Coastal Dune Restoration Environmental Assessment

Errata

April 2015

mechanical removal, which is discussed under *Alternative D*. Staging and access, monitoring, and environmental protection measures are also discussed above under *Actions Common to All Action Alternatives*.

As described earlier in this chapter, herbicide use on lands managed by the Park Service requires initiation and approval of a Pesticide Use Proposal or PUP. PUP requests are reviewed and approved by the Pacific West Regional Integrated Pest Management (IPM) Coordinator or by officials at the Washington D.C. office (WASO). Approvals require tracking of quantities and areas where pesticides are used. All herbicide application would be in compliance with manufacturers' labels and would occur only under appropriate weather conditions.

Project logistics greatly depend on the size of the treatment area, location, and number of sensitive resources that must be avoided. However, it is likely that all projects would involve working across the landscape in a sequential fashion to minimize potential for reinvasion of restored areas.

European Beachgrass Removal Using Herbicide

Chemical treatment would consist of foliar application with 2% concentration of glyphosate (formulated as AquaMaster®; currently marketed as Roundup Custom®; or other formulation without an incorporated surfactant), 1% concentration of imazapyr (formulated as Habitat® or another formulation), 1% concentration of a non-ionic vegetable oil surfactant (Competitor® or another formulation), and 1.5% concentration of a blue dye, using label specifications for combined total treatment (initial and any follow-up) of no more than 8 quarts or 8 lbs acid equivalent (a.e.)/acre/year of glyphosate concentrate and no more than 6 pints or 1.5 lbs a.e./acre/year of imazapyr. The concentration of dye will be increased or decreased where necessary, based on visual assessments made after the first and second herbicide application. These concentrations were determined by following species-specific label recommendations, evaluating past experience with herbicide application on European beachgrass, and by considering recommendations from land managers coping with similar invasive species' issues.

Glyphosate is a broad-spectrum, non-selective, post-emergence systemic herbicide developed by Monsanto (Franz 1985; Franz et al. 1997 *in* SERA 2011a; http://www.cdms.net/LabelsMsds/LMDefault.aspx?manuf=23&t=). Glyphosate inhibits the shikimic acid pathway in plants, which is involved in the production of essential aromatic amino acids (SERA 2011a). This inhibition leads to an inhibition or cessation of growth, cellular disruption, and, at sufficiently high levels of exposure, plant death (SERA 2011a). The time course for these effects can be relatively slow, depending on the plant species, growth rate, climate, and application rate (SERA 2011a). By 2003, when glyphosate was no longer protected by patent, the number of commercial formulations had increased substantially and continues to grow (SERA 2011a). Some of these formulations incorporate a surfactant, and some do not: Some Round-Up® products, for example, contain a surfactant (SERA 2011a). Because there are concerns that surfactants in glyphosate formulations such as Round-Up® may be even more toxic than glyphosate or enhance the toxicity of glyphosate (SERA 2011a), the park typically does not use formulations of glyphosate that incorporate a surfactant, but uses so-called technical grade glyphosate formulations such as AquaMaster® (currently marketed as Roundup Custom®). AquaMaster® or Roundup Custom® is an aquatic label formulation classified as a Caution-level or Toxicity Class III chemical, one level higher than chemicals considered non-toxic (Toxicity Class IV).

For Roundup Custom®, the recommended label application rate for European beachgrass varies from a 3.5% to 8% solution, with a 0.5-1.5% non-ionic surfactant added and applied on a low-volume basis. However, to decrease the amount of herbicide being used and based on past experience with the park's and other agencies' projects, the proposed concentration for glyphosate would be approximately 2% concentration. In accordance with label instructions, the application would occur before 50% of green leaf color is lost during fall senescence.

Imazapyr is a non-selective herbicide used to control a variety of grasses, broadleaf weeds, vines, and brush or woody species (SERA 2011b; *http://www.cdms.net/LabelsMsds/LMDefault.aspx?pd=7136*). Imazapyr is an imidazolinone compound that enters the plant through its foliage and, to a lesser extent, its roots and then translocates through the xylem and phloem portions of plants to the roots, where it disrupts enzymes or amino acids specific to plant growth (ImazapyrFactSheet.pdf n.d.). The original formulation of imazapyr was Arsenal® (ImazapyrFactSheet.pdf n.d.), but imazapyr is now off patent, and numerous formulations are available both from BASF and other companies, including Habitat®, which is most commonly used for many wildland weed issues. Habitat® is classified as an aquatic-label formulation that is classified as a Caution-level or Toxicity Class III chemical, one level higher than chemicals considered non-toxic (Toxicity Class IV). While imazapyr formulations can be used in pre-emergence applications, the most common applications are post-emergent where the vegetation to be controlled is growing vigorously (SERA 2011b).

Based on classifications on the Habitat® label, the distribution and size of European beachgrass in most areas of the park constitutes a robust, perennial grass at the heavily-established-infestation qualifier-level. Habitat® can be applied at 4-6 pints/acre for species with this designation. Habitat® cannot be applied at more than the equivalent of 6 pints or 1.5 lbs a.e./acre/year, which represents a 1.5% hand-held-concentration, however, for beachgrass treatment, a lower concentration solution (1%) would typically be used.

Both imazapyr and glyphosate must be combined with a suitable surfactant to facilitate uptake and translocation of the herbicide down into the rhizomes. One of the types of adjuvants recommended for use with these types of herbicide is methylated seed oil, which is a type of "spreader" that disperses the droplet of herbicide mixture on the leaf surface to improve herbicide uptake and overall effectiveness. Surfactants are also used to control spray drift by altering the surface tension of the solution so small droplets cannot form (PRI 2010). The park currently uses Competitor®, which is a modified vegetable oil containing a non-ionic emulsifier system.

An inert marker dye or colorant will also be added. Colorants (dyes) are added to the herbicide mixture to the dye is to mark areas that have been treated with herbicides to ensure full coverage and avoid duplicative treatments (PRI 2010). The dye also serves to notify workers and the general public of the location of treated areas (PRI 2010).

Treatment would be conducted using either a backpack sprayer with a calibrated nozzle, where spray volume is adjusted specifically to minimize drift, or through direct contact with wicking from a wand. Use of the latter is not subject to drift. No broadcast application methods would be allowed. When work is conducted near rare plants or native dune mat, either a 10-foot buffer must be implemented, OR a drift shield can be employed instead. Crews would be directed to avoid native vegetation intermixed within European beachgrass or iceplant to the maximum extent practicable. Also, as mentioned under environmental protection measures, there would be no spraying under adverse weather conditions, including wind speeds exceeding 10 mph at the level of the target plant; rainfall, including no treatment 24 hours after a rainfall event or 24 hours before a predicted rainfall event when there is a 20% chance of rainfall; or moderate to heavy fog conditions.

In terms of impacts, *Alternative B* would probably have the least impacts during or shortly after implementation, followed by *Alternative C*, and then *Alternative D*. Impacts posed by *Alternative B* relate largely to the disturbance caused by contractor crews and use of all-terrain vehicles such as UTVs. *Alternative C* would pose risks to resources through use of herbicide and potentially mowing or prescribed burning used as pre- and post-treatment measures. Some of the same herbicide risks would exist under *Alternative D*, albeit to a lesser degree, as spot spraying would be used only for re-treatment under that alternative. While data is far from conclusive, herbicides proposed for use by the park would appear to have the potential for no more than negligible to at most minor impacts on a short-term basis to the Seashore's dune resources, particularly as re-treatment needs may be greatly reduced relative to manual removal. Burning and mowing could also have short-term impacts on resources. Mechanical removal would have impacts during implementation from the disturbance caused by heavy equipment, contractor crews, and UTVs, but could also have longer term indirect impacts on adjacent native dunes, wetlands, and grasslands due to remobilization of sands accumulated over decades due to stabilization by European beachgrass and iceplant.

In summary, then, *Alternative B* would have the least impacts during and shortly after implementation, but would also deliver the least benefit on either a project-area or park-wide scale. This alternative would restore fewer acres, offer fewer benefits for listed species and natural processes, require more frequent re-treatment, and have the highest potential for failure of the four alternatives. *Alternative C* may result in slightly more impact than *Alternative B* during and shortly after implementation, but, over the long-term, it would restore more acres and offer more benefits for listed species and natural processes. *Alternative D*, on the other hand, would have more impact than *Alternative C* during and after implementation and would deliver fewer benefits to the Seashore's dunes on a park-wide scale, although there may be considerable benefits on a project-area scale. Based on this analysis, *Alternative* C would be the approach that best "protects, preserves and enhances historic, cultural and natural resources."

