt grass would continue to invade the central and south-central portion of the Refuge. If left untreated, the existing stands of perennial veldt grass would continue to spread, and restrict the opportunity for desirable native vegetation or natural bare-sand dune habitats to become re-established or restored. Implementation of the No Action Alternative would ultimately allow for 20 acres of habitat infested by perennial veldt grass to develop into a grassland monoculture. These 20 acres would continue to exist as a seed bank for further dispersal of perennial veldt grass.

Alternative 2 (Proposed Action): Perennial Veldt Grass Control Using Aerial Herbicide Application

Under Alternative 2 (Proposed Action) up to 20 acres of central coast dune scrub located on the Refuge would be treated to control perennial veldt grass using aerial herbicide application of herbicide from a helicopter equipped with a spray boom (Padre Associates, Inc. 2014).

The preferred herbicide that would be used is Arrow 2EC® (MANA 2013). Although Arrow 2EC® is labeled for aerial application, it is not labeled for application to wildlife refuges, wild lands, or parks (MANA 2009). Therefore, to apply Arrow 2EC® on the Refuge for the proposed action, a Special Local Need Registration (SLN) would be needed under Section 24(c) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; 7 U.S.C. 136 *et seq.*) and Title 40, Code of Federal Regulations (40 CFR), section 162.152. A SLN authorizes state pesticide regulators to register a new end-use product or an additional use of a federally registered pesticide product to address an existing or imminent pest situation. The pest situation must be a special local need within the state that cannot be mitigated by a currently registered product.

In the event that a SLN is not obtained for the use of Arrow 2EC®, or Arrow 2EC® proves to be ineffective against perennial veldt grass, then an alternative herbicide would be used. This alternative herbicide would be Poast® (BASF 2012). Poast® is labeled for aerial application and use in such locations as "set aside conservation reserve areas" and fallow land (BASF Corporation 2010). Therefore, a SLN would not be needed for aerial application of Poast on the Refuge.

Herbicide would be applied by helicopter at a height no greater than 10 feet above the vegetation level. The study area is currently heavily dominated by perennial veldt grass, with low densities

of native plants. The nearest wetlands, riparian woodlands, federally listed species, or non-Refuge lands are located more than 200 yards from the proposed treatment sites. The potential is extremely low for runoff or drift to carry herbicide into these sensitive areas or non-Refuge lands. Further, due to its remoteness, Refuge staff have not observed or detected the presence of visitors in this portion of the Refuge in more than eight years.

To determine the appropriate buffer zone for future applications, a spray drift study zone would be established around the herbicide spray areas to monitor for herbicide drift. Water sensitive spray drift cards would be placed at equal intervals along this spray drift study zone to monitor the dispersal of herbicide beyond the herbicide treatment area. Aerial application of herbicide would not be conducted during weather conditions that could increase drift or runoff, such as high winds or precipitation.

Herbicide Mix. An herbicide mix would be created using tap water, the selected herbicide (either Arrow 2EC® or Poast®), and two different adjuvants, Agri-Dex® and Mist Control®.

Arrow 2 EC®. Specimen label instructions for Arrow 2EC® recommend adding one pint of crop oil concentrate per acre to the spray solution. Specimen label instructions further recommend that for aerial applications, a minimum of 3 gallons per acre (gal/A) of spray solution is applied, but should be increased up to a minimum of 10 gal/A for dense grass foliage (BASF 2010). Based on local experience with perennial grasses, the pilot for this project has recommended an application rate of 20 gal/A (English 2013). To control perennial grasses, the recommended concentration of Arrow 2EC® per application is 6-16 fluid ounces per acre (oz/A), with a maximum of 32 oz/A per year (BASF 2010). The maximum concentration of Arrow 2EC® in the herbicide spray mix would be 0.8 fluid ounces per gallon (oz/gal).

Poast®. Specimen label instructions for Poast® recommend adding one to two pints of a crop oil concentrate per acre to the spray solution. For aerial applications specimen label instructions further recommend that a minimum of 5-10 gallons per acre (gal/A) of spray solution is applied. Based on local experience with perennial grasses, the pilot for this project has recommended an application rate of 20 gal/A (English 2013). To control perennial grasses, the recommended concentration of Poast® per application is 24-72 oz/A (BASF 2010), with a maximum of 40 oz per acre. The maximum application rate per season is 120 oz/A per year. The maximum concentration of Poast® in the herbicide spray mix would be 2.0 oz/gal.

Agri-Dex®. Agri-Dex®, a crop oil concentrate, would be added to the herbicide spray mixture to promote adhesion of the herbicide to the surfaces of plants and uptake into the plant. This crop oil concentrate contains a non-ionic surfactant to emulsify the oil in the spray solution and lower the surface tension of the overall spray solution. The addition of a crop oil concentrate adjuvant to spray mixtures results in the need to spray less herbicide mix to adequately cover each sprayed plant, and further helps to reduce the amount of herbicide applied per unit area of spray. As specified in its specimen label, the dosage of Agri-Dex® would be 1% volume to volume, or 1.28 oz/gallon (Helena Chemical Company 2012).

Mist Control®. Mist Control®, a polyvinyl polymer, would be added to the herbicide spray mixture to retard drift and improve deposition. As specified by the specimen label for aerial applications, the dosage of Mist Control® would be 0.64-1.28 oz/gal (Miller Chemical and Fertilizer Corporation 2011).

Vegetation Monitoring. A total of 20 plots would be selected for monitoring by qualified biological consultants along vegetated dunes in the central and south-central portions of the Refuge. Each plot would occupy 2.0 acres of land area (74 feet by 1,177 feet). From these 20 plots, 10 would be randomly selected to receive treatment, and the remaining 10 would be used as control plots. The proposed study area was selected to avoid sensitive environmental resources and target areas of extensive perennial veldt grass infestation (Fig. 1). To help assure physical independence (Hurlbert 1984, Hurlbert 2012) between all study plots, a minimum distance of 200 feet would be established as a buffer zone between all study plots.

The treatment plots would be sprayed with herbicide; however, the control plots would not be sprayed with herbicide. The control plots would be selected based on their similarity to the treatment plots, including soil types, plant species composition, percent vegetation cover, aspect, slope, and topography. Quantitative and qualitative sampling methods would be used to conduct a baseline botanical inventory at the treatment plots and control plots. Vegetation sampling would be conducted both prior to herbicide application and following herbicide application at treatment plots control plots.

Since all clusters of perennial veldt grass do not grow at the same period or rates, they would not intake applied herbicide at the same levels. Therefore, repeat treatments of perennial veldt grass with herbicide during the same growing season may be necessary to increase suppression of perennial veldt grass.

The vegetation data to be collected would include measures of species richness, absolute vegetation cover, including native and non-native plant cover. Permanent transects and photopoint stations would be established within the study plots. Six, 100-meter (m) long transects would be distributed throughout each study plot using a stratified random sampling design. The point-intercept method would be used to sample vegetation at 2-m intervals along each transect. At each sample point, all plant species present and its status of vigor would be recorded. For example, if a plant is intersected, it will be recorded, along with "D" for dead or "L" for live. The distinction will be made based on the part of the plant that intersects the point, not the overall health of the plant. Furthermore, a belt transect would also be established along the transect edge of 1-meter width (100-meters by one meter). All perennial species and identifiable annual species that are rooted within the designated belt would be recorded. Photopoint stations would be established at the start and finish of each transect. Photographs would be taken along the individual transects from each station for comparison over time.

Qualitative assessment would focus on visual estimates of perennial veldt grass cover, using a standardized California Native Plant Society (CNPS) Cover Diagram (CNPS 2013). These sampling methods would primarily focus on the determination of absolute percent plant species cover and species numbers, and the changes in these values over time. Qualitative assessment of the study plots would be conducted approximately two months after herbicide application to determine the need for additional treatment.

Following the conclusion of each season of aerial application of herbicide, additional quantitative vegetation data would be collected to compare with the baseline data. The methods for collecting post-treatment data would be consistent with the methods for which the baseline data were collected. Quantitative assessment of the study plots would be conducted approximately four months after the final herbicide application conducted each season to assess the efficacy of the treatment.

The results of the study would be presented in a final report, including vegetation data, drift card monitoring data, and supporting photographs.

Herbicide Drift Monitoring. Buffer zones would be established around one randomly selected treatment plot and monitored for drift by qualified biological consultants. Water sensitive spray drift cards (Gempler's #TJC or comparable) would be placed at equal intervals along the buffer zones to monitor the dispersal of herbicide beyond the treatment unit. The spray drift cards would set in place the morning of or evening before the early morning herbicide applications, and then retrieved immediately after treatment to accommodate for heavy fog conditions that could cause false readings. Spray drift cards would also be placed inside treatment plots under full spray conditions for a reference to determine the percentage that have detection. The spray drift card data would be used to assess the spray accuracy of aerial herbicide application, in order to determine the appropriate buffer needed to protect sensitive resources in future treatments.

Equipment. The herbicide mixture would be applied with the use of a helicopter by a Qualified Applicator, following the specifications for use within the State of California provided on the Specimen Label and Material Safety Data Sheet (MSDS) for each product. The helicopter would be equipped with a spray boom. For all herbicide treatment areas, due to the speed of aerial spraying, the application of herbicide would be conducted in less than one day.

A helibase would be designated on the Refuge to facilitate loading spray solution and refueling, if necessary. The helibase location would be selected by the pilot, would have safe aerial access, and would be located away from wetlands and any other sensitive habitats. A support vehicle equipped with a mixing tank, water tank, and aviation fuel would be stationed at the helibase.

Staffing. In addition to providing a contracted helicopter pilot, the Land Conservancy or another qualified entity would provide all staffing in the form of employees and/or sub-contractors. Staffing would be limited to essential personnel who are supporting the spray efforts. A project manager would be designated to oversee and coordinate all aspects of the aerial application. The commercial aerial spray contractors would consist of a pilot and mix master. Monitors would be staged near the buffer areas to place and retrieve drift cards, and monitor weather conditions. A traffic manager and public information representative would secure the treatment area and answer questions regarding the project objectives. The Wildlife Refuge Manager would be kept informed of all project activities, and would provide final approval prior to the commencement of any spray activities.

Schedule. Herbicide treatment would be scheduled to target perennial veldt grass during its active growth cycle. Generally, perennial veldt grass grows after the first rains of the season, and becomes dormant in the summer. Clethodim herbicides are only effective with controlling grasses when they are applied during the active growth phase, prior to seed head development. Treatment of perennial veldt grass with herbicides is typically most efficacious during the winter and into spring, after seasonal rains. Depending on the varying weather conditions in the Dunes

Complex, the growing season can begin as early as November and continue until as late as April. The peak of the growing season in the Dunes Complex typically is between December and February. Drought conditions or cold conditions can inhibit growth of perennial veldt grass.

Depending on weather conditions and growth conditions, the perennial veldt grass treatment "season" would occur between early November and late April of each year. Depending upon completion dates for all environmental documents required for this Proposed Action and local weather conditions, the first herbicide application date would be targeted to occur during the period from early November 2014 to late April 2015.

