U.S. Fish & Wildlife Service

San Diego
National Wildlife Refuge
Comprehensive Conservation Plan

Volume 2

Appendix C. Compatibility Determinations

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U. S. Fish and Wildlife Service
Pacific Southwest Region
2800 Cottage Way, Room W-1832
Sacramento, CA 95825-1846

May 2017

Compatibility Determination
(December 2016)

Use: Upland Hunting

Refuge Name: San Diego National Wildlife Refuge (San Diego County, California)

Establishing and Acquisition Authorities:

The San Diego NWR was established in 1996 under the authorities of the Fish and Wildlife Act of 1956, as amended (16 U.S.C. 742(a)-754), Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), and Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) (USFWS 1995). Establishment occurred on April 10, 1996, when approximately 1,826 acres of land (referred to at the time as Rancho San Diego) were conveyed to the Service for management as a national wildlife refuge.

Refuge Purposes:

The purposes for the initial acquisition for the San Diego NWR included:

> ". . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species . . . or (B) plants. . ." 16 U.S.C. § 1534 (Endangered Species Act of 1973);
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> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . ." 16 U.S.C. § 742f(a)(4) ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . ." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956); and
>
> ". . . (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species . . ." 16 U.S.C. § 460k-460k-4 (Refuge Recreation Act of 1962).

Subsequent acquisitions have been made to meet these and other refuge purposes outlined in the Land Protection Plan (LPP) for the Otay-Sweetwater Unit of the

San Diego NWR, approved in April 1997. In accordance with the LPP, "The purpose of the San Diego National Wildlife Refuge is to protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals" (USFWS 1997).

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is “to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans” (National Wildlife Refuge System Administration Act of 1966, as amended).

Description of Use:

The Service is proposing to open approximately 160 acres of the San Diego NWR to upland hunting. The designated hunting area is located in the southeastern portion of the Otay Mesa and Lakes area within the Otay-Sweetwater Unit. Hunting in this area would occur in accordance with California Department of Fish and Wildlife regulations and any refuge-specific conditions, generally allowing the take of big game, resident small game, and resident and migratory upland game birds.

This hunting area abuts other public lands open to hunting that are managed by the California Department of Fish and Wildlife (CDFW) and the Bureau of Land Management (BLM). Refuge specific hunting regulations would be generally consistent with State hunting regulations as they pertain to the CDFW Otay Mountain Ecological Reserve (California Code of Regulations, Title 14 [Public Resources] Section 630). Due to the lack of Refuge frontage along Otay Lakes Road, along with the recent presence of Quino checkerspot butterfly and its associated host plants on the ridge within the northern portion of the site, access into the hunt area will be via foot from adjacent CDFW and BLM lands where hunting is also permitted. It is our intent to continue to work with these other land managers in an effort to identify options for improving hunting access into this area from the public right-of-way. Public access would not be permitted within the Otay Lakes and Mesa area outside of the designated hunt area, and only hunters would be permitted within the designated hunt area.

The National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), which amended the National Wildlife Refuge System Administration Act (Administration Act), identifies hunting as one of the six wildlife-dependent recreational uses of a refuge, along with fishing, wildlife observation and photography, and environmental education and interpretation. Hunting is considered a priority general public use of the Refuge System that should receive enhanced consideration over non-priority uses. Because hunting programs can promote understanding and appreciation of natural resources and their management on lands and waters in the Refuge System, Refuge managers are encouraged to provide visitors with quality hunting opportunities when they are compatible with Refuge purposes.

The hunt program on the Refuge will provide high quality, safe, and cost-effective hunting opportunities close to San Diego and will be carried out consistent with State regulations. The guiding principles of the Refuge System's hunting programs (Service Manual 605 FW 2) are to:

- Mange wildlife populations consistent with Refuge System-specific management plans approved after 1997 and, to the extent practicable, State fish and wildlife conservation plans;
- Promote visitor understanding of and increase visitor appreciation for America's natural resources;
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6;
- Encourage participation in this tradition deeply rooted in America's natural heritage and conservation history; and
- Minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.
- The Refuge must ensure that practices within the Refuge boundary do not put populations outside the Refuge at risk. Therefore, management of the hunt program will be based on good science and the ability to maintain a quality hunt program which, according to the Service Manual 605 FW 1.6:
- Promotes safety of participants, other visitors, and facilities;
- Promotes compliance with applicable laws and regulations and responsible behavior;
- Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan;

- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation;
- Minimizes conflicts with neighboring landowners;
- Promotes accessibility and availability to a broad spectrum of the American people;
- Promotes resource stewardship and conservation;
- Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources;
- Provides reliable/reasonable opportunities to experience wildlife;
- Uses facilities that are accessible to people and blend into natural setting; and
- Uses visitor satisfaction to help define and evaluate programs.

Prior to officially opening the Refuge to hunting and implementing a hunt program, the Refuge will develop a detailed step-down hunt plan that will provide the specific details of the hunting program. The preparation of a step-down hunt plan can begin upon approval of a Final Comprehensive Conservation Plan (CCP) for the San Diego NWR. Listed here are potential topics to be included in the step-down plan:

- Purpose/goals of the hunting program;
- Regulatory framework;
- State hunting regulations;
- Species to be hunted;
- Refuge specific regulations, including: hunt area boundaries, methods of harvest, use of non-lead shot, access, and maintaining hunting dogs under voice control at all times within the approved hunt area boundaries;
- Public outreach;
- Safety;
- Law Enforcement management of the hunt;
- Harvest data collection and analysis;
- Facility improvements to support hunting;
- Annual post-season evaluation of the program; and
- Partnership opportunities.

Although the specific details of the hunt plan will be refined during the step-down planning process, there are several provisions that must be included in all refuge

hunt plans. Among these provisions is the requirement that each person while engaged in public hunting on a National Wildlife Refuge shall:

- Possess the required State license;
- Comply with all applicable State laws, unless further restricted by Federal law or regulation;
- Comply with the regulations authorizing access or use of a refuge, including the terms and conditions under which hunting permits are issued; and
- Comply with refuge-specific regulations governing hunting on a refuge.

National Wildlife Refuges in California and Nevada require use of non-toxic shot (as described in 50 CFR 20.21(j)) for hunting waterfowl, upland game birds, and small game. In accordance with recent State legislation (AB 711) non-lead ammunition will be required for all wildlife hunting by July 1, 2019.

The Refuge's hunting program will comply with the Code of Federal Regulations Title 50, 32.1 and will be managed in accordance with Service Manual 605 FW2, Hunting. Hunting will generally be permitted within the framework of State regulations as they apply to the CDFW Otay Mountain Ecological Reserve, which are intended to ensure that hunting will be compatible with the conservation of wildlife and their habitats. Therefore, upland hunting on the Refuge would comply with the Improvement Act and the Refuge Recreation Act of 1962 (16 U.S.C. 460k).

Availability of Resources:

The San Diego NWR was not previously open to hunting, therefore, implementing the new hunting program will require some initial staff time, as presented in Table 1, to prepare the step-down hunt plan and the refuge opening package, conduct public meetings and public outreach, coordinate with CDFW and BLM, and post the designated hunt area. Ongoing annual costs are estimated in Table 2. If CDFW manages the Refuge hunting program, the costs would be reduced. Minor costs associated with boundary markers, public outreach materials, and other refuge signage would be incurred during the first year.

Potential funding sources include the Refuge's annual budget, partnerships with the CDFW, San Diego Fish and Wildlife Advisory Council, individual hunting groups, and contributions from conservation groups, corporate sponsors, and Friends groups. Local hunting groups may be willing to support the program with

funding for minor construction, boundary marking, and by providing volunteers for ongoing maintenance.

Table 1
First Year Staff Involvement Associated with Establishing and Implementing a Hunting Program on the San Diego NWR

Position	Involvement	FTE*	Cost
Project Leader	Participation and oversight in the development of the step-down hunt plan, including public meetings and coordination with CDFW regarding future management of the hunting program.	0.05	$8,700
Deputy Project Leader	Participation and oversight in the development of the step-down hunt plan, including public meetings and coordination with CDFW regarding future management of the hunting program.	0.10	$12,970
Refuge Manager	Preparation and oversight of the step-down hunt plan, participate in public meetings and coordination with CDFW regarding future management of the hunting program, process the opening package, conduct public outreach, provide oversight of the first year hunt season.	0.30	$38,004
Refuge Operations Specialist	Assist in the preparation of the step-down hunt plan, mark and post hunting area boundaries.	0.20	$16,512
Total FTE/Annual Costs for Staffing		**0.65**	**$76,186**

FTE (full time equivalent)

Table 2
Ongoing Annual Staff Involvement
Associated with Managing a Hunting Program on the San Diego NWR

Position	Involvement	FTE	Cost
Refuge Manager	General oversight of the hunt program	0.05	$6,334
Wildlife Biologist	Conduct monitoring and analyze harvest data	0.05	$4,828
Maintenance Worker	Maintain boundary markers	0.05	$2,466
Federal Wildlife Officer	Conduct periodic patrol of hunting area	0.10	$7,202
Total FTE/Annual Costs for Staffing		0.25	$20,830

Anticipated Impacts of the Use:

Hunting will result in direct and indirect impacts to Refuge upland wildlife. The direct impact of hunting is the death of the hunted species. Indirect impacts to wildlife include indirect mortality (wounding or premature death caused by human activity), lower productivity, reduced use of the land, reduced use of preferred habitat and aberrant behavior/stress (Purdy et al. 1987; Pomerantz et al. 1988). Hunting can alter wildlife behavior, population structure, and distribution patterns of wildlife (Cole and Knight 1990).

Human disturbance associated with hunting includes human presence, walking through vegetation, vegetation trampling, rapid movements and loud noises, such as those produced by shotguns. This disturbance, especially when repeated over time, can cause some wildlife species to change foraging habits, feed only at night, or relocate (Hammitt and Cole 1998). Disturbance of wildlife and sensitive vegetation is the primary concern regarding Refuge hunting activity.

Individual plants and animals may be disturbed by human contact to varying degrees. Human disturbance in the form of trampling can result in the loss of sensitive plants, reptiles, and invertebrates. Human activities on trails can result

in direct effects on wildlife through harassment, a form of disturbance that can cause physiological effects, behavioral modifications, or death (Smith and Hunt 1995). Many studies have shown that birds can be affected by human activities on trails when they are disturbed and flushed from feeding, resting, or nesting areas (Holmes and Geupel 2005). Flushing, especially repetitive flushing, can strongly affect habitat use patterns of many bird species. Flushing from an area can cause birds to expend more energy, be deterred from using desirable habitat, change resting or feeding patterns, increase exposure to predation, or abandon sites with repeated disturbance (Smith and Hunt 1995). Depending on the species (especially migrants vs. residents), some birds may habituate to some types of recreation disturbance and either are not disturbed or will immediately return after the initial disturbance (Knight and Temple 1995).

Hunting on the refuge will be conducted on foot by individuals or small groups, often accompanied by a hunting dog. Since hunting is not limited to designated trails, direct impacts to vegetation will occur from trampling. However, because hunters tend to travel in dispersed patterns over wide areas, rather than using the same pathway over and over again, the effects of trampling would be limited and short-term. As a result, impacts to Refuge vegetation by hunters would be expected to be minimal and insignificant.

The literature suggests that hunting impacts can be reduced by providing adjacent non-hunting areas where hunting does not occur and wildlife can feed and rest relatively undisturbed (King and Workman 1986). The Comprehensive Conservation Plan for the Refuge proposes to preserve large blocks of undisturbed habitat within the Otay-Sweetwater Unit, providing extensive sanctuary areas for hunted species. In addition, no other public uses are proposed for the Otay Mesa and Lakes area and Refuge management would be generally limited to species and habitat monitoring; therefore, the overall level of disturbance in this area would be low.

Recreational hunting will remove individual animals, but is not expected to negatively affect wildlife populations. This is because hunting on refuges is highly regulated and the effects of hunting are monitored annually. In addition, hunting generally takes place at specific times and seasons when game animals are less vulnerable, reducing the magnitude of disturbance to the population as a whole (Cline et al. 2007).

To manage wildlife populations subject to hunting, the Refuge takes into consideration the harvest regulations set by CDFW within Federal framework guidelines. The California Fish and Game Commission, in consultation with CDFW, annually reviews the population censuses to establish season lengths and harvest levels. Refuges use this information along with the results of annual habitat management reviews conducted to evaluate wildlife population levels, habitat conditions, and visitor service activities, in considering the need for any refuge specific hunting regulations.

Impacts to Hunted Species:

To avoid adverse effects to dove populations in California from hunting, the length and timing of the annual hunting season and bag limits for doves are developed based on population data derived from Ca11 Count Survey heard and seen data, Breeding Bird Survey data, and a population abundance index derived from banding and harvest data that is collected within the mourning dove Western Management Unit. Additional information about dove management and the determination of hunting limits is provided in the Final CCP and EA for the San Diego NWR (USFWS 2017).

CDFW has trustee responsibility for the conservation and management of deer, quail, and other wildlife in California. Section 1801 of the Fish and Game Code establishes the overall Wildlife Conservation Policy for CDFW, which includes the following relevant objectives:

1. perpetuate all species of wildlife for their intrinsic and ecological values, as well as for their direct benefits to all persons; and

2. maintain diversified recreational uses of wildlife, including the sport of hunting, as proper uses of certain designated species of wildlife, subject to regulations consistent with the maintenance of healthy, viable wildlife resources, the public safety, and a quality outdoor experience.

With respect to California quail, CDFG (2004) determined that the removal of individual animals from resident game bird populations statewide would not significantly reduce those populations and therefore would not have a significant adverse effect on resident game birds.

CDFW implements a Deer Management Program throughout the state, and as part of that program, biologists develop hunting regulations, provide expertise on

habitat and population assessments, compile harvest information, conduct and direct research needs, monitor and estimate populations, and respond to various public inquiries related to deer in California. CDFW is currently developing a Strategic Plan for California Deer to provide the tools necessary to manage the State's deer population more effectively.

Within the south coastal area of California, which includes the areas in and around the San Diego NWR (Zone D-16), estimates of the deer population from 1990 to 1996 indicate a fairly stable population with a moderate increase between 1993 and 1994. The estimated population in 1996 was just under 20,000. In 2006, the San Diego Union Tribune (Ed Zieralski, September 16, 2006) reported that according to a CDFW biologist, the county's deer herd (excluding Camp Pendleton) was considered stable and slightly increasing with an estimated population of approximately 6,000.

To minimize the potential for adverse effects to natural resources from hunting activities on the Refuge, the following measures would be implemented as a part of the hunting program:

1. Large contiguous areas of the Refuge will be closed to hunting to provide adequate sanctuaries for wildlife; and

2. No motorized access associated with hunting will be permitted on the Refuge.

Endangered and Threatened Species: Although the area proposed for hunting is located within designated critical habitat for the Quino checkerspot butterfly (*Euphydryas editha quino*), the boundaries of the hunt area have been designed to avoid any known or potential Quino habitat areas. To ensure that no adverse effects to Quino checkerspot butterflies occur outside of the hunting boundaries on Refuge land, the step-down hunt plan will include approved hunter access routes into the hunt area. The remainder of the Otay Mesa and Lakes area would be closed to all public access. Therefore, there is little potential for impacts to this species and any other listed species from the proposed hunting program.

Public Review and Comment:

Opportunities for hunting on the San Diego NWR were discussed at the scoping meetings held on June 14 and 15, 2006, to initiate the CCP process. A Notice of Intent was published in the Federal Register on May 24, 2006 (71 FR 29973). At

that time, written comments were solicited. At the scoping meetings, the public was encouraged to provide verbal comments or to send us written comments following the meetings. Additional discussion on the topic of hunting, as well as other public uses, occurred at a public workshop held on January 6, 2007. A CCP web page was established to provide the public with specific information regarding the CCP process and the results of the public scoping. Planning Updates have also been prepared to summarize the progress of the CCP and to discuss specific planning issues.

A draft Compatibility Determination for upland hunting was made available for public review and comment concurrent with the distribution of the San Diego National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment (CCP/EA) (USFWS 2014). Although we did not receive any comments specific to the Compatibility Determination, we did receive many comments related to the hunting proposals included in the draft CCP/EA. Refer to the Responses to Comments provided in Appendix F-2 of the Final CCP (USFWS 2017).

Determination:

 Use is Not Compatible

 Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

The measures present here will be implemented to ensure that hunting on the Refuge is compatible with purposes for which this Refuge was established.

- Large contiguous blocks of land within the Refuge will be closed to public use, including hunting, to provide a sanctuary for wildlife;
- No public uses, other than hunting in the designated hunt area, will be permitted within the Otay Mesa and Lakes area to minimize disturbance to wildlife;
- Hunting will be conducted in accordance with State law and CDFW regulations as they pertain to hunting on the CDFW Otay Mountain Ecological Reserve, except as may be modified to protect refuge resources;
- Hunting area boundaries will be clearly posted;

- A public outreach program describing the Refuge hunting program will be developed and implemented prior to the opening of the initial hunting season;
- Federally approved non-lead shot will be used on the Refuge; and
- Field checks by Refuge Federal Wildlife Officers will be planned, conducted, and coordinated to maintain compliance with Federal, State and Refuge regulations.

Justification:

The Refuge's location adjacent to urban/suburban development provides an excellent opportunity to provide a hunting program close to where the demand for hunting exists. A secondary benefit of a hunting program comes from instilling an "ownership" ethic in those who participate in the program. Hunters using refuge lands will view the area as "their" land. This most likely reduces vandalism, littering, and poaching; it also strengthens Service visibility in the local community. Through a quality hunting program, the public can gain a deeper appreciation of wildlife and an enhanced understanding of the importance of conserving habitat, which ultimately contributes to the Refuge System mission.

Evaluation of the proposed hunt program has considered the purpose and goals of the San Diego NWR, the availability of resources, and the potential for adverse effects to Refuge trust resources, including listed and sensitive species. Based on the analysis conducted for the CCP and this Compatibility Determination, we have determined that allowing the implementation of limited hunting on the Refuge would not materially interfere with or detract from fulfilling the Refuge purpose of protecting endangered or threatened fish, wildlife or plants nor does it interfere with or detract from fulfilling the Refuge System mission.

Mandatory Reevaluation Date:

Mandatory 15-Year Reevaluation (for priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

☐ Categorical Exclusion without Environmental Action Statement

☐ Categorical Exclusion and Environmental Action Statement

☐ Environmental Assessment and findings of No Significant Impact

☐ Environmental Impact Statement and record of Decision

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U.S. Fish and Wildlife Service (USFWS). 2017. San Diego National Wildlife Refuge Comprehensive Conservation Plan. San Diego National Wildlife Refuge Complex, Chula Vista, CA.

Refuge Determination:

Prepared by: _____ (Signature) 12/16/16 (Date)

Project Leader Approval: _____ (Signature) 12/16/16 (Date)

Concurrence:

Refuge Supervisor: _____ (Signature) 3/23/17 (Date)

Assistant Regional Director, Refuges: _____ (Signature) 3.28.17 (Date)

Compatibility Determination
(December 2016)

Use: Recreational Fishing

Refuge Name: San Diego National Wildlife Refuge (San Diego County, California)

Establishing and Acquisition Authorities:
The San Diego NWR was established in 1996 under the authorities of the Fish and Wildlife Act of 1956, as amended (16 U.S. C. 742(a)-754), Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), and Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) (USFWS 1995). Establishment occurred on April 10, 1996, when approximately 1,826 acres of land (referred to at the time as Rancho San Diego) were conveyed to the Service for management as a national wildlife refuge.

Refuge Purposes:
The purposes for the initial acquisition for the San Diego NWR included:

> ". . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species . . . or (B) plants. . ." 16 U.S.C. § 1534 (Endangered Species Act of 1973);
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> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . ." 16 U.S.C. § 742f(a)(4) ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . ." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956); and
>
> ". . . (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species . . ." 16 U.S.C. § 460k-460k-4 (Refuge Recreation Act of 1962).

Subsequent acquisitions have been made to meet these and other refuge purposes outlined in the Land Protection Plan (LPP) for the Otay-Sweetwater Unit of the San Diego NWR, approved in April 1997. In accordance with the LPP, "The purpose of the San Diego National Wildlife Refuge is to protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals" (USFWS 1997).

National Wildlife Refuge System Mission:
The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended).

Description of Use:
The proposed use is recreational fishing along the Sweetwater River. Fishing is a priority public use, as identified in the National Wildlife Refuge Improvement Act. The San Diego NWR is not currently open to fishing, although evidence of fishing activity has been documented along the Sweetwater River, particularly around some year-round pools that exist along the Sweetwater River as it narrows south and west of State Highway 94. At the public scoping meetings for the Comprehensive Conservation Plan (CCP), a member of the public requested that we consider allowing fishing along the banks of the Sweetwater River.

Several wetland areas occur on the Refuge, including approximately 5.7 miles of the Sweetwater River, which flows through the Otay-Sweetwater Unit; a short portion of Steele Canyon Creek, an ephemeral drainage with a few small pools holding water for all or most of the year; and three small stock ponds located along the base of Mother Miguel Mountain, only one of which holds water throughout the year. Of these areas, only the Sweetwater River is known to support game fish.

No native game fish have occurred on the Refuge since the southern steelhead (*Oncorhynchus mykiss*) was extirpated from the Sweetwater River watershed (Good et al. 2005). While no specific fish surveys have been conducted on the Refuge, casual observations confirm the presence of four non-native fish species in the Sweetwater River. These include three game fish: green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and carp (*Cyprinus carpio*), and western mosquitofish (*Gambusia affinis*). Also present on the Refuge are red swamp crayfish (*Procambarus clarki*) and Asian clam (*Corbicula fluminea*); these species are also non-native. There are no opportunities for fishing on the Del Mar Mesa Vernal Pool Unit of the Refuge.

If fishing were to be permitted on the Refuge, it would have to occur along the banks of the Sweetwater River. There are currently no facilities available to accommodate fishing, and access to potential fishing areas would require disturbance to and potential loss of sensitive riparian vegetation. An added constraint is the nature of the water flows within the Sweetwater River, which are managed by the Sweetwater Authority, the water district that maintains the Loveland Reservoir, located upstream of the Refuge, and the Sweetwater Reservoir, located downstream of the Refuge. The water flows in the river vary tremendously throughout the year, as water levels in the Sweetwater Reservoir and Loveland Reservoir are regulated by the Sweetwater Authority. When water levels are too high in the Loveland Reservoir or water levels are too low in the Sweetwater Reservoir, the Sweetwater Authority releases water from Loveland Reservoir that travels down through the Sweetwater River channel. Any fishing sites would have to be designed to accommodate these changes in flow volumes through the river.

Opportunities for fishing are currently available in the immediate vicinity of the Refuge, including at the Sweetwater Reservoir, Lower Otay Reservoir, and Loveland Reservoir.

Availability of Resources:
Funding would have to be identified to provide facilities to accommodate a recreational fishing program on the Refuge. No restrooms, water, or fish cleaning facilities are currently

available on or near the Refuge. Direct costs to administer a recreational fishing program would include funding to construct facilities and staff time. Table 1 describes the level of involvement by Refuge staff that would be required annually to manage and monitor recreational fishing on the Refuge, and Table 2 describes the facilities and/or construction costs associated with implementing a recreational fishing program on the Refuge (based on FY 2011 costs).

Table 1
Annual Staff Involvement
Associated with Managing a Recreational Fishing Program on the San Diego NWR

Position	Involvement	FTE	Cost
Refuge Operations Specialist	Periodic on-site oversight, monitoring, public contact	0.10	$8,257
Wildlife Biologist	Monitoring and reporting	0.10	$9,655
Federal Wildlife Officer	Enforcement	0.10	$7,202
Maintenance Worker (new position)	Site cleanup, repair	0.20	$9,865
TOTAL FTES AND COSTS FOR STAFFING		0.50	$34,979

*FTE (full time equivalent)

Table 2
Equipment Associated with Managing a Recreational Fishing Program on the San Diego NWR

Type of Equipment/Facility	Explanation of Need	Cost
On-Refuge Parking Area	Needed to provide small parking area (2-4 cars) and access onto the Refuge	$100,000
Restroom	Needed to avoid impacts to Refuge resources	$25,000
Water Source and Fish Cleaning Area	Needed to accommodate the use	$30,000
TOTAL COST FOR EQUIPMENT		$155,000

Anticipated Impacts of the Use:
Opening the Refuge to recreational fishing would increase human activity within sensitive riparian habitat along the Sweetwater River. The anticipated result is direct and indirect impacts to sensitive vegetation and the listed and sensitive nesting bird species supported by this vegetation. Anticipated impacts include trampling, damage, or removal of vegetation; loss or fragmentation of habitat; reductions in habitat quality; an increase in the number of

pathways within riparian areas leading to the establishment of additional invasive plants along this riparian corridor; shoreline and streambed erosion; an increase in water turbidity; damage or loss of bird nests; and displacement of wildlife. Many species of migratory birds, including passerines, raptors, waterfowl, and wading birds, as well as native mammals, use the habitat in and around the Sweetwater River.

DeLong and Schmidt (2000), in their literature review of the effects of human disturbance on wildlife, summarized the results of a number of studies related to fishing. The majority of these studies concluded that fishing activities could influence the composition, distribution, abundance, and productivity of waterbirds. Such effects include bird fatalities resulting from entanglement with fishing line, trampling of vegetation, degraded habitat due to litter accumulation, and reduced water quality due to bank erosion and the deposition of sewage and other chemicals. DeLong's (2002) literature review of impacts associated with recreation identified a correlation between human disturbance from various activities, including fishing, and changes in bird distribution and abundance, reduced reproductive success, increased predation rates, and changes in foraging behavior. Research suggests that anglers create an area around them within which birds will not venture (Liddle and Scorgie 1980), and fishing activity within naturally vegetated areas results in degradation of wildlife habitat (Liddle and Scorgie 1980). Other studies document the potential for human activity within riparian vegetation to result in damage or destruction of bird nests that occur at various levels throughout the vegetation, particularly cup nests of Neotropical migratory birds located on or near the ground.

In general, fishing results in longer periods of human presence within riparian habitat than occurs during regular trail use because fishing involves someone being present in a particular area for an hour or more. As a result, this continued human presence can disrupt bird foraging activity, and on the Refuge may lead to a reduction in species richness along those areas of the Sweetwater River where non-native game fish are present. For many passerine species, primary song occurrence and consistency can be affected by a single visitor (Gutzwiller et al. 1994, 1997). In areas where primary song was affected by disturbance, birds appeared to be reluctant to establish nesting territories (Reijnen and Foppen 1994).

Finally, the fish that are present on the Refuge are not native and have the potential to adversely affect other native aquatic species. Rather than allow for their proliferation on the Refuge, actions are included in the CCP to control and, where possible, eradicate non-native aquatic species to meet the Refuge's endangered species and other wildlife objectives.

Endangered and Threatened Species

Human activity associated with fishing can have adverse impacts to endangered, threatened, and sensitive species, particularly when the associated disturbance disrupts nesting or foraging activities. The least Bell's vireo (*Vireo bellii pusillus*) is a federally listed endangered species that nests and forages within the Refuge's Sweetwater River riparian corridor. This corridor has been designated as critical habitat for the vireo (*Federal Register*, 59 FR 4845- 4867, February 2, 1994). Human disturbance, such as trampling of nests or nest sites or clearing of vegetation, can cause nest failure and abandonment (USFWS 1998). Kus (2002) indicated that brood parasitism and habitat

fragmentation are the primary factors causing the species decline and are both results of human-induced disturbance. In addition, the federally listed threatened coastal California gnatcatcher (*Polioptila californica californica*) nests and forages in coastal sage scrub adjacent to the Refuge's riparian habitat and ponds.

Although survey results have been negative for the federally listed endangered arroyo toad (*Anaxyrus californicus*) and southwestern willow flycatcher (*Empidonax traillii extimus*), suitable habitat, and designated critical habitat for the flycatcher, exists on the Refuge along the Sweetwater River corridor. Suitable habitat is also available to support the southwestern pond turtle (*Emys marmorata pallida*), a species covered by the San Diego Multiple Species Conservation Program (MSCP). The San Diego NWR CCP includes strategies to reintroduce or improve habitat conditions to support the natural recruitment of these species within suitable habitat areas along the Sweetwater River. These efforts could be impacts by known threats to these species from the human activity associated with fishing. Such threats include disturbance during foraging and nesting and/or breeding, displacement from preferred feeding areas for prolonged periods, nest and/or breeding failure, direct habitat loss through trampling, and for the turtle, incidental capture by anglers (Madden-Smith et al. 2005). In addition, new user-created trails in Refuge riparian areas would invite increased human access and disturbance into this area for non-fishing related activities.

Increased access and activity could also promote the spread of invasive plants into native habitats. Non-native fish, crayfish, and clams have the potential to be competitors and predators of native listed species, such as the federally listed endangered arroyo toad and California red-legged frog (*Rana aurora draytonii*). As noted, the CCP and an Integrated Pest Management Plan prepared for the Refuge include actions to control these non-native species.

Public Review and Comment:

The potential to provide opportunities for fishing on the San Diego NWR were discussed at the scoping meetings held on June 14 and 15, 2006, to initiate the CCP process. A Notice of Intent was published in the *Federal Register* on May 24, 2006 (71 FR 29973). At that time, written comments were solicited. At the scoping meetings, the public was encouraged to provide verbal comments or to send us written comments following the meetings. A CCP web page was established to provide the public with specific information regarding the CCP process and the comments provided during public scoping. Planning Updates have also been prepared to summarize the progress of the CCP and to discuss specific issues related to the planning process.

The draft Compatibility Determination was made available for public review and comment as Appendix A of the San Diego National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2014). No comments related to fishing were received.

Determination:

◯ Use is Not Compatible

◯ Use is Compatible with the Following Stipulations

Justification:
Although the Refuge includes approximately 5.7 miles of the Sweetwater River, opportunities for fishing are limited by both minimal water depths along much of the River and the lack of the presence of native fish populations within this watershed. There are some deeper pools located along the river course that support non-native fish; however, the eradication of non-native fish from the Refuge is proposed to support the reestablishment of populations of southwestern pond turtle and the federally endangered arroyo toad along suitable segments of the Sweetwater River.

The general guidelines for wildlife-dependent recreation, as presented in 605 FW 1.6 of the Service Manual, provide a range of criteria to be considered when opening a refuge to a particular recreational experience. Some of these criteria include consideration of applicable laws and regulations, minimizing conflicts with fish and wildlife population and habitat goals, promoting accessibility and availability to a broad spectrum of the American people, promoting resource stewardship and conservation, providing reliable and reasonable opportunities to experience wildlife, and using visitor satisfaction to help define and evaluate programs. We develop and evaluate quality wildlife-dependent recreation programs based on these criteria, which necessarily involves considering the existing and projected future conditions on a refuge. Such conditions include the lack of native fish within the watershed and the projected future lack of non-native fish in accordance with the Integrated Pest Management Plan that accompanies the CCP.

The guidance also addresses the need to consider applicable laws and regulation, including the ESA, and minimizing conflicts with fish and wildlife population and habitat goals. The portion of the Sweetwater River that extends through the Refuge is designated as critical habitat for the least Bell's vireo and southwestern willow flycatcher, and has the potential to support the federally endangered arroyo toad and red-legged frog, and MSCP-covered southwestern pond turtle. The habitat adjacent to the Refuge's riparian and pond areas support the federally listed threatened coastal California gnatcatcher.

The opportunities to harvest fish from the Sweetwater River at present are low and will be essentially nonexistent in the future. Based primarily on the limited fishing opportunities available along the Sweetwater River, but also considering the potential for increased disturbance within habitat designated as critical for the recovery of the least Bell's vireo and southwestern willow flycatcher, the Refuge Manager has determined not to open the Refuge to recreational fishing.

Mandatory Reevaluation Date (provide month and year):

Mandatory 15-year Reevaluation Date (for priority public uses)

_____ Mandatory 10-year Reevaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

☐ Categorical Exclusion without Environmental Action Statement

☐ Categorical Exclusion and Environmental Action Statement

☐ Environmental Assessment and Finding of No Significant Impact

☐ Environmental Impact Statement and Record of Decision

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Refuge Determination:

Prepared by: _____ (Signature) 12/13/2016 (Date)

Project Leader Approval: _____ (Signature) 12/15/16 (Date)

Concurrence:

Refuge Supervisor: _____ (Signature) 3/23/17 (Date)

Assistant Regional Director, Refuges: _____ (Signature) 3.28.17 (Date)

Compatibility Determination
(December 2016)

Use:
Wildlife Observation, Photography, Environmental Education, and Interpretation

Refuge Name:
San Diego National Wildlife Refuge (San Diego County, California)

Establishing and Acquisition Authorities:
The San Diego NWR was established in 1996 under the authorities of the Fish and Wildlife Act of 1956, as amended (16 U.S. C. 742(a)-754), Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), and Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) (USFWS 1995). Establishment occurred on April 10, 1996, when approximately 1,826 acres of land (referred to at the time as Rancho San Diego) were conveyed to the Service for management as a national wildlife refuge.

Refuge Purposes:
The purposes for the initial acquisition for the San Diego NWR included:

> ". . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species . . . or (B) plants. . ." 16 U.S.C. § 1534 (Endangered Species Act of 1973);
>
> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . ." 16 U.S.C. § 742f(a)(4) ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . ." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956); and
>
> ". . . (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species . . ." 16 U.S.C. § 460k-460k-4 (Refuge Recreation Act of 1962).

Subsequent acquisitions have been made to meet these and other refuge purposes outlined in the Land Protection Plan (LPP) for the Otay-Sweetwater Unit of the San Diego NWR, approved in April 1997. In accordance with the LPP, "The purpose of the San Diego National Wildlife Refuge is to protect, manage, and restore habitats for federally listed

endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals" (USFWS 1997).

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended).

Description of Use:

This Compatibility Determination addresses wildlife observation, photography, environmental education, and interpretation, all uses that are identified as priority public uses in the National Wildlife Refuge Improvement Act. These uses are presently occurring in various locations throughout the Refuge, generally, but not always, from existing trails and pathways that have been created within the Refuge. There is evidence of off-trail activity occurring in various parts of the Refuge that are resulting in wildlife disturbance and habitat degradation.

To address the need for providing opportunities for these uses while also protecting the species and habitats included within the Refuge boundaries, the San Diego NWR Comprehensive Conservation Plan (CCP) (USFWS 2016) proposes to establish a designated trail system within the Refuge. A trail plan has been developed and is included in the Final CCP. The vast majority of the public uses proposed for the Refuge, with the exception of a limited hunting program, would take place on the designated trails. All other areas of the Refuge would be closed to public use.

The CCP includes an objective for wildlife and plant observation that states that by 2018, the Refuge will provide opportunities for 16,000 visitors annually to observe the native wildlife and plants preserved within on the Refuge. The objective for photography states that by 2018, the Refuge will provide quality opportunities for at least 250 annual visits to the Refuge for the purpose of nature photography. As stated, the vast majority of these activities will occur along the designated trail system.

The guiding principles of the Refuge System's environmental education programs (605 FW 6 of the Service Manual) are to:

- teach awareness, understanding, and appreciation of our natural and cultural resources and conservation history;
- allow program participants to demonstrate learning through refuge-specific stewardship tasks and projects that they can carry over into their everyday lives;

- establish partnerships to support environmental education both on- and off-site;
- support local, State, and national educational standards through environmental education on refuges;
- assist refuge staff, volunteers, and other partners in obtaining the knowledge, skills, and abilities to support environmental education;
- provide appropriate materials, equipment, facilities, and study locations to support environmental education;
- give refuges a way to serve as role models in the community for environmental stewardship; and
- minimize conflicts with visitors participating in other compatible wildlife-dependent recreation activities.

The San Diego NWR Complex's Environmental Education program works with Earth Discovery Institute, a local non-profit educational organization, to provide curriculum for elementary and middle school students. In the 2010-2011 school-year, the program expanded its study locations to include the San Diego NWR, and about 240 middle school students participated in environmental education activities on the Refuge that addressed topics such as the importance of coastal sage scrub and willow riparian habitats to native wildlife and endangered species and the effects of habitat fragmentation on habitat quality and wildlife.

The Refuge has also worked with San Diego Audubon on their South County Student Stewardship and Education Initiative project. Under this grant-funded project, San Diego Audubon works with local elementary schools within two miles of conserved lands in the south county to determine how students at these schools might participate in an education or service learning opportunity on the Refuge or other area of conserved land in south county. Nature programs are developed at selected school sites based on the results of the school outreach and inventory process.

Some of the environmental education programs being implemented in the south county include:

- OutdoorExplore! is an after-school enrichment program conducted by San Diego Audubon for underserved elementary school children. The goal of this program is to connect children to their local open spaces through nature interpretation and experiential learning techniques. San Diego Audubon proposes to expand this program to include a minimum of three schools that will focus their activities within conserved lands in the Otay-Sweetwater region. Fourteen elementary schools located within one mile of Otay-Sweetwater conserved lands have been identified as potential participants in the program.

- Nearby Nature School Field Trips is a product of the San Diego Children and Nature Collaborative in which elementary school teachers are mentored in using nearby natural areas as "outdoor classrooms" to teach curriculum-based content. Through school outreach, San Diego Audubon will build relationships with local elementary school teachers that may be interested in implementing this locally-based science curriculum. A preliminary geographic analysis showed that there are a total of 29 elementary schools within two miles of Otay-Sweetwater conserved lands. The goal is to obtain program participation commitments from at least five classrooms, resulting in up to 150 student visits to South County conserved lands. Bus transportation will enhance access to these lands and will be offered to local schools based on need.

San Diego Audubon is also working on a service-learning program to benefit South County land conservation. In collaboration with the Refuge, the California Department of Fish and Wildlife (CDFW), and other landowners, San Diego Audubon will develop a service learning program that exclusively serves South County conserved lands. Approximately 100 students from up to eight local high schools will be recruited to take part in a structured, geographically-focused stewardship program that will educate students on local conservation efforts and engage them in natural resource management activities.

The Refuge, together with conservation partners such as Earth Discovery Institute, San Diego Audubon, CDFW, and Bureau of Land Management, will also promote opportunities on the Refuge for environmental education and connecting people with nature by supporting requests for Refuge visits by educational institutions, non-governmental organizations, and archaeological/historical societies.

The guiding principles of the National Wildlife Refuge System's interpretive programs (605 FW 7 of the Service Manual) are to:

- promote visitor understanding of, and increase appreciation for, America's natural and cultural resources and conservation history by providing safe, informative, enjoyable, and accessible interpretive opportunities, products, and facilities;
- develop a sense of stewardship leading to actions and attitudes that reflect interest and respect for wildlife resources, cultural resources, and the environment;
- provide quality interpretive experiences that help people understand and appreciate the individual refuge and its role in the Refuge System;
- provide opportunities for quality recreational and interpretive experiences consistent with criteria describing quality found in 605 FW 1.6;

- assist refuge staff, volunteers, and community support groups in attaining knowledge, skills, and abilities in support of interpretation; and
- minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.

To date, interpretive signs on the Refuge can be found at some trailheads and along portions of the Sweetwater Loop and River Trail. The interpretive signs along the Sweetwater Loop Trail, which were installed by an Eagle Scout, provide information on some of the endangered and threatened species that may be observed in the area. The San Diego NWR CCP proposes the installation of additional interpretive elements at various locations on the Refuge per available funding.

Currently, opportunities for wildlife observation, photography, and interpretation are also provided through the "Hike with a Ranger" program. These hikes are offered approximately once a month. In addition, special tours are periodically conducted to support the Refuge's public use objectives. It is through these types of activities that visitors are introduced to the National Wildlife Refuge System, the San Diego NWR, and the many resources protected on the Refuge. Some walks have a special theme, such as a pollinator hike to coincide with the Pollinator Week, a migratory bird hike to highlight Migratory Bird Day, or they may address a specific habitat type, species, or Refuge project (e.g., reintroduction of the endangered plant, San Diego ambrosia [*Ambrosia pumila*]).

Community outreach events such as volunteer work days, combine interpretation and volunteer projects, and special activities for children that provide opportunities to view native wildlife, hike with a biologist, and create artwork and stories based on their observations, are also conducted periodically throughout the year.

These four wildlife-dependent recreational activities (i.e., wildlife observation, photography, environmental education, interpretation) are conducted on those portions of the Refuge open to the public. By providing opportunities for the public to participate in these activities, we are able to enhance the public's understanding and appreciation for the need to conserve the many species and habitats supported within the Refuge boundary.

As of 2016, Refuge facilities to accommodate these uses are limited. Only one parking area is available for the public to access the Refuge, and this parking area only provides access to the McGinty Mountain area of the Refuge. Some additional parking is available off the Refuge, but those lots are managed by other agencies, and have been provided primarily as access and staging areas for the County's Sweetwater Loop and River Trail, which extends through the Sweetwater River and San Miguel Mountain areas of the Refuge. A few kiosks have been erected where trails provide access onto the Refuge.

A number of additional facilities are proposed to accommodate wildlife-dependent recreational uses on the Refuge. These include a parking lot, visitor contact station, and trail staging area with restroom and information kiosk to be located to the west of Millar Ranch Road and south of Highway 94 on land proposed for transfer to the Refuge from Caltrans. These facilities will allow for staging of the Refuge's environmental education programs, as well as some of the guided hikes and other Refuge-sponsored activities that occur on the Refuge. Other facilities, that would be implemented per available funding, include a birding trail within the Las Montañas area of the Otay-Sweetwater Unit, the construction of a universally accessible photography blind in an appropriate location within the Otay-Sweetwater Unit, and the installation of additional interpretive signage throughout the Refuge. The photo blind would be available on a first come, first serve basis. If necessary due to the popularity of the blind, a reservation system could be established to ensure that everyone who wishes the opportunity to use the blind has the chance to do so.

Availability of Resources:

Currently, the direct costs to provide opportunities for wildlife observation, photography, environmental education, and interpretation are primarily in the form of staff time. However, providing the new facilities and expanded programs described in the CCP would require additional staff and funding in excess of current annual allocations. The costs for providing additional staff are presented in Table 1. The funding needs for new construction projects (e.g., interpretive elements, parking areas, visitor contact station) are presented in Table 2 (see additional project details in the Final San Diego NWR CCP). New programs would be implemented, and new facilities would be designed and constructed when funding is secured for individual projects. Potential funding sources include Federal cost share grants, interagency partnerships, state and private grants, and contributions from Friends groups.

Table 1
Annual Staff Involvement Associated with Managing Proposed Wildlife Observation, Photography, Environmental Education, and Interpretation on the San Diego NWR

Position	Involvement	FTE*	Cost
Project Leader/Deputy Project Leader	General oversight	0.05/ 0.05	$15,185
Refuge Manager	Coordinate with staff and Community Outreach Coordinator on events; public outreach with partners in environmental education delivery, Friends group coordination, conduct tours, process permits, conduct NEPA, and manage construction.	0.30	$38,004

Refuge Operations Specialist	Periodic oversight, monitoring, outreach, enforcement, informational signs and kiosks maintenance, and participation in interpretive and educational events.	0.25	$20,642
Wildlife Biologist	Monitoring, reporting, reviewing interpretive plan, assessing impacts from visitor services related to construction and events, participation in interpretive and educational events, conducting outreach.	0.25	$48,277
Environmental Education Specialist	Coordinate the development of curriculum for the environmental education program and assist in the design of the interpretive plan, build partnerships with other agencies and organizations, and outreach to schools	0.95	$91,514
Park Ranger	Coordinate and assist in the delivery of the interpretive program	0.50	$41,283
Federal Wildlife Officer	Enforcement of Refuge regulations and protection of Refuge resources	0.30	$21,607
Maintenance Worker	Maintain interpretive areas and amenities	0.30	$14,797
Total FTES/ Annual Costs for Staffing		**3.0**	**$291,309**

*FTE (full time equivalent)

Table 2
Construction and Facilities Costs Associated with Managing Wildlife Observation, Photography, Environmental Education, and Interpretation on the San Diego NWR

Material/Facility Required	Explanation of Need	Cost
Visitor Staging Area/Temporary Contact Station	Currently, no facilities are available on the Refuge where visitors can interact with Refuge staff and can ask questions and receive information about Refuge resources, regulations, safety, or other topics. Also, there is no formal parking/staging area available within the Sweetwater River and San Miguel Mountain areas, which represent the largest contiguous area of land (about 6,700 acres) on the Refuge.	$2,000,000

Enhanced Interpretive Elements Along the Sweetwater River	A number of listed and sensitive species occur in this area of the Refuge, providing an excellent opportunity to inform visitors of the importance of the habitat located within the Refuge.	$50,000
Interpretive and Informational Kiosks (5) at Major Trailheads on the Refuge	Information in the kiosks will inform visitors that they are entering a NWR, and explain the purpose of the Refuge, its resources, and why those resources needed to be protected.	$120,000
Bird Identification Signs on the future Las Montañas birding trail	These identification signs will support wildlife observation, photography, and interpretive programs throughout the Refuge.	$20,000
Develop and Implement an Expanded Environmental Education Program	Develop curriculum specific for the San Diego NWR and/or inland habitat/species for an elementary school program and implement annually.	$60,000
Total Cost for Facilities		**$2,250,000**

Anticipated Impacts of the Use:

Once considered "non-consumptive" recreational uses, it is now recognized that recreational uses such as wildlife observation, nature photography, environmental education, interpretation, and trails can negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat (Purdy et al. 1987, Knight and Cole 1995). Purdy et al. (1987) and Pomerantz et al. (1988) described six categories of public use impacts to wildlife:

- direct mortality (i.e., immediate, on-site death of an organism);
- indirect mortality (i.e., eventual, premature death of an organism caused by an event or agent that predisposed the organism to death);
- lowered productivity (i.e., reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site);
- reduced use of refuge (i.e., wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity);
- reduced use of preferred habitat on the refuge (i.e., wildlife use is relegated to less suitable habitat on the refuge due to visitor activity); and

- aberrant behavior/stress (i.e., wildlife demonstrating unusual behavior or signs of stress likely to result in reduced reproductive or survival rates).

Individual plants and animals may be disturbed by human contact to varying degrees. Human disturbance in the form of trampling can result in the loss of sensitive plants, reptiles, and invertebrates. Human activities on trails can result in direct effects on wildlife through harassment, a form of disturbance that can cause physiological effects, behavioral modifications, or death (Smith and Hunt 1995). Many studies have shown that birds can be affected by human activities on trails when they are disturbed and flushed from feeding, resting, or nesting areas.

Flushing, especially repetitive flushing, can strongly affect habitat use patterns of many bird species. Flushing from an area can cause birds to expend more energy, be deterred from using desirable habitat, change resting or feeding patterns, increase exposure to predation, or abandon sites with repeated disturbance (Smith and Hunt 1995).

Nest predation for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1976), and waterfowl (Boyle and Samson 1985) tends to increase in areas more frequently visited by people. In addition, for many passerine species, primary song occurrence and consistency can be affected by a single visitor (Gutzwiller et al. 1994). In areas where primary song was affected by disturbance, birds appeared to be reluctant to establish nesting territories (Reijnen and Foppen 1994).

Depending on the species (especially migrants vs. residents), some birds may habituate to some types of recreation disturbance and either are not disturbed or will immediately return after the initial disturbance (Hockin et al. 1992, Burger et al. 1995, Knight and Temple 1995, Madsen 1995, Fox and Madsen 1997). Rodgers and Smith (1997) calculated buffer distances that minimize disturbance to foraging and loafing birds based on experimental flushing distances for 16 species of waders and shorebirds. They recommended 100 meters as an adequate buffer against pedestrian traffic; however, they suggest this distance may be reduced if physical barriers (e.g., vegetation screening) are provided, noise levels are reduced, and traffic is directed tangentially rather than directly toward birds. Screening may not effectively buffer noise impacts, thus visitors should be educated on the effects of noise and noise restrictions should be enforced (Burger 1981, Burger 1986, Klein 1993, Bowles 1995, Burger and Gochfeld 1998).

Of the wildlife observation techniques, wildlife photographers tend to have the largest disturbance effects (Klein 1993, Morton 1995, Dobb 1998). While wildlife observers frequently stop to view species, wildlife photographers are more likely to approach wildlife (Klein 1993). Even a slow approach by wildlife photographers can result in behavioral

consequences to wildlife species (Klein 1993). Other impacts include the potential for photographers to remain close to wildlife for extended periods of time in an attempt to habituate the wildlife subject to their presence (Dobb 1998) and the tendency of casual photographers, with low-power lenses, to get much closer to their subjects than other activities would require (Morton 1995), including wandering off trails. This usually results in increased disturbance to wildlife and habitat, including trampling of plants.

Education helps make visitors aware that their actions can have negative impacts on Refuge species, and can increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who had spoken with refuge staff or volunteers were less likely to disturb birds. Monitoring is recommended to adjust management techniques over time, particularly because it is often difficult to generalize about the impacts of specific types of recreation in different environments. Local and site - specific knowledge is necessary to determine effects on birds and other species and to develop effective management strategies (Hockin et al. 1992, Klein et al. 1995, Hill et al. 1997).

The construction and maintenance of trails, interpretive elements, and parking lots will have minor impacts on soils and vegetation around the trails. This could include an increased potential for erosion, soil compaction (Liddle 1975), reduced seed emergence (Cole and Landres 1995), alteration of vegetative structure and composition, and sediment loading (Cole and Marion 1988). To avoid impacts to water quality and adjacent native habitat during the construction of the trail facilities proposed to support wildlife-dependent recreational use, the CCP includes a range of best management practices that would be implemented prior to, during, and following construction.

Disturbance of wildlife and sensitive vegetation is the primary concern associated with the proposed uses. To reduce the overall effect of these uses on Refuge resources, large areas of the Refuge would be closed to public use. Where public use is permitted, disturbance would be localized, intermittent, and for the most part restricted to the trail corridor and areas located immediately adjacent to the trails. Increased activity around facilities and high visitation would likely cause some displacement of species and habitat. To minimize the effect of disturbance on the Refuge's most sensitive species, the development of facilities expected to attract larger numbers of visitors would occur away from sensitive habitat areas.

Environmental education and interpretation activities generally support the Refuge's purposes and impacts can largely be minimized (Goff et al. 1988). The minor resource impacts attributed to these activities are generally outweighed by the benefits gained by educating present and future generations about refuge resources. Environmental education is a public use management tool used to develop a resource protection ethic within society.

While it targets school age children, it is not limited to this group. This tool allows us to educate refuge visitors about endangered and threatened species management, wildlife management, and ecological principles and communities.

A secondary benefit of environmental education comes from instilling an 'ownership' or 'stewardship' ethic in visitors, which most likely reduces vandalism, littering, and poaching; it also strengthens service visibility in the local community. Disturbance by environmental education activities is considered to be of minimal impact because students and teachers will be instructed in wildlife observation etiquette and the best ways to view wildlife with minimal disturbance; education groups will be required to have a sufficient number of adults to supervise the group; and observation areas, binoculars, and scopes are provided to view wildlife at a distance which reduces disturbance.

The Refuge's location within and adjacent to urban/suburban development makes it attractive to the recreating public. While we acknowledge deleterious effects to wildlife from the presence of humans as noted by the references cited above, closing all access to the Refuge would reduce the human communities' support for the Refuge's overall conservation program, including land acquisition, species monitoring, habitat restoration, and management. By allowing the public onto the Refuge, and making education and interpretation of the Refuge's biological diversity an important component of everyday Refuge work, we can reduce the deleterious effects and garner support from the public for ongoing and future conservation actions.

Endangered and Threatened Species and Sensitive Species

As noted, human activity can have adverse impacts to wildlife species, particularly when reproductive or foraging activities are disrupted. Of particular concern are potential disturbances to the endangered least Bell's vireo (*Vireo belli pusillus*), Quino checkerspot butterfly (*Euphydryas editha quino*) and San Diego fairy shrimp (*Branchinecta sandiegonensis*), the threatened coastal California gnatcatcher (*Polioptila californica californica*), and candidate Hermes copper butterfly (*Hermelycaena [Lycaena] hermes*). Appropriate siting of visitor service facilities, interpretive signs, and trails would minimize disturbance to these species. Permanent trail closures of redundant or unsustainable user-created trails, seasonal trail closures in particularly sensitive areas (e.g., nest sites), posting regulatory and interpretive signage to keep unauthorized users out of sensitive areas, and Refuge staff, including Federal Wildlife Officers, educating the public on how to minimize impacts to Refuge resources.

Other federally-listed species susceptible to harm as a result of off-trail activity are plants including the endangered San Diego ambrosia and San Diego thornmint (*Acanthomintha*

ilicifolia), threatened Otay tarplant (*Deinandra conjugens*), and vernal pool plants including endangered San Diego button-celery (*Eryngium aristulatum* var. *parishii*), California Orcutt grass (*Orcuttia californica*), Otay mesa mint (*Pogogyne nudiscula*) and threatened spreading navarretia (*Navarretia fossalis*). The measures described above will also minimize the potential for impacts to these species as a result of authorized public uses. Fencing has been installed at several locations (e.g., the 30-acre vernal pool restoration southeast of Sweetwater Reservoir, adjacent to populations of San Diego ambrosia) to direct Refuge users away from these sensitive resources. Additional signage and/or fencing will be installed in other areas of the Refuge if monitoring indicates a need to protect plants or wildlife.

Sensitive species present on the Refuge include those covered by the Multiple Species Conservation Program (MSCP) such as burrowing owl (*Athene cunicularia*), San Diego horned lizard (*Phrynosoma coronatum*), Palmer's goldenbush (*Ericameria palmeri*), and San Diego barrel cactus (*Ferocactus viridescens*). As with listed species, impacts to sensitive species can be avoided and minimized by appropriate trail placement and maintenance, permanent and/or seasonal trail closures, and outreach and education about the Refuge's biological resources.

Disturbance as a result of the regular passage of the public along Refuge trails may decrease the functional area of suitable habitat for foraging and breeding listed and sensitive bird and butterfly species. However, public activity along these trails has been an ongoing regular activity for more than two decades and was occurring prior to establishment of the Refuge; therefore, the effect of human use may already have been manifested. By closing redundant or unauthorized trails and focusing wildlife-dependent recreational uses in areas with lower sensitivity, this disturbance can be reduced.

Public Review and Comment:

Opportunities for wildlife observation, photography, environmental education, and interpretation on the San Diego NWR were discussed at the scoping meetings held on June 14 and 15, 2006, to initiate the CCP process. A Notice of Intent was published in the *Federal Register* on May 24, 2006 (71 FR 29973). At that time, written comments were solicited. At the scoping meetings, the public was encouraged to provide verbal comments or to send us written comments following the meetings. A CCP web page was established to provide the public with specific information regarding the CCP process and the comments provided during public scoping. Planning Updates were prepared to summarize the progress of the CCP and to discuss specific issues related to the planning process. The draft Compatibility Determination was available for public comment as Appendix A of the San Diego NWR Draft CCP (USFWS 2014). Comments related to these wildlife-dependent recreational uses are presented in the Response to Comments (Appendix F-2 of the Final CCP).

Determination:

☐ Use is Not Compatible

☐ Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

The measures present here will be implemented to ensure that wildlife observation, photography, environmental education, and interpretation are compatible with purposes for which this Refuge was established.

- Adequate areas of the Refuge will be designated as wildlife sanctuary with no or limited public use activities to provide high quality habitat for feeding, resting, and nesting.
- Regulations and wildlife friendly behavior (e.g., requirements to stay on designated trails, dogs must be kept on leash) will be posted on kiosks and at the visitor contact station and will be described in brochures.
- All public access onto the Refuge will be restricted to daylight hours (i.e., sunrise to sunset).
- Areas of the Refuge may be restricted seasonally or permanently to reduce impacts during breeding or nesting season, or to protect habitat or sensitive species.
- All activities associated with wildlife observation and photography will be restricted to the designated trail system, Refuge established overlooks, and photo blinds.
- Participants in the Refuge's environmental education and interpretation programs will be restricted to the designated trail system, visitor contact station, established environmental education areas, and other designated sites.
- A program regarding wildlife observation etiquette including ways to reduce wildlife disturbance will be established and this program will be presented to teachers during environmental education program orientation, as well as to students upon arrival during their welcome session, and to participants of guided Refuge hikes.
- Educational groups will be required to have a sufficient number of adults to supervise their groups, a minimum of 1 adult per 12 students, and the teacher and adult supervisors are responsible for ensuring that students follow wildlife observation etiquette.
- Interpretive signage, displays, kiosks, and brochures will be maintained and updated as necessary to ensure that the public is receiving the message about the need to protect Refuge resources.
- Regular monitoring of public activities on the Refuge will be conducted by Refuge staff and monitoring results will be analyzed and used by the Refuge Manager to

develop future modifications, if necessary, to ensure compatibility of wildlife observation, photography, environmental education, and interpretive programs.

Justification:

Providing opportunities for wildlife observation, photography, environmental education, and interpretation on the San Diego NWR will enhance the public's appreciation of the wildlife and habitat present on the Refuge. Public uses will support the Service's initiative for connecting people, particularly children, with nature, and lays a foundation for *Conserving the Future's* urban Refuge initiatives. Through these activities, the Refuge has the opportunity to introduce the public to the importance of protecting sensitive habitats not only because these habitats support federally listed species, but because of the role these habitat play in supporting migratory birds, and rare and local plant and wildlife species. These outcomes are consistent with the Refuge purposes of protecting listed species. Information kiosks have been or will be installed at access points to inform visitors about Refuge habitats, wildlife, regulations, visiting opportunities, and techniques to minimize adverse impacts.

A review of the environmental consequences of implementing these uses was provided in Chapter 5 of the San Diego NWR CCP/EA (USFWS 2014). This analysis demonstrates that these uses would not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission, provided the stipulations to ensure compatibility are followed. Further, wildlife observation, photography, environmental education, and interpretation are four of the six priority public uses of the System, as defined by the Improvement Act. Therefore, implementation of these programs would contribute to the fulfillment of the Refuge System mission, and the achievement of the goals established for the Refuge, particularly the goal to enhance public appreciation, understanding, and enjoyment of the Refuge's biological and cultural resources.

Mandatory Reevaluation Date (provide month and year):

_____ Mandatory 15-year Reevaluation Date (for priority public uses)

_____ Mandatory 10-year Reevaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

☐ Categorical Exclusion without Environmental Action Statement

☐ Categorical Exclusion and Environmental Action Statement

☐ Environmental Assessment and Finding of No Significant Impact

☐ Environmental Impact Statement and Record of Decision

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Refuge Determination:

Prepared by: _____ (Signature) 12/16/16 (Date)

Project Leader Approval: _____ (Signature) 12/16/16 (Date)

Concurrence:

Refuge Supervisor: _____ (Signature) 3/23/17 (Date)

Assistant Regional Director, Refuges: _____ (Signature) 3.28.17 (Date)

Compatibility Determination

(December 2016)

Use: Non-Motorized Recreational Trails

Refuge Name: San Diego National Wildlife Refuge (San Diego County, California)

Establishing and Acquisition Authorities:

The San Diego NWR was established in 1996 under the authorities of the Fish and Wildlife Act of 1956, as amended (16 U.S. C. 742(a)-754), Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), and Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) (USFWS 1995). Establishment occurred on April 10, 1996, when approximately 1,826 acres of land (referred to at the time as Rancho San Diego) were conveyed to the Service for management as a national wildlife refuge.

Refuge Purposes:

The purposes for the initial acquisition for the San Diego NWR included:

> "...to conserve (A) fish or wildlife which are listed as endangered species or threatened species ...or (B) plants..." 16 U.S.C. § 1534 (Endangered Species Act of 1973);
>
> "...for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)"...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude..." 16 U.S.C. § 742f(b)(l) (Fish and Wildlife Act of 1956); and
>
> "...(1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species ..." 16 U.S.C. § 460k-460k-4 (Refuge Recreation Act of 1962).

Subsequent acquisitions have been made to meet these and other refuge purposes outlined in the Land Protection Plan (LPP) for the Otay-Sweetwater Unit of the San Diego NWR, approved in April 1997. In accordance with the LPP, "The purpose of the San Diego National Wildlife Refuge is to protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals" (USFWS 1997).

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended).

Descriptions of Use:

This Compatibility Determination addresses the proposal to allow non-motorized recreational trail use, including hiking, jogging, walking a leashed dog, mountain biking, and horseback riding, on portions of the Refuge. Trail use in and of itself is not identified as a priority public use in the National Wildlife Refuge Improvement Act, however, trails do accommodate priority public uses such as wildlife observation, photography, environmental education, and interpretation, all of which contribute to the public's understanding and appreciation of the Refuge's resources.

When the Refuge was established in 1996, the establishment document (USFWS 1995) recognized the community's interest in accessing for recreational purposes the lands to be acquired as part of the San Diego NWR. The document stated: "wildlife-oriented recreational, educational, and interpretive uses are identified as one of the purposes of the establishment of the proposed San Diego NWR." Following refuge establishment, two trails were approved for the Refuge. The Sweetwater Loop and River Trail is a designated San Diego County regional trail that traverses portions of the San Miguel Mountain and Sweetwater River areas of the Otay-Sweetwater Unit. This trail is open to non-motorized multiple uses (i.e., hiking, biking, equestrian). An additional trail was approved for the area west of Par Four Drive in the northern portion of the Sweetwater River area. This trail, also designated for multiple uses, is one of the primary equestrian routes used by Bright Valley Farms.