Alternatives Considered, but Dismissed

During the alternatives development process, the project team may evaluate a wide range of options before selecting alternatives or alternative components that will be carried forward for further analysis. Decision-making on whether an alternative or component is reasonable and distinct during the alternative development process should be strongly tied to the ability of alternative or alternative components to meet the project purpose and objectives and available information on existing natural and cultural resources, conflicts with existing land uses, human health and safety needs, and potential for socioeconomic impacts. Through consideration of objectives and planning criteria and use of available information, the project team eliminates alternatives or alternative components or actions (specific tasks or actions within alternatives) that are considered infeasible for technical or economic reasons and that are, therefore, not carried forward for further analysis.

In general, this EA follows the same structure as the 2009 EA for Abbotts Lagoon Coastal Dune Restoration Project, which evaluated alternatives that varied in the primary approach to control of European beachgrass, but often incorporated multiple control methods. *A number of methods have been used for eradicating weeds; some of these methods are more applicable to removal of European beachgrass and iceplant than others. These methods include saltwater application, hydromechanical obliteration (HMO), hot foam treatments, vinegar application, grazing, use of black* *plastic sheeting or mulching, and competitive displacement of non-native invasive species through active revegetation*.

- **Saltwater**: As discussed earlier in this chapter, application of saltwater is still considered by most restoration practitioners to be experimental and has not had demonstrated success in treating invasives such as European beachgrass and iceplant in dune systems as yet*, although there may be some initial success with use of this method at Kent Island in Bolinas Lagoon*.
- **HMO / Hot Foam**: No examples of use of HMO or hot foam for treatment of European beachgrass could be found, however, limiting factors on application of the former would be volume of non-saline water required for high pressure water jets or hot water-foam to "obliterate" biomass and rhizomes, given rooting depth of at least European beachgrass. In addition, HMO treatment and other water-intensive treatment methods may be logistically constrained by access difficulties for equipment within sandy dunes, as the sheer weight of heavily laden HMO equipment precluded access during the winter for at least one other non-dune invasives removal project (Alvarez et al. 2012).
- ***Grazing:*** *One of the new – or perhaps, more correctly, resurrected – tools for control of invasive species is targeted grazing by goats, cattle, or sheep. Certain types of livestock will preferentially target seemingly even unpalatable species. In general, cattle do not eat established European beachgrass (Department of Agriculture-Australia. 1896): they may eat young shoots, but these are likely to represent only a small proportion of plants or biomass within an established stand. This information is supported by conversations of park staff with ranchers regarding grazing of European beachgrass. Based on literature review of potential methods for beachgrass and iceplant removal by CDPR, there is no established literature on grazing of European beachgrass by either goats or sheep. Grazing animals such as goats, cattle, or sheep may reduce the biomass but it would not be effective alone, as European beachgrass resprouts from below-ground rhizomes (CDPR 2012). Iceplant leaves are salty and astringent, and the stems are woody and fibrous, making it unlikely that grazing would be an effective control for iceplant (Albert 2000 in CDPR 2012). Grazing is also highly non-selective, and grazing would also impact native and even rare plant species that are intermixed or adjacent to European beachgrass and iceplant stands.*
- ***Vinegar****: Vinegar works as a non-selective, post-emergence, contact herbicide causing rapid desiccation of plant tissues following application as the result of damage to cell membranes (Barker and Prostak 2008). Vinegar is most effective at killing weeds when applied as a foliar spray at concentrations ranging 10 to 20% vinegar and when the weeds are about 6 to 9 inches tall or less (Radhakrishnan et al., 2002; Doll, 2002 in Barker and Prostak 2008). Generally 80 to 100% kill rates can be expected for small annual and perennial weeds, but perennial species with persistent root systems will begin to re-grow within several weeks (Barker and Prostak 2008). Young (2002 in Barker and Prostak 2008) tested a number of natural-based herbicides including vinegar against glyphosate as post-emergence treatments to roadside annual and perennial weeds in northern California. Two applications of vinegar were deemed marginally effective at controlling annual species (vinegar resulted in about a 70% reduction in weed plant growth compared to an untreated weeds) and were not effective at controlling perennial species (Young 2002 in Barker and Prostak 2008). It was reported that soil pH was reduced significantly (from a range of pH 5.9 to 6.6 to a range of pH 4.7 to 5.2) on a temporary basis (at least a month), following vinegar treatment (Barker and Prostak 2008). Vinegar would not appear to be an*

- *effective choice to eradicate European beachgrass, as European beachgrass is a deeply rooted perennial species well over 6 to 9 inches tall. Treatment would require repeated applications of vinegar, which could acidify soils and have impacts on soil microbiota and organisms (DiTomaso 2013).*

- ***Mulch or Plastic Sheeting****: Use of thick layers of chips or black plastic sheeting is typically only feasible for very small weed infestations (<1 acre; CDPR 2012). Success rates have been equivocal, with no documented success for beachgrass and variable success for iceplant (CDPR 2012). Use of plastic sheeting and even chips is very difficult to areas subject to high winds, as even staked down plastic sheeting can be loosened by strong gusts and then blown across the landscape, creating trash that could be a hazard to wildlife and other plants. At least one study found "significant physical, chemical, and biological changes in the soil that can last up to several years" (Tu et al. 2001* in *CDPR 2012). During mechanical removal, approximately 3 feet of clean sand is required to "cap" areas of buried rhizomes, as European beachgrass can re-grow very quickly even through fairly thick sand layers: application of a layer of mulch or chips at a depth of 3 feet would be logistically infeasible at the scale that projects would be conducted.*

- ***Revegetation***: *The difficulties with planting species to compete with European beachgrass is that few native – and even non-native – species have proven to be able to compete with this aggressive import from Europe. Beachgrass typically grows taller than most dune herbs and taller than most of the shrub species, as well, eliminating the potential for natives to "shade out" this species. It spreads very rapidly through its deeply rooted rhizomes, laterally expanding as much as 3 to 14 feet in a year (see p. 96 in Chapter 3). This eliminates open space for native dune species to take hold and try to establish. As discussed on p. 181 in Environmental Consequences, a number of studies have documented displacement of native species and communities by both beachgrass and iceplant. While the native coyotebrush might be able to compete somewhat with this species, as it is also considered a fast establisher under the right conditions, a community dominated by this shrub would not support rare federally listed dune plant species or common native dune plant species that serve as nectar sources for the federally endangered butterfly, Myrtle's silverspot butterfly.*

Should practicable alternative treatment methodologies be developed in the future, the Seashore and managers at other dune systems may opt to re-evaluate invasive treatment options in future years.

In the long term, continued expansion of European beachgrass or iceplant stands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be unlikely to have any beneficial or adverse effect on California brown pelicans, California least terns, willow flycatchers, or Point Reyes jumping mouse. There would be no effect on Sonoma spineflower, as it occurs within adjacent grasslands some distance (> 0.5 miles) from the dunes.

Based on the scale of dune restoration efforts proposed within the region, cumulative effects of these non-park projects with Alternative A would either have no impact on special status resources within the region or adverse impacts ranging from negligible to minor in intensity, with the only potential for detectable adverse cumulative effects possibly being for Tidestrom's lupine.

IMPACT OF ALTERNATIVE B

Analysis

Under this alternative, restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would primarily use manual methods to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such as European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Listed Plant Species

In the long term, Sonoma spineflower (*Chorizanthe valida*) would not likely be affected, as it does not occur in or near (> *0.7* mile) any of the Seashore's dune systems. *There are very few populations of Sonoma spineflower, and all of them occur in the park. The main or "wild" population of this species occurs in the northern portion of G Ranch and would not be impacted by activities proposed in this EA, the nearest action of which is at AT&T, approximately 1 mile away to the northeast. Sonoma spineflower has also been introduced at F Ranch, with the nearest colony being approximately 1 mile south of the AT&T. Lastly, this species was also reintroduced at two sites in 2011 in the eastern section of AT&T, which are approximately 0.7 miles south of the AT&T project area. These sites are not considered self-sustaining or successful at this time.*

Removal of European beachgrass and iceplant could cause remobilization of sands trapped for decades by these invasive non-native species. During the course of a year, the prevailing wind direction in this area tends to be from the northwest (>36% of the time), but the winds can switch direction, with winds blowing from the southeast approximately 21% of the time (WRCC; Pt Reyes RCA data). Winds very rarely blow from the southwest in a northeasterly direction, however (~8% of the time; WRCC; Pt Reyes RCA data). As discussed under Chapter 2, Actions Common to All Alternatives, the proposed project would implement a number of impact avoidance and minimization measures to prevent sand from remobilizing into adjacent lands, including phasing of backdune restoration efforts, revegetation of backdune areas, tapering of grading efforts, and other measures. However, even largely without these measures, results of monitoring sand movement at Abbotts shows that almost all of the sand remobilized by more extensive removal approaches such as mechanical deposited within the larger project area or directly inland of the dunes, although finer sand particles could be transported further. In terms of sand burial, populations or colonies of Sonoma spineflower that are more than 0.7 miles away would not be expected to be impacted by sand burial. Therefore, the proposed

<u>project at AT&T and other project areas would have no effect on Sonoma spineflower.</u>

Beach Layia

Long-Term Effects

Under Alternative B, European beachgrass and iceplant would be removed manually from relatively small areas at AT&T/North Beach and B Ranch/Davis Property that support beach layia. (Beach layia is not documented from A Ranch or Limantour.) Hand removal of iceplant may yield some long-term benefits for this species, as hand removal of particularly sparse iceplant patches is relatively successful in terms of eradicating this invasive. In general, however, European beachgrass areas restored through manual removal are typically less successful than iceplant ones, because they are more likely to be re-impacted in the future through re-growth of this deeply rooted non-native, invasive species. As was discussed under Vegetation Resources, very small fragments of this rhizomatous species can re-root or re-grow from buried rhizomes not completely removed by manual means. In addition, manual removal of European beachgrass is much more costly per acre than iceplant, which reduces the number of acres that can be potentially restored. A more complete description of the long-term impacts associated with continued expansion of European beachgrass and iceplant on beach layia can be found under Alternative A.