The objective of the aerial spray application is to kill perennial veldt grass, to deplete the perennial veldt grass seed bank in the soil, facilitate the growth of native plant species, and ultimately to restore native plant communities or active sand dunes. Accordingly, follow-up treatments would likely be necessary for several seasons to attain these objectives. Depending on available funding and the efficacy of treatments, aerial herbicide applications would continue for at least one season and up to five seasons. Therefore, this project could possibly continue until the fall of 2019. Depending on seasonal needs, and specimen label restrictions, at least one, and up to three herbicide applications may be made per treatment season. To reduce the potential for adverse environmental effects, efforts would be made to limit the physical volume and frequency of herbicide applications.

Best Management Practices. The following eight Best Management Practices (BMPs) have been incorporated into the project design of the Proposed Action to ensure that effects to humans and the environment are negligible. Each of these measures would also be listed as a requirement under a Special Use Permit that would be issued to the Land Conservancy and other organizations working on the Refuge:

1) Precautions would be taken to reduce impacts to human health and environment. Public access to portions of the Refuge within one-half mile of aerial spray activities would be prohibited during treatment operations, and staff access would be limited to essential personnel for at least 12 hours, until after the spray has dried. During days of aerial spraying, public access closure signs would be placed along hiking paths that lead to the project spray areas. Project team members would also patrol access points in a utility terrain vehicle (UTV) along these hiking paths. Patrols would start one hour before spray activities start, and continue until one hour after spray activities have been completed. Together with assistance from the helicopter pilot, these staff members would ensure that no unauthorized persons are in the treatment area until after the herbicide is dry. In the event that a trespasser is observed within one-half mile of the herbicide treatment area during spray operations, the helicopter would stop work until the trespasser is escorted from the area;

2) All USFWS, State of California, and product specimen label pesticide use policies and directions would be followed. All herbicide applications would be directly supervised by a pesticide applicator who is in possession of a State of California Qualified Applicator's License (QAL);

3) To minimize the risk of a crash into sensitive habitats and to reduce harassment of wildlife, the spray helicopter would be prohibited from flying directly over or within 200 yards of wetland or riparian woodland habitats. The Wildlife Refuge Manager will brief the helicopter pilot about areas to avoid prior to the start of any flight activities;

4) The treatment area was selected to avoid potential impacts to wetlands, riparian woodlands, other sensitive habitats, and listed species. A spray buffer of at least 200 yards from any wetland or riparian woodland would be established to reduce the likelihood of herbicide runoff or drift into these habitats. The 200-yard helicopter flight buffer would also serve to reduce harassment of wildlife that occurs in wetland and riparian habitats where listed species are more likely to occur. Due to the low spray volumes and the high porosity of the sand-dominated soils, potential runoff distance would likely be limited to no more than a few feet from the spray zone. The flight buffers and spray buffers would serve to minimize the likelihood for helicopter-bird strikes to occur with such species as great horned owl, red tailed hawk, and mallard (*Anas platyrhnychos*) that tend to occur in the Refuge wetlands and/or riparian woodlands;

5) All spraying would be conducted at least 200 yards from Refuge boundaries. Therefore, herbicide application would occur in locations where it would be extremely unlikely for drift or runoff to carry any herbicides off the Refuge, where undetected listed species, other special status species, or other sensitive habitats may be present;

6) To reduce herbicide drift and runoff into non-treatment areas, the following measures would be implemented: aerial herbicide treatment would not be conducted when winds are above 10 miles per hour (mph) in the project area (ideally, winds would be 3 to 6 mph); aerial herbicide treatment would not be conducted when air inversions are occurring in the spray zone; treatment would not begin if rain is forecasted within the next 24 hours; spray droplet size would be maximized; an anti-drift agent (Mist Control®) would be added to the spray mix to help maintain a larger droplet size; boom pressure would be maintained at less than 40 psi; spray pressure would be monitored during flight; spray nozzles designed for medium to coarse droplet size (240-400 microns) would be used; the spray area boundaries would be clearly marked for the helicopter pilot; accurate GPS navigation would be used by the helicopter pilot; weather conditions in the immediate spray area would be monitored and recorded in real-time; and spray drift cards would be installed and monitored; application would be made in accordance with diurnal wind patterns resulting from the heating and cooling of the ground surface; to prevent herbicide from drifting downslope into sensitive habitats, winds would be upslope (typically in the morning); the specific time would be determined by real-time weather monitoring;

7) To avoid introducing new invasive plant species onto the Refuge or bringing invasive plant species off the Refuge, all equipment, vehicles, and aircraft involved in the project would be cleaned of soil and plant materials prior to entering the Refuge. A Refuge staff member or a qualified biological consultant would inspect all equipment, aircraft and vehicles before they enter the Refuge;

8) Accidental spill response materials would be onsite daily or staged close to the work areas, to help minimize negative impacts on the environment in the event of a chemical spill.

B. **Alternatives Considered, But Rejected**

The following alternatives were considered in the initial planning stage, but they were rejected as not being feasible or practical, and they do not meet the purpose and need for action.

1) Alternative 2 (Proposed Action), Plus the Use of Heavy Equipment to Remove Dense Monoculture Stands of Perennial Veldt Grass

In addition to the activities specified above for Alternative 2 (Proposed Action), the use of heavy equipment such as dozers, front end loaders, and excavators was considered for use to mechanically remove large, dense monoculture stands of perennial veldt grass. However, this alternative was rejected due to the potential to disturb historical and cultural resources.

2) Use of Livestock Grazing to Control Perennial Veldt Grass

The use of livestock grazing to control invasive plants was considered as an additional means to control invasive plants. However, in past years, grazing has been associated with causing eutrophication in several Refuge ponds and with trampling endangered plants (USFWS 2012). This alternative was rejected due to the lack of sufficient fencing to control movement on or off the Refuge. Also, livestock have the potential to spread the seeds of invasive plants and graze special status plants.

3) Use of Controlled Burns to Control Perennial Veldt Grass

The use of controlled burns to control large monoculture stands of perennial veldt grass was considered as an additional means to control invasive plants. This alternative was rejected due to potential adverse effects to air quality in such nearby areas as Guadalupe, Nipomo, and Santa Maria.

4) Perennial Veldt Grass Control Using Backpack Spray Application of Herbicide

The use of backpack sprayers to apply clethodim or sethoxydim herbicide mixes to perennial veldt grass on up to 20 acres of Refuge land was considered. Spraying from a backpack would not be conducted within 100 feet of any listed species, wetlands, or other sensitive habitats. These herbicide applications would be repeated for several growing seasons, until the perennial veldt grass seed bank was exhausted.

This alternative was rejected because prior experience in the Dunes Complex indicates that this method is neither time nor cost efficient when applied on an area that is larger than a few acres in size.

5) Perennial Veldt Grass Control Using Utility Terrain Vehicles (UTV) Equipped With Spray Hoses and/or Spray Booms for the Application of Herbicide

The use of a UTV, such as a Polaris Ranger© or Honda Big Red© to apply herbicides mixes was considered. The vehicles would be equipped with holding tanks that contain clethodim

or sethoxydim herbicide mix. Ideally, the holding tanks would accommodate a minimum of 80 gallons of herbicide mix. After accessing the treatment areas with the UTV, the herbicide mix would be applied using a spray hose and/or a spray boom. Herbicide mix would be applied to treat perennial veldt grass on up to 20 acres of Refuge lands. Spraying from a UTV would not be conducted within 100 feet of any listed species, wetlands, or other sensitive habitats. These herbicide applications would be repeated for several growing seasons, until the perennial veldt grass seed bank was exhausted.

This alternative was rejected because of 1) the potential of a loaded UTV with a gross weight of at least 2,500 pounds to trample sensitive habitats, plants, and animals; 2) the potential for the spray hose to damage imperiled and other native plants, and 3) the inaccessibility of many steep slopes of the Refuge. Additionally, prior experience in the Dunes Complex indicates that while more efficacious than using a backpack sprayer, spraying from a UTV would likely not be as time or cost efficient as aerial spraying when applied on an area that is larger than a few acres in size. However, Alternative 4 may be investigated in the future for use in accessible habitats that are already highly-invaded by perennial veldt grass, and no longer considered to be sensitive.

Section III: AFFECTED ENVIRONMENT

A. Physical Environment

The Refuge is located in Central California, along the coast of southwestern San Luis Obispo County, and is part of the 18-mile long Guadalupe-Nipomo Dunes Complex that stretches from Pt. Sal in Santa Barbara County north to Pismo Beach in San Luis Obispo County (Fig. 1). At 20,000 acres, the Dunes Complex is one of the largest dune landscapes on the west coast of North America. The 2,553-acre Refuge occupies about 13% of the land area of the Dunes Complex. Land elevations on the Refuge range from sea level to about 175 feet above mean sea level (MSL). The Refuge landscape primarily exists as sandy beaches, unvegetated sand dunes, and vegetated sand dunes.

The Refuge is bordered on the west by 1.8-miles of the Pacific Ocean, and its boundaries extend about three miles inland, where it is bordered by vegetated back dunes and active sand dunes. The Guadalupe Restoration Project (former Guadalupe Oil Fields) lies to the south of the Refuge, and it is currently being managed by the Chevron Environmental Management Company for habitat restoration. The Oso Flaco Natural Area of the Oceano Dunes State Vehicular Area lies to the north of the Refuge, and is managed by California Department of Parks and Recreation as a wildlife preserve. The Santa Maria River Valley, an internationally famous agricultural area, lies about a quarter-mile to half-mile from the Refuge, mostly to the east.

The Refuge and most areas of the Central California Coast are characterized as having a Mediterranean climate, with winters that are typically cool and wet, and summers that tend to be warmer and drier than winter. Fog can be common at any season of the year, but is more prevalent during the summer months. More than 90% of the annual rainfall usually occurs

from November through April of each year (Smith et al. 1976). The approximate annual rainfall for the Guadalupe area from 1964-2010 was a minimum of 4.8 inches, maximum of 28.2 inches, and mean of 13.7 inches (Chevron Environmental Management Company, unpublished data).

B. Biological Environment

The vegetation of the Refuge exists as an ever-changing mosaic of plant communities and unvegetated sand dunes. These plant communities and unvegetated sand dunes include seven communities, coastal strand and active primary dunes, central coast foredunes, central coast dune scrub with active interior dunes, coastal dune swale, coastal dune freshwater marsh and pond, coastal dune riparian woodland, and agrestal (Holland and Keil 1989, Holland et al. 1995).

Although seven plant communities have been identified on the Refuge, the proposed project would only affect two of these, central coast dune scrub with active interior dunes and agrestal.

The project study would occur in central coast dune scrub with active interior dunes. Central coast dune scrub with active interior dunes is the most common plant community on the Refuge, and it typically begins to occur immediately inland of the foredunes, and extends inland all the way to the Refuge eastern boundary, about three miles inland. This habitat is dominated by both native and non-native plant species. Common native plant species in this plant community include silver bush lupine (*Lupinis chamissonis*), mock heather (*Ericameria ericoides*), prickly phlox (*Linanthus californicus*), sea cliff buckwheat (*Eriogonum parvifolium*), coyote bush (*Baccharis pilularis*), wedgeleaf horkelia (*Horkelia cuneata*), California poppy (*Eschscholzia californica*), and clustered field sedge (*Carex praegracilis*). Common non-native plant species include perennial veldt grass, sea fig, ripgut brome (*Bromus diandrus*), narrowleaf iceplant (*Conicosia pugioniformis*), and wild oat (*Avena sativa*).