An estimated 25,000 to 30,000 people annually access the existing network of trails on the Otay-Sweetwater Unit to walk, run, and ride bicycles and horses. This may, however, be an underestimation of use based on the results of a short observational study conducted by a volunteer at the interpretive loop trail in spring 2011. Over 22 days of observation, 446 visitors were recorded, of which 310 were walking and 136 were running (Cortopassi 2011). Based on these observations, it was estimated that approximately 13,000 people annually use the interpretive loop, which represents only a small portion of the lands included within the Refuge. This study also revealed considerable use of the trails in the vicinity of the interpretive loop by dog walkers. During the study, a total of 140 dog walker visits were recorded, with several walkers accompanied by two or more dogs.

Bright Valley Farm, a horse stable and trail ride facility located adjacent to the Refuge, leads trail rides on the Refuge, and horse boarders at this facility tend to ride their horses primarily on Refuge land located to the north of Highway 94 and west of Park Four Drive. The interpretive loop study showed equestrians in that area on eight of the 22 observation dates. A total of 33 horses and riders were observed during the study. Equestrians may access the Sweetwater Loop and River Trail more frequently in other seasons when the area south of Highway 94 is accessible by crossing under the Highway 94 bridge at the Sweetwater River. During the time of the study, the area under the bridge was not accessible due to high water. Access to the loop trail area by equestrians is available from a county-maintained parking area located near Singer Lane and the old steel bridge. Equestrians can also access this area from various neighborhoods near the Refuge and from the Summit site of Sweetwater County Park near the Sweetwater Reservoir in Bonita.

Mountain biking may be the most frequently observed use on Refuge trails. The study referenced previously noted cyclists on 20 of the 22 observation dates, with a total of 212 cyclists recorded. This user group typically travels greater distances than other users and, along with equestrians, comprises the more frequently encountered trail users in more remote portions of the Refuge. As with other user groups, cyclists access the Refuge from many locations, with the largest numbers accessing the Refuge from the Singer Lane/old steel bridge parking area and/or the communities in Bonita and Chula Vista.

Numerous pathways, old roads, utility easements, and user-created trails crisscross the lands included within the Refuge. The Comprehensive Conservation Plan (CCP) for the San Diego NWR (USFWS 2017) includes a designated system of trails that will connect users to various portions of the Refuge, as well as connect to existing County trails that abut the current Refuge boundary. The trail system has been designed to ensure that Refuge purposes can be met, particularly those purposes related to the protection of listed and sensitive species and habitats, while also addressing the desire to provide opportunities for wildlife-oriented recreation. The designated system of trails takes into consideration the availability of legal public access onto the Refuge through other public lands and from appropriate locations along adjacent public rights-of-way.

The trail alignments on the Refuge parcels included within the Del Mar Mesa Vernal Pool Unit have been developed as part of the City of San Diego's Carmel Mountain and Del Mar Mesa Preserves Resource Management Plan (City of San Diego 2015). Additional information regarding the designated trail system is provided in the Final CCP for the San Diego NWR (USFWS 2017).

Availability of Resources:

The direct costs of providing a designated system of non-motorized recreational trails on the Refuge include costs associated with staff time for designing, constructing, and/or rehabilitating trails, and monitoring trail use and the effects of trail use on sensitive habitats and species. Other

costs could include realigning some trail segments to improve safety and/or sustainability, installing trail bridges, signing designated trails as open and signing other existing trails as closed, recontouring and revegetating closed trails and pathways to reduce the extent of habitat fragmentation, and providing facilities to accommodate trail use, such as parking areas, informational and interpretive kiosks, restrooms, and a visitor contact station on the Refuge.

To fully implement a sustainable trail system with appropriate access points and signage would require staff time above and beyond the Refuge's current staffing level and/or willing volunteers to assist Refuge staff in this work. The staff positions and estimated time allocations for managing and maintaining a designated trail system are presented in Table 1. The funding needs for construction and rehabilitation associated with this use are presented in Table 2 (additional project details are provided in the Final San Diego NWR CCP). New facilities would be designed and constructed as funding for these projects is identified. Potential funding sources include Federal cost share grants, interagency partnerships, State and private grants, and contributions from Friends groups.

Anticipated Impacts of the Use:

Impacts to Refuge resources from trail use can range from soil impacts to loss of listed or sensitive species. Foot traffic, bicycle tires, and horse hooves can all cause physical impacts on soil surfaces, particularly when the trail surface is damp or wet or the trail grade is steep (Cessford 1995). It is anticipated that trail use within the Refuge will cause minor soil erosion along some trails until the designated trail system becomes established. As discussed in detail in Chapter 5 of the Draft CCP/EA (USFWS 2014), existing erosion and siltation issues can be addressed through the realignment and/or closure of trails and pathways that follow the fall line of the slope and in some cases, through trail tread improvements such as the addition of grade reversals to minimize the amount of water on the trail. At a minimum, existing trails that are experiencing excessive erosion will be realigned and/or closed to minimize adverse effects to the environment.

Trail use can also result in unauthorized off trail activity, which can result in damage or loss of vegetation, trampling of invertebrates and reptiles, and/or disturbance or damage to nesting and breeding wildlife. Efforts involving public outreach, education programs, signage, and fencing would be implemented as appropriate on the Refuge to encourage trail users to stay on designated trails. Although many users will comply, some will not. We anticipate that noncompliance will be limited. In addition, large blocks of undisturbed habitat, closed to public use, will be available as sanctuary for native wildlife and plants.

Table 1
Annual Staff Involvement Associated with Managing the Designated Trail System on the San Diego NWR

Position	Involvement	FTE*	Cost
Project Leader/ Deputy Project Leader	General oversight.	0.05/0.05	$15,185
Refuge Manager	Oversight and management of the trail plan; process permits; conduct NEPA compliance; oversee future trail realignments, trail closures, and associated construction projects; general oversight of trail use.	0.30	$38,004
Refuge Operations Specialist	Manage future trail realignments, trail closures, and associated construction projects; general oversight of trail use, including monitoring and outreach; informational signs and kiosks maintenance.	0.20	$16,513
Wildlife Biologist	Monitor effects of trail uses on Refuge resources; assess the effects of trail closures and realignments on habitat and species.	0.20	$19,310
Park Ranger (New position)	Maintain trails, signs, and other trail facilities; monitor dog activity on the trail to assess compliance with leash and cleanup requirements.	0.30	$24,770
Federal Wildlife Officer	Law enforcement.	0.30	$21,607
Maintenance Worker (New position)	Maintain trails, trail closures, signs, and other trail related facilities.	0.30	$14,797
Total FTES/Annual Costs for Staffing		**1.70**	**$150,186**

*FTE (full time equivalent)

Table 2
Construction and Facilities Costs Associated with
Managing the Designated Trail System on the San Diego NWR

Material/Facility Required	Explanation of Need	Cost
Implement the trail plan for the Otay-Sweetwater Unit	To minimize impacts to Refuge trust species, sensitive habitats, and water quality, implement the recommendations for trails included in the Final CCP (USFWS 2017), including new construction, trail rehabilitation, trail closures, and realignments of unsustainable trail segments, as well as re-contouring of eroded areas, improving overall trail sustainability, and addressing visitor safety.	$1,500,000
Construct Visitor Parking Area, Trailhead, Information Kiosk, Temporary Contact Station	Currently, no facilities are available on the Refuge where visitors can interact with Refuge staff and have an opportunity to ask questions and receive information about Refuge resources, regulations, safety, or other topics. There is no formal parking/ trail staging area available within the Sweetwater River and San Miguel Mountain areas, which represent the largest contiguous area of land (approximately 6,700 acres) within the Refuge.	$2,000,000
Interpretive/Informational Kiosks (5) at Major Trailheads on the Refuge	Information in the kiosks will inform visitors that they are entering a national wildlife refuge and explain the purpose of the Refuge, its resources, and why those resources needed to be protected.	$120,000
Install Two Trail Bridges	Design, construct, and install two trail bridges, including one near the confluence of Sweetwater River and Steele Canyon Creek and another over the drainage to the east of the Sweetwater River Trail Bridge, to reduce impacts to riparian habitat and ephemeral streams.	$230,000
Provide a Parking Area for the south Las Montañas Area	Design/construct a parking area, restroom, and required street improvements from Highway 94 for the south Las Montañas area to accommodate trail and wildlife-dependent recreational uses at this location. Access from Highway 94 will require a traffic study and Caltrans encroachment permit, improvements to Highway 94 for	$1,500,000

Material/Facility Required	Explanation of Need	Cost
	ingress/egress, and a short vehicular bridge to cross Steele Canyon Creek.	
Improve Accessibility on the Sweetwater River Trail Bridge	Design, construct, and install two new access ramps for the Sweetwater River Trail Bridge to accessibility and better accommodate equestrians.	$100,000
Total Cost for Facilities		**$5,450,000**

Note: Some of these same facilities are also listed in Compatibility Determinations for other uses proposed on the Refuge. For those facilities, the cost would only be incurred once, satisfying the needs of all such uses.

Trail use, including dog walking, can also result in wildlife disturbance. The effects of disturbance vary with the wildlife species involved and the type, level, frequency, duration, and time of year that the disturbance occurs. A number of studies have been conducted to evaluate the effects of trail use on wildlife, with some of these studies summarized in a literature review prepared for the Stillwater NWR (DeLong and Schmidt 2000). In summarizing the findings of these studies, DeLong and Schmidt state, that wildlife observation can "negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat." Huffman (1999), in observing waterbird disturbance in South San Diego Bay, documented disturbance to migratory birds as a result of pedestrian activity along the shoreline. This disturbance was greatest when pedestrians left designated access ways to explore the mudflats.

Trulio and Sokale (2008), while conducting studies along the San Francisco Bay Trail, found that the number of birds decreased at trail sites as trail use increased on higher use over lower use days. Their results also seemed to support the proposal that disturbance to birds may be less when trail users are not directly approaching foraging areas, such as when they are traveling along a trail that is parallel to foraging areas rather than extending through foraging areas.

Fernández-Juricic et al. (2009) found that overall tolerance of the State listed endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) to human disturbance varies depending upon the level of disturbance occurring in a given area, as well as between seasons. In areas where there is little, if any, public use activities, alert and flight responses to human approaches were observed to be greater than those observed in higher use areas. A trend for greater alert distance and flight distance was also observed in the non-breeding season (Fernández-Juricic et al. 2009). Fernández-Juricic et al. (2005) found that in grassland systems, bird species differed in their alert and flight response when approached by humans depending on whether approached directly or from an angle.

Whittaker and Knight (1998) noted that wildlife response could include attraction, habituation, and avoidance. Human induced avoidance by wildlife can prevent animals from using otherwise suitable habitat. According to Knight and Cole (1991), behavioral changes associated with disturbance from recreational use include short term shifts in habitat use and complete abandonment of disturbed areas in favor of undisturbed sites.

Flight in response to other disturbance can lower songbird nesting productivity, cause disease, and in extreme cases (predation) can result in death. Knight and Cole (1991) suggest that recreational activities occurring simultaneously may have a combined negative impact on wildlife. Hammitt and Cole (1998) conclude that the frequent presence of humans in wildland areas can dramatically change the normal behavior of wildlife, mostly from unintentional harassment. Other studies of recreation effects on wildlife have found that smaller mammals flush from humans who are at a further distance away than do larger mammals (Taylor and Knight 2003) and that mammals exhibit both spatial and temporal displacement from recreational trails (George and Crooks 2006).

Seasonal sensitivities are also important in wildlife responses to human disturbance. For an animal species that is already stressed, human disturbance can compound the already stressful situation. Examples of such disturbance include regularly flushing birds during nesting, exposing juvenile animals to greater predation levels, or causing mammals to flee during winter months. Hammitt and Cole (1998) note that females (such as deer) with young are more likely to flee from a disturbance than those without young.

Anticipated impacts of bicycle use on wildlife would be similar to the impacts of foot travel and include temporal disturbances to species using habitat directly adjacent to the designated routes. Although there is some temporary disturbance to wildlife due to human activities, the disturbance is generally localized and does not have an adverse effect on overall populations. Wildlife disturbance from horseback riding is not well documented, but some studies suggest that many wildlife species are habituated to livestock and that equestrians can approach wildlife at closer distances than by other forms of travel. Burger (1986) found that people on horseback did not seem to threaten birds even though they frequently moved rapidly. Birds flushed only to avoid trampling. Burger (1986) surmised that the birds perceived only the horse and not the person riding the horse.

The presence of dogs, even on-leash, can have a negative effect on wildlife since they may be perceived as predators by wildlife that are prey for canids and scent-mark along the trail (George and Crooks 2006; Lenth et al. 2008). Off leash, while they may not be effective hunters, dogs may chase prey animals or alarm wildlife while moving through vegetation. Dogs, when leashed, are permitted on the Refuge, but may only use those trails designated for multiple use. Nearly a third of trail users in the interpretive loop trail area are accompanied by dogs. Some of this user group has expressed to Refuge staff that they might not otherwise come to the Refuge but for their dog. The level of disturbance from dogs diminishes with distance (Sime 1999); therefore,

large areas of the Refuge where no trail use is permitted would not be affected by the presence of dogs elsewhere on the Refuge.

The alternative of closing off access to dog-walkers would likely reduce the neighboring communities' support for the Refuge's overall conservation program, including land acquisition, species monitoring, habitat restoration and management. Therefore, members of the public will be conditionally allowed to walk leashed dogs on multiple use trails, provided the leash is six feet or shorter in length and all dog waste is properly collected and disposed of in designated trash receptacles. Refuge staff will continue outreach and education efforts to minimize the negative effects of dogs on wildlife and habitat quality. If the presence of dogs on the Refuge is determined in the future to have unanticipated deleterious effects on wildlife, habitat, or water quality, dogs may be prohibited on some or all areas of the Refuge without prior notice.

Education and public outreach can help make visitors aware that their actions can have negative impacts on birds and other wildlife, and will increase the likelihood that visitors will abide by restrictions on their actions. For example, Klein (1993) demonstrated that visitors who had spoken with refuge staff or volunteers were less likely to disturb birds. Increased surveillance may also help reduce visitor caused disturbance (Knight and Gutzwiller 1995). Refuge staff has developed a brochure for dog walkers that provides information on why dogs must be leashed and where off-leash dog parks are located. Monitoring is recommended to adjust management techniques over time, particularly because it is often difficult to generalize about the impacts of specific types of recreation in different environments. Local and site-specific knowledge is necessary to determine effects on wildlife, and to develop effective management strategies (Hockin et al. 1992; Klein et al. 1995; Hill et al. 1997).

Endangered and Threatened Species and Sensitive Species

As noted above, human activity can have adverse impacts to wildlife species, particularly when reproductive or foraging activities are disrupted. Of particular concern are potential disturbances to the endangered least Bell's vireo (*Vireo belli pusillus*), Quino checkerspot butterfly (*Euphydryas editha quino*) and San Diego fairy shrimp (*Branchinecta sandiegonensis*), the threatened coastal California gnatcatcher (*Polioptila californica californica*), and candidate Hermes copper butterfly (*Hermelycaena [Lycaena] hermes*). Appropriate trail placement and maintenance that accommodate authorized trail use will avoid and minimize disturbance to these species. Permanent trail closures of redundant or unsustainable user-created trails, seasonal trail closures in particularly sensitive areas (e.g., breeding sites), posting regulatory and interpretive signage to keep unauthorized users out of sensitive areas, and Refuge staff, including Federal Wildlife Officers, educating the public on appropriate trail use will also aid in avoiding and reducing impacts.

Other federally-listed species susceptible to harm as a result of off-trail activity are plants including the endangered San Diego ambrosia (*Ambrosia pumila*) and San Diego thorn-mint (*Acanthomintha ilicifolia*); threatened Otay tarplant (*Deinandra conjugens*); and vernal pool

plants including endangered San Diego button celery (*Eryngium aristulatum* var. *parishii*), California Orcutt grass (*Orcuttia californica*), Otay Mesa mint (*Pogogyne nudiscula*) and threatened spreading navarretia (*Navarretia fossalis*). The measures described above will also minimize the potential for impacts to these species as a result of authorized public uses. Fencing has been installed at several locations of these species (e.g., at the 30-acre vernal pool restoration southeast of Sweetwater Reservoir and at San Diego ambrosia populations) to direct Refuge users away and further minimize disturbance to these species. Additional signage and fencing could be installed in problem areas.

Sensitive species present on the Refuge include those covered by the Multiple Species Conservation Program (MSCP) such as burrowing owl (*Athene cunicularia*), San Diego horned lizard (*Phrynosoma coronatum*), Palmer's goldenbush (*Ericameria palmeri*), and San Diego barrel cactus (*Ferocactus viridescens*). As with listed species, impacts to sensitive species can be avoided and minimized by appropriate trail placement and maintenance, permanent and/or seasonal trail closures, and outreach and education to trail users about the Refuge's biological resources.

Listed birds and butterflies may be disturbed by the regular passage of the public along the trails, which may decrease the functional area of suitable habitat for foraging and breeding. However, trail use along proposed trails has been an ongoing regular activity for more than two decades and was occurring prior to establishment of the Refuge; therefore, the effect of human use may already have been manifested. By closing redundant or unauthorized trails, there is the potential to reduce the effects of that type of disturbance. Death of listed bird species is not anticipated from use of approved trails. Listed or candidate butterflies may have a small potential for death or injury since adults may be nectaring on or eggs/larvae may be present in habitat/plants immediately adjacent to trails. If a trail user steps off trail to allow another to pass (as is common for hikers and cyclists to do when passing equestrians), injury or death to these butterfly species may occur. Specific trail alignments developed during trail planning will take into consideration sensitive habitats that support these and other potentially vulnerable species and will align trails in a manner that avoids the potential for such deleterious effects.

Sensitive species, such as San Diego horned lizard and orange-throated whiptail lizard (*Aspidoscelis hyperythra beldingi*), as well as snakes, small mammals, and insects are more likely to be killed or injured from trail use since they may be encountered on the ground. Because a bicycle's tire is in constant contact along the trail, as opposed to discrete steps of either a horse or human foot, bikes may pose a greater death or injury risk to animals that are ground dwellers. Bicyclists, given their mode of transportation, are likely travel longer distances and thus have more chance of encounters with trail-surface wildlife. We do not have robust data on these species' populations, and animals are rarely found dead on the trail since are quickly removed by scavengers. Therefore, it would be difficult to detect if trail-related uses are negatively affecting populations. Educating trail users about the presence of such species will raise awareness and potentially lead to avoidance or minimizing impacts to these species.

Public Review and Comment:

Opportunities for trail use on the San Diego NWR were discussed at the scoping meetings held on June 14 and 15, 2006 to initiate the CCP process. A Notice of Intent was published in the Federal Register on May 24, 2006 (71 FR 29973). At that time, written comments were solicited. At the scoping meetings, the public was encouraged to provide verbal comments or to send us written comments following the meetings. A CCP web page was established to provide the public with specific information regarding the CCP process and the comments provided during public scoping. Planning Updates have also been prepared to summarize the progress of the CCP and to discuss specific issues related to the planning process.

This draft Compatibility Determination was made available for public review and comment as Appendix A of the San Diego National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2014). Comments were received regarding the desire for trails on the Refuge, as well as regarding the potential adverse effects of trail use on Refuge resources. The comments are addressed in the Response to Comments provided in Appendix F-2 of the Final CCP (USFWS 2017).

Determination:

☐ Use is Not Compatible

☐ Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- All trail uses are restricted to the Refuge's designated trail system, with non-motorized trail use, specifically pedestrian use, bicycling, horseback riding, and leashed dog-walking, permitted on the Refuge on those trails designated and posted for multiple use.
- Only pedestrian use is permitted on Refuge trails designated and posted for hiking only.
- All public access, including trail use, on the Refuge will be restricted to daylight hours (i.e., sunrise to sunset).
- Areas of the Refuge may be restricted seasonally or permanently to reduce impacts during breeding or nesting season, or to protect habitat or sensitive species.
- Organized group events or trail use for special events (e.g., non-Refuge hikes, runs, rides), will require a public use permit.
- Regulatory and directional signs will clearly mark designated routes of travel and areas closed to the public.
- Trail maps and public use information will be made available at Refuge offices, kiosks, and the Refuge's website: http://www.fws.gov/sandiegorefuges/Otay.htm.

- Regulations and wildlife-friendly behavior (e.g., requirements to stay on designated trails, dogs must be kept on leash, clean up after dog) will be posted on kiosks and at the visitor contact station and will be described in brochures.
- Adequate blocks of undisturbed habitat have been set aside within the Refuge to provide sanctuary for wildlife and protection of listed and sensitive plants from disturbance and trampling.
- Interpretive signage, displays, kiosks, and brochures will be maintained and updated as necessary to ensure that the public is receiving the message about the need to protect Refuge resources.
- Regular monitoring of trail use, including dog-walking, on the Refuge will be conducted by Refuge staff, and monitoring results will be analyzed and used by the Refuge Manager to develop future modifications, if necessary, to ensure compatibility.
- Periodic law enforcement patrols will be conducted.

Justification:

The Refuge's location within and adjacent to urban/suburban development makes it attractive to the recreating public. While we acknowledge deleterious effects to wildlife from the presence of humans, as noted by the references cited previously, restricting access to the Refuge would minimize our ability to generate support for the Refuge's overall conservation program, including land acquisition, species monitoring, and habitat restoration and management. By allowing the public onto the Refuge, and making education and interpretation of the Refuge's biological diversity an important component of everyday Refuge work, we can reduce the deleterious effects and garner support from the public for ongoing and future conservation actions.

While not listed as a priority, wildlife-dependent recreational use under the National Wildlife Refuge Improvement Act, as amended, non-motorized trail use does provide opportunities for the public to observe wildlife and native habitats, engage in nature photography, and participate in interpretive and environmental education programs on the San Diego NWR. By providing for these opportunities, we can enhance the public's appreciation for the biological, cultural, and physical resources present within this Refuge. Public uses will support the Service's initiative for connecting people, particularly children, with nature, and lays a foundation for *Conserving the Future's* urban Refuge initiatives. Through these activities, the Refuge has the opportunity to introduce the public to the importance of protecting sensitive habitats, not only because these habitats support federally listed species, but also because of the role these habitat play in supporting migratory birds, and rare and local wildlife. All of these outcomes are consistent with the Refuge purposes of protecting listed species. Bicycling, horseback riding, and dog walking on designated trails are considered low impact uses. Many parts of the refuge are unavailable for day use without bike or horse access since distances are too great to allow access by foot. Allowing leashed dogs will permit the dog-walking community to also gain appreciation of the

conservation actions of the Refuge. Information kiosks have been or will be installed at access points to inform visitors about Refuge habitats, wildlife, regulations, visiting opportunities, and techniques to minimize adverse impacts, including areas closed to access.

The trail system described in the Final CCP includes achieving to the maximum extent feasible, sustainably constructed trails. Trail alignments will avoid sensitive habitats and areas that support listed and sensitive species. The Final San Diego NWR CCP defines specific trail alignments, along with some alignments to be determined following additional site analysis. Those existing trails or trail segments that represent the greatest potential for impact to Refuge resource will be identified, and short term measures (e.g., full or seasonal trail closures, drainage corrections, minor realignments) will be developed that can be implemented using a combination of existing staff, available funding, and volunteer assistance. Unsustainable trail segments will be closed and, in many cases, replaced by a sustainable trail alignment.

The analysis of potential effects to the environment provided in the environmental assessment prepared to accompany the CCP (USFWS 2014) demonstrates that trail use would not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission, provided the stipulations to ensure compatibility are followed. Further, trail use facilitates other uses such as wildlife observation, photography, interpretation, and environmental education, therefore, contributing to the fulfillment of the Refuge System mission and the achievement of the goals established for the Refuge, particularly the goal to enhance public appreciation, understanding, and enjoyment of the Refuge's biological and cultural resources through outreach opportunities and quality wildlife-dependent recreation.

Mandatory Reevaluation Date:

Mandatory 15-year Re-Evaluation Date (for priority public uses)

Mandatory 10-year Re-Evaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

- ☐ Categorical Exclusion without Environmental Action Statement
- ☐ Categorical Exclusion and Environmental Action Statement
- ☐ Environmental Assessment and Finding of No Significant Impact
- ☐ Environmental Impact Statement and Record of Decision

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Refuge Determination:

Prepared by: _____ (Signature) 12/16/16 (Date)

Project Leader Approval: _____ (Signature) 12/16/16 (Date)

Concurrence:

Refuge Supervisor: _____ (Signature) 3/24/2017 (Date)

Assistant Regional Director, Refuges: _____ (Signature) 3.28.17 (Date)

FINDING OF APPROPRIATENESS OF A REFUGE USE

Written Justification

Refuge Name: San Diego National Wildlife Refuge

Use: Non-Motorized Recreational Trails

Justification for Determining that this Use is an Appropriate Use for the Refuge:

Although trail use is not identified as a wildlife-dependent recreational use, trails do provide opportunities for the public to participate in a number of wildlife-dependent recreational uses including wildlife observation, photography, interpretation, and environmental education. The Refuge's location within and adjacent to urban/suburban development makes it attractive to the members of the public interested in recreation. While we acknowledge some deleterious effects to wildlife from the presence of humans, closing all access to the Refuge would reduce public support for the Refuge's overall conservation program, including land acquisition, species monitoring, and habitat restoration and management. Establishing a designated trail system through a portion of the Refuge, while maintaining other large blocks of Refuge land as closed to public access, will provide the public with opportunities to experience the range of habitats and species conserved within the Refuge in a manner that does not compromise overall habitat quality or species recovery. In my professional judgment permitting non-motorized recreational trail use, including pedestrian, equestrian, and mountain bike use and leashed dog walking, is an appropriate use on the San Diego NWR.

Refuge Manager: _____ Date: 12/16/2016

Refuge Supervisor: _____ Date: 3/24/2017

Compatibility Determination
(December 2016)

Use: Scientific Research

Refuge Name: San Diego National Wildlife Refuge (San Diego County, California)

Establishing and Acquisition Authorities:
The San Diego NWR was established in 1996 under the authorities of the Fish and Wildlife Act of 1956, as amended (16 U.S. C. 742(a)-754), Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), and Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) (USFWS 1995). Establishment occurred on April 10, 1996, when approximately 1,826 acres of land (referred to at the time as Rancho San Diego) were conveyed to the Service for management as a national wildlife refuge.

Refuge Purposes:
The purposes for the initial acquisition for the San Diego NWR included:

> ". . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species . . . or (B) plants. . ." 16 U.S.C. § 1534 (Endangered Species Act of 1973);
>
> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . ." 16 U.S.C. § 742f(a)(4) ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . ." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956); and
>
> ". . . (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species . . ." 16 U.S.C. § 460k-460k-4 (Refuge Recreation Act of 1962).

Subsequent acquisitions have been made to meet these and other refuge purposes outlined in the Land Protection Plan (LPP) for the Otay-Sweetwater Unit of the San Diego NWR, approved in April 1997. In accordance with the LPP, "The purpose of the San Diego National Wildlife Refuge is to protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals" (USFWS 1997).

National Wildlife Refuge System Mission:
The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and; where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended).

Description of Use:
This Compatibility Determination addresses the continuation of scientific research on the Refuge. Scientific research has played an important role in the development of management actions on the San Diego NWR, particularly with respect to monitoring strategies, understanding the phenology and life cycle processes of listed and sensitive species, control of invasive species, species interactions, and the effects of fire on plants and wildlife.

The Refuge Manager receives periodic requests to conduct scientific research on the Refuge. Research is not identified as a wildlife-dependent recreational use by the National Wildlife Refuge System Improvement Act; however, scientific research can benefit Refuge resources through facilitation of informed management decisions. The knowledge gained through scientific research also contributes to environmental educational and interpretation. In so doing, scientific research conducted on the Refuge would support Refuge purposes and the mission of the National Wildlife Refuge System. Based on the Refuge purposes, priority would be given to scientific research that contributes to the enhancement, protection, and management of listed and sensitive species and their habitats. However, research that addresses migratory birds, fire management, invasive species, and other wildlife and habitat management issues, along with research directed at understanding the effects of recreational activities on Refuge resources, would all benefit the Refuge and support Refuge purposes.

Research applicants would be required to submit a proposal summarizing:

1) objectives of the study;
2) justification for the study;
3) detailed study methodology and schedule;
4) potential impacts to Refuge wildlife and/or habitats, including short- and long-term disturbance, injury, and mortality;
5) research personnel required and their qualifications and experience;
6) status of necessary permits (i.e., scientific collecting permits, endangered species permit);

7) costs to Refuge and Refuge staff time requested, if any; and
8) anticipated end products (i.e., reports, publications).

Research proposals would be reviewed by Refuge staff or others, as appropriate. The criteria listed here, and others as necessary, would be used to assess research proposals.

1) Research that would contribute to the enhancement, protection, and management of listed species and their habitats and research that could provide insight into current or future Refuge management would have higher priority than other requests.
2) Research that would conflict with other ongoing research, monitoring, or management programs would not be approved.
3) Research projects that can be carried out elsewhere (off-Refuge) would be less likely to be approved.
4) Research that causes undue disturbance or is intrusive would likely not be approved. The degree and type of disturbance would be carefully weighed when evaluating a research request. Many nesting birds, including the federally listed least Bell's vireo (*Vireo bellii pusillus*) and the federally listed threatened coastal California gnatcatcher (*Polioptila californica californica*), are sensitive to human disturbance (DeLong and Schmidt 2000, Kus 2002, Varanus Biological Services, Inc. and Campbell BioConsulting, Inc. 2003), and disturbance around nesting and foraging sites could have an adverse effect on reproductive success. Listed and sensitive plants are could be subject to trampling.
5) Evaluation of research requests would determine whether any effort has been made to minimize disturbance through study design (for example, by considering adjustments in the location, timing, or scope of the study; the number of participants, study methods; the number of study sites, etc.).
6) If it would be impossible for the Refuge to monitor researcher activities because of staffing or logistical constraints, requests for research may be denied, depending on the circumstances.
7) The duration of the project would be considered and agreed upon before approval.

Open-ended research projects would not be approved. All projects would be reviewed annually to assess whether they continue to meet these criteria (and others as necessary), continue to operate as originally proposed, and contribute to the objectives of the study.

Approved research projects would be conducted under a Refuge-issued Special Use Permit (SUP) with case-specific stipulations.

Availability of Resources:
Adequate funding and staff exist to manage some level of scientific research at the San Diego NWR. As always, discretionary use of staff time would be weighed through a cost-benefit analysis. Direct costs to administer research activities are primarily in the form of staff time. Table 1 describes the level of involvement by Refuge staff that will be required annually to manage and monitor research activities on the Refuge, as well as the associated funding and annual costs (based on FY 2011 costs).

Table 1
Annual Staff Involvement
Associated with Managing Scientific Research Conducted on the San Diego NWR

Position	Involvement	FTE	Cost
Refuge Manager	Periodic on-site oversight	0.04	$5,067
Wildlife Biologist	Review and oversight of research proposals; preparation of SUP; monitoring to ensure compatibility; report review; coordination of researcher access	0.20	$19,311
Total FTEs and Costs for Staffing		0.24	$24,378

*FTE (full time equivalent)

Anticipated Impacts of the Use:
Through the Special Use Permit process, project-specific conditions can be placed on individual research proposals to ensure that the potential for impacts to Refuge resources are minimized. Some level of disturbance is expected with all research activities since most researchers will be entering areas that are normally closed to the public and may be collecting samples or handling wildlife. Impacts related to the implementation of scientific research on the Refuge are discussed in greater detail in Chapter 5 of the Environmental Assessment for the San Diego National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2017).

Endangered and Threatened Species: Human activity can have adverse impacts on endangered and threatened species, particularly when it disrupts bird nesting or foraging activities for species such as least Bell's vireo (Kus 2002) and coastal California gnatcatcher, or when it results in trampling of listed plants, Quino checkerspot butterfly host plants, or butterfly larvae. The Refuge supports critical habitat for a number of listed species, as described in the CCP, and human disturbance associated with scientific research has the potential to directly affect habitat quality and individual plants or animals, as well as indirectly affect species and habitat due to physical disturbance to the site.

To minimize disturbance to wildlife and habitat resources, proposals for research activities would be evaluated and appropriate restrictions would be imposed to ensure that no significant adverse effects to such resources would occur. For example, restrictions would be imposed in spring in areas that support listed or sensitive butterfly larvae or nesting listed bird species, in October through July in the vicinity of eagle nests, or in winter in hibernating bat habitat. Such restrictions would be imposed whether research projects are or are not directly related to such species. All research would be evaluated to ensure that no adverse effects to listed species or their habitat would occur as a result of the study design and/or implementation, or to ensure that if adverse effects occur, they are minimal and are outweighed by the benefit to the management of the species.

Researchers working directly with federally listed species would be required to comply with section 10(a)(1)(A) of the Endangered Species Act and possess the appropriate permit.

Public Review and Comment:

The proposal to continue to accommodate compatible scientific research on the Refuge was discussed at the scoping meetings held on June 14 and 15, 2006, to initiate the CCP process. A Notice of Intent was published in the *Federal Register* on May 24, 2006 (71 FR 29973). At that time, written comments were solicited. At the scoping meetings, the public was encouraged to provide verbal comments or to send us written comments following the meetings. A CCP web page was established to provide the public with specific information regarding the CCP process and the comments provided during public scoping. Planning Updates have also been prepared to summarize the progress of the CCP and to discuss specific issues related to the planning process.

The draft Compatibility Determination was made available for public review and comment as Appendix A of the San Diego National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment (USFWS 2014). No comments related to research were received.

Determination:

☐ Use is Not Compatible

☐ Use is Compatible with the Following

Stipulation necessary to Ensure Compatibility:

Concerns about protecting listed species and the overall integrity of the habitats present on the Refuge require that Refuge staff closely review proposed research projects and that research activities and impacts be monitored. To minimize the potential for adverse effects to Refuge resources related to scientific research, the following measurers would be implemented:

- All research requests must include a detailed description of the study proposal (at a minimum, the description should address the purpose of the research, the potential benefits to Refuge management and/or Refuge resources, the number of participants, the times of the year in which field studies and/or data collection would occur, how the studies or data collection will be implemented, the areas on the Refuge that would be accessed, any potential adverse effects on Refuge resources that could occur and the measures that would be implemented to minimize such impacts, and when study results would be made available to the Refuge Manager);
- Highly intrusive or manipulative research will generally not be permitted;
- Proposed research methods that have the potential to adversely affect Refuge resources will generally not be permitted (however, if it can adequately demonstrated that the research will provide significant benefits in terms of achieving Refuge purposes despite the potential for some adverse effects, the Refuge Manager has the discretion to permit such research provided the researcher can identify potential impacts in advance of their occurrence, implement measures to minimize potential impacts, and agrees to all conditions presented in the Special Use Permit);
- Approval of research projects on the Refuge will be permitted at the discretion of the Refuge Manager, who will consider the compatibility of the proposed research with Refuge purposes, the proximity of research activities to sensitive habitat and known nesting areas, the potential for impacts to Refuge resources, and the availability of Refuge staff to manage and monitor the research activities;

- All research projects will be conducted under a Special Use Permit, which will have additional project-specific stipulations;
- Special Use Permits will be valid for a time period specified in the permit and reviewed annually to assess whether they continue to meet permit criteria (renewals will be subject to review and approval by the Refuge Manager, who will consider the current status of the study, the researcher's compliance with the conditions outlined in the Special Use Permit, and the extent of anticipated or unanticipated impacts, if any, that occurred as a result of the specific research project);
- Refuge staff may accompany researchers at any time to assess study methods and the potential for impacts to Refuge resources;
- The Refuge Manager can suspend or modify conditions or terminate on-refuge research that is already permitted and in progress, should unacceptable impacts or issues arise or be noted;
- Researchers will be responsible for acquiring and/or renewing any necessary State and Federal permits prior to beginning or continuing their project;
- Research must adhere to current species protocols for data collection; and
- If the phenology of the phenomenon being studied allows, research will generally be conducted outside of the breeding season of the bird species using the Refuge.

Justification:
To be permitted on the Refuge, scientific research projects would be required to contribute to the enhancement, protection, use, preservation, and/or management of Refuge resources. The anticipated level of research to be conducted on the Refuge at any given time would be compatible because the Refuge would ensure that research proposals support the purpose of the Refuge and mission of the System. In view of the impacts research activities may have on the Service's ability to achieve the Refuge purpose, sufficient restrictions will be placed on the researcher to ensure that disturbance is kept to a minimum. This program as described is determined to be compatible.

Mandatory Reevaluation Date (provide month and year):

_____ Mandatory 15-year Reevaluation Date (for priority public uses)

Mandatory 10-year Reevaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

☐ Categorical Exclusion without Environmental Action Statement

☐ Categorical Exclusion and Environmental Action Statement

☐ Environmental Assessment and Finding of No Significant Impact

☐ Environmental Impact Statement and Record of Decision

References Cited:

DeLong, Anita and Janet Schmidt. 2000. Literature Review: Effects of Human Disturbance on Wildlife with Emphasis on Wildlife-Dependent Recreation Relevant to Stillwater National Wildlife Refuge (Draft).

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Refuge Determination:

Prepared by: _____ (Signature) 12/13/2016 (Date)

Project Leader Approval: _____ (Signature) 12/15/16 (Date)

Concurrence:

Refuge Supervisor: _____ (Signature) 3/23/17 (Date)

Assistant Regional Director, Refuges: _____ (Signature) 3/28/17 (Date)

FINDING OF APPROPRIATENESS OF A REFUGE USE

Written Justification

Refuge Name: San Diego National Wildlife Refuge

Use: Scientific Research

Justification for Determining that this Use is an Appropriate Use for the Refuge:

Although scientific research is not identified as a wildlife-dependent recreational use, the information provided as a result of selectively permitting such use on the Refuge can benefit Refuge resources and facilitate informed management decisions. Based on the Refuge proposes, priority would be given to scientific research that contributes to the enhancement, protection, and management of listed and MSCP-covered species and their habitats. All research applications would be reviewed to ensure that the research objectives and justification, study methodology, schedule, and anticipated end products would provide useful information to assist with resource management on the Refuge. Additionally, all proposals would be reviewed to ensure that implementation of the research proposal would not result in significant disturbance or other impacts to Refuge resources. Because sufficient restrictions can be placed on the researcher to ensure that disturbance and other potential impacts are kept to a minimum, in my professional judgment scientific research is an appropriate use on the Refuge.

Refuge Manager: _____ Date: 12/16/2016

Refuge Supervisor: _____ Date: 3/24/2017

Integrated Pest Management Plan
for the
San Diego National Wildlife Refuge

Prepared by: Jill Terp Date: December 13, 2016
Jill Terp
Refuge Manager, San Diego NWR

Concurrence: _____ Date: _____
Regional Integrated Pest
Management Coordinator

Concurred: Stacy Armstrong Date: 3/23/17
Refuge Supervisor

Approved: _____ Date: 3.28.17
Assistant Regional Director, Refuges
(Pacific Southwest Region)

Integrated Pest Management Plan
for the
San Diego National Wildlife Refuge

Prepared by: _____ Date: _____
Jill Terp
Refuge Manager, San Diego NWR

Concurrence: Duston Taylor Date: 12/20/2016
Regional Integrated Pest
Management Coordinator

Concurred: _____ Date: _____
Refuge Supervisor

Approved: _____ Date: _____
Assistant Regional Director, Refuges
(Pacific Southwest Region)

Integrated Pest Management Plan

for the

San Diego National Wildlife Refuge

San Diego County, California

U.S. Fish and Wildlife Service

January 2017

Monoculture of non-native black mustard at Otay tarplant restoration area

Non-native bullfrog encountered in a stream at the base of Mother Miguel Mountain

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I. Introduction

This document explains the concept of integrated pest management (IPM) and its application to the San Diego National Wildlife Refuge (Refuge or San Diego NWR). It provides guidance for controlling or managing pests on the Refuge in a manner that will provide the most benefit to Refuge trust species and their habitats. IPM is also addressed in the objectives and strategies developed for the San Diego NWR in the Refuge's Final Comprehensive Conservation Plan (CCP) (USFWS 2017).

In August 2010, the U.S. Fish and Wildlife Service (Service) approved an IPM policy for pest management activities on and off Service lands. This IPM policy (Part 569, FW1 of the Service Manual), which is consistent with the Department of the Interior (Department) IPM policy (517 DM 1) and other applicable authorities, establishes procedures and responsibilities for pest management activities, adopts IPM as the Service's method for making pest management decisions, and provides guidance to employees on how to implement IPM for all pest management activities. Although the IPM policy does not require each refuge to prepare a separate IPM plan, it does encourage a refuge with employees engaging in pest management practices to include a separate pest management plan or incorporate IPM strategies into other resource planning documents, such as a CCP. Further, preparation of an IPM plan benefits refuge operations because it provides the opportunity for the refuge to receive multi-year approvals of certain proposed pesticide uses that would normally require regional or national level review.

IPM is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. Examples of tools listed in the IPM definition include but are not limited to:

- Cultural tools (e.g., crop rotation, alterations in planting dates, and sanitation);
- Physical tools (e.g., barriers, traps, hand-pulling, hoeing, mowing, and tilling);
- Biological tools (e.g., predators, parasites, and pathogens); and
- Chemical tools (e.g., pesticides, such as herbicides, insecticides, or fungicides).

IPM is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the refuge staff, as well as other resource experts, is used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 CFR 46.145, adaptive management is particularly relevant where long-term impacts may be uncertain and future monitoring will be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of refuge resource objectives and the ecology of pest species, one or more methods, or combinations

thereof, will be selected that are feasible, efficacious, and most protective of non-target resources, including native species (e.g., fish, wildlife, and plants), and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding will be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as CCP strategies (Chapter 5.2 of Final San Diego NWR CCP) in an adaptive management context to achieve Refuge objectives. In order to satisfy requirements for IPM planning as identified in the Director's Memo (dated September 9, 2004) entitled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into the Refuge's Final CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to Refuge biological resources and environmental quality in accordance with effects analyses presented in Chapter 5 (Environmental Consequences) of the Environmental Assessment (EA) prepared for the CCP. The pesticide uses that will be allowed for use within the National Wildlife Refuge System (NWRS or Refuge System), including the San Diego NWR, are those that are likely to only cause minor, temporary, or localized effects to Refuge biological resources and environmental quality. Pesticide use on the Refuge will also include the implementation of appropriate best management practices (BMPs) to further minimize or avoid adverse effects.

This appendix does not describe the more detailed process to evaluate potential effects associated with aerial applications of pesticides, as they are not permitted on the Refuge. Moreover, it does not address the effects of pesticide use (i.e., larvicide, pupacide, adulticide applications) to control mosquitoes. However, the basic framework to assess potential effects to Refuge biological resources and environmental quality from the use of insecticides for mosquito management would be similar to the process described in this Appendix for other pesticides.

II. Refuge Overview

The San Diego NWR is located in San Diego County, California. The Refuge includes two distinct areas, the Del Mar Mesa Vernal Pool Unit and the Otay-Sweetwater Unit (Figure 1). The Del Mar Mesa Vernal Pool Unit is located in the northwestern portion of the City of San Diego (Figure 2), while the Otay-Sweetwater Unit is located on the eastern edge of the San Diego metropolitan area (Figure 3). The Otay-Sweetwater Unit encompasses portions of the unincorporated communities of Jamul, Bonita, and Spring Valley, and the cities of Chula Vista and El Cajon. The Refuge was established in 1996 when 1,826 acres were acquired. As of August 2013, the Refuge included approximately 11,530 acres of native scrubland, native and non-native grassland (some supporting vernal pools), cottonwood-willow riparian forest, and oak woodland (Figure 4), and additional lands will likely be added to the Refuge over the next few years.

San Diego NWR is a unit of the National Wildlife Refuge System. The mission of the National Wildlife Refuge System as established by the National Wildlife Refuge System Improvement Act of 1997 is "*to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans*."

San Diego NWR was created to "protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals." The Refuge provides designated critical habitat for two threatened or endangered bird species, one endangered insect, and four threatened or endangered plants. The Refuge also provides habitat for at least 34 species of plants and animals that are designated as "covered" under the MSCP. In addition, the San Diego NWR supports six California Bird Species of Special Concern that are not otherwise protected by the MSCP. A list of threatened, endangered, covered, and special status species and their status is included in Table 1.

The Refuge has also been designated an Important Bird Area for California and is known to support over 180 species of birds. Many native plants that have been lost or reduced elsewhere can be found on the Refuge, making it a valuable source for seeds that have been used in restoration projects throughout southern coastal San Diego County.

San Diego NWR has been inhabited and likely managed by humans for thousands of years. Evidence of the past activities by local Native American Kumeyaay culture includes grinding stones where acorns and other foods were processed. The Kumeyaay used wildfire to rejuvenate plant species and habitats that supported the community's needs (Connolly 2011).

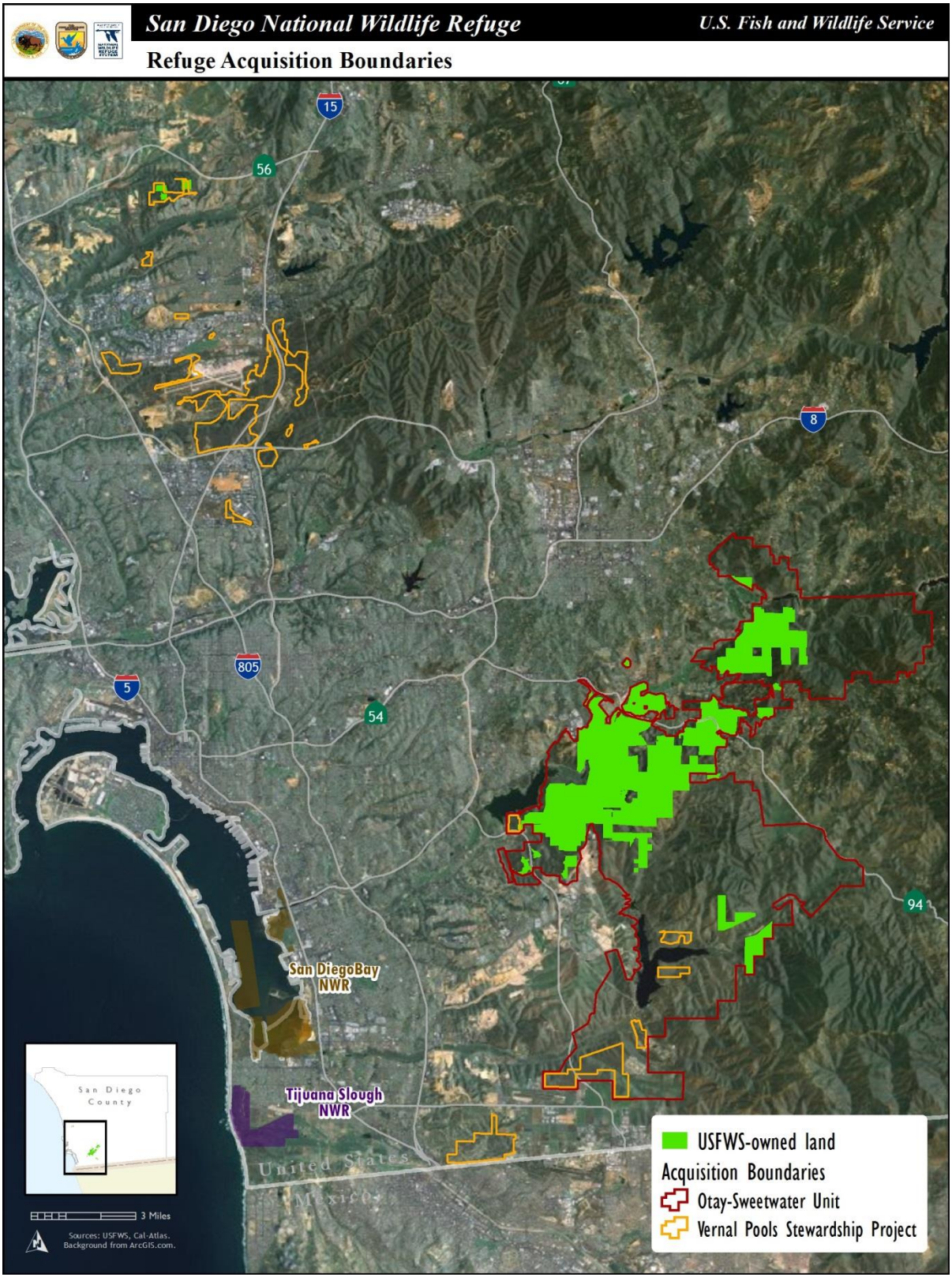

Figure 1. Location Map – San Diego NWR, San Diego County, CA

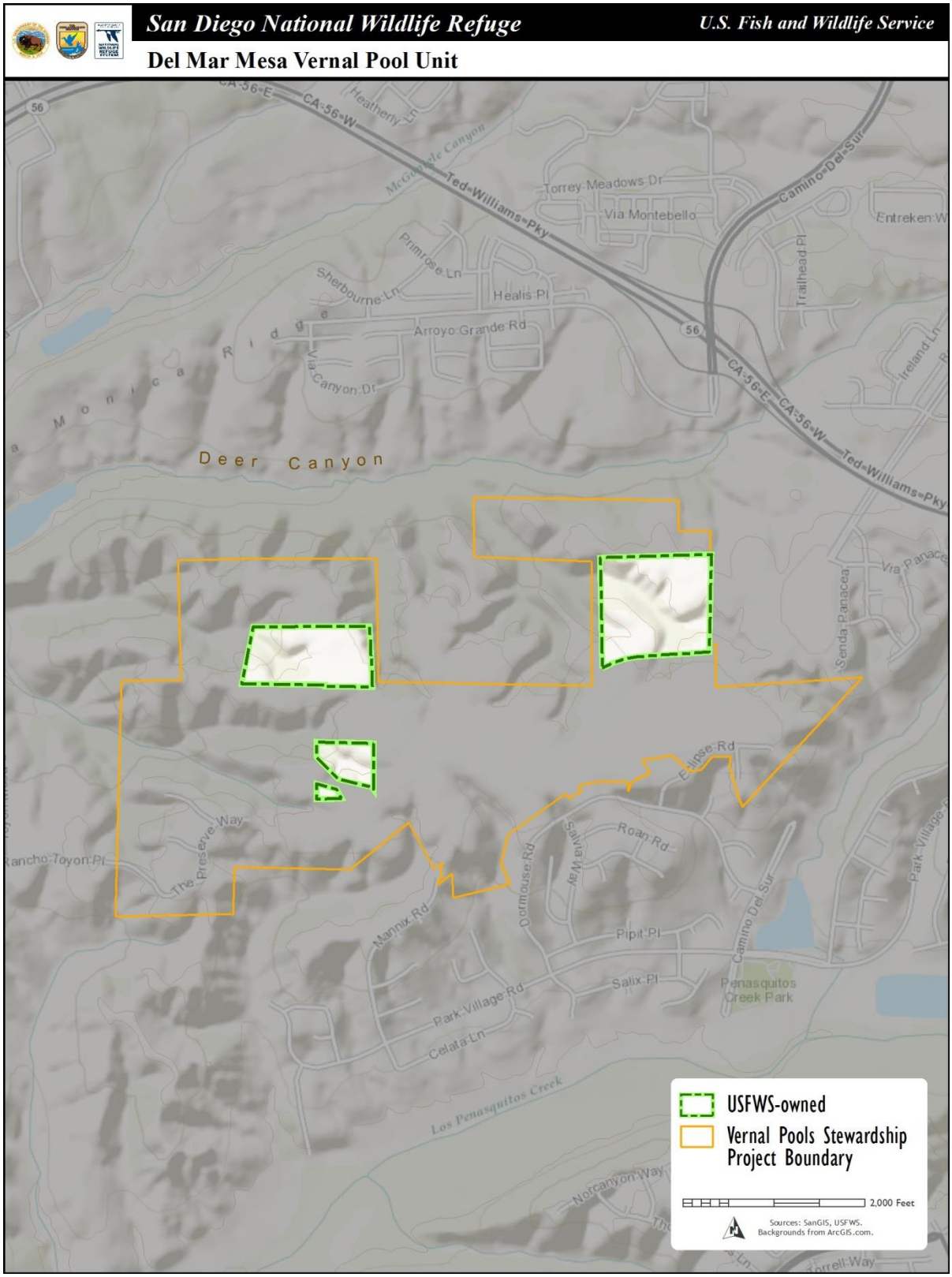

Figure 2. Location Map for the Del Mar Mesa Vernal Pool Unit of the San Diego NWR

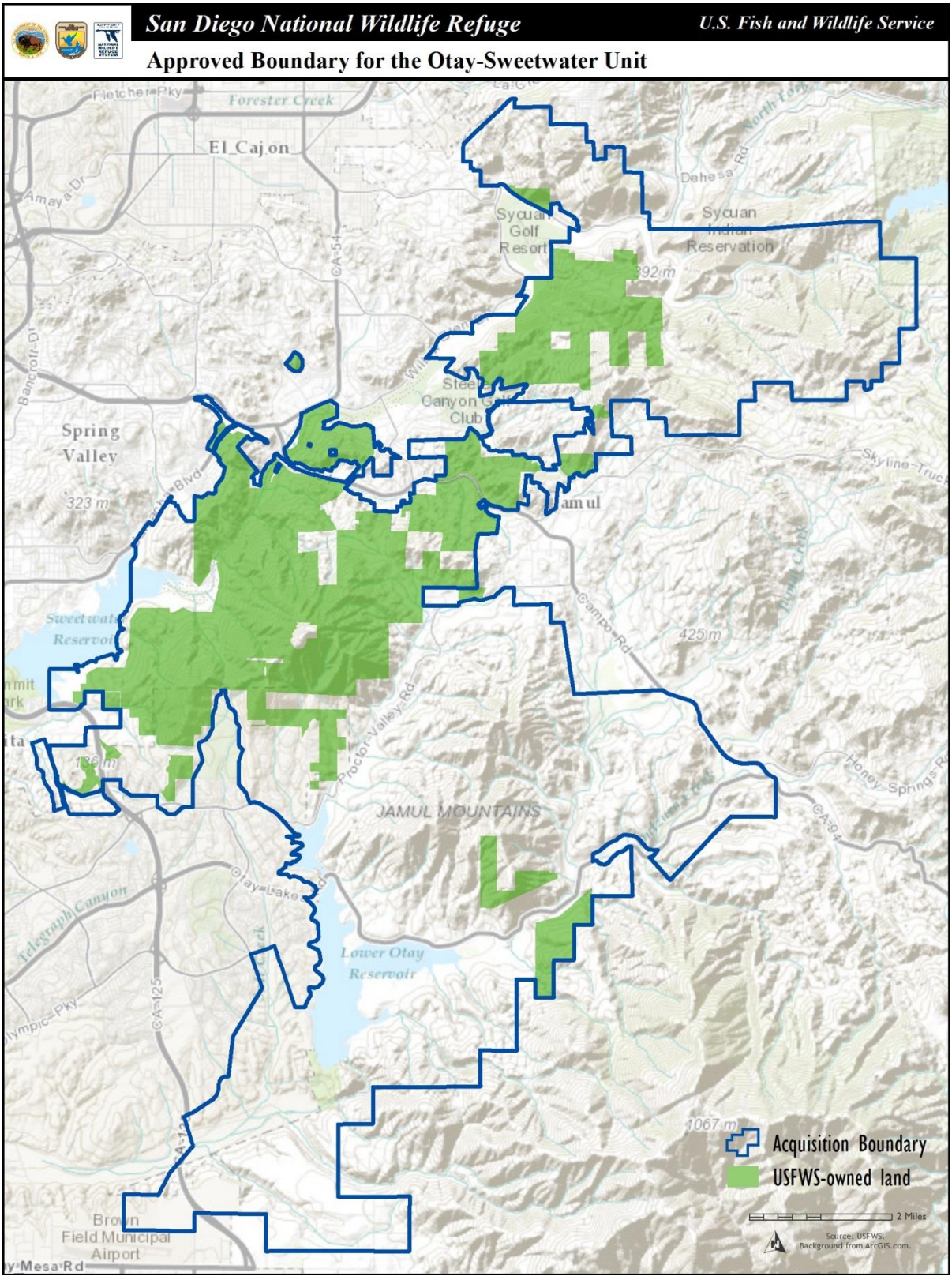

Figure 3. Location Map for the Otay-Sweetwater Unit of the San Diego NWR

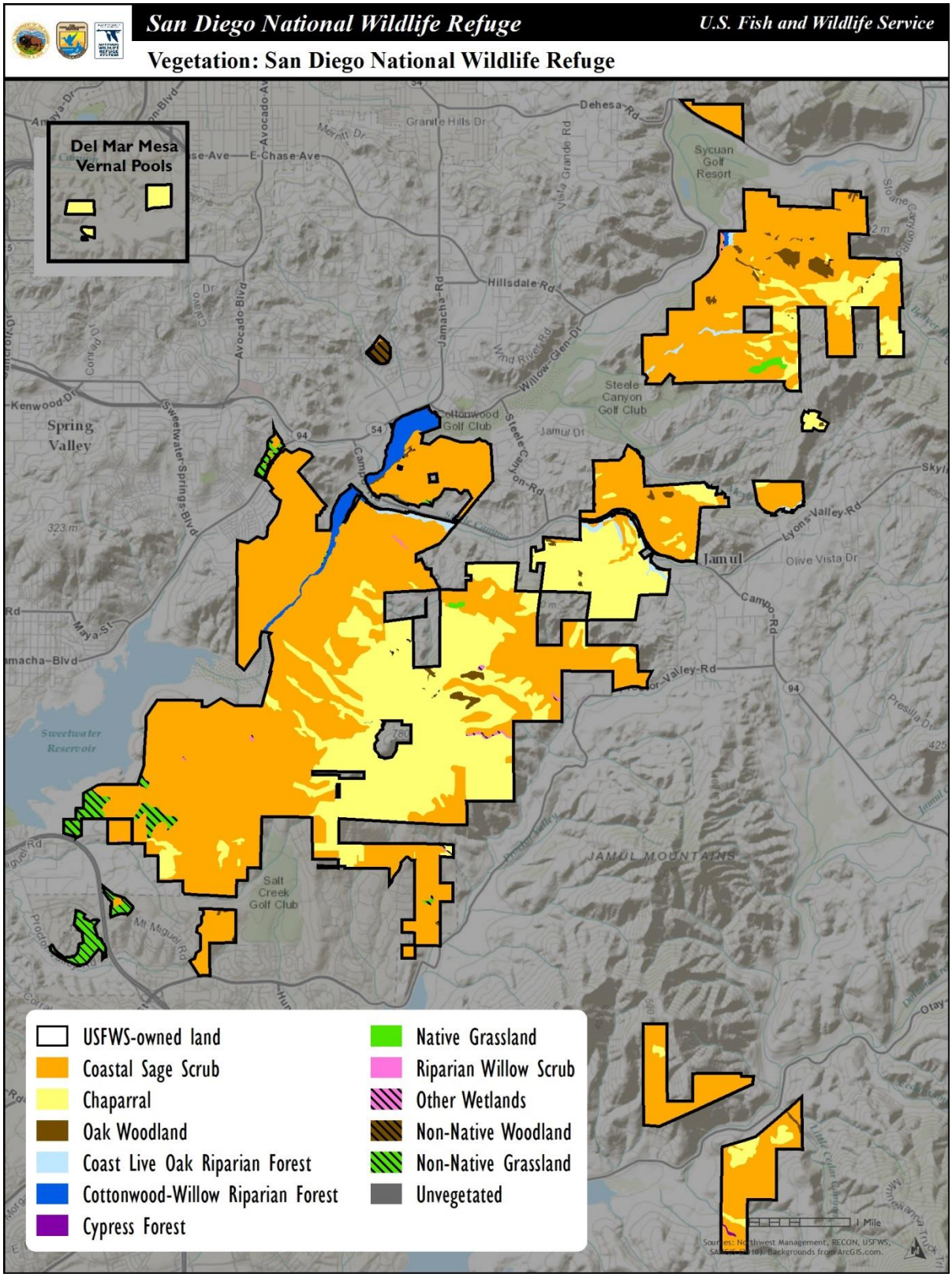

Figure 4. Vegetation Types on San Diego NWR

Table 1 - Special Status Species on San Diego NWR

Scientific Name	Common Name	Status[1]
Crustaceans		
Branchinecta sandiegonensis	San Diego fairy shrimp	FE, M
Insects		
Euphydryas editha quino	Quino checkerspot	FE
Lycaena hermes	Hermes copper	FC
Amphibians		
Anaxyrus californicus	Arroyo toad	FE, M, CSC
Spea hammondii	Western spadefoot toad	CSC
Reptiles		
Emys marmorata pallida	Southwestern pond turtle	M, CSC
Cnemidophorus hyperythrus beldingi	Orange-throated whiptail	M, CSC
Phrynosoma coronatum	San Diego horned lizard	M, CSC
Eumeces skiltonianus interparietalis	Coronado Island skink	CSC
Salvadora hexalepis virgultea	Coast patch-nosed snake	CSC
Crotalus ruber ruber	Red diamondback rattlesnake	CSC
Birds		
Branta canadensis	Canada goose	M
Pelecanus erythrorhyncos	American white pelican	CSC
Circus cyaneus	Northern harrier	M, CSC
Accipiter cooperii	Cooper’s hawk	M
Buteo swainsoni	Swainson’s hawk	M
Buteo regalis	Ferruginous hawk	M, CSC
Aquila chrysaetos	Golden eagle	M, CFP
Elanus leucurus	White-tailed kite	CFP
Falco peregrinus	Peregrine falcon	M, CFP
Athene cunicularia hypugea	Western burrowing owl	M, CSC

Scientific Name	Common Name	Status[1]
Empidonax traillii extimus	Southwestern willow flycatcher	FE, M
Lanius ludovicianus	Loggerhead shrike	CSC
Campylorhynchus brunneicapillus	Cactus wren	M, CSC
Polioptila californica californica	Coastal California gnatcatcher	FT, M, CSC
Sialia mexicana	Western bluebird	M
Vireo bellii pusillus	Least Bell's vireo	FE, M
Dendroica petechia brewsteri	Yellow warbler	CSC
Icteria virens	Yellow-breasted chat	CSC
Ammodramus savannarum	Grasshopper sparrow	CSC
Aimophila ruficeps canescens	Southern California rufous-crowned sparrow	M
Agelaius tricolor	Tricolored blackbird	M, CSC
Mammals		
Eumops perotis californicus	Western mastiff bat	CSC
Nyctinimops femorosaccus	Pocketed free-tailed bat	CSC
Neotoma lepida intermedia	San Diego desert wood rat	CSC
Taxidea taxus	American badger	M, CSC
Felis concolor	Mountain lion	M
Odocoileus hemionus fulginosus	Southern mule deer	M
Plants		
Acanthomintha ilicifolia	San Diego thornmint	FE, M, CE
Ambrosia pumila	San Diego ambrosia	FE, M
Arctostaphylos glandulosa ssp. crassifolia	Del Mar manzanita	FE, M
Arctostaphylos otayensis	Otay manzanita	M
Calochortus dunnii	Dunn's mariposa lily	M, CR
Ceanothus verrucosus	Wart-stemmed ceanothus	M
Cupressus forbesi	Tecate cypress	M

Scientific Name	Common Name	Status[1]
Dudleya variegata	Variegated dudleya	M
Ericameria palmeri var. palmeri	Palmer's goldenbush	M
Eryngium aristulatum var. parishii	San Diego button celery	FE, M, CE
Ferocactus viridescens	San Diego barrel cactus	M
Deinandra conjugens	Otay tarplant	FT, M, CE
Lepichinia ganderi	Gander's pitcher sage	M
Monardella hypoleuca ssp. lanata	Felt-leaved monardella	M
Muilla clevelandii	San Diego goldenstar	M
Navarettia fossalis	Spreading navarettia	FT, M
Nolina interrata	Dehesa beargrass	M, CE
Cylindropuntia californica var. californica	Snake cholla	M
Orcuttia californica	California Orcutt grass	FE, M, CE
Pogogyne abramsii	San Diego Mesa mint	FE, M, CE
Pogogyne nudiuscula	Otay Mesa mint	FE, M, CE
Satureja chandleri	San Miguel savory	M
Senecio ganderi	Gander's butterweed	M
Solanum tenuilobatum	Narrow-leaved nightshade	M
Tetracoccus dioicus	Parry's tetracoccus	M

[1] FE: Federally Endangered; FT: Federally Threatened; FC: Candidate for Federal listing as Threatened or Endangered; M: covered by the Multiple Species Conservation Plan; CE: California State Endangered; CR: California State Rare; CT: California State Threatened; CSC: California Species of Special Concern; CFP: California Fully Protected.