Under Alternative B, then, beach layia populations at AT&T, North Beach, Davis Property, and B Ranch could continue to decline in numbers or even be lost due to the reduced scale and efficacy of using strictly manual removal restoration methods. Benefits of restoration to beach layia would definitely be reduced relative to Alternatives C and D, although they would be possibly greater than under Alternative A.

During or shortly after implementation, manual removal and staging and access for restoration would have no more than negligible to minor adverse impacts on any of these special status species. Short-term minor impacts could occur on a localized scale for red-legged frog if sand remobilization buries portions of wetlands where active breeding is occurring, thereby impacting egg masses and tadpoles.

Based on the scale of other dune restoration projects proposed within the region, cumulative effects of these projects with those that may be conducted Alternative B would be no more than negligible to at most minor on a regional scale, with the only potential for detectable adverse cumulative effects possibly being on red-legged frogs, although, frogs occur in many different types of wetlands within the park, the intensity of this effect would be relatively negligible.

IMPACT OF ALTERNATIVE C

Analysis

Under this alternative, restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Listed Plant Species

As was discussed under Alternative B, in the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> *0.7 mile*) any of the Seashore's dune systems.

Beach Layia

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on beach layia can be found under Alternative A.

Under Alternative C, beach layia would be expected to increase within restored locations, although populations could continue to decline in numbers or even be lost in unrestored areas within AT&T, North Beach, B Ranch, and Davis Property. Beach layia has not been documented at A Ranch or Limantour. There is less information available on success of this particular approach for restoring beach layia than with mechanical removal. However, some of the areas treated chemically at Abbotts Lagoon had beach layia establishing within the first year after treatment. Restoration using this approach should provide benefits for this dune species, and these benefits could be greater than those under Alternatives B and D due to the potential increase in acreage restored at AT&T, North Beach, B Ranch, and Davis Property.

Given these factors, over the long-term, Alternative C could result in potentially minor to moderate long-term benefits to beach layia at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

cases substantially below – the level of concern, ranging from 0.002 (acute exposure following consumption of contaminated insects) to 0.7 (acute exposure following consumption of contaminated grasses).

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on western snowy plover, because mowing would most likely be conducted in the fall, when the breeding season is over. No mowing would be conducted within 500 feet of an active nest.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burning would also be likely to occur in the fall, when the breeding season is over. Burning would not be conducted within 500 feet of an active nest. Even with a 500-foot buffer, plovers may be disturbed by drifting smoke. No information on the effects of fire or smoke on snowy plovers is available, except for reports of potential nest abandonment due to disturbance from human camping, campfires, and smoke (USFWS 2007).

Based on these factors, including proposed impact avoidance and minimization measures, chemical control and its associated pre- and post-treatment methods would have negligible to minor adverse impacts during and shortly after implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential additional mitigation measures to protect broods, discussed later in this section, could reduce impacts to negligible.

California brown pelican

The California brown pelican was recently delisted by the USFWS. Brown pelicans may occupy open water habitats near some dunes where restoration could occur, but do not occur within the dunes themselves. Under this alternative, the primary impact to pelicans would be from mechanical removal of European beachgrass and, to a much lesser degree, run-off of herbicides into adjacent water bodies such as Estero de Limantour.

Use of heavy equipment near open water bodies such as Limantour may disturb this species, or even cause individuals to temporarily abandon the area, especially if it is very loud and/or extends over several days. Although some individual pelicans may habituate to non-threatening, continuous or frequently occurring noise levels, others do not. Waterfowl studies indicate that this group of birds is particularly slow in acclimating to continuous noise (Bowles 1995). Pelicans could retreat to other areas of the same water body or the ocean to get away from the noise of excavators or other heavy equipment, and some individuals may permanently leave the area. Each of these behaviors would have negative impacts on pelicans, as swimming or flying away from the source of noise increases energy expenditures, and time spent in escape can take away from feeding. In addition, pelicans may be displaced from higher quality habitat if the noise is so disruptive as to cause them to abandon the site.

Because *herbicide* treatment would be distant from most water bodies and relatively short-term, adverse impacts during and shortly following restoration *from either run-off or drift* would be negligible or perhaps minor at Estero de Limantour. As discussed for Vegetation Resources and some of the other Special Status Species subsections, the likelihood of herbicide run-off into adjacent open water bodies is very low and would, therefore, pose only a very negligible potential adverse impact on this species.

Based on the USFS risk assessment worksheets, which use the USEPA's AgDRIFT model to estimate drift (SERA 2011a), application of the proposed concentrations could result in drift of only 0.8% of the applied solution within 25 feet of the application area, which would correspond to 0.033 lbs a.e./acre for glyphosate and 0.008 lbs a.e./acre. Risks to the general public, wildlife, and plants from accidental and non-accidental exposures are often *expressed in hazard quotients (HQs), in which a HQ of 1 is considered the threshold level of concern. Based on USFS risk assessment worksheets for backpack-applied glyphosate, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only generally approach the level of concern (1.0) for sensitive fish and amphibian species (0.9 to 1.1), with the rest of the HQs below and mostly well below 0.6. Based on USFS risk assessment worksheets for imazapyr, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only exceed the level of concern (1.0) for macrophytes (e.g., eelgrass), with HQs ranging from 2 - 7. HQs for aquatic species were almost all well below 0.2. Again, the NPS would implement impact avoidance and minimization measures that would prevent accidental spills into adjacent waters and greatly minimize the potential for drift such as maintaining a 25-foot buffer between wetlands and spray activities; use of backpack sprayers with calibrated nozzles; and cessation of spraying when average wind speeds at plant level exceed 10 mph, or when winds frequently gust more than 10 mph, or when moderate to heavy fog conditions exist.*

In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on pelicans.

California least tern

During implementation, no direct impacts from mechanical or manual removal are expected, although indirect impacts in the form of noise disturbance or disturbance from the presence of humans may temporarily displace an individual from its territory. Pacific jumping mice are mainly nocturnal, but show some crepuscular activity (Bolster 1998).

Also, there is the potential for mice to be impacted by drift associated with chemical control, however, based on the discussion of this threat for other special status species and the proposed impact avoidance and minimization measures, the potential for this impact is very minimal, particularly as this species may be primarily nocturnal. Pacific jumping mice are primarily granivorous, preferring seeds of forbs, grasses and grass-like monocots (Jones et al. 1978 *in* Bolster 1998). They also eat fruits, berries, certain fungi, and insects (Krutzsch 1954, Jones et al. 1978 *in* Bolster 1998). Pacific jumping mice forage mostly at ground level in moist places where they cut plant stems in order to reach ripening seed heads (Bailey 1936, Gannon 1988 *in* Bolster 1998).

Non-target impacts to seeds and fruits that these mice might eat would be minimized by the 25-foot non-spray buffer to wetlands where they might occur. Based on worksheets developed for USFS by SERA, at application rates of 4 lbs a.e./acre, accidental spraying of glyphosate onto non-target plant species could result in acute exposure of mice from contaminated fruits ranging from 2.15 to 10.1 mg/kg/day. For the current USFS risk assessment, the no-observed-adverse-effect level (NOAEL) of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a), which corresponds at the proposed application rate of 4 lbs a.e./acre into a HQ of <0.01 to 0.06, which is well below the level of concern (1). At an application rate of 1 lb a.e./acre, accidental spraying of imazapyr onto non-target plant species could result in acute exposure of mice from contaminated fruits ranging from 0.52 to 28.0 mg/kg/day. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a HQ of 0.003 to 0.08, which is well below the level of concern (1).