The staging area for the proposed action would be located in an agrestal plant community. An agrestral plant community (habitat previously disturbed by cultivation) exists on the Refuge at a location commonly called Beigle Flats (Fig. 1). This location is adjacent to the Refuge administrative entrance road that is also known as Beigle Road. Beigle Flats occupies approximately two acres of land area, and is the only portion of the existing Refuge that is not located within coastal dune or beach habitat. Beigle Flats was previously farmed for at least 60 years, primarily for strawberries and broccoli. Farming ceased on this land in 2007. Due to its long history of disturbance from farming, this land area is now dominated by a variety of weed species such as bull mallow (*Malva nicaeensis*), cheeseweed (*Malva parviflora*), and common knotweed (*Polygonum aviculare* subsp. *depressum*).

A wide variety of animal species inhabit the Refuge, and some of the more common species include coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus)*, red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), northern raccoon (*Procyon lotor*), feral pig (*Sus scrofa*), opossum (*Didelphis virginiana*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), Lompoc kangaroo rat (*Dipodomys heermanni arenae*), deer mouse

(*Peromyscus maniculatus*), great horned-owl (*Bubo virginianus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), California quail (*Callipepla californica*), spotted towhee (*Pipilo maculatus*), sage sparrow (*Amphispiza belli*), coast garter snake (*Thamnophis elegans terrestris*), California striped racer (*Coluber lateralis lateralis*), southern Pacific rattlesnake (*Crotalus oreganus helleri),* San Diego gopher snake (*Pituophis catenifer annectens*), Coast Range fence lizard (*Sceloporus occidentalis bocourtii)*, Skilton's skink (*Plestiodon skiltonianus skiltonianus*), San Diego alligator lizard (*Elgaria multicarinata webbii*), California legless lizard, Sierran treefrog (*Pseudacris sierra*), several noctuid moths (*Pseudorthodes puerilis*, *Ululonche niveiguttata*, and *Copablepharon robertsoni*), western tiger swallowtail (*Papilio rutulus*), Acmon's blue butterfly (*Plebejus acmon*), and Morro blue butterfly (*Plebejus icarioides moroensis*).

Small populations of American badger *(Taxidea taxus)* are scattered around the Refuge, and occasionally American black bear (*Ursus americanus*) and mountain lion (*Felis concolor*) are also present. No species of fish have been found to inhabit any waterbodies located within the boundaries of the Refuge. Since the Refuge boundary occurs at the mean high tide line, the fish species found in the surf zone adjacent to the Refuge technically occur in State of California waters.

Special Status Species. At least 22 taxa (species, subspecies, and varieties) of special status plants have been found on the Refuge (USFWS, unpublished data). Blecha et al. (2007) report that at least 118 taxa (species and subspecies) of special status invertebrates, amphibians, reptiles, birds, and mammals have been found on the Dunes Complex, and most of these taxa are likely present on the Refuge. These taxa are considered to be of special status because they have been listed by a government agency (such as California Department of Fish and Wildlife or USFWS) or a conservation organization (such as the International Union for Conservation of Nature or California Native Plant Society) as being endangered, threatened, rare, and/or of limited geographic distribution.

Special status plants on the Refuge include the federally endangered marsh sandwort (*Arenaria paludicola*), Gambel's watercress (*Nasturtium gambelii*), and La Graciosa thistle, and the state threatened surf thistle (*Cirsium rhothophilum*) and beach spectacle pod (*Dithyrea maritima*). Several of the dominant or common plant species on the Refuge are considered to be non-listed special status (not threatened or endangered) such as California spineflower (*Mucronea californica*), prickly phlox, dune ragwort (*Senecio blochmaniae*), San Luis Obispo monardella (*Monardella undulata* subsp. *undulata*), and crisp dune mint (*Monardella undulata* subsp. *crispa*).

Special status animals on the Refuge include the federally endangered California least tern, and federally threatened western snowy plover and California red-legged frog. Non-listed special status animal species that are present include the American badger, golden eagle (*Aquila chrysaetos*), American peregrine falcon (*Falco peregrinus anatum),* white-tailed kite (*Elanus leucurus*), western burrowing owl (*Athene cunicularia hypugaea*), loggerhead shrike (*Lanius ludovicianus*), two-striped garter snake, California legless lizard, *Copablepharon robertsoni* (noctuid moth*),* monarch butterfly (*Danaus plexippus*), sand dunes metalmark (*Apodemia virgulti arenaria*), and Morro blue butterfly.

Despite the large number of special status plant and animal species present on the Refuge, the project would likely only directly affect two of them, the California legless-lizard and Morro blue butterfly. However, due to low toxicity of the applied herbicide, low herbicide spray volumes, and the potential for restoring wildlife habitat, the net cumulative effects on the California legless lizard and Morro blue butterfly would likely be beneficial. Since the California legless lizard primarily lives in subterranean habitat, it would not likely to be substantially exposed to direct herbicide applications. Since Refuge staff members already use UTVs in the area, the additional impacts to the California legless lizard and other wildlife species from a limited amount of UTV use from the proposed project would likely be negligible. Since Refuge staff members already periodically walk in this area, the additional impacts to wildlife from project staff members walking in the project area would also likely be negligible.

The proposed action would likely have no effect on the California red-legged frog, due to its unlikely presence in the action area.

Designated Critical Habitat. The Refuge serves to protect designated critical habitat units for the La Graciosa thistle and western snowy plover.

With the exception of the beach and the western edge of the foredunes, most of the Refuge is part of Designated Critical Habitat Unit 1, Subunit A for the La Graciosa thistle (74 FR 56978). This designation includes 94% (2,402 acres) of the Refuge (Fig.1). After eight years of searching by biologists from the USFWS and several other natural resource agencies and conservation organizations, the La Graciosa thistle is still only known to occur on the Refuge in one valley located in the southeast corner of the Refuge. Project activities would occur at least 200 yards from this population of La Graciosa thistle. Since all project activities would occur within the boundaries of Designated Critical Habitat Unit 1, Subunit A, critical habitat would be affected. The proposed action may affect, but is not likely to adversely affect, critical habitat for the La Graciosa thistle because any potential adverse effects would be very small and, therefore, are insignificant. Further, the net effects of the Proposed Action on this critical habitat would likely be positive (USFWS 2014).

All of the Refuge coastal strand and large portions of the western foredunes are included in designated Critical Habitat Unit CA-31 (Pismo Beach/Nipomo Dunes Unit) for the western snowy plover (77 FR 36728). This designation includes approximately 9.5% (242 acres) of the Refuge (Fig. 1). Since the proposed project area is located at least 1,800 yards inland of Critical Habitat Unit CA-31, there would likely be no effect on critical habitat for the western snowy plover (USFWS 2014).

C. Cultural Resources

The Refuge is located within an area traditionally utilized by the Obispeño Chumash. The boundary between the Obispeño and the Purismeño, their Chumash neighbors to the south, is not distinct, but between them, the two groups occupied the outer shore of the California coast from what is now known as Morro Bay to the north and Point Conception to the south. The Handbook of North American Indians provides a comprehensive overview of these

groups (Greenwood 1978). Several radiocarbon dates from archaeological sites in San Luis Obispo County date occupation back as far as 9,000-9,300 years ago.

The Obispeño occupied the narrow coastal terraces which often included sand dunes and small valleys as well as the windswept outer shore: "It is a habitat of great variety at an interface of northern and southern plant associations and warm-water and cold-water marine life, yielding an abundance of wild plant foods, land and sea mammals, fish, birds, molluscan resources, all of which were utilized from the earliest periods" (Greenwood 1978). There have been 28 recorded archaeological sites within the Refuge boundaries since 1967.

First contact between the Chumash of this region and Europeans is reported to have occurred during the early years of the Manila-Acapulco Galleon trade era in the late 16th century when a Spanish galleon commanded by Pedro de Unamuno landed at Morro Bay in October 1587. More Spanish expeditions followed, though none stayed long in the area until the late 18th century when the Mission San Luis Obispo de Tolosa was established in the area in 1772. While the Chumash and other native people resisted Spanish control, the period took a heavy toll on their numbers and their culture as they succumbed to European diseases and forced relocation.

The Mission Era was followed by the Rancho Era, when California was annexed to Mexico in 1822 and former mission lands such as those at San Luis Obispo were distributed to Mexican citizens, along with the mission's cattle herds. The Refuge appears to be located primarily within the boundaries of Rancho Guadalupe, a grant bestowed by the Mexican government (Juan Alvarado, Governor) on Teodoro Arellanes and Diego Olivera on March 21, 1840, (Adam v. Norris, U.S. Supreme Court, 103 U.S. 591 (1880)). The Rancho encompassed 43,682 acres running along the coast and inland to what is now the town of Guadalupe. Rancho Guadalupe was bordered on the north by Rancho Bolsa de Chamisal, and the Refuge boundary appears to occur close to the (apparently) indistinct boundary between the two Ranchos. There have been numerous owners throughout Rancho Guadalupe's history, as well as ownership disputes regarding boundaries, foreclosures, and the division and selling off of parcels.

D. Social Environment

The town of Guadalupe is located in Santa Barbara County about two miles southeast of the southeast corner of the Refuge, and the unincorporated community of Nipomo is located in San Luis Obispo County about seven miles east-northeast of the northeast corner of the Refuge (Fig. 1). The Santa Maria Valley is a major agricultural area, with cattle grazing becoming established in the late 1830's. Currently, the closest cattle grazing operations to the Refuge are located on private lands in the Santa Maria River channel, about two miles south of the Refuge southern boundary.

In the mid-1800's grain and orchard crops were commonly cultivated, and by 1897 irrigated crops such as beets became established (Smith et al. 1976). Several thousand acres of land areas to the north, east, and southeast of the Refuge have a long history of farming, and some of the local farms have been in existence for more than 100 years. Broccoli, strawberries,

and lettuce are the primary crops currently grown on these farmlands. These farmlands are primarily irrigated with wells that access local groundwater.

In 1938, the Mobil Oil Company acquired the 2,553 acres of what are now Refuge lands for conducting oil exploration activities. However, only two active oil wells were established on the Refuge, near the southern boundary.

In 1974, the lands of the current Refuge and several neighboring Dunes Complex lands were collectively incorporated by the National Park Service into the 11,533-acre Nipomo Dunes - Pt. Sal Coastal Area National Natural Landmark (NNL). The NNL Program was established in 1962 by the Secretary of the Interior under the authority of the Historic Sites Act of 1935 (16 U.S.C. 461 et seq.) to encourage the preservation of the best remaining examples of the major biotic communities and geologic features composing the nation's natural landscape. The program is managed by the National Park Service (NPS). The NNL Program is the only natural areas program of national scope that identifies and recognizes the best examples of biological and geological features in both public and private ownership.