Evidence of European culture includes areas of alluvial soil in the Sweetwater River floodplain that were farmed, including some areas that were irrigated. Cattle grazing occurred on lands currently managed by the Refuge as late as the early 1990s and has likely contributed to the predominance of exotic annual grasses on the Refuge (Diffendorfer et al. 2002) and altered vegetation composition and surface microtopography on the Refuge. Several ephemeral drainages on the Refuge have been dammed to create water sources for livestock, altering the stream hydrology. Roads were graded for agricultural and utility access, creating disturbed areas prone to invasion by exotic plant species.

The legacy resulting from human activity at the Refuge is the introduction of over 130 non-native plant species, at least seven exotic vertebrates, and an undetermined number of exotic invertebrates. Recovery efforts for the Refuge's sensitive species are dependent on the long-term management of these non-native pest species. This will require: 1) identification of invasive and pest species problems, 2) development of a Refuge-wide strategy for managing invasive and pest species, 3) prioritization of management actions, 4) characterization of management tools and techniques available to meet invasive/pest species management needs, and 5) implementation of those tools and techniques.

Impact of Invasive Plant Species on San Diego National Wildlife Refuge

Invasive species cause environmental damage and losses worth almost $120 billion per year, and approximately 42 percent of all threatened and endangered species are at risk primarily because of non-native species (Pimentel et al. 2005). Economic effects are easier to calculate than ecological consequences, which are sometimes difficult to perceive, let alone quantify (Hanson and Sytsma 2001). According to the Service, invasive species have become the single greatest threat to the Refuge System. Rare species with limited ranges, small numbers, and restricted habitat requirements—such as the endemic plant and animal species of coastal southern California found at the Refuge—are often particularly vulnerable.

Non-native and pest plant species alter ecosystem structure and function, disrupt food chains and other ecosystem characteristics vital to wildlife (including rare and endangered species), and alter key ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regime (Randall 1996, Brooks and Pyke 2001).

As of August 2013, the Refuge supported an estimated 7,700 acres of coastal sage scrub. This vegetation type supports many rare and sensitive species endemic to coastal southern California, including federally threatened coastal California gnatcatcher (*Polioptila californica californica*), endangered Quino checkerspot butterfly (*Euphydryas editha quino*), Endangered Species Act (ESA) listing candidate Hermes copper butterfly (*Lycaena hermes*), endangered San Diego ambrosia (*Ambrosia pumila*), and threatened San Diego thornmint (*Acanthomintha ilicifolia*). Non-native annual grasses invaded coastal sage scrub over the past several centuries and increased their cover in recent decades (Minnich 2008). In some cases, exotic annuals have essentially replaced the coastal sage scrub community, resulting in type conversion to non-native grassland. Many biologists have noted that type conversion or

degradation has been occurring in coastal scrub for many years (Zedler et al. 1983, Westman 1987, Freudenberger et al. 1987, Giessow and Zedler 1996, Minnich and Dezzani 1998, Stylinski and Allen 1999, Allen et al. 2000, Keeley et al. 2005, Talluto and Suding 2008). These authors identified native coastal scrub converting to plant communities dominated by non-native species—in particular, annual grasses.

While other processes may subsequently influence the conversion to a non-native community, the presence of non-native plants (or their seeds) is the fundamental precursor condition to type conversion in coastal sage scrub. Because the processes that drive type conversion occur over various temporal and spatial scales, habitat types are not necessarily converted evenly or discretely over the landscape. Habitats that have not completely converted are considered "degraded"; type conversion may be considered the extreme end of the habitat degradation process. Essentially all of the coastal sage scrub on the Refuge is infested to some degree with exotic annual grasses such as wild oat (*Avena barbata, A. fatua*), Mediterranean brome (*Bromus madritensis* ssp. *rubens*), rip-gut brome (*B. diandrus*), soft chess (*B. hordeaceus*), rat-tail fescue (*Vulpia myuros*), Italian ryegrass (*Lolium multiflorum*), and common Mediterranean grass (*Schismus barbatus*); and/or exotic annual forbs such as red-stem fillaree (*Erodium cicutarium*), broad-leaved fillaree (*E. botrys*), Maltese star thistle (*Centaurea melitensis*), black mustard (*Brassica nigra*), short-pod mustard (*Hirschfeldia incana*), and smooth cat's ear (*Hypochaeris glabra*), and is therefore degraded to some extent. These species and other exotic annuals tend to germinate earlier in the season, in response to less rainfall, than native species, and are thus effective competitors with native coastal sage scrub plants, suppressing their growth and recruitment. After a disturbance (e.g., trampling, grazing, fire) damages the native vegetation, exotic annuals respond more quickly than natives to the decreased competition that the disturbance has caused, outcompeting native coastal sage scrub seedlings (Eliason and Allen 1997) and thus increasing non-native abundance and cover.

The interaction between exotic annual grasses and wildfire is particularly problematic. Upon dying, individual plants cure (dry) and often persist as a layer of fine, dry fuel that readily ignites and carries fire. In contrast, native forbs, when cured, do not provide much fuel for fire (Minnich and Franco-Vizcaíno 2005). Areas with dead non-native grasses are more likely to burn than areas of regrowing native sage scrub without non-native annuals (Cione et al. 2002). Additionally, the presence of dead, non-native annual plants can extend the fire season by allowing fires to burn earlier (Keeley 2005). This results in a feedback loop in which the time between fires at a given site decreases (i.e., an increased fire frequency) (Zedler et al. 1983, Keeley et al. 2005).

The problem of habitat type conversion is further exacerbated by anthropogenic atmospheric pollutants, which can directly harm coastal scrub plants or place them at a competitive disadvantage compared to non-native plants. For example, the input of nitrogen-based compounds (nitrification) increases the mortality rate of coastal scrub plants (Allen et al. 1998) and causes shifts in mycorrhizal communities that favor non-native plant species

(Egerton-Warburton and Allen 2000). Many, if not most, non-native annual grass species respond strongly to nitrogen additions by increasing growth and seed production (Jones and Evans 1960, Jones 1963, Yoshida and Allen 2004).

Also, atmospheric sulfur dioxide and ozone were implicated in a significant reduction of foliage and root growth in coastal scrub (Westman 1985), conferring a competitive advantage to exotics in the community. In contrast, *Bromus madritensis* ssp. *rubens* has inherited a tolerance to sulfur dioxide and ozone in southern California (Preston 1993). There is some controversy over the exact role of nitrogen deposition in type conversions of California shrublands (Keeley 2005), but the strong positive response of annual grasses to nitrogen fertilization clearly implicates nitrogen deposition in such conversion (Weiss 1999).

The exotic annual-dominated plant community is very different in structure and floristic composition from coastal sage scrub, with deleterious effects on coastal sage scrub-obligate wildlife species such as Quino checkerspot butterfly, California gnatcatcher, San Diego horned lizard (*Phrynosoma coronatum*), orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*), and variegated dudleya (*Dudleya variegata*).

As of August 2013, the Refuge supported approximately 170 acres of cottonwood-willow riparian forest, which has been infested to varying degrees with a variety of woody perennial exotic plant species, including salt cedar (*Tamarix ramosissima*), giant reed (*Arundo donax*), Mexican fan palm (*Washingtonia robusta*), Canary Island date palm (*Phoenix canariensis*), and pampas grass (*Cortaderia sellowiana*). Salt cedar is known to disrupt native communities by monopolizing limited water and lowering water tables, increasing soil salinity, suppressing the germination and establishment of native species, and reducing available forage and access to water for wildlife (Carpenter 1999, Dudley and DeLoach 2004, Dudley et al. 2000, Lovich and DeGouvenain 1998, Vandersande et al. 2001). Giant reed tends to form dense, monotypic stands that replace native riparian vegetation and naturally occurring open areas between vegetation groups. The displacement of native vegetation typically results in reduced vegetative species diversity (Cushman and Gaffney 2010), reduced structural heterogeneity, and reduced abundance and diversity of arthropods (Herrera and Dudley 2003) with concomitant changes to the native flora and fauna. Typical dense stands of giant reed greatly increase the fuel load within a riparian forest, increasing the likelihood and intensity of fire. Pampas grass clumps also include large amounts of dead vegetation that may exacerbate fire risk and degree of damage. The two palm species inhabiting the Refuge are large plants with high potential to compete with native species for light and water. They also retain dead foliage on the stem, which increases the fuel load in the community.

San Diego NWR has two areas of vernal pool habitat, supporting several federally threatened and endangered plant and animal species. Qualitative assessments suggest that exotic vegetation is not currently a major detriment to wildlife and plants on the Del Mar Mesa Vernal Pool Unit. In contrast, the Shinohara vernal pool area has a history of agricultural

disturbance, and weeds there have high potential to compete for light, water, and nutrients with sensitive vernal pool plants. The thick thatch typically formed in an exotic annual-dominated grassland shades seedling vernal pool plants, inhibiting their development. This thatch also serves as fuel and may increase the intensity of fires that occur in vernal pool areas. Extensive stands of exotic plants may alter relationships among animals and the vernal pool biota by providing an abundant food supply for fossorial rodents, ants, and rabbits (Bauder 1996), which may also eat vernal pool plants or their seeds. Sensitive vernal pool plant species such as *Pogogyne* sp. typically disappear from vernal pools where exotic plant species dominate, presumably by competitive exclusion (Scott McMillan, AECOM, pers. comm. to John Martin, San Diego NWR).

Specific occurrences of species that are very limited in distribution may be adversely affected by weeds. For example, San Diego thornmint occurs on the Refuge in only three fairly small locations. Thus, a relatively limited infestation of weeds may have a disproportionate effect on this rare species. Other species of very limited distribution include San Diego ambrosia (*Ambrosia pumila*), spreading navarretia (*Navarretia fossalis*), California Orcutt grass (*Orcuttia californica*), Otay mesa mint (*Pogogyne nudiuscula*), San Diego fairy shrimp (*Branchinecta sandiegonensis*), and Quino checkerspot butterfly.

Sensitive grassland species on the Refuge are likely being affected by changes to the vegetation structure wrought by invasive exotic species. Predators of insects and small vertebrates, such as loggerhead shrike (*Lanius ludovicianus*) and burrowing owl (*Athene cunicularia*), both California species of special concern, may not forage as effectively in areas with thick thatch of dead exotic annual grasses. Grasshopper sparrow (*Ammodrammus savannarum*), another California species of special concern, generally prefers open grasslands with patchy bare ground (Vickery 1996). Though the impact of exotic annual grass thatch on this species is not well understood (Unitt 2008), it probably reduces habitat quality.

Impact of Invasive Animal Species on San Diego National Wildlife Refuge

Animal invaders threaten native species by competing with and displacing or preying on indigenous wildlife, acting as vectors or reservoirs of disease and physically altering habitats (Pimentel et al. 2005). Examples include feral and domestic cats (*Felis catus*) that prey on native birds, mammals, reptiles, and amphibians; European starlings (*Sturnus vulgaris*) that have the potential to affect native birds through competition for nest sites with secondary cavity-nesting species such as the acorn woodpecker (*Melanerpes formicivorus*), Nuttall's woodpecker (*Picoides nuttallii*), downy woodpecker (*Picoides pubescens*), western bluebird (*Sialia mexicana*), ash-throated flycatcher (*Myiarchus cineraeus*), and oak titmouse (*Baeolophus inornatus*); and the brown-headed cowbird (*Molothrus ater*), a brood parasite that lays its eggs in the nests of open cup-nesting passerine birds, including threatened and endangered birds such as California gnatcatcher, least Bell's vireo (*Vireo bellii pusillus*), and southwestern willow flycatcher (*Empidonax traillii extimus*). Other exotic animal species that represent a threat to Refuge resources include wild turkey (*Meleagris gallopavo*) and feral

pigs (*Sus scrofa*). Additional information about these species and the potential effects they could have on Refuge resources is provided in Chapter 4.3 of the Final CCP. Although control of these species is mentioned in this document, actions to control or eradicate these species on the Refuge are not covered under this IPM plan; rather, they are addressed through a variety of programs described in Chapter 3 of the Final CCP.

The control of exotic aquatic species is addressed under this IPM plan, although control is not proposed at the current time. A control program may, however, be initiated during the 15-year life of the CCP as more information regarding the feasibility, cost, and likelihood of success becomes available and funding is identified to implement a control program. Aquatic species known to occur on the Refuge include crayfish (*Procambarus clarkii*), bullfrogs (*Rana catesbeiana*), African clawed frog (*Xenopus laevis*), red-eared slider (*Trachemys scripta*), spiny softshelled turtle (*Trionyx spiniferus*), mosquito fish (*Gambusia affinis*), carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), and green sunfish (*Lepomis cyanellus*). It is likely that all of these species were intentionally introduced by humans: as discarded pets, for mosquito control, for food, for sport fishing, or as bait. These species represent a threat to amphibian species, as well as to the southwestern pond turtle. More information about these species and the potential effects they could have on Refuge resources is provided in Chapter 4.3 of the Final CCP. Another aquatic exotic species established in the Sweetwater River on the Refuge is the Asian clam (*Corbicula fluminea*). It is not currently known to have a deleterious effect on wildlife species of management concern but, in large concentrations, may reduce the amount of planktonic fauna in the water, reducing food resources for native species.

III. Refuge Resources

The very high biodiversity and presence of listed species was a driving force behind the establishment of the Refuge. Past land use over the last 100 years introduced non-native species and created conditions favorable for their establishment. Designation as a national wildlife refuge has stopped the threat of direct habitat destruction. However, the Refuge's proximity to urban areas, the ubiquity of many weed species in the landscape, and the wide variety of recreational and utilitarian activities on San Diego NWR create disturbance and conditions favorable to introduction and expansion of non-native species.

The high level of endemism on the Refuge and presence of federally listed and otherwise sensitive species may constrain management options available. Effects of different weed management methods (i.e., chemical, mechanical, biological) on sensitive and listed species are generally not well understood. Until effects on sensitive and listed species are tested, Refuge policy is to minimize risk to listed and sensitive non-target plants and animals.

The unfortunate reality is that many invasive species are now part of the flora and fauna of the Refuge and are too widespread, abundant, and in close physical proximity to listed, sensitive, and otherwise desirable native biota to be eradicated. An IPM program will be needed in perpetuity to reduce the establishment of new weed species, to reduce the spread of

existing infestations into new areas, to control existing infestations such that deleterious ecological effects are reduced, and to create and/or maintain areas of high-quality habitat for species of management concern.

Refuge Endangered Species Management and Recovery

The purpose for which the San Diego NWR was established emphasizes protection, management, and restoration of habitats for federally listed threatened and endangered species. The objective is to restore populations of listed species to a non-listed status (though, in most cases, management of healthy habitats and populations on the Refuge alone will not be sufficient to de-list species). Recovery plans for least Bell's vireo, southwestern willow flycatcher, arroyo toad, California red-legged frog, Quino checkerspot butterfly, vernal pools of southern California, and Otay tarplant include specific recovery actions for the removal and control of non-native species. Actions applicable to San Diego NWR are presented in Table 2.

Table 2 - Exotic Species Management Measures Specified in Recovery Plans for Federally Threatened and Endangered Species Occurring on San Diego NWR

Species	Recovery Plan Section	Exotic Species Management-related Recovery Actions
Least Bell's vireo *(Vireo bellii pusillus)*	1.7	Control non-native plant species.
Southwestern willow flycatcher *(Empidonax traillii extimus)*	1.1.2.3.4	Reduce incidence of flammable exotics.
	1.1.3.2	Manage exotic plant species.
Arroyo toad *(Anaxyrus californicus)*	1.1.5	Monitor and remove exotic vegetation (iceplant, tamarisk, and giant reed) in affected drainages. Determine if the removal benefits arroyo toad populations.
	3.3	Identify and implement necessary management actions. When new populations or subpopulations and habitats are found… management actions necessary for securing them should be implemented. Such actions may include… controlling exotic species…
California red-legged frog *(Rana aurora draytoni)*	1.34	[in Sweetwater River watershed] … restore habitat….
	10.0	Restore habitat conditions for the California red-legged frog at or near historical localities…

Species	Recovery Plan Section	Exotic Species Management-related Recovery Actions
Quino checkerspot butterfly *(Euphydryas editha quino)*	1.7.1.1	Intensive restoration of agricultural areas and degraded habitat in the Southwest San Diego Recovery Unit will be needed within the Otay Lakes/Rancho Jamul Occurrence Complex, in Proctor Valley, and on Otay Mesa. Landscape connectivity should be enhanced across Otay Mesa through continued expansion of vernal pool restoration and other habitat restoration activities.
San Diego fairy shrimp *(Branchinecta sandieogonensis)*	4	Manage protected habitat. In general, management plans prepared for all preserves should…control exotic plant and animal species.
California Orcutt grass *(Orcuttia californica)*		
Spreading navarretia *(Navarretia fossalis)*		
Otay Mesa mint *(Pogogyne nudiuscula)*		
San Diego button celery *(Eryngium aristulatum var. parishii)*		
Otay tarplant *(Deinandra conjugens)*	4.1	Develop and implement appropriate techniques to control invasive weeds within suitable *Deinandra conjugens* habitat.

IV. 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 assure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (refuge) lands and waters is also 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).

Pests are defined as "…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" from Department policy 517 DM 1 (Integrated Pest Management policy). Similarly, 569 FW 1 defines pests as "…invasive plants and introduced or native organisms that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." 517 DM 1 also defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this document, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of Refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests on the San Diego NWR would conserve and protect the fish, wildlife, and plant resources on the Refuge, as well as maintain environmental quality. The IPM policy states that animal or plant species, which are considered pests, may be managed if the following criteria are met:

- The pest is causing a threat to human health and wellbeing or private property, the acceptable level of damage by the pest has been exceeded, or State or local government has designated the pest as noxious;
- The pest is detrimental to resource objectives as specified in a refuge resource management plan (e.g., CCP, habitat management plan); and
- The planned pest management actions will not interfere with attainment of resource objectives or the purposes for which a refuge was established.

The specific justifications for pest management activities on the San Diego NWR include:

- Protecting human health and safety;
- Preventing substantial damage to important Refuge resources, including federally listed threatened and endangered species;
- Protecting newly introduced or reestablished native species;
- Controlling non-native (exotic) species in order to support existence for populations of native species; and
- Providing the public with quality, compatible wildlife-dependent recreational opportunities.

Service policy 620 FW 1 (Habitat Management Plans) provides additional management directives regarding invasive species found on Refuge lands and waters. Specifically, the Service is "prohibited by Executive order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere." The Habitat Management Plan policy requires that we: "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species," and conduct "refuge habitat management activities to prevent, control, or eradicate invasive species..."

Animal species identified as damaging or destroying Federal property and/or considered detrimental to the management program of a refuge may be controlled as described in 50 CFR 31.14 (Official Animal Control Operations) and generally do not require a pesticide use proposal**.** For example, the trapping and removing wild turkeys or feral pigs may be conducted without a pest control proposal. Additionally, exotic aquatic species that threaten the success of reestablishing populations of arroyo toads, California red-legged frogs, and/or southwestern pond turtles can be controlled without a pest control proposal using the most effective techniques considering site-specific factors.

Trespass and feral animals also may be controlled on Refuge lands. Based upon 50 CFR 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing or molesting humans or wildlife may be disposed of in the interest of public safety and protection of the wildlife. Feral animals should be disposed by the most humane method(s) available and in accordance with relevant Service directives (including Executive Order 11643). Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species will only be made after securing State approval (50 CFR 30.11 [Donation and Loan of Wildlife Specimens]**).**

Recovery plans for the least Bell's vireo, southwestern willow flycatcher, arroyo toad, California red-legged frog, vernal pools of southern California (including San Diego fairy shrimp, spreading navarretia, California Orcutt grass, Otay Mesa mint, and San Diego button celery), Quino checkerspot butterfly, and Otay tarplant list invasion by exotic species as a major threat to the listed species. Likewise the five-year reviews for San Diego ambrosia and San Diego thornmint (species for which recovery plans have not been prepared) note that competition with exotic plants constitutes a threat. Achieving the Refuge's establishment purpose to protect, manage, and restore habitats for federally listed endangered and threatened species and migratory birds and to maintain and enhance the biological diversity of native plants and animals will entail reduction of deleterious effects (competition, predation, parasitism, or alteration of ecological processes) caused by exotic species.

Integrated pest management will address specific Recovery Tasks for several threatened and endangered species on the Refuge. Integrated pest management conforms to Refuge goals

and addresses several objectives within the CCP. It will also help the Service meet the objectives of the MSCP; meet the objectives of the California Partners in Flight Bird Conservation Plan for Coastal Scrub and Chaparral, Grasslands, Oak Woodlands and Riparian habitats; and maintain the Refuge's status as an Important Bird Area of California (Cooper 2004).

V. Incorporating the IPM Program into Refuge Management

Integrated pest management is a decision making process for determining if pest suppression treatments are needed, when they are needed, and what strategy and mix of tactics should be used. Treatments are chosen and timed to be most effective and least disruptive to natural ecosystem processes (Olkowski 1980). Taking this a step further, San Diego NWR will strive toward ecologically-based integrated pest management, which requires describing current plant and animal communities and their ecology, including how they are affected by the presence of invasive species and describing the desired future conditions. Then the processes and management actions necessary to drive those ecological process changes can be incorporated into the efforts to remove or minimize invasive plant and animal populations.

San Diego NWR will employ a variety of control methods, and treatment methodologies will be based upon the best information available from pest management literature and professional expertise. The most appropriate treatment for an infestation typically depends on the scale of the infestation and on the biology and ecology of the target species (Evans et al. 2003a). Invasive plant management approaches are expected to change and become more refined as more experience is gained. Pest management on the Refuge would be coordinated with adjacent landowners, as well as upstream landowners to the extent possible to ensure effect control of invasive plants, particularly those that occur within the Sweetwater watershed.

A series of standard operating procedures will be followed on a project-by-project basis to minimize impacts to sensitive plant and animal species as a result of the pest plant and animal control methods described in the IPM plan. These standard operating procedures are described here.

- During planning and development of Refuge IPM projects, impacts to Federal and State listed species will be avoided to the maximum extent practical. If impacts are unavoidable, they will be minimized and mitigated to provide a net benefit to the species or ecosystem that supports the species. All access routes, staging areas, and work areas will be determined prior to the start of an IPM project activity. Refuge staff will work with contractors to clearly identify these project features and, if necessary, flag or erect construction fencing to minimize unauthorized impacts. The impact minimization measures described in the IPM are intended to be guidelines. During project planning, Refuge staff or contractors will not be limited to best management practices (BMPs) indicated in the IPM, and they are encouraged to

develop appropriate buffers or other BMPs as needed to minimize impacts to sensitive plant and animal resources from IPM projects.

- Prior to the start of IPM projects, a habitat assessment for sensitive biological resources will be made. If appropriate habitat is identified and impacts cannot be avoided, then surveys will be completed. The number of individuals impacted by the project will be determined. Where annual take authorizations are imposed by State and Federal permit conditions, take will be limited to the permit conditions.

- Prior to commencing IPM projects, Refuge staff or designee will conduct a briefing to educate all personnel working on the project regarding sensitive species that may be present and project-specific BMPs to minimize impacts.

- Standard operating procedures will be regularly updated and modified through the adaptive management process described in the IPM.

Through the adaptive management process, it is expected that these procedures will be regularly revised as new information is gained.

The removal of targeted invasive species—while a simple prescription—does not address the plethora of factors that facilitate the dominance of invasive species. Ecological processes can be used to make native communities more resistant to invasion by non-native species. The ultimate objectives for land management should be the focus of the non-native species management plan. The ultimate objective is not simply the removal of invasive species but the maintenance of federally listed and otherwise sensitive species, overall biological diversity, and ecological function. Additionally, an integrated pest management program must be based on the overall conservation and management goals of the area for which it was designed (Evans et al. 2003a).

Primary conservation targets and recreational management goals as they relate to invasive species management at San Diego NWR are described here.

Endangered Species Management and Recovery

San Diego NWR's primary purpose is the protection, management, and restoration of habitats for federally listed threatened and endangered species, with the objective to assist in the recovery of the listed species present or historically present on the Refuge. As described previously, the recovery plans for several of the listed species present on the Refuge include specific recovery actions related to the control and removal of pest species.

Habitat Restoration

For all of the federally threatened and endangered species currently present on the Refuge and for those that may potentially be reintroduced, likelihood of population persistence could be increased by some degree of habitat restoration. "Restoration" of habitat implies returning the habitat to a historic condition from which it has diverged over time. The

presence of exotic species and their ecological effects is a significant divergence from historic biotic habitat conditions under which the Refuge's threatened and endangered species were once abundant. Therefore, management of exotic species is an integral part of habitat restoration. Conversely, restoration of historic conditions, either abiotic (e.g., fire frequency, hydrology, air quality, topography) or biotic (reestablishment of a native-dominated vegetation community), in some cases may restore the biota such that the native biotic community can competitively exclude exotic species to some degree. Abiotic factors affecting habitat and ecology on the Refuge originate primarily off-site and therefore are more difficult to manage.

Resource Protection

The goals of the National Wildlife Refuge System are to "provide for the conservation of fish, wildlife, and plants within the System; ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans…" and "…monitor the status and trends of fish, wildlife, and plants in each refuge." In addition to specifically managing for federally listed species, San Diego NWR has an obligation to appropriately manage and protect non-listed species and ecosystem integrity on the refuge.

Funding

Funding is an important consideration in development and implementation of IPM strategies. Successful control of exotic species present on the Refuge requires an initial treatment, careful monitoring, and additional follow-up treatments. All eradication projects must include provisions and a budget for subsequent follow-up treatments; otherwise, the investment on the initial control will likely be wasted. Funding for follow-up monitoring and treatments should be built into proposals and secured prior to implementation. For invasive plants, eradication often takes multiple growing seasons due to the presence of a seed bank in the soil. Depending on the level of infestation, multiple years of follow-up treatments may be needed to successfully eradicate non-native weeds from a site. A similar or greater level of effort is needed to eradicate or control invasive animal species.

Invasive species management should be coordinated through multiple funding sources and, where possible, coupled to a variety of Refuge activities, including threatened and endangered species recovery, habitat restoration, recreational use, educational and volunteer initiatives, and Refuge maintenance operations.

Contingency funds are needed to deal with invasive species outbreaks. Timing of annual funding cycles may not correspond to the need to address a problematic outbreak or occurrence of an exotic species. Invasive species outbreaks are best controlled or eradicated by early intervention when the outbreak is small and can be contained. A contingency fund could be used to address this issue. For example, the introduction of bass into the Mother Miguel pond is not unlikely to occur, but the timing of an introduction and its discovery are unpredictable. Management's response to new

occurrences must be rapid to prevent proliferation of the unwanted species. Unusually wet or warm winters often create boom years for invasive plant species when more seed germinates than is typical. Intervention during these years is imperative. A contingency fund would allow the Refuge to adequately address these unusual events as they occur.

VI. IPM Strategies for Invasive Plants

Historical land practices including grazing, agricultural production, mining, and general public use have created conditions on various parts of the Refuge favorable for invasion by non-native annual plants and shrubs. Increased fire frequency within Refuge habitats has also contributed to an increase in the presence of invasive plants. Table 3 lists the invasive plant species that will be targeted for management at San Diego NWR. This list is intended to be a living document that will need to be reviewed and updated biennially or as more information is gained.

Table 3 - Non-native Plant Species Present on San Diego NWR

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Acacia cyclops	Coastal wattle	
Acacia melanoxylon	Australian blackwood	
Aegilops cylindrica	Jointed goatgrass	
Ailanthus altissima	Tree-of-heaven	Yes
Aira caryophyllea	Silver hairgrass	
Amaranthus albus	Prostrate pigweed	
Anagallis arvensis	Scarlet pimpernel	
Apium graveolens	Wild celery	
Arundo donax	Giant reed	Yes
Asphodelus fistulosus	Onion weed	Yes
Atriplex glauca	Waxy saltbush	
Atriplex lindleyi	Lindley's saltbush	
Atriplex semibaccata	Australian saltbush	
Avena barbata	Wild oat	Yes
Avena fatua	Wild oat	Yes
Bassia hyssopifolia	Fivehook bassia	

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Beta vulgaris ssp. maritima	Wild beet	
Bidens pilosa	Hairy beggarticks	
Brachypodium distachyon	Purple false brome	Yes
Brassica nigra	Black mustard	Yes
Brassica rapa	Field mustard	
Brassica tournefortii	Sahara mustard	Yes
Bromus diandrus	Rip gut brome	
Bromus hordeaceus	Soft chess	
Bromus madritensis ssp. rubens	Red brome	
Bromus sterilis	Sterile brome	
Caesalpinia gilliesii	Yellow bird of paradise	
Cakile edentula var. edentula	American sea rocket	
Cakile maritima	American sea rocket	
Carduus pycnocephalus	Italian thistle	Yes
Carpobrotus edulis	Ice plant	Yes
Centaurea melitensis	Maltese star thistle	Yes
Cerastium glomeratum	Sticky chickweed	
Chamaesyce maculata	Spotted spurge	
Chamaesyce serpens	Creeping spurge	
Chenopodium album	Lamb's quarters	
Chenopodium murale	Nettleleaf goosefoot	
Chrysanthemum coronarium	Crown daisy	Yes
Cirsium vulgare	Bull thistle	
Conium maculatum	Hemlock	
Convolvulus arvensis	Field bindweed	
Conyza floribunda	Horseweed	
Cortaderia selloana	Pampas grass	Yes

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Cotula australis	Australian brass buttons	
Cotula coronopifolia	Brass buttons	
Crypsis schoenoides	Swamp pricklegrass	
Cynara cardunculus	Artichoke thistle	Yes
Cynodon dactylon	Bermudagrass	Yes
Delairea odorata	Cape ivy	Yes
Dimorphotheca sinuata	African daisy	
Dittrichia graveolens	Stinkwort	Yes
Ehrharta calycina	Perennial veldtgrass	Yes
Erodium botrys	Broad-leaved cranesbill	
Erodium brachycarpum	White-stemmed filaree	
Erodium cicutarium	Red-stemmed filaree	
Erodium moschatum	White-stemmed filaree	
Eucalyptus camaldulensis	River red gum	Yes
Eucalyptus globulus	Blue gum	Yes
Ficus carica	Fig	
Foeniculum vulgare	Fennel	Yes
Gastridium ventricosum	Nit grass	
Gazania linearis	African daisy	
Genista monspessulana	French broom	Yes
Hedypnois cretica	Crete weed	Yes
Hirschfeldia incana	Short-pod mustard	
Hordeum marinum, H. murinum	Hare barley	
Hypochaeris glabra	Smooth cat's ear	
Hypochaeris radicata	Hairy cat's ear	
Lactuca serriola	Prickly lettuce	
Lamarckia aurea	Goldentop grass	

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Leptosyne maritima	Sea dahlia	
Lobularia maritima	Sweet alyssum	
Logfia gallica	Narrowleaf cottonrose	
Lolium multiflorum	Italian ryegrass	Yes
Lolium perenne	Perennial ryegrass	
Lythrum hyssopifolium	Hyssop loosestrife	Yes
Malva parviflora	Mallow	Yes
Marrubium vulgare	Horehound	
Medicago polymorpha	Burclover	
Melilotus indicus	Yellow sweetclover	
Melinis repens	Natal grass	Yes
Mesembryanthemum crystallinum	Crystal ice plant	
Mesembryanthemum nodiflorum	Slenderleaf ice plant	
Myoporum laetum	Ngaio	
Nicotiana glauca	Tree tobacco	Yes
Olea europaea	Olive	
Oxalis pes-caprae	African wood sorrel	
Parapholis incurva	Sicklegrass	
Pennisetum setaceum	Fountain grass	Yes
Phalaris aquatica	Harding grass	
Phalaris minor	Littleseed canarygrass	
Phalaris paradoxa	Hood canarygrass	
Phoenix canariensis	Canary island date palm	Yes
Phytolacca americana	Pokeweed	
Picris echioides	Bristly ox-tongue	Yes
Piptatherum miliaceum	Smilo grass	Yes
Plantago major	Common plantain	

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Polygonum aviculare	Knotweed	
Polypogon monspeliensis and subspp.	Rabbitsfoot grass	
Portulaca oleracea	Purslane	
Potentilla norvegica	Norwegian cinquefoil	
Pseudognaphalium luteoalbum	Jersey cudweed	
Raphanus sativus	Wild radish	
Ricinus communis	Castor bean	Yes
Rumex crispus	Curly dock	
Rumex dentatus	Toothed dock	
Salsola australis	No common name	
Salsola tragus	Russian thistle	
Schinus molle	Peruvian pepper	Yes
Schinus terebinthifolius	Brazilian pepper-tree	Yes
Schismus arabicus, Schismus barbatus	Mediterranean grass	
Senecio vulgaris	Groundsel	
Senna didymobotrya	Popcorn senna	
Setaria pumila	Yellow foxtail	
Silene gallica	Common catchfly	
Silybum marianum	Milk thistle	
Sinapis arvensis	Field mustard	
Sisymbrium irio	London rocket	
Sisymbrium officinale	Hedge mustard	
Sisymbrium orientale	Indian hedge mustard	
Solanum americanum	American nightshade	Yes
Sonchus asper	Prickly sow thistle	Yes
Sonchus oleraceus	Sow thistle	Yes
Stellaria pallida	Lesser chickweed	

Scientific Name	Common Name	Targeted for control on San Diego NWR?
Tamarix ramosissima	Salt cedar	
Trifolium hirtum	Red clover	
Ulmus parviflora	Chinese elm	Yes
Urtica urens	Dwarf nettle	
Vinca major	Periwinkle	Yes
Vulpia bromoides	European foxtail fescue	
Vulpia myuros	Rat-tail fescue	Yes
Washingtonia robusta	Mexican fan palm	Yes
Invasive and Pest Plant Watch List (all are targeted for control)		
Euphorbia terracina	Carnation spurge	
Sesbania punicea	Red sesbania	
Lepidium latifolium	Perennial pepperweed	
Aegilops triuncialis	Barbed goatgrass	
Onchosyphon piluliferum	Globe chamomile	
Charictera annua	Ward's weed	
Senecio linearifolius	Fireweed groundsel	
Araujia sericifera	Bladderflower	

To fully embrace IPM as identified in 569 FW 1, the following strategies, where applicable, would be carefully considered on the Refuge for each pest species:

- Prevention;
- Early detection and identification of pests and natural enemies;
- A monitoring and recordkeeping system for regular sampling of pest and natural enemy populations;
- monitoring is an ongoing activity throughout any IPM program;
- Setting injury levels or determining the size of the pest population correlated with an injury sufficient to warrant treatment (in determining injury levels, the amount of aesthetic, ecological, or economic damage that can be tolerated must be correlated with the population size of pests, natural enemies, time in the season, and/or life stage of the pest or host);
- Setting action levels based on the pest population size and other variables such as weather from which it can be predicted that injury levels will be reached within a certain time if no treatments are undertaken;
- An integration of treatment methods that are effective against the pest, least disruptive to natural controls, and least hazardous to human health and the environment; and
- An evaluation system to determine the outcome of treatment actions.

The ongoing monitoring of treatments and results of an IPM program is critical to the adaptive management approach. Information provided by monitoring results will be used to evaluate the effectiveness of treatment methods to achieve conservation goals. Managers will use this information to adjust priorities, modify treatments, and improve planning and budgeting (Evans et al. 2003b).

Prevention

Prevention is the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of established pests to uninfested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points planning can be used to determine if current management activities on a refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention. See http://www.haccp-nrm.org for more information.

Prevention may include source reduction such as using pathogen-free or weed-free seeds or fill; exclusion methods (e.g., barriers); and/or sanitation methods (e.g., wash stations) to prevent introductions by various mechanisms, including Service vehicles, construction equipment, or boats. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new satellite pest populations. Prevention would require consideration of the scale and scope of land management activities

that may promote pest establishment within uninfested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason for prevention is to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

Prevention and early detection is the cheapest and most effective weed control method. Prevention and early detection strategies will lead to a reduction in the number of acres treated for non-native species in the future by reducing or preventing their establishment (USDI BLM 1996).

Because disturbance often encourages or can favor the spread of weeds, actions on the Refuge will include a weed risk assessment as part of the National Environmental Policy Act (NEPA) process when it is determined that an action may introduce or spread noxious weeds. If the risk is moderate or high, the Refuge will modify the project to reduce the likelihood of weeds infesting the site and include, if necessary, follow-up monitoring and identification of specific control measures to be implemented if weeds do infest the site.

A review of current Refuge policies and standard operating procedures regarding road maintenance and other Refuge operations will also be made to identify if these should, or can be, modified to reduce the potential to spread invasive species. Often, simple changes to routine activities can go a long way toward preventing establishment or spread of invasive species, but changing behavior is often hard to accomplish.

Cultural Control

Cultural control can be defined in different ways. The first definition involves the management and manipulation of competitive interactions so that weeds are placed at a disadvantage. This type of cultural control includes a broad range of normal management practices that can be modified or manipulated to manage one or more pest problems, either by minimizing the conditions those pests need to live (e.g., water, shelter, food) or by minimizing opportunities for introduction. Cultural control as discussed here is at the heart of integrated pest management at San Diego NWR because rarely can a single treatment address every invasive species and all situations. Integrated pest management requires the ability to adapt and combine control techniques to meet shifting management needs.

Soil Seed Bank

One form of management that falls under cultural control is control and management of soil seed banks. The seeds of many plant species (in particular noxious weeds) are able to persist for many years in the soil. If a site has had a heavy weed infestation for an extended period of time, it will be necessary to deplete weed seed from the soil seed bank prior to actual revegetation work. Depending on the weed species, different methods (e.g., non-chemical and chemical techniques) can be employed. Non-chemical techniques

include tilling, mulching, mowing, cutting, and solarization. Chemical techniques are treatments with sterilizing agents or herbicides. Depending on the weed species and degree of infestation, it can take one to several growing seasons before a site may be ready for seeding and planting natives.

If the soil seed bank is heavily infested with noxious weeds and has relatively few sensitive native species to be avoided, it is far more cost-effective to begin control and continue to use less precise weed control techniques such as grazing or broadcast application of herbicide initially. Once revegetation with desirable species has begun, weed control techniques must be shifted to more expensive labor intensive techniques such as flaming, spot spraying, and/or manual removal. If a site is still heavily infested with weeds, it can be costly to target weed species while preserving desirable species.

There are many cultural control techniques that are used to address managing weeds in the soil seed bank. A few are discussed here.

Mulches and Soil Amendments. Mulches can be included as one component of an integrated approach. Mulches can provide a physical barrier that can reduce weed germination and establishment. Mulches can, however, also inhibit native seedlings at the same time. When considering whether or not to use mulch, cost must be considered. For large projects, the benefits may not be worth the added expense. Instead of adding mulches to an entire site, a lower cost alternative would be to place mulches around plantings to improve water relations and establishment and to reduce direct competition with weeds. Weeds within interspaces could then be more easily treated with herbicides. The following considerations regarding mulches and soil amendments are summarized from the Beginners Guide to Desert Restoration (Bainbridge et al. 1995).

Consider whether mulches are necessary; often they are not. Do not use mulches that may have weed seeds in areas where invasive species are likely to flourish once established. Mulches in dry climates should have a high carbon to nitrogen (C:N) ratio and be added to pits and around planted seedlings and imprinted areas to increase soil moisture and enhance seed germination and plant establishment. Potential mulches include bark, rice hulls, almond shells, straw, and wood chunks. Mulches should be wind resistant or mulch should be placed in pits or protected areas where it cannot be blown away. Large pieces or heavy materials work better since they will deteriorate more slowly and do not blow away as easily as lighter materials. Crimping or punching in straw can make it more wind resistant.

Do not add mulches that have a low C:N ratio since semi-arid plants are not adapted to high nutrient input and invasive species are more likely to invade. Soil amendments and mulches are often unnecessary in the semi-arid environments, although adding organic matter may increase germination and establishment. Mulch can provide wind protection, reduce evaporation, increase infiltration and rainwater retention, reduce erosion, and improve plant microclimate. Materials with lots of lignin and a high C:N ratio appear to

be desirable in most semi-arid soils, providing a long-term food source for fungi and subsequent grazing by microarthropods. This grazing makes mineral nitrogen available to plants. Mulches can also be used to tie up available nutrients as an "antifertilizer" (St. John 1987) so that the site is less suitable for invasive exotics. Native plants are, in general, adapted to relatively low nutrient sites and do not respond strongly to fertilization. Invasive exotics, in contrast, are often from areas of high disturbance and/or high fertility and will respond very strongly to fertilization. Nitrogen and phosphorus in fertilizer can also depress important microbial activity and prevent root inoculation by soil symbionts. High nutrient levels can also decrease the root-to-shoot ratio and limit root spread. These many factors may interact to increase moisture stress on plants and reduce survival. Herbivores also tend to prefer plants with more nitrogen.

Super-absorbent polymers that store many times their own weight in water are often touted for desert planting. While these amendments have proved useful in some cases (primarily where water is available at regular intervals), the polymer chunks may limit root growth and do not reduce plant water use.

Grow and Kill Cycles. “Grow and kill cycles” is a management technique where weed seed in the soil seed bank is depleted prior to planting and seeding. Grow and kill refers to allowing weeds to germinate under conditions that encourage maximum germination and then killing the seedlings before they can produce seed. The kill portion of the cycle can be completed using herbicide, biocontrol (such as grazing) or a mechanical means (such as mowing). Weed seed germination is generally increased by supplemental irrigation using a water truck or flood irrigation, and tilling the soil. Depending on the weed species being managed, chemicals such as liquid smoke (that help break seed dormancy) can be applied. This technique is particularly useful in controlling weed species, like non-native grasses, that produce large quantities of seed and are highly competitive. Dr. Elsa Cleland of the University of California at San Diego is investigating use of non-seasonal supplemental watering to grow and kill exotic annual grasses in coastal sage scrub and grassland in coastal southern California (Elsa Cleland, UCSD, pers. comm. to John Martin, San Diego NWR). Depending on the weed species and weather conditions, multiple grow and kill cycles can be applied in a single year. In most cases, multiple grow and kill cycles are needed to significantly deplete the seed bank. Following treatment, it is imperative that the soil is not tilled or disturbed in such a way as to bring new weed seed to the surface where it can germinate. In heavily infested sites, using a season or two of grow and kill cycles prior to revegetation has the advantage of reducing the level and cost of weed management needed during the first year or two of a project.

Water Management. There are several ways that careful irrigation management can be used to help reduce weed competition. The first uses irrigation to pre-germinate weeds as described earlier; however, only one cycle is completed before planting. The second is “planting to moisture” in which, after irrigation when weeds have been killed and the top

2-3 inches of soil are allowed to dry out, this soil is pushed away and container plants and large seeded species are planted in the moist subsoil. A third technique is the use of buried drip irrigation, which is more expensive but probably most effective in small scale projects.

Cultural control can also mean modifying human behavior or activities in an effort to avoid invasive seed transport and the improper disposal of non-native and pest plant debris. "Cultural control," as discussed here, consists of awareness of the ways seeds are transported, disposal of non-native and pest plant debris, and public and staff education.

Vehicles, clothing, and equipment can disperse seeds great distances. There may be long-lived seeds of species that persist in mud, debris, and soils from infested locations. If just one seed germinates and the plant matures to reproductive age, it can start a new infestation. Before leaving a site where weeds are present, visitors and staff should be encouraged to clean equipment and to check boots, tires, etc., for the presence of weed seeds or vegetative parts. Contractors and fire personnel will also be encouraged to wash their vehicles at the Refuge maintenance facility before leaving San Diego or when moving from a weed infested area to a weed-free area.

As a general prevention measure, the amount of existing vegetation or soil that is disturbed or destroyed during Refuge operations will be minimized. Additional prevention measures include the use of weed-free seed, hay, pellets, mulch, fill, gravel, soil, and mineral materials. All plant materials used for restoration will be free of weeds and pathogens and obtained from a reputable nursery supplier. Straw wattles and other materials used for erosion control stabilization should be certified weed seed free. In addition, power washing or using compressed air to clean vehicles and equipment before entering the Refuge may be required as needed to reduce the spread of weeds into the Refuge.

A number of construction and restoration projects are ongoing or planned for the near future at San Diego NWR. These activities have the potential to create a large amount of ground disturbance and therefore should incorporate weed prevention measures, starting with the planning phase and looking at how to minimize the area of disturbance. Known weed populations should be treated prior to the start of a project, and areas to avoid should be flagged. Construction and restoration contracts can be written with language requiring preventative measures. A few examples provided by the University of Nevada Cooperative Extension (Siegel and Donaldson 2003) include:

- Provide training to construction workers and equipment operators on the identification of weeds to be avoided;
- Certify that all construction material sources used for supplies of sand, gravel, rock, and mulch are weed-free prior to obtaining or transporting any material from them;
- Clean (power or high-pressure cleaning) all vehicles and equipment of mud, dirt, and plant parts prior to bringing them to the Refuge;

- Wash or use an air compressor to blow clean all vehicles (including tires and undercarriage) that may have entered weed-infested areas prior to moving to an uninfested area of the job site; and
- Revegetate using seed and other plant materials that are certified as weed-free.

Cultural control extends into how weed debris is managed. It can be removed from the ground and either left on site for consumption during a prescribed burn or moved to another area for pile burning at a later date. Ultimately, the debris should be burned so that it does not add to solid waste. Extra care is necessary when weed debris is moved off-site in order to avoid contaminating other areas with live plants and seed.

Cultural control includes educating people and encouraging them to adjust their activities and surroundings to minimize the spread of weedy species. By carefully managing recreational use and educating the public on the potential impacts of recreational activities on vegetation, the amount of damage to native vegetation and soil can be minimized at high use areas. Early detection in recreation areas is focused on roads and trails where much of the weed spread occurs.

At San Diego NWR, information will be provided to the public in the form of signs, interpretive displays, brochures, and programs about the threat of non-native and pest plant species and about the need to control them. Volunteer days spent pulling weeds or de-thatching in endangered species habitat areas present opportunities to educate the public about invasive species, their impacts on wildlife, and how people can help reduce the problem.

Cultural control also extends to Refuge staff. Weed information, primarily as flyers and emails, will be disseminated to the staff on how to identify priority weed species on the Refuge. Refuge staff and contractors will also attend briefings as needed for specific projects on the appropriate best management practices that must be employed.

Early Detection and Identification of Pests

Regular inventory and monitoring will be essential to detecting and addressing invasive weed outbreaks in a timely manner. Currently, there is no comprehensive inventory of weed infestations on the Refuge. In March 2011, a SDNWR and Service Region 8 Inventory and Monitoring Program initiated a pilot program to inventory and map weeds, as well as to plan and prioritize management of invasive exotic plants on the Refuge. As part of this program, in May 2011, the Refuge contracted a private cooperator to map infestations of selected weed species on the 1,186-acre Rancho San Miguel Mitigation Bank located within the Refuge. Infestations were mapped by helicopter. This novel method appears to be an efficient means of mapping weeds over large areas of challenging terrain.

Monitoring is also important following weed control efforts. Future treatment areas on the Refuge will be monitored to assess effectiveness of treatment and to guide follow-up

treatments if necessary. Continued monitoring of treatment sites should be yearly, at a minimum, and preferably multiple times a year during the first three to four years of treatments.

Assessment Protocol

A prioritization strategy is necessary to effectively use the limited funds available to eradicate or control the many non-native species found throughout the Refuge. The first step in prioritizing species and treatment sites is to assess all non-native and pest species, ranking them according to their actual or potential negative impact on native biodiversity and Refuge management.

Through the National Wildlife Refuge System's Inventory and Monitoring Program that began in March 2011, San Diego NWR has been developing a methodology for prioritizing exotic plant infestations and potential infestation by plants that do not currently occur on the Refuge. Initially, the prioritization system, which is still in development, was based on *An Invasive Species Assessment Protocol* (Morse et al. 2004), a collaborative effort of NatureServe and The Nature Conservancy. The protocol considers the factors presented here when assessing invasive species impacts and prioritizing target species and treatment sites.

- Ecological impact: impacts on native plant and animal populations, ecosystem processes, and ecological community structure and composition; and the significance of those species and communities that are threatened (i.e., rare, endemic, keystone, or T&E species; unique ecosystems).
- Current distribution and abundance: size of infestation, proximity to valuable resources, and diversity of habitats or ecological systems invaded.
- Trend in distribution and abundance: the potential for spread, especially to new, uninfested areas; the rate of spread; and reproductive characteristics.
- Management difficulty: susceptibility to treatment/difficulty of control, accessibility of sites, and potential for control methods to affect non-target species.

At roughly the same time that the Refuge began this prioritization project, a similar project was initiated by the Conservation Biology Institute (CBI) and the San Diego Management and Monitoring Program (SDMMP) to develop a regional framework and strategy for management of invasive plants. This project covers a broader geographic area that includes the Refuge, and it addresses many of the same exotic plant species and listed and sensitive species and habitats. Biologists at the Refuge will review the document developed by CBI and the SDMMP and incorporate sections and ideas into our prioritization scheme as appropriate.

A high impact rank does not always translate into a high priority for treatment. Other considerations such as cost or likelihood of success can change priorities. For instance, the suite of exotic annual grasses that are responsible for the type conversion of some stands of coastal sage scrub severely impact multiple federally listed species and so have a high impact

rank. However, because they are ubiquitous across the landscape, a Refuge-wide eradication strategy is not likely to succeed and is not the best use of limited funds. On the other hand, a species that may rank low in these areas could be a high priority for treatment if it is a new or small infestation and can be readily eradicated.

This assessment can be applied to a species Refuge-wide (targeted species approach) or to one or more species within a management area (resource-based Refuge management unit approach). Integrated pest management at San Diego NWR will include both a site-specific management strategy, using occurrences of high-quality habitat for particular listed and sensitive species or co-occurrences of such species, and a targeted species approach. Both approaches will enable Refuge staff to shift management priorities as needed to best address sensitive species management needs and take advantage of a variety of funding opportunities.

Targeted Exotics Approach

Where control of an exotic species is likely to successfully eradicate it from a large area of the Refuge, reduce its populations to the extent that wildlife populations will benefit for a prolonged period, or reduce or eliminate its potential for spread, that exotic species will be targeted for control wherever it occurs on the Refuge. For example, carnation spurge (*Euphorbia terracina*) is not known to occur on the Refuge, but it has a high potential for spread and is highly deleterious to native biota. Furthermore, its first occurrence on the Refuge is likely to be relatively small and thus an eradication program will more likely be successful than it would be if we waited until the occurrence got larger or threatened a specific, identifiable resource.

Targeted Resource Approach

A targeted resource approach will be used when a spatially-explicit specific wildlife resource (e.g., a high-quality habitat patch for a rare species or a habitat patch that supports multiple sensitive species) is threatened by exotic species, we will use a targeted resource approach to reduce exotic species impacts on the resource(s), even though probability of eradication Refuge-wide is low and complete eradication will not be attempted.

Manual, Mechanical, and Physical Control

Manual, mechanical, and physical methods will be used as appropriate to remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand and hand tools (manual), power tools (mechanical), and physically removing the plants by pulling, grubbing, digging out root systems, cutting plants at ground level, and removing individual competing plants around desired species. Other methods may include “topping” annual weeds prior to seed set, placing mulch around desired vegetation to limit competitive growth, tilling/disking, cutting, swathing, grinding, sheering, girdling, mowing, or mulching of the pest plants. Other types of physical control may include solarization, prescribed fire, and the use of flamers.

Depending upon the circumstances, each of these methods provides variable degrees of success and is generally applicable to a specific situation. Treatments such as hand pulling and hoeing are most effective where the weed infestation is limited and soil types allow for complete removal of the plant material (Rees et al. 1996). Additionally, pulling works well for annual and biennial plants, shallow-rooted plant species that do not resprout from residual roots, and plants growing in sandy or gravelly soils. Repeated treatments are often necessary due to soil disturbance and residual weed seeds in the seed bank.

Manual techniques can be used in many areas and usually with minimal environmental impacts. Although they have limited value for weed control over a large area, manual techniques have the advantage of being highly selective so that impacts to desirable native plants can be minimized. Manual treatment can be used in sensitive habitats such as riparian areas, areas where burning or herbicide application would not be appropriate, and areas in which weeds are interspersed within a community of native plants. Manual treatments are expensive and labor intensive compared to other vegetation management methods such as prescribed burning and herbicide application. Manual methods may present some danger to the workers involved in implementation because of the use of sharp tools and possibly steep terrain. Some weeds may contain potentially toxic or hazardous compounds. While manual techniques may not be very efficient or cost effective over large acreages, they may be very useful for highlighting specific invasive species problems and for educating public land users. Care must be taken to thoroughly inspect and clean equipment and clothing before moving off-site to avoid dissemination of weeds.

If timed correctly, mechanical controls can effectively suppress most annual and biennial pest plants. To control perennial plants, the root system has to be destroyed or it will resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plant's root system. Although some mechanical tools (e.g., disking, plowing) may damage root systems, they may stimulate regrowth, producing a denser plant population that may aid in the spread of the plant, depending upon the target species (e.g., giant cane [*Arundo donax*], perennial pepperweed [*Lepidium latifolium*]). In addition, proximity to sensitive species and/or habitat and existing soil conditions are factors that can limit the use of many mechanical control methods.

One advantage to mechanical control methods is that they are not harmful to sensitive ecosystems in the same way that herbicides can be; however, some mechanical methods will affect non-target vegetation, and the use of heavy equipment can damage sensitive soils such as cryptobiotic crusts. Care must be used with mechanical methods, as new disturbance can create additional opportunities for weedy invasive species. A major disadvantage is that often mechanical control takes a long time to become effective and is very labor intensive. It is important to thoroughly clean and inspect all equipment prior to moving it off-site. Mechanical methods are widely used on national wildlife refuges with large areas of alluvial soil but have not been used extensively on San Diego NWR, in part because of its steep rocky terrain and prevalence of sensitive soils and species.

Mowing tools, such as rotary mowers or straight-edged cutter bar mowers, can be used to cut herbaceous and woody vegetation above the ground surface. Mowing is often done along highway rights-of-way to reduce fire hazards, improve visibility, prevent snow buildup, or improve the appearance of the area. Mowing is also used in sagebrush habitats to create a mosaic of uneven-aged stands and enhance wildlife habitat. Mowing is most effective on annual and biennial plants (Rees et al. 1996). Weeds are rarely killed by mowing, and an area may have to be mowed repeatedly for the treatment to be effective (Colorado Natural Areas Program 2000).

Combining mechanical control methods (e.g., mowing, stump cutting) with the use of herbicides can be a very effective technique for controlling perennial species. For example, cutting perennial plants, followed sequentially by treating the cut stump with a systemic herbicide, often improves the efficacy of the herbicide compared to herbicide treatment only. The combination of mechanical and herbicide control will be used from time to time on the Refuge to control invasive plants such as Brazilian peppertree (*Schinus terebinthifolius*), Peruvian peppertree (*Schinus molle*), tree tobacco (*Nicotiana glauca*), and tree-of-heaven (*Ailanthus altissima*). Another example is the use of a "wet blade," in which an herbicide flows along the mower blade and is applied directly to the cut surface of the treated plant; this has greatly improved the control of some species. At San Diego NWR, mowing may be used to remove above-ground biomass of some species, such as *Malva parviflora*, prior to seed set. Mowing is not recommended on species that can sprout from stem or root fragments unless cut fragments will be collected.

Soil solarization is a non-chemical method for controlling diseases, pests, and weed seed in the seed bank. It has been traditionally used in agricultural settings but is also applicable to weed management in habitat restoration settings (Bainbridge 1990). This method is usually not 100 percent effective; repeated treatments or use integrated with other methods will generally yield the best results. This simple technique captures radiant heat energy from the sun, thereby causing physical, chemical, and biological changes in the soil. Transparent polyethylene plastic placed on moist soil during the hot summer months increases soil temperatures to levels lethal to many soil-borne plant pathogens, weed seeds, and seedlings (including parasitic seed plants), nematodes, and some soil residing mites. Soil solarization also improves plant nutrition by increasing the availability of nitrogen and other essential nutrients.

Prescribed fire is the intentional application of fire to wildland fuels under specified conditions of fuels, weather, and other variables. The intent is for the fire to stay within a predetermined area to achieve site-specific resource management objectives. Prescribed fire may be necessary to restore the natural fire regime and is used to control vegetation; enhance the growth, reproduction, or vigor of fire-dependent species; manage fuel loads; and maintain vegetation community types that meet management objectives (USDI BLM 1996). Burning may be used prior to other treatments to remove vegetation (such as exotic annual grass

thatch) that reduces the effectiveness of various treatments, including herbicide applications (Rees et al. 1996).

All fire treatments must be implemented according to Service fire management policy and the Refuge Fire Management Plan. A Prescribed Fire Plan is a standalone legal document that provides the prescribed fire burn boss all the information needed to implement the project. Prescribed fire projects must be implemented in compliance with the written plan. Several factors are considered when designing a burn plan and implementing a prescribed burn. These include weather conditions; vegetation types and density; slope; fuel moisture content; time of year; risks to dwellings and property; alternative treatment methods; and potential impacts on air quality, land use, cultural resources, and threatened and endangered species. Coastal sage scrub, chaparral, and grassland vegetation types on the Refuge have evolved in an environment in which fire is a natural phenomenon, and the native vegetation and wildlife communities are, in many ways, dependent on periodic fire to create and maintain conditions necessary for survival and reproduction. However, as noted previously, a combination of increasing human population (resulting in higher ignition frequency) and prevalence of exotic annual grasses throughout the landscape (resulting in rapid redevelopment of fuel loads in previously burned areas) have led to shorter fire intervals than those with which coastal southern California wildlife and plants evolved, facilitating the conversion of native vegetation communities to exotic-dominated communities. Thus, controlled burning has high potential to exacerbate the very problems that it may be used to remedy. In addition, the proximity of San Diego NWR to dense residential and commercial development and the occurrence of multiple mega-fires in the last decade resulting in regionally significant environmental impacts and tragic losses of life and property create a political and social climate in which public acceptance of prescribed fire as a management tool is problematic. Under the current Refuge Fire Management Plan, the policy is for complete suppression of fire. Use of prescribed fire in this environment will have to be undertaken very carefully, if at all.