Based on these factors and the impact avoidance and minimization measures proposed, adverse impacts during and shortly following restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: To reduce potential localized adverse impacts during and after implementation to Sonoma alopecurus and California red-legged frog at AT&T, the following measures may be taken. In addition to densely revegetating adjacent dune slopes as discussed earlier, mechanical removal could be performed as a straight cut, which would reduce the mobility of sands adjacent to the swale. This would require transport of excavated sands to another location. Another potential measure would be to eliminate or delay treatment within the 60-foot wetland buffer adjacent to this particular swale, or mechanical removal may be performed only on the downwind edge and in areas where the steepness of slope would not encourage fallback of sands into the drainage swale. The latter approach would decrease sustainability of restoration efforts due to the propensity for European beachgrass to reinvade treated areas. Lastly, the dune peaks to the west and east of the drainage swale could also be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds.

To determine when whether additional measures may be needed to mitigate for impacts (e.g., adaptive restoration), the perimeter of the swale would be GPSed prior to project implementation and also marked with permanent poles. During implementation, staff would routinely reassess the perimeter and look for active signs of slumping into the swale. Should there appear to be more than a 1% change in areal extent as determined by the perimeter, active measures would be taken to further stabilize sand within the buffer such as installation of biodegradable erosion control blankets, and slumped sand may then be carefully removed from the swale to reverse effects. This action would require full-time construction monitoring under the supervision of qualified California red-legged frog and Sonoma alopecurus biologists.

Should western snowy plover adults and chicks move into the immediate work area during chemical treatment operations, treatment would be stopped immediately, and treatment crews would move operations elsewhere until plovers leave the area (chemical control).

Based on the scale of other dune restoration projects proposed within the region, cumulative effects of these projects with those that may be conducted under Alternative C would be no more than negligible to possibly moderate on a regional scale, with the only potential for detectable adverse cumulative effects possibly being on red-legged frogs, although, as dunes are not this species' primary habitat, the intensity of this effect would be relatively negligible.

IMPACT OF ALTERNATIVE D

Analysis

Alternative D would restore dune habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by using primarily a mechanical approach to remove European beachgrass. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Listed Plant Species

As was discussed under Alternative B, in the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> *0.7* mile) any of the Seashore's dune systems.

Beach Layia

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on beach layia can be found under Alternatives B and C. Under Alternative D, beach layia would be expected to prosper within restored locations, although populations could continue to decline in numbers or even be lost in unrestored areas at AT&T, North Beach, Davis Property, and B Ranch.

Past restoration projects at the park suggest that this species could benefit from mechanical removal projects, although benefits have not been as dramatic perhaps as for Tidestrom's lupine for unknown reasons. Following mechanical removal of European beachgrass near the mouth of Abbotts Lagoon in 2003-2004, 182 Tidestrom's lupine and 18 beach layia seedlings were found growing (Rodgers 2006). Establishment of beach layia in newly restored areas south of Abbotts Lagoon has also been reduced relative to that of Tidestrom's lupine, with most of the new beach layia plants found on the edges of the restored area adjacent to native dunes or along access roads until 2014, when beach layia was found within the interior portions of mechanically restored areas. Some of this disparity between Tidestrom's lupine and beach layia in the speed with which new habitat was colonized may be due to the that beach layia is an annual and/or due to seedbank dynamics, such that this species' seeds are not as long-lived or resilient as Tidestrom's lupine's.

Restoration primarily utilizing mechanical removal as the primary treatment approach should provide benefits for this dune species, although these benefits could be lower under this alternative than under Alternative C due to the potential decrease in total restored acreage, as well as the acreage restored at individual project areas.

Given these factors, over the long-term, Alternative D could result in negligible to minor benefits at AT&T, North Beach, Davis Property, and B Ranch. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Mammals

Over the long-term, no benefits or adverse effects from removing European beachgrass and iceplant would be expected on Point Reyes jumping mouse. Based on factors discussed under Alternative C, adverse impacts during implementation from noise and disturbance would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Staging and access would be expected to have at most a very negligible adverse effect at these dune system areas.

Possible Additional Mitigation Measures: To reduce potential localized adverse impacts during and after implementation to Sonoma alopecurus and California red-legged frog at AT&T, the following measures may be taken. In addition to densely revegetating adjacent dune slopes as discussed earlier, mechanical removal could be performed as a straight cut, which would reduce the mobility of sands adjacent to the swale. This would require transport of excavated sands to another location. Another potential measure would be to eliminate or delay treatment within the 60-foot wetland buffer adjacent to this particular swale, or mechanical removal may be performed only on the downwind edge and in areas where the steepness of slope would not encourage fallback of sands into the drainage swale. The latter approach would decrease sustainability of restoration efforts due to the propensity for European beachgrass to reinvade treated areas. Lastly, the dune peaks to the west and east of the drainage swale could also be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds.

To determine when whether additional measures may be needed to mitigate for impacts (e.g., adaptive restoration), the perimeter of the swale would be GPSed prior to project implementation and also marked with permanent poles. During implementation, staff would routinely reassess the perimeter and look for active signs of slumping into the swale. Should there appear to be more than a 1% change in areal extent as determined by the perimeter, active measures would be taken to further stabilize sand within the buffer such as installation of biodegradable erosion control blankets, and slumped sand may then be carefully removed from the swale to reverse effects. This action would require full-time construction monitoring under the supervision of qualified California red-legged frog and Sonoma alopecurus biologists.

Should western snowy plover adults and chicks move into the immediate work area during either mechanical removal or chemical treatment operations, construction or treatment would be stopped immediately, and either treatment crews would move operations elsewhere until plovers leave the area (chemical control), or Park Service oversight staff would contact the Park Service wildlife biologist for further direction.

Effectiveness of Possible Additional Mitigation Measures: This would reduce the range of potential adverse long-term impacts to Sonoma alopecurus and red-legged frog at AT&T from minor to moderate to negligible to minor/possibly moderate. In addition, short-term impacts to red-legged frog at AT&T would be reduced from negligible to minor.

Possible additional mitigation measures for snowy plover would reduce potential impacts during implementation of both mechanical removal and chemical control from no more than minor to negligible.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on special status species would be the same as described under Alternative A.

Beach layia. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would likely have negligible to minor beneficial effects on beach layia distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have negligible beneficial impacts on viability of this species.

Tidestrom's lupine. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would probably

Alternative A and small mammal sub-section above. In summary, as direct spray did not appear to result in acute toxicity to small mammals, it is unlikely that drift in the volumes as described above would result in any acute toxicity to larger mammals, either.

Based on the USFS risk assessment worksheets, which use the USEPA's AgDRIFT model to estimate drift (SERA 2011a), application of the proposed concentrations could result in drift of only 0.8% of the applied solution within 25 feet of the application area, which would correspond to 0.033 lbs a.e./acre for glyphosate and 0.008 lbs a.e./acre. Risks to the general public, wildlife, and plants from accidental and non-accidental exposures are often expressed in hazard quotients (HQs), in which a HQ of 1 is considered the threshold level of concern. Based on USFS risk assessment worksheets for backpack-applied glyphosate, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only generally approach the level of concern (1.0) for sensitive fish and amphibian species (0.9 to 1.1), with the rest of the HQs below and mostly well below 0.6. Based on USFS risk assessment worksheets for imazapyr, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only exceed the level of concern (1.0) for macrophytes (e.g., eelgrass), with HQs ranging from 2 - 7. HQs for aquatic species were almost all well below 0.2. Again, the NPS would implement impact avoidance and minimization measures that would prevent accidental spills into adjacent waters and greatly minimize the potential for drift such as maintaining a 25-foot buffer between wetlands and spray activities; use of backpack sprayers with calibrated nozzles; and cessation of spraying when average wind speeds at plant level exceed 10 mph, or when winds frequently gust more than 10 mph, or when moderate to heavy fog conditions exist.

Following spray activities, larger terrestrial mammals may consume fruit, vegetation, or small mammals contaminated by herbicide. Based on USFS risk assessment worksheets developed by SERA, at application rates of 4 lbs a.e./acre, spraying of glyphosate onto non-target (and target) plant species could result in acute exposure of large mammals from contaminated grasses ranging from 26.4 to 211 mg/kg/day. There is no specific assessment for consumption of glyphosate-contaminated fruit or seed by larger mammals, but at least one study documented that rabbits will eat seeds of iceplant (Novoa et al. 2012). Consumption of contaminated small mammals by carnivorous mammals could result in acute exposure of 8.39 mg/kg/day. Chronic, longer-term consumption of contaminated vegetation on-site could expose large mammals to doses ranging from 0.42 to 33.8 mg/kg/day. For the current USFS risk assessment, the NOAEL of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a). All of these estimated risk exposures fall well below that NOAEL. No hazard quotient estimates are available for less toxic glyphosate formulations.