The NNL Program was established to encourage and support the voluntary conservation of sites that illustrate the nation's geological and biological history, and to strengthen the public's appreciation of America's natural heritage. The program offers participants the opportunity to share information, solve problems cooperatively, and conserve important natural areas. Since 1962, the NNL Program has involved private, municipal, state, federal, and other landowners working together to conserve natural resources. Land acquisition by the federal government is not a goal of this program; NNLs are owned by a variety of land stewards, and participation in the program is voluntary. The federal action of NNL designation imposed no new land use restrictions or regulations that were not in effect before the designation.

In 1989, the Mobil Oil Company transferred ownership of its 2,553-acre oil exploration lands to The Nature Conservancy. The Nature Conservancy managed these lands as a wildlife preserve called the "Mobil Coastal Preserve" until 2000. On August 1, 2000, The Nature Conservancy transferred ownership of these lands to the United States of America, to allow for the creation of the Refuge, to be operated by the USFWS.

Most portions of the Refuge are open to the public, with seasonal access restrictions enacted during western snowy plover breeding season, which typically runs from 1 March through 30 September of each year. During western snowy plover breeding season, public access is limited to the lower beach portion of the Refuge and to escorted hikes in the Refuge interior. Due the presence of sensitive habitats and listed species, several wetland areas on the Refuge are currently closed to the public. Due to the close proximity of private lands where both agricultural activities (which includes aerial spraying of pesticides) and hunting (primarily for mule deer, feral pig, and California quail) take place, all of the 100-foot wide "panhandle" section along the northern and northeastern portion of the Refuge (Fig. 1) is closed to public access.

Since its creation in 2000, the Refuge has been averaging about 1,200-2,000 visitor-use days per year. Due to the long hiking distances involved to reach the Refuge, most visitors stay on the beach and foredune areas, and few visit the inland areas of the Refuge. Most of the visitors who venture to the inland areas of the Refuge are present as members of Refuge sponsored hikes.

The most popular Refuge visitor activities include surf fishing, beach combing, hiking, photography, and wildlife observation. Hunting, vehicles, camping, fires, smoking, and pets are prohibited on the Refuge.

Section IV: ENVIRONMENTAL CONSEQUENCES

A. Alternative 1: No Action

Physical Environment. Alternative 1 would not result in any (or minor if we are still doing backpack spraying) physical disturbance to the environment. Therefore this alternative would have no effect on the physical environment.

Biological Environment. While the No Action Alternative would protect non-target Refuge plants, animals, and habitats from exposure to herbicide, it would do nothing to control the spread of invasive plant species. Implementing the No Action Alternative would reduce the opportunity to control invasive plants on the Refuge. Perennial veldt grass would continue to spread and the 20 acres infested with Veldt grass would continue to develop into a grassland monoculture that would eventually displace native plants and animals.

Cultural Resources. No ground disturbing activities would occur with the No Action Alternative, and no other activities are likely to disturb historical or cultural resources. Therefore, no effects to historical or cultural resources are likely to occur.

Social Environment. The No Action Alternative would not have any direct effects on the social environment. However, the unchecked movement of perennial veldt grass through the research area may reduce wildlife observation opportunities for the general public.

Cumulative Effects. Under the No Action Alternative, we would take no action in the study area to control perennial veldt grass. Under this alternative there would be no cumulative impacts, because no direct or indirect effects would accumulate with the effects of other actions.

B. Alternative 2 (Proposed Action): Perennial Veldt Grass Control Using Aerial Herbicide Application

Physical Environment. Potential impacts to the physical environment under Alternative 2 are minor because herbicide application would be limited to 20 acres of land that is located in the central and south-central portion of the Refuge. Since the herbicide mixes would be applied from the air, there would be limited physical disturbance to the land resulting in minimal

impacts to the terrestrial habitat. Limited impacts to the exiting Refuge trails would occur from UTVs and foot traffic from the research study crew. Since Refuge staff members already periodically drive UTVs in this area, the additional impacts to the Refuge trails would be negligible. Since Refuge staff members already periodically walk in this area, the additional impacts from foot traffic of project team members in the project area would also be negligible.

Biological Environment. The primary potential biological effects from Alternative 2 are 1) air strikes with birds; 2) helicopter harassment of wildlife; 3) trampling of imperiled plants, animals, and habitats; and 4) wildlife and non-target plant contact with herbicide mix. These effects are evaluated below:

1) Since the spray helicopter will not fly over or closer than 200 yards to wetlands or riparian forests, where most of the birds occur in this part of the Refuge, the likelihood for bird strikes is low.

2) By avoiding the wetland and riparian forest habitats, the level of wildlife harassment would be greatly reduced. Since the helicopter can spray about 30 acres of ground per hour, the amount of time spent over a particular location would only be a few minutes at most. Therefore, if harassment to wildlife does occur, it would be for just a short amount of time.

3) An already-existing 10 mph speed limit for UTVs would reduce the likelihood for UTVs to trample wildlife. The research study ground crew would consist of environmental professionals who are trained to identify and avoid sensitive natural resources. Therefore, the likelihood to trample imperiled plants, animals, and habitats is negligible.

4) Wildlife and non-target plants in the spray zone would be subject to potential contact with herbicide mix. However, for the reasons described below, the effects of the herbicide mixes on non-target animals and plants are not expected to be substantial.

Potential Herbicide Mix Effects

Potential Effects of Arrow 2 EC®. Arrow 2 EC® is a selective post-emergence clethodim-based herbicide in the cyclohexanedione class (MANA 2013). The concentration of clethodim (Chemical Abstract Services Registry Number [CAS#] 99129-21-2) in Arrow 2 EC® is 26.2%. Commercial clethodim products similar to Arrow 2EC® include Envoy Plus®, Clethodim 2E®, Clethodim 2EC®, Intensity®, Centurion®, Compass®, Select®, Select 2EC®, and Select Max®.

Arrow 2 EC® and similar clethodim herbicides are graminicides (herbicides specifically designed to control weedy grasses) that target annual and perennial grasses, but have little to no effect on sedges, rushes, and broadleaf plants (dicots).

Broadleaf plants are tolerant to this herbicide family, but a wide range of perennial and annual grasses are susceptible. Sedges or broadleaf weeds are typically not controlled by clethodim (BCMAFF 2004). Field observations in the Dunes Complex at the Guadalupe

Restoration Project have indicated that clethodim does not harm either sedges or rushes (Padre Associates, Inc. 2014). Within the Dunes Complex, very few non-target grasses occur within the type of habitat where this project is proposed, central coast dune scrub. The non-target grasses that have been observed, primarily melic grass (*Melica imperfecta*) and six-weeks fescue (*Festuca octoflora*), generally comprise one to four percent absolute cover (Padre Associates, Inc. 2014).

Since it only controls grasses, Arrow 2EC® is suitable for broadcast application within plant communities that do not possess a large component of native grasses, such as the central coast dune scrub that is present on the Refuge.

Clethodim is absorbed up by the foliage of sprayed plants. Typically, clethodim penetrates the cuticle within one hour of application, and then moves in the phloem to areas of new growth. Plant lipids are vital to the integrity of cell membranes and to new plant growth. The mode of action of clethodim is by inhibiting lipid synthesis (BCMAFF 2004).

All clusters of perennial veldt grass do not grow at the same period of time. Perennial veldt grass germinates and grows most during the winter months, becoming dormant after precipitation ceases. Due to the enormous seed bank of perennial veldt grass, multiple crops can germinate throughout the rainy season, making repeat treatments necessary.

Arrow 2 EC® has received a human health rating from the National Fire Protection Association (NFPA) of 1, meaning that it only presents a slight health risk to humans (MANA 2013).

The amount of Arrow 2EC® to be applied on the proposed project site is low, with a maximum of 32 oz/ac/yr. Since the concentration of sethoxydim in Arrow 2EC® is 26.4%, this equates to a maximum application of clethodim of 8.448 oz/ac/yr or 0.000194 oz/ft^2/yr (Appendix 1).

The following summary information related to toxicological effects, ecological effects, and environmental fate for clethodim was extracted from the Extension Toxicology Network (EXTOXNET 2014a):

Acute Toxicity. Clethodim is moderately toxic by ingestion. The reported oral LD_{50s} are 1,630 mg/kg and 1,360 mg/kg in male and female rats, respectively. Reported LD_{50s} for Select 2 EC formulation are 3,610 mg/kg and 2,920 mg/kg in male and female rats, respectively. Clethodim is practically non-toxic by dermal absorption. The reported dermal LD_{50} is greater than 5,000 mg/kg in rabbits for the technical product as well as the formulation. The technical product did not cause skin irritation in the rabbit, but the formulation (Select) caused moderate skin as well as eye irritation in the rabbit. Eye irritation was reversible within 8-21 days. Select formulation caused no skin sensitization in guinea pigs. No data regarding skin sensitization or eye irritation were available for the technical product. Clethodim is practically non-toxic by the inhalation route as well. The reported rodent 4-hour inhalation LC_{50s} for clethodim technical and Select® formulation are greater than 3.9 mg/L and 4.4 mg/L, respectively. Effects of acute exposure to clethodim or Select® may include eye or skin irritation or central nervous system effects, such as salivation, decreased motor activity, incoordination, unsteady gait, and hyperactivity. These

latter effects may be in large measure due to the aromatic constituents of the formulation, as these effects commonly occur upon exposure to such compounds.

Chronic Toxicity. In a one-year feeding study of dogs, doses of 75 mg/kg/day resulted in increased relative and absolute liver weights, with anemia-like alterations in blood chemistry such as reduced hemoglobin, erythrocyte and hematocrit counts. In a two-year chronic study of rats, no compound-related effects on the structure and function of the liver were observed, and no changes in liver weights were observed at the highest dose tested, approximately 100 mg/kg/day. Reduced body weight gain was observed in another study on rats at 350 mg/kg/day, but not at 100 mg/kg/day, over an unspecified period.

Reproductive Effects. No effects on fertility, length of gestation or growth and development of offspring were observed at doses up to and including the highest dose tested, 263 mg/kg/day. No other data were available regarding reproductive effects; while these data are insufficient, it appears unlikely that reproductive effects would occur in humans under normal circumstances.

Teratogenic Effects. Reductions in fetal body weights and increases in skeletal abnormalities were observed in rats at doses of 350 mg/kg/day and higher. In another study of rats, there were significant reductions in fetal body weight, litter size and significant increases in cervical rib deformation at doses of 700 mg/kg/day, but not at lower doses. In rabbits, no teratogenic or developmental effects were seen in offspring at doses up to and including the highest dose tested, 300 mg/kg/day. The evidence suggests that while there have been documented teratological effects in animal studies, such effects are unlikely in humans under normal conditions of exposure.

Mutagenic Effects. Results of the Ames Mutagenicity Assay indicated that clethodim did not show mutagenic potential. Testing for unscheduled DNA synthesis in mouse liver cells following oral administration of 5,000 mg/kg was negative. Tests for structural chromosomal damage in rat bone marrow cells after oral administration of 1,500 mg/kg were also negative. The available data for mutagenicity and genotoxicity yield no evidence for mutagenic or genotoxic activity.

Carcinogenic Effects. No carcinogenic effects were observed in mice administered clethodim at doses of 24 mg/kg/day over an 18 month period. No carcinogenic effects were observed in rats fed up to the highest dose tested, approximately 100 mg/kg/day, in a two-year carcinogenicity study. Based on the available data, it appears that clethodim is not carcinogenic.