At San Diego NWR, fire may be of most use in removing biomass or the remains of the previous year's growth prior to treatment with herbicides. The potential use of prescribed fire to benefit resources will have to be addressed in the Fire Management Plan.

Under circumstances where the spot application of herbicides is undesirable, the direct application of fire to individual plants can be used for weed control. Flamers are the method of choice for this technique. The following paragraph includes a summary of flamers and a discussion of the direct application of fire for spot weed control, as described by the University of California Division of Agriculture and Natural Resources in Publication 7250.

Flamers are useful for weed control. Propane-fueled models are the most common. Flaming does not burn weeds to ashes; rather, the flame rapidly raises the temperature of the weeds to more than 130°F; the sudden increase in temperature causes the plant's cell sap to expand, rupturing the cell walls. For greatest flaming efficiency, weeds must have fewer than two true leaves. Grasses are difficult to impossible to kill by flaming because the growing point is protected underground. After flaming, weeds that have been killed rapidly change from a glossy appearance to a duller appearance. Typically, flaming can be applied at a speed of 3-5 mph through fields, although this depends on the heat output of the unit being used. Best results are obtained under windless conditions, as winds can prevent the heat from reaching the target weeds. The efficiency of flaming is greatly reduced if moisture from dew or rain is present on the plants. Early morning and early evening are the best times to observe the flame patterns and adjust the equipment.

Biological Control

Classical biological control involves the deliberate introduction and management of natural enemies (e.g., parasites, predators, or pathogens) to reduce pest populations. The Service strongly supports the development and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and non-indigenous or pest species. To date, the intentional use of biological control agents has not been implemented on San Diego NWR.

Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, potentially causing widespread economic damage to crops, or to outcompete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost prohibitive or impractical. It is typically when a pest populations has become so widespread that eradication or effective control would be difficult or no longer practical that biological controls are implemented.

Biological control has advantages as well as disadvantages. Benefits include reducing pesticide usage, host specificity for target pests, long-term self-perpetuating control, low cost per acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts will develop resistance to agents. Disadvantages include limited availability of agents from their native lands, the dependence of control on target species density, slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it works well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood; whereas, others are only partially or not at all understood.

The use of biological control agents would not eradicate a target pest; rather, when using biological control agents, residual levels of the target pest typically are expected. The agent population level or survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) would tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agent's search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on the Refuge would include diseases, invertebrates (e.g., insects, mollusks), vertebrates, and invasive plants (the most common group). Often it is assumed that biological control would address many, if not most, of these pest problems. There are several well-documented success stories of biological control of invasive weed species, including Mediterranean sage, St. Johnswort (Klamath weed) and tansy ragwort. Emerging success stories include Dalmatian toadflax, diffuse knapweed, leafy spurge, purple loosestrife, and yellow star thistle. However, historically, each new introduction of a biological control agent in the United States has only about a 30 percent success rate (Coombs et al. 2004).

Before a natural enemy of an invasive species can be released in the United States for biological control, the potential agent must undergo rigorous testing to ensure that it will not harm other organisms. If a biological control agent is proposed for release on the Refuge, Refuge staff will ensure that the particular agent has been approved by the applicable authorities.

Except for a small number of formulated biological control products registered by U.S. Environmental Protection Agency (USEPA) under the Federal Insecticide, Fungicide and Rodenticide Act of 1996 (FIFRA), most biological control agents are regulated by the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service, Plant Protection and Quarantine unit (APHIS-PPQ). APHIS-PPQ review includes independent analysis by the Technical Advisory Group for Biological Control Agents of Weeds, an independent voluntary committee that is responsible for reviewing release petitions and providing an exchange of views, information, and advice to researchers. In addition, the State of California has additional approval authority. The statuary authority of the State program is provided in the State's Food and Agricultural Code. Section 403 of the Code states that the Department of Food and Agriculture "shall prevent the introduction and spread of injurious insect or animal pests, plant diseases, and noxious weeds;" and Section 405(a) states that

"with the prior approval of the Department of Fish and Game [now referred to as the California Department of Fish and Wildlife] and the Office of Environmental Health Hazard Assessment, the Department of Food and Agriculture and the Department of Pesticide Regulation may reproduce or distribute biological control organisms that are not detrimental to the public health and safety which are known to be useful in reducing or preventing plant or animal damage due to pests or diseases." The San Diego County Agricultural Commissioner may have additional approval authority; therefore, contact will be made with the Agricultural Commissioner prior to implementing any proposal to release a biological control agent on the Refuge.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biological control agents from another state. Form 526 may be obtained by writing: USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, Maryland 20737; or on the Internet at URL address: http://www.aphis.usda.gov/plant_health/permits/organism/plantpest_howtoapply.shtml.

The State of California Department of Food and Agriculture and the San Diego County Agricultural Commissioner may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds (USDA-PPQ Form 226 USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, MD 20737) to release specific biological control agents in a state and/or county. Additionally, certification regarding the biological control agent's identity (e.g., genus, specific epithet, sub-specie, variety) and purity (e.g., parasite free, pathogen free, biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 7 RM 8 (Exotic Species Introduction and Management). In addition, Refuge staff must follow the International Code of Best Practice for Classical Biological Control of Weeds (http://www.ars.usda.gov/SP2UserFiles/Place/53254300/Reports/code.pdf), as ratified by delegates to the X International Symposium on Biological Control of Weeds, Bozeman, Montana, July 9, 1999. This code states the following:

1. Ensure target weed's potential impact justifies release of non- endemic agents.
2. Obtain multi-agency approval for target.
3. Select agents with potential to control target.
4. Release safe and approved agents.
5. Ensure only the intended agent is released.
6. Use appropriate protocols for release and documentation.
7. Monitor impact on target.

8. Stop releases of ineffective agents, or when control is achieved.
9. Monitor impacts on potential non-targets.
10. Encourage assessment of changes in plant and animal communities.
11. Monitor interaction among agents.
12. Communicate results to the public.

Biological control agents formulated as pesticide products and registered by the USEPA (e.g., *Bti*) are also subject to PUP review and approval.

A record of any releases will be maintained by the Refuge staff with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

Prior to using any biological control agents, the Service would prepare a National Environmental Policy Act (NEPA) document (e.g., EA, environmental impact statement) that addresses the potential biological and other environmental effects of using the proposed biological control agent. The Service would also review and, where appropriate, incorporate by reference information included in NEPA documents prepared by another Federal agency, where the scope is relevant to evaluation of releases on Refuge lands. Possible source agencies for such NEPA documents include the Bureau of Land Management, U.S. Forest Service, National Park Service, U.S. Department of Agriculture Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 CFR 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

Another potential form of biological control is the use of domestic animals, such as cattle, sheep, or goats, to control the top growth of certain non-native invasive and noxious weeds, which can weaken the plants and reduce their reproduction potential. The animals benefit by using the weeds as a food source and can, after a brief adjustment period, consume weeds as 50 percent or more of their daily diet, depending on the animal species (Tu et al. 2001). Grazing can be used to affect ecological processes and alter the vegetation community. Prescribed grazing is used to enhance and maintain habitat for the federally endangered Bay checkerspot (*Euphydryas editha bayensis*) (Weiss 1999). Grazing may be an effective strategy to the improve habitat for the Quino checkerspot on the Refuge. Cattle primarily eat grass but also eat some shrubs and forbs. Sheep consume many forbs, as well as grasses and shrubs, but tend not to graze an area uniformly. Goats typically eat large quantities of woody

vegetation, as well as forbs, and tend to eat a greater variety of plants than sheep (USDI BLM 1996, Tu et al. 2001). Goats and sheep are effective control agents for leafy spurge, Russian knapweed, toadflax, other weed species, and some types of shrubs (Colorado Natural Areas Program 2000).

In order for this treatment to be effective, the right combination of animals, stocking rates, timing, and site rest must be used. Grazing by domestic animals should occur when the target species is palatable and when feeding on the plants can damage them or reduce seed set and dissemination as much as possible. Additionally, grazing should be restricted during critical growth stages of desirable competing species. When desirable species are present, there needs to be adequate rest following the treatment to allow the desirable species to recover.

Whenever the use of livestock to control undesirable vegetation is being considered, the needs of the domestic animals, as well as the other multiple use objectives for the area, must be considered. A herder, fencing, or mineral block may be required to keep the animals within the desired area. Many weed species are less palatable than desired vegetation, so the animals may overgraze desired vegetation rather than the weeds. Additionally, some weeds may be toxic to certain livestock and not to others, which will influence the management option selected (Tu et al. 2001). Proper management of the domestic animals is extremely important if this method of treatment is to be successful (Olson 1999). In addition, the livestock operator must have adequate financial incentive to adhere to a grazing protocol that will achieve the desired natural resource management objectives.

Grazing is not widely used for management of wildlife habitat in the San Diego area, nor have wildlife biologists in the San Diego area natural resource conservation community embraced it as a management tool (except the use of goats for fuel modification at the wildland-urban interface). Multiple studies document that livestock grazing dramatically reduces lichen/moss cover and species richness of cryptobiotic crusts (Belnap et al. 2001). Before this technique is implemented on San Diego NWR, further analysis in accordance with the National Environmental Policy Act (NEPA) would be required.

Pesticides (Chemical Control)

The size of some infestations and/or the characteristics of some species, which cannot be controlled by physical or mechanical means or by cultural methods alone, will require the use of pesticides. The selective use of pesticides on the Refuge will be based upon pest ecology (including mode of reproduction), the size and distribution of its populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to utilize BMPs to reduce and/or eliminate potential effects to non-target species, sensitive habitats, and the potential to contaminate surface and groundwater. All pesticide usage, including the type of product used, target species, application rate, and method of application, will comply with the applicable Federal (FIFRA) and State regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on Refuge lands and waters, pesticide use

proposals (PUPs) must be prepared and approved in accordance with Section 569 FW 1 of the Service Manual. PUP records will provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on the Refuge. All PUPs will be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service's intranet (https://systems.fws.gov/pups). Only Service employees would be authorized to access PUP records in this database.

Herbicides, which are chemicals that kill or injure plants, are widely used for controlling weeds and are generally considered an effective eradication tool under most circumstances. They are classified by their mode of action and include growth regulators, amino acid inhibitors, grass meristem destroyers, cell membrane destroyers, root and shoot inhibitors, and amino acid derivatives, all of which interfere with plant metabolism in a variety of ways (Bussan and Dyer 1999). Herbicides can also be selective or non-selective. Selective herbicides kill only a specific type of plant (e.g., broad-leaved plants). An herbicide selective for broad-leaved plants would allow control of broad-leaved noxious weeds while maintaining desirable grass species. Other herbicides (e.g., glyphosate) are non-selective; therefore, care must be used around non-target plants (Rees et al. 1996).

Herbicides considered for use on the Refuge include Milestone and Milestone VM, active ingredient aminopyralid**;** Envoy Plus, Prism, Select Max, Select 2EC and Tapout, active ingredient clethodim; Telar XP, active ingredient chlorsulfuron; Fusilade DX, active ingredient fluazifop-p-butyl; Glyphosate Pro 4, AquaNeat, Buccaneer, Makaze, Prosecutor, Razor Pro, and Extra Credit 5, active ingredient glyphosate; Surflan AS and Surflan WDG, active ingredient oryzalin; and Garlon 3A, Garlon 4, Pathfinder II, and Remedy, active ingredient triclopyr. More information about these products can be found in the Chemical Profiles provided in Attachment B of this appendix, and additional information about how these products are used on the Refuge can be found in Chapter 2 of the Final CCP.

Pesticide application equipment is selected to provide site-specific delivery to target pests while minimizing or eliminating direct or indirect (e.g., drift) exposure to non-target areas and degradation of surface water and groundwater quality. Where possible, target-specific equipment (e.g., backpack sprayer, wiper) will be used to treat target pests. Other target-specific equipment to apply pesticides could include use of a hand wand attached to an ATV sprayer; soaked wicks or paint brushes for wiping vegetation; and lances, hatchets, or syringes for direct injection into stems. If used, granular pesticides would be applied using seeders or other specialized dispensers. No aerial spraying (e.g., fixed wing or helicopter) is proposed on this Refuge.

Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action will be considered for treatments on Refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season are necessary for habitat maintenance and

restoration activities to achieve resource objectives. Integrated chemical and non-chemical controls also are highly effective, where practical, because pesticide resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on a refuge. If the least expensive pesticide could result in harm to natural resources or people, then a different product will be selected. The most efficacious pesticide available with the least potential to degrade environment quality (e.g., soils, surface water, and groundwater), as well as the least potential effect to native species and communities of fish, wildlife, plants, and their habitats, would be acceptable for use on the Refuge in the context of an IPM approach.

Habitat Restoration and/or Maintenance

Restoration and/or proper maintenance of Refuge habitats associated with achieving wildlife and habitat objectives is the most important step that can be taken to ensure the long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Masters et al. 1996, Masters and Shelly 2001, Brooks et al. 2004). Although herbicide treatment may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with site-appropriate native plant species is necessary to direct and accelerate plant community recovery and to achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors, including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/ temperature regimes, and shade conditions). Seed or plant availability and cost, ease of establishment, seed production, and competitive ability are also important considerations.

The San Diego NWR CCP includes objectives and associated strategies for managing existing habitats to maximize habitat quality. The strategies proposed for implementation to achieve this objective include monitoring and maintaining native plant restoration areas to ensure that these areas are not reinvaded with invasive non-native plants and initiating the timely revegetation of treated areas with appropriate native plant species to reduce the potential for reinvasive of the treated sites. Additionally, the CCP includes objectives for restoring native habitats that are currently dominated by non-native weedy species. The implementation of these various strategies will reduce the numbers of plant pests on the Refuge, as well as reduce the need for continued chemical and mechanical control of infested sites.

Revegetation with native species following treatment may be used to restore the native plant community, to eliminate or reduce the conditions that favor invasive species, and/or to competitively exclude some exotics, with the ultimate goal of providing habitat for wildlife. Complete reestablishment of a native plant community may not be possible. Reseeding or

replanting may be required to revegetate sites in which the soil has been disturbed or vegetation removed and where there is insufficient native vegetation or soil seed bank for natural succession to revegetate the site. In some cases a revegetation plan that describes specifically the plant palette, seed mixes, and maintenance regime may be necessary to guide revegetation efforts.

All seed, plant materials, and methods used for revegetation projects will be approved and implemented under the supervision of the Refuge Biologist. Preferably, seed and plant materials from local genetic stock will be used. All planting and seeding will be done at an appropriate time of year and conditions or as directed by Refuge staff. Planting and seed mixtures will be adapted for the treatment area and site uses. The seeding and planting palettes will include a variety of species to enhance the value of the site for wildlife and improve aesthetic quality.

Several standard operating procedures for site revegetation are described here.

- Prior to revegetation, all weed infestations must be under control. With heavy infestations, multiple herbicide treatments are expected prior to seeding and planting to ensure follow-up maintenance is reduced. However, reseeding after an initial herbicide treatment that is followed by tilling may be possible when using competitive native grasses that are tolerant of the herbicide being used.
- The soil will be prepared for planting and seeding as necessary. Depending on the site this may include re-contouring to mimic the natural surface contours and decompaction. The soil surface should be textured (e.g., pitted, imprinted, trackwalked, scarified) so that seed will remain on the site and not be blown away after it is sown. Pre-plant fertilizers are rarely required, as most native species are adapted to grow under lower soil nitrogen conditions, and plants that have been fertilized may be preferentially grazed by herbivores. However, in areas where cryptobiotic soil surface crusts are well-developed, disturbance of the soil surface will be minimized.
- Follow-up monitoring and maintenance will be required. The success and failure of revegetation projects often depends on these activities. During the first growing season after installation, at least three spot spray treatments with an approved herbicide or manual removal should be expected. The amount of follow-up treatments is expected to decrease during subsequent growing seasons.
- All follow-up weed maintenance must be done before the weeds have an opportunity to set and disseminate seed.
- Revegetate sites once work is completed or soon after a disturbance.
- Use seed that is free of noxious and invasive weeds.
- Use clean equipment, free of plants and plant parts, on revegetation projects to prevent the inadvertent introduction of weeds into the site.

During revegetation, clearing or removal of native plant materials should be restricted for an appropriate period of time to allow native vegetation to become established and reduce the probability that weeds will reestablish on the site. This includes brush removal for fire protection.

Revegetation preplanning is essential. Mature seed must be collected within the appropriate geographic area or purchased ahead of time. However, there are a few companies that sell seed of native plants. If seed is obtained from a commercial dealer, seed lots with high purity rates must be used. With commercially grown seed, there is the potential for seed lots to contain weedy species, and this must be carefully monitored. Because much of the seed applied is likely to be eaten by insects and wildlife, a typical application rate of 30 pounds of pure live seed per acre should be used. If seed is applied by hand, a carrying agent should be used to help evenly distribute the seed as it is being applied; rice hulls, cracked wheat, or bran can be mixed (50 percent by volume). In smaller areas, after seeding, the surface can be lightly raked to cover the seed.

Salvaged materials, transplants, and container stock can also be used to establish trees, grasses, shrubs, sedges, and rushes. The advantage of using these materials is that they provide immediate improved habitat structure and can facilitate more rapid reestablishment of a native vegetation community. Plantings should ideally be done at the end of the dry season (i.e., October-November) to take advantage of the spring growing season for the best growth and survivorship. Tree shelters or wire cages should be placed around young woody transplants in areas where there is a high risk of grazing from herbivorous animals. If using transplanted container stock, provisions must be made for irrigation. In remote areas, hand watering and watering with a water truck are practical alternatives. The bottom of planting holes should be filled with some water just prior to planting to reduce transplant shock. Container stock should be hardened off on or near the site for at least a week prior to planting. All transplant material removed from a donor site should not exceed 10 percent of the total vegetative cover for that area.

VII. IPM Strategies for Invasive Animals

As with weeds, the prevention of introduction of non-native animals is the cheapest and most effective control method, followed by early detection and eradication. However, because animals are more difficult to detect in the landscape than plants, there is likely to be a time lag between an introduction and detection, during which time impacts to native species and ecosystems are occurring. It may be necessary in the future to control invasive animal species on the Refuge to protect listed or sensitive species; therefore, this IPM Plan addresses the various forms of control that could be implemented on the Refuge.

Table 4 lists the invasive animal species that will be targeted for management at San Diego NWR. This list is intended to be living document that will need to be reviewed and updated biennially or as more information is gained.

Prevention and Early Detection of Invasive Animal Species

Simple changes to everyday activities can go a long way toward preventing establishment or spread of invasive species; however, human behavior often makes this hard to accomplish. All the exotic animals that currently or potentially present problems on the Refuge have been introduced intentionally. A public that is informed of the causes of these introductions and the problems associated with them is more likely to assist in their prevention. Therefore, the Refuge should continue to produce and display interpretive materials on invasive species and their impacts on the native wildlife of coastal southern California.

Table 4 - Invasive Wildlife Species Targeted on San Diego NWR

Scientific Name	Common Name
Felis catus	Domestic cat
Molothrus ater	Brown-headed cowbird
Rana catesbeiana	Bullfrog
Xenopus laevis	African clawed frog
Trachemys scripta	Red-eared slider
Trionyx spinifera	Spiny soft-shelled turtle
Micropterus salmoides	Largemouth bass
Gambusia affinis	Mosquitofish
Lepomis cyanellus	Green sunfish
Cyprinus carpio	Carp
Procambarus clarkii	Red swamp crayfish
Corbicula fluminea	Asian clam
INVASIVE WILDLIFE WATCH LIST	
Sus scrofa	Pig
Meleagris gallopavo	Wild turkey

Inventory and Monitoring

Regular monitoring of Refuge lands is essential to detecting new non-native animal species and preventing their spread. The best way to monitor aquatic habitat is through a trapping program, which also aids in controlling non-native fish and crayfish. Such a program would be implemented for the Refuge's wetland areas if and when funding is identified to support such a program on a regular basis.

Prioritization of Target Management Units and Species

Criteria for Prioritization

The prevention and early detection of non-native animal species is an essential component of an IPM program; however, given the resources available, the following criteria would be used to rank target species and management units:

- Ecological impact;
- Current distribution and abundance;
- Trend in distribution and abundance; and
- Management difficulty.

Impacts that would be considered include the threat to San Diego endemic and federally-listed species, the threat to ecosystems that support listed species (*e.g.,* reduce aquatic productivity), the threat to previous habitat restoration projects (*i.e.,* the continued success of previous projects), the potential to transform from a local to Refuge-wide infestation, and the level of effort needed to eradicate or contain the invasive species (see *Eradication vs. Containment*).

Target species would typically receive the highest priority; however, new infestations of non-native, invasive animal species should take precedence to contain and, ideally, eradicate.

Eradication vs. Containment

Some listed species habitat units and target species may be classified for either "eradication" or "containment" of invasive species. The size of an infestation, its pervasiveness, its potential impact, and management difficulty would determine whether the goal is eradication or containment.

Eradication is defined as the "elimination of pest species at a given site." These sites represent areas that have a new or small infestation that can easily be eradicated or areas that are high priority sites due to hydrological restoration activities. For instance, a relatively confined population of African clawed frog would be targeted for eradication.

Containment is defined as "limitation to the current site/management unit with no expansion." The sites chosen under this category contain large infestations or species for which total eradication would be difficult or impossible (e.g., bullfrogs, bass) without unacceptable loss of native species. The goal of containment is to not allow further growth of the species' population or expansion into uninfested areas of the Refuge. The goal for mosquitofish and crayfish would likely be containment via best management practices, with the potential for control if listed species are introduced or detected on the Refuge that may be impacted by these invasive species.

Invasive Animal Control Methods

A variety of control methods may be employed on the Refuge to control invasive animal species. Treatment methodologies would be selected based upon the best information available from pest management literature and professional expertise. The most appropriate treatment for an infestation typically depends on the size of the infestation and on the biology and ecology of the target species (Evans et al. 2003a). Non-native animal management techniques are expected to change and become more refined as more experienced is gained.

Cultural controls would be implemented to reducd the potential for the introduction of nonnative animal species onto the Refuge. In addition, Service employees or their authorized agents may use mechanical or physical methods (including trapping) to control animal pests. Trapping is permitted on refuges in accordance with 50 CFR 31.2, which allows trapping to reduce surplus wildlife populations for a "balanced conservation program" in accordance with Federal or State laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the California Department of Fish and Wildlife (CDFW).

Cultural Control

Cultural control methods include a broad range of normal management practices that can be modified or manipulated to manage one or more pest problems, usually by minimizing the conditions those pests need to live (e.g., water, shelter, food). The intent of cultural control is to shift the competitive balance towards native species.

Physical Control

Exclusion and Barriers. Animal invasives can sometimes be excluded from an area by simple barriers. Fish barriers have been used successfully in Ash Meadows NWR to prevent movement of non-native fish. Research is being conducted on the use of electrical barriers for fish and for mitten crabs. Electrical barriers have been installed in Central Arizona Project canals to prevent the movement of Colorado River fishes into the Gila River drainage (Clarkson 2004, Dawson and Kolar 2003). This technology might eventually prove useful at San Diego NWR to control the movements of bass, green sunfish, and perhaps, crayfish.

Fish barriers would be considered in the planning for all hydrological systems undergoing restoration on the Refuge. However, barriers have disadvantages such as construction costs, maintenance costs, environmental impacts, and prevention of native amphibian movements (Dawson and Kolar 2003). Since barriers are effective only when intact, another disadvantage as a control method comes from their vulnerability to human tampering. It may not take long to undo an exclusion that took months or years to achieve. In addition, seasonal high-flow events are likely to make physical or electronic barriers impracticable in the Sweetwater River.

Trapping. Trapping is the most commonly employed method of non-native aquatic species removal. When infestations are pervasive, trapping is rarely effective at eliminating all individuals of a species, but keeping the invasive species controlled can reduce impacts on native species until a better method is available. The type of equipment used depends on the species and the habitat being trapped.

Several different types of metal mesh "cages" can be used for exotic species removal. We anticipate working with U.S. Geological Survey (USGS) biologists to obtain information regarding the most effective traps to control bullfrogs, bass, green sunfish, and crayfish.

Dip nets may be used to scoop mosquitofish from the surface. Gill nets and trammel nets have been used in other locations such as spring pools and streams to capture bass and are most effective when left overnight. Mesh sizes vary but are large enough that native fish are not caught. However, steps would have to be taken to address the potential for other non-target species, such as diving ducks, to become entangled in the nets and drown.

Spears may be used in river pools and reservoirs to remove bass, sunfish, and bullfrogs. Bullfrog gigging, which is used elsewhere to control bullfrog populations, is conducted at night by first spotlighting and then spearing the frog.

Fishing. Targeted fishing or overharvesting of specific species of fish has been used to regulate fish populations in other areas, but it has not resulted in elimination of a species (Dawson and Kolar 2003). If utilized, this technique would be conducted by Refuge staff, other agency staff, or a contractor, as public fishing is not proposed on the Refuge.

Electrofishing was originally used as a means of sampling fish for population estimates. It involves using a power unit, transformer, and electrodes to pass a field of electricity through the water that interferes with the neurological pathway between the brain and muscles of the fish (Allen-Gil 2000). It does not kill the fish but stuns it, allowing its capture and removal.

Electrofishing is size selective: the smaller the fish, the greater the current necessary to affect it. Increasing the field strength to capture smaller fish will increase mortality due to the higher voltage gradient (Couchman 2006). This size selectivity allows use on bass with reduced risk of mortality to native fauna (e.g., amphibian larvae). Electrofishing efficiency can also be affected by stream conductivity, temperature, depth, clarity of water, and vegetation.

Biological Control

Potential biological control methods currently being investigated throughout the United States for controlling non-native species include the use of living organisms, biopesticides, biochemicals, genetic manipulation, and fertility control (Dawson and Kolar 2003).

The use of living organisms involves using natural enemies of the pest species or disease-causing organisms. The use of a disease-causing organism would require that the organism be species-specific and not capable of adaptation to new hosts (Dawson and Kolar 2003). At this time, there are no organisms that meet those requirements for the non-native aquatic species found in the San Diego region. As for using a natural enemy, it would be difficult to find a predator of a non-native species that would not also affect native species. Therefore, there are no plans to introduce a new living organism to San Diego NWR for the purposes of controlling non-native species.

Biopesticides are materials derived from natural sources and include biochemicals that control non-native species by non-toxic means. Pheromones are one type of biochemical that is species-specific; some are attractants and others are repellents. Pheromones might some day be used to interrupt mating behavior or to lure non-native species into traps (Dawson and Kolar 2003), but that knowledge does not yet exist for the species of interest on the Refuge.

Genetic manipulation can potentially be used to create monosex populations of fish, and fertility control using an immuno-contraceptive agent that is species-specific has also been proposed in some locations (Dawson and Kolar 2003). However, due to the connectivity between Refuge waters and off-Refuge waters where no exotic species control occurs, this method is unlikely to be effective.

Chemical Control

Species that cannot be controlled by a combination of cultural methods, trapping, netting, electrofishing, and barriers may require the use of chemicals. Pesticides used to kill fish are called piscicides, and include such chemicals as rotenone and antimycin. Use of piscicides on San Diego NWR, which is not currently proposed, is likely to be problematic because of the connectivity between the Refuge and drinking water sources (i.e., Sweetwater Reservoir) and urban areas where people, pets, and livestock downstream may be at risk of exposure (e.g., Mother Miguel pond, Steele Canyon Creek).

Targeted Aquatic Species

No quantitative surveys have been conducted for exotic aquatic species on San Diego NWR. Incidental observations indicate that bass and green sunfish occur throughout suitable habitat in the Sweetwater River but not in Steele Canyon Creek or in the Mother Miguel pond. Crayfish occur throughout the Sweetwater River and Steele Canyon Creek. Therefore, if a program to control aquatic exotic species is undertaken, it is likely to have to continue for the foreseeable future, as populations on the Refuge will be continually supplemented by immigrants.

Biologists at the Western Ecological Research Center, USGS, Biological Resources Division, have been investigating control methods for bass, bullfrogs, green sunfish, and crayfish in the

Sweetwater River in Sloane Canyon, approximately six miles upstream from the Refuge. Their control efforts have been under way for approximately three years. They are analyzing their data and will share information regarding methodology, cost, and effectiveness. This information is expected to inform our efforts to manage aquatic invasive animals on the Refuge.

African Clawed Frogs

Refuge staff have discussed with biologists from the California Department of Fish and Wildlife and USGS the possibility of introducing sensitive aquatic species (i.e., southwestern pond turtle and/or red-legged frog) on the Refuge, specifically at Mother Miguel pond. The only exotic vertebrate known to occur there is African clawed frog. This pond has four ponds in its upstream watershed on the Salt Creek Golf Course, property owned and managed by Otay Water District. This upstream watershed is sufficiently small and so disjunct from other waters infested with exotic aquatic animals that an eradication effort here is likely to have lasting benefit to aquatic wildlife on the Refuge, notably in Mother Miguel pond.

Largemouth Bass

Although no quantitative surveys for bass have been conducted on the Refuge, incidental observations show that bass occur throughout the Sweetwater River, but they have not been observed in other perennial waters on the Refuge (i.e., Mother Miguel pond or Steele Canyon Creek). There are established populations of bass in Loveland Reservoir, Sweetwater Reservoir, and presumably all of the perennial water in between. Controlling immigration of bass into the Refuge from populations either upstream or downstream using physical barriers is likely to be impracticable and ineffective, given the seasonal high-flow events in the river, the Sweetwater Authority's use of the river to transfer water between reservoirs, and the likelihood of vandalism.

The most effective methods for eliminating largemouth bass are water manipulation and piscicides; rotenone effectively kills bass. Trapping or netting bass is ineffective, as bass typically avoid active trapping methods. Gill nets and seines have been successful at removing bass in small bodies of water that support only a few bass. Other methods of control that have proved successful are electroshocking, spearing, and standard rod and reel fishing. Given the low likelihood of success, high cost of control, and the presumed absence of listed species that they may affect (i.e., arroyo toad, red-legged frog), there are currently no plans to control bass on the Refuge. When USGS presents their findings regarding control of aquatic exotic animals, we may initiate control measures.

Mosquitofish

Gambusia affinis, better known as the mosquitofish, is native to the southern and central portions of the United States. Its current natural range is from about the eastern border of Mississippi west to eastern Texas. To the west of the Mississippi River, their range extends at least into southern Missouri (Hole 1995). The mosquitofish, which feeds on

mosquito larvae, has been introduced into habitats worldwide for mosquito control (Sigler and Sigler 1996).

Mosquitofish are members of the Poecilioidae family and are live-bearers. They reach sexual maturity at four to six weeks of age when they are approximately one inch in length. Three to four generations are possible within a year in ideal conditions. Five broods are thought to be the maximum for an individual, with up to 315 young per brood (Krumholtz 1948). A mosquitofish may live up to 15 months in the wild.

Mosquitofish rely on vegetation for cover and typically live at or near the surface of the water. Without cover they are at risk of extirpation by predators (Sigler and Sigler 1996). Due to the high biological potential of this species, they are able to rapidly adjust to population fluctuations. Presence of largemouth bass does not preclude presence of mosquitofish, as evidenced by the continued presence of both species in the Sweetwater River.

Trapping mosquitofish is moderately effective if the trap openings are placed near the surface of the water. Trapping at Ash Meadows NWR from 1995-2000 resulted in an average of 19.4 mosquitofish per trap (n=64,893 mosquitofish/3,345 traps). This equates to an average of 31.8 fish per hour in 2,040 hours of trapping. Traps were baited with dry dog food. Other forms of netting, such as seining with long handle dip nets, have been effective in the smaller open water spring pools at Ash Meadows. However, the connectivity of waters on San Diego NWR to off-Refuge populations of mosquitofish reduces the likelihood of success of control efforts on the Refuge.

Control of mosquito fish would only be considered if the presence of arroyo toad or red-legged frog is detected on the Refuge or if a decision is made to reintroduce one or both of these species into appropriate habitats on the Refuge.

Green Sunfish

Green sunfish are native to east-central North America. They have been introduced throughout much of the United States, in many cases by people who thought they were bluegills (*Lepomis macrochirus*), a more desirable game fish. Green sunfish have been identified as a serious threat to other fish species due to their large numbers, which eat or outcompete young of other species (Scott and Crossman 1973).

Green sunfish are relatively small and occur in great numbers within proper habitats. They feed on insects, crustaceans, mollusks, and small fish. When larger in size, they also eat crayfish. Green sunfish require habitats similar to the largemouth bass (Sigler and Sigler 1996). They live to 11 years, reach sexual maturity at two to three years, and lay many eggs. If control of green sunfish were to be implemented on the Refuge, control would be implemented through water manipulation and potentially the use of approved piscicides, as described under the discussion for largemouth bass.

Red Swamp Crayfish

The red swamp crayfish is a freshwater crustacean native to the southeastern United States. It has been widely introduced throughout the United States, including on San Diego NWR. Crayfish have a high biotic potential compared to many macroinvertebrates. *P. clarkii* is able to produce one to three generations per year, depending on water temperature (Huner and Barr 1984), with each brood consisting of 200 to 500 offspring. A typical life span is up to two years. Mating usually occurs in spring and fall but is year round in warmer climates. Incubation of offspring (under the mother's abdomen) is as short as two to three weeks. The offspring are able to reach sexual maturity in three months in favorable conditions. Crayfish commonly dig burrows to escape cold winter temperatures or desiccation. They are capable of migrating considerable distances (Helfrich et al. 2001).

Trapping crayfish is problematic due to the restraints of the trapping method and selectivity of crayfish trapped. Trapping on Ash Meadows NWR from 1995-2000 resulted in an average of 12.5 crayfish per trap (n=42,117 crayfish/3,345 traps) and an average of 20.6 crayfish per hour (baited with dry dog food) in 2,040 hours of trapping. The number of crayfish per trap varied considerably. Minnow traps with ¼-inch mesh lined with nylon screen door mesh to prevent young crayfish from escaping were the trap type most frequently used during this period. Due to the small one-inch entrances of these minnow traps, larger crayfish may not have been able to get into the traps. Crayfish traps with larger 2¼-inch entrances may prove to be more effective.

Largemouth bass are effective predators of crayfish (Stein 1976), but the abundance of both in the Sweetwater River demonstrates that bass are not an effective crayfish control method. Another potential control method, water level management, has limited effectiveness, as crayfish will dig burrows up to three feet deep to reach the water table and will remain until water level increases. However, rapidly draining Mother Miguel pond to control other aquatic exotics may help manage crayfish populations if they occur there.

Pesticides are another potential control method, but unfortunately at present, there are no pesticides registered specifically for aquatic crayfish control. Since crayfish molt many times per year (up to every 5-10 days in warm water) (Huner and Barr 1984), pesticides that inhibit the exoskeleton molt of invertebrates could be useful. Since pesticides affect most invertebrates, including prey species for other aquatic wildlife, pesticide application would have to be carefully considered and limited. There are no plans at this time to control crayfish on San Diego NWR. As more information becomes available on the cost, feasibility, and likelihood of success of control, a control program for this species may be implemented in the future.

Bullfrogs

The bullfrog is native to the United States east of the Rocky Mountains. They were widely introduced in the western states in the late 1800s and early 1900s as a game or commercial species (Lawler et al. 1999). The bullfrog is a large raniid and is quite common in proper habitats. Habitat requirements include permanent water, cover in the form of either emergent or submerged vegetation, and abundant prey. They feed on a wide variety of animal life, including fish, reptiles, amphibians, small mammals, crayfish, insects, and birds. Bullfrogs readily adapted to western conditions and have widely displaced native species. They either directly predate on native fish and wildlife or compete with them for resources. Recent research indicates that this species consistently carries a pathogenic fungus (*Batrachochytrium dendrobatidis*) that has been implicated in global amphibian declines and species extinctions (Garner et al. 2006).

Bullfrogs occur throughout the permanent freshwater areas of the Refuge. Adult bullfrogs occur in wet areas associated with both flowing and standing water, but tadpoles are typically restricted to slow-moving or standing water.

Trapping bullfrog tadpoles with minnow traps can be minimally effective. Trapping from 1995 to 2000 in San Diego resulted in an average of 2.6 tadpoles per trap (n=8,864 tadpoles/3,345 traps) and an average of 4.3 per hour (baited with dry dog food) in 2,040 hours of trapping. Other forms of netting, such as seining, have met with limited success in the open water spring pools because tadpoles can burrow down under the algae and soft bottom sediment. Trapping of adults has not been attempted, but gigging is occasionally conducted. Future control methods to be explored include gigging and trapping, habitat manipulation, and chemical and biocontrol methods; however, no sites have been specifically targeted for bullfrog control due to the lack of information on how to effectively control this species. As more information becomes available (i.e., from USGS biologists) on the cost, feasibility, and likelihood of success of control, we may initiate a control program for this species in the future.

VIII. Priorities for Treatment

For many refuges, the magnitude (number, distribution, and sizes of infestations) of pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. There are currently at least 132 non-native plant species known to be present on the Refuge (refer to Table 3), as well as a variety of non-native aquatic animal species. To manage pests on the Refuge, it is essential that treatment of infestations be prioritized. Highest priority treatments would be focused on early detection and rapid response to eliminate infestations of new pests, if possible. This is especially important for aggressive pests potentially affecting species, species groups, communities, and/or habitats of species associated with Refuge purpose(s); NWRS resources of concern (e.g., federally listed species, migratory birds, and selected marine mammals); and native

species needed to maintain and/or restore biological integrity, diversity, and environmental health on the Refuge.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small new outbreaks of invasive plants eventually would infest an area larger than the established source population. They also found that control efforts focusing on the large main infestation rather than the new small satellites reduced the chances of overall success. The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus on containment of the perimeter followed by work to control/eradicate the established infested area. If containment or control of a large infestation is not effective, then efforts would focus on halting pest reproduction or managing source populations. Maxwell et al. (2009) found treating fewer populations that are sources represents an effective long-term strategy for reducing the total number of invasive populations and decreasing metapopulation growth rates.

Although State listed noxious weeds are always of high priority for management, other pest species known to cause substantial ecological impact will also be considered. Pest control would likely require a multi-year commitment from Refuge staff. Essential to the long-term success of pest management would be pre- and post-treatment monitoring, assessment of the successes and failures of treatments, and the development of new approaches when proposed methods do not achieve desired outcomes.

As noted earlier, San Diego NWR is currently involved in a pilot program to develop a methodology for identifying, mapping, and prioritizing exotic plant infestations using, at least initially, *An Invasive Species Assessment Protocol* (Morse et al. 2004) that considers factors such as ecological impact, current distribution and abundance of the exotic plants, trend in distribution and abundance, and management difficulty when assessing invasive species impacts and prioritizing target species and treatment sites.

IX. Reporting and Adaptive Management

The IPM reporting program is intended to streamline mandated reporting requirements for Refuge operations and threatened and endangered species management, and it provides the basis for the adaptive management strategy described in the IPM. Many of the elements of the IPM annual reporting will be prepared as part of reporting requirements for specific project funding, Refuge System reporting, and the Refuge Annual Accomplishment Report. As such, the IPM annual reporting will likely be a composite of these other reports with specific information added to satisfy the adaptive management needs of the IPM.

Reporting

On an annual basis, activities conducted under the IPM will be summarized and compiled to assist in recordkeeping and the adaptive management process. It will include:

- Areas on the Refuge treated under the IPM, including either a single map or simply a compilation of project maps.
- A summary of the pesticides and quantities used per location treated.
- A summary of noxious species and acreages treated.
- A summary and acreage estimate of revegetation efforts (if any) implemented to benefit threatened and endangered species or mitigate project-related impacts.
- Weed inventory and monitoring activities conducted during the year.
- Summary of IPM effectiveness monitoring.
- Summary of changes to techniques, methods, or operating procedures based on field experiences, effectiveness monitoring, and post-implementation assessments.

Effectiveness Monitoring

An evaluation system to determine the outcome of treatment actions is an important part of the IPM strategy. As part of all projects implemented under the IPM, annual follow-up monitoring of treated areas will be conducted. This treatment will include the following elements:

- Where IPM treatments affect sensitive plants and wildlife, Refuge staff will conduct a post-implementation assessment. This assessment will determine if the proposed impacts to sensitive species in the project description are accurate. For species where State and Federal permits authorize take of individuals, this assessment will be used for tracking this information. Observations made during the assessment will also be used to inform and adapt standard operating procedures.

- Sites will be revisited at least once a year following the initial treatment. Depending on the level of funding, follow-up monitoring may be either quantitative or qualitative. At a minimum, Refuge staff will set up photo monitoring points and make a visual estimate of the relative cover of target weed species at representative locations. If funding is available, quantitative monitoring will be conducted, including but not limited to transect and quadrat-based sampling.

- Treatment areas will be visited at least once a year at the start of the growing season so that, if necessary, areas may be retreated prior to seed maturation.

X. Best Management Practices (BMPs)

BMPs can minimize or eliminate possible effects associated with pesticide usage to non-target species and/or sensitive habitats, as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of Interior Pesticide Use Policy (517 DM 1) and the Service Pest Management Policy and Responsibilities (30 AM 12), the use of applicable BMPs (where feasible) during the application of pesticides will minimize the potential for adverse effects to federally listed species and/or their critical habitats.

Presented here are the BMPs pertaining to the mixing, handling, and application of all ground-based treatments of pesticide that will considered and utilized, as appropriate, based upon target- and site-specific factors and time-specific environmental conditions on the Refuge. Although not listed here, the most important BMP to eliminate and/or reduce potential impacts to non-target resources would be an IPM approach to prevent, control, eradicate, and contain pests.

Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks will not be left unattended during filling.
- All pesticide spray equipment will be properly cleaned. Where possible, rinsate will be used as part of the makeup water in the sprayer tank and applied to treatment areas.
- All pesticide containers will be triple rinsed, and the rinsate will be used as water in the sprayer tank and applied to treatment areas.
- When a pesticide container is marked as recyclable, Refuge staff will deliver the triple rinsed pesticide containers to the appropriate herbicide container collection site.
- All unused pesticides will be properly discarded at a local “safe send” collection.
- Pesticides and pesticide containers will be lawfully stored, handled, and disposed of in accordance with the label and in a manner that will safeguard human, fish, and wildlife health and that will prevent soil and water contamination.
- Refuge staff will consider the water quality parameters (e.g., pH, hardness) that are important to ensure the greatest efficacy when specified on the pesticide label.
- All pesticide spills will be addressed immediately and reporting requirements will be implemented as follows: consistent with the California Hazardous Materials Spill/Release Notification Guidance (California Offices of Emergency Services 2014), should a significant release of herbicide occur in association with work being conducted by or for the Refuge, the California Office of Emergency Service (OES) and National Response Center (NRC) shall be notified immediately by telephone with

a written Follow-Up Report required within seven days if the release equals or exceeds the Federal Reportable Quantities; if the spill occurs within the Sweetwater River watershed, the Sweetwater Authority shall be contacted immediately following OES and NRC notification.

Applying Pesticides

- Pesticide treatments will only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate State or BLM certification to safely and effectively conduct these activities on Refuge lands and waters.

- Refuge staff will comply with all Federal, State, and local pesticide use laws and regulations, as well as Departmental, Service, and NWRS pesticide-related policies. For example, Refuge staff will use application equipment and apply rates for the specific pest(s) identified on the pesticide label as required under FIFRA.

- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators will review the product label, Material Safety Data Sheet (MSDS), and PUP for each pesticide, determining the target pest, appropriate mix rate(s), personal protective equipment (PPE), and other requirements listed on the pesticide label.

- A one-foot no-spray buffer from the water's edge will be used, where applicable, and when it does not detrimentally influence effective control of pest species.

- Refuge staff will use low impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) rather than broadcast foliar applications (e.g., boom sprayer, other larger tank wand applications), where practical.

- Refuge staff will use low volume rather than high volume foliar applications when the low impact methods described above are not feasible or practical to maximize herbicide effectiveness and ensure correct and uniform application rates.

- Applicators will use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.

- Applicators will use the largest droplet size that results in uniform coverage.

- Applicators will use drift reduction technologies such as low-drift nozzles, where possible.

- Spraying will occur during low (average less than 7 mph; preferably 3-5 mph) and consistent direction wind conditions with moderate temperatures (less than 85 °F).

- Applicators will avoid spraying during inversion conditions (often associated with calm or very low wind conditions) that can cause large-scale herbicide drift to non-target areas.
- Equipment will be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications will be made at the lowest height for uniform coverage of target pests to minimize or eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) will typically be conducted during early morning hours.
- Spray applications will not be conducted on days with greater than 30 percent forecast for rain within six hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) or pesticides that need rain to activate the product (e.g., oryzalin) so as to minimize or eliminate potential runoff.
- Applicators will use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Applicators will use a non-toxic dye to aid in identifying treated target areas and any areas of overspray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, application will stop until repairs are made to the sprayer.
- When drift cannot be sufficiently reduced through altering equipment set up and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. When an application is required adjacent to a sensitive habitat area, it will only occur when the wind is blowing away from the habitat area.
- To eliminate unnecessary pesticide applications, Refuge staff will examine the target area for the presence of expected pests prior to applying a pesticide product.
- Refuge staff will consider the timing of a pesticide application to ensure that native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Application equipment (e.g., backpack sprayer, transport vehicles) will be thoroughly cleaned and PPEs removed and properly disposed of on-site after treatments.

XI. Safety

Personal Protective Equipment (PPE)

All applicators will wear the specific PPE identified on the pesticide label, and the appropriate PPE will be worn at all times during handling, mixing, and applying of the pesticide. PPEs can include disposable (e.g., Tyvek) or laundered coveralls, gloves (e.g., latex, rubber, or nitrile), rubber boots, eye protective wear, and/or a National Institute for Occupational Safety and Health-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care will be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, appropriate footwear, and a face shield.

Coveralls and other protective clothing used during an application will be laundered separately from other laundry items. Transporting, storing, handling, mixing and disposing of pesticide containers will be consistent with label requirements, USEPA and OSHA requirements, and Service policy.

If a respirator is necessary for a pesticide use, the respirator will be used in accordance with the Service's Respiratory Protection policy (242 FW 14). Use of respirator in accordance with this policy requires that there be a written, site-specific respiratory protection plan for each work area where employees are required to wear respirators, a sufficiently trained Respiratory Protection Program Administrator to conduct and coordinate the respiratory protection plan at each facility requiring it, the availability of appropriate respirators and accessories for those who must wear them, and a clean storage area for respirators and their accessories at the work site. Respirators will only be issued to individuals who complete a Request for Respirator Clearance, pass a medical evaluation documenting that the individual is medically qualified for respirator use, complete the required respirator training, and successfully pass respirator fit testing. Respirators must be fit tested at least once a year. The policy also includes specific requirements for maintaining, cleaning, inspecting, and storing Service respirators.

Notification

The restricted entry interval is the time period required after the application at which point someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide treated area within the stated re-entry time period on the label will be notified about treatment areas. Posting will occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the Refuge. Where required by the label and/or State-specific regulations, sites will also be posted on its perimeter and at other likely locations of entry.

Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor the use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel will be medically monitored if one or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); use pesticides in a manner considered "frequent pesticide use;" or use pesticides in a manner that requires a respirator (see 242 FW 14 for respirator use requirements). In 242 FW7.7A, "Frequent Pesticide Use means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period." Under some circumstances, individuals may be medically monitored who use pesticides infrequently, experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2. This decision will consider the individual's health and fitness level, the pesticide's specific health risks, and the potential risks from other pesticide-related activities. Other authorized agents (e.g., State and county employees) will be responsible for their own medical monitoring needs and costs. Standard examinations (at the Refuge's expense) of appropriate Refuge staff will be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

Certification and Supervision of Pesticide Applicators

Appropriate Refuge staff or approved volunteers handling, mixing, and/or applying or directly supervising others engaged in pesticide use activities will be trained and State or federally (BLM) licensed to apply pesticides on San Diego NWR. In accordance with 242 FW7.18A and 569 FW 1.10B, certification is required to apply restricted use pesticides based upon USEPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. A Qualified Applicator Certificate, as required by the State of California, will be obtained by any person on the Refuge who applies or supervises the application of federally restricted use pesticides or State restricted materials. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of pesticides and containers will receive orientation and training before handling or using any products. Documentation of training will be kept in the files at the Refuge office.

Recordkeeping

Labels and Material Safety Data Sheets (MSDSs)
Approved PUPs stored in the PUPS database typically contain website links (URLs) to pesticide labels and MSDSs. Pesticide labels and MSDSs for all products approved for use on San Diego NWR are maintained in a binder adjacent to the hazardous material and pesticide storage cabinets. These documents are also be carried by field applicators, where possible. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed will also be kept in the mixing area for quick reference while mixing is in progress.

Pesticide Use Proposals (PUPs)

A PUP is prepared for each proposed pesticide use associated with annual pest management on Refuge lands and waters. Each PUP includes specific information about the proposed pesticide use, including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with Service guidelines (Director's memo [December 12, 2007]), Refuge staff may receive up to five-year approvals for Washington Office and field reviewed proposed pesticide uses based on meeting identified criteria, including an approved IPM plan, where necessary (http://www.fws.gov/contaminants/Issues/IPM.cfm). This IPM plan for San Diego NWR has been completed in association with a CCP, and the environmental effects of implementing the plan, as required by NEPA, are addressed in Chapter 5 of the Environmental Assessment that accompanies the Final CCP (USFWS 2017).

Pesticide Usage

In accordance with 569 FW 1, the Refuge Project Leader is required to maintain records of all pesticides annually applied on lands or waters under Refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, State and county governments, and non-government applicators, including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, desiccants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information is reported for approved PUPs in the PUPS database: pesticide trade name(s), active ingredient(s), total acres treated, total amount of pesticides used (pounds [lbs.] or gallons), total amount of active ingredient(s) used (lbs.), target pest(s), and efficacy (percent control). To determine whether treatments are efficacious (i.e., eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response is monitored both pre- and post-treatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation

density, percent cover, density), as well as habitat and/or wildlife response to treatments, may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a geo-referenced data management system (e.g., Refuge Lands GIS [RLGIS]) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 CFR 46.145.

Evaluating PUPs

Pesticides will only be used on San Diego NWR for habitat management and facilities maintenance after approval of a PUP. Approval of a PUP generally is issued where there would likely be only minor, temporary, or localized effects to fish and wildlife species; minimal potential to degrade environmental quality; and pesticide application is proposed to be implemented with appropriate BMPs as discussed previously. Potential effects to listed and non-listed species are evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality are determined based upon pesticide characteristics of environmental fate (e.g., water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments, characteristics of environmental fate, and potential to degrade environmental quality are all documented in Chemical Profiles as discussed previously.

These profiles are to include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality.

Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide(s) proposed for use on the Refuge. This process is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazard, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision making. It provides an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 CFR Part 1502.22. Protocols for ecological risk assessment of pesticide uses on refuge lands and waters were developed through research and established by the USEPA (2004). Assumptions for these risk assessments are presented in the section of this appendix titled Priorities for Treatment.

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the USEPA to meet regulatory requirements under FIFRA. These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be utilized for risk assessment protocols. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in the section of this appendix titled Priorities for Treatment.

Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on San Diego NWR to cause direct adverse effects to fish and wildlife would be evaluated using USEPA's Ecological Risk Assessment Process (USEPA 2004). Understanding the potential risks poses to trust resources protected on the Refuge are particularly important because the Refuge protects habitats that support at least 14 federally listed threatened or endangered species and at least 34 species considered covered by the San Diego Multiple Species Conservation Program (MSCP) Plan.

The Ecological Risk Assessment Process, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, integrates exposure estimates (estimated environmental concentration [EEC] and toxicological endpoints [e.g., LC_{50} and oral LD_{50}]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates for managing units of the NWRS. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effect (Table 5).

$$RQ = EEC/Toxicological\ Endpoint$$

The level of risk associated with direct effects of pesticide use are characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by USEPA (1998 [Table 5]). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on a NWR: acute listed species, acute non-listed species, chronic listed species, and chronic non-listed species.

Table 5 - Ecotoxicity Tests Used to Evaluate Potential Effects to Birds, Fish, and Mammals to Establish Toxicity Endpoints for Risk Quotient Calculations

Species Group	Exposure	Measurement Endpoint
Bird	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1]
Fish	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[2]
Mammal	Acute	Oral Lethal Dose (LD_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[3]

[1] Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).

[2] Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.

[3] Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

Acute risk indicates the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC_{50} and LD_{50} tests are used as toxicological endpoints for RQ calculations. In contrast, chronic risks indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction are used as toxicological endpoints for RQ calculations. Where available, the NOAEC is preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973 (16 USC 1531-1544, 87 Stat. 884, as amended-Public Law 93-205). For listed species, potential adverse effects are assessed at the individual level because loss of individuals from a population could detrimentally affect a species. In contrast, risks to non-listed species are considered effects at the population level. A RQ<LOC indicates the proposed pesticide use "may affect, not likely to adversely affect" individuals (listed species), and it would not pose an unacceptable risk for adverse effects to populations (non-listed species) for each taxonomic group (Table 6). In contrast, a RQ>LOC

indicates a "may affect, likely to adversely affect" for listed species, and it would also pose unacceptable ecological risk for adverse effects to non-listed species.

Table 6 - Presumption of Unacceptable Risk for Birds, Fish, and Mammals

Risk Presumption		Level of Concern	
		Listed Species	Non-listed Species
Acute	Birds	0.1	0.5
	Fish	0.05	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0
	Fish	1.0	1.0
	Mammals	1.0	1.0

Source: (USEPA 1998)

Environmental Exposure

Following release into the environment through application, pesticides experience several different routes of environmental fate. Pesticides that are sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as non-target vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (e.g., leaching) (Baker and Miller 1999, Pope et. al. 1999, Butler et. al. 1998, Ramsay et. al. 1995, EXTOXNET 1993a). Pesticides that are injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but it does indicate that movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but may also involve transportation of pesticides over long distances (Barry 2004, Woods 2004).

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel is used to assess ground-based applications of pesticides. Tier outputs (EECs) are calculated with AgDRIFT using the following input variables: maximum application rate (acid basis), low boom (20 inches), fine to medium droplet size, USEPA-defined wetland, and a 25-foot or more distance (buffer) from treated area to water.

Field drift studies conducted by the Spray Drift Task Force, which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy USEPA pesticide registration spray drift data requirements and as a scientific basis to

evaluate off-target movement of pesticides from particle drift and to assess potential effects of exposure to wildlife. Several versions of the computer model have been developed (i.e., v2.01 through v2.10). The Spray Drift Task Force AgDRIFT model version 2.01 (AgDRIFT 2001, SDTF 2003) would be used to derive EECs resulting from drift of pesticides to Refuge aquatic resources from ground-based pesticide applications 25 feet or more from the high water mark. The Spray Drift Task Force AgDRIFT model is publicly available at http://www.agdrift.com. At this website, click AgDRIFT 2.0, click Download Now, and follow the instructions to obtain the computer model.

Terrestrial Exposure - The EEC for exposure to terrestrial wildlife is quantified using a USEPA screening-level approach (USEPA 2004). This screening-level approach is not affected by product formulation because it evaluates pesticide active ingredient(s). This approach would vary depending upon the pesticide and method of application to be used.

For spray applications, exposure is determined by using the Kanaga nomogram method (Pfleeger et al. 1996, USEPA 2004, USEPA 2005a) through the USEPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3 (USEPA 2005b). To estimate the maximum (initial) pesticide residue on short grass (less than 20 cm tall) as a general food item category for terrestrial vertebrate species, T-REX input variables include the following from the pesticide label: maximum pesticide application rate (pounds active ingredient [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 ppm per lb. ai/acre) for worst-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach provides a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model requires the weight of surrogate species and Mineau scaling factors (Mineau et al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table 7) can be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors are entered manually with values, which are unique to a particular pesticide or group of pesticides, ranging from 1 to 1.55. If specific information to select a scaling factor is not available, then a value of 1.15 is used as a default. Alternatively, zero is entered if it is known that body weight does not influence toxicity of the pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram is used as an EEC for calculation of RQs. This approach yields a conservative estimate of ecological risk.

Table 7 - Average Body Weight of Selected Terrestrial Wildlife Species Frequently Used in Research to Establish Toxicological Endpoints

Species	Body Weight (kg)
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Common grackle	0.114
Japanese quail	0.178
Bobwhite quail	0.178
Rat	0.200
Rock dove (aka pigeon)	0.542
Mammal (1000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

Source: (Dunning 1984)

Granular pesticide formulations and pesticide-treated seed pose a unique route of exposure for avian and mammalian species. In these cases, the pesticide is applied in discrete units that birds or mammals might accidentally ingest with food items or intentionally ingest when actively seeking and picking up seed to eat or gravel or grit to aid digestion. Granules may also be consumed by wildlife foraging on earthworms, slugs, or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments are calculated by dividing the maximum milligrams of active ingredient (ai) exposed (e.g., EEC) on the surface of an area equal to one square foot by the appropriate LD_{50} value multiplied by the surrogate's body weight (refer to Table 7). An adjustment to surface area calculations is made for broadcast, banded, and in-furrow applications. An adjustment is also made for applications with and without incorporation of the granules. Without incorporation assumes that 100 percent of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but they are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it is

assumed that only 15 percent of the applied granules remain available to wildlife. Following in-furrow applications, it is assumed that only one percent of the granules are available on the soil surface.

EECs for pesticides applied in granular form and as seed treatments are calculated based on potential ingestion rates of avian or mammalian species (e.g., 10-30 percent body weight per day). This provides an estimate of maximum exposure that may occur as a result of granule or seed treatment spills, which commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates is also considered by calculating the loading per unit area (LD_{50}/ft^2) for comparison to USEPA LOCs (USEPA 1998). The T-REX version 1.2.3 (USEPA 2005b) contains a submodel that automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas are used to calculate EECs depending upon the type of granular pesticide application:

For in-furrow applications, assume a typical value of 1% granules, bait, or seed remain unincorporated.

$$\textit{mg a.i./ft.}^2 = [(\textit{lbs. product/acre})(\%\ \textit{a.i.})(453{,}580\ \textit{mg/lbs})(1\%\ \textit{exposed}))] / \{[(43{,}560\ \textit{ft.}^2\textit{/acre})/(\textit{row spacing (ft.)})] / (\textit{row spacing (ft.)}\}$$

or

$$\textit{mg a.i./ft}^2 = [(\textit{lbs. product/1000 ft. row})(\%\ \textit{a.i.})(1000\ \textit{ft row})(453{,}580\ \textit{mg/lb.})(1\%\ \textit{exposed})$$

$$\textit{EEC} = [(\textit{mg a.i./ft.}^2)(\%\ \textit{of pesticide biologically available})]$$

For incorporated banded treatments, assume that 15% of granules, bait, seeds are unincorporated.

$$\textit{mg a.i./ft.}^2 = [(\textit{lbs. product/1000 row ft.})(\%\ \textit{a.i.})(453{,}580\ \textit{mg/lb.})(1\text{-}\%\ \textit{incorporated})] / (1{,}000\ \textit{ft.})(\textit{band width (ft.)})$$

$$\textit{EEC} = [(\textit{mg a.i./ft.}^2)(\%\ \textit{of pesticide biologically available})]$$

For broadcast treatment without incorporation, assume 100% of granules, bait, or seeds are unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}590\ mg/lb.)] / (43{,}560\ ft.^2/acre)$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

Note:

- *% of pesticide biologically available = 100% without species specific ingestion rates*
- *Conversion for calculating mg a.i./ft.^{2} using ounces: 453,580 mg/lb. /16 = 28,349 mg/oz.*

The following equation is used to calculate a RQ based on the EEC calculated by one of the previous equations. The EEC is divided by the surrogate LD_{50} toxicological endpoint multiplied by the body weight (refer to Table 7) of the surrogate.

$$RQ = EEC / [LD_{50}\ (mg/kg) * body\ weight\ (kg)]$$

As with other risk assessments, a RQ>LOC is presumed an unacceptable ecological risk. A RQ<LOC is considered an acceptable risk with only minor, temporary, or localized effects to species.

Aquatic Exposure - Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) are evaluated separately for ground-based pesticide treatments. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios must be considered as a result of contrasting application equipment and techniques. In addition, the type of pesticides used to control pests as part of facilities maintenance (e.g., roadsides, parking lots, trails) may vary from those used to manage habitats on the refuge. Further, pesticide applications may be done less than 25 feet from the high water mark of aquatic habitats for habitat management treatments; whereas, no-spray buffers (greater than or equal to 25 feet) would be used for facilities maintenance treatments.

For the worst-case exposure scenario to non-target aquatic habitats, EECs (Table 8) are derived from Urban and Cook (1986) and assume an intentional overspray to an entire, non-target water body (one foot depth) from a treatment less than 25 feet from the high water mark using the maximum application rate (acid basis). However, use of BMPs for applying pesticides (see the section of this appendix titled IPM

Strategies for Invasive Plants) would likely minimize/eliminate potential drift to non-target aquatic habitats during actual treatments.

An unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100 percent overspray (RQ>LOC) would likely result in a proposed pesticide being disapproved or the pesticide proposal being approved at a lower application rate to minimize or eliminate unacceptable risk to aquatic organisms (RQ=LOC).