At an application rate of 1 lb a.e./acre, accidental spraying of imazapyr onto target and non-target plant and animal species could result in acute exposure of larger mammals from consumption of contaminated fruit ranging from 0.3 to 13.2 mg/kg/day. Consumption of contaminated grasses could result in higher acute exposures of 2.0 to 158 mg/kg/day, while consumption of contaminated insects and contaminated mammals could lead to exposures ranging from 0.4 to 22.4 mg/kg/day (insects) and 2.72 mg/kg/day (small mammals). Chronic, longer-term consumption of contaminated fruits and grasses on-site could expose larger mammals to doses ranging from 0.07 to 76.2 mg/kg/day. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a hazard quotient of 0.00009 to 0.1, which is well below the level of concern (1.0).

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible to possibly minor effects on larger mammals. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so larger mammals within dense European beachgrass stands could flee prior to being struck or killed. However, there is a potential for some medium-sized mammals to freeze in response to disturbance.

Another pre-treatment measure that may be used is prescribed burning. Larger mammals would be able to escape a fire and would likely vacate the area when humans or UTVs approach. Impacts would be short-term, adverse and at most minor for most species, with most impacts occurring for medium-sized mammals such as brush rabbits and raccoons.

Based on these factors, adverse impacts during and shortly following restoration would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor impacts to medium-sized mammals resulting from either pre- or post-treatment mowing or prescribed burning.

Due to the factors discussed above, including proposed impact avoidance and minimization measures, the potential for dune restoration to impact amphibians and reptiles would largely appear related to drift during spray operations and run-off from sprayed areas into adjacent wetlands. The potential for accidental contact to amphibians and garter snakes during spray operations appears extremely negligible due to the fact that sprayed areas are unlikely to be used by this species during the dry season, however, fence lizards may be inadvertently sprayed.

A more complete description of issues related to drift can be found under Vegetation Resources-Alternative C. In summary, based on USFS risk assessment worksheets developed by SERA, the proportion of glyphosate subject to drift drops dramatically even at 25 feet to 0.8% of total herbicide applied (0.03 lbs a.e./acre) and at 50 feet to 0.4% (0.017 lbs a.e./acre). Using similar worksheets for imazapyr (SERA 2011b), a similar proportion of this herbicide would drift with backpack application, but the volume was lower, ranging from 0.008 a.e./acre at 25 feet and 0.004 a.e./acre at 50 feet due to the lower total volume of imazapyr used. The potential for run-off would also be quite low due to the very sandy soils and moderate rainfall totals: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible" (SERA 2011b). The potential for impact associated with run-off would be further reduced by impact avoidance measures such as spraying during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

Exposure of amphibians to herbicides has generated strong concerns in recent years due to a number of studies that have shown herbicide-associated adverse effects on frogs or reported observations of frogs in the field with various deformities. Use of glyphosate has been the cause of most of the concerns. Numerous studies address the acute lethal potency of glyphosate and glyphosate formulations to amphibians (SERA 2011a). For ecotoxicology purposes, glyphosate formulations are often separated into toxic and less toxic formulations. Most of the herbicide-related concerns for amphibians have revolved around use glyphosate formulations such as Round-Up® that incorporate the surfactant called POEA, which is considered to be more toxic than glyphosate itself (SERA 2011a). The park proposes to use aquatic-label glyphosate formulations such as AquaMaster® (now marketed as Round-Up Custom®), which is a less toxic glyphosate formulation known as glyphosate isopropylamine (IPA) that has no integrated surfactant.

In amphibians, the lesser toxicity of glyphosate IPA relative to other glyphosate formulations is well documented (SERA 2011a). Based on some of the available literature on glyphosate and its effects on amphibians and fish, the USEPA conducted an assessment is to evaluate potential direct and indirect effects on the red-legged frog arising from use of glyphosate and its salts on agricultural and non-agricultural sites (USEPA 2008). In general, most uses that would have resulted in "Likely to Adversely Affect" scenarios were those with higher application rates (e.g., 7.5 lbs a.e./acre in forestry settings); those using reduced application rates of particular formulations; and those where reduced application rates were applied via aerial spraying (~3.5 lbs a.e./acre; USEPA 2008). Use of glyphosate at application rates of 3.85 lb a.e./acre and below had no acute or chronic direct effects on aquatic or terrestrial habitats for red-legged frog (No Effect; USEPA 2008).

The USEPA also conducted a risk assessment on use of imazapyr and red-legged frogs (USEPA 2007). This risk assessment indicated that no direct effects *were* expected on either the aquatic or terrestrial phase for red-legged frog, nor were there indirect effects expected for frogs through direct effects to either its terrestrial or aquatic food sources (No Effect; USEPA 2007). It did conclude that red-legged frogs might be adversely affected through

860 mg a.e./kg bw, both for contact with and ingestion of contaminated vegetation (SERA 2011b). This apparently low acute toxicity is consistent with the toxicity data on mammals and birds (SERA 2011b). Using the same modeling approach for imazapyr, the acute risk from ingesting contaminated fruit would range from 1.92 to 33 mg a.e./kg bw, which is also well below the level the NOAEL threshold of 860 mg a.e./kg bw.

Mowing may be used before and after chemical treatment. Mowing would be expected to have negligible to possibly minor effects on terrestrial invertebrates on a localized scale, with higher intensity impacts occurring for non-flying insects. In keeping with impact avoidance and minimization measures for Myrtle's silverspot, mowing would not be conducted within the butterfly's flight season, which should reduce impacts for other terrestrial invertebrates, as well. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so many invertebrates within dense European beachgrass stands could flee prior to being struck or killed. However, some invertebrates would be injured or killed. Prescribed burning may also be used as a pre-treatment measure and would also have possibly minor effects.

Based on these factors, adverse impacts from implementation would be characterized as negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Adverse impacts from staging and access would be negligible at these project areas.

Fish species would typically only occur in adjacent open water bodies such as Estero de Limantour or in marshes in adjacent wetlands due to the ephemeral nature of most Dune Swale wetlands. Implementation would be expected to have very negligible impacts on fish communities within adjacent water bodies at Limantour. *As discussed under Mammals, Based on USFS risk assessment worksheets for backpack-applied glyphosate, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only generally approach the level of concern (1.0) for sensitive fish and amphibian species (0.9 to 1.1), with the rest of the HQs below and mostly well below 0.6. Based on USFS risk assessment worksheets for imazapyr, the potential HQs for either accidental (spill of herbicide into waters) or non-accidental (spray drift) acute exposures into water bodies such as Estero de Limantour or Drakes Estero would only exceed the level of concern (1.0) for macrophytes (e.g., eelgrass), with HQs ranging from 2 - 7. HQs for aquatic species were almost all well below 0.2. Again, the NPS would implement impact avoidance and minimization measures that would prevent accidental spills into adjacent waters and greatly minimize the potential for drift such as maintaining a 25-foot buffer between wetlands and spray activities; use of backpack sprayers with calibrated nozzles; and cessation of spraying when average wind speeds at plant level exceed 10 mph, or when winds frequently gust more than 10 mph, or when moderate to heavy fog conditions exist*. Over the long-term, dune restoration would be expected to have no effect on the park's fish populations.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wildlife would be the same as described under Alternative A. From a regional perspective, based on the scale of projects conducted historically in the park and proposed outside the park, the proposed dune restoration efforts would likely have very negligible adverse and possibly even negligible beneficial effects on wildlife species within the region, as most of the species are common ones that occur in a diverse number of habitats.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal potentially.

Under Alternative C, dune restoration could provide negligible to possibly moderate benefits for certain species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. These include certain small mammal, reptile, passerine bird, and sand-burrowing arthropod species. For other species, dune restoration may offer no benefit and could, for some, have negligible to minor adverse impacts. Higher intensity impacts result from the fact that European

Federal policy requires proposed actions to result in no net loss of wetlands, and Park Service Management Policies push parks to strive for a net gain in wetland acreage. For this reason, impact thresholds reflect this mandate by establishing more stringent thresholds for adverse impacts. *The Park Service requires a statement of finding and mitigation for any projects that may impact > 0.25 acres of "natural" wetlands except potentially for certain types of projects involving habitat restoration, recreational facilities (e.g., overlooks, bike/foot trails, and signs), minor stream crossings that completely span channel and wetlands (i.e., no pilings, fill, or other support structures), maintenance of existing structures, and scientific monitoring (NPS 2012b).*

Were wetlands to be lost as part of this action, the loss would most likely result from indirect rather than direct impacts due to remobilization of accumulated sands in restored dunes. For this reason, this type of loss may not be subject to oversight by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act, as it only regulates direct impacts from fill and, in certain circumstances, dredging. Based on NPS Management Policies, mitigation may be required if the proposed restoration project has the potential to have either direct or indirect impacts on more than 0.25 acre of wetlands. Other agencies such as California Coastal Commission and Regional Water Quality Control Board may also regulate indirect wetland impacts and require mitigation, although the mitigation requirement may be different than that for direct wetland fills or dredging activities. The NPS has found that mitigation planning for wetlands impacts is typically an activity that needs to be worked out with several agencies to reach mutual agreement and is, therefore, more efficiently conducted with permitting/consultation phase of environmental compliance, which occurs subsequent to the approval of the FONSI. The proposed projects would need to secure regulatory approval of both the proposed restoration and mitigation plan before any project could proceed.