Organ Toxicity. The liver was the primary organ affected in chronic animal studies. Although potential effects associated with acute exposure are reported to include central nervous system effects, no available chronic data pointed to such effects.

Fate in Humans & Animals. Clethodim is readily absorbed in the gastrointestinal tract, with approximately 90% absorption of oral doses. This herbicide is rapidly metabolized and

eliminated (primarily sulfoxide metabolites, about 63%) with less than 1% recoverable unchanged.

Effects on Birds. Clethodim is practically non-toxic to birds. Reported eight-day dietary LC_{50s} are greater than 6,000 ppm in the mallard duck and bobwhite quail and greater than 5,000 ppm for the Japanese quail. Under the likely conditions of use, it is unlikely to pose a hazard to avian species.

Effects on Aquatic Organisms. Clethodim is slightly toxic to fish and aquatic invertebrate species. Reported 96-hour LC_{50s} ranged from 18 mg/L to 56 mg/L in rainbow trout, and 33 mg/L in bluegill sunfish. A 48-hour LC_{50} of 20.2 mg/L has been reported for Daphnia (water flea, a type of small crustacean) species for the formulation. No effects were seen at concentrations of 5.5 mg/L in Daphnia. No significant bioaccumulation has been observed in fish. Under likely conditions of use, it is unlikely to pose a hazard to aquatic species.

Effects on Other Animals (Nontarget species). Clethodim is practically non-toxic to honeybees, with a reported LD_{50} of greater than 100 ug/bee for the technical product. The U.S. Environmental Protection Agency (EPA) has stated that "available...wildlife data indicate that the proposed uses on cotton and soybeans will result in minimal hazard to nontarget and endangered beneficial insect, avian and freshwater fish and mammalian species". Clethodim is selectively toxic to plants, affecting only grass species.

Breakdown of Chemical in Soil and Groundwater. Clethodim is of low persistence in most soils with a reported half-life of approximately three days. Breakdown is mainly by aerobic processes, although photolysis may make some contribution. Volatilization loss and hydrolysis are probably not important processes in the soil breakdown of clethodim. The main breakdown products in soils under aerobic conditions are sulfoxide, sulfone and oxazole sulfone. Clethodim and these degradates are weakly bound to soils, with reported soil Kd (soil-water partition coefficient unadjusted for soil organic matter) values of 0.05 and 0.23 over a range of five soils. Thus, while it may be somewhat mobile in the soil environment, it is very short-lived. The EPA has stated "under present use patterns and under most circumstances clethodim does not appear to threaten groundwater". In field studies, no vertical movement of the parent compound or residues was observed below the top 20 cm of the soil.

Breakdown of Chemical in Surface Water. Clethodim may be highly persistent in the aquatic environment. Reported half-lives for clethodim in the aquatic environment are 128 days in the aqueous phase and 214 days in the sediment. The reported hydrolysis half-life at pH 7-9 is approximately 300 days. The main pathway for degradation of clethodim in the aquatic environment is anaerobic metabolism by microorganisms. However, due to the low persistence and mobility of the compound, it is unlikely to be found in surface waters.

Breakdown of Chemical in Vegetation. **C**lethodim is rapidly degraded on the leaf surfaces by an acid-catalyzed reaction and photolysis. Remaining clethodim will rapidly penetrate the cuticle and enter the plant. Little information is available regarding translocation and

accumulation, but it is hypothesized that it may translocate and accumulate at growing points. Within soybeans, cotton, and lettuce it is rapidly metabolized.

Based on the above information related to low application rates, low toxicity levels, and rapid degradation in the environment, the effects of clethodim on plants, animals, and the environment are likely to be *de minimis*.

Potential Effects of Poast®. Poast® is a selective post-emergence sethoxydim-based herbicide in the cyclohexanedione class. The concentration of sethoxydim (CAS# 74051-80-2) in Poast® is 18.0% (BASF 2012). Commercial sethoxydim products similar to Poast® include Torpedo®, Ultima®, Vantage®, Conclude®, and Rezult®.

Poast® and similar sethoxydim herbicides are graminicides that target annual and perennial grasses, but have little to no effect on sedges, rushes, and dicots. Dicots are tolerant to this herbicide family, but a wide range of perennial and annual grasses are susceptible. Sedges or broadleaf weeds are typically not controlled by sethoxydim (BCMAFF 2004). Since it only controls grasses, Poast® and other sethoxydim herbicides are suitable for broadcast application within plant communities that do not possess a large component of native grasses, such as the central coast dune scrub that is present on the Refuge.

Sethoxydim is absorbed rapidly through leaf surfaces, transported in the xylem and phloem, and accumulated in meristematic tissues. The mode of action for this herbicide is lipid biosynthesis inhibition. Sensitivity has been demonstrated to be due to a greater susceptibility at the acetyl-CoA carboxylase (ACCase) enzyme of grass species. These grass species are killed by the inhibition of the ACCase enzyme, which is a key enzyme in the lipid biosynthetic pathway (EPA 2005).

Non-susceptible broadleaf species have a different acetyl CoA carboxylase binding site, rendering them immune to the effects of sethoxydim. The inhibition of acetyl CoA carboxylase prevents fatty acid production, which leads to failure of cell membrane integrity, especially in regions of active growth. This activity results in a cessation of shoot and rhizome growth, leading to necrosis and death of shoot meristems and rhizome buds, and ultimately plant death (Tu et al. 2001).

Poast® has received a human health rating from the National Fire Protection Association (NFPA) of 1, meaning that it only presents a slight health risk to humans (BASF 2012).

The amount of Poast® to be applied on the proposed project site is low, with a maximum of 120 oz/ac/yr. Since the concentration of sethoxydim in Poast® is 18.0%, this equates to a maximum application of sethoxydim of 21.600 oz/ac/yr or 0.000496 oz/ft^2/yr (Appendix 1).

The following summary information related to toxicological effects, ecological effects, and environmental fate for sethoxydim was extracted from the Extension Toxicology Network (EXTOXNET 2014b):

Acute Toxicity. Sethoxydim is slightly toxic by ingestion, and practically nontoxic by dermal absorption. However, sethoxydim may cause skin and eye irritation. Inhalation of

dusts or vapors can cause irritation of the throat and nose. Other symptoms of poisoning include incoordination, sedation, tears, salivation, tremors, blood in the urine, and diarrhea. Sethoxydim does not cause allergic skin reactions. The oral LD_{50} for sethoxydim in rats is 2,600 to 3,100 mg/kg. The dermal LD_{50} in rats is greater than 5,000 mg/kg and the 4-hour inhalation LC_{50} for sethoxydim in rats is greater than 6.3 mg/L.

Chronic Toxicity. Long-term contact with sethoxydim can cause redness and swelling of the eyes or skin. No adverse effects were observed in mice given 2, 6, or 18 mg/kg/day for 2 years. In a one-year dog feeding study, doses above 8.86 mg/kg/day in males and 9.41 mg/kg/day in females produced anemia.

Reproductive effects. When pregnant rabbits were fed 40, 160, or 480 mg/kg/day, decreased litter size, low fetal weights, severe maternal weight loss, increased fetal resorptions, spontaneous abortions, and maternal deaths occurred at the 480 mg/kg level. Based on this study, reproductive effects are unlikely in humans at expected exposure levels.

Teratogenic Effects. No developmental effects were observed in offspring of rats at maternal dose levels of 40, 100, or 250 mg/kg/day. Increased numbers of skeletal and visceral abnormalities occurred in rabbits at doses of 480 mg/kg/day. These data suggest that sethoxydim is unlikely to be teratogenic in humans at expected exposure levels.

Mutagenic Effects. Several tests of the mutagenicity of sethoxydim indicate that it is not mutagenic.

Carcinogenic Effects. No carcinogenic effects were observed at any dose level when mice were fed 6, 18, 54, or 162 mg/kg/day for 2 years. This suggests that sethoxydim is not carcinogenic.

Organ Toxicity. Liver and bone marrow effects and increased thyroid weight have been reported in dogs.

Fate in humans and animals**.** Single doses of the compound fed to rats were nearly completely eliminated (98.6%) through urine and feces within 48 hours.

Effects on Birds. Sethoxydim is practically nontoxic to birds. The acute oral LD_{50} for sethoxydim in mallard ducks is greater than 2,510 mg/kg, and in Japanese quail is greater than 5,000 mg/kg. The dietary LC_{50} for sethoxydim in mallards and bobwhite quail is greater than 5,620 ppm.

Effects on Aquatic Organisms. Sethoxydim is moderately to slightly toxic to aquatic species. A three-hour LC_{50} of 1.5 mg/L is reported in Daphnia. In fish, 96-hour LC_{50} values range from 1.6 mg/L in carp, to 32 mg/L in rainbow trout, and 100 mg/L in bluegill sunfish.

Effects on Other Organisms. Sethoxydim has low toxicity to wildlife, and it is nontoxic to bees.

Breakdown in Soil and Groundwater. Sethoxydim is of low soil persistence. Reported field half-lives are 5 to 25 days. This herbicide has a weak tendency to adsorb to soil particles. Laboratory leaching tests have suggested that sethoxydim could leach in soil. However, in field tests, sethoxydim did not leach below the top 4 inches of soil, and it did not persist. On soil, photodegradation of sethoxydim takes less than 4 hours. Poast® photodegrades on soil surfaces with a half-life of approximately 3.7 hours. Disappearance of sethoxydim is primarily due to action by soil microbes.

Breakdown in Water. In water, photodegradation of sethoxydim takes less than 1 hour. Poast® is fairly stable to the chemical action of water (hydrolysis), with a half-life of about 40 days in a neutral solution at 25 ^{o}C.

Breakdown in Vegetation. Sethoxydim is absorbed rapidly by roots and foliage, and moves both upward and downward in plants from the point of absorption. In most tolerant plants, sethoxydim is rapidly detoxified. Poast® accumulates in the tissues of crops planted in fields after harvest of treated crops. Measured residues were all below 0.066 ppm.

Based on the above information related to low application rates, low toxicity levels, and rapid degradation in the environment, the effects of sethoxydim on plants, animals, and the environment are likely to be *de minimis*.

Potential Effects of Inert Ingredients. Inert ingredients are classified as all ingredients that are not active ingredients as defined in 40 CFR 153.125 and include, but are not limited to, the following types of ingredients (except when they have a pesticidal efficacy of their own): solvents such as alcohols and hydrocarbons; surfactants such as polyoxyethylene polymers and fatty acids; carriers such as clay and diatomaceous earth; thickeners such as carrageenan and modified cellulose; wetting, spreading, and dispersing agents; propellants in aerosol dispensers; microencapsulating agents; and emulsifiers. The term "inert" is not intended to imply nontoxicity; the ingredient may or may not be chemically active. Generally, EPA has exempted inert ingredients from the requirement of a tolerance based on the low toxicity of the individual inert ingredients.