Table 8 - Estimated Environmental Concentrations of Pesticides in Aquatic Habitats (1 foot depth) Immediately after Direct Application

Lbs./acre	EEC (ppb)
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1103.5
4.00	1471.4
5.00	1839
6.00	2207
7.00	2575
8.00	2943
9.00	3311
10.00	3678

Source: (Urban and Cook 1986)

Use of Information on the Effects of Specific IPM Practices

Where the scope of a NEPA document prepared by another Federal agency is relevant to the evaluation of the effects of pesticide uses on refuge lands, that document may, in accordance with 43 CRF 46.120(d), be incorporated by reference into Service NEPA documents that address the impacts of pesticides on refuge resources. As such, it may be appropriate to incorporate through reference ecological risk assessments prepared by the U.S. Forest Service (http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm) and Bureau of Land Management (http://www.blm.gov/ wo/st/en/prog/ more/ veg_eis.html). These risk assessments and the associated documentation are available in total with the administrative record for the Final Environmental Impact Statement entitled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (U.S. Forest Service 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (Bureau of Land Management 2007).

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the U.S. Forest Service are incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethylate (NPE) based surfactants

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicides and pesticide degradates and adjuvants, prepared by the Bureau of Land Management, are incorporated by reference:

- Bromacil
- Chlorsulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants

Assumptions for Ecological Risk Assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with utilization of the USEPA (2004) process. These assumptions may be risk neutral or may lead to an overestimation or underestimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether or not they may lead to recommendations that are risk neutral or may underestimate or overestimate ecological risk from potential pesticide exposure.

1. Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.

2. Exposure to a pesticide product can be assessed based upon the active ingredient; however, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Non-target organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (USEPA 2004). This conservative approach may lead to an overestimation of risk characterization from pesticide exposure.

3. Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would most often be used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. Sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity for mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data is selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals), assuming the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data will not be limited to the species previously listed as common surrogates.

4. The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration, typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide.

5. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide, length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years, or generations). However, when a test is limited to a single length of time, the time response data is usually not available for inclusion into risk assessments, and without time response data, it is difficult to determine the concentration that elicited a toxicological response.

6. Using maximum EECs for chronic risk estimates may result in an overestimate of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC is used for chronic risk assessments although it may result in an overestimate of risk. TWAs may be used for chronic risk assessments, but they will be applied judiciously considering the potential for an underestimate or overestimate of risk. For example, the number of days exposure exceeds the LOC may influence the suitability of a pesticide use. The greater the number of days the EEC exceeds the

LOC translates into greater the ecological risk. This is a qualitative assessment, and is subject to reviewer's expertise in ecological risk assessment and tolerance for risk.

7. The length of time used to calculate the TWA can have a substantial effect on the exposure estimates, and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides, which do not bioaccumulate, may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs will require justification, and it will not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.

8. Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as bi-phasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, this data is often not available and it can be misleading particularly if the compound is prone to "wash-off". Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of Refuge lands would be utilized, if available.

9. For species found in the water column, it is assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.

10. Actual habitat requirements for any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption produces a maximum estimate of exposure for risk characterization and will likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (USEPA 2004).

11. Exposure through incidental ingestion of pesticide contaminated soil is not considered in the USEPA risk assessment protocols. Research suggests less than 15 percent of the diet can consist of incidentally ingested soil, depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion will not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the

present assumption that the entire diet consists of a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.

12. Exposure through inhalation of pesticides is not considered in the USEPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at the time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The USEPA (1990) reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of two to five microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than one percent of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to ASAE medium or coarser drop size distribution.

13. Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post-application and would pertain to those pesticides with a high vapor pressure. The USEPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.

14. The effect from exposure to dusts contaminated with a pesticide cannot be assessed generically, as partitioning issues related to application site, soils, and chemical properties of the applied pesticides render the exposure potential from this route highly situation specific.

15. Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint; incidental contact with contaminated vegetation; or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991); however, research related to wildlife dermal contact with pesticides is extremely limited. Dermal toxicity values are common for some mammals used as human surrogates, particularly rats and mice. The USEPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high risk

pesticides such as some organophosphates or carbamate insecticides, which act by a similar mechanism to organophosphate pesticides. If protocols are established by the USEPA for assessing dermal exposure to pesticides, they will be considered for incorporation into pesticide assessment protocols.

16. Exposure to a pesticide may occur from consuming surface water, dew, or other water on treated surfaces. Water soluble pesticides have the potential to dissolve in surface runoff, and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, as well as the soils types and meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The USEPA is actively developing protocols to quantify drinking water exposures from puddles and dew. If and when such protocols are formally established by the USEPA, these protocols will be incorporated into pesticide risk assessment protocols.

17. Risk assessments are based upon the assumption that the entire treatment area will be subject to pesticide application at the rates specified on the label. In most cases, however, there is potential for uneven application of pesticides through such plausible incidents as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling, application equipment, and applicator skill. Inappropriate use of pesticides and the occurrence of spills represent a potential underestimate of risk; however, this is generally a minor factor for risk characterization. All pesticide applicators are required to be certified by the state in which they apply pesticides. Certification training, which requires yearly updates, includes the safe storage, transport, handling, and mixing of pesticides; appropriate equipment calibration; and proper application.

18. The USEPA relies on Fletcher (1994) for setting the assumed pesticide residues in wildlife dietary items. The USEPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify." Fletcher's (1994) research suggests that the pesticide active ingredient residue assumptions used by the USEPA represent a 95th percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates USEPA residue assumptions for short grass was not exceeded. Baehr and Habig (2000) compared USEPA residue assumptions with distributions of measured pesticide residues for the USEPA's Uptake, Translocation, Accumulation, and Biotransformation (UTAB) database. Overall residue selection level will tend to overestimate risk characterization. This is particularly evident when

wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues, whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole above-ground plant material, while others will preferentially select different plant structures. Species may also preferentially select a specific food item despite the presence of multiple food items. Without species-specific knowledge regarding foraging behavior, characterizing ecological risk other than in general terms is not possible.

19. Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC_{50} or "no observed effect concentration" (NOEC) values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.

20. It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However, the spatial distribution of wildlife is usually not random, because wildlife distributions are often related to habitat requirements of the species. Clumped distributions of wildlife may result in an underestimation or overestimation of risk, depending upon where the initial pesticide concentration occurs relative to the species or species habitat.

21. For species found in the water column, it is assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments is considered minimal. Adsorption and bioconcentration occurs at lower levels for many newer pesticides compared with older more persistent bioaccumulative compounds. For pesticides with RQs close to listed species' LOC, the potential for additional exposure from these routes may be a limitation of risk assessments because potential pesticide exposure or risk may be underestimated.

22. Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation, and sediment partitioning) are not considered in ecological risk assessments. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that the pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is its concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for the potential to concentrate pesticide through evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated, and applied pesticides have low rates of degradation and volatilization.

23. For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event, analyses and latent responses to instantaneous exposure, risk would likely be overestimated.

24. For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of invertebrate life-cycle or fish early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the USEPA relies on chronic exposure toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors, including: localized meteorological conditions; runoff characteristics of the watershed (e.g., soils, topography); hydrological characteristics of receiving waters; environmental fate of the pesticide active ingredient; and the method of pesticide application. Also, chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on several undefined variables, risk associated with chronic exposure may, in some situations, underestimate risk and overestimate risk in others.

There are several other assumptions that can affect non-target species that are not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic and biotic factors), and behavioral changes induced by exposure to a pesticide. These factors may exist at some level, contributing to adverse effects to non-target species, but they are usually characterized in the published literature in only a general manner, limiting their value in the risk assessment process. As this type of information becomes available, it would be included, either quantitatively or qualitatively, in this risk assessment process.

USEPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity or act the same within an organism. Currently, USEPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term “active ingredient” is defined by FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or it is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label, along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier such as clay in which the active ingredient is impregnated on the clay particle in dry formulations. For example, if isopropyl alcohol would be used as a solvent in a pesticide formulation, it would be considered an inert ingredient. FIFRA only requires that inert ingredients be identified if they pose a hazard to man or the environment. Inert ingredients that are not classified as hazardous are not required to be identified. The only other requirement is to state on the product label the percentage by weight of all inert ingredients.

The USEPA (September 1997) issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term “other ingredients” for “inert ingredients” in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on non-target organisms and, therefore, are not necessarily inert. Whether referred to as “inerts” or “other ingredients,” these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA

categorizes regulated inert ingredients as follows (http://www.epa.gov/opprd001/inerts/index.html):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

Comprehensively assessing potential effects to non-target fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients, as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk assessments for each component in the spray mixture individually. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the U.S. Forest Service (2005) found that mixtures of pesticides used in land (forest) management were not likely to cause additive or synergistic effects to non-target species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (ATSDR 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources, including:

- TOMES (a proprietary toxicological database including USEPA's IRIS, the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]);
- USEPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms);
- TOXLINE (a literature searching tool);
- Material Safety Data Sheets (MSDSs) from pesticide suppliers; and
- Sources such as the Farm Chemicals Handbook.

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredient(s).

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides would represent a source of uncertainty for assessing risk.

USEPA-approved labels specify whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action would be common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for two or more pesticides applied as a mixture should be completely reviewed, where products with the least potential for negative effects would be selected for use on the Refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides, and the USEPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of

pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

Determining Effects to Soil and Water Quality

The approval process for pesticide use considers the potential to degrade water quality on and off Refuge lands. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from runoff or wind; and/or
- Dissolve in water subjected to runoff or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess the potential for the product to enter ground and/or surface waters. These would include persistence, sorption coefficient (K_{oc}), groundwater ubiquity score (GUS), and solubility. Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: non-persistent (less than 30 days), moderately persistent (30-100 days), and persistent greater than 100 days (Kerle et al. 1996). Half-life data is usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time (DT_{50}). This represents the time required for 50 percent of the deposited pesticide to degrade and move from a treated site; whereas, half-life describes the rate for degradation only. Similar to half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation time is the preferred data for use to estimate pesticide concentrations in the environment; however, soil half-life is the most common persistence data cited in published literature. If field or foliar dissipation data is not available, soil half-life data may be used. The average or representative half-life value of the most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement). The degree of pesticide adsorption to soil particles and organic matter (Kerle et

al. 1996) is expressed as the soil adsorption coefficient (K_{oc}). The soil adsorption coefficient is measured as micrograms of pesticide per gram of soil (µg/g) that can range from near zero to the thousands. Pesticides with higher K_{oc} values are strongly sorbed to soil and, therefore, would be less subject to movement.

The Groundwater Ubiquity Score (GUS) is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It utilizes soil persistence and adsorption coefficients in the following formula: $GUS = \log_{10}(t_{½}) \times [4 - \log_{10}(K_{oc})]$. The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS less than 0.1 would be considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 would be low, 2.0-3.0 would be moderate, 3.0-4.0 would be high, and greater than 4.0 would have a very high potential to move toward groundwater.

Water solubility describes the amount of pesticide dissolving in a specific quantity of water, where it is usually measured as milligrams of pesticide dissolved per liter of water (mg/l) or parts per million (ppm). Solubility is useful as a comparative measure because pesticides with higher values are more likely to move by runoff or leaching. For example, pesticides with solubility less than 0.1 ppm are virtually insoluble in water, 100-1000 ppm are moderately soluble, and greater than 10,000 ppm highly soluble (USGS 2000). As pesticide solubility increases, there is greater potential for off-site movement.

GUS, water solubility, $t_{½}$, and K_{oc} values are available for selected pesticides from the OSU Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm. Many of the values in this database were derived from the SCS/ARS/CES Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are most likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- **Permeability -** This is the rate at which water moves vertically through the soil. It is affected by soil texture and structure. Coarse textured soils (e.g., high sand content) have a larger pore size and are generally more permeable than fine textured soils (i.e., high clay content). The potential for pesticides to move vertically down through the soil profile is greater the more permeable the soils are within the treatment area. Soil permeability rates (inches per hour) are usually available in county soil survey reports. In the case of San Diego NWR, an array of soil types can be found throughout the Refuge (Bowman et al. 1973).

- **Soil Texture -** Soil texture is defined by the relative percentage of sand, silt, and clay present in the soil. In general, greater clay content would lower the likelihood and rate at which water would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide

than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water holding capacity would have a greater potential for water to leach through them.

- **Soil Structure -** Soil structure describes soil aggregation. Soils with a well-developed soil structure have looser, more aggregated, structure that would be less likely to be compacted. Both characteristics would allow for less restricted flow of water through the soil profile, resulting in greater infiltration.

- **Organic Matter Content -** This is the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter, reducing their rate of downward movement through the soil profile. Also, soils high in organic matter tend to hold more water, which may make less water available for leaching.

- **Soil Moisture Content -** Soil moisture content affects how the velocity at which water moves through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would run off rather than infiltrate into the soil profile. Soil moisture also influences microbial and chemical activity in soil, which effects pesticide degradation.

- **Soil pH -** Soil pH influences the chemical reactions that occur in the soil. This, in turn, determines whether or not a pesticide will degrade, as well as the rate of degradation, and, in some instances, the types of degradation products that are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination are sandy soils with low organic matter. In contrast, the least vulnerable soils are well-drained, clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate BMPs will be used in an IPM framework to treat pests while minimizing effects to non-target biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through runoff and leaching would also be affected by site-specific environmental and abiotic conditions, including rainfall, water table conditions, and topography (Huddleston 1996). Water is necessary to separate pesticides from soil. This can occur in two basic ways: 1) pesticides that are soluble would move easily with runoff water, and 2) pesticide-laden soil particles could be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into the soil, to a large extent, determines pesticide concentrations in surface runoff. The timing of the rainfall after application would also have an influence on the total pesticide concentrations in surface runoff. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called

the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or run off depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone), reducing total runoff during the initial rainfall event following application, as well as during subsequent rainfall events.

Terrain slope would also affect the potential for surface runoff and the intensity of the runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.

Depth to groundwater is also an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would be more likely to influence groundwater quality. Soil survey reports, available for individual counties, provide data regarding the water table depths. In some situations, a hard pan may exist above the water table, preventing the pesticide from leaching into the groundwater.

Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure. The extent to which a pesticide may volatilize is influenced by temperature, sorption, soil moisture, and the pesticide's solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where "I" represents a vapor pressure index. In general, pesticides with I less than 10 would have a low potential to volatilize; whereas, pesticides with I greater than 1,000 would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

XII. Preparing a Chemical Profile

The following instructions will be used by Service personnel to complete Chemical Profiles for pesticides. Specifically, profiles will be prepared for pesticide active ingredients (e.g., glyphosate, aminopyrlid, chlorsulfuron) that would be contained in one or more trade name products, registered and labeled with USEPA. A blank Chemical Profile form is provided as Attachment A. All fields under each category (e.g., Toxicological Endpoints, Environmental Fate) on the Chemical Profile must be completed. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete Chemical Profiles. Each entry of scientific information would be shown with applicable references.

Completed Chemical Profiles will provide a structured decision making process utilizing quantitative assessment and screening tools with threshold values, where appropriate, that would be used to evaluate potential biological and other environmental effects to Refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for Refuge habitat management and facilities maintenance. Where the "worst-case scenario" is likely to result in only minor, temporary, and localized effects to listed and non-listed species (when appropriate BMPs are implemented), the proposed pesticide's use would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a Chemical Profile. In some cases, the Chemical Profile will include a lower application rate than the maximum labeled rate in order to protect Refuge resources. As necessary, Chemical Profiles will be periodically updated to include new scientific information or include a new pesticide proposed for use on the Refuge through the PUPs process that possesses the same active ingredient described in the Chemical Profile.

Currently, seven Chemical Profiles have been prepared for San Diego NWR, one each for the active ingredients aminopyralid, glyphosate, chlorsulfuron, clethodim, fluazifop-p-butyl, oryzalin, and triclopyr triethylamine (Attachments B-1 through B-7). These Chemical Profiles address the active ingredients used in Milestone, Milestone VM, Envoy Plus, Prism, Select Max, Select 2EC, Tapout, Telar XP, Fusilade DX, Glyphosate Pro 4, AquaNeat, Buccaneer, Makaze, Prosecutor, Razor Pro, Extra Credit 5, Surflan AS, Surflan WDG, Garlon 3A, Garlon 4, Pathfinder II, and Remedy. All of these products have or will be approved for use on the Refuge through the PUPs process.

The Chemical Profile will clearly identify threshold values in order to prevent or minimize potential biological and environmental effects. Comparison of these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and facilities maintenance on the Refuge. In general, PUPs will be approved for pesticides with Chemical Profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize and/or eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

The following information will be recorded for each Chemical Profile that is completed or updated.

General Information

Date. Service personnel will record the date when the Chemical Profile is completed or updated. Chemical Profiles (e.g., currently approved pesticide use patterns) will be periodically reviewed and updated, as necessary. The most recent review date will be recorded on a profile to document when it was last updated.

Trade Name(s). Service personnel will accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product among several pesticides with the same active ingredient. Service personnel will record a

Common Chemical Name(s). Service personnel will record the common name(s) listed on the pesticide label or MSDS for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and on the MSDS, Section 2: Composition/Information on Ingredients. A Chemical Profile is completed for each active ingredient.

Pesticide Type. Service personnel will record the type of pesticide for an active ingredient as one of the following: herbicide, desiccant, fungicide, fumigant, growth regulator, insecticide, pisicide, or rodenticide.

USEPA Registration Number(s). This number (EPA Reg. No.) appears on the title page of the label and MSDS, Section 1: Chemical Product and Company Description. It is not the USEPA Establishment Number that is usually located near it. Service personnel will record the USEPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

Pesticide Class. Service personnel will list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

CAS (Chemical Abstract Service) Number. Service personnel will record this number, which is often located in the second section (Composition/Information on Ingredients) of the MSDS, in the Chemical Profile. The MSDS table listing components usually contains this number immediately prior to or following the percent composition.

Other Ingredients. From the most recent MSDS for the proposed pesticide product(s), Service personnel will include any chemicals in the pesticide formulation not listed as an active ingredient that are described as toxic or hazardous or that are regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), Occupational Safety and Health Administration (OSHA), State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled Hazardous Identifications, Exposure Control/Personal Protection, and Regulatory Information. If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel will record this information in the Chemical Profile by trade name. MSDS(s) may be obtained from the manufacturer, manufacturer's website or from an online database maintained by Crop Data Management Systems, Inc.

Toxicological Endpoints

Toxicological endpoint data is collected for acute and chronic tests with mammals, birds, and fish. This data will be recorded in the Chemical Profiles as available in the scientific literature. If no data are found for a particular taxonomic group, then "No data available is references" will be recorded as the data entry. Throughout the Chemical Profile, references (including toxicological endpoint data) will be cited using parentheses (#) following the recorded data.

Mammalian LD_{50}. For test species in the scientific literature, Service personnel will record available data for oral lethal dose (LD_{50}) in mg/kg-bw (body weight) or ppm-bw. The most common test species in scientific literature are the rat and mouse. The lowest LD_{50} value found for a rat will be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table 5).

Mammalian LC_{50}. For test species in the scientific literature, Service personnel will record available data for dietary lethal concentration (LC50) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species in scientific literature are the rat and mouse. The lowest LC_{50} value found for a rat will be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table 5).

Mammalian Reproduction. For test species listed in the scientific literature, Service personnel will record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], No Observed Adverse Effect Concentration [NOAEC]) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, new born weight). The most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for a rat will be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 5).

Avian LD_{50}. For test species available in the scientific literature, Service personnel will record values for oral lethal dose (LD_{50}) in mg/kg-bw or ppm-bw. The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD_{50} value found for an avian species will be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table 5).

Avian LC_{50}. For test species available in the scientific literature, Service personnel will record values for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC_{50} value found for an avian species will be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table 5).

Avian Reproduction. For test species available in the scientific literature, Service personnel will record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for an avian species will be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 5).

Fish LC_{50}. For test freshwater or marine species listed in the scientific literature, Service personnel will record a LC_{50} in ppm or mg/L. The most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC_{50} value found for a freshwater fish species will be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table 5).

Fish Early Life Stage (ELS)/Life Cycle. For test freshwater or marine species available in the scientific literature, Service personnel will record test results (e.g., LOEC, NOAEL, NOAEC, LOAEC) in ppm for test procedure(s) (e.g., early life cycle, life cycle). The most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) will be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 5).

Other. For test invertebrate, as well as non-vascular and vascular plant species, available in the scientific literature, Service personnel will record LC_{50}, LD_{50}, LOEC, LOEL, NOAEC, NOAEL, or EC_{50} (environmental concentration) values in ppm or mg/L. The most common test invertebrate species available in scientific literature are the honey bee and the water flea (*Daphnia magna*). Green algae (*Selenastrum capricornutum*) and pondweed (*Lemna minor*) are frequently available test species for aquatic non-vascular and vascular plants, respectively.

Ecological Incident Reports

After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The USEPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and State agencies and non-government organizations. Information provided in an incident report includes date and location of the incident, type and magnitude of affects observed in various species, type(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports pertaining to the active ingredient addressed in a Chemical Profile and the associated information related to the reported incident will be recorded. If no reports are available, this, too, will be noted.

Environmental Fate

Water Solubility. Service personnel will record values for water solubility (Sw), which describes the amount of pesticide that dissolves in a known quantity of water. Sw is expressed as mg/L (ppm). Pesticide Sw values would be categorized as one of the following: insoluble (less than 0.1 ppm) moderately soluble (100 to 1000 ppm), highly soluble (greater than 10,000 ppm) (US Geological Survey 2000). As pesticide Sw increases, there is a greater potential for water quality to be degraded through runoff and leaching. Sw will be used to evaluate potential for bioaccumulation in aquatic species (see Octanol-Water Partition Coefficient (Kow) section).

Soil Mobility. Service personnel will record available values for soil adsorption coefficient (K_{oc} [µg/g]), which provides a measure of a chemical's mobility and leaching potential in soil. K_{oc} values are directly proportional to organic content, clay content, and surface area of the soil. K_{oc} data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand). K_{oc} values will be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

Soil Persistence

Service personnel will record values for soil half-life ($t_{½}$), which represents the length of time (days) required for 50 percent of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the $t_{½}$ value, soil persistence would be categorized as one of the following: non-persistent (less than 30 days), moderately persistent (30-100 days), and persistent greater than 100 days (Kerle et. al. 1996). Along with K_{oc}, soil $t_{½}$ values will be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater section).

The following threshold has been established for approving PUPs:

Where soil $t_{½}$ is less than or equal to 100 days, a PUP will be approved without additional BMPs to protect water quality.

Where soil $t_{½}$ is greater than 100 days, a PUP will only be approved with additional BMPs implemented specifically to protect water quality.

When BMPs are required to protect water quality, one or more of the following measures will be included in the Specific Best Management Practices (BMPs) section of the Chemical Profile and will be implemented during the application of the specific pesticide to minimize potential surface runoff and leaching that can degrade water quality:

- Do not exceed one application per site per year.
- Do not use on coarse-textured soils where the groundwater table is less than 10 feet and average annual precipitation greater than 12 inches.
- Do not use on steep slopes if substantial rainfall is expected within 24 hours or the ground is already saturated.

Soil Dissipation

Dissipation time (DT_{50}) represents the time required for 50 percent of the deposited pesticide to degrade and move from a treated site; whereas, soil t½ describes the rate for degradation only. As for t½, units of dissipation time are usually expressed in days. Field dissipation time will be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies as compared to soil t½, which is derived in a laboratory. However, soil t½ is the most common persistence data available in the published literature. If field dissipation data is not available, soil t½ data will be used in a Chemical Profile. The average or representative half-life value of the most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments. Along with Koc, soil DT_{50} values (preferred over soil t½) will be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below), if available.

Based upon the DT_{50} value, environmental persistence in the soil will also be categorized as one of the following: non-persistent (less than 30 days), moderately persistent (30-100 days), and persistent (greater than 100 days).

The following threshold has been established for approving PUPs:

> Where soil DT_{50} is less than or equal to 100 days, a PUP will be approved without additional BMPs to protect water quality.
>
> Where soil DT_{50} is greater than 100 days, a PUP will only be approved with additional BMPs implemented specifically to protect water quality.

When BMPs are required to protect water quality, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile and will be implemented during the application of the specific pesticide to minimize potential surface runoff and leaching that can degrade water quality:

- Do not exceed one application per site per year.
- Do not use on coarse-textured soils where the ground water table is greater than 10 feet and average annual precipitation greater than 12 inches.
- Do not use on steep slopes if substantial rainfall is expected within 24 hours or the ground is already saturated.

Aquatic Persistence

Service personnel will record values for aquatic $t_{½}$, which represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially) in water. Based upon the $t_{½}$ value, aquatic persistence would be categorized as one of the following: non-persistent (less than 30 days), moderately persistent (30-100 days), and persistent (greater than 100 days) (Kerle et al. 1996).

The following threshold has been established for approving PUPs:

> Where aquatic $t_{½}$ is less than or equal to 100 days, a PUP will be approved without additional BMPs to protect water quality.
>
> Where aquatic $t_{½}$ is greater than 100 days, a PUP will only be approved with additional BMPs implemented specifically to protect water quality.

When BMPs are required to protect water quality, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile and will be implemented during the application of the specific pesticide to minimize potential surface runoff and leaching that can degrade water quality:

- Do not exceed one application per site per year.
- Do not use on coarse-textured soils where the ground water table is less than 10 feet and average annual precipitation greater than 12 inches.
- Do not use on steep slopes if substantial rainfall is expected within 24 hours or the ground is already saturated.

Aquatic Dissipation

Dissipation time (DT_{50}) represents the time required for 50 percent of the deposited pesticide to degrade or move (dissipate); whereas, aquatic $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Based upon the DT_{50} value, environmental persistence in aquatic habitats also would be categorized as one of the following: non-persistent (less than 30 days), moderately persistent (30-100 days), and persistent (greater than 100 days).

The following threshold has been established for approving PUPs:

> Where aquatic DT_{50} is less than or equal to 100 days, a PUP will be approved without additional BMPs to protect water quality.
>
> Where aquatic DT_{50} is greater than 100 days, a PUP will only be approved with additional BMPs implemented specifically to protect water quality.

When BMPs are required to protect water quality, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile and will be implemented during the application of the specific pesticide to minimize potential surface runoff and leaching that can degrade water quality:

- Do not exceed one application per site per year.
- Do not use on coarse-textured soils where the ground water table is less than 10 feet and average annual precipitation greater than 12 inches.
- Do not use on steep slopes if substantial rainfall is expected within 24 hours or the ground is already saturated.

Potential to Move to Groundwater

The Groundwater Ubiquity Score (GUS) = $\log_{10}$ (soil t ½) x [4 – $\log_{10}$ (K_{oc})]. If a DT_{50} value is available, it will be used rather than a t ½ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater will be recorded as one of the following categories: extremely low potential (less than 1.0), low (1.0 to 2.0), moderate (2.0 to 3.0), high (3.0 to 4.0), or very high (greater than 4.0).

The following threshold has been established for approving PUPs:

Where GUS is less than or equal to 4.0, a PUP will be approved without additional BMPs to protect water quality.

Where GUS is greater than 4.0, a PUP will only be approved with additional BMPs implemented specifically to protect water quality.

When BMPs are required to protect water quality, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile and will be implemented during the application of the specific pesticide to minimize potential surface runoff and leaching that can degrade water quality:

- Do not exceed one application per site per year.
- Do not use on coarse-textured soils where the ground water table is less than 10 feet and average annual precipitation greater than 12 inches.
- Do not use on steep slopes if substantial rainfall is expected within 24 hours or the ground is already saturated.

Volatilization

Pesticides may volatilize (evaporate) from soil and plant surfaces and move off-target into the atmosphere. In general, pesticides with I less than 10 would have low potential to volatilize; whereas, pesticides with I greater than 1,000 would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually

available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database (see References).

The following threshold has been established for approving PUPs:

Where I is less than or equal to 1000, a PUP will be approved without additional BMPs to minimize drift and protect air quality.

Where I is greater than 1000, a PUP will only be approved with additional BMPs implemented specifically to minimize drift and protect air quality.

When BMPs are required to protect air quality, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile and will be implemented during the application of the specific pesticide to reduce volatilization and drift:

- Do not treat when wind velocities are less than 2 or greater than 10 mph with existing or potential inversion conditions.
- Apply the largest diameter droplets possible for spray treatments.
- Avoid spraying when air temperatures are greater than 85ºF.
- Use the lowest spray height possible above target canopy.
- Where identified on the pesticide label, soil incorporate the pesticide as soon as possible during or after application.

Octanol-Water Partition Coefficient (K_{ow})

The octanol-water partition coefficient (K_{ow}) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, K_{ow} will be used to assess the potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If K_{ow} is less than 1000 or S_w is less than 1 mg/L and soil $t_{½}$ is greater than 30 days, then there is a high potential for a pesticide to bioaccumulate in aquatic species such as fish (USGS 2000).

The following threshold has been established for approving PUPs:

If there is not a high potential for a pesticide to bioaccumulate in aquatic species, then the PUP would be approved.

If there is a high potential to bioaccumulate in aquatic species (K_{ow} less than 1000 or S_w less than 1 mg/L and soil $t_{½}$ more than 30 days), then the PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Bioaccumulation/Bioconcentration

This is the physiological process whereby pesticide concentrations in tissue would increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation will be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate will be recorded as one of the following: low (0-300), moderate (300-1000, or high (greater than 1000) (Calabrese and Baldwin 1993).

The following threshold has been established for approving PUPs:

If BAF or BCF is less than or equal to 1000, then a PUP would be approved without additional BMPs; and

If BAF or BCF is greater than 1000, then a PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Worst-Case Ecological Risk Assessment

Max Application Rates (acid equivalent). Service personnel will record the highest application rate of an active ingredient (ae basis) for habitat management and facilities maintenance treatments in this data field of a Chemical Profile. These rates can be found in Table CP.1 of Attachment A under the column heading "Max Product Rate – Single Application (lbs./acre – AI on acid equiv basis)." This table is to be filled out prior to completing the Chemical Profile to provide the basic information needed to complete the Chemical Profile. The information included on this table can be found on the product labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

EECs. EECs represent potential exposure of fish and wildlife (birds and mammals) to a pesticide applied on the Refuge. EECs would be derived by Service personnel using a USEPA screening-level approach (USEPA 2004). For each max application rate (see description under Max Application Rates [acid equivalent]), Service personnel will record two EEC values in a Chemical Profile; these will represent the worst-case terrestrial and aquatic exposures for habitat management and facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see description for data entry under Presumption of Unacceptable Risk/Risk Quotients, which is the next field for a Chemical Profile.

Presumption of Unacceptable Risk/Risk Quotients. Service personnel will calculate and record acute and chronic risk quotients (RQs) for birds, mammals, and fish using the provided tabular formats for habitat management and/or facilities maintenance treatments. RQs recorded in a Chemical Profile will represent the worst-case assessment for ecological risk. For aquatic assessments associated with habitat management treatments, RQ calculations will be based upon selected acute and chronic toxicological

endpoints for fish, and the EEC will be derived from Urban and Cook (1986) assuming 100 percent overspray to an entire one-foot-deep water body using the max application rate (ae basis).

For aquatic assessments associated with facilities maintenance treatments, RQ calculations will be calculated by Service personnel based upon selected acute and chronic toxicological endpoints for fish, and an EEC will be derived from the aquatic assessment in AgDRIFT model version 2.01 under Tier I ground-based application with the following input variables: max application rate (acid basis [see above]), low boom (20 inches), fine to medium/coarse droplet size, 20 swaths, USEPA-defined wetland, and 25-foot distance (buffer) from treated area to water. See the section of this appendix titled Aquatic Exposure for more details regarding the calculation of EECs for aquatic habitats for habitat management and facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations will be calculated by Service personnel based upon dietary exposure, where the "short grass" food item category will represent the worst-case scenario. For terrestrial spray applications associated with habitat management and facilities maintenance treatments, exposure (EECs and RQs) will be determined using the Kanaga nomogram method through the USEPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3. T-REX input variables will include the following: max application rate (acid basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on food items for terrestrial vertebrate species in short (less than 20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see the section of this appendix titled Terrestrial Exposure for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with LOCs established by USEPA (see Table 6). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (T&E) species and non-listed species. See the section of this appendix titled Priorities for Treatment for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

The following threshold has been established for approving PUPs:

If RQs is less than or equal to LOCs, then a PUP would be approved without additional BMPs; and

If RQs is greater than LOCs, then a PUP would only be approved with additional BMPs implemented specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species.

When BMPs are required to reduce the potential risk to listed or non-listed species, one or more of the following measures will be included in the Specific Best Management Practices section of the Chemical Profile:

- The application rate will be lowered and/or fewer number of applications will be conducted so RQs are less than or equal to LOCs.
- For aquatic assessments (fish) associated with facilities maintenance, the buffer distance will be increased beyond 25 feet so RQs is less than or equal to LOCs.

Justification for Use

Service personnel will describe the reason(s) for using the pesticide to control specific pests or groups of pests. In most cases, the pesticide label provides the appropriate information regarding control of pests, which can be included in the section.

Specific Best Management Practices (BMPs)

Service personnel will record specific BMPs necessary to minimize or eliminate potential effects to non-target species and/or to minimize or eliminate degradation of environmental quality related to drift, surface runoff, or leaching. These BMPs will be based upon scientific information documented in previous data fields of a Chemical Profile. Where necessary and feasible, these specific practices will be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, Service personnel will describe why the potential effects to Refuge resources and/or degradation of environmental quality is outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See the section of this appendix titled IPM Strategies for Invasive Plants for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary chemical-specific BMPs.

Specific BMPs have been identified for several of the products used or proposed for use on the San Diego NWR. These specific BMPs, which are listed on the chemical profile for each product, are summarized here.

- **Triclopyr** (Garlon, Pathfinder, Remedy): maintain a 25-foot treatment buffer zone from surface water resources, except for cut stump treatments of target woody pest species.
- **Clethodim** (Envoy, Prism, Select, Tapout): may spray up to one-foot of the high water mark of surface water resources.
- **Oryzalin** (Surflan): limited to one application @ 1.5 pounds a.i./acre/year; maintain a minimum 25-foot buffer zone between all upland treatment site(s) and the high water

mark of the nearest surface water resource(s); and do not apply to sites upslope of surface water resources with a greater than 10° slope.

- **Sulfonyl Urea** (Telar XP): do not apply within 25 feet of irrigation water intended for use on sensitive cultivated crops; ground application only; spot (less than one acre per treated site) treatment only, no wide area applications.

- **Glyphosate** (AquaNeat, Buccaneer, Extra Credit, Glyphosate Pro, Makaze, Prosecutor, Razor Pro): apply aquatic labeled glyphosate formulations to aquatic habitats, and surfactant free glyphosate formulations to riparian habitats within 25 feet of surface water resources tank-mixed w/surfactants classified as slight acute toxicity (greater than 10 ppm) to aquatic organisms.

References

Service personnel will record scientific resources used to provide data/information for a Chemical Profile. Use the number sequence to uniquely reference data in a chemical profile.

The following online data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods)

2. ECOTOX database. Office of Pesticide Programs, US Environmental Protection Agency, Washington, DC. (http://cfpub.epa.gov/ecotox/)

3. Extension Toxicology Network (EXTOXNET) Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University and University of Idaho through Oregon State University, Corvallis, Oregon. (http://extoxnet.orst.edu/pips/ghindex.html)

4. FAO specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, Food and Agriculture Organization, United Nations. (http://www.fao.org/ag/agp/agpp/Pesticid/Specs/docs/Pdf/new/procymid.pdf)

5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, US Department of Agriculture, US Forest Service. (http://www.fs.fed.us/foresthealth/pesticide/)

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (http://www.clemson.edu/extension/pest_ed/safety_ed_prog/label_msds/factshee.html)

7. Pesticide Fact Sheets. National Pesticide Information Center. (http://npic.orst.edu/npicfact.htm)

8. Pesticide product labels and material safety data sheets. Crop Data Management Systems, Inc. (CDMS) (http://www.cdms.net/pfa/LUpdateMsg.asp) or multiple websites maintained by agrichemical companies.

9. Weed Research & Information Center. University of California Cooperative Extension and Agricultural Experiment Station. UC Davis. (http://wric.ucdavis.edu/)

10. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (http://www.hc-sc.gc.ca/pmra-arla/)

11. Reptile and Amphibian Toxicology Literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. (http://publications.gc.ca/collections/Collection/CW69-5-357E.pdf)

12. Specific Chemical Fact Sheet – New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. U.S Environmental Protection Agency, Washington, DC. (http://www.epa.gov/pesp/htmlpublications/biopesticides_fact_sheet.html)

13. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (http://tnsweeds.ucdavis.edu/handbook.html)

14. Wildlife Contaminants Online. US Geological Survey, Department of Interior, Washington, D.C. (http://www.pwrc.usgs.gov/contaminants-online/)

15. One-liner database. 2000. US Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C.

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Attachment A – Blank Chemical Profile Form

Chemical Profile

Date:			
Trade Name(s):		**Common Chemical Name(s):**	
Pesticide Type:		**EPA Registration Number:**	
Pesticide Class:		**CAS Number:**	
Other Ingredients:			

Toxicological Endpoints

Mammalian LD_{50}:	
Mammalian LC_{50}:	
Mammalian Reproduction:	
Avian LD_{50}:	
Avian LC_{50}:	
Avian Reproduction:	
Fish LC_{50}:	
Fish ELS/Life Cycle:	
Other:	

Ecological Incident Reports

Environmental Fate

Water solubility (S_w):	
Soil Mobility (K_{oc}):	
Soil Persistence ($t_{½}$):	
Soil Dissipation (DT_{50}):	
Aquatic Persistence ($t_{½}$):	
Aquatic Dissipation (DT_{50}):	
Potential to Move to Groundwater (GUS score):	
Volatilization (mm Hg):	
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Biocentration:	**BAF:`** **BCF:**

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** **Croplands/Facilities Maintenance:**
EECs	**Terrestrial (Habitat Management):** **Terrestrial (Croplands/Facilities Maintenance):** **Aquatic (Habitat Management):** **Aquatic (Croplands/Facilities Maintenance):**

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish (100%)	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Justification for Use:	
Specific Best Management Practices (BMPs):	
References:	

Table CP.1 Pesticide Name

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

Attachment B – Completed Chemical Profiles for the San Diego NWR

B-1 Active Ingredient Aminopyralid

B-2 Active Ingredient Chlorsulfuron

B-3 Active Ingredient Clethodim

B-4 Active Ingredient Fluazifop-p-Butyl

B-5 Active Ingredient Glyphosate

B-6 Active Ingredient Oryzalin

B-7 Active Ingredient Triclopyr

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B-1 Formulations Containing Aminopyralid Chemical Profile

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

Date:	9/20/11				
Pesticide Class:	Pyridine carboxylic acid	**Common Chemical Name(s):**	Aminopyralid	**Pesticide Type:**	Herbicide, Group 4
Trade Name(s):	Milestone, Milestone VM	**EPA Registration Number:**	62719-519, 62719-537	**CAS Number:**	566191-89-7 566191-89-7
Other Ingredients:	59.4% inert ingredients (TIPA and water). No ingredients requiring regulatory advisories (1).				

Toxicological Endpoints

Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

Mammalian LD_{50}:	**Aminopyralid Tech.** *Rat*: > 5,000 mg/kg (oral in males and females) (1,2,3,4,6,7,8), NOAEL (90-day feeding) = 520 mg/kg/day (8); **Milestone:** *Rat* = 5,000 mg/kg bw (7).
Mammalian LC_{50}:	**Aminopyralid Tech:** *Rat*: NOEL = > 1,000 ppm (6)

Mammalian Reproduction:	**Aminopyralid Tech.:** *Rabbit*: NOAEL = (dam) 250 mg/kg/day, = (fetus) 500 mg/kg/day (2,8), LOAEL = (dam) = 500 mg/kg/day; NOAEL = 1,000 mg/kg/day (2); *Rat*: 2-generation NOEL (dam & fetus) = 1,000 mg/kg/day (2,5,8); **Milestone:** *Rabbit*: NOAEL = (dam) 104 mg/kg/day, = (fetus) 260 mg/kg/day (2,4,8), LOAEL = (dam) 260 mg/kg/day, = (fetus) 520 mg a.e./kg/day (2,8); *Rat*: NOAEL (dam & fetus) = 520 mg a.e./kg/day (4,8);
Avian LD_{50}:	**Aminopyralid Tech:** *Bobwhite*: > 2,250 mg a.e./kg bw (2,3,6)
Avian LC_{50}:	**Aminopyralid Tech:** *Bobwhite*: NOEC = 5,556 ppm a.e. (2,5,7). *Mallard*: NOEC = 5,496 ppm a.e. (2,5,7).
Avian Reproduction:	**Aminopyralid Tech:** *Bobwhite*: LOEC = 640 mg a.e./kg diet (2). *Mallard*: NOEC = 2,623 mg a.e./ kg diet (2,7).
Fish LC_{50}:	**Aminopyralid Tech.:** *Bluegill*: 96-hour > 100 ppm a.e. (2,3,5). *Rainbow Trout*: 96-hour > 100 ppm a.e. (2,3,5,6). *Sheepshead Minnow*: 96-hour > 120 ppm a.e. (2,3,5).
Fish ELS/Life Cycle:	**Aminopyralid Tech.:** *Fathead Minnow*: NOEC = 1.36 ppm a.e., LOEC = 2.44 ppm a.e. (2,5);
Amphibians/Reptiles:	**Aminopyralid Tech.:** *Northern Leopard Frog*: 96-hour LC50 > 95.2 mg a.e./L (2,5)

Invertebrates/Plants:	**Aminopyrlaid Tech.:** *Blue-green Algae*: 120-hour EC50 = 27 ppm a.e. (3). *Daphnia magna*: 48-hour EC50 > 98.6 ppm a.e. (2,5); 21-day NOEC = 100 ppm a.e. (6), LOEC = >102 ppm a.e. (3,5). *Duckweed*: 14-day EC50 > 88 ppm a.e. (2,3,5), NOEC = 44 ppm a.e. (2,5). *Earthworm*: 14-day LC50 > 1,000 mg a.e./kg soil (3,6). *Eastern Oyster*: 48-hour EC50 > 89 ppm a.e. (2,5). *Green Algae*: 72-hour ErC50 = 30 ppm a.e., NOEC = 23 ppm a.e. (3,5). *Honey Bee*: 48-hour LD50 (contact) > 100 µg a.e./bee (2,3,5). *Midge*: NOEC = 130 ppm a.e. (3). *Mysid Shrimp*: 96-hour LC50 > 100 ppm a.e. (2,3,5).
Other Endpoints:	Carcinogenic: Negative (1), Teratogenic: Negative (1); Mutagenic: Negative (1); Endocrine disruption: Negative (8)

Ecological Incident Reports

No incident reports in references.

Environmental Fate

Water solubility (S_w):	= 203 g/L (pH 5 @ 20ºC), 205 g/L (pH 7 @ 20ºC, and 212 g/L @ 20ºC (2,4,8); = 2.48 g/L @ 18ºC (3,5,8).
Soil Mobility (K_{oc}):	= 1.05 to 24.3 mL/g (2,5); =10.8 mL/kg (3).
Soil Persistence ($t_{½}$):	*Aerobic degradation*: Aerobic microbial degradation is the primary route of breakdown in soils. Aerobic soil half-life (across range of 5 soil types) = 31.5 - 533.2 days , USEPA assumes half-life = 103.5 days (2,3,5) for risk assessments, however, persistence may be up to 5x longer (5). *Photolysis*: Soil photodegradation half-life = 61 days (3); = 72.2 days (2,5).
Soil Dissipation (DT_{50}):	*Terrestrial field dissipation*: surface soil = 20 days, total soil =26 days (CA); surface soil = 32.1 days, total soil =34 days (MS) (5); DT_{50} =21.1 days (6).

Aquatic Persistence ($t_{½}$):	*Aerobic degradation*: Aerobic sediment-water degradation (aquatic metabolism) half-life = 462 to 990 days (2). Water-sediment DT_{50} =712 days (6). *Anaerobic degradation*: Anaerobic aquatic metabolism ½ life = stable (4). Anaerobic sediment-water degradation half-life = stable (2,5). *Hydrolysis*: =Stable (3). *Photolysis*: Primary route of degradation is photolysis (2); Half-life = 0.6 days (2,3,5,6) in clear/shallow water, considerably longer in turbid/deep water (5).
Aquatic Dissipation (DT_{50}):	Water = 250 days (6).
Potential to Move to Groundwater (GUS score):	=4.8 (high probability of leaching) (6).
Vapor Pressure (mm Hg):	$7.14x10^{-11}$ mm Hg @ 20ºC (2,3,5); $1.92x10^{-10}$ mm Hg @ 25ºC (2).
Octanol-Water Partition Coefficient (K_{ow}):	Log Kow = 0.201 (unbuffered water), -1.75 (pH 5), -2.87 (pH 7), -2.96 (pH 9) @ 20ºC (2,4,5,6); Kow = 1.58 @ 20ºC (5).
Bioaccumulation/Biocentration:	**BAF:** No information in references. **BCF:** = 100 (7).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 0.11 lbs. a.e./acre **Croplands/Facilities Maintenance:** 0.11 lbs. a.e./acre
EECs	**Terrestrial (Habitat Management):** 26.4 ppm **Terrestrial (Croplands/Facilities Maintenance):** 26.4 ppm **Aquatic (Habitat Management):** 0.04 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.00037 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	<0.01 [0.1]	<0.01 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.04 [1]	=0.04 [1]
	Mammals	=0.01 [1]	=0.01 [1]
	Fish	=0.03 [1]	=0.03 [1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	<0.01 [0.1]	<0.01 [0.5]
	Mammals	<0.01 [0.1]	<0.01 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.04 [1]	=0.04 [1]
	Mammals	=0.01 [1]	=0.01 [1]
	Fish	<0.01 [1]	<0.01 [1]

Justification for Use:	Control of many noxious and invasive weed species in the Aster family notably thistles and knapweeds.
Specific Best Management Practices (BMPs):	Do not treat within 25 feet of surface water intended for irrigation of sensitive cultivated crops.

References:

[1]_____. 2006. Milestone and Milestone VM MSDS. Dow AgroSciences LLC, Indianapolis, IN. 4 pp.

[2]_____. 2005. Pesticide fact sheet – aminopyralid. USEPA, Office of Prevention, Pesticides and Toxic Substances, Washington, D.C. 56 pp.

[3]_____. 2005. Aminopyralid – technical bulletin. Dow AgroSciences, LLC. Indianapolis, IN. 19 pp.

[4]_____. 2007. Regulatory note – aminopyralid. Pest Management Regulatory Agency, Health Canada, Ottawa, Canada. 87 pp.

[5]_____. 2005. Environmental fate and ecological risk assessment for the registration of aminopyralid. Office of Pesticide Programs, Environmental Fate and Effects Division, USEPA, Washington, D.C. 151 pp.

[6]_____. 2009. The Pesticide Properties Database (PPDB) developed by the Agricultural & Environment Research Unit (AERU), University of Hertfordshire, funded by UK national sources and the EU-funded FOOTPRINT project (Hatfield, UK); Last accessed: 6 September 2011.

[7]_____. 2007. Aminopyralid: Human Health and Ecological Risk Assessment – Final Report. Prepared by USDA Forest Service and National Park Service by Syracuse Environmental Research Associates, Inc (USDA Contract#: AG-3187-C-06-0010).

[8]_____. 2005. Aminopyralid: Aggregate Human Health Risk Assessment for the Proposed Uses on Wheat, Grasses, Non-cropland Areas, and Natural Areas. USEPA Health Effects Division, Scientific Data Reviews, Series 361, File R112051, 61 pp

Table CP.1 Pesticide Name

Active Ingredient = aminopyralid

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI or acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Milestone	H	0.055 gal/acre	0.11 lbs a.e./acre	1	0.055 gal/acre/season	0
Milestone VM	H	0.055 gal/acre	0.11 lbs a.e./acre	1	0.055 gal/acre/season	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

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B-2 Formulations Containing Clethodim Chemical Profile

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

Date:	5/10/12				
Pesticide Class:	Cyclohexanedione	**Common Chemical Name(s):**	Clethodim	**Pesticide Type:**	Herbicide
Trade Name(s):	Arrow 2EC, Intensity, Section 2EC, Select 2EC , Select Max	**EPA Registration Number:**	66222-60, 34704-864, 42750-72-1381, 59639-3, 59639-132	**CAS Number:**	99129-21-2, 99129-21-2, 99129-21-2, 99129-21-2, 99129-21-2
Other Ingredients:	**Arrow 2EC (Clethodim [CTD]):** 26.4% CTD, 22.1% heavy aromatic petroleum hydrocarbons (including 2.2% naphthalene), 51.5% proprietary ingredients (1a), **Intensity:** 26.4% CTD, 73.6% proprietary ingredients (including xylene range aromatic solvents, and naphthalene) (1b), **Section 2EC:** 25-27% CTD, 65-70% petroleum distillates, 2-3% trimethylbenzene, 5-7% naphthalene, 3-10% proprietary ingredients (1c), **Select 2EC:** 25-27% CTD, 65-71% total hydrocarbons, 5-7% naphthalene, 2-3% trimethylbenzene, 1-10% proprietary ingredients (1d), **Select Max:** 12-14% CTD, 45-48% Total hydrocarbons (including < 5% naphthalene), 39-42% proprietary ingredients (1e)				

Clethodim sulfoxide (CTD-SX): 1st order (major) toxicologically significant degradate of CTD (2,3,7),

Clethodim sulfone CTD-SN): 1st order (minor) toxicologically significant degradate of CTD (2,3,7)

Toxicological Endpoints

Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

Mammalian LD_{50}:	**CTD (%AI Unk):** *Rat*: acute oral = 1,133 mg/kg (7,8). **CTD (98.6% AI):** *Rat*: Single oral dose, females = 1,400 mg/kg bw (10). **CTD (83.3%AI):** *Dog*: 1-yr feeding study: LOEL = 75 mg/kg/day, NOEL = 1 mg/kg/day (10). *Mouse*: Single oral dose: females = 2,430 mg/kg bw, males = 2,570 mg/kg bw (10). *Rat*: Single oral dose: females = 1,360 mg/kg bw (3,10), males = 1,630 mg/kg bw (10). **CTD (26.1% AI):** *Rat*: Single oral dose: females = 2,920 mg/kg bw, males = 3,610 mg/kg bw (10). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Mammalian LC_{50}:	**CTD:** No information in references. **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Mammalian Reproduction:	**CTD (%AI Unk):** *Rat*: 2-generation reproductive study: NOEL = 500 ppm ai (= 51 mg/kg/day) (3,10), LOEL = 2,500 ppm; NOEL = 263 mg/kg/day) (10). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Avian LD_{50}:	**CTD (82.0% AI):** *Bobwhite*: Single dose, 14-d observation period: > 2,000 mg/kg (1a,e,3,4,6,9,10), NOEL = 1,250 mg/kg (6). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Avian LC_{50}:	**CTD (82.0% AI):** *Bobwhite*: 5-d, 10 day old > 4,270 ppm (3,4,6,10), 5-d NOEL = 4,270 ppm (6). *Mallard*: 5-d, 10 day old > 3,978 ppm (4,6,10), 5-d NOEL = 2,750 ppm (6). **CTD-SX:** No information in references; **CTD-SN:** No information in references.

Avian Reproduction:	**CTD (83.3% AI):** *Bobwhite*: 22-week reproductive study LOEL = 833 ppm, NOEL = 250 ppm (3,6); Reproductive NOEL = 300 mg/kg (9). *Mallard*: 19-week reproductive study LOEL > 833 ppm, NOEL = 833 ppm (6). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Fish LC_{50}:	**CTD (%AI Unk):** *Bluegill*: 96-h LC50, age unk = 13 ppm (10). *Rainbow Trout*: 96-h LC50, age unk = 15 ppm ai (3); 96-h, age un) = 25 ppm (8), 21-d NOEC = 3.9 ppm (8); 96-h LC50, age unk = 18 ppm (10). **CTD-SX:** *Rainbow Trout*: 96-h, age unk > 100 ppm (8). **CTD-SN**: No information in references.
Fish ELS/ Life Cycle:	**CTD (83.3% AI):** *Bluegill*: 96-h LC50, av. Wt. 0.53 g > 33 ppm (4,5,6), 96-h NOEL = 33 ppm (6). *Rainbow Trout*: 96-h LC50, av. wt. 0.67 g = 19 ppm (4,5,6), 96-h NOEL < 18 ppm (6). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Amphibians/ Reptiles:	**CTD:** No information in references. **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Invertebrates/ Plants:	**CTD (%AI Unk):** *Daphnia magna*: 48-h LC50, age unk. = 5.7 ppm ai (3); 48-h EC50 > 100 ppm (8), 21-d NOEC = 49 ppm (8). *Duckweed*: 7-d EC50, biomass)= 1.9 ppm (8). *Earthworm*: 14-d LC50 = 454 mg/kg dry soil (8,9). *Green Algae*: 5-d EC50 = 11.0 ppm ai (3); 72-d EC50, growth > 12 ppm (8). *Honey Bee*: 48-h LD50 > 43 µg/bee (8). **CTD (82.4-88.0% AI):** *Honey Bee*: 48-h LD50, worker bee > 100 µg/bee (4,6,9,10). *Duckweed*: 14-d EC50, growth = 1.34 ppm (4,5,6), 14-d NOEL = 0.37 ppm (6). *Green algae*: (5-d EC50, growth) > 11.4 ppm (4,5,6), (5-d NOEL) = 8 ppm (6).

	CTD (25.6% AI): *Daphnia magna*: 48-h EC50, < 24 h old = 20.2 ppm (4,5,6,10), 48-h NOEL = 5.5 ppm (6,10). *Duckweed*: 14-d EC50, growth = 166 ppm (4,5,6), 14-d NOEL = 4.1 ppm (6). *Green algae*: 5-d EC50, growth = 76 ppm (4,5,6), 5-d NOEL = 43.5 ppm (6). *Honey Bee*: 48-h LD50, worker > 100 µg/bee (6). **CTD (12% AI):** *Green Algae*: 96-h EC50, growth = 22.9 ppm (3,4). **CTD-SX: (%AI Unk):** *Duckweed*: 7-d EC50, biomass = 88 ppm (8). *Earthworm*: 14-d LC50 > 500 mg/kg dry soil (8). *Green Algae*: 72-d EC50, growth > 100 ppm (8). **CTD-SN:** No information in references.
Other:	**CTD:** Neurotoxic: Negative (8); Carcinogenic: Negative (1a,b,7,8); Teratogenic: Positive only at maternally toxic dose levels (1a,b,d,e,8); Mutagenic: Negative (1a,8,10); Genotoxic: Unlikely, some cellular tests positive, but whole animal tests were negative (1a,7); Endocrine disruption: Negative (8); **CTD-SX:** Carcinogenic: Negative (8); No information in references on other endpoints; **CTD-SN:** Carcinogenic: Negative (8), Genotoxic: Negative (7); No information in references on other endpoints.

Ecological Incident Reports

No reports in references.

Environmental Fate

Water solubility (S_w):	**CTD:** Highly dependent on pH (3), = 5 - 270 mg/L (3), = 5,400 mg/L @ pH 7 (3); = 53 mg/L @ pH 4 (7); @ pH 7, 20°C = 5,450 mg/L (7,8), @ pH 9 = 58,900 mg/L (7), @ pH 10 = 30,000 mg/L (7). **CTD-SX:** = 73 mg/L (7,8). **CTD-SN:** = 46.4 mg/L (7).
Soil Mobility (K_{oc}):	**CTD:** Highly mobile in soil (7). **CTD-SX:** Highly mobile in soil (7), (mean) = 9 mL/g (7); range = 5 - 270 mL/g (3). **CTD-SN:** Highly mobile in soil (7), mean = 9.66 mL/g (7); = 5 - 270 mL/g (3).

Soil Persistence ($t_{½}$):	**CTD:** Metabolism by micro-organisms dominate the degradation process with no photoproducts being formed (2). Fairly non-persistent under aerobic conditions, much more persistent in anaerobic conditions (3). *Aerobic degradation*: = 1 to 3 d (2), (sandy) = 1 d (2); < 3 d (3), = 3 d (9); = 1 to 2.6 d (10). *Anaerobic degradation*: = 177 d (9). *Photolysis*: = 3 d (9). **CTD-SX:** Low to moderate persistence in soil (7). **CTD-SN:** Low to moderate persistence in soil (7).
Soil Dissipation (DT_{50}):	**CTD:** *Aerobic*: light or dark @ 25ºC = 5 d (2), dark @ 5ºC = 23 d (2); = 0.16 d (irradiated samples) (7), = 2.88 d (darkness) (7), (sandy loam, pH 7.1, 25ºC) = 2.55 d (7), (sandy loam @ pH 7.5, 20ºC) = 1.08 to 1.18 d (7), (clay loam, pH 7.3 @ 20ºC) = 0.23 to 0.36 d (7), (loam, pH 6.8 @ 20ºC) = 0.36 to 0.38 d (7), (loamy sand @ pH 5.7, 20ºC) = 0.40 to 0.52 d (7), Mean = 0.56 d (7); typical = 0.55 d (8), lab @ 20ºC = 0.55 d (8), field = 3 d (8). *Anaerobic*: Canadian slough water/sediment: in darkness @ 25ºC = 177 d, in darkness @ 5ºC = 559 d (2,3). **CTD-SX:** *Aerobic*: ~ 35 d (3); Mean = 7.01 d (7), = 2.6 to 26.3 d @20ºC (7), = 1.55 d (7), Stable in dark (7), sandy loam, pH 7.1, 25ºC = 22.14 d (7), sandy loam, pH 7.5, 20ºC = 15.92 to 16.42 d (7), clay loam, pH 7.3, 20ºC = 3.58 to 3.67 d (7), loam, pH 6.8, 20ºC = 5.42 to 7.82 d (7), loamy sand, pH 5.7, 20ºC = 3.7 to 5.0 d (7); Typical = 9 d (8), lab @ 20ºC = 7.97 d (8), field = 17 d (8). **CTD-SN:** *Aerobic*: ~ 35 d (3), Mean = 12.53 d (7), = 2.9 to 55.9 d (20ºC) (7), (sandy loam, pH 7.1, 25ºC) = 22.14 d (7), (sandy loam, pH 7.5, 20ºC) = 15.92 to 16.42 d (7), (clay loam, pH 7.3, 20ºC) = 3.58 to 3.67 d (7), (loam, pH 6.8, 20ºC) = 5.42 to 7.82 d (7), (loamy sand, pH 5.7, 20ºC) = 3.7 to 5.0 d (7): Typical = 15 d (8), (lab, 20ºC) = 13.9 d (8).
Aquatic Persistence ($t_{½}$):	**CTD:** Fairly non-persistent under aerobic conditions, much more persistent in anaerobic conditions (3). *Aerobic degradation*: = 5 d (3). *Photolysis*: = 1.4 d @ pH 5, = 4 to 6 d @ pH 7, = 9.3 @pH 9 (3,10); = 128 d (9,10). **CTD-SX:** No information in references. **CTD-SN:** No information in references.

Aquatic Dissipation (DT_{50}):	**CTD:** *Dissipation Time DT50*: Maximum = 19.7 d (7), Sediment = 1,000 d (7). *Hydrolysis*: = stable @ pH 7, 20°C (8), = 41 d @pH 5, 7, & 9, 25°C (8); Water-sediment = 16.7 d (8), water only = 7 d (8); = 26 d @ pH 5 (10), = 300 d @ pH 7 & 9 (10). *Photolysis*: = 1.49 to 1.71 d @ pH 5, 25°C (7), = 4.05 to 6.84 d @ pH 7, 25°C (7), = 6.0 to 9.57 d @ pH 9, 25°C) (7), = 1.6 d @ pH 5, 25° (7); = 5.45 d @ pH 7), = 7.79 d @ pH 9 (8) **CTD-SX:** Max. value = 31.3 d (7), water-sediment = 26 d (8). **CTD-SN:** Max. value = 360 d (7).
Potential to Move to Groundwater (GUS score):	**CTD:** -0.69 (8). **CTD-SX:** = 2.74 (8). **CTD-SN:** = 3.49 (8).
Vapor Pressure (mm Hg):	**CTD:** = 7.14 x 10^{-11} (20°C) (9), = 1 x 10^{-7} (10). **CTD-SX:** No information in references. **CTD-SN:** No information in references.
Octanol-Water Partition Coefficient (K_{ow}):	**CTD:** = 15,848.9 (3); pH 7 @ 20°C = 13,803.8 (7,8), @ pH 9 = 16,595,9 (7); = 15,000 (10). **CTD-SX:** = 117.5 (7,8). **CTD-SN:** No information in references.
Bioaccumulation/ Biocentration:	**BAF:** No information in references. **BCF: CTD** = 2.1 (8).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** =0.24 lb. a.i./acre **Croplands/Facilities Maintenance:** =0.24 lb. a.i./acre
EECs	**Terrestrial (Habitat Management):** =57.6 ppm **Terrestrial (Croplands/Facilities Maintenance):** =57.6 ppm **Aquatic (Habitat Management):** =0.092 ppm **Aquatic (Croplands/Facilities Maintenance):** =0.0018 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.02 [0.1]	=0.02 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.23 [1]	=0.23 [1]
	Mammals	=0.10 [1]	=0.10 [1]
	Fish	<0.01 [1]	<0.01 [1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.02 [0.1]	=0.02 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.23 [1]	=0.23 [1]
	Mammals	=0.10 [1]	=0.10 [1]
	Fish	<0.01 [1]	<0.01 [1]

Justification for Use:	Annual and perennial grass control, specifically *Vulpia myuros,* of which fluazifop-p-butyl (trade name = Fusilade DX) is not effective.
Specific Best Management Practices (BMPs):	May spray up to 1 foot of high water mark of surface water resources.
References:	[1a] _____. 2008 & 2010, respectively. Arrow 2EC specimen label & MSDS. Makhteshim Agan of North America, Inc., Raleigh, NC. 64 & 6 pp., respectively. [1b] _____. 2010 & 2009. Intensity Specimen label and MSDS. Loveland Products, Inc., Greeley, CO. 42 & 3 pp., respectively. [1c] _____. 2011 & 2010. Section 2EC specimen label and MSDS. Winfield Solutions, LLC., St. Paul, MN. 47 & 3 pp.