Impact Thresholds

***Negligible*:** There would be no measurable chemical, physical, or biological changes to water bodies or wetlands within or adjacent to dune systems, or change would be barely detectable and often within the natural range of variability. There would be a negligible increase (= 0.05 acre) or decrease (= 0.1 acre) in the overall areal extent of jurisdictional wetlands (NPS 2007).

***Minor*:** There would be small, but detectable or measurable chemical, physical, or biological changes to water bodies or wetlands within or adjacent to dune systems changes, but no standard or criterion would be exceeded because of proposed actions. For beneficial impacts, there would be a minor increase (> 0.05 and = 1 acre) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a minor decrease (> 0.1 acre and = 0.25 acre) in the overall areal extent of jurisdictional wetlands (NPS 2007).

***Moderate*:** There would be apparent or appreciable chemical, physical, or biological changes to water bodies or wetlands, but no standard or criterion would be exceeded, except during implementation or on a short-term basis. There would be no long-term changes to water quality or hydrology. For beneficial impacts, there would be a moderate increase (> 1 and = 5 acres) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a moderate decrease (> 0.25 acre and = 1.0 acre) in the overall areal extent of jurisdictional wetlands. If the decrease in overall areal extent of jurisdictional wetlands is > 1.0, the loss must be for the purpose of Aquatic Habitat Restoration, Establishment, and Enhancement Activities as defined by conditions in the Corps' Nationwide Permit #27.

***Major*:** There would be striking or highly noticeable chemical, physical, or biological changes to water bodies or wetlands. Standards and criterions may be exceeded on a long-term basis. For beneficial impacts to wetlands, there would be a substantial and major increase (> 5 acres) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a substantial or major decrease (> 1.0 acre) in the overall areal extent of jurisdictional wetlands. If the decrease in overall areal extent of jurisdictional wetlands is > 1.0, the loss would be purposes other than those defined under the Aquatic Habitat Restoration, Establishment, and Enhancement Activities as defined by conditions in the Corps' Nationwide Permit #27.

IMPACT OF ALTERNATIVE A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

adjacent excavated dune soils into the wetland. The potential for this long-term impact would be greatly minimized through installation of the required silt fencing along the wetland perimeter, which not only helps to demarcate the wetland, but, as it's stapled to the ground, minimizes fallback of dune sands into the wetland.

Indirect effects could result from remobilization of sand following restoration. A much more detailed description of this issue can be found under Natural Physical Processes and Soils. As was discussed under that section, the intensity of sand remobilization is directly related to the extent and type of restoration conducted. Projects primarily using mechanical removal could potentially have more long-term impacts, particularly as European beachgrass has resulted in storage of very large volumes of sand deposited over the decades. Under more natural conditions, less sand would be stored in dunes, because sands would have gradually moved inland over time.

The 2011 Abbotts Lagoon dune restoration project, which primarily used mechanical removal, has already affected wetland morphology within this area by burying a few smaller wetland features within the interior of the dunes, as well as wetland swales immediately inland of the dunes. Estimated acreage of jurisdictional wetlands impacted totaled at least 2.5 acres as of spring 2013 (Johnson 2013a). The mechanical removal also inadvertently expanded some wetlands by simply removing contaminated sands on the perimeter of wetlands without "capping" them, which enabled waters from these wetlands to flow into these areas and create more open water edges. In addition, over time, as these excess sands migrate inland, wetlands may re-develop in the trough between foredune and elevated areas behind the foredunes where the water table is low enough to sustain seasonal ponding (Pickart and Sawyer 1998).

Projects primarily relying on chemical control would not be expected to remobilize as much sand as mechanical removal, because European beachgrass rhizomes decay very slowly and seemingly help to stabilize sands. While the propensity for dunes to migrate inland could increase as beachgrass decomposes, this potential could be countered to some degree by establishment of new vegetation or expansion of remnant native vegetation within treated areas: new plants are already colonizing treated areas near Abbotts Lagoon, although most of them, with the exception of wild cucumber, are annuals so far that would not contribute much to stabilization of dune soils. However, many of the intermixed dune shrubs that occurred there prior to treatment are still alive, so these may help hold soils until other shrubs can establish. Based on monitoring, no migration of dune occurred inland of these herbicide-treated areas in 2013: any impacts to wetlands that have occurred within this area resulted from use of mechanical removal in wetland buffers (Johnson 2013a).

As discussed in more detail under Alternative B, manual removal would also not be expected to have more than negligible adverse long-term indirect impacts on wetlands from remobilization of sands, as the depth of excavation is relatively shallow (less than 1.5 feet) and would not result in turnover of soil horizons. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best and would not offset any potential adverse effects associated with manual or mechanical removal.

Remobilized sand or incidental fallback of sands into wetlands would not be expected to have long-term impacts on water quality of adjacent open water bodies such as Abbotts Lagoon or Estero de Limantour. *Predominant wind direction must be taken into account in evaluating the potential for remobilized sand to have impacts: the* *primary wind direction at Limantour is from the northwest-west, therefore winds would be blowing remobilized sand away/towards the Estero de Limantour and the wetlands behind Limantour Beach (Limantour Marsh/Limantour Pond; WRCC, Pt Reyes Lighthouse). Some sand may be occasionally blown into the Estero de Limantour, but impacts would be minimal, because sand is heavy and would quickly fall to the bottom of the Limantour and other open water bodies. However, there could be impacts to Limantour Marsh and Limantour Pond, which directly adjoin the dunes.*

Under Alternative C, the scale of long-term impacts from sand remobilization would be reduced relative to Alternative D, because mechanical removal would not be the primary restoration method, and backdune areas would be actively revegetated. While some sand remobilization could occur in chemically treated once European beachgrass and iceplant decompose, by that time, native vegetation from plantings and natural recruitment should have established, thereby helping to stabilize soils. In addition, at AT&T <u>*and Limantour Marsh/Pond*</u>, special impact avoidance and minimization measures, including selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures below for more information.

Based on the extent of restoration that may be implemented under this alternative, this alternative could have negligible to possibly moderate adverse long-term effects on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Within these project areas, <u>*less*</u> than 0.25 acre of wetlands might be lost due to long-term sand remobilization, <u>*particularly as backdune areas would be actively revegetated*</u>. <u>*However, losses at some sites with more accumulated sands (or larger dunes) exceeding 1 acre*</u>. For these reasons, higher intensity impacts may be expected at project areas such as AT&T <u>*and possibly at dunes adjacent to Limantour Marsh/Pond*</u>, but, as discussed earlier, these impacts would potentially be mitigated through a number special impact avoidance and minimization measures. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative A, although the intensity of access and staging requirements – and impacts – may slightly increase, as mechanical removal would be used in wetland and organic pasture buffer areas. Staging and access would generally have no effect or negligible to minor short-term adverse effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with the latter occurring at AT&T if temporary fills in wetlands are required for access.

Manual Removal: Potential implementation-related and short-term impacts of manual removal on wetlands are very similar to those discussed under Alternative B, although the intensity of impact may be slightly less than under Alternative B, as manual removal would only be used for removal of iceplant and European beachgrass in wetland and buffer areas. Given these factors, potential adverse impacts to wetlands during and shortly after implementation from manual removal would be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Most of the potential impacts associated with mechanical removal would be long-term direct or indirect ones, such as incidental fallback or burial of wetland features with sand remobilization. However, there is some potential for short-term impacts associated with secondary access within dune restoration areas. As with adjacent grasslands, no secondary access would be allowed within or through wetlands to the maximum extent practicable. If no other access route for heavy equipment exists, access may be temporarily allowed through wetlands, but only within pre-established routes that result in the least impact to these features.