Both Arrow 2EC® and Poast® contain large percentages of inert ingredients in their formulations. In addition to 26.4% clethodim, the formulation of Arrow 2EC® also contains 22.1% heavy aromatic petroleum hydrocarbons (CAS# 64742-94-5) and 2.2% naphthalene (CAS# 91-20-3) (MANA 2011). In addition to 18.0% sethoxydim, the formulation of Poast® also contains 65.35% solvent naphtha (CAS# 64742-94-5), 7.32% naphthalene (CAS# 91-20-3), and 9.33% proprietary ingredients (BASF 2011). The CAS# for the heavy aromatic petroleum hydrocarbons contained in Arrow 2EC® is the same as the CAS# for the solvent naphtha contained in Poast®, indicating that these label names are synonyms for the same chemical compounds. For uniformity, we will hereafter refer to these synonyms simply as solvent naphtha.

While both Arrow 2EC® and Poast® contain solvent naphtha (CAS# 64742-94-5), Poast® contains about three times the concentration of this compound than Arrow 2EC®. Also, Poast® contains more than three times the concentration of naphthalene (CAS# 92-20-3)

than Arrow 2EC®. Although both Arrow 2EC® and Poast® have a NFPA human health hazard rating of 1, the lower concentrations of solvent naphtha and naphthalene make Arrow 2EC® more ecologically desirable for use than Poast®.

Information regarding the ecotoxicological effects and environmental fates of the inert ingredients contained in Arrow 2EC® and Poast® were not as readily available as for the active ingredients.

Potential Effects of Solvent Naphtha. By definition, solvent naphtha (CAS# 64742-94-5) consists of a complex combination of hydrocarbons obtained from distillation of aromatic streams. Besides being called heavy aromatic petroleum hydrocarbons, other synonyms for solvent naphtha include Hans solvent; heavy aromatic bottoms; heavy aromatic naphtha; heavy aromatic naphtha solvent; heavy aromatic petroleum solvent; heavy aromatic solvent naphtha (petroleum); petroleum distillates; intermediate catalytic cracked, (polyethyl) benzenes; solvent naphtha, heavy aromatic; and solvent naphtha (petroleum), heavy aromatic (Ash and Ash 2007).
Solvent naphtha are a clear yellow liquid with a mild aromatic hydrocarbon odor, and consists of aromatic hydrocarbons having carbon numbers predominantly in the range of C9 through C16, and boiling in the range of approximately 165 ^{o}C to 290 ^{o}C (330 ^{o}F to 554 ^{o}F). The molecular weight for solvent naphtha averages about 160 grams/mole (Megaloid 2009).

Effects, Acute Exposure. Skin contact produces little to no effect. Absorption through the skin is slight, and no toxic effects are likely presented by this route. Poorly absorbed by ingestion, and may cause a (temporary) laxative effect. Solvent naphtha have received a Hazardous Materials Identification System (HMIS) rating for human health of 1 (= slight), meaning that irritation or minor reversible injury is possible (Megaloid 2009).

Effects, Chronic Exposure. Prolonged exposure may cause dermatitis; may damage liver & kidneys. Not a sensitizer in humans or animals. Not considered a tumorigen or a carcinogen in humans or animals. No known reproductive effects in humans or animals. No known mutagenic effects on humans or animals. The existence of synergistic effects is not known. Using the solvent naphtha products *Solvesso 200® and Exxon Antwerp®,* the LD_{50} for rats (oral) was 7,050mg/kg, rabbit LD_{50} (skin) was 3,160mg/kg, and rat LC_{50} (inhalation) was 590mg/m^3 (Megaloid 2009).

Aquatic Toxicity. Fish LC_{50} (96-hour) was 41-50 mg/L for fathead minnows; 2.3 mg/L for rainbow trout; 1,740 mg/L for bluegill; and 8,000 mg/L for tilapia. Invertebrate LC_{50} (48-hour) was 0.95 mg/L for *Daphnia magna* (water flea, a crustacean) and 4,720 mg/L for *Dendronereides heteropoda* (polychaete, bristle worm) (Megaloid 2009).

Environmental Fate. May be a bioaccumulator. Degrades readily and rapidly in the presence of oxygen, with a half-life of about 1.2 to 1.6 days near the surface and 30-60 days in deeper soil layers. Reacts with atmospheric hydroxyl radicals, and the estimated half-life in air is 0.10-0.7 days (for the major constituent molecules of Aromatic 200®). Water insoluble and does moves slowly in soil and water (Megaloid 2009).

Potential Effects of Naphthalene. Naphthalene (CAS# 91-20-3) is also referred to as naphthene, naphthalin, naphthaline, tar camphor, NCI-C5290, dezodorator, white tar, aldocarbon, moth flakes, or moth balls. A white solid that exhibits a typical mothball odor at ambient temperature, naphthalene is a polycyclic aromatic hydrocarbon composed of two fused benzene rings with the empirical formula of $C_{10}H_8$. The principal end use of naphthalene is as a raw material for the production of phthalic anhydride, a raw material used in the plastics industry. Naphthalene is also used as an intermediate for synthetic resins, celluloid, lampblack, smokeless powder, solvents, and lubricants. Naphthalene is used directly as a moth repellant, insecticide, anthelmintic, and intestinal antiseptic (RAIS 1993).

Naphthalene is a common PAH found in numerous petroleum products and byproducts, particularly the middle distillate petroleum products (such as diesels, #1 and #2 fuel oils, and heating oil). Most common petroleum products contain naphthalene, including jet fuels and mineral turpentine (Irwin et al. 1997).

Acute Toxicity. Acute oral and subchronic inhalation exposure of humans to naphthalene has resulted in neurotoxic effects (confusion, lethargy, listlessness, vertigo), gastrointestinal distress, hepatic effects (jaundice, hepatomegaly, elevated serum enzyme levels), renal effects, and ocular effects (cataracts, optical atrophy). A number of deaths have been reported following intentional ingestion of naphthalene-containing mothballs. The estimated lethal dose of naphthalene is 5-15 grams for adults and 2-3 grams for children. Naphthalene is a primary skin irritant and is acutely irritating to the eyes of humans (RAIS 1993).

Oral LD_{50} values for male and female rats are 2,200 and 2,400 mg/kg, respectively, and 533 and 710 mg/kg, for male and female mice, respectively. One dog administered a single 1,525 mg/kg/day dose of naphthalene in food developed hemolytic anemia (RAIS 1993).

The NFPA has provided a health rating for naphthalene of 2 (Acros Organics, N.V. 2000), meaning that is considered to be moderately toxic.

Subchronic and Chronic Toxicity. Increased mortality, clinical signs of toxicity, kidney and thymus lesions, and signs of anemia were observed in rats treated by gavage with 400 mg/kg of naphthalene for 13 weeks. No adverse effects occurred at 50 mg/kg. Transient clinical signs of toxicity were seen in mice exposed by gavage to 53 mg/kg for 13 weeks. Cataracts have been reported in individuals occupationally exposed to naphthalene and in rabbits and rats exposed orally to naphthalene. Subchronic oral exposure to 133 mg/kg/day for 90 days produced decreased spleen weights in female mice. Reduced numbers of pups/litter were observed when naphthalene was administered orally to pregnant mice. Negative results in a two-year feeding study with rats receiving 10-20 mg naphthalene/kg/day and equivocal results in a mouse lung tumor bioassay suggest that naphthalene is not a potential carcinogen (RAIS 1993).

A subchronic and chronic oral reference dose (RfD) of 4E-2 mg/kg/day for naphthalene has been calculated by the EPA. These values are based on a No-Observed-Effect Level

(NOEL) of 50 mg/kg/day derived from a subchronic oral toxicity study with rats. A reference concentration (RfC) for chronic inhalation exposure has not been derived by U.S. EPA.

Reproductive Effects. No information available (Acros Organics N.V. 2000).

Neurotoxicity. No information available (Acros Organics N.V. 2000).

Carcinogenicity. Naphthalene has been rated by the American Conference of Government Industrial Hygienists (ACGIH) as Category A4 - Not Classifiable as a Human Carcinogen (Acros Organics N.V. 2000). During an evaluation performed by the EPA, available cancer bioassays were insufficient to assess the carcinogenicity of naphthalene. Therefore, the EPA has placed naphthalene in weight-of-evidence group D, meaning that it is not classifiable as to human carcinogenicity (RAIS 1993).

Aquatic Toxicity. Rainbow trout exhibited an LC_{50} of 1.60 mg/L during a 96-hour flow-through study at 15 ^{o}C. Fathead minnows displayed an LC_{50} of 6.14 mg/L during a 96-hour flow-through study at 24.5 ^{o}C. Daphnia displayed an EC_{50} of 2.16-8.60 mg/L during a 48-hour flow through study (Acros Organics N.V. 2000). One study reports 4 or 5 mg/L of naphthalene killed sunfish in one hour, but another study set the lethal concentration at 10 mg/L.

During an exposure of one hour, 17.1 mg/L did not kill minnows, but caused them to stop eating. A concentration of 4.3 mg/L had no effect. For perch, the killing strength has been given as40 mg/L in some studies, and as 20 mg/L in another study. One study exposed minnows to naphthalene for six hours in both distilled and hard water. The minimum lethal dose in distilled water at 19 ^{o}C was 11-13 mg/L, and in hard water at 16 ^{o}C was 15-18 mg/L (Irvine et al. 1997).

These and other data indicate that naphthalene is harmful to aquatic life in very low concentrations (Acros Organics N.V. 2000). However, in the proposed project, a 200-yard buffer zone from any wetlands would be enforced, and no wetland or aquatic habitats would be affected.

Aquatic Fate. Releases into water are lost due to volatilization, photolysis, adsorption, and biodegradation. The principal loss processes will depend on local conditions but half-lives can be expected to range from a couple of days to a few months. When adsorbed to sediment, biodegradation occurs much more rapidly than in the overlying water column.

Bioconcentration. Bioconcentration occurs to a moderate extent, but since depuration and metabolism readily proceed in aquatic organisms, this is a short term problem. In the atmosphere, naphthalene rapidly photodegrades, and has a half-life three to eight hours. Naphthalene shows low biological oxygen demand (BOD) and is expected to cause little oxygen depletion in aquatic systems (Acros Organics N.V. 2000).

Terrestrial Fate. The sorption of naphthalene to soil will be low to moderate depending on its organic carbon content. Passage through sandy soil will be rapid. Naphthalene will undergo biodegradation which may be rapid when the soil has been previously contaminated with polycyclic aromatic hydrocarbons (PAH), with a typical half-life of a few hours to a few days. Without previous PAH contamination, the biodegradation would be otherwise be slow (half-life > 80 days). Evaporation of naphthalene from the top soil layer will be important, but the importance of the process will gradually decrease as the soil depth increases (Irwin et al. 1997).

Soil Adsorption/Mobility. Naphthalene is adsorbed moderately by soil and sediment. Although it adsorbs to aquifer material, in simulations of ground-water transport systems and rapid infiltration sites, and in field studies, naphthalene frequently appears in the effluent. A half-life of 65 hours due to sediment adsorption in a flowing river of 1 meter depth and flow of 0.5 meters/sec has been predicted (Irwin et al. 1997).

Atmospheric Fate. Naphthalene reacts with photochemically produced hydroxyl radicals and degrades with a half-life of about three to eight hours. Although photolysis should occur, no data could be found to assess its importance (Irwin et al. 1997).