[1d] _____. 2007 & 2000. Select 2EC specimen label and MSDS. Valent USA Corp., Walnut Creek, CA. 30 & 10 pp., respectively.

[1e] _____. 2010. Select Max specimen and label and MSDS. Valent USA Corp., Walnut Creek, CA. 43 and 9 pp., respectively.

[2] FAO specifications and evaluations for plant protection products – Glyphosate. 2001. Food and Agriculture Organization, United Nations, New York, NY. 40 pp.

[3] Dean R. and J. Angier. 2008. Memo: Registration Review-Preliminary Problem Formulation for the Ecological Risk Assessment of Clethodim. U.S. EPA Environmental Fate and Effects Division, Office of Pesticide Programs. 23 pp.

[4] US Environmental Protection Agency. 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4.0: http:/www.epa.gov/ecotox; Last accessed 15 April 2012.

[5] Kegley, S.E., B.R. Hill, S. Orme, and A.H. Choi., 2011. PAN Pesticide Database, Pesticide Action Network, San Francisco, CA; Last accessed 15 April 2012.

[6] US Environmental Protection Agency. Office of Pesticide Program's Pesticide Ecotoxicity Database: http://www.ipmcenters.org/ecotox/DataAccess.cfm; Last accessed 15 April 2012.

[7] European Food Safety Authority (EFSA), November 2011, Conclusion on the peer review of the pesticide risk assessment of the active substance clethodim, EFSA Journal 9(10):2417.

[8] The Pesticide Properties Database (PPDB) developed by the Agricultural & Environment Research Unit (AERU), 2009, University of Hertfordshire, funded by UK national sources and the EU-funded FOOTPRINT project (Hatfield, UK); Last accessed: 4 May 2012.

[9] Herbicide Fact Sheet – Clethodim, 2006, U.S. Department of Energy, Bonneville Power Administration. 10 pp.

[10] Herbicide Profiles, Cornell University. Clethodim. 5pp. Last accessed: 4 May 2012.

Table CP.1 Pesticide Name

Active Ingredient = clethodim

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Arrow 2EC,						
Intensity,	H, CF	0.12 gal	0.24	1	0.24	0
Section 2EC,	H, CF	0.25 gal	0.24	1	0.24	0
Select 2EC,						
Select Max,						

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

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B-3 Chemical Profile Chlorsulfuron (Telar XP)

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

Date:	7/12/12				
Pesticide Class:	Sulfonylurea	**Common Chemical Name(s):**	Chlorsulfuron	**Pesticide Type:**	Herbicide
Trade Name(s):	Chlorsulfuron 75, Glean XP, Telar XP,	**EPA Registration Number:**	81927-43, 352-653, 352-654	**CAS Number:**	64902-72-3, 64902-72-3, 64902-72-3
Other Ingredients:	**Chlorsulfuron 75 (chlorsulfuron [CSF]):** 75% CSF, 25% proprietary ingredients (1a); **Glean XP:** 75.0% CSF, 25.0% proprietary ingredients (1b); **Telar XP:** 75% CSF, 25% proprietary ingredients (1c).				

Toxicological Endpoints

Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

Mammalian LD_{50}:	**CSF (Tech.):** *Rabbit*: Developmental study: NOAEL = 75 mg/kg/day, LOAEL = 200 mg/kg/day (2). *Rat*: acute, time/age unk > 5,000 mg/kg bw (1a,7,8), acute, time/age unk = 5,500 mg/kg (2). **CSF (91.9-95.0% AI):** *Rat*: Single dose, 14-d observation period = 5,545 mg/kg (males), = 6,293 mg/kg (females) (3,9). **CSF (80.0% AI):** *Rat*: Single dose, 14-d observation period = 7,699 mg/kg (males), = 7,634 mg/kg (females) (3). **CSF (75% AI):** *Rat*: acute, time/age unk > 2,000 mg/kg (1b,c); Single dose, 14-d observation period (males) = 3,053 mg/kg (3), (females) = 2,341 mg/kg (3).

Mammalian LC_{50}:	**CSF (Tech.):** *Rat*: time/age unk > 100 ppm (7).
Mammalian Reproduction:	**CSF (%AI Unk):** *Rabbit*: Reproductive Study: NOAEL, dams = 200 mg/kg/day; NOAEL, fetus > 1,000 mg/kg (3). *Rat*: Reproductive study NOEL = 25 mg/kg/day (3). **CSF (98.2% AI):** Rat: Reproductive Study: NOAEL (dams) = 165 mg/kg/day, NOAEL (fetus) = 500 mg/kg (3); 3-generation NOEL = 500 ppm (3).
Avian LD_{50}:	**CSF (Tech.):** *Mallard*: Short-term dietary, time/age unk > 634 mg/kg bw/day (7). **CSF (91.1% AI):** *Bobwhite*: Single dose, 14-d observation period: LD50 > 5,000 ppm (1a,b,3,4,6,8,9), 14-d NOEL = 2,500 (6). *Mallard*: Single dose, 14-d observation period: LD50 > 5,000 ppm (1a,b,2,3,4,6,7,8,9).
Avian LC_{50}:	**CSF (Tech.):** *Bobwhite*: 5-d, 14 d old > 5,620 ppm (1b,3,4,6,8,9). *Mallard*: 5-d, 14 d old > 5,620 mg/kg (1b,3). **CSF (91.0% AI):** *Mallard*: 5-d, 14 d old > 5,000 ppm (3,4,6,8,9).
Avian Reproduction:	**CSF (98.2% AI):** *Bobwhite*: Reproduction study (time not specified): NOEL = 174 ppm, LOEL = 961 ppm (2); 27-weeks reproductive study: LOEL = 928 ppm, NOEL = 166 ppm (6). *Mallard*: 1-generation reproductive study: LOEL > 987 ppm, NOEL = 987 ppm (6).
Fish LC_{50}:	**CSF (Tech.):** *Bluegill*: 96-h, age unk. > 128 ppm (1b,1c,9). *Rainbow Trout*: 96-h LC50, age unk > 250 ppm (1a,2,3,4,8); 96-h, age unk. > 122 ppm (1b,c,7,9); 21-d NOEC, age unk. = 32 ppm (2,7). *Sheepshead Minnow*: 96-h LC50 > 980 ppm (1a,b,c,2,3). **CSF (40% AI):** *Brown Trout*: 96-h, age unk. = 40 ppm (3,5), 96-h NOEL = 30 ppm (3).

Fish ELS/ Life Cycle:	**CSF (91.0-98.2% AI):** *Bluegill*: 96-h LC50, juvenile > 300 ppm (3,4,5,6,8), 96-h NOEL = 217 ppm (3). *Channel Catfish*: 96-h LC50, juvenile > 50 ppm (3,4,5,6). *Fathead Minnow*: 96-h LC50, juvenile > 300 ppm (3,4,5,6). *Rainbow Trout*: Early life stage, 77-d: LOEL = 64.8 ppm, NOEL = 31.4 ppm (6,9), 96-h LC50, juvenile > 250 ppm (4,5,6). *Sheepshead Minnow*: 96-h LC50, av. wt. 0.19 g > 980 ppm (3,4,5,6,8), 96-h NOEL = 980 ppm (3,6). **CSF (75% AI, Glean):** *Brown Trout*: 96-h LC50, juveniles = 38 ppm (4,5).
Amphibians/ Reptiles:	**CSF:** No information in references.
Invertebrates/ Plants:	**CSF (%AI Unk.):** Mesocosm study indicates CSF can cause changes in phytoplankton communities at concentrations as low as 0.01 ppm (3). *Daphnia magna*: 48-h LC50 > 100 ppm, 48-h NOEL = 10 ppm (3); 6-d NOEL, growth = 0.001 ppm (5). *Daphnia pulex*: 48-h NOEL = 32 ppm (3); 48-h LC50 not calculated, between 32 ppm (no mortality) and 100 ppm (100% mortality) (3). *Duckweed*: 96-h EC50, growth = 0.0007 ppm (3). *Green Algae*: 72-h EC50 = 0.000055 ppm (1a,2), 72-h NOEC = 0.0000095 ppm (2); 5-d EC50 = 0.05 ppm (1b). *Sago Pondweed*: 96-h EC50 = 0.00025 ppm (3), 28-d LC50 = 0.001 ppm (3). **CSF (Tech):** *Daphnia magna*: 21-d NOEC = 12 ppm (7). *Duckweed*: 7-d EC50, biomass = 0.00035 ppm (2,7), 7-d NOEC = 0.00024 ppm (2); 96-h EC50, biomass = 0.007 ppm (4), 96-h LOEL = 0.007 ppm (4), 96-h NOEL = 0.004 ppm (3,4). *Earthworm*: 14-d LC50 > 750 ppm (7), 14-d NOEC, reproduction = 187.5 ppm (7). *Green Algae*: 96-h EC50, growth = 0.135 ppm (4), 96-h LOEL = 0.019 ppm (4), 96-h NOEL < 0.019 ppm (4); 72-h EC50, growth = 0.068 ppm (7). *Honey Bee*: 48-h LD50 > 100 µg/bee (7,9). *Mysid Shrimp*: 96-h LC50 = 89 ppm (2,3), 96-h NOEC = 35 ppm (3); 96-h LC50 = 71 ppm (7). **CSF (91.0-99% AI):** *Daphnia magna*: 48-h EC50 = 370.9 ppm (1a,2,3,4,5,6,8); 21-d life cycle: LOEC = 36 ppm, NOEL = 20 ppm (2,3,6,9); 48-h EC50 > 112 ppm (1b,c,7,9). *Duckweed*: 14-d EC50, # of normal fronds = 0.00042 ppm (6,9), 14-d EC50, biomass =

	0.00035 ppm (9), 14-d NOEL = 0.00024 ppm (6,9); 5-d NOEL = 0.0094 ppm (6). *Eastern Oyster*: 48-h EC50 = 385 ppm (1a,3,6,8), 48-h LC25 = 905 ppm (3), 48-h NOEL = 328 ppm (6); 48-h EC50 = 376 ppm (3,4,5,6), 48-h NOEL = 200 ppm (3,6). *Green Algae*: 5-d EC50 = 0.05 ppm, 5-d NOEL = 0.01 ppm (3,9), 24-h EC50, growth = 0.56 ppm (3), 24-h EC50, cell reproduction = 0.4 ppm (3); 14-h EC50, cell volume growth = 0.56 ppm (4), 24-h EC50, cell reproduction = 0.4 ppm (4); 96-h EC50, biomass, *C. saccharophila* = 54 ppm (4), 96-h NOEC = 9.3 ppm (4), 96-h EC50, biomass, *S. acutus* = 0.22 ppm (4), 96-h NOEC = 0.07 ppm (4,5). *Honey Bee*: 48-h LD50, adult > 25 µg/bee (1a,2,3,4,8), 48-h NOEL < 1.6 ppm (6). *Mysid Shrimp*: 96-h LC50, juvenile = 89 ppm (3,4,5,6), 96-h NOEL = 35 ppm (3,6). **CSF (75% AI):** *Green Algae*: 72-h EC50, growth = 0.8 ppm (3). **CSF (75% AI, Glean):** *Green Algae*: 96-h EC50, growth = 0.7 ppm (3,4,5). **CSF (75%AI, Telar XP):** *Green Algae*: 72-h EC50, growth > 0.24 ppm (1c), 72-h EC50, biomass = 0.088 ppm (1c). **CSF (73.4% AI):** *Duckweed*: 14-d EC50, growth = 0.44 ppm (6), 14-d NOEL = 0.29 ppm (6). *Green Algae*: 72-h EC50, growth = 0.067 ppm (6), 72-h NOEL = 0.0124 ppm (6).
Other:	**CSF:** Neurotoxic: Negative (3,7); Carcinogenic: Negative (2,8); Teratogenic: Negative (3,8); Mutagenic: Negative (1a,b,c,3,8); Genotoxic: Possibly, status not identified (7); Endocrine disruption: Negative (3). **NOTE:** Results from a number of field studies, greenhouse studies, and laboratory studies suggest that chlorsulfuron applied at label rates may result in high risk to non-target plants grown in the vicinity of application sites. Several researchers have concluded that these studies indicate that small quantities of chlorsulfuron change plant reproduction without altering vegetative growth (e.g. may severely reduce crop yields and fruit development on plants). Plant reproductive processes may be more sensitive to chlorsulfuron than growth effects. Low levels of chlorsulfuron appear to adversely influence plant reproduction, which is not characteristic of many common herbicides. (2).

Note: No toxicologically significant degradates; degradates appear to be considerably less toxic (100-fold) than parent compound of CSF (3). CSF degrades to nonphytotoxic, low-molecular-weight compounds (8).

Ecological Incident Reports

The USEPA EIIS contained five incident reports involving chlorsulfuron. In all five incidents, crops were allegedly damaged by chlorsulfuron. The incident reports listed the probability that chlorsulfuron caused the observed damage as "highly probably" in one incident and "possible" in four incidents (10).

Environmental Fate

Water solubility (S_w):	**CSF:** = 125 mg/L at 20°C (2); = 125 mg/L at 25°C (3), = 100 to 120 mg/L at 22°C (3), = 430 mg/L at 25°C (3), = 5,587 mg/L (3), = 27,900 mg/L at 25°C, pH 7 (3); = 3.18 x 10^4 mg/L at pH 7 (3,8,9); = 12,500 mg/L at 20°C (7); = 590 mg/L at pH 5 (9).
Soil Mobility (K_{oc}):	**CSF:** Av. = 36 mL/g (range = 14 - 60) (3), = 1.02 mL/g (3), @ pH 7 = 40 mL/g (3), silt loam = 17 to 20 mL/g (3), sandy loam = 13 mL/g (3), loam = 54 mL/g (3), = 33 mL/g (8).
Soil Persistence ($t_{½}$):	**CSF:** *Mechansim not specified*: = 14 to 320 d (2). *Aerobic degradation*: Av. = 32 d (range = 13 – 88 d) (3), clay = 168 d (3), loam = 37 d (3), sand = 47 d (3). *Hydrolysis*: sterile sandy clay = 53 d (3), sandy loam = 51 d and 149 d (2 different sites) (3), clay = 70 d (3), silty clay = 59 d (3), sandy loam = 18 d (3), flooded soils = 47 - 86 d (3), field conditions in slightly acidic soils = 1 month (3), field conditions in alkaline soils = 2 to 3 months (3); Soil Types: Typic Haplorthox: 0-30 cm deep: @ 25°C = 7.32 d, @ 40°C = 2.41 d; 50-200 cm deep: @ 25°C = 8.23 d, @ 40°C = 1.19 d (3); Typic Acrohumox: 0-40 cm deep: @ 25°C = 10.18 d, @ 40°C = 2.35 d; 100-200 cm deep: @ 25°C = 29.05 d, @ 40°C = 5.04 d (3); Typic Haplohumox: 0-15 cm deep: @ 25°C = 8.20 d, @ 40°C = 3.48 d; 70-150 cm deep: @ 25°C = 25.67 d, @ 40°C = 4.66 d (3); = 28 to 42 d (8).
Soil Dissipation (DT_{50}):	**CSF:** Av. = 56 d (range = 10 – 185 d) (3), = 28 to 56 d (3), fall application = 192 d (3), spring application = 49 d (3), sandy loam = 19 d (3), clay loam = 34 d (3), sand = 47 d (3), clay = 62 d (3), calcareous sandy loam = 26 d (3). *Aerobic degradation*: typical = 160 d (7), lab at 20°C = 51.4 d (7), *Field dissipation*: = 36.2 d (7).
Aquatic Persistence ($t_{½}$):	**CSF:** *Anaerobic degradation*: = 109 - 263 d (3), Stable at pH 7 and 9 for at least 4 weeks (3). *Aqueous photolysis*: Occurs slowly with half-life = 198 d, photolysis not a significant contributor to degradation (3). *Hydrolysis*: Degradation by hydrolysis appears to be the most significant mechanism of degradation, but only significant in acidic environments. Half-life at pH 5 = 23 d (2), at neutral to high pHs = stable (2); = 203 d (3), = 198 d (3), exposed to light = 80 d (3), @ pH 7.1 = 69 d (3); @ pH 4, 20°C = 7 d (3), @ pH 4, 10°C = 10 to 14 d (3), @ pH 5 = 23 d (3), @ pH 5 = 24 d, @ pH 7 or 9 > 365 d (3).

Aquatic Dissipation (DT_{50}):	**CSF:** Under growing season conditions = 4 to 6 weeks (3), aquatic loam = 154 d (3). *Hydrolysis*: @ pH 7, 20°C = stable (7), water-sediment = 26 d (7), water only = 21 d (7). *Photolysis*: @ pH 7 = 18.8 d, not a major degradation route (7).
Potential to Move to Groundwater (GUS score):	**CSF:** = 5.38 (potential groundwater contaminant) (7); CSF is moderately persistent and highly mobile and has potential to enter surface waters from runoff, however, the very low application rates and microbial breakdown suggest that CSF has little potential to enter ground water (8).
Vapor Pressure (mm Hg):	**CSF:** = 4.6 x 10^{-6} (25°C) (2).
Octanol-Water Partition Coefficient (K_{ow}):	**CSF:** = 1.02 x 10^{-1} (20°C, pH 7) (7); = 1.11 (2); @ pH 5 = 2.13 (3), @ pH 7 = 0.1 (3), @ pH 9 = 0.0398 (3); @ pH 5, 25°C = 2.089 to 2.188 (9), @ pH 7, 25°C = 0.095 to 0.110 (9),@ pH 9, 25°C = 0.039 (9).
Bioaccumulation/ Biocentration:	**BAF:** No potential (8). **BCF:** *Bluegill*: < 1 in edible tissue (3). *Channel Catfish*: = 1.5 in edible muscle, < 12 in viscera and liver (3); = 75 (7). *Green Algae*: =8 @ pH 6 (4),= 36 @ pH 5.3, =53 @ pH 5 (4).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 0.188 lb. a.i./acre **Croplands/Facilities Maintenance:** 0.188 lb. a.i./acre
EECs	**Terrestrial (Habitat Management):** 45.1 ppm **Terrestrial (Croplands/Facilities Maintenance):** 45.1 ppm **Aquatic (Habitat Management):** 0.0735 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.00049 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.01 [0.1]	=0.01 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.27 [1]	=0.27 [1]
	Mammals	=0.09 [1]	=0.09 [1]
	Fish	<0.01 [1]	<0.01[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.01 [0.1]	=0.01 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.27 [1]	=0.27 [1]
	Mammals	=0.09 [1]	=0.09 [1]
	Fish	<0.01 [1]	<0.01 [1]

Justification for Use:	Preferred herbicide for perennial pepperweed control. Also efficacious on Dalmatian toadflax, common mullein, poison hemlock, Russian knapweed, biennial thistles, hoary cress and yellow starthistle. Optimum application rate and timing depends upon species.
Specific Best Management Practices (BMPs):	1 application/treatment site/year Do not apply within 25 feet of surface water resources. Ground application only. Spot treatment only. Not efficacious on brush species.

References:

[1a] _____. 2010, Chlorsulfuron 75 specimen label and MSDS, Alligare, LLC, Opelika, AL. 5 & 4 pp., respectively.

[1b] _____.2009 & 2010 respectively. Glean XP speciement label and MSDS. Dupont, Wilmington, DE. 17 & 9 pp., respectively.

[1c] _____. 2010 & 2011, respectively. Telar XP specimen label & MSDS. DuPont, Wilmington, DE. 15 & 9 pp., respectively.

[2] _____. 2005. Reregistration eligibility decision (RED) – Chlorsulfuron. USEPA, Prevention, Pesticides, and Toxic Substances, Washington, D.C. 90 pp.

[3] _____. Klotzbach, J and P.R. Durkin. 2005. Chlorsulfuron: Human Health and Ecological Risk Assessment – Final Report. Prepared for the USDA Forest Service by Syracuse Environmental Research Associates, Inc (GSA Contract#: GS-10F-0082F). 180 pp.

[4] US Environmental Protection Agency. 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4.0: http:/www.epa.gov/ecotox; Last accessed 12 April 2012.

[5] _____. 2011. Kegley, S.E., B.R. Hill, S. Orme, and A.H. Choi., PAN Pesticide Database, Pesticide Action Network, San Francisco, CA; Last Accessed 12 April 2012.

[6] US Environmental Protection Agency. Office of Pesticide Program's Pesticide Ecotoxicity Database: http://www.ipmcenters.org/ecotox/DataAccess.cfm; Last accessed 12 April 2012.

[7] _____. 2009. Pesticide properties database. Agricultural & Environmental Research Unit, Science and Technology Research Institute, University of Hertfordshire, Hatfield, UK. Last accessed 27 April 2012.

[8] 2000. Chlorsulfuron fact sheet. Bonneville Power Administration, U.S. Dept. of Energy. 8 pp.

[9] FAO specifications and evaluations for Agricultural Pesticides – Chlorsulfuron. 2003. Food and Agriculture Organization, United Nations, New York, NY. 24 pp.

[10] ENSR International and Bureau of Land Management, " Chlorsulfuron, Ecological Risk Assessment, Final Report" (2005). All U.S. Government Documents (Utah Regional Depository). Paper 74. 138 pp.

Table CP.1 Pesticide Name

Active Ingredient = Chlorsulfuron

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Chlorsulfuron 75	H	0.25 lbs/acre	0.188 lb a.i./acre	1	0.25 lbs/acre	0
Glean XP	CF	0.028 lbs/acre	0.021 lb a.i./acre	1	0.028 lbs/acre	0
Telar XP	H	0.217 lbs/acre	0.163 lb a.i./acre	1	0.217 lbs/acre	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

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B-4 Formulations Containing Fluazifop-p-Butyl Chemical Profile

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

Date:	6/28/12				
Pesticide Class:	Aryloxyphenoxy Propionates	**Common Chemical Name(s):**	Fluazifop-p-butyl	**Pesticide Type:**	Herbicide
Trade Name(s):	Fusilade DX, Fusilade II	**EPA Registration Number:**	100-1070, 100-1084	**CAS Number:**	79241-46-6, 79241-46-6
Other Ingredients:	**Fusilade DX (Fluazifop-p-butyl [FPB]):** 24.5% FPB, 75.5% proprietary ingredients, including maphthalene (< 5%), petroleum distillates (light paraffinic), and petroleum solvent (1a); **Fusilade II:** 24.5% FPB, 75.5% proprietary ingredients, including maphthalene (< 5%), petroleum distillates (light paraffinic), and petroleum solvent (1b)				

Toxicological Endpoints

Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

Mammalian LD_{50}:	**FPB: (%AI Unk):** *Rat*: Acute oral, age/time unk: males = 3,680 mg/kg bw, females = 2,451 mg/kg bw (3,5,7); 90-d short-term oral NOAEL = 0.9 mg/kg bw/day (5); oral, age/time unk = 4,096 mg/kg bw (8). *Mouse*: Acute oral, age/time unk > 2,000 mg/kg bw/day (5). **FP:** No information in references.
Mammalian LC_{50}:	**FPB:** No information in references (see LD50 data). **FP:** No information in references (see LD50 data).

Mammalian Reproduction:	**FPB: (%AI Unk):** *Rabbit*: Maternal and developmental NOAELs = 10 mg/kg bw/day (5). *Rat*: 2-generation study, LOAEL: (males) = 5.8 mg/kg/day, (females) = 7.1 mg/kg/day (2); Maternal NOAEL = 20 mg/kg bw/day (5), Developmental NOAEL = 2 mg/kg bw/day (5). **FP:** No information in references.
Avian LD_{50}:	**FPB (% AI Unk):** *Mallard*: Acute oral, age/time unk > 3,960 mg/kg bw (3,5,7); Acute NOEL, age/time unk = 3,960 mg/kg bw (3); Short-term dietary, age/time unk > 942 mg/kg bw/day (5,7). **FPB (95.8% AI):** *Mallard*: Single dose, 14-d observation period, 16 wks old > 3,528 mg/kg bw (1a,b,6), NOEL = 3,528 mg/kg bw (6). **FP:** No information in references.
Avian LC_{50}:	**FPB (89.1-95.8% AI):** *Bobwhite*: 5-d, 11 d old > 5,230 ppm (3,5,6), NOEL = 2,980 ppm (6). *Mallard*: 5-d, 9 d old > 4,850 ppm, NOEL < 1,040 ppm (6). **FP:** No information in references.
Avian Reproduction:	**FPB (Tech.):** *Bobwhite*: Reproductive NOEL = 50 ppm (3). *Mallard*: Reproductive NOEL = 50 ppm (3). **FP:** No information in references.
Fish LC_{50}:	**FPB (%AI Unk):** *Bluegill*: 96-h, age unk = 0.53 ppm (8). *Rainbow Trout*: 96-h, age unk > 1.41 ppm (3,7); 96-h age. unk = 1.37 ppm (8). **FP:** No information in references.
Fish ELS/Life Cycle:	**FPB (%AI Unk):** *Fathead Minnow*: 32-d early life stage study: Hatching, survival, & growth NOEC = 0.077 ppm (5). **FPB (Tech.):** *Fathead Minnow*: 28-d early life stage study NOEC = 0.077 ppm (3). **FP (%AI Unk):** *Fathead Minnow*: 32-d early life stage study: Hatching, survival, & growth NOEC = 1.46 ppm (5).

Amphibians/ Reptiles:	**FPB:** No information in references. **FP:** No information in references.
Invertebrates/ Plants:	**FPB (%AI Unk):** *Daphnia magna*: 48-h LC50 > 0.62 ppm (5,7). *Duckweed*: 7-d EC50, biomass > 1.4 ppm (7); 14-d EC50, growth > 1.4 ppm (3,5). *Earthworm*: 14-d LC50 > 500 mg/kg dry soil (5,7). *Eastern Oyster*: 48-h LC50, age unk = 0.53 ppm (5). *Honey Bee*: 48-h LD50 > 200 µg/bee (7). **FPB (Tech.):** *Daphnia magna*: 48-h EC50, immobility > 1 ppm (3); 21-d reproductive study NOEC = 0.25 ppm (3). *Green Algae*: 72-h EC50, biomass & growth > 1.8 ppm (3,5,7). *Honey Bee*: 24-d LD50, contact and oral > 200 µg ai/bee (3). **FPB (90.0-92.2% AI):** *Eastern Oyster*: 96-h EC50, spat = 0.47 ppm, NOEL = 0.17 ppm (6). *Mysid Shrimp*: 96-h LC50 = 0.51 ppm, NOEL = 0.20 ppm (6); 96-h LC50, age unk = 0.54 ppm (5,7). **FPB (81.3% AI):** *Green Algae*: 96-h EC50, growth > 1.8 ppm, NOEL = 0.88 ppm (6). **FPB (13.8% AI):** *Honey Bee*: 24-h LD50, adult > 200 µg/bee, NOEL = 63 µg/bee (6). **FP (53.0% AI):** *Green Algae*: *C. pyrenoidosa* 96-h EC50, growth = 15.66 ppm (9,10); *S. quadricauda*, 96-h EC50, growth = 18.3 ppm (9,10); *C. vulgaris,* 96-h EC50, growth = 21.7 ppm (9,10); *S. acutus,* 96-h EC50, growth = 26.7 ppm (9,10); *R. subcapitata,* 96-h EC50, growth = 1.048 ppm (11).
Other:	**FPB:** Neurotoxic: Negative (5,7); Carcinogenic: Negative (1a,b,3,5,7); Teratogenic: Negative (1a,b,5); Mutagenic: Negative (1a,b,3,7); Genotoxic: Negative (5); Endocrine disruption: Negative (7); **NOTE:** Drought conditions renders the herbicide (growth regulator) ineffective due to lack of new plant growth (8); FP: Neurotoxic: No information in references; Carcinogenic: Unknown (9); Teratogenic: Unknown (9); Mutagenic: Unknown (9); Genotoxic: No information in references; Endocrine disruption: Unknown (9)

Fluazifop-P [FP]: 1st- order metabolite of FPB, readily formed through hydrolysis in soils and water (8)

Ecological Incident Reports

As of 2 December, 2010, seven incident reports have been reported by the Pest Management Regulatory Agency (PMRA) for products containing FPB. Three of the incidents were in Canada (2 were accidental human exposure from spray operations) and the third was a warehouse fire, where several pesticides, including products containing fluazifop-p-butyl, were being stored. Water from fighting the fire entered a stream via a storm drain and a fish kill was reported. The causality of the other four incidents could not be established by the PMRA because they occurred in the U.S (4). Information on U.S. incidents not available in references.

Environmental Fate

Water solubility (S_w):	**FPB:** = 1 mg/L (almost insoluble) (1a,b,2); 20ºC, pH 5 = 0.93 mg/L (5,7); 20ºC = 1.1 mg/L (3,4,5,9); Not water soluble (8). **FP:** (20ºC) = 780 mg/L (5).
Soil Mobility (K_{oc}):	**FPB:** Binds strongly with soil (8). Estimated Koc = 67,000 mL/g (2); Not mobile (4); Slight mobility (5); loamy sand = 3,394 mL/g (5,7). **FP:** Av. = 20 mL/g (range 8.3 to 51) in four UK soils; sensitive to pH and was lowest (8.3) at the highest soil pH tested (6.8) (2), Mobile (2), (silt loam, pH 7) = 32 to 179 mL/g (5), (sandy clay loam, pH 5.8) = 33 to 100 mL/g (5), (sandy loam, pH 7.2) = 23 to 300 mL/g (5), (loamy sand, pH 5.3) = 5.9 to 478 mL/g (5), (sandy clay loam, pH 7.1) = 23 to 294 mL/g (5), (clay loam, pH 7.7) = 28 to 579 mL/g (5).
Soil Persistence ($t_{½}$):	**FPB:** Dominant fate process is microbially-assisted hydrolysis to FP (2,4). *Aerobic degradation*: = a few hours (2,4). *Photolysis*: = 195 d (2); Av. = 15 d (8); Higher rates of degradation in warm/moist soils (8). **FP:** *Aerobic degradation*: = 11 to 26 d (2). *Anaerobic degradation*: Soil studies indicate that FP is stable (half-lives of 315 to 1,155 d) in flooded soil systems and hydrolysis studies (2).
Soil Dissipation (DT_{50}):	**FPB:** *Aerobic degradation*: typical = 1.0 d (7), lab at 20ºC = 1.0 d (7), field = 8.2 d (7). *Mechanism not specified*: Sandy clay loam, pH 6, 20ºC = 0.4 – 3.3 d (5), Clay, pH 7.4, 20ºC = 0.3 d (5), Loamy sand, pH 5.4, 20ºC = 2.9 d (5). **FP:** *Mechanism not specified*: Sandy clay loam, pH 6, 20ºC = 10.4 – 17.8 d (5); Clay, pH 7.4, 20ºC = 5.1 to 17.5 d (5); Loamy sand, pH 5.4, 20ºC = 7.7 – 38.6 d (5); Silt loam, pH 7, 20ºC = 8.3 d (5); Sandy clay loam, pH 5.8, 20ºC = 7.3 d (5); Sandy loam, pH 7.2, 20ºC = 2.7 d (5); Sandy clay loam, pH 7.1, 20ºC) = 2.1 d (5), Clay loam, pH 7.7, 20ºC = 1.6 d (5).

Aquatic Persistence ($t_{½}$):	**FPB:** Degraded primarily by hydrolysis and secondarily by microbial metabolism, not degraded by photolysis (8), Relatively stable to breakdown by UW or sunlight (8). *Hydrolysis*: Hydrolysis is pH dependent, rapidly degraded in the water phase (lab) mainly to FP (5); ½ life at pH 9 = 9 hrs, ½ life at pH 7 = 78 d, ½ life = stable at pH 5 (2,5). *Photolysis* = 6 d (2,3). **FP:** *Hydrolysis*: Stable at 25°C, pH 5, 7 & 9 (2,5).
Aquatic Dissipation (DT_{50}):	**FPB:** *Hydrolysis*: Degradation pH sensitive; = 78 d at pH 7, 20ºC (7), = stable at pH 5 (7), = 29 hrs at 25ºC, pH 9 (3,7), = 0.1 d in water-sediment, water pH 7-9, sediment pH ~5.5 (5,7),) = 0.1 d in water-sediment, water pH 8-9, sediment pH ~7.8 (5,7), = 0.1 d water only (7). *Photolysis*: = 6 d @ pH 7 (5,7). **FP:** *Mechanism not specified*: = 163 to 342 d in water-sediment, water pH 7-9, sediment pH ~5.5 (5), = 49.5 to 54.9 d in water-sediment, water pH 8-9, sediment pH ~7.8 (5).
Potential to Move to Groundwater (GUS score):	**FPB:** Does not present an appreciable risk of groundwater contamination due to high binding affinity with soils (8); = 0.00 (7). **FP:** No information in references.
Vapor Pressure (mm Hg):	**FPB:** (20°C) = 4.5 x 10^{-7} (1a,b), (20°C) = 2.475 x 10^{-7} (3,4), (20°C) = 9.0 x 10^{-8} (5). **FP:** No information in references.
Octanol-Water Partition Coefficient (K_{ow}):	**FPB:** (20ºC, pH 7) = 3.16 x 10^{4} (2,3,4,5,7). **FP:** No information in references.
Bioaccumulation/ Biocentration:	**FPB: BAF:** No information in references; **BCF:** = 320 (7). **FP: BAF:** No information in references; **BCF:** No information in references.

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 0.188 lb. a.i./acre **Croplands/Facilities Maintenance:** 0.188 lb. a.i./acre
EECs	**Terrestrial (Habitat Management):** 45.1 ppm **Terrestrial (Croplands/Facilities Maintenance):** 45.1 ppm **Aquatic (Habitat Management):** 0.0735 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.00049 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.01 [0.1]	=0.01 [0.5]
	Fish	=0.139 [0.05]	=0.139 [0.5]
Chronic	Birds	=0.90 [1]	=0.90 [1]
	Mammals	=1.13 [1]	=1.13 [1]
	Fish	=0.95 [1]	=0.95 [1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.01 [0.1]	=0.01 [0.5]
	Mammals	=0.01 [0.1]	=0.01 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.90 [1]	=0.90 [1]
	Mammals	=1.13 [1]	=1.13 [1]
	Fish	=0.01 [1]	=0.01 [1]

Justification for Use:	Control invasive annual grass weeds in non-crop land areas including native restoration sites.
Specific Best Management Practices (BMPs):	• Must maintain a minimum 25-foot treatment buffer zone between treatment site and all surface water resources if ESA listed aquatic species are present at or near the action area. • 1 application per year.

References:

[1a] _____. 2011. Fusilade DX specimen label & MSDS. Syngenta Crop Protection, LLC, Greensboro, NC, 39 & 6 pp., respectively.

[1b] _____. 2009 & 2011, respectively. Fusilade II specimen label & MSDS. Syngenta Crop Protection, LLC, Greensboro, NC,. 37 & 6 pp., respectively.

[2] USEPA, 2004, Memorandum: Fluazifop-p-butyl. Report of the metabolism assessment review committee, Office of Prevention, Pesticides, and Toxic Substances, No. 0052680, 40 pp.

[3] FAO specifications and evaluations for plant protection products – Fluazifop-p-butyl. 2000. Food and Agriculture Organization, United Nations, New York, NY. 21 pp.

[4] 2008. Proposed Re-evaluation Decision – Fluazifop-p-butyl. Pest Management Regulatory Agency, Health Canada, Ottawa, Canada. 33 pp.

[5] European Food Safety Authority (EFSA). 2010. Conclusion on the peer review of the pesticide risk assessment of the active substance Fluazifop-P (evaluated variant fluazifop-p-butyl) , EFSA Journal 8(11):1905.

[6] US Environmental Protection Agency. Office of Pesticide Program's Pesticide Ecotoxicity Database: http://www.ipmcenters.org/ecotox/DataAccess.cfm: Last accessed 21 April 2012.

[7] _____. 2009. Pesticide properties database. Agricultural &Environmental Research Unit, Science and Technology Research Institute, University of Hertfordshire, Hatfield, UK. Last accessed: 17 May 2012.

[8] Tu, *et. al*. 2004. Fluazifop-p-butyl. Weed control methods handbook. The Nature Conservancy. 6 pp.

[9] _____. 2011. Kegley, S.E., B.R. Hill, S. Orme, and A.H. Choi., PAN Pesticide Database, Pesticide Action Network, San Francisco, CA; Last Accessed 25 June 2012.

[10] US Environmental Protection Agency. 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4.0: http:/www.epa.gov/ecotox; Last accessed 25 June 2012.

[11] Ma J *et al.* 2006. Toxicity assessment of 40 herbicides to the green algae *Raphidocelis subcapitata*. Ecotoxicology and Environmental Safety 63:456-462

Table CP.1 Pesticide Name

Active Ingredient = Fluazifop-p-butyl

Trade Name[a]	Treatment Type[b,c]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI or acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Fusilade DX	H (terrestrial)	0.0938 gal/acre	0.188 lb. a.i./acre	1	0.188 lb./acre/season	0
Fusilade DX	H (aquatic)	0.0 gal/acre	0.0 lb. a.i./acre	0	0	0
Fusilade DX	CF	0.0938 gal/acre	0.188 lb. a.i./acre	1	0.188 lb./acre/season	0
Fusilade II	H (terrestrial)	0.0938 gal/acre	0.188 lb. a.i./acre	1	0.188 lb./acre/season	0
Fusilade II	H (aquatic)	0.0 gal/acre	0.0 lb. a.i./acre	0	0	0
Fusilade II	CF	0.0938 gal/acre	0.188 lb. a.i./acre	1	0.188 lb./acre/season	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

B-5 Glyphosate Formulations Chemical Profile

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

Date:	4/6/12				
Pesticide Class:	EPSP synthase inhibitor	**Common Chemical Name(s):**	Glyphosate	**Pesticide Type:**	Herbicide Group 9
Trade Name(s):	Accord Concentrate, Aqua Star, AquaMaster, AquaNeat, Buccaneer, Buccaneer Plus, Cornerstone, Cornerstone Plus, Gly Star Plus, Glyfos Aquatic, Glyfos XTRA, Glypro, Honcho, Honcho Plus, Makaze, Razor Pro, Rodeo, Roundup Original, Roundup Original MAX, Roundup Pro, Roundup PRO Concentrate, Roundup WeatherMAX	**EPA Registration Number:**	62719-324, 42750-59, 524-343, 228-365, 55467-10, 55467-9, 1381-191, 524-454-1381, 42750-61, 4787-34, 4787-23, 62719-324, 524-445, 524-454, 34704-890, 228-366, 62719-324, 524-445, 524-539, 524-475, 524-529, 524-537	**CAS Number:**	38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 70901-12-1, 38641-94-0, 38641-94-0, 70901-12-1

Other Ingredients:	**Accord Concentrate (glyphosate N-(phosphonomethyl)glycine, isopropylamine salt (IPA)):** 53.8% IPA, 46.2% other ingredients (1a); **Aqua Star:** 53.8% IPA, 46.2% other (1b); **AquaMaster:** 53/8% IPA, 46.2% water (1c); **AquaNeat:** 53.8% IPA, 46.2% other (1d); **Buccaneer:** 41.0% IPA, 59.0% other (1e); **Buccaneer Plus:** 41.0% IPA, 59.0% other (1f); **Cornerstone:** 41.0% IPA, 59.0% other (1g); **Cornerstone Plus:** 41.0% IPA, 59.0% other (1h); **Gly Star Plus:** 41.0% IPA, 59.0% other (1i); **Glyfos Aquatic:** 40-70% IPA, 30-60% other (1j); **Glyfos XTRA:** 30-60% IPA, 5-15% surfactant (trade secret), 25-65% other (1k); **Glypro:** 53.8% IPA, 46.2% other (1l); **Honcho:** 41.0% IPA, 59.0% other (1m); **Honcho Plus:** 41.0% IPA, 59.0% other (1n); **Makaze:** 41.0% IPA, 59.0% other (1o); **Razor Pro:** 41.0% IPA, 59.0% other (including 14% POEA [polyethoxylated tallow amine] surfactant) (1p,3); **Rodeo:** 53.8% IPA, 46.2% other (1q); **Roundup Original:** 41.0% IPA, 59.0% other (1r); **Roundup Original MAX (glyphosate N-(phosphonomethyl) glycine, potassium salt (K)):** 48.7% K, 51.3% other (1s), including unknown % of POEA surfactant (18); **Roundup Pro:** 41.0% IPA, 59.0% other (including unknown % of trade secret surfactant) (1t); **Roundup PRO Concentrate:** 50.2% IPA, 13.0% surfactant, 36.8% other (1u,3); **Roundup WeatherMAX:** 48.8% K, 51.2% other (1v).

Toxicological Endpoints

Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

Mammalian LD_{50}:	**Glyphosate Tech 95.0-98.7%:** *Dog*: NOEL = 500 mg/kg/day (11). *Goat* (female): 96-h = 3,500 mg/kg bw (3). *Mice*: 96-h = 1,568 mg/kg bw (3); NOAEL = 3,125 mg/kg diet (10). *Rabbit*: 96-h = 3,800 mg/kg bw (3); 21-d NOAEL = 175 mg ae/kg/day (20). *Rat*: 96-h >4,320 mg/kg (2,7,11); 96-h = 4,873 mg/kg bw (3); 96-h > 2000 mg/kg (6); 96-h > 4,770 mg ae/kg bw (8), NOAEL < 3,125 mg/kg diet (10); Systemic Toxicity LOEL males = 940 mg/kg/day, females = 1,183 mg/kg/day (11); Systemic Toxicity NOELs: males = 362 mg/kg/day, females = 457 mg/kg/day (11); = 2,047 mg ae/kg/day (20). **Glyphosate Tech 88.0%:** *Rat*: 96-h >4,440 mg ae/kg bw (8). **Glyphosate Tech 76.0%:** 96-h >3,800 mg ae/kg bw (8). **AMPA 95.4-97.2%:** *Dog*: 90-d NOEL =263 mg/kg/day (20). *Rat*: >1,920 mg ae/kg bw (3); >4,750 mg ae/kg bw (3); >4,770 mg ae/kg bw (3); >4,800 mg ae/kg bw (3); >4,860 mg ae/kg bw (3); 90-d NOEL =400 mg/kg/day, LOEL =1,200 mg/kg/day (20). **AMPA 88.0%:** *Rat*: >4,400 mg ae/kg bw (3).

	AMPA 76.0%: *Rat*: >3,800 mg ae/kg bw (3). **IPA 62.0%:** *Rat*: >5,000 mg/kg (1c); Mouse: > 5,000 mg/kg (1c). **IPA 53.8%:** *Rat*: >5,000 mg/kg (1a). **IPA 41.0%:** *Rat*: >5,000 mg/kg (1i,m,o,r), = 5,108 mg/kg bw (1t). **K:** No information in references.
Mammalian LC_{50}:	**Glyphosate Tech (95.0-98.7%):** *Rat*: NOEL (diet) =150 ppm (6).
Mammalian Reproduction:	**Glyphosate Tech:** *Rabbit*: Maternal toxicity NOEL =175 mg/kg/day, LOEL =350 mg/kg/day (2,8,10); Developmental toxicity NOEL > 175 mg/kg/day (1c,e,f,h,m,n,r-v,2,8). *Rat*: Maternal & developmental toxicity NOEL = 1,000 mg/kg/day, LOEL = 3,500 mg/kg/day (2,3); 3-generation: Systemic & reproductive toxicity NOEL < 30 mg/kg/day (1c,e,f,2,8,10,20); Developmental toxicity NOEL=10 mg/kg/day, LOEL =30 mg/kg/day (2); 2-generation: Systemic & developmental toxicity NOEL =500 mg/kg/day, LOEL =1,500 mg/kg/day (2,3,8); Reproduction NOEL =1,500 mg/kg/day (1m,n,r-v,2,3); 21-d dietary NOEL =400 mg/kg/day (20). **AMPA 98.7%:** *Rat*: Systemic & Reproductive NOEL =740 mg/kg/day, LOEL =2,268 mg/kg/day (3). **IPA:** No information in references. **K:** No information in references.

Avian LD_{50}:	**Glyphosate Tech 95.6-99.0%:** *Bobwhite*: >3,851 mg ae/kg diet (1c,s,v,20); 96-h >1,912 mg/kg bw, NOAEL = 1,912 mg/kg bw (8); 8-d dietary =4,000 ppm (11); 8-d dietary > 4,640 mg ae/ kg diet (7,20). *Mallard*: 8-d dietary =4,000 ppm (11); 8-d dietary >4,640 mg ae/kg diet (7,20). **Glyphosate Tech 83.0%:** *Bobwhite*: 96-h >2,000 mg/kg (2,11); 96-h >3,196 mg ae/kg bw (8). **AMPA:** *Bobwhite*: >3,800 mg/kg (1b,i); >1,912 mg ae/kg bw (3); 8-d dietary >5,620 mg/kg diet, NOEC = 5,620 mg/kg diet (20); (Single Dose LC50) >2,250 mg ae/kg diet (20). *Mallard*: 8-d dietary >5,620 mg/kg diet, NOEC = 5,620 mg/kg diet (20). **AMPA 87.8%:** *Bobwhite*: 96-h >1,976 mg ae/kg, NOAEL = 1,185 mg ae/kg (8). **IPA 41.0%:** *Bobwhite*: >3,800 mg/kg (1g). *Japanese Quail*: 5-d dietary >5,000 ppm (1k,4). **K:** No information in references.
Avian LC_{50}:	**Glyphosate (95.6-98.5%):** *Bobwhite*: 5-d >5,620 ppm diet (1t); 8-d >4,500 ppm (1d,p); 96-h >4,570 ppm ae, NOAEC = 4,570 ppm ae (3,8); 96-h >4,971.2 ppm ae, NOAEC = 4,971.2 ppm ae (3); 5-d LC50 (14-d old) >4,640 ppm (22). *Mallard*: 5-d >5,620 ppm diet (1t); 8-d >4,500 ppm (1d,p); 96-h > 4,570.4 ppm ae, NOAEC = 4,770.4 ppm ae (3,8); 96-h >4,971.2 ppm ae, NOAEC = 4,971.2 ppm ae (3); 5-d LC50 (14-d old) >4,640 ppm, NOEL =1,000 ppm (22). **AMPA (87.8%):** *Bobwhite*: >4,934 ppm, NOAEC = 4,934 ppm (3,8). *Mallard*: > 4,934 ppm, NOAEC = 4,934 ppm (3,8). **IPA (Unk. %AI):** *Mallard*: 8-d LC50 >4,640 ppm (4). *Bobwhite*: 8-d LC50 >4,640 ppm (4). **K:** No information in references.

Avian Reproduction:	**Glyphosate Tech (94.4-98.5%):** *Bobwhite*: 8-d >4,640 ppm diet (1c,s,v,2). *Mallard*: 5-d > 4,640 ppm diet (1c,s,v,2). **Glyphosate Tech (90.4%):** *Mallard*: No effects up to 30 ppm (2); NOAEC =27 ppm, LOAEC >27 ppm (3,8). **Glyphosate Tech (83.0%):** *Mallard*: No effects up to 1,000 ppm (2,11); NOAEC =830 ppm (3,8), LOAEC >830 ppm (8). *Bobwhite*: No effects up to 1,000 ppm (2); NOAEC = 830 ppm (3,8), LOAEC > 830 ppm (8). **IPA:** No information in references. **K:** No information in references. **AMPA:** No information in references.
Fish LC_{50}:	**Glyphosate Tech. (95.4-99.7%):** *Bluegill*: 96-h >24 ppm (2,20); 96-h =43 ppm ae (3,5,8), NOAEC = 30.6 ppm (3,8); 96-h LC50 (pH 6.5 @ 22°C) =140 ppm (3,4,5,14); 96-h LC50 (pH 9.5 @ 22°C) =220 ppm (4,5,14); 96-h =78 ppm (7); 96-h =100.2 ppm ae (8); 96-h, static water =34.0 ppm (10); 96-h flow-through water =5.8 ppm (10); 96-h = 150 ppm (11); 96-h =120 ppm (12,20). *Channel Catfish*: 48-h =140 ppm (2); 96-h LC50 @ 22°C =130 ppm (4,5,11,14); 96-h =93 ppm ae (8); 96-h = 39 ppm (10). *Chinook*: 96-h =20 ppm (10). *Coho*: 96-h =22 ppm (10). *Fathead Minnow*: 48-h =97 ppm (2,11); 96-h LC50 @ 22°C =97 ppm (4,5,14), NOAEC = 25.7 ppm ae (8); 96-h =69.4 ppm ae (8); 96-h = 23 ppm (10). *Pink*: 96-h =14 to 33 ppm (10). *Rainbow Trout*: 96-h >1,000 ppm (1b); 96-h =128.1 ppm, NOAEC = 30.6 ppm (dark coloration observed at 53.6 ppm) (3,8); 96-h LC50 (pH 6.5 @ 12°C) =140 ppm (3,4,5,11,14); 96-h LC50 (pH 9.5 @ 12°C) =240 ppm (4,5,14); 96-h LC50 =38 ppm (6,7); 21-d NOEC =25 ppm (6); 96-h =100.2 ppm ae (8); 96-h = 128.1 ppm ae (8); 96-h (static water) = 15 to 26 ppm (10); 96-h (flow-through water) =8.2 ppm (10). **Glyphosate Tech (83.0-87.3%):** *Bluegill*: 96-h =99.6 ppm, NOAEC = 83 ppm (3,8); 96-h =120 ppm (1d,5); 48-h =120 ppm (2). *Fathead Minnow*: 48-h =84.9 ppm (2). *Rainbow Trout*: 96-h =86 ppm (1d,3,5,12,20); 96-h NOEC =42 ppm (20); 96-h =71.4 ppm ae (8).

	AMPA (94.4-95.6% AI): *Species Unknown*: 96-h =499 ppm, NOAEC = 174 ppm (3,8); 96-h LC50 =520 ppm, NOEC =33 ppm (20). *Bluegill*: 96-h >1,000 ppm (1b). **IPA (%AI Unk):** *Rainbow Trout*: 21-d NOEC =52 ppm (20); **IPA (62.0%):** *Bluegill*: 96-h >461.8 ppm ae (3). *Rainbow Trout*: 96-h >461.8 ppm ae (3). **IPA (53.6-53.8%):** *Channel Catfish*: 96-h =130 ppm (4,14,20). *Fathead Minnow*: 96-h NOEC =1,000 ppm (3,5); 96-h =97 ppm (4,14,20). *Rainbow Trout*: 96-h >2,500 ppm (1a,l,q), NOEC =1,000 ppm (3,20). **IPA (41% w/ 15% POEA surfactant):** *Bluegill*: 96-h @ 22°C =5 ppm (5,14); 96-h @ 17°C =7.5 ppm (5,14); 96-h @ 22°C =5 ppm (14); 96-h @ pH 6.5 =4.2 ppm (14); 96-h 2 pH 7.5 =2.4 ppm (4,5,14); 96-h =6.4 ppm (11). *Channel Catfish*: 96-h @ 22°C =13 ppm (11,14). *Fathead Minnow*: 96-h @ 22°C = 2.3 ppm (5,14); 96-h =2.4 ppm (11). *Rainbow Trout*: 96-h @12°C =8.3 ppm (4,5,11,14); 96-h @ 7°C =14 ppm (4,5,14); 96-h @ 12°C =7.5 ppm (4,5,14); 96-h @ pH 6.5 =7.6 ppm (4,5,14); 96-h @ pH 7.5 =1.6 ppm (4,5,14); Behavioral LOEC =13.5 ppm (4,5); 21-d NOEC =2.4 ppm (20). **K:** No information in references.
Fish ELS/Life Cycle:	**Glyphosate Tech (%AI unk.):** *Coho*: NOEC (15.5-16.9 g smolts, plasma Na concentrations) = 2.78 ppm ae (3). **Glyphosate Tech (95.4-99.7%):** *Bluegill*: Av. wt. 0.4-0.9g @ 22°C, =44 ppm CaCO3; LC50s: @ pH 6.5: 24-h =240 ppm; 96-h =140 ppm (4,5); @ pH 7.4: 24-h =150 ppm; 96-h =135 ppm (4,5); @ pH 9.5: 24-h =230 ppm; 96-h =220 ppm (4,5). *Channel Catfish*: Av. wt. 2.2g @ 22°C: 24 & 96-h =130 ppm (4,5). *Chinook*: Av. wt. 0.3-0.7g: Creek (soft) water LC50s: 24-h =55 ppm; 96-h =30 ppm (4,5,15,20): Lake (hard) water LC50s: 24-h =220 ppm; 96-h =211 ppm (4,5,15,20). *Chum*: Av. wt. 0.3-0.7g: Creek (soft) water LC50s: 24-h =26 ppm; 96-h =22 ppm (4,5,15,20); Lake (hard) water LC50s: 24-h =202 ppm; 96-h =148 ppm (4,5,15,20).

	Coho: Av. wt. 0.3-0.7g: Creek (soft) water LC50s: 24-h =55 ppm; 96-h =36 ppm (4,5,15,20); Lake (hard) water LC50s: 24-h =210 ppm; 96-h =174 ppm (4,5,15,20). *Fathead Minnow*: Av. wt. 0.6g @ 20C, LC50s: 24 & 96-h =97 ppm (4,5). *Pink*: Av. wt. 0.3-0.7g: Creek (soft) water LC50s: 24-h =63 ppm; 96-h =23 ppm (4,5,15,20); Lake (hard) water LC50s: 24-h =380 ppm; 96-h =190 ppm (4,5,15,20). *Rainbow Trout*: Av. wt. 0.3-0.7g: Creek (soft) water LC50s: 24-h =32 ppm; 96-h =22 ppm (4,5,15,20); Lake (hard) water LC50s: 24-h =220 ppm; 96-h =197 ppm (4,5,15,20); Av. Wt. 0.7-0.8 g @12C, soft water, LC50s: @ pH 6.5: 24-h =240 ppm; 96-h =140 ppm (4,5); @ pH 7: 24 & 96-h =130 ppm (4,5); @ pH 9.5: 24 & 96-h =240 ppm (4,5). **Glyphosate Tech (41.%AI):** *Bluegill*: Av. wt. 0.7g @ 22°C @ pH 7.4 @ 44 ppm CaCO3, LC50s: 24-h =6.8 ppm; 96-h =5.6 ppm (4,5); Av. wt. 0.5g @ pH 7.4 @ 44 ppm CaCO3, LC50s: @17°C: 24-h =9.6 ppm; 96-h =7.5 ppm (4,5): @22°C: 24-h =6.4 ppm; 96-h =5 ppm (4,5); @27°C: 24-h =4.3 ppm; 96-h =4 ppm (4,5); Av. wt. 0.3g @ 22°C @ 44 ppm CaCO3, LC50s: @pH 6.5: 24-h =7.6 ppm; 96-h =4.2 ppm (4,5); @pH 7.5 24-h =4 ppm; 96-h =2.4 ppm (4,5); @pH 8.5: 24-h =3.9 ppm; 96-h =2.4 ppm (4,5); @pH 9.5: 24-h =2.4 ppm; 96-h =1.8 ppm (4,5); Degradation (degr.) study (av. wt. 0.5g, 12°C, pH 7.4, 44 ppm CaCO3): LC50s: 0-d degr.: 24-h =4.3 ppm; 96-h =4 ppm (4,5); 1-d degr.: 24-h =6.6 ppm; 96-h =6 ppm (4,5); 3-d degr.: 24-h =8 ppm; 96-h =7 ppm, (4,5); 7-d degr.: 24-h =6.2 ppm; 96-h =5.6 ppm (4,5); Av. wt. 1.3g, 20°C, 272 ppm CaCO3: LC50: 96-h =5.5 ppm (4,5). *Channel Catfish*: Av. wt. 0.2g, 20°C: 24 & 96-h =4.4 ppm (4,5); Av. wt. 0.6 g, 22°C: 24 & 96-h =13 ppm (4,5); Eyed eggs (20°C): LC50 96-h =43 ppm (4,5); 225°C, LC50s: Swim-up Fry: 24-h =3.7 ppm 96-h =3.3 ppm (4,5); Yolk-sac Fry: 24 & 96-h =4.3 ppm (4,5). *Fathead Minnow*: Av. wt. 0.6-0.9 g, pH 7.4, 44 ppm CaCO3, LC50s: @15°C: 24-h =7 ppm; 96-h =4.8 ppm (4,5); @20°C: 24-h =4.1 ppm; 96-h =2.9 ppm (4,5); @22°C: 24-h =2.4 ppm; 96-h =2.3 ppm (4,5); @25°C: 24-h =6.4 ppm: 96-h = 4.3 ppm (4,5). *Rainbow Trout*: @12°C, pH 7.4, 44 ppm CaCO3, LC50s: Av. wt. 0.4 g: 24-h = 12 ppm; 96-h =7.6 ppm (4,5); Av. wt. 0.5 g: 24-h =5.2 ppm; 96-h =1.3 ppm (4,5); Av. wt. 1.0 g: 24 & 96-h =8.3 ppm (4,5); Av. wt. 0.7g @pH 7.4, 44 ppm CaCO3, LC50s: @7°C: 24 & 96-h =14 ppm (4,5); @12°C: 24-h =14 ppm; 96-h =7.5 ppm (4,5); @17°C: 24-h =7.5 ppm; 96-h =7.4 ppm (4,5); Av. wt. 0.4g, @12°C, 44 ppm CaCO3, LC50s: @pH 6.5: 24-h =14 ppm; 96-h =7.6 ppm (4,5); @pH 7.5: 24-h =2.4 ppm; 96-h =1.6 ppm (4,5); @pH 8.5 & 9.5: 24-h =2.4 ppm; 96-h =1.4 ppm (4,5); Degradation (degr.) study (av. wt. 0.5g, 12°C, pH 7.4, 44 ppm CaCO3, LC50s: 0-d degr.: 24-h =19 ppm; 96-h =9 ppm (4,5); 1-, 3- & 7-d degr.: 24-h =14 ppm; 96-h =7.6 ppm (4,5); Yolk-sac fry (10°C), LC50s: 24-h = 11 ppm; 96-h =3.4 ppm (4,5). **AMPA:** *Fathead Minnow*: NOEC (life-cycle) = 25.7 ppm (3).

	IPA (96.7%): *Bluegill*: 96-h LC50, av. wt. 1g =120 ppm, NOEL =100 ppm (22). *Channel Catfish*: 96-h LC50, av. wt. 2.2g =130 ppm (22). *Fathead Minnow*: 96-h LC50, av. wt. 0.6g =97 ppm (22). **IPA (83.0-87.3%):** *Fathead Minnow*: Life Cycle (LOEL) > 25.7 ppm, (NOEL) = 25.7 ppm (22). *Rainbow Trout*: 96-h LC50, av. wt. 0.8g =140 ppm (22). **IPA (62.4%):** *Rainbow Trout*: 96-h LC50, av. wt. 0.22) >1,000 ppm (22). **IPA (53.6-53.8%):** *Striped Bass*: Av. wt 1g: 1-h =131 ppm, 6-h =50 ppm, 96-h =23.5 ppm (4,5). **IPA (40.7-41.8%):** *Bluegill*: 96-h LC50, av. wt. 0.45g =14 ppm, NOEL =8.7 ppm (22); 96-h LC50, av. wt. < 2.5g =2.4 ppm (22); 96-h LC50, av. wt. 0.25g =5.8 ppm, NOEL = 2.2 ppm (22); 96-h LC50, av. wt. 0.11g =134 ppm, NOEL <100 ppm (22); 96-h LC50, av. wt. 0.5g = 4.0 ppm (22). *Channel Catfish*: 96-h LC50, av. wt. 0.6g =13 ppm (22); 96-h LC50, av. wt. 3.0g =16 ppm, NOEL =9.4 ppm (22). *Fathead Minnow*: 96-h LC50, av. wt. 0.6g =9.4 ppm, NOEL =5.6 ppm (22). *Rainbow Trout*: 21-d NOEC =0.43-0.81 ppm (1k); 96-h LC50, av. wt. 0.5g =1.3 ppm (22); 96-h LC50, fingerling =8.3 ppm (22); 96-h LC50, av. wt. 0.4g =150 ppm, NOEL =100 ppm (22); 96-h LC50, av. wt. 2.4g =8.2 ppm, NOEL =5.8 ppm (22); 96-h LC50, av. wt. 0.5g =120 ppm (22). **IPA (7.03%):** *Bluegill*: 96-h LC50, av. wt. 0.18g =830.8 ppm, NOEL =180 ppm (22). *Rainbow Trout*: 96-h LC50, av. wt. 1.0g =240 ppm, NOEL =180 ppm (22). **IPA (41% w/ 10% POEA surfactant):** *Coho*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =54 ppm, 96-h =51 ppm (4,5,15), Lake (hard) water: 24 & 96-h = 25 ppm (4,5,15). *Chum*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =62 ppm, 96-h =58 ppm (4,5,15), Lake (hard) water: 24-h =25 ppm, 96-h =23 ppm (4,5,15); Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =31 ppm, 96-h =19 ppm (4,5,15), Lake (hard) water: 24-h =17 ppm, 96-h =11 ppm (4,5,15). *Rainbow Trout*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =33 ppm, 96-h =31 ppm (4,5,15), Lake (hard) water: 24-h =31 ppm, 96-h =17 ppm (4,5,15), 96-h (av. wt 0.37 g): (dechlorinated city water, pH 6.1) =26 ppm, (lake water, pH 7.7) =15 ppm (4,20). **IPA (41% w/ 15% POEA surfactant):** *Channel Catfish*: 96-h, sac fry =4.3 ppm (4,14), swim-up fry =3.3 ppm (4,14), Av. wt 2.2g) =13 ppm (14).