Every effort would be made to not alter these features to improve would occur during spring winds, as well as actively revegetated. In addition, there may be selective retention of some European beachgrass-dominated wetland buffers. *Areas adjoining Limantour Marsh/Pond may also be actively revegetated, even though these areas aren't considered backdunes.*

Effectiveness of Possible Additional Mitigation Measures: In addition to reducing impacts to Sonoma alopecurus and California red-legged frog, this would reduce the potential adverse long-term impacts to some of the AT&T *and Limantour Marsh/Pond wetlands* from possibly moderate *or minor* to negligible *or, at most, minor*.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands and water bodies would be the same as those discussed under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, these projects could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies is expected under this alternative.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

This alternative would have less potential long-term impacts on wetlands than Alternative D, because mechanical removal would not be the primary removal method and would only be potentially used in wetland and organic pasture buffers. Mechanical removal can impact wetlands by remobilizing sands and causing burial of some of the interior and adjacent wetlands. In this alternative, burial potential would be reduced and commensurate with the amount of buffer subject to excavation. Some sand remobilization could occur once European beachgrass and iceplant decompose, but, by that time, native vegetation should have established, thereby helping to stabilize soils. In addition, active revegetation would be conducted in backdune areas *and in dune areas adjacent to Limantour Marsh/Pond*, which would help to minimize the potential for remobilization after decomposition of European beachgrass to negatively impact adjacent wetlands. Less than 0.25 acre of wetlands at each of the North Beach, B Ranch, A Ranch, Davis Property, and Limantour project areas would be expected to be lost under this alternative due to long-term sand remobilization, *particularly as backdune areas would be actively revegetated*. *Losses* at some sites with more wetlands or accumulated sands (or larger dunes) such as AT&T could potentially exceed 1 acre. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

Based on these factors, restoration could have either negligible to possibly moderate long-term adverse impacts at AT&T, B Ranch, and Limantour, with moderate impacts potentially expected at AT&T. While losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T *and near Limantour Marsh/Pond* to reduce impacts from possibly moderate to negligible or minor. These include *active revegetation*, selective retention of some European beachgrass-dominated wetland buffers or regrading of steep slopes: See Possible Additional Mitigation Measures section for more information. No long-term impacts would be expected on adjacent water bodies or water quality within these water bodies.

Potential impacts to wetlands and water bodies at AT&T, B Ranch, and Limantour during or shortly after restoration would result primarily from staging, primary and secondary access, and chemical control. These impacts would range from no effect to minor. In general, staging and access would have no impact, as wetlands would be avoided during siting of primary and secondary access roads and staging areas, but, if temporary access or fills are required, there may be negligible to minor short-term impacts to wetlands. Chemical control may have very negligible to minor adverse impacts, with minor adverse impacts potentially from drift of imazapyr onto non-target wetland plant species. However, these impacts would be very short-term in nature, and wetland plants would be expected to quickly recolonize any areas impacted due to the fact that many species reproduce vegetatively. Mechanical removal in wetland buffers would most likely have no effect or negligible short-term effects on wetlands within the project areas.

From a regional perspective, based on the scale of projects proposed inside and outside the park, these projects could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies is expected under this alternative.

IMPACT OF ALTERNATIVE D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term impacts associated with continued expansion of European beachgrass and iceplant and dune restoration on wetlands can be found under Alternatives A, B, and C.

Based on the scale of restoration that may be implemented under this alternative, this alternative could have negligible to moderate adverse long-term effects on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity impacts potentially occurring in sites with more wetlands and larger dunes such as AT&T. The intensity of long-term impacts to these project areas would probably be higher under Alternative D than under Alternatives C and B, because mechanical removal would be the primary restoration method, and mechanical removal can result in more sand remobilization than other removal methods. Sand remobilization impacts would be minimized under this and other action alternatives, because active revegetation would be conducted in backdune areas *and in dune areas adjoining Limantour Marsh/Pond*, which would help to stabilize sands. *Predominant wind direction must be taken into account in evaluating the potential for remobilized sand to have impacts: the primary wind direction at Limantour is from the northwest-west, therefore winds would be blowing remobilized sand away/towards the Estero de Limantour and the wetlands behind Limantour Beach (Limantour Marsh/Limantour Pond; WRCC, Pt Reyes Lighthouse).* *Some sand may be occasionally blown into the Estero de Limantour, but impacts would be minimal, because sand is heavy and would quickly fall to the bottom of the Limantour and other open water bodies. However, there could be impacts to Limantour Marsh and Limantour Pond, which directly adjoin the dunes.*

More than 0.25 acre of wetlands might be lost due to long-term sand remobilization within each of these project areas, with losses at some sites such as AT&T exceeding 1 acre due to the fact that dunes are larger with more accumulated sands, and more wetlands are present. While these losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T *and at Limantour Marsh/Pond* to reduce impacts from moderate to minor. These include selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures section for more information.

There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative B, although the intensity of access and staging requirements – and impacts – may increase, as mechanical removal would be the primary removal method. Staging and access would generally have negligible to minor short-term adverse effect on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor effects occurring at AT&T if temporary fills are required for access.

Manual Removal: Potential short-term impacts would be the same as discussed under Alternative C. Given these factors, potential adverse impacts to wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour from manual removal would be very negligible.

Mechanical Removal: Potential short-term impacts of mechanical removal on wetlands are similar to those discussed under Alternative C, although the intensity of impact may be increased relative to that alternative, as mechanical removal would be the primary removal method. Mechanical removal would most likely have either no short-term effects on wetlands or water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour or, should temporary secondary access through wetlands be required, negligible to minor adverse short-term effects.

Chemical Control: Potential short-term impacts of chemical control on wetlands are similar to those discussed under Alternative C, although the intensity of impact would be greatly reduced as herbicide would be primarily used for spot-spraying of re-sprouts in mechanical removal areas. Based on factors discussed under Alternative C, including proposed impact avoidance and minimization measures, selective spot-spraying in non-wetland areas would be likely to have no effect or very negligible effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: As was discussed in much more detail under *Special Status Species* sections for Sonoma alopecurus and California red-legged frog and under *Water Resources*-Alternative C, to reduce potential localized adverse impacts to Sonoma alopecurus and wetlands, to reduce potential localized adverse impacts to wetlands and special status species, sands adjacent to the swale in which Sonoma alopecurus occurs at AT&T could be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds, as well as actively revegetated. In addition, there may be selective retention of some European beachgrass-dominated wetland buffers. *Areas adjoining Limantour Marsh/Pond may also be actively revegetated, even though these areas aren’t considered backdunes.*

Effectiveness of Possible Additional Mitigation Measures: In addition to reducing impacts to Sonoma alopecurus and California red-legged frog, this would reduce the potential adverse long-term impacts at some of the AT&T wetlands from moderate to minor *and at Limantour Marsh from possibly moderate to negligible or minor*.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands and water bodies would be the same as those discussed under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, this alternative could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies would be expected with any of the proposed or potential projects.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

This alternative would potentially have more long-term impacts on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour than Alternatives C and B, because mechanical removal would be the primary removal method, and mechanical removal can result in more sand remobilization that can bury wetlands. However, active revegetation would be conducted in backdune areas *and in dune areas adjoining Limantour Marsh/Pond*, which would help reduce remobilization of sand after European beachgrass decomposes and, therefore, reduce negative impacts on interior and adjacent wetlands.

Based on the scale of restoration that may be implemented under this alternative, this alternative could have negligible to moderate long-term adverse effects on interior and adjacent wetlands within the project areas, with minor to moderate impacts potentially occurring at AT&T/North Beach and B Ranch/A Ranch/Davis Property. More than 0.25 acre of wetlands might be lost within each of the project areas due to long-term sand remobilization, with losses at some sites such as AT&T potentially exceeding 1 acre due to the fact that the dunes are larger with more accumulated sands, and more wetlands are present. While these losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T *and in dunes areas adjoining Limantour Marsh/Pond* to reduce impacts from moderate to minor. These include selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures section for more information. No long-term impacts would be expected on adjacent water bodies or water quality within these water bodies.

Under this alternative, potential impacts to wetlands and water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour during or shortly after restoration would result primarily from staging and primary and secondary access. These impacts would range from no effect to minor. In general, staging and access would have no impact as wetlands would be avoided during siting of primary and secondary access roads and staging areas, but, if temporary access or fills are required, there may be negligible to minor short-term impacts to wetlands. Chemical control would have no more than very negligible effects on wetlands on a localized scale, as herbicide would only be used for spot-spraying of re-sprouts. Mechanical removal would most likely have either no short-term effects on wetlands or water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour or, should temporary secondary access through wetlands be required, negligible to minor adverse short-term effects.

Based on these factors and those discussed under Alternative B, potential long-term adverse effects to public safety from dune restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with the potential for both beneficial and adverse impacts being highest at Limantour and North Beach due to the fact they are much more heavily visited by the public. Some of these impacts could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to negligible beneficial effects.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on risks to public health and safety would be identical to those under Alternative B although the intensity of access and staging requirements -- and impacts – may increase slightly relative to Alternative B, because heavy equipment may be needed for mechanical removal of European beachgrass in wetland and organic pasture buffers. Potential impacts on public safety from staging and access would range from very negligible to possibly minor adverse effects. Potential minor adverse effects on public safety risks may occur if staging is located in public areas, such as parking lots at Limantour and North Beach.