Aquatic Fate. Low-molecular-weight PAHs, such as naphthalene, are readily volatilized from the water column. In general, volatilization half-lives from surfaces are shorter than 100 hours for low-molecular weight PAHs such as naphthalene. However, this number may vary depending upon surface wind velocity and turbulence. Naphthalene and methyl naphthalene are degraded in water by photolysis and biological processes. The half-life for photolysis of naphthalene in surface water is estimated to be about 71 hours, but the half-life in deeper water (> 5 m) is estimated at 550 days. Photolysis, volatilization, biodegradation, and adsorption may all be important loss mechanisms for naphthalene discharged into water (Irwin et al. 1997).

Summary of Inert Ingredients Potential Effects. As indicated above, at least 24.3% of the formulation of Arrow 2EC® and at least 72.67% of the formulation of Poast® are composed of inert ingredients. Consequently, non-target species exposure to these ingredients may be greater than exposure to the assessed active ingredients. The EPA currently has no specific method of accounting for the potential additional toxicity and risk of these inert ingredients, but it cannot be ignored.

We were unable to determine the composition of these proprietary inert ingredients, specifically due to Confidential Business Information rights that are contained in FIFRA. However, we will address the uncertainty associated with the proprietary and inert ingredients solvent naphtha (CAS# 64742-94-5) and naphthalene (CAS# 91-20-3) qualitatively. Although we cannot quantify the effects of inert ingredients on nontarget species, such effects may be present. However, the effects of these inert ingredients contained in both Arrow 2EC® and Poast® are likely to be *de minimis*. We base this conclusion on the following information:

- Spatial application of herbicide will be limited to 20 acres of non-sensitive upland habitat that has been invaded by perennial veldt grass.

- Minimum buffers of 200 yards will be established to protect wetlands and other sensitive habitats.

- There likely will be no herbicide spray exposure to listed species.

- Herbicide treatments would be limited to one or two applications per season, for three to five seasons, dependent on funding.

- The amount of Arrow 2EC® sprayed per unit area would have a maximum volume of 32 oz/ac/yr. For inert solvent naphtha ingredients, this equates to a maximum of 7.072 oz/ac/yr or 0.00016 oz/ft^2/yr. For inert naphthalene ingredients, this equates to a maximum of 0.704 oz/ac/yr or 1.61616E-05 oz/ft^2/yr. (Appendix 1).

- The amount of Poast® sprayed per unit area would have a maximum volume of 120 oz /ac/yr. For inert solvent naphtha ingredients, this equates to a maximum of 78.420 oz/ac/yr or 0.00180 oz/ft^2/yr. For inert naphthalene ingredients, this equates to a maximum of 8.784 oz/ac/yr or 0.00020 oz/ft^2/yr (Appendix 1).

- As mentioned above, solvent naphtha and naphthalene are typically short-lived in the environment. In the atmosphere, solvent naphtha has a typical half-life of about 0.1-0.7 days. In soil, solvent naphtha has a half-life of about 1.2 to 1.6 days near the surface and 30-60 days in deeper soil layers. In the atmosphere, naphthalene rapidly photodegrades, and has a half-life three to eight hours. In soil, naphthalene typically has a half-life of a few hours to a few days, and in some situations, greater than 80 days.

Potential Effects of Agri-Dex®. Agri-Dex® (CAS# 64741-88-4 & 647-89-5) is a nonionic oil concentrate that is included in the oil surfactant chemical family. The active ingredients of Agri-Dex® constitute 99% of the product formulation. A mixture of heavy and light range paraffin base petroleum oils (CAS# 64741-88-4 & CAS#64741-89-5) constitute 82% of the formulation. Polyol fatty acid esters and polyoxyethylated polyol fatty acid esters (not identified further) constitute 17% of the formulation (surfactant / emulsifier on EPA List 3 [inerts of unknown toxicity]). Unspecified inert ingredients constitute 1% of the formulation (Bakke 2007).

The surfactant activity of the formulation is provided by the polyoxyethylated polyol fatty acid ester and polyol fatty acid ester. The name polyoxyethylated polyol fatty acid ester refers to a group of chemicals that consist of unspecified fatty acid esters of unspecified polyoxyethylated alcohols. Similarly, the name polyol fatty acid ester refers to unspecified fatty acid esters of unspecified alcohols. A more specific identification of these surfactants was not available.

The paraffin base petroleum oil assigned to the CAS numbers is described in the Registry File of Chemical Abstracts as a solvent refined paraffinic distillate containing a mixture of hydrocarbons having carbon numbers predominantly in the range C20-C50 (heavy paraffinic, CAS#64741-88-4) or C15-C30 (light paraffinic, CAS# 64741-89-5). The paraffinic oil mixtures are not on the U.S. EPA lists of Inert Ingredients of Pesticides, although other paraffinic oils are on the list. For example, light (C15-C30) and heavy (C20-C50) paraffinic oils produced by vacuum distillation of the residue from atmospheric distillation of crude oil (CAS# 64741-50-0 and CAS# 64741-51-1) are on EPA List 2 (potentially toxic other ingredients/high priority for testing inerts). The reason why certain paraffinic oils are on the U.S. EPA inerts list and others are not is not apparent (Diamond and Durkin 1997).

Agri-Dex® would be applied at a maximum rate of 1.28 oz/gal of herbicide mix. Either Arrow EC® or Poast® would be applied at the rate of 20 gallons per acre per treatment. Due to specimen label restrictions, the maximum number of herbicide treatments that can be applied would be two treatments with Arrow 2EC® (= 40 gallons) or three treatments with Poast® (= 60 gallons). Therefore, Agri-Dex® would be applied in a maximum of 60 gal/acre/year of herbicide. This would equate to a maximum Agri-Dex® volume of 76.8 oz/ac/yr or about 0.0018 oz/ft^2/yr (Appendix 1).

Acute Effects. The National Fire Protection Association (NFPA) has rated Agri-Dex® with a human health hazard value of 1, meaning it is considered only slightly toxic. Agri-Dex has been rated with a low oral toxicity, with an LD_{50} for rats of > 5,010 g/kg. Dermal toxicity is also low, with a reported LD_{50} for rabbits of > 2,020 g/kg. Contact with the eyes may cause mild irritation (Helena Chemical Company 2009).

Chronic Effects. Excessive exposure to Agri-Dex may cause mild irritation to the eyes, nose, and throat (Helena Chemical Company 2009).

Aquatic Organism Effects. For Agri-Dex®, the reported EC_{50} for oyster embryogenesis was 60.2 mg/L; 48-hour EC_{50} for *Daphnia magna* was > 1,000 mg/L; bluegill sunfish 96-hour EC_{50} was > 1,000 mg/L; juvenile rainbow trout 96-hour EC_{50} was > 237-305 mg/L; adult rainbow trout 96-hour EC_{50} was > 1,000 mg/L; and 48-hour EC_{50} for unidentified tadpoles was > 1,000 mg/L. Based on these data, Agri-Dex is practically non-toxic to *Daphnia magna*, many fishes and unspecified species of tadpoles. Further, when tested by itself, Agri-Dex was determined to be the surfactant least acutely toxic to aquatic invertebrates and fish. Also, Agri-Dex does not contain the suspected endocrine disruptors, nonylphenol and octylphenol (WSDA 2012).

Carcinogenic Effects. No carcinogenic effects attributed to Agri-Dex® are currently known. However, Agri-Dex® contains ethoxylated ingredients. Ethoxylates are formed by reactions of ethylene oxide. In the manufacturing process, some unreacted ethylene oxide as well as the contaminant 1, 4-dioxane can become part of the final formulation. Both ethylene oxide and 1,4-dioxane are considered likely human carcinogens (Bakke 2007).

Based on the above information related to low application rates, low toxicity levels, and rapid degradation in the environment, the effects of Agri-Dex®, on plants, animals, and the environment are likely to be *de minimis*.

Potential Effects of Mist Control. Mist Control® is a slightly turbid, odorless liquid that contains unlisted proprietary ingredients. Due to a paucity of information about this proprietary product, the following information was extracted solely from the Mist Control® MSDS (Miller Chemical and Fertilizer Corporation 1994):

As determined by the Occupational Safety and Health Administration (OSHA) and state right-to-know laws, Mist Control® contains no hazardous ingredients.

Acute Effects. Minor irritation.

Chronic Effects. Minor irritation.

Carcinogenic Effects. Not known to be carcinogenic.

Mist Control® would be applied at a maximum rate of 1.28 ounces per gallon of herbicide mix. Either Arrow EC® or Poast® would be applied at the rate of 20 gallons per acre per treatment. Due to specimen label restrictions, the maximum number of herbicide treatments that can be applied would be two treatments with Arrow 2EC® (= 40 gallons) or three treatments with Poast® (= 60 gallons). Therefore, Mist Control® would be applied in a maximum of 60 gal/acre/year of herbicide. This would equate to a maximum Mist Control® volume of 76.8 oz/ac/yr or 0.0018 oz/ft^2/yr (Appendix 1).

Based on the above information related to low application rates and low toxicity levels, the effects of Mist Control® on plants, animals, and the environment are likely to be *de minimis*.

Potential Effects on Special Status Species. If this project proves successful, a direct effect would be the protection and potential enhancement of Refuge habitat by protecting a rare central coast dune scrub landscape that is inhabited by nearly 144 imperiled species. If successful, this project would protect and enhance central coast dune scrub habitat by stopping it from transitioning into a grassland monoculture.

Due to the physical locations of the Proposed Action, this alternative would likely have no effect any of the federally or state listed species present on the Refuge. The Proposed Action would not likely destroy or adversely modify designated critical habitat for the western snowy plover. Further, the Proposed Action would not likely to destroy or adversely modify designated critical habitat for the La Graciosa thistle. Rather, the Proposed Action is likely to improve the quality of up to 20 acres of designated critical habitat for La Graciosa thistle by controlling perennial veldt grass, an invasive pest species that can outcompete La Graciosa thistle.

Potential Effects on Cultural Resources. No ground disturbing activities would occur with Alternative 2, and no other activities are likely to disturb historical or cultural resources. Therefore, no effects to historical or cultural resources would occur.

Potential Effects on Social Environment. Performing the project activities of Alternative 2 would not change the social environment on the Refuge. However, benefits to the public through improved conditions for wildlife viewing may occur.

Cumulative Effects. Cumulative effects result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. Because of the localized nature of the proposed herbicide application, the area of consideration for cumulative effects is limited to the Refuge. The proposed action in combination with other past and ongoing refuge management actions would result in minor effects to the physical environment.

Cumulative effects to the biological environment would also be relatively minor because the past and ongoing refuge management activities are focused on limiting invasive plant species and improving habitat for listed species. Currently the only other herbicide spray project on the Refuge is a small experimental project that is limited to five acres of backpack spraying of European beach grass in the Refuge foredunes with Fusilade DX (fluazifop-p-butyl). This experimental project will end by 2016, and is not in the same location as the proposed action.

An invasive species management program will be part of the in-progress Comprehensive Conservation Plan (CCP; a 15-year management plan for the Refuge). The invasive species management program would include a variety of methods to reduce the number of invasive species on the Refuge, including the potential use of herbicides. The environmental effects of the proposed invasive species management plan will be considered in the NEPA document that accompanies the CCP.