	Chinook: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =41 ppm, 96-h =27 ppm (4,5,15,20), Lake (hard) water: 24 & 96-h =17 ppm (4,5,15,20), Av. wt. 4.6g, dechlorinated city water, pH 6.1: 96-h =20 ppm (4,20). *Chum*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =31 ppm, 96-h =19 ppm (4,5,15,20), Lake (hard) water: 24-h =17 ppm, 96-h =11 ppm (4,5,15,20). *Coho*: Av. wt. 0.3-0.7g: Creek (soft) water: 24 & 96-h =27 ppm (4,5,15,20), Lake (hard) water: 24-h =14 ppm, 96-h =13 ppm (4,5,15,20), 96-h, av. wt. 0.3g @ 15°C =42 ppm (4,5,16,20); Av. wt. 11.8g, dechlorinated city water @ pH 6.2: 96-h =22 ppm (4,20). *Pink*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =33 ppm, 96-h =31 ppm (4,5,15,20), Lake (hard) water: 24-h =17 ppm, 96-h =14 ppm (4,5,15,20). *Rainbow Trout*: 96-h, eyed eggs =16 ppm (4,5,14), sac fry =3.4 ppm, swim-up fry =2.4 ppm (4,5,14); 96-h, av. wt. 1g =1.3 ppm (4,5,14), 96-h, av. wt. 2g =8.3 ppm (4,5,14); Av. wt. 0.3-0.7g: Creek (soft) water: 24-h =21 ppm, 96-h =15 ppm (4,5,15,20), Lake (hard) water: 24-h =17 ppm, 96-h =14 ppm (4,5,15,20); 96-h, av. wt. 0.33g, 15°C =28 ppm, av. wt. 0.6g, 14.5°C =25.5 ppm (4,5,16). *Sockeye*: 96-h, av. wt. 3.8 g, 4.2°C) =26.7 ppm (4,5,16,20), Av. wt. 0.25 g, 4.5°C =28.8 ppm (4,5,16).
Amphibians/Reptiles:	**Glyphosate Tech (95.0% +):** *Gray Tree Frog*: 26-d NOEL, metamorphosis, growth & survival =0.0069 ppm (4,5). *Green Frog*: 24-h & 96-h LC50s, embryo >38.9 ppm (4,11); 7-d & 14-d NOEL, mortality =3.7 ppm (4,5); 15-d LOEL, immunological =3.7 ppm (4,5). *Leopard Frog*: 40 to 45-d NOEL, metamorphosis, growth & survival =0.0069 ppm (4,5); NOAEC =1.8 ppm ae (8). *Xenopus laevis*: 96-h LC50 @ pH 7.6 =7,297 ppm ae; 96-h LC05 @ pH 7.6 = 5,516 ppm ae (3). **AMPA: No data in references.** IPA (53.8%): *African Clawed Frog*: 96-h LC50, embryo =7,296.8 ppm ae (4,5); 96-h LC10, embryo = 5,867.2 ppm ae (4); 96-h LC05, embryo =5,515.5 ppm ae (4); 96-h LOEL, growth =6,000 ppm ae (4,5), NOEL, growth 4,000 ppm ae (4,5); 96-h LC50, embryo @ pH 6.5 =4,341.6 ppm ae (4,5); 96-h LC10, embryo @ pH 6.5 = 3,023.4 ppm ae (4); 96-h LC50, embryo @ pH 8.0 =645.2 ppm ae (4,5); 96-h LC10, embryo @ pH 8.0 = 395.2 ppm ae (4). **IPA (25.2%):** *American Bullfrog*: 16-d NOEL, growth & survival =1 ppm (4,5), LOEL growth & survival =2 ppm (4,5); 16-d LC50 =2.07 ppm (5,17). *American Toad*: 16-d NOEL growth & survival =1 ppm (4,5), LOEL =2 ppm (4,5); 16-d LC50 =2.52 ppm (5,17). *Gray Tree Frog*: 16-d NOEL growth & survival =2 ppm (4,5); 16-d LC50 =1.35 ppm (5,17).

	Green Frog: 16-d NOEL growth & survival =1 ppm (4,5), LOEL =2 ppm (4,5); 16-d LC50 =2.17 ppm (5,17). *Leopard Frog*: 16-d NOEL growth & survival =2 ppm (4,5); 16-d LC50 =2.46 ppm (5,17). *Wood Frog*: 16-d NOEC =1 ppm (4,5); 16-d LC50 w/o predator =1.32 ppm (5,17), LC50 w/ predator [Red-spotted Newt] 0.55 ppm (5,17). **IPA (13.0%):** *Leopard Frog*: 23-d LOEL, 29% reduction in survival w/out predation by Red-spotted Newts (RSN) = 1.3 ppm (4), (23-d LOEL, w/ predation by RSN, additional 21% reduction in survival =1.3 ppm (4,5). *Gray Tree Frog*: 23-d NOEL 0% reduction in survival = 1.3 ppm (4,5), LOEL 0% survival =1.3 ppm (4); Red-Spotted Newt: 23-d NOEL, survival =1.3 ppm (4,5). **IPA (41.0% w/ 15% POEA surfactant):** *African Clawed Frog*: 96-h LC50, embryo =9.3 ppm ae (4,5); 96-h LC10, embryo = 8.0 ppm ae (4); 96-h LC05, embryo =7.7 ppm ae (4); 96-h LC50, embryo @ pH 6 15.6 ppm ae (4,5,8); 96-h LC10, embryo @ pH 6 =6.2 ppm ae (4); 96-h LC50, embryo @ pH 7.5 =7.9 ppm ae (4,5,8); 96-h LC10 embryo @ pH 7.5 =4.0 ppm ae (4); 96-h LC50, larvae @ pH 6 =2.1 ppm ae (4,5,8); 96-h LC10 larvae @ pH 6 =1.99 ppm ae (4); 96-h LC50 larvae @ pH 7.5 =0.88 ppm ae (4,5,8); 96-h LC10 larvae @ pH 7.5 =0.85 ppm ae (4); 96-h LOEL growth =10 ppm ae (4), NOEL growth) = 8 ppm ae (4). *American Bullfrog*: 96-h LC50 larvae = 1.55 ppm ae (9). *American Toad*: 24-h LC50 embryo =13.5 ppm (4); 96-h LC50 embryo <12.9 ppm (3,4,5,8); 96-h LC50 embryo @ pH 6 =4.8 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 =2.2 ppm ae (4); 96-h LC50 embryo @ pH 7.5 =6.4 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 =4.3 ppm ae (4); 96-h LC50 larvae @ pH 6 =2.9 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 = 2.1 ppm ae (4); 96-h LC50 larvae @ pH 7.5 =1.7 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 =1.2 ppm ae (4); 96-h LC50 larvae <4 ppm ae (9); 16-d LC50 larvae =1.89 ppm ae (9). *Gray Tree Frog*: 96-h LC50 larvae =1.0 ppm ae (9). *Green Frog*: 96-h LC50 embryo =6.5 ppm (3,4,5,8); 96-h LC10 larvae =3.9 ppm (4); 96-h LC50 larvae =8.7 ppm (4); 96-h LC50 embryo @ pH 6 =5.3 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 =2.6 ppm ae (4); 96-h LC50 embryo @ pH 7.5 =4.1 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 =2.8 ppm ae (4); 96-h LC50 larvae @ pH 6 =3.5 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 =2.1 ppm ae (4); 96-h LC50 larvae @ pH 7.5 =1.4 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 =0.89 ppm ae (4); 96-h LC50 larvae =2.0 ppm ae (4,5,9); 16-d LC50 =1.63 ppm ae (4,5,9); Field enclosure studies (tadpoles) 96-h LC50s: Site A = 4.34 ppm ae (4,5,9), Site B =2.70 ppm ae (4,5,9). *Northern Leopard Frog*: 24-h LC50 embryo =11.9 ppm (4); 96-h LC50 embryo =9.2 ppm (3,4,5,8); 96-h LC10 larvae =10.5 ppm (4); 96-h LC50 larvae =13.7 ppm (4); 96-h LC50 embryo @ pH 6 =15.1 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 =13.1 ppm ae (4); 96-h LC50 embryo @ pH 7.5 =7.5 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 =6.7 ppm ae (4); 96-h LC50 larvae @ pH 6 =1.8 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 =1.1 ppm ae (4); 96-h LC50 larvae

	@ pH 7.5 =1.1 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 =0.83 ppm ae (4); 96-h LC50 larvae =2.9 ppm ae (4,5,9); 16-d LC50 =1.85 ppm ae (9); Field enclosure studies (tadpoles) 96-h LC50s: Site A =11.47 ppm ae (4,5,9), Site B =4.25 ppm ae (4,5,9). *Wood Frog*: 24-h LC50 embryo =18.1 ppm (4); 96-h LC50 embryo =16.5 ppm (4,5,8); 96-h LC50 larvae =16.5 ppm (3,5); 96-h LC50 larvae =5.1 ppm ae (9); 16-d LC50, w/o predator =1.0 ppm ae (9); 16-d LC50 w/ predator =0.41 ppm ae (9). **K (48.8%):** Roundup WeatherMAX: New Mexico Spadefoot & Great Plains Toad: 48-h NOEC survival = 1.301 L/acre (21). **K (48.7% AI w/ unk % POEA surfactant – Roundup Original MAX:** *American Bullfrog*: 96-h LC50 larvae =0.8 ppm ae (3,18); 96-h LC10 & LC90 larvae =0.5 & 1.2 ppm ae (18). *American Toad*: 96-h LC50 larvae =1.6 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.2 & 2.1 ppm ae (18). *Blue-spotted Salamander*: 96-h LC50 larvae =3.2 ppm ae (3,18); 96-h LC10 & LC90 larvae = 2.7 & 3.7 ppm ae (18). *Cascades Frog*: 96-h LC50 larvae =1.7 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.2 & 2.1 ppm ae (18). *Gray Tree Frog*: 96-h LC50 larvae =1.7 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.4 & 2.0 ppm ae (18). *Green Frog*: 96-h LC50 larvae =1.4 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.0 & 1.8 ppm ae (18). *Leopard Frog*: 96-h LC50 larvae =1.5 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.2 & 1.8 ppm ae (18). *Northwestern Salamander*: 96-h LC50 larvae =2.8 ppm ae (3,18); 96-h LC10 & LC90, larvae =2.4 & 3.3 ppm ae (18). *Spotted Salamander*: 96-h LC50 larvae =2.8 ppm ae (3,18); 96-h LC10 & LC90 larvae =2.4 & 3.3 ppm ae (18). *Spring Peeper*: 96-h LC50 larvae =0.8 ppm ae (3,18); 96-h LC10 & LC90 larvae =0.1 & 1.6 ppm ae (18). *Red-spotted Salamander*: 96-h LC50 larvae =2.7 ppm ae (3,18); 96-h LC10 & LC90, larvae =2.3 & 3.1 ppm ae (18). *Western Toad*: 96-h LC50 larvae =2.0 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.7 & 2.4 ppm ae (18). *Wood Frog*: 96-h LC50 larvae =1.9 ppm ae (3,18); 96-h LC10 & LC90 larvae =1.3 & 2.8 ppm ae (18).

Invertebrates/Plants:	**Glyphosate Tech (95.0-99.7%):** *Daphnia magna*: (48-h EC50) = 930 ppm (1c,7), (48-h EC50, immobilization) = 40 ppm (6), (21-d NOEC) = 30 ppm (6), NOAEC = 49.9 ppm ae (8), (48-h EC50, w/ aeration) = 37 ppm (10), (48-h EC50, w/out aeration) = 24 ppm (10), (48-h EC50) = 13 ppm (10); *Duckweed*: 7-d EC50 phytotoxicity =21.5 ppm (2); 7-d EC50 biomass =12 ppm (6); 7-d EC50 =10 ppm ae (20); 14-d EC50 growth =25.5 ppm ae, NOEC = 16.6 ppm ae (20). *Earthworm*: 14-d LC50 >5,000 mg kg dry soil (1c); 14-d LC50 >480 mg/kg (6), NOEC reproduction >28.8 mg/kg (6); 14-d LC50 >3,750 mg/kg soil, NOEC = 118.7 (20). *Eastern Oyster, eggs*: 48-h LC or EC50 >10 ppm ae (20). *Fatmucket Clam*: 48-h LC50, larvae >200 ppm ae (3,4,5); 96-h LC50 juvenile >200 ppm ae (3,4,5); 21-d LC50 >200 ppm ae (3,4,5). *Fiddler Crab*: 96-h LC50 =934 ppm (2,11,20). *Grass Shrimp*: 96-h LC50 =281 ppm (2,11,20). *Green Algae*: 96-h EC50 phytotoxicity =12.5 ppm (2); 72-h EC50 growth inhibition =166 ppm (1c); 72-h EC50 growth =4.4 ppm (6). *Honeybee*: 48-d contact LD50 >100 µg/bee (1c,2,4). 48-h LD50, oral & contact ≥100 µg/bee (6,7,8,10,11,20). *Midge*: 48-h LC50 =55 ppm (2,3,5); 48-h LC50 =53.2 ppm ae (8); 48-h LC50 =53.2 ppm ae (8). *Mysid Shrimp*: 96-h LC or EC50 >1,000 ppm ae (20). **Glyphosate Tech (83.0%):** *Daphnia magna:* 48-h LC50 =780 ppm (1d,2); 21-d, life cycle NOEC = 49.9 ppm, LOEC = 95.7 ppm (3). **Glyphosate Tech (41.0% AI):** *Buzzer midge*: 3rd instar, 22°C, hard water, LC50s: (48-h) > 10 ppm @ pH 7.4); (48-h) = 55 ppm @ pH 7.4; 48-h >56 @ pH 6.6 (4,5). *Daphnia magna*: 1st instar, 22°C, hard water, LC50s: (24-h) = 5.3 ppm; 48-h = 2.95 ppm (4,5). **AMPA (94.4-98.5%):** *Daphnia magna*: 48-h EC50 =683 ppm, NOAEC = 320 ppm (3,8); 48-h LC or EC50 =690 ppm (20). *Duckweed*: 7-d EC50 growth =46.9 ppm ae (3); 7-d EC10 growth =3.78 ppm ae (3). *Honeybee*: 48-h LD50 contact >100 µg/bee (3). *Green Algae*: 48-h EC50 growth =270 ppm (3); 48-h EC10 growth =92.5 ppm (3); 96-h EC50 growth =55.9 ppm ae (3); 96-h IC50 growth = 24.7 ppm (3).

	AMPA (83.0%): *Ceriodaphnia dubia*: 48-h LC50 =147 ppm ae (3). *Daphnia magna*: 48-h EC50 =647.4 ppm ae, NOAEC = 464.8 ppm ae (3,8); 48-h EC50 =128.1 ppm ae, NOAEC = 95.6 ppm ae (3). **IPA (Unk %AI):** *Daphnia pulex*: 48-h EC50 < 24 h old =7.9 ppm (22). *Duckweed*: 48-h EC50 growth =2.0 ppm (22); 48-h EC50 growth > 16.91 ppm, NOEL =16.91 ppm (22). *Honeybee*: 48-h LD50 contact >100 µg/bee (22). **IPA (95.0-99.7%):** *Daphnia magna*: 21-d early life LOEC =96 ppm, NOEL =50 ppm (22). *Eastern Oyster*: 48-h LC50 embryo-larvae >10 ppm (22). *Fatmucket Clam*: 48-h LC50 larvae = 5.0 ppm ae (4,5); 96-h LC50 juvenile = 7.2 ppm ae (4,5). *Fiddler Crab*: 96-h LC50 =934 ppm, NOEL = 650 ppm (22). *Midge*: 48-h LC50 4th instar =55 ppm (22); 48-h LC50 juvenile =18 ppm (22). *Shore Shrimp*: 96-h LC50 =281 ppm, NOEL = 210 ppm (22). **IPA (83.0%):** *Daphnia magna*: 48-h EC50 =780 ppm, NOEL = 560 ppm (22). **IPA (62.4%):** *Daphnia magna*: 48-h EC50 =401.3 ppm ae, NOAEC = 147.8 ppm ae (3); 48-h LC50 1st instar = 869 ppm, NOEL = 320 ppm (22). **IPA (53.5-56.8%):** *Ceriodaphnia dubia*: 48-h LC50 = 415 ppm ae (3,4,5); 24-h LC50 = 707 ppm ae (4). *Daphnia magna*: 48-h LC50 = 218 ppm (3,4,5); 48-h LC50 = 35.5 ppm, NOEC immobility = 13 ppm (3); 48-d LC50 =130 ppm (4). *Duckweed*: growth inhibition = 24.4 ppm (1a,l,q). *Earthworm*: LC50 > 1,000 ppm (1a,l,q). *Fatmucket Mussel*: 48-h EC50 larvae > 148 ppm ae (3,4,5); 96-h LC50 juvenile > 148 ppm ae (3,4,5); 28-d LC50 = 43 ppm ae (3,4,5). *Green Algae*: growth inhibition = 127 ppm (1a,1l,1q); 96-h IC50 growth = 41.0 ppm (3). *Honeybee* contact LD50: > 100 µg/bee (1a,l,q). *Midge*: 48-h EC50 immobilization = 5,600 ppm (3,4,5,20); 48-h LC50 =1,216 ppm (3,5); 24-h EC50 immobilization = 5,900 ppm (4,5). **IPA (40.7-41.4% AI):** *Crayfish*: Adult, 22^{o}C, hard water, 96-h LC50 = 7 ppm (4,5,22).

	Daphnia magna: 48-h EC50 = 21.6 ppm (1k); 48-h LC50 = 11.0 ppm (1t); 21-d NOEC = 1.5 ppm (1k,5); 48-h EC50 immobility, first instar, w/o suspended sediments @ 22°C = 3 ppm (5,19); 48-h EC50, 1st instar =3 ppm (22); 48-h EC50, < 24 h old = 310 ppm, NOEL =56 ppm (22); 48-h EC50, < 24 h old = 72 ppm (22); 48-h EC50 < 24 h old = 5.3 ppm, NOEL = 1.9 ppm (22). *Daphnia pulex*: 48-h EC50 immobility, w/o suspended sediments @ 15°C = 7.9 ppm (4,5,19); 48-H EC50 immobility, w/ suspended sediments (50 mg clay/L) @ 15°C = 3.2 ppm (5,19); 48-h EC50 < 24 h old = 242 ppm, NOEL < 60 ppm (22). *Duckweed*: 7-d EC50 = 27.0 ppm (1k). *Earthworm*: 14-d EC50 > 1,000 ppm (dry soil) (1k); 14-d EC50 > 1,250 mg/kg soil (1t). *Green Algae*: 72-h IC50 = 17.4 ppm (1k); 96-h IC50 = 2.2 ppm (1k). *Honeybee*: 24-h LD50 contact) > 20 µg/bee (1k). **IPA (25.2%):** *Pouch Snail*: 13-d NOEL = 3.8 ppm (4,5). *Marsh Pond Snail*: 13-d NOEL = 3.8 ppm (4,5). *Marsh Rams-Horn*: 13-d NOEL = 3.8 ppm (4,5). **IPA (7.03%):** *Daphnia magna*: 48-h EC50 1st instar > 1,000 ppm, NOEL = 560 ppm (22). **IPA (41% w/ 10-20% POEA surfactants):** *Ceriodaphnia dubia*: (24-h LC50) = 6.0 ppm ae (4,5), (48-h LC50) = 5.7 ppm ae (4,5); **IPA (41% w/ 15% POEA surfactants):** *Daphnia pulex*: 96-h EC50 = 25.5 ppm (4,5,12,16). *Duckweed*: 7-d EC50 growth = 15.1 ppm ae (20); 14-d EC50 growth = 4.9 ppm ae (20). *Earthworm*: 14-d LC50 >5,000 mg ae/kg soil (20), NOEC =500 mg ae/kg soil (20). *Midge*: 48-h LC50 = 16 ppm (11). **K:** No information in references.
Other:	Glyphosate Tech: Carcinogenic: Negative (2,6,11); Teratogenic: Negative (10,11); Mutagenic: Slightly, but not in mammals (3,11); Genotoxic: Potential; however, the research that raised the largest concerns involved the use of a formulation marketed in S. America (w/ EPA Registration No. 524-424) (3); Endocrine disruption: Unknown (5,6), Negative in mammals (11); AMPA: Unknown (5); Teratogenic: Negative (10,11); Mutagenic: Negative (10); Endocrine disruption: Unknown (5), Negative in mammals (11)

Glyphosate: 1st- order degradate of glyphosate salts (e.g. isopropylamine (IPA) and potassium (K)) (1d);
Aminomethylphosphonic Acid (AMPA): 2nd- order degradate of glyphosate salts (7,12).

Ecological Incident Reports

No incident reports in references.

Environmental Fate

Water solubility (S_w):	**Glyphosate:** Highly water soluble (2,12); = 11,600 ppm at 25°C (7); = 12,000 ppm at 25°C (8); = 10,500 ppm at 20°C (10); = 10,500 ppm at pH 1.9 (11); = 900,000 ppm (12); = 1.2 x 10^4 at 25°C (13); = 10,000 to 15,700 mg/L at 25°C (20). **IPA:** =786,000 ppm at pH 4.06 (11).
Soil Mobility (K_{oc}):	**Glyphosate:** =884-60,000 L/kg, absorbs strongly to soil (1c,e,f,h,m,n,r-v,2); = 1435 (slightly mobile) (6); sand = 58,000 mL/g (8); sandy loam = 3,100 – 13,000 mL/g (8), silty clay loam = 33,000 – 47,000 mL/g (8); = 2,640, 2,100, & 500 (12).
Soil Persistence ($t_{½}$):	**Glyphosate:** Primary degradation mechanism is biotic metabolism to AMPA (2,7,11,12). *Aerobic degradation*: Sandy loam =1.85 d (2), Silt loam =2.06 d (2); =96.4 d (7); Sandy loam =1.8 & 5.4 d, Silt loam =2.6 d (8), Remained in pond sediments at ≥ 1 ppm at 1 year post-treatment (8); = 2 to 197 d (11), Av. =47 d (11,12); Av. =0.9 d (0.6 to 1.1 d) (13). *Anaerobic degradation*: =22.1 d (7); *Photolysis*: Stable to photodegradation on soil (2); = stable (for at least 30 d) (8), **AMPA:** *Aerobic degradation*: = max. of 29% at 40 d (8).
Soil Dissipation (DT_{50}):	**Glyphosate:** =2-174 d (1c,1e,1f,1h,1m,1n,1r- v,13); Av. =13.9 days (2.6 in TX to 140.6 in IA) (2), Half lives are longer in colder climes (28.7 d in MN, 127.8 d in NY) (2), = av. 100 d (35 – 158 d) (2); field (aerobic) = 12 d (6), lab at 20°C = 49 d (6); =44 to 60 d (7); =7.3 d (OH), =1.7 d (TX), =17 d (AZ), =114 d (NY), =25 d (MN), =8.3 d (GA), =13 d (CA) (8); forest soil = 14.8 & 24.2 (13); = 27.3 to 55.5 d (20); = 1.7 to 141.9 d (20). **AMPA:** = 119 d (OH), =131 d (TX), =142 d (AZ), =240 d (NY), =302 d (MN), =958 d (GA), =896 d (CA) (2,8); = av. 118 d (71 to 165 d) (2).

Aquatic Persistence ($t_{½}$):	**Glyphosate:** < 7 d (1c,1e,1f,1h,1m,1n,1r- v). *Aerobic degradation*: Silty clay loam incubated in dark at ~25°C for 30 days =7 d (2); water-silty clay loam = 14.1 d (8); = 3 to 91 d (11). *Anaerobic degradation*: Silty clay loam sediment = 8.1 d (2); water-silty clay loam = 208 d (8). *Hydrolysis*: Stable to hydrolysis at pH 3,6, and 9 @ 5 & 35°C. *Photolysis*: Stable to photodegradation in pH 5,7, and 9 under natural sunlight (2,7,10,11); = stable (for at least 30 d) (8). **AMPA:** *Aerobic degradation*: = 19-25% at 7-30 d (8), =7 to 14 d (20), considered comparable to glyphosate (20). *Anaerobic degradation* = max. of 25% at 15 d (8).
Aquatic Dissipation (DT_{50}):	**Glyphosate:** = 7.5 d (irrigation water) (2,8); = 120 d (pond in MO) (2); > 35 d (av. across several temperatures and pH levels) (7); =stable at pH 5 to 8 at 25°C (6); Water-sediment DT50 = 87 d (6); = 7 & 14 d (20). *Hydrolysis*: DT50 = stable at pH 7, 20°C (6). *Photolysis*: DT50 = 33 d (pH 5), = 69 d (pH 7), 77 d (pH 9) (6).
Potential to Move to Groundwater (GUS score):	**Glyphosate:** Low potential (2,7,11,12). **AMPA:** Low potential (2)
Vapor Pressure (mm Hg):	**Glyphosate:** low (2,7), = 7.5 x 10^{-8} (6), = 1.84 x 10^{-7} at 45°C (11); **IPA:** = 1.58 x 10^{-8} at 25°C (11);
Octanol-Water Partition Coefficient (K_{ow}):	**Glyphosate:** low (2,7), = 6.31 x 10^{-4} at pH 7, 20°C, low, (6), = 0.00033, very low (7), < 6 x 10^{-4} at pH 5, 7 & 9 (10), = 0.02512 (12), = 2.57 x 10^{-5} to 0.01995 (20);
Bioaccumulation/ Biocentration:	**Glyphosate:** BCF (Bluegill) < 1 for whole fish (1c,e,f,h,m,n,r-v), = 0.52x (whole fish) (2), BCF = 0.5 (6). BAF: no significant bioaccumulation expected (1c,e,f,h,m,n,r-v).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 1.0 lb. a.e./acre **Croplands/Facilities Maintenance**: 1.0 lbs. a.e./acre
EECs	**Terrestrial (Habitat Management):** 240 ppm **Terrestrial (Croplands/Facilities Maintenance):** 240 ppm **Aquatic (Habitat Management):** 0.368 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.00335 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.05 [0.1]	=0.05 [0.5]
	Mammals	=0.13 [0.1]	=0.13 [0.5]
	Fish	=0.06 [0.05]	=0.06 [0.5]
Chronic	Birds	=0.29 [1]	=0.29 [1]
	Mammals	=0.40 [1]	=0.40 [1]
	Fish	=0.28 [1]	=0.28 [1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.05 [0.1]	=0.05 [0.5]
	Mammals	=0.13 [0.1]	=0.13 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.29 [1]	=0.29 [1]
	Mammals	=0.40 [1]	=0.40 [1]
	Fish	<0.01 [1]	<0.01 [1]

Justification for Use:	Efficacious non-selective annual, biannual and perennial broadleaf and grass weed control.
Specific Best Management Practices (BMPs):	Apply aquatic labeled glyphosate formulations to aquatic habitats, and surfactant free glyphosate formulations to riparian habitats within 25 feet of surface water resources tank-mixed w/ surfactants classified as practically non-toxic or slight acute toxicity (>10 ppm) to aquatic organisms. Slight acute toxicity surfactants include LI-700, AgriDex, Activate Plus, Big Sur 90, Sil Energy, Dyne-Amic, Freeway, Cygnet Plus, Sun-Wet, Hasten Modified Vegetable Oil, Kinetic or Class Act Next Generation.
References:	[1a] _____. 2008 & 2004, respectively. Accord Concentrate specimen label and MSDS. Dow AgroSciences LLC, Indianapolis, IN. 17 & 3 pp. [1b] _____. 2002 & 2011, respectively. Aqua Star specimen label and MSDS. Albaugh, Inc. Ankeny, IA. 16 & 4 pp. [1c] _____. 2009 & 2005. AquaMaster label and MSDS. Monsanto Co., St. Louis, MO. 21 & 8 pp.

[1d] _____. 2008 & 2007, respectively. AquaNeat specimen label and MSDS. Nufarm Americas, Inc., Burr Ridge, IL. 9 & 6 pp.

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[1g] _____. 2010. Cornerstone specimen label and MSDS. Winfield Solutions LLC, St. Paul, MN. 70 & 3 pp.

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[1i] _____. 2010 & 2008, respectively. Gly Star Plus specimen label and MSDS. Albaugh, Inc., Ankeny, IA. 72 & 4 pp.

[1j] _____. 2009 & 2006, respectively. Glyfos Aquatic specimen label and MSDS. Cheminova, Inc., Wayne, NJ. 20 & 6 pp.

[1k] _____. 2008 & 2005**,** respectively. Glyfos X-TRA specimen label and MSDS. Cheminova, Inc., Wayne, NJ. 21 & 5 pp.

[1l] _____. 2006 & 2004, respectively. Glypro specimen label and MSDS. Dow AgroSciences LLC, Indianopolis, IN. 17 & 3 pp.

[1m] _____. 2007. Honcho specimen label and MSDS. Monsanto, Co., St. Louis, MO. 24 & 9 pp.

[1n] _____. 2010. Honcho Plus specimen label and MSDS. Monsanto Co., St. Louis, MO. 26 & 9 pp.

[1o] ____. 2009. Makaze specimen label and MSDS. Loveland Products, Inc., Greeley, CO. 26 & 3 pp.

[1p] _____. 2011 & 2007, respectively. Razor Pro specimen label and MSDS. Nufarm Americas, Inc., 32 & 6 pp.

[1q] _____. 2006 & 2004, respectively. Rodeo specimen label and MSDS. Dow AgroSciences LLC, Indianapolis, IN. 17 & 3 pp.

[1r] _____. 2008 & 2006**,** respectively. Roundup Original specimen label and MSDS. Monsanto Co., St. Louis, MO. 23 & 9 pp.

[1s] _____. 2007 & 2006, respectively. Roundup Original MAX specimen label and MSDS. Monsanto Co., St. Louis, MO. 27 & 9 pp.

[1t] _____. 2010 & 2011, respectively. Roundup PRO specimen label and MSDS. Monsanto, Co., St. Louis, MO. 21 & 9 pp.

[1u] _____. 2010 & 2011, respectively. Roundup PRO Concentrate specimen label and MSDS. Monsanto Co., St. Louis, MO. 22 & 9 pp.

[1v] ____. 2009 & 2008, respectively. Roundup WeatherMAX specimen label and MSDS. Monsanto, Co., St. Louis, MO. 54 & 9 pp.

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Table CP.1 - Pesticide Name

Active Ingredient = glyphosate

Trade Namea	Treatment Typeb, c	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Accord Concentrate	H, CF	0.25	1.0	1	1.0	0
Aqua Star	H, CF	0.25	1.0	1	1.0	0
AquaMaster	H, CF	0.25	1.0	1	1.0	0
AquaNeat	H, CF	0.25	1.0	1	1.0	0
Buccaneer	H, CF	0.33	1.0	1	1.0	0
Buccaneer Plus	H, CF	0.33	1.0	1	1.0	0
Cornerstone	H, CF	0.33	1.0	1	1.0	0
Cornerstone Plus	H, CF	0.33	1.0	1	1.0	0
Gly Star Plus	H, CF	0.33	1.0	1	1.0	0
Glyfos Aquatic	H, CF	0.25	1.0	1	1.0	0
Glyfos XTRA	H, CF	0.33	1.0	1	1.0	0
Glypro	H, CF	0.25	1.0	1	1.0	0
Honcho	H, CF	0.33	1.0	1	1.0	0
Honcho Plus	H, CF	0.33	1.0	1	1.0	0
Makaze	H, CF	0.33	1.0	1	1.0	0
Razor Pro	H, CF	0.33	1.0	1	1.0	0
Rodeo	H, CF	0.25	1.0	1	1.0	0
Roundup Original	H, CF	0.33	1.0	1	1.0	0

Trade Namea	Treatment Typeb, c	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Roundup Original MAX	H, CF	0.22	1.0	1	1.0	0
Roundup Pro	H, CF	0.33	1.0	1	1.0	0
Roundup PRO Concentrate	H, CF	0.33	1.0	1	1.0	0
Roundup Weather MAX	H, CF	0.22	1.0	1	1.0	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

B-6 Oryzalin Chemical Profile (Surflan)

Date:	6/8/11		
Trade Name(s):	Surflan AS Surflan WDG	**Common Chemical Name(s):**	oryzalin
Pesticide Type:	Herbicide/Grp 3	**EPA Registration Number:**	70506-44 70506-50
Pesticide Class:	dinitroaniline	**CAS Number:**	19044-88-3
Other Ingredients:	**Surflan AS:** <40% by wt. glycerin, <40% by wt. propylene glycol (1). **Surflan WDG:** 15% by wt. kaolin (2).		

Toxicological Endpoints

Mammalian LD_{50}:	Rats: >5000 mg/kg (1,2,3,7). Mice: >5000 mg/kg (3). Dog: >1000 mg/kg (3). Chicken: >1000 mg/kg (3).
Mammalian LC_{50}:	Dietary NOEL >300 ppm (7).
Mammalian Reproduction:	No adverse effects on reproduction in a three-generation study fed dietary concentrations up to 112.5 mg/kg/day (3,9).
Avian LD_{50}:	Bobwhite: =1046 mg/kg (1,2); >500 mg/kg (3); =506.7 mg/kg (4,9). Mallard: >500 mg/kg (3); =427 mg/kg (7). Chicken: =1000 mg/kg (3).
Avian LC_{50}:	Bobwhite: >5000 ppm (3,4,9,10). Mallard: >5000 ppm (3,4,9,10).
Avian Reproduction:	Bobwhite: LOEL =1000 ppm (10), NOEL =1000 (10). Mallard: LOEL =1000 ppm (10), NOEL =1000 ppm (9,10).
Fish LC_{50}:	Bluegill: =2.88 ppm (3,5,8,9,10). Rainbow trout: =2.86 ppm (7); =3.26 ppm (3,5,9,10); =3.355 ppm (8); =3.45 ppm (5,10). Goldfish: =1.4 ppm (3).
Fish ELS/Life Cycle:	Rainbow trout: 21-day chronic NOEC =0.46 ppm (7,9,10). Fathead minnow: MATC =0.22 ppm (9); LOEL =0.43 ppm (10), NOEL =0.22 ppm (10).

Other:	Water flea: EC_{50} =1.5 ppm (5,10); =1.02 ppm (7); =1.4 ppm (9); 21-day chronic NOEC =0.36 ppm (7). Aquatic sowbug: =0.4 ppm (5); =0.7 ppm (8). Scud: =0.19 ppm (5); =0.495 ppm (8). Red Swamp crayfish: =400-10,000 ppm (5). Midge: 28-day chronic NOEC =1.0 ppm (7). Honeybee: oral >100 ug (1,2); =>11ug (3,9,10); =32 ug/bee (7). Blue-green algae: EC_{50} =0.0181 ppm (7); =0.024 ppm (8,10). Green algae: =0.042 ppm (8,9,10). Duckweed: EC_{50} =0.0154 ppm (5,7,8,9,10). Earthworm: LC_{50} >500 mg/kg (7).

Ecological Incident Reports

No reports in references.

Environmental Fate

Water solubility (S_w):	=1.13 mg/L (7); =3.0 mg/L (8).
Soil Mobility (K_{oc}):	=949 ml/g (7); =807 ml/g (8).
Soil Persistence ($t_{½}$):	=20 days (3). Soil photolysis =0.933 days (6,9). Aerobic soil metabolism =63 days (6,8,9). Anaerobic soil metabolism =10 days (6,8,9).
Soil Dissipation (DT_{50}):	=20-120 days (3). Aerobic soil degradation =20 days (7). Field dissipation =68 days in sand soil FL (9); biphasic degradation in silty clay loam soil in MI 77 days and 146 days, and in loam soil in CA 58 days and 138 days (9).
Aquatic Persistence ($t_{½}$):	Hydrolysis =Stable @ pH 5-9 (6,9); =28 days (8) =stable (7). Aquatic photolysis =0.0958 days @ pH 5 (6); =0.21 days @ pH 5 (9); =0.08 days (7).
Aquatic Dissipation (DT_{50}):	Water-sediment =32.7 days (7); water phase only =5.9 days (7).
Potential to Move to Groundwater (GUS score):	=1.33
Volatilization (mm Hg):	$=7.5x10^{-07}$ mm Hg (7).
Octanol-Water Partition Coefficient (K_{ow}):	Kow $=5.37x10^{-3}$ (7).
Bioaccumulation/Biocentration:	**BAF:** Low (7). **BCF:** Edible tissue =37.5; viscera =122; whole body =75.8 (6), =66.1 (7). Bluegill =32.2 edible tissue; =105.7 viscera; =66.1 whole fish (9), >75% depuration within 24 hrs.

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 2.0 lbs. a.i./acre **Croplands/Facilities Maintenance:** 2.0 lbs. a.i./acre
EECs	**Terrestrial (Habitat Management):** 480 ppm **Terrestrial (Croplands/Facilities Maintenance):** 480 ppm **Aquatic (Habitat Management):** 0.552 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.00503 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	=0.10 [0.1]	=0.10 [0.5]
	Mammals	=0.04 [0.1]	=0.04 [0.5]
	Fish	=0.39 [0.05]	=0.39 [0.5]
Chronic	Birds	=0.48 [1]	=0.48 [1]
	Mammals	=0.21 [1]	=0.21 [1]
	Fish	=1.20 [1]	=1.20 [1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	=0.10 [0.1]	=0.10 [0.5]
	Mammals	=0.04 [0.1]	=0.04 [0.5]
	Fish	<0.01 [0.05]	<0.01 [0.5]
Chronic	Birds	=0.48 [1]	=0.48 [1]
	Mammals	=0.21 [1]	=0.21 [1]
	Fish	=0.01 [1]	=0.01 [1]

Justification for Use:	
Specific Best Management Practices (BMPs):	1 application @ 1.5 lbs. a.i./acre/year. Maintain a minimum 25-foot buffer zone between all upland treatment site(s) and the high water mark of the nearest surface water resource(s). Do not apply oryzalin to sites upslope to surface water resources with >10° slope.
References:	[1]_____. 2005 & 2009, respectively. Surflan AS specimen label & MSDS. United Phosphorus, Inc., King of Prussia, PA. 12 and 8 pp., respectively. [2]_____. 2006 & 2009, respectively. Surflan WDG specimen label & MSDS. United Phosphorus, Inc., King of Prussia, PA. 6 & 8 pp., respectively. [3]_____. 1996. EXTOXNET – Pesticide Information Profile, Oryzalin. Web database maintained by Oregon State Univ., Corvallis, OR. [4] Office of Pesticide Programs. 2000. ECOTOX: terrestrial report, pesticide ecotoxicity database. Environmental Fate and Effects Division, USEPA, Washington, D.C. [5] Office of Pesticide Programs. 2000. ECOTOX: aquatic report, pesticide ecotoxicity database. Environmental Fate and Effects Division, USEPA, Washington, D.C. [6] Office of Pesticide Programs. 2000. Pesticide fate database: active Ingredient fate studies. Environmental Fate and Effects Division, USEPA, Washington, D.C. [7]_____. 2009. Pesticide properties database. Agricultural & Environmental Research Unit, Science and Technology Research Institute, University of Hertfordshire, Hatfield, UK. [8]____. 2000. Pesticide database – oryzalin. Pesticide Action Network, San Francisco, CA. [9] Special Review and Reregistration Division. 1994. Reregistration eligibility decision (RED) – oryzalin EPA 738-R-94-016. Office of Prevention, Pesticides and Toxic Substances, U.S. EPA, Washington, D.C. 223 pp. [10]_____. 2000. U.S. EPA one-liner database. Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C.

Table CP.1 Pesticide Name

Active Ingredient = oryzalin

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Surflan AS	H	0.5 gal/acre	2.0	1	0.5 gal/acre	0
Surflan WDG	H	2.35 lbs/acre	2.0	1	2.35 lbs/acre	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

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B-7 Triclopyr Containing Formulations Chemical Profile

Date:	6/14/11		
Trade Name(s):	Garlon 3A, Garlon 4, Pathfinder II, Remedy	**Common Chemical Name(s):**	Triclopyr TEA, Triclopyr BEE, Triclopyr BEE, Triclopyr BEE
Pesticide Type:	herbicide	**EPA Registration Number:**	62719-37, 62719-40, 62719-176, 62719-70
Pesticide Class:	Pyridine carboxylic acid	**CAS Number:**	057213-69-1, 64700-56-7, 64700-56-7, 64700-56-7
Other Ingredients:	**Garlon 3A (triclopyr triethylamine (TEA)):** 3.0% w/w triethylamine (1a), 2.1% w/w ethanol (1a), 50.5% w/w unidentified compounds (1a). **Garlon 4 (triclopyr butoxyethyl ester (BEE)):** 18.6-31.0% kerosene (1b), 0.5% ethylene glycol monobutyl ether (1b), 0.2% naphtha (1b), 6.7-19.1% unidentified compounds (1b). **Pathfinder II (triclopyr BEE):** 86.2% w/w unidentified compounds (1c). **Remedy (triclopyr BEE):** 31% kerosene, 7.4% unspecified (1d). **TCP:** 1st-order degradate (7,8).		

Toxicological Endpoints

Mammalian LD_{50}:	**Acid:** =Rat, oral: =630-729 mg/kg (4,6,7,8,11); >2000 mg/kg (female) (7), =1915 mg/kg (male) (7); =1847 mg/kg (8). Rabbit: =550 mg/kg (4). Guinea pig: =310 mg/kg (4). **TEA:** Rat, oral: >2,000 mg/kg (4); =1847 mg/kg (female) (7), =2574 mg/kg (male) (7). **TCP:** Toxicity similar to parent acid (7).
Mammalian LC_{50}:	Rat, dietary: NOEL=3 mg/kg (11).

Mammalian Reproduction:	**Acid:** 3-generation dietary study, >30 mg/kg/day (4,7). Exposure during gestation (maternal body weight, litter size, fetal body weight), >100 mg/kg/day (4). 2-generation study, LOEL >250 mg/kg (6,8), NOEL =25 mg/kg (6,8). 2-generation dietary study, fertility and neonatal toxicity NOEL =25 mg/kg/day and parental systemic toxicity NOEL =5 mg/kg/day (7). **TEA:** Gestation gavage study, LOEL =300 mg/kg (7), NOEL =100 mg/kg (7). Gestation gavage study, developmental NOEL=100 mg/kg/day (7), embryo-toxicity (dose) NOEL =100 mg/kg/day (7).
Avian LD_{50}:	**Acid:** Mallard: =1698 mg/kg (2,6,7,9,11), NOEL=464 mg/kg (2). **TEA:** Mallard: =3176 mg/kg (2,9), NOEL<215 mg/kg (2); =1698 mg/kg (2,9); =2055 mg/kg (6,7). **BEE:** Bobwhite: =849 mg/kg (9); =735 mg/kg (9).
Avian LC_{50}:	**Acid:** Bobwhite: =2934 ppm (2,6,7,9); =2935 ppm (4,8,9). Mallard: =5620 ppm (2,6,7,9,11); =5000 ppm (8). Coturnix quail: =3272 ppm (2,6,7); Jap quail: =3278 ppm (4,8). **TEA:** Bobwhite: =11,622 ppm (2,6,7,8,9), NOEC=1000 ppm (2). Mallard: >10,000 ppm (2,6,7,8,9), NOEC<4640 ppm (2). **BEE:** Bobwhite: >5620 ppm (9); >5401 ppm (9); =9026 ppm (9). Mallard: >5401 ppm (9). Zebra finch: =1923 ppm (9).
Avian Reproduction:	**Acid:** Bobwhite: LOEL=200 ppm (2,6,7), NOEL=100 ppm (2,6,7); LOEC >500 ppm (6,8), NOEC =500 ppm (6,8). Mallard: LOEL=200 ppm (2,8), NOEL=100 ppm (2,8); LOEL =500 ppm (7), NOEL =200 ppm (7). **TEA:** Bobwhite: LOEL>500 ppm (2), NOEL=500 ppm (2). Mallard: LOEL=200 ppm (2), NOEL=100 ppm (2).
Fish LC_{50}:	**Acid:** Bluegill: =148 ppm (2,4,6,7,8,10); =124 ppm (5). Fathead minnow: =120.0-947 ppm (10). Rainbow: =117 ppm (2,4,6,7,8,11); =5.26 ppm (5); =7.6 ppm (10); =420 ppm (10). Chum: =7.5 ppm (10); =275.0 ppm (10). Chinook: =9.7 ppm (10). Coho: =3.94 ppm (5); =9.6 ppm (10). Pink salmon: =6.1 ppm (10). Sockeye: =3.46 ppm (5); =311.0 ppm (10). Chinook: =5.02 ppm (5). **TEA:** Bluegill: =891 ppm (2), NOEC =560 ppm (2); =471 ppm (2,6,7,8); =681 ppm (5); =893 ppm (6,7,8); =344 ppm (7); =286 ppm (7). Rainbow: =400 ppm (1); =552 ppm (2), NOEC =240 ppm (2); =240 ppm (2,8); =447.3 ppm (5); =613 ppm (6,7,8); =240 ppm (6,7). Coho: =478.2 ppm (5); =400 ppm (7). Sockeye: =321.5 ppm (5). Chinook: =335.5 ppm (5). Channel catfish: =446 ppm (1); =344 ppm (7); =141 ppm (7). Fathead minnow: =546 ppm (2), NOEC=370 ppm (2); =947 ppm (2,6,7,8); =373 ppm (5); =544 (6,7,8); =279 ppm (2,6,7,8), NOEC=98 ppm (2); =891 ppm (7); =400 ppm (7); =245 ppm (7); =120 ppm (7). **BEE:** Rainbow: =2.7 ppm (10); =1.1 ppm (10). Pink salmon: =1.2 ppm (10); =0.5 ppm (10). Chum salmon: =1.7 ppm (10); =0.3 ppm (10). Coho: =2.1 ppm (10); =1.0 ppm (10). Chinook: =2.7 ppm (10); =1.1 ppm (10). Sockeye: =1.4 ppm (10); =0.4 ppm (10). **TCP:** Bluegill: =12.5 ppm (7,8). Rainbow: =12.6 ppm (7,8); =1.5 ppm (7,8). Coho: =1.8 ppm (7,8). Sockeye: =2.5 ppm (7,8).

Fish ELS/Life Cycle:	**Acid:** Fathead minnow: LOEC=162 ppm (2,6,8), NOEC=104 ppm (2,6,8). Species unknown: =46.3 ppm (11). **TCP:** Rainbow: Overall survival LOEC=0.273 ppm (7), NOEC=0.134 ppm (7). Weight and length LOEC=0.134 ppm (7), NOEC=0.0808 ppm (7).
Other:	**Acid:** EC_{50}, *Daphnia*: =132.9 ppm (2,6,7,8); >131 ppm (1,11). 21-day chronic NOEC =48.5 ppm (11). Green algae: =32.5 ppm (2), NOEC=7.0 ppm (2). Duckweed: =2.56 ppm (5); =0.8 ppm (11). Midge: 28 d NOEC=23.0 ppm (11). Honeybee: >100 ppm (11). Earthworm: >521 ppm (11). **TEA:** EC_{50}, *Daphnia*: =132.9 ppm (2), NOEC=32 ppm (2); =775 ppm (2), NOEC<100 ppm (2); =1496 ppm (2,6,7); =1170 ppm (4,7); =1,155 ppm (5); =1110 ppm (7); =1496 ppm (8). ErlyLf: LOEC<149 ppm (2,6,7,8), NOEC>80.7 ppm (2,6,7,8). Green algae: =45 ppm (1); =39.1 ppm (2), NOEC=25 ppm (2). Bluegreen algae: =5.9 ppm (2,8), NOEC=2.0 ppm (2). Duckweed: =6.7 ppm (6), NOEC=0.4 ppm (7); =11 ppm (6,8), NOEC =3.5 ppm (6); =24 ppm (8); =8.8 ppm (8). Amphibian (frog): Species not identified: =162.5 ppm (8).

Ecological Incident Reports

No incident reports in references.

Environmental Fate

Water solubility (S_w):	**Acid:** =435 ppm (3); =440 mg/L (4); =430 mg/L (6,8); =8100 mg/L (11). **TCP:** =49,100 ppm (8).
Soil Mobility (K_{oc}):	=68 mg/L (range =12-160) (3); =62 mg/L(5); =27 mg/L (8); =48 ml/g (11). **TCP:** Koc =151 m/L (8).
Soil Persistence ($t_{½}$):	**Acid:** The predominant degradation pathway in soil is microbial degradation (6). Aerobic soil ½ life =13 days (5); =8-18 days (6); =32 days (3). Anaerobic soil ½ life =1,600 days (5); =1300 days (6). Average soil ½ life = 46 days (30-90 days) (4). **TCP:** (3,5,6-trichloro-2-pyridinol): is a major metabolite of triclopyr acid and is found in both soil and water (7).
Terrestrial Field Dissipation (DT_{50}):	**Acid:** Terrestrial field dissipation: =35 days (range=15-84); =46 days (range=18-84 days) GA, ND, OR, TX, WV, WY) (3). =30 days (11).

Aquatic Persistence ($t_{½}$):	**Acid:** The primary degradation pathway in water is photodegradation (6). Aqueous photolysis: =0.5 day in sterile water and =1.3 day in natural water (6,8); =0.1 days @ pH 7 (11). =8.7 days @ pH 7 (11). Hydrolysis: =Stable (8). Anaerobic aquatic metabolism ½ half = 142 days (6,8). **Salt:** Aquatic ½ life = 0.12-0.5 days (4). **TCP:** (3,5,6-trichloro-2-pyridinol): is a major metabolite of triclopyr acid and is found in both soil and water (7). Aqueous photolysis ½ life = 0.08 days (8). Hydrolysis = Stable (8). Exposure to UV light ½ life = 0.017 days (8).
Aquatic Dissipation (DT_{50}):	Aquatic field dissipation ½ life: =0.5-4.7 days (6,8); <1 to 7.9 days (8). Water-sediment =29.2 days (11); water phase only =24.8 days (11).
Potential to Move to Groundwater (GUS score):	=3.69 (11).
Volatilization (mm Hg):	=0.75 (11).
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Bioconcentration:	**BAF:** Low potential (11). **BCF:** =0.77 (11).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 2 lbs. a.e./acre **Croplands/Facilities Maintenance:** 2 lbs. a.e./acre
EECs	**Terrestrial (Habitat Management):** 480 ppm **Terrestrial (Croplands/Facilities Maintenance):** 480 ppm **Aquatic (Habitat Management):** 0.736 ppm **Aquatic (Croplands/Facilities Maintenance):** 0.0067 ppm

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.25 [0.1]	=0.25 [0.5]
	Mammals	=0.33 [0.1]	=0.33 [0.5]
	Fish	=1.84[1] [0.05] =0.21[2] [0.05]	=1.84[1] [0.5] =0.21[2] [0.5]
Chronic	Birds	=0.96 [1]	=0.96 [1]
	Mammals	=0.96 [1]	=0.96 [1]
	Fish	=0.02 [1]	=0.02 [1]

[1]Triclopyr butoxyethyl ester (BEE)

[2]Triclopyr acid

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.25 [0.1]	=0.25 [0.5]
	Mammals	=0.33 [0.1]	=0.33 [0.5]
	Fish	=0.02 [0.05]	=0.02 [0.5]
Chronic	Birds	=0.96 [1]	=0.96 [1]
	Mammals	=0.96 [1]	=0.96 [1]
	Fish	<0.01 [1]	<0.01 [1]

Justification for Use:	Control of woody plants including salt cedar.
Specific Best Management Practices (BMPs):	Must maintain 25-foot treatment buffer zone from surface water resources, except for cut stump treatments of target woody pest species.
References:	[1a]_____. 2006. Garlon 3A specimen label and MSDS. Dow AgroSciences LLC, Indianapolis, IN. 9 & 5 pp., respectively. [1b]_____. 2007 & 2009, respectively. Garlon 4 specimen label and MSDS. Dow AgroSciences LLC, Indianapolis, IN. 13 & 10 pp., respectively. [1c]_____. 2006 & 2007, respectively. Pathfinder II specimen label and MSDS. Dow AgroSciences, Indianapolis, IN. 4 pp.

[1d]_____. 2010 & 2007, respectively. Pathfinder II specimen label and MSDS. Dow AgroSciences, Indianapolis, IN. 8 & 4 pp., respectively.

[2]_____. 2000. USEPA one-liner database.

[3]_____. 1995. ARS pesticide properties database. USDA-ARS, Washington, D.C.

[4]_____. 1996. Triclopyr. EXTOXNET, Extension Toxicology Network, Pesticide Information Profiles, Oregon State Univ., OR. 4 pp.

[5]_____. 2000. Pesticide database. Pesticide Action Network, San Francisco, CA.

[6]_____. 1988. Reregistration eligibility decision (RED) – triclopyr. USEPA, Prevention, Pesticides, and Toxic Substances, Washington, D.C. 92 pp.

[7]_____. 2003. Triclopyr – revised human health and ecological risk assessments final report. Prepared for: USDA, Forest Service, Forest Health Protection (GSA Contract No. GS-10F-0082F), Arlington, VA by Syracuse Environmental Research Associates, Inc., Fayetteville, NY. 230 pp.

[8] Antunes-Kenyon, S. E. and G. Kennedy. 2004. A review of the toxicity and environmental fate of triclopyr. Massachusetts Dept. of Agric. Res., Boston, MA. 47 pp.

[9] Office of Pesticide Programs. 2000. ECOTOX database – terrestrial report. Environmental Fate and Effects Division, USEPA, Washington, D.C.

[10] Office of Pesticide Programs. 2000. ECOTOX database – aquatic report. Environmental Fate and Effects Division, USEPA, Washington, D.C.

[11]_____. 2009. Pesticide properties database. Agricultural & Environmental Research Unit, Science and Technology Research Institute, University of Hertfordshire, Hatfield, UK.

Table CP.1 Pesticide Name

Active Ingredient = triclopyr

Trade Name[a]	Treatment Type[b,c]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)
Garlon 3A,	H	0.67 gal/acre	2.0 lbs. a.e./acre	1	0.67 gal/acre/season	0
Garlon 4,	H	0.5 gal/acre	2.0 lbs. a.e./acre	1	0.5 gal/acre/season	0
Pathfinder II,	H	2.67 gal/acre	2.0 lbs. a.e./acre	1	2.67 gal/acre/season	0
Remedy	H	0.5 gal/acre	2.0 lbs. a.e./acre	1	0.5 gal/acre/season	0

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

[c] Treatment type is for ecological risk assessment purposes only. The product label will determine whether or not the treatment type is permissible under Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act.

Feral Pig Monitoring and Eradication Plan
for the
San Diego National Wildlife Refuge

December 2016

Prepared by: _____ Date: 12/16/2016
Victoria Touchstone, Refuge Planner

Concurred: _____ Date: December 13, 2016
Jill Terp, Refuge Manager

Concurred: _____ Date: 3/23/17
Refuge Supervisor

Approved: _____ Date: 3.28.17
Assistant Regional Director, Refuges
(Pacific Southwest Region)

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1. Introduction

The presence of feral pigs (*Sus scrofa*) in San Diego County has raised concerns about the adverse effects that their potential spread, both numerically and geographically, could pose on the region's unique natural and cultural resources (Conservation Biology Institute [CBI] 2009). This threat, left unaddressed, would likely result in substantial damage to the significant public and private investments that have been made to conserve native species and lands in accordance with the San Diego Multiple Species Conservation Program (MSCP) and other land conservation programs throughout the region, including the lands acquired for the San Diego National Wildlife Refuge (NWR or Refuge). In response to this threat, an inter-governmental group on feral pig impacts has been formed to develop an "all-lands" approach to dealing with an expanding feral pig population in the San Diego region. To ensure the protection of the natural and cultural resources conserved on the San Diego NWR from this threat, the U.S. Fish and Wildlife Service (Service) proposes to become a partner in this regional effort, joining the various Federal, State, tribal, and local governments and agencies already participating in this group.

In accordance with Service policy, this Feral Pig Monitoring and Eradication Plan, a step-down plan to the San Diego NWR Comprehensive Conservation Plan (CCP), has been prepared to describe the details of future actions to monitor for and control, when deemed necessary, the presence of feral pigs on the Refuge. The potential effects to the human environment of implementing this proposal were analyzed in the draft CCP/environmental assessment (EA) for the San Diego NWR.

2. Refuge Overview

Located in San Diego County, California, the San Diego NWR includes two distinct areas, the Otay-Sweetwater Unit and Del Mar Mesa Vernal Pool Unit (Figure 1). The Otay-Sweetwater Unit, consisting of 11,470 acres (as of August 2013), is located on the eastern edge of the San Diego metropolitan area (Figure 2), while the 60-acre Del Mar Mesa Vernal Pool Unit is located in the northwestern portion of the City of San Diego (Figure 3).

The San Diego NWR was established in 1996 for the purpose of protecting, managing, and restoring habitats for federally listed endangered and threatened species and migratory birds, as well as for maintaining and enhancing the biological diversity of the native plants and animals supported on the Refuge. Over the years, core habitat areas have been acquired for inclusion in the San Diego NWR, supporting a range of upland and wetland habitats. Today, the Refuge plays a critical role in the regional effort to maintain the high biological diversity of southwestern San Diego County. At least 16 species listed as threatened or endangered under the Federal Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) are known to occur on the Refuge or were supported on the Refuge within the last 20 years. Many other species of concern, including species covered by the San Diego Multiple Species Conservation Program (MSCP) (City of San Diego 1998) have also been documented on the Refuge.