Because Alternative 2 would not change visitor use of the Refuge, there are no cumulative effects to the social environment.

Section V: Compliance, Consultation, and Coordination with Others

A. Compliance and Consultation

Pest Management Laws and Policies. In accordance with Service Policy 569 FW 1 (Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System can be controlled to ensure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on federal (refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 USC 668dd-668ee);
- Plant Protection Act of 2000 (7 USC 7701 *et seq*.);
- Noxious Weed Control and Eradication Act of 2004 (7 USC 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 USC 136-136y);
- National Invasive Species Act of 1996 (16 USC 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 USC 4701);

- Food Quality Protection Act of 1996 (7 USC 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 USC 426-426c, 46 Stat. 1468).

Additionally, this environmental assessment (EA) was prepared in compliance with the following pertinent laws, executive orders, and regulations:

1) National Environmental Policy Act. This EA has been prepared in compliance with the provisions of the National Environmental Policy Act of 1969, as amended (NEPA; 42 U.S.C. 4321 *et seq*.).

2) Endangered Species Act. An informal consultation was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) using a Biological Evaluation Form for the potential effects of the Proposed Action on the federally endangered La Graciosa thistle (*Cirsium scariosum* var. *loncholepis*) and its designated critical habitat, federally endangered marsh sandwort (*Arenaria paludicola*), federally endangered Gambel's watercress (*Nasturtium gambelii*), federally threatened western snowy plover (*Charadrius nivosus nivosus*) and its designated critical habitat, and federally threatened California red-legged frog (*Rana draytonii*). During this informal consultation, the following determinations were made (USFWS 2014):

   a) The Proposed action will likely have no effect on the La Graciosa thistle; and may affect, but is not likely to adversely affect, critical habitat for the La Graciosa thistle.

   b) The Proposed Action will likely have no effect on the marsh sandwort;

   c) The Proposed Action will likely have no effect on the Gambel's watercress;

   d) The Proposed Action will likely have no effect on the western snowy plover, and will likely have no effect on western snowy plover critical habitat, and

   e) The Proposed Action will likely have no effect on the California red-legged frog.

3) National Historic Preservation Act. In accordance with the National Historic Preservation Act (NHPA; 16 U.S.C. 470 *et seq*.), coordination was initially conducted with the USFWS Cultural Resources Team in Sherwood, Oregon. However, since ground disturbing activities would not be conducted with this project, no other coordination was required.

4) Coastal Zone Management Act. In accordance with section 307(c)(1) of the Federal Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451 *et seq*.), the USFWS has determined that approval of the Proposed Action, as described above, would not affect any land use, water use, or natural resources of the coastal zone, and, therefore, does not require a consistency determination. Concurrence with the USFWS negative determination will be

requested from the California Coastal Commission before any herbicide spray activities begin.

5) USFWS Regulations. In accordance with USFWS regulations, a Pesticide Use Permit (PUP) will be prepared for the use of Arrow 2EC® and/or Poast®. The PUP for this herbicide will be approved by the USFWS Regional Integrated Pest Management Coordinator before any herbicide spray activities begin. Additionally, a Special Use Permit (SUP) will be prepared for the Land Conservancy and other qualified organizations to authorize project activities on the Refuge.

B. Coordination With Others

During the project planning process, the following people were contacted:

- Don Antonowich, Research Authorizations, Pesticide Registration Branch, Department of Pesticide Regulation, Sacramento, California
- Alysssa Berry, Senior Biologist, Padre Associates, Inc., Guadalupe, California
- Melissa Boggs, Senior Environmental Scientist, California Department of Fish and Wildlife, Office of Spill Prevention and Response, San Luis Obispo, California
- Daniel Bohlman, Conservation Director, Land Conservancy of San Luis Obispo County, San Luis Obispo, California
- Marco Buske, Integrated Pest Management Coordinator, USFWS, Region 8, Klamath Falls, Oregon
- Mike Connell, Environmental Scientist, California Department of Fish and Wildlife , Office of Spill Prevention and Response, San Luis Obispo, California
- Mark Delaplaine, Federal Consistency Supervisor, California Coastal Commission, San Francisco, CA
- Mark Elvin, Fish and Wildlife Biologist, Ventura Fish and Wildlife Office, USFWS, Ventura, CA
- Mark English, Pilot/Owner/QAL, English Air Services, Santa Maria, California
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C. Public Comment

This Draft EA will be made available for public review and comment for a period of 30 days. The draft EA will be available on the Refuge's website. A hard copy is available upon request. The public will be notified of the draft EA through a press release, a newspaper notice, and through electronic mail notification.

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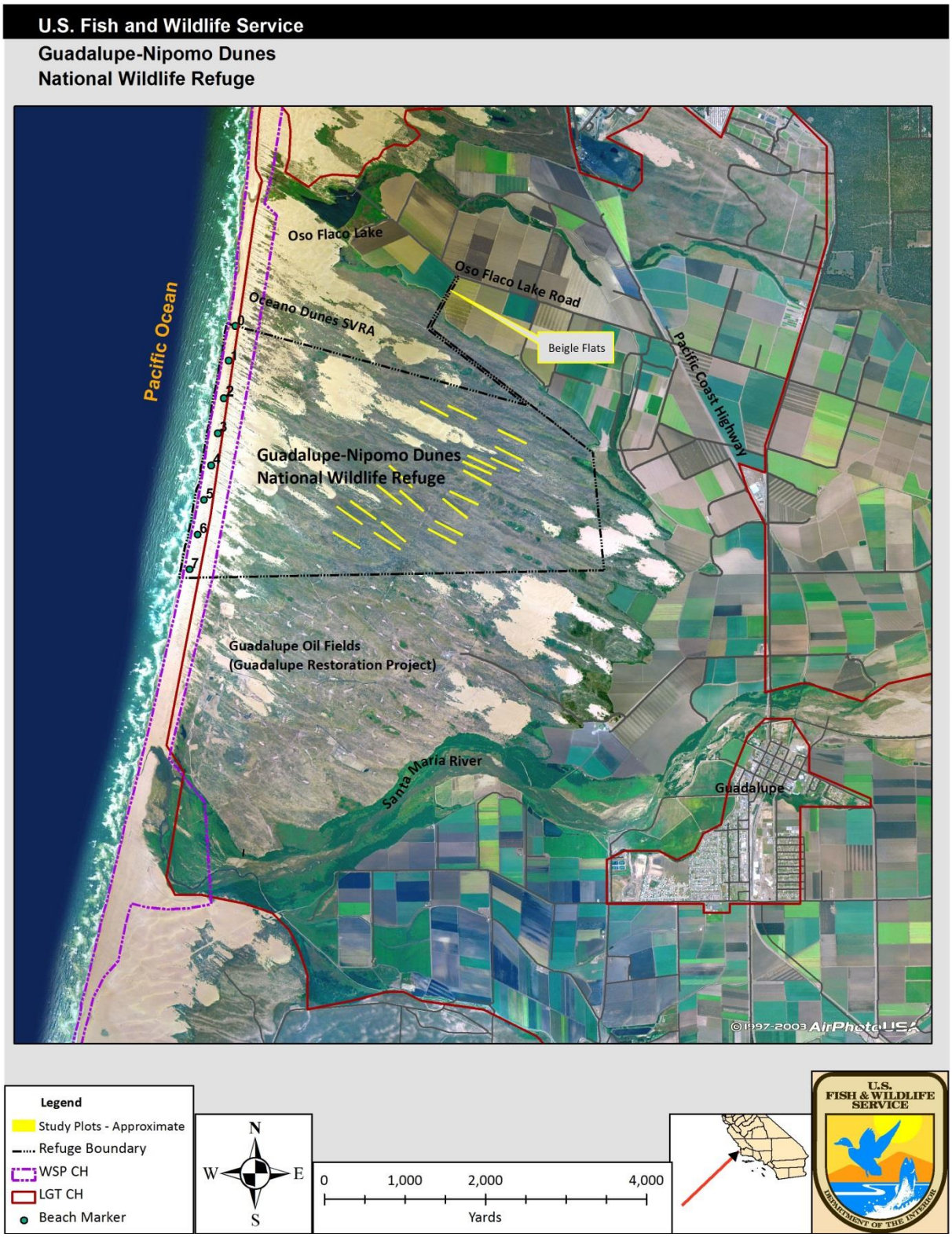

Figure 1. Map of Guadalupe-Nipomo Dunes National Wildlife Refuge, San Luis Obispo County, California and vicinity. Legend abbreviations: LGT CH = La Graciosa thistle critical habitat, WSP CH = western snowy plover critical habitat. The locations of the study plots are approximate and are subject to slight location changes.

Appendix 1. Proposed maximum spray volumes per unit area for the herbicides Arrow 2EC®, Poast® and the adjuvants Agri-Dex® and Mist Control® that may be applied during the proposed Aerial Herbicide Application Research Study on the Guadalupe-Nipomo Dunes National Wildlife Refuge, San Luis Obispo County, California.

Arrow 2EC®										
max. herbicide oz/ac/yr	**Clethodim**			**Heavy Aromatic Petroleum Hydrocarbons* (HAPH) [CAS# 64742-94-5]**			**Naphthalene [CAS# 91-20-3]**			**Combined Inerts max oz/ft^2/yr**
	% clethodim in herbicide	max. clethodim oz/ac/yr	max. clethodim oz/ft^2/yr	% HAPH in herbicide	max. HAPH oz/ac/yr	max. HAPH oz/ft^2/yr	% naphthalene in herbicide	max. naphthalene oz/ac/yr	max. naphthalene oz/ft^2/yr	
32	26.4%	8.448	0.00019	22.1%	7.072	0.00016	2.2%	0.704	1.6162E-05	0.00018

Poast®										
max. herbicide oz/ac/yr	**Sethoxydim**			**Solvent Naphtha* [CAS# 64742-94-5]**			**Naphthalene [CAS# 91-20-3]**			**Max. Combined Inerts oz/ft^2/yr****
	% sethoxydim in herbicide	max. sethoxydim oz/ac/yr	max. sethoxydim oz/ft^2/yr	% solvent naphtha in herbicide	max. solvent naphtha oz/ac/yr	max. solvent naphtha oz/ft^2/yr	% naphthalene in herbicide	max. naphthalene oz/ac/yr	max. naphthalene oz/ft^2/yr	
120	18.0%	21.600	0.000507	65.35%	78.420	0.00180	7.32%	8.784	0.00020	0.00200

* Heavy aromatic petroleum hydrocarbons and solvent naphtha have the same Chemical Abstract Services Registration Number (CAS#), and are synonyms for the same chemical product. ** Poast® also contains 9.33% proprietary ingredients that were not included in these calculations.

max. herbicide* gal/ac/yr	**Agri-Dex®**			**Mist Control®**		
	Agri-Dex® oz/gal of herbicide	Agri-Dex® oz/ac/yr	Agri-Dex® oz/ ft^2 /yr	Mist Control® oz/gal of herbicide	Mist Control® oz/ac/yr	Mist Control® oz/ft^2/yr
60	1.28	76.800	0.00176	1.28	76.800	0.00176

* These data are based on a maximum application of 20 gallons of herbicide mix per acre, with a maximum of either two treatments of Arrow 2EC® per year or three treatments of Poast® per year.