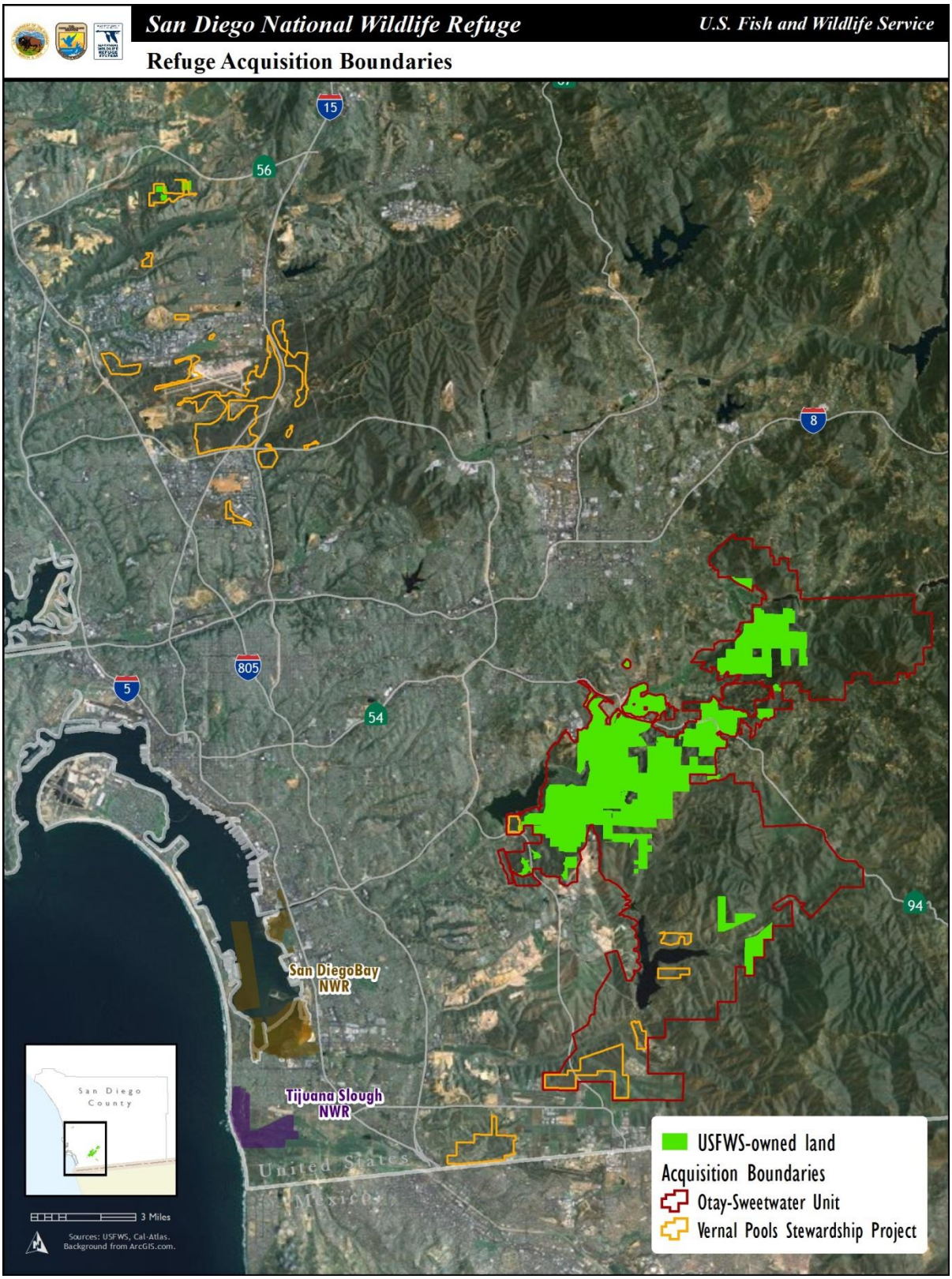

Figure 1. Location Map – San Diego National Wildlife Refuge

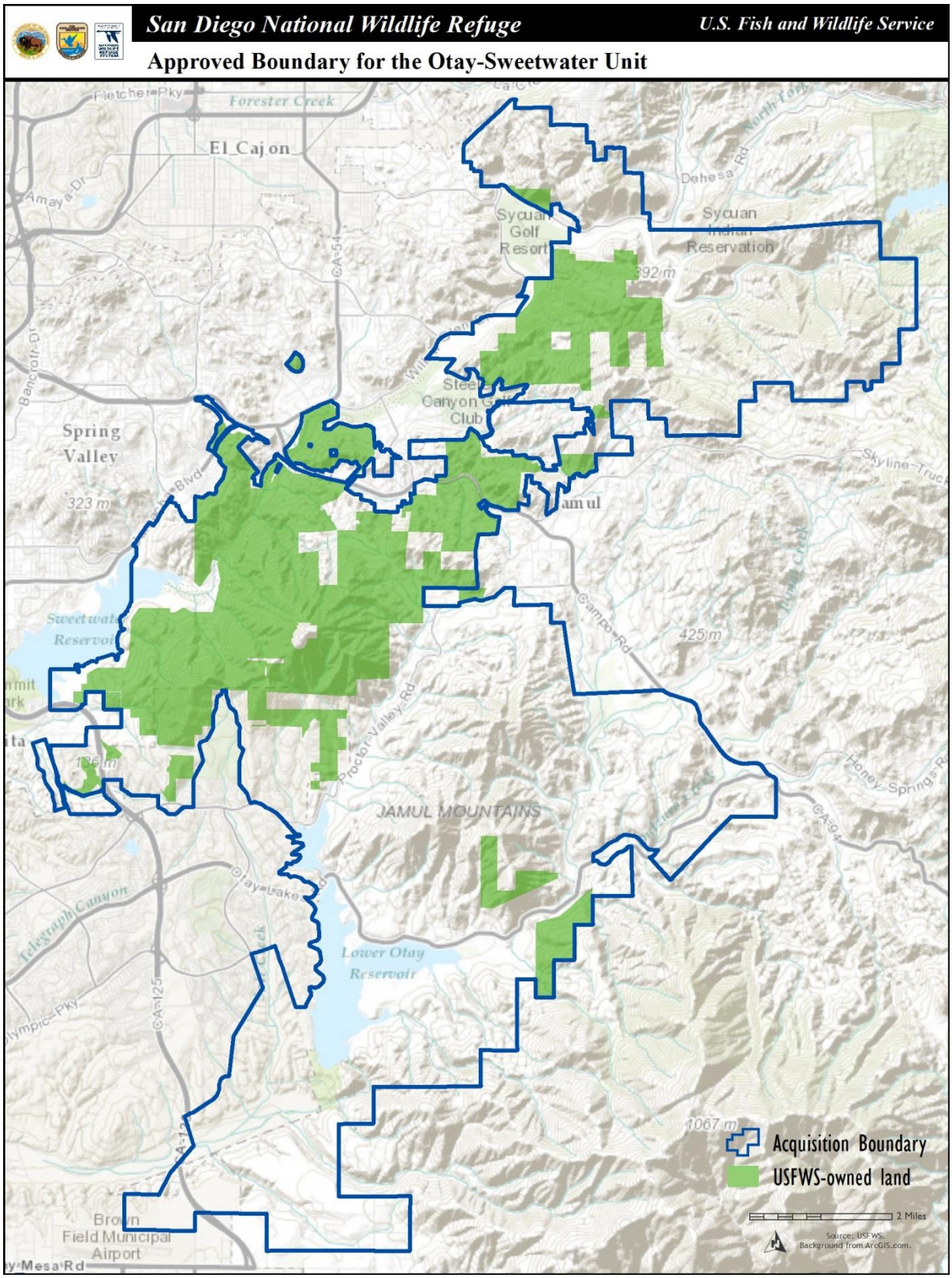

Figure 2. Location Map - Otay-Sweetwater Unit

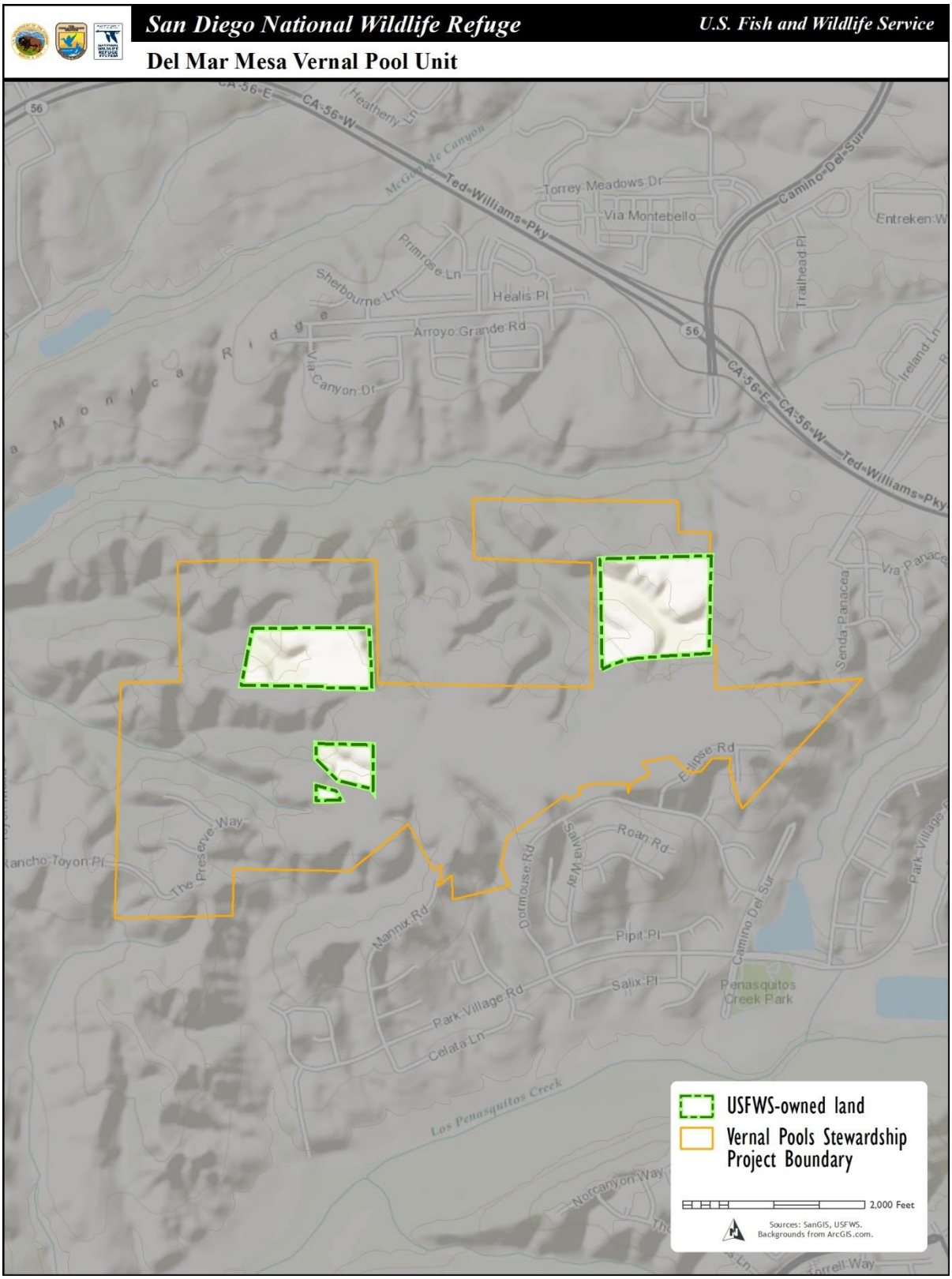

Figure 3. Location Map - Del Mar Mesa Vernal Pool Unit

The initial acquisition that established the San Diego NWR was made under the authorities of: the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884), ". . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species . . . or (B) plants . . .;"the Fish and Wildlife Act of 1956, as amended (16 U.S. C. 742(a)-754), ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . ." [16 U.S.C. § 742f(a)(4)] ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . ." [16 U.S.C. § 742f(b)(1)]; and the Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4) ". . . (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species . . ."

Management of the San Diego NWR is guided by the following goals of the National Wildlife Refuge System (Fish and Wildlife Service Manual, Part 601 FW1, NWRS Mission and Goal, and Refuge Purposes):

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

3. Refuge Resources

Collectively, the lands within the San Diego NWR support a range of habitats including native scrubland, native and non-native grassland (some supporting vernal pools), cottonwood-willow riparian forest, riparian scrub, and oak woodland (Figure 4). As of August 2013, the Refuge supported an estimated 7,700 acres of coastal sage scrub. This vegetation type supports many rare and sensitive species endemic to coastal southern California, including the federally threatened coastal California gnatcatcher (*Polioptila californica californica*) and endangered Quino checkerspot butterfly (*Euphydryas editha quino*). Listed and sensitive species also occupy the Refuge's riparian and oak woodland habitats, as well as the Refuge's highly sensitive vernal pool habitat.

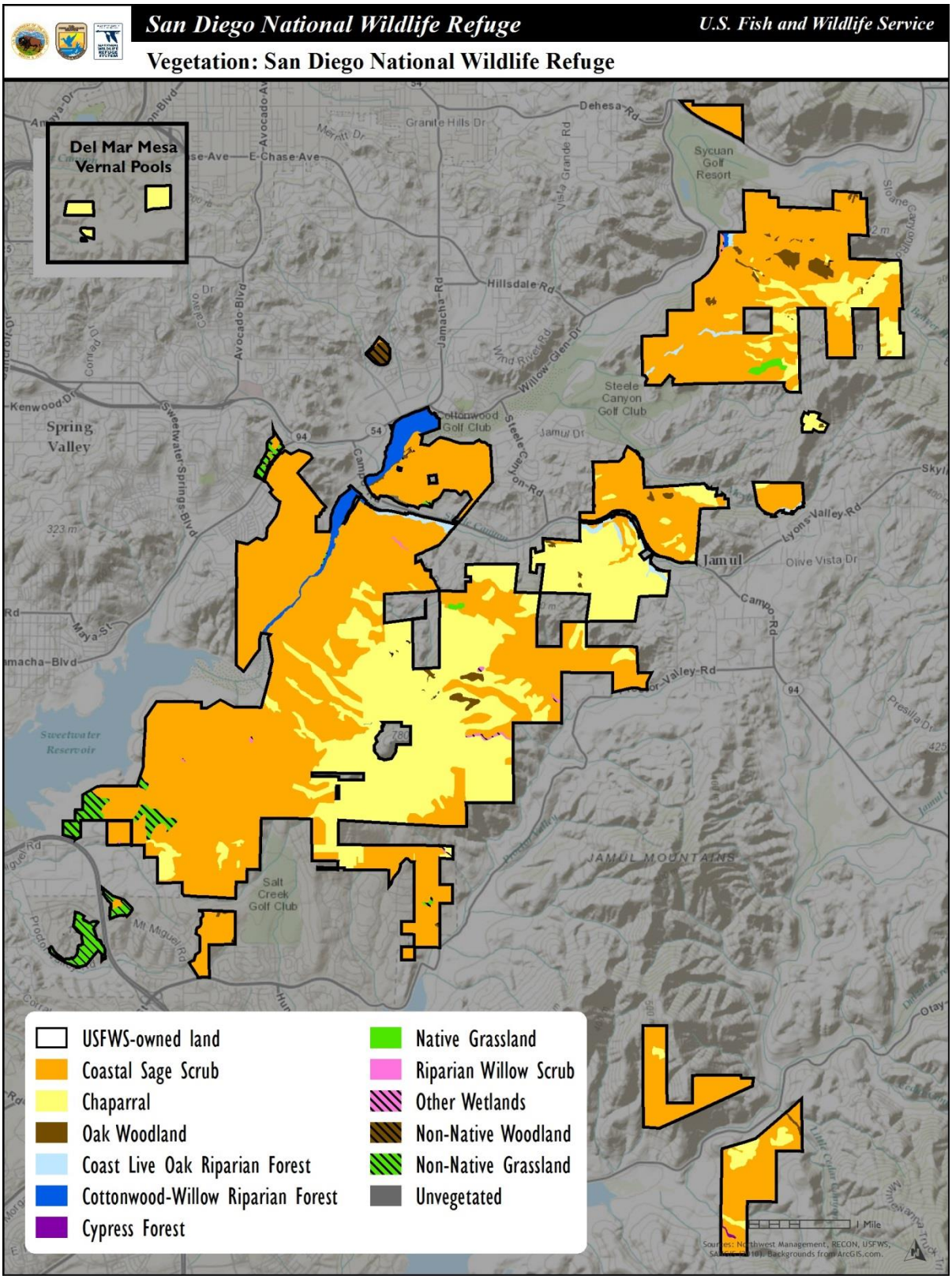

Figure 4. Vegetation Map – San Diego National Wildlife Refuge

The Refuge includes designated critical habitat for one threatened and two endangered bird species, one endangered insect, and four threatened or endangered plants. The Refuge also provides habitat for at least 34 species of plants and animals that are designated as "covered" under the San Diego MSCP. In addition, the San Diego NWR supports six California Bird Species of Special Concern that are not otherwise protected by the MSCP. The Refuge has also been designated an Important Bird Area for California and is known to support over 180 species of birds. Many native plants that have been lost or reduced elsewhere can be found on the Refuge, making it a valuable source for seeds that have been used in restoration projects throughout southern coastal San Diego County.

A list of threatened, endangered, San Diego MSCP-covered, and special status species known to occur or with the potential to occur on the San Diego NWR is presented in Table 1. As illustrated in Figures 5 and 6, large portions of the San Diego NWR are designated as critical habitat for one or more federally listed endangered species.

Table 1
Special Status Species Known to Occur or with the Potential to Occur on the Refuge

Scientific Name	Common Name	Status[1]
Crustaceans		
Branchinecta sandiegonensis	San Diego fairy shrimp	FE, M
Insects		
Euphydryas editha quino	Quino checkerspot	FE
Lycaena hermes	Hermes copper	FC
Amphibians		
Anaxyrus californicus	Arroyo toad	FE, M, CSC
Spea hammondii	Western spadefoot toad	CSC
Reptiles		
Emys marmorata pallida	Southwestern pond turtle	M, CSC
Cnemidophorus hyperythrus beldingi	Orange-throated whiptail	M, CSC
Phrynosoma coronatum	San Diego horned lizard	M, CSC
Eumeces skiltonianus interparietalis	Coronado Island skink	CSC
Salvadora hexalepis virgultea	Coast patch-nosed snake	CSC
Crotalus ruber ruber	Red diamondback rattlesnake	CSC
Birds		
Branta canadensis	Canada goose	M
Pelecanus erythrorhyncos	American white pelican	CSC
Circus cyaneus	Northern harrier	M, CSC
Accipiter cooperii	Cooper's hawk	M
Buteo swainsoni	Swainson's hawk	M
Buteo regalis	Ferruginous hawk	M, CSC
Aquila chrysaetos	Golden eagle	M, CFP

Scientific Name	Common Name	Status[1]
Elanus leucurus	White-tailed kite	CFP
Falco peregrinus	Peregrine falcon	M, CFP
Athene cunicularia hypugea	Western burrowing owl	M, CSC
Empidonax traillii extimus	Southwestern willow flycatcher	FE, M
Coccyzus americanus occidentalis	Yellow-billed cuckoo	FC, CE
Lanius ludovicianus	Loggerhead shrike	CSC
Campylorhynchus brunneicapillus	Cactus wren	M, CSC
Polioptila californica californica	Coastal California gnatcatcher	FT, M, CSC
Sialia mexicana	Western bluebird	M
Vireo bellii pusillus	Least Bell's vireo	FE, M
Dendroica petechia brewsteri	Yellow warbler	CSC
Icteria virens	Yellow-breasted chat	CSC
Ammodramus savannarum	Grasshopper sparrow	CSC
Aimophila ruficeps canescens	Southern California rufous-crowned sparrow	M
Agelaius tricolor	Tricolored blackbird	M, CSC
Mammals		
Eumops perotis californicus	Western mastiff bat	CSC
Nyctinimops femorosaccus	Pocketed free-tailed bat	CSC
Neotoma lepida intermedia	San Diego desert wood rat	CSC
Taxidea taxus	American badger	M, CSC
Felis concolor	Mountain lion	M
Odocoileus hemionus fulginosus	Southern mule deer	M
Plants		
Acanthomintha ilicifolia	San Diego thornmint	FE, M, CE
Ambrosia pumila	San Diego ambrosia	FE, M
Arctostaphylos glandulosa ssp. *crassifolia*	Del Mar manzanita	FE, M
Arctostaphylos otayensis	Otay manzanita	M
Baccharis vanessae	Encinitas baccharis	FT, CE, M
Calochortus dunnii	Dunn's mariposa lily	M, CR
Ceanothus verrucosus	Wart-stemmed ceanothus	M
Cupressus forbesi	Tecate cypress	M
Dudleya variegata	Variegated dudleya	M
Ericameria palmeri var. *palmeri*	Palmer's goldenbush	M
Eryngium aristulatum var. *parishii*	San Diego button celery	FE, M, CE
Ferocactus viridescens	San Diego barrel cactus	M
Deinandra conjugens	Otay tarplant	FT, M, CE
Lepichinia ganderi	Gander's pitcher sage	M
Monardella hypoleuca ssp. *lanata*	Felt-leaved monardella	M

Scientific Name	Common Name	Status[1]
Muilla clevelandii	San Diego goldenstar	M
Navarettia fossalis	Spreading navarettia	FT, M
Nolina interrata	Dehesa beargrass	M, CE
Cylindropuntia californica var. *californica*	Snake cholla	M
Orcuttia californica	California Orcutt grass	FE, M, CE
Pogogyne abramsii	San Diego Mesa mint	FE, M, CE
Pogogyne nudiuscula	Otay Mesa mint	FE, M, CE
Satureja chandleri	San Miguel savory	M
Senecio ganderi	Gander's butterweed	M
Tetracoccus dioicus	Parry's tetracoccus	M

[1] FE: Federally Endangered; FT: Federally Threatened; FC: Candidate for Federal listing as Threatened or Endangered; M: covered by the San Diego Multiple Species Conservation Program; CE: California State Endangered; CR: California State Rare; CT: California State Threatened; CSC: California Species of Special Concern; CFP: California Fully Protected.

4. Background and Need for the Plan

Status of Feral Pigs in San Diego County. Feral pigs are a non-native species known to occur in California and throughout the United States. These wild populations can consist of escaped domestic stock, introduced European wild boar, or a hybrid of both types. They are considered an invasive species in California and the rest of the Americas (California Department of Parks and Recreation [CDPR] 2013).

In the 1990s, San Diego County was considered free of feral pigs, however, over the past several years, feral pigs have been introduced into native habitat areas by people, either intentionally or inadvertently, with several populations now occurring in the Cleveland National Forest to the east of the Refuge. Based on data being collected by ground surveys, habitat mapping, and modeling, in 2013, the feral pig population in San Diego County was estimated at between 300 and 500 animals (CDPR 2013).

Status of Feral Pigs on the San Diego NWR. As of May 2016, feral pigs were not known to be present on any lands within the San Diego NWR, but modeling of the geographic expansion of pig distribution in San Diego County predicts that pigs inhabiting oak woodland and chaparral in and around the Capitan Grande Indian Reservation have the potential to reach the Refuge within one to two dispersal events (CBI 2009). It is not clear however how frequently pigs cross suboptimal habitat to colonize new areas of high-quality habitat; thus, it is difficult to accurately predict when pigs might be likely to colonize the Refuge.

Effects of Feral Pigs on the Environment. Feral pigs are habitat generalists, meaning they can be found in a variety of habitats and are very adaptable. As opportunistic omnivores, feral pigs will eat almost anything. Their diet consists primarily of plants (e.g., roots, tubers, fruit, acorns), but they will also eat worms, insects, small mammals, eggs, and young of ground-nesting birds and reptiles.

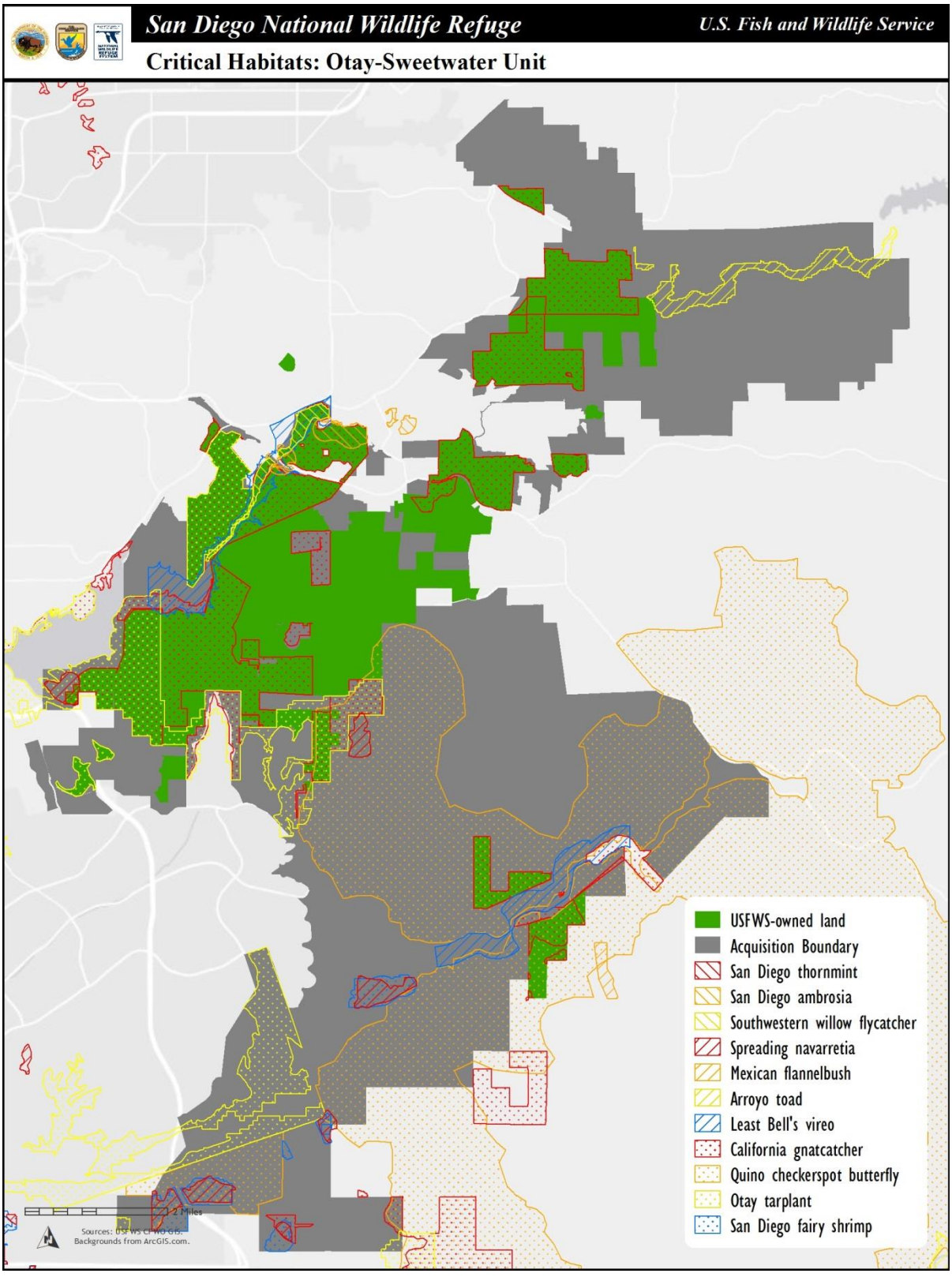

Figure 5. Critical Habitat Areas – Otay-Sweetwater Unit

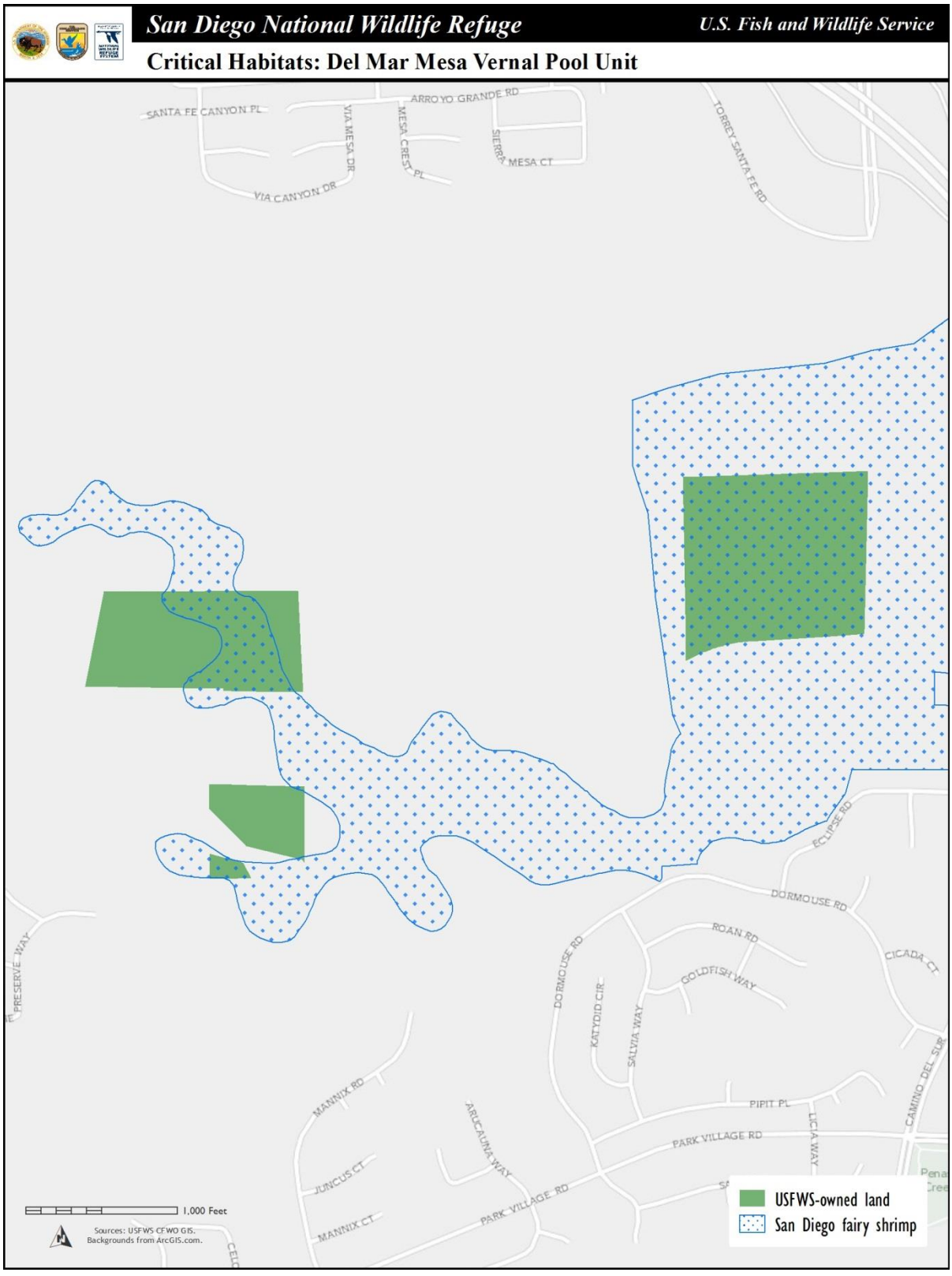

Figure 6. Critical Habitat Areas –Del Mar Mesa Vernal Pool Unit

Their foraging habits include turning up the soil with their snouts while rooting for food. They also create wallows in riparian and oak grassland habitats. Both activities physically disturb soils and associated resources (e.g., plants, animals, cultural resources) (Sweitzer and Van Vuren 2002, 2008), representing a serious threat to the region's native ecosystems. On the Refuge, oak woodlands, native grasslands, riparian areas, and vernal pool habitat, all of which support listed and sensitive species, are at risk of substantial disturbance should feral pigs colonize the Refuge.

Reduced oak regeneration has been documented in areas where feral pigs are present, most likely because they consume large quantities of acorns (Sweitzer and Van Vuren 2002, 2008). Given current declines in populations of coast live oak due to stressors such as increased wildfire frequency, drought, and the spread of the goldspotted oak borer, further stress caused by pigs could present a significant problem for oak woodlands within San Diego County and on the Refuge.

Cushman et al. (2004) hypothesized that vegetation changes due to pig rooting and wallowing provide greater opportunities for exotic grass colonization. The presence of these grasses threatens a range of habitats including coastal sage scrub, vernal pools, and native grasslands. Pigs can also compete with or prey on native wildlife and game species. Habitat damage in sensitive areas may have a negative impact on numerous listed and sensitive species, as well as game species such as deer. Pigs may also destroy the nests, eggs, and offspring of ground-nesting birds, such as northern harrier, and can impact other animals directly or indirectly. Sensitive butterfly larvae are also vulnerable to disturbance caused by feral pigs.

Feral pigs can grow quite large and depending on available food resources can weigh as much 250 pounds. Due to their large size, feral pigs have few predators. They are sexually mature at six months of age and can have up to two litters a year with an average litter size of three to eight piglets with a high of up to 12 piglets (CDPR 2013). Once present in an area, feral pig populations can grow rapidly, and dispersal can result in pigs quickly colonizing and populating new areas (Waithman et al. 1999). Throughout the U.S., feral pigs cause serious damage to habitat, competition with native species, negative impacts to drinking water quality, damage to agriculture and rangelands, destruction of archeological sites, and transmission of diseases to livestock and humans.

Feral pig activity has been known to impact water quality in reservoirs and streams by increasing turbidity (sediment and nutrient loading due to rooting and wallowing activities). Feral pigs can also increase bacterial contamination. The potential exists for increased fecal coliform concentrations (at levels exceeding human health standards) in waters located downstream of areas supporting feral pigs. If pigs were to become established on the Refuge, water quality in the Sweetwater River and Sweetwater Reservoir could be adversely affected. Feral pigs also carry diseases such as brucellosis and psuedorabies, which can impact livestock, as well as human health.

Opportunities for Control. In recent years, feral pig populations in San Diego County have been growing as expected during the early phase of an introduction (San Diego Natural History Museum [SDNHM] 2010). Survey results suggest that the feral pig population in San Diego County remains isolated from populations to the north (i.e., Riverside and Los Angeles Counties) and to the south in Baja Mexico (SDNHM 2010). Due to this isolation, it is still possible to eradicate the feral pig population in San Diego County. Through the establishment of a monitoring program to tract pig movement near the Refuge, it may also be possible to stop the establishment of a feral pig population on the Refuge through rapid response and removal of pigs around the perimeter of the Refuge.

Trapping efforts have occurred in San Diego County on private lands. These efforts have resulted in notable decreases to feral pig damage in certain areas. For example, trapping occurred on Vista Irrigation District lands near Lake Henshaw in 2011 (USDA Forest Service 2013). There was a notable decrease in feral pig sign on Palomar Mountain following the trapping effort. Feral pig damage has also been reduced in the Upper San Diego River, most likely due to trapping efforts on adjacent private ranchlands and hunts organized by the Barona Tribe on the Capitan Grande Indian Reservation. These efforts demonstrate that a desirable decrease in feral pig damage can occur as the result of actions to reduce pig populations (USDA Forest Service 2013).

A good deal of research has attempted to relate rooting disturbance to feral pig density or abundance (Hone 1988, Vtorov 1993, Choquenot et al. 1996). Results of these studies suggest a curvilinear relationship between pig density and rooting disturbance. In other words, a moderate reduction (20 to 30 percent) in pig density may lead to little or no reduction in damage, whereas a reduction of 40 to 50 percent may significantly reduce rooting in an area (CDPR 2013).

A working group of scientists and land managers for numerous Federal, State, tribal, and local governments and agencies in San Diego County has analyzed a number of options for managing feral pigs in San Diego County. One of these options, a “systematic campaign,” would involve participating agencies, tribes, and organizations adopting common goals, a unified strategy, and a jointly supported leadership model. The underlying goal of most feral pig eradication and control efforts is to reduce or eliminate rooting-related disturbance caused by pigs in the local native ecosystem.

5. Project Purposes

The purposes of the Feral Pig Monitoring and Eradication Plan for the San Diego NWR are to minimize the potential for the dispersal of feral pigs onto the Refuge and, if necessary, to eliminate or significantly reduce feral pig numbers on the Refuge to minimize damage to natural and cultural resources. While successfully stopping feral pigs from populating the Refuge or eradicating them once detected is preferable, it may not be possible. Therefore, controlling and reducing feral pig populations on the Refuge would also meet the purposes of this plan.

Another purpose for preparing this plan is to complete the necessary planning steps and required analysis under the National Environmental Policy Act (NEPA) to enable the Service to become a participant in the Inter-Governmental Group on Feral Pig Impacts (Group) that has been formed in San Diego County. The objectives of the Group are to protect endangered and threatened species and habitats, natural ecosystems, watersheds, source water, human health, agriculture, and public and private property by conducting a feral pig eradication and control project that would involve public agencies, tribes, and participating organizations adopting common goals through a unified strategy.

The Federal, State, tribal, and local governments and agencies participating in the Group propose to implement an integrated feral pig damage management approach wherein the most effective, selective and environmentally desirable method or combination of methods allowed would be tailored to site specific field conditions. Based on variables encountered in the field such as location, topography, land uses, vegetation type, and numbers of pigs, the members of the Group would decide which of the allowable control methods would be most suitable for their own jurisdictions. The proposed action can be implemented at different levels of intensity depending on the amount of funding that is received to carry out the effort. To become a member of the Group will require signing a Memorandum of Understanding that addresses the funding sources and goals and strategies necessary to eradicate and control feral pig impacts in San Diego County.

Specific objectives of the Refuge Step-down Plan:

- Avoid impacts to federally and State listed endangered and threatened species and other species of concern by working in partnership with others to eliminate or reduce to manageable levels the feral pig populations in San Diego County.
- Minimize the potential for impacts to native habitats and species by rapidly initiating planned actions to eliminate feral pigs should they be identified on the Refuge.

6. Consistency with Pest Management Laws and Policies

In accordance with 569 FW 1 (Integrated Pest Management) of the Service Manual, plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System can be controlled to assure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Vertebrate pest control on Federal (refuge) lands is also 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.); Food Quality Protection Act of 1996 (7 USC 136); Executive Order 13112; and Animal Damage Control Act of 1931 (7 USC 426-426c, 46 Stat. 1468).

Department of the Interior (Department) policy 517 DM 1 (Integrated Pest Management policy) defines pests as "…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety,"

and defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Similarly, Service policy 569 FW 1 defines pests as "…invasive plants and introduced or native organisms that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety."

Applicable elements of the Service's pest management policy include: 1) promote and adopt pest prevention as the first line of defense by using a pathway management strategy to prevent unintended spread of species and biological contamination; and 2) focus on conserving more pristine habitats, monitor these areas, and protect them from invaders. Service policy also states that we will manage pests if:

- The pest is causing a threat to human health and wellbeing or private property, the acceptable level of damage by the pest has been exceeded, or State or local government has designated the pest as noxious;
- The pest is detrimental to resource objectives as specified in a refuge resource management plan (e.g., CCP, habitat management plan); and
- The planned pest management actions will not interfere with attainment of resource objectives or the purposes for which a refuge was established.

Control of animal species identified as damaging or destroying Federal property and/or considered detrimental to the management program of a refuge is also permitted as described in 50 CFR 31.14 (Official Animal Control Operations).

The specific justifications for pest management activities on the San Diego NWR include:

- Protecting human health and safety;
- Preventing substantial damage to important Refuge resources, including federally listed threatened and endangered species and cultural resources;
- Protecting newly introduced or reestablished native species;
- Controlling non-native (exotic) species in order to support existence for populations of native species; and
- Providing the public with quality, compatible wildlife-dependent recreational opportunities.

Recovery plans for various endangered and threatened species present on the San Diego NWR list invasion by exotic species as a major threat to the listed species. Achieving the Refuge's establishment purpose of protecting, managing, and restoring habitats for federally listed endangered and threatened species and migratory birds and maintaining and enhancing the biological diversity of native plants and animals will entail reduction of deleterious effects (e.g., disturbance, competition, predation, alteration of ecological processes) that are known to be caused by feral pigs.

The control of feral pigs conforms to Refuge goals presented in the San Diego NWR CCP, as well as the following objective:

> Objective 2.8: Control Invasive Non-native Species
>
> Over the life of the CCP, implement an integrated approach to pest management to reduce the percent coverage of non-native, invasive forbs, grasses, woody shrubs, and trees by at least 20 percent in areas of relatively intact shrubland; remove at least 90 percent of all large non-native woody shrubs and trees from cottonwood-willow riparian forest and oak riparian forest; and implement actions when necessary to address other pests including insects, such as shot hole borers, feral pigs, and at least 80 percent of the wild turkeys from the Otay-Sweetwater Unit.

Controlling feral pigs on the Refuge and throughout the region is consistent with the objectives of the San Diego MSCP (City of San Diego 1998) and the Land Use Adjacency Guidelines for the City of San Diego's MSCP Multi-Habitat Planning Area (MHPA) (City of San Diego 1997). Actions to control feral pigs would also support the goals of the California Partners in Flight Bird Conservation Plans for Coastal Scrub and Chaparral, Grasslands, Oak Woodlands and Riparian habitats, as well as assist the Refuge in maintaining its status as an Important Bird Area of California.

7. Proposed Action

This Feral Pig Monitoring and Eradication Plan is generally consistent with the feral pig eradication plan developed by the Forest Service (USDA Forest Service 2013) and California Department of Parks and Recreation (CDPR 2013) for the San Diego region. It is the Service's intent to become an active participant in the inter-governmental group on feral pig impacts. This group has developed Principles of Understanding to work together to address feral pig impacts in San Diego County and to develop an "all-lands" approach to dealing with the feral pig population. The feral pig working group, which includes a representative from the Carlsbad Fish and Wildlife Office, was established for key participants from multiple agencies in the San Diego region to come together to share knowledge and develop strategies for dealing with the feral pig population in the County across jurisdictional boundaries. Upon approval of this plan, the Refuge would have the option of signing a Memorandum of Understanding to participate in this "all-lands" approach.

The proposed action to monitor and control feral pigs on the Refuge is an integrated feral pig damage management approach wherein the most effective, selective, and environmentally desirable method or combination of methods allowed under this alternative would be tailored to site-specific field conditions. Based on variables encountered in the field such as location, topography, land uses, vegetation type, and numbers of pigs, the Service would decide which of the allowable control methods would be most suitable for implementation on the Refuge. The proposed action can be implemented at different levels of intensity depending on the

amount of funding that is received to carry out the effort. Project activities and control methods are described below.

The initial steps of this Refuge step-down plan include:

- Keeping apprised of current trends in feral pig dispersal and colonization within the region;
- Establishing agreements for controlling feral pigs on the Refuge well in advance of determining that their presence on the Refuge is imminent; and
- Periodically inspecting Refuge lands for evidence of feral pig activity, adjusting the frequency of these inspections based on current sighting information in the area and regional survey results.

Should the presence of pigs be verified on Refuge lands, immediate action would be taken to begin eradication to ensure that a pig population is not established on the Refuge. As part of this action, the location(s) and level of infestation would be determined and the extent of resource (e.g., biological, cultural, watershed) damage, if any, would be documented. This information would be provided to our regional partners to assist in prioritizing control actions and determining the appropriate method of control.

The project activities and control methods described here are consistent with those described by the Forest Service (USDA Forest Service 2013) and the California Department of Parks and Recreation (CDPR 2013) to address actions to be taken under the "all-lands" approach. The same actions could be implemented by the Refuge independent of the "all-lands" approach should the Service choose not to become part of the larger group.

A. Inventory Feral Pig Populations and Areas of Resource Damage

The Inter-Governmental Group on Feral Pig Impacts has been gathering data throughout the region to assist in tracking and estimating the total pig population. In addition, areas that have been damaged by feral pigs are mapped and the extent of damage described. Feral pig location data has been acquired by ground surveys, habitat mapping and modeling, and a review of existing documentation concerning the location of feral pig populations. Future efforts to identify the location of pigs may include trail cameras, which can be used to track size and habits of sounders of pigs (a family group of pigs made up of sows, typically related and representing about three generations, and their piglets). Use of radio-collared "Sentinel Pigs" may also occur, which would involve capturing feral pigs, outfitting them with radio collars and GPS units and releasing them so that they may be tracked and potentially reveal locations of additional animals. All this information will help concentrate trapping and hunting efforts in key areas and make those efforts as effective as possible.

On the Refuge, staff will conduct periodic surveys looking for signs of feral pig activity. Contact with other land managers will also be maintained to track pig sightings on nearby

lands. If pig activity is identified on the Refuge, staff will respond immediately to initiate the control methods that follow.

B. Removal of Feral Pigs

Three methods would be employed to remove feral pigs from public lands within the project area. The methods, which would be implemented by professional animal control personnel such as staff the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture, will be used strategically and in coordination to maximize the reduction in feral pig numbers. Most, if not all, animals will be removed by trapping, with professional ground-based marksmen used to pursue and shoot (dispatch) "trap-averse" animals after trapping efforts have taken place. Trapping has already proved to be an effective way to reduce feral pig impacts in San Diego County. Although unlikely to occur on the Refuge, aerial dispatch (shooting from helicopters) could be utilized in remote locations that are difficult to access on foot. This option would only be used to pursue animals or sounders that are difficult to trap. Aerial dispatch would be the least used feral pig removal method, but may be necessary to completely clear some areas of feral pigs.

Trapping

Trapping is expected to be the largest part of feral pig damage control effort on Federal lands. In general, corral style traps large enough to hold multiple animals will be utilized in areas frequented by pigs. Open corral-style traps allow large non-target wildlife such as deer to escape. Other trapping options include drop-nets, cage traps, and/or box traps. Traps would be checked on a daily basis. It is expected that no more than 20 to 30 traps would be in use at any one time and these would be located throughout the project limits. The number of traps utilized would be based on the population of feral pigs in a treatment area. The size of traps may be up to 20 feet wide by 20 feet long.

Determinations as to where traps will be located will be based on the results of ongoing efforts to monitor pig populations and their impacts. They will likely be set near water sources, riparian areas, or groves of oak trees where pigs are likely to congregate and forage. Traps will be set to avoid resource damage within areas of sensitive biological, cultural, or watershed resources (e.g., wetlands, riparian zones). Trapping in areas easily accessible by or visible to the public will be avoided as much as possible. If an important trapping location is used that is accessible or visible by the public, there may be a need for small-scale temporary closures of some areas. Installation of traps may involve minor ground disturbance associated with the installation of fence t-posts and anchors, as well as the activity of the pigs themselves while they are inside the traps. Traps will be baited with grain or other food attractive to feral pigs.

Trapping locations in remote areas may be logistically supported by helicopter as needed. Trapping may also be supported by limited use of packstock when feasible. Stock would be restricted to designated trails.

All proposed trapping locations on the Refuge would be flagged on the ground and GPS locations provided to Service archaeological and biological staff. Using GIS location data for proposed trapping locations, Service archaeologists and biologists would complete a records review and field survey, if necessary, to ensure that trapping locations are not located within a cultural resource site, or a site that may have deleterious effect on sensitive species.

Humane treatment of captured feral pigs will be emphasized throughout the control program. During all capture operations, traps would be set in the afternoon/evening and checked early the following morning to avoid the possibility of feral pigs overheating in traps prior to the arrival of a technician for dispatch. Captured pigs would be dispatched quickly by gunshot to the head. For scientific purposes and for evaluating the progress of the control effort for changes in population age structure, basic biological data will be collected. After dispatch, all carcasses will be removed as soon as possible and transported to another location for disposal in compliance with California Department of Fish and Wildlife codes and regulations and any other applicable laws and regulations. Blood and tissue remaining in or around the traps will be covered with soil or diluted with water to avoid attracting other wildlife.

During the first intensive trapping session, all traps will be set for captures for a minimum of five consecutive nights. Traps should then be locked open and prebaited for five to seven days prior to being set for another five-day capture period. Traps would typically be in one place no longer than two or three weeks to avoid acclimatizing pigs to the traps in those locations. Successive pre-baiting and capture periods would continue for the duration of the trapping session.

Technicians/contractors would move traps to new locations when no additional captures are being made in an area. If large numbers of non-target wildlife that would be unable to escape the set trap were observed accessing the bait, the trap would be moved. At the end of the first session of intensive trapping, all traps would be removed from trapping locations, cleaned, repaired, and stored until the second trapping session. After the initial intensive trapping phase, both professional contract dispatchers and agency personnel would actively track and dispatch pigs during regular surveys in the project areas. This phase may also include tracking with dogs and aerial dispatch utilizing helicopters. Periodic surveys for fresh rooting disturbance would be used to assist trackers in locating areas with active groups of feral pigs.

Ground Dispatch, Potentially with Trained Dogs

Ground dispatch utilizing professional marksmen will systematically cover terrain and work through each drainage basin to ensure no pigs are missed. The marksmen will work closely with their trained dogs. The dogs will be trained to bark and corner pigs, but trained not to attack them nor harass wildlife. Dogs will be outfitted with radio collars and/or GPS units so marksmen will be aware of their locations at all times. Once cornered, pigs would be shot by the marksman. Ground operations may be logistically supported by helicopter as needed and would include landing in remote locations. Limited use of packstock to support ground operations may occur when feasible. Packstock would be restricted to designated trails. Night dispatch with the use of night vision technology may occur.

Aerial Dispatch with Helicopters

Aerial dispatch (as allowed under law) would involve a helicopter with a professional marksman systematically covering the terrain with precision low altitude flights and working through each drainage basin searching for pigs. Helicopter landings in remote locations during these activities may be needed. Feral pigs are active in the mornings and evenings, so most flights are likely to occur during those times. Aerial dispatch would typically occur in remote locations that are inaccessible by roads. To ensure public safety and minimize noise impacts, buffer zones of ½ mile would be established around communities and residential subdivisions; buffer zones of 1,000 feet would be established around private lands and other facilities. Areas actively undergoing aerial dispatch activities may be temporarily closed to the public to protect public safety. When pigs are found, they would be quickly dispatched by lethal rifle shots. Individual carcasses may be left in place to decompose; multiple carcasses in the same area may be removed by helicopter and disposed of off-site, if feasible.

C. Temporary Fencing

Short spans (less than 500 feet in length) of temporary fencing (typically 4x4 hog wire fence) may be constructed within the project area to restrict or funnel movement of feral pig populations during trapping, and search and dispatch activities to enhance the effectiveness of those efforts. Fencing may also be used to protect environmentally sensitive areas from feral pig damage. Feral pig fences would be constructed with openings at ground level so as not to restrict the movement of rodents, other small mammals, and wildlife. In addition, all temporary fencing would be installed as to not preclude migration patterns of any large mammals.

D. Monitoring

As described previously, basic biological information from trapped or dispatched pigs will be obtained. After locations have been cleared of feral pigs, these areas would be regularly monitored for up to five years to ensure the pigs have truly been eliminated and do not return. Subsequently, intermittent long-term monitoring would continue indefinitely in case the animals are re-introduced to the area. Monitoring methods could involve the use of trail cameras and visual surveys of likely use areas for signs of fresh rooting. Use of local volunteer organizations would be an important component of both short-term and long-term monitoring efforts. In the event feral pigs are found in an area in which they were believed to have been eliminated, trapping, and search and dispatch activities would resume in that location.

E. Adaptive Management

If after 5 years of intensive efforts, resource impacts from feral pigs have not been eliminated from the project area, then project goals shall be re-evaluated. If it is determined at that time that elimination of feral pig impacts from the project area is not a practical objective, then efforts would be changed to focus on reducing, rather than eliminating, environmental impacts of feral pigs by decreasing their numbers to the extent possible.

F. Public Safety

Public and worker safety will be a top priority during all feral pig management activities. Professional marksmen are highly trained individuals who will only take shots when a target is visible and identifiable. If operations need to occur in an area with public access, there may be temporary trailhead or road closures. Any signage posted will be in English and Spanish and will use standard universal symbols to express the closure.

Aerial dispatch operations are generally going to occur in very remote areas with little to no public access. All special use permittees in an area where professional marksmen (including aerial dispatch) may occur will be notified prior to commencing dispatch activities. Aerial dispatch will not by conducted during extreme fire weather conditions, and helicopters will only operate at altitudes and under weather conditions that are considered safe for the operations being conducted.

G. Helicopter Flight Paths and Landing Areas

Helicopter flight paths and landing areas would be screened for effects on threatened, endangered, and sensitive species to avoid negative impacts to those resources. Monitoring of nest locations for golden and bald eagles would occur annually. This information would be used to establish operating buffers and seasonal use restrictions for helicopters around active nest sites. Helicopter landing areas would be located in existing openings in vegetation and in previously disturbed locations. No improved landing areas would be constructed.

8. Conservation Measures

The following conservation measures will be implemented as part of the selected alternative to avoid negative effects to resources and public safety as a result of implementation:

- Pre-Activity Surveys for Feral Pig Damage and Focused Removal Efforts: Prior to initiation of feral pig removal activities, surveys will be carried out to identify specific locations being impacted by feral pigs. Pig removal efforts will be highly focused and limited to such areas.
- Trap Placement and Vegetation Trimming: Proposed trap locations and vegetation trimming activities will be screened and/or surveyed to ensure that no ground disturbance or vegetation removal is proposed that could impact an archeological site or would result in disturbance within or damage to designated critical habitat, sensitive vegetation communities, or other habitat supporting threatened, endangered, and sensitive species. Traps may be placed in riparian areas, but will not be placed directly in or directly adjacent to stream channels to avoid water quality impacts. In addition, no riparian vegetation will be destroyed or removed. No trapping or helicopter flights will be permitted within 6,000 feet of known bald eagle or golden eagle nesting or wintering sites during the species' nesting or wintering seasons. Trap placement will avoid areas visible from recreation facilities, trails, and roads to protect recreation resources and avoid potential vandalism. A qualified biologist will periodically visit active trapping sites to ensure that all practicable measures are being employed to avoid incidental disturbance of stream habitat and any listed or sensitive species.
- Lead Free Ammunition: To avoid lead contamination and the potential for adverse effects to wildlife, only lead-free ammunition will be used during aerial and ground dispatch and the euthanization of trapped pigs.
- Aerial Dispatch: Although this practice may not be necessary on the Refuge, if helicopter use is required to control pigs in remote portions of the Refuge, helicopter operation would not be permitted within 0.5 mile around communities or subdivisions and within 1,000 feet of private lands and other facilities.
- Short Term Closures of Public Lands: During periods of active aerial and ground based dispatch operations, limited areas of public lands might be closed to public access for safety reasons. Closures will be restricted to the minimum size and duration needed for public safety. Closures of high use recreation areas will be avoided during weekends and holidays whenever possible.
- Use of Weed-Free Feed for Packstock: Any use of packstock will require certification of weed-free feed to minimize chances of introducing non-native and noxious weeds into the project area.

9. Approvals

Following the approval of this step-down plan, the Service may choose to enter into a Memorandum of Understanding with other agencies to participate in the implementation of a five-year integrated feral pig eradication and control approach wherein the most effective, selective, and environmentally desirable method, or combination of methods allowed under this alternative, would be tailored to site-specific conditions.

The Cleveland National Forest has prepared an EA (USDA Forest Service 2013) in compliance with NEPA and other relevant Federal laws and regulations for the actions proposed in this step-down plan. The activities covered under the Forest Service EA would occur on the Cleveland National Forest, part of the National Forest System lands, administered by USDA Forest Service, as well as on lands administered by the Bureau of Land Management (BLM), Palm Springs - South Coast and El Centro Field Offices, and on the Capitan Grande Indian reservation for actions with Federal funding or undertaken by the Bureau of Indian Affairs (BIA). The proposed Feral Pig Eradication and Control Project area addressed by the Forest Service is located within San Diego County within the foothill and mountain zone, portions of southern Riverside County, and Forest Service lands within the Santa Ana Mountains of northwestern San Diego, Orange, and southwestern Riverside counties. The California Department of Parks and Recreation has also prepared a Final Initial Study and Mitigated Negative Declaration (CDPR 2013) in accordance with the California Environmental Quality Act to address feral pig eradication and control in San Diego County. Other agencies participating include the California Department of Fish and Wildlife, City of San Diego, County of San Diego, Vista Irrigation District, and Helix Water District.

10. Monitoring and Reporting

The numbers and locations of feral pigs within the region will be monitored during the implementation of this plan. In addition, sites where control has occurred will be surveyed to determine if the actions taken successfully removed all pigs from the area. Monitoring on the Refuge will initially address whether or not pig activity or pigs have been identified on refuge lands, and areas in proximity to the Refuge where pigs have been documented will be noted.

In addition to monitoring, a summary of the actions taken, as well as a discussion of the effectiveness of the action in achieving the plan objectives, will be provided in an annual report that will likely be prepared by the Group. The annual report will also present information regarding the numbers of pigs controlled and in which locations and habitat types. The extent of disturbance caused by feral pigs will also be documented. Recommendations on how feral pig control and surveillance might be improved or expanded would be reported, and an evaluation would be provided of whether the current year's control and monitoring actions were achieving the plan objectives.

11. Alternatives Considered

In addition to the proposed monitoring and eradication plan presented above, various alternatives for addressing the control of feral pigs on the Refuge were considered. These included:

No Action

Under this alternative, no feral pig control efforts would be undertaken on the Refuge. As stated in the draft CCP/EA for the San Diego NWR, no action to stop feral pigs from establishing populations on the Refuge would result in an expanding pig population throughout the Refuge along with the associated damage to sensitive habitats and species, cultural resources, and water quality. Allowing pigs to establish populations on the Refuge would hamper the efforts of other land managers to control feral pig populations on their lands. This alternative would also be inconsistent with Department and Service policy related to integrated pest management, Refuge goals and objectives for protecting the Refuge's sensitive natural and cultural resources, and regional conservation goals.

Non-lethal Feral Pig Control Methods

This alternative was considered in response to public comments received by the Forest Service on their environmental assessment for Feral Pig Damage Control Project on Cleveland National Forest and Bureau of Land Management Lands (USDS Forest Service 2013). Public comments recommended non-lethal methods of feral pig population control such as pig relocation and sterilization.

Feral pig control efforts have been carried out for many years across the United States and a variety of methods have been tried. Lethal methods are the most widely used and recognized as the most effective means of feral pig control (West et al. 2009). Although in some situations non-lethal methods may be appropriate and effective, in most cases they are not a good option, either because they do not work well or are too expensive (Hamrick et al. 2011). Methods such as relocation of feral pigs are complex, labor intensive, and not practical given the magnitude of the problem (Sweitzer 2003). There are no known facilities in the region that are capable of lawfully handling captured feral pigs for relocation purposes. In addition, wild pigs are known carriers of at least 45 different parasites (external and internal) and diseases (bacterial and viral) that pose a threat to livestock, pets, native wildlife, and in some cases, human health (Hamrick et al. 2011).

In addition to relocation, other non-lethal methods of control include fertility control, fencing, repellents, and diversionary feeding. Fertility control can be effective in decreasing the numbers of feral hogs in cases where they occur in isolated populations (Massei et al. 2011), however, where immigration and emigration affect the population dynamics, this approach is generally ineffective in addressing ongoing habitat

destruction. This approach also requires that the pigs be trapped, injected, and then released back into the native habitat areas. This is costly and fails to address the purpose and need for control, which is to protect sensitive resources and water quality from the adverse effects of pig activity on the Refuge.

The use of exclosure fencing to protect sensitive resource areas does have some benefits, but would not be effective in meeting the overall purpose and need for control, which is to keep all pigs off the Refuge. This is because it would be impractical to fence the enter Refuge and even if it was possible, it would have an adverse effect on public access. Fencing can also result in increased damage to resources in areas adjacent to exclosure fencing.

Other methods such as the use of repellents and diversionary feeding are generally ineffective for large habitat areas. Repellents are only effective for a short time and its use is only practical at a small scale. Similar to fencing, the use of repellents in one area could concentrate damage in adjacent areas (Massei et al. 2011). Diversionary feeding, which is more often considered in agricultural settings, is labor intensive and has the potential to increase reproductive output, which would exacerbate the existing problem.

The exclusive use of non-lethal methods of control would fail to provide a permanent solution to the feral pig problem in the region and would not address the purpose and need for this action. It is for this reason that this alternative was dropped from further consideration and will not be further evaluated in this document.

Distributing Feral Pig Meat for Human Consumption

This alternative was considered in a desire on the part of the Service that feral pig meat should not be wasted. Under this alternative, feral pigs would need to be captured alive and transported to an approved USDA inspected slaughter facility. The closest such facilities for pigs are located in northern California, several hundred miles from the project area. Capturing pigs alive in remote locations with rugged topography, dense vegetation, and limited access and transporting them to approved slaughter facilities would not be practical or financially feasible given the scale of the project. Therefore, this alternative was not given further consideration.

Use Military or Volunteers to Dispatch Feral Pigs

The alternative that volunteers or military personnel be offered the opportunity to hunt feral pigs was considered in response to public comments received by the Forest Service on their environmental assessment for Feral Pig Damage Control Project on Cleveland National Forest and Bureau of Land Management Lands (USDS Forest Service 2013). The proposal for military personnel to implement the program is not within the direct mission of the military. In addition, if military priorities shift, the program might not be

completed. Effective removal of feral pigs from impacted areas requires the consistent presence of trained personnel throughout the control process.

With respect to volunteers, these programs are prone to turnover and participants vary considerably in their skills and physical abilities. In addition, the government assumes liability and is responsible for physical injuries or accidents when incurred as part of official volunteer duties. A single accident could significantly increase the cost of operations. To address issues of safety and efficiency, highly trained and experienced professional sharpshooters are required to carry out pig removal efforts on the Refuge. For these reasons, the use of military or volunteers to implement feral pig control was not consideration in detail.

No Aerial Dispatch Alternative

An alternative that addresses feral pig control without an aerial dispatch component (i.e., using trained sharpshooters to remove feral pigs in remote areas using a helicopter) was considered because of public concern about human and animal welfare/humane treatment associated with implementing lethal control of pigs from helicopters. However, we eliminated this alternative from detailed analysis for a variety of reasons, including our need to have access to all available tools to ensure early and complete control of feral pigs on the Refuge.

Although the potential for using this control technique on the Refuge is limited, we believe it is a valuable tool that may be necessary to completely remove feral pigs from Refuge lands. Aerial dispatch could assist in early, effective removal of pigs in inaccessible areas. Further, early control of the pig population will reduce the population numbers and minimize the potential for reproduction, thereby reducing the total number of pigs that would need to be killed.

Concerns about public safety will be mitigated by only using highly trained professionals and by conducting aerial operations in closed or inaccessible areas of the Refuge. This technique is being used elsewhere in the U.S. without human safety incidents. Concerns about noise will be mitigated by operational buffers around developed areas.

12. Justification

Over the past decade, following introduction by people, either intentionally or inadvertently, feral pig populations were established in portions of San Diego County's undeveloped lands. Ongoing monitoring confirmed that the feral pig population in the San Diego region was growing and expanding in distribution. Further, damage associated with pig rooting and wallowing was documented in native vegetation, particularly sensitive oak woodland habitat, within the Cleveland National Forest and elsewhere. A large cultural site in the Cleveland National Forest was also damaged by feral pig activity.

Feral pigs represent a serious threat to the diversity of habitats and species protected within the region's conserved lands, including the range of listed and sensitive species supported on the San Diego NWR. Their presence also threatens the integrity of cultural resource sites, the quality of habitats and water within our protected watersheds, and potentially human health. There is currently an opportunity to successfully eradicate feral pigs from the region, however, this effort requires participation by a range of land managers, governments, tribes, and other stakeholders, including the San Diego NWR.

To protect the substantial investment in terms of costs and management effort by staff, volunteers, scientist, and others, it is necessary to implement actions that can quickly and effectively reduce and ultimately eliminate the feral pig population in the region, avoiding the expansion of feral pig populations onto the Refuge and elsewhere in southwestern San Diego County. Over the past few years, actions taken by other local, State, and Federal agencies, along with the effects of drought on native vegetation, have resulted in a substantial decrease the number of feral pigs in San Diego County. Continued control and participation by all land managers could successfully eradicate feral pigs from the County. Actions to eliminate this threat are consistent with Service policy and regulations, are compatible with the purposes for which the Refuge was established, and will assist in achieving the goals and objectives for the San Diego NWR as stated in the San Diego NWR CCP.

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