Manual Removal: Impacts of manual removal on risks to public health and safety would be very similar to those discussed under Alternative B. Based on factors discussed under Alternative B, manual removal would have no more than a negligible effect on public safety risks at AT&T, B Ranch, and Limantour.

Mechanical Removal: Mechanical removal has the potential to impact public health and safety through the presence of heavy equipment. For safety reasons, the public would not be allowed within the work area during construction, and signs would be posted near the work area to that effect. Equipment operators would cease operation should a member of the public approach the equipment while in operation despite area being closed. Notices about the presence of construction equipment would also be posted at trailheads and on the park's website. Safety risks would be further minimized by limiting construction hours to weekdays from 7 a.m. to 6 p.m., with weekends only permissible with express approval of the park: Beach visitation is highest on the weekends.

Based on these factors, including proposed impact avoidance and minimization measures, mechanical removal would have the potential for no more than a very negligible effect on public safety at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Impact intensity would be reduced relative to Alternative D, because mechanical removal would be used only in wetland and organic pasture buffers.

Chemical Control: Chemical control has the potential to impact public health and safety through drift during spray operations and through direct contact with sprayed vegetation. Treatment areas would be posted as no public entry during and 24 hours after spraying regardless of the fact that herbicides proposed for use do not have a mandatory restricted-entry interval (REI). Notices about these closures would be posted at trailheads*, all potential access points, at the Bear Valley Visitor Center, and on the park's website.*

Two herbicides would be used under this alternative, as well as a surfactant and a dye. The two herbicides are glyphosate and imazapyr. By far, glyphosate has received the most attention, *perhaps due to the fact that a very large number of glyphosate products exist, as well as the wide availability to the general public of products such as Round-Up®.*

The EA principally relies on the risk assessment reports prepared by Syracuse Environmental Research Associates in 2011 for the U.S. Forest Service (USFS) for evaluation of potential impacts to human health and safety from use of herbicide during dune restoration. These reports discuss in extensive detail many of the medical and public *health studies that have been conducted and incorporate this information into development of public health risk assessments for the respective herbicides. The EA is not intended to be an encyclopedic discussion of all of the studies that have been conducted, but instead leverages the information and conclusions from these reports and from the associated risk assessment worksheets to assess potential risks to human health and other factors from application of the identified herbicides to the visiting public.*

A large body of literature exists on potential human health effects of herbicides, particularly on glyphosate. These glyphosate studies span a wide range of glyphosate types, formulations, concentrations, and settings (agriculture, forestry, laboratory studies). Medical conditions that have been potentially linked or associated with use of herbicide and herbicide formulations incorporating a surfactant include endocrine disruption, reproductive and developmental effects, carcinogenicity and mutagenicity, skin and eye irritation and sensitization, systemic toxic effects from dermal exposure, inhalation exposure, and toxicological interactions (SERA 2011a, SERA 2011b). In the United States, glyphosate was one of the first set of chemicals to be tested for endocrine disrupting effects by the USEPA as part of the USEPA Endocrine Disruptor Screening Program (EDSP; USEPA 2012). In March 2015, the World Health Organization announced that it was classifying glyphosate as "probably" causing cancer, although the USEPA reviewed research studies on glyphosate as recently as last year and concluded that there was "evidence of non-carcinogenicity for humans" (Pollack 2015).

The toxicity of glyphosate can vary widely based on the type (acid vs. salt); formulation (whether it incorporates a surfactant and surfactant type); application method (backpack spraying, boom spray, aerial spraying, etc.), and volume of herbicide applied. In some instances, some of the surfactants integrated or combined at the factory into glyphosate formulations such as may be even more toxic than the glyphosate itself (SERA 2011a):, studies clearly indicate that the toxicity of polyethoxylated tallow amine (POEA) surfactants integrated into the widely available Round-Up® product found at hardware stores and other retail outlets may be up to nine times more toxic than glyphosate (SERA 2011a). (As noted above, the park would not use a glyphosate formulation that has an integrated surfactant, but would instead use a non-ionic modified vegetable oil-based product such as Competitor®.) One of the most difficult issues in extrapolating from many of these research studies to the proposed use is that cell culture research studies often use much higher concentrations than would ever be experienced in weed management applications. For example, glyphosate concentrations in cellular toxicity studies often range from 0.1–1% in the cell culture medium: A concentration of 1% could only be achieved in a human body by a person drinking at least half a cup of a 44% glyphosate product, representing an acute poisoning scenario (PRI 2015).

For technical grade glyphosate, most available data clearly indicates that the mammalian toxicity of glyphosate is low, and very few specific hazards can be identified (SERA 2011a). Doses of technical grade glyphosate that exceed around 300 mg a.e./kg bw may cause signs of toxicity, including decreased body weight gain, changes in certain biochemical parameters in blood as well as tissues, and inhibition of some enzymes (i.e., P450) involved in certain metabolic cycles (SERA 2011a). At doses from about 1,000 to 5,000 mg a.e./kg bw, glyphosate can cause death (SERA 2011a). The most sensitive endpoint for glyphosate – i.e., the adverse effect occurring at the lowest dose – involves developmental effects: accordingly, the USEPA-derived reference doses (RfDs) for glyphosate are based on developmental effects (SERA 2011a). These adverse effects relate primarily to delayed development, which occurs only at doses causing signs of maternal toxicity (SERA 2011a). There is no indication that technical grade glyphosate causes birth defects (SERA 2011a).

The exposure assessments developed in the USFS risk assessments for both glyphosate (and imazapyr) are based on Extreme Values rather than a single value (SERA 2011a).

Extreme value exposure assessments, as the name implies, bracket the most plausible estimate of exposure (referred to statistically as the central or maximum likelihood estimate) with lower and upper bounds of credible exposure levels (SERA 2011a). This Extreme Value approach is essentially an elaboration on the concept of the Most Exposed Individual (MEI), sometime referred to as the Maximum Exposed Individual (SERA 2011a). Exposure assessments that use the MEI approach attempt to characterize the extreme, but still plausible, upper limit on exposure (SERA 2011a). This common approach to exposure assessment is used by USEPA, other government agencies, and the International Commission on Radiological Protection (e.g., ATSDR 2002; ICRP 2005; Payne-Sturges et al. 2004 *in* SERA 2011a). In addition to concern for the most exposed individual, there is concern for individuals who may be more sensitive than most members of the general population to exposure to a specific herbicide (SERA 2011a). This concern is considered in the dose-response assessment by USFS, which bases exposures on the most sensitive endpoint in the most sensitive species and uses an uncertainty factor for sensitive individuals (SERA 2011a). Young women are typically used, because lower body weight of women results in higher chemical dosages per unit body weight (e.g., Boxenbaum and D'Souza. 1990 *in* SERA 2011a), as well as being one of the more sensitive individuals in terms of reproductive effects as discussed above for glyphosate specifically (SERA 2011a).

Consistent with the USEPA approach, the current USFS risk assessment does not adopt an explicit acute RfD for glyphosate and uses the chronic RfD to characterize risks associated with both acute and longer-term exposures (SERA 2011a). The Office of Drinking Water (USEPA/ODW 1998 *in* SERA 2011a) proposes a 20 mg/L 10-day health advisory for glyphosate (SERA 2011a). The 10-day health advisory is based on the no-observed-adverse-effect level (NOAEL) of 175 mg/kg/day from a rabbit reproduction study (Rodwell et al. 1980b *in* SERA 2011a). While rats are typically used in research studying potential effects on humans, the developmental studies submitted to the USEPA clearly indicate that rabbits are more sensitive than rats (SERA 2011a). An uncertainty factor of 100 was applied to this NOAEL, and the 10-day exposure limit was set at 1.75 mg/kg/day and rounded to 2 mg/kg bw/day, identical to the chronic RfD derived by USEPA (SERA 2011a). The uncertainty factor of range from 0.00003 to 0.002 mg a.e./kg/event, which is well below the acute RfD of 2 mg a.e./kg bw/day. *The upper end of the exposure range for a reproductive woman swimming in waters for 1 hour would be 0.00000055 mg a.e. kg/event, while that for a child would be 0.037 mg a.e. kg/event, again well below the acute RfD of 2 mg a.e./kg bw/day*.

Risks to the general public from accidental and non-accidental exposures are often expressed in hazard quotients (HQs), in which a HQ of 1 is considered the threshold level of concern. Based on USFS risk assessment worksheets developed by SERA, HQs for contact of an adult female wearing shorts and a t-shirt with vegetation sprayed with glyphosate would range from 0.0007 to 0.006, well below the level of concern (1.0). HQs for possible direct body or leg spray of either a child or an adult female associated with drift would range from 0.00001 to 0.001, again well below the level of concern (1.0). *The HQs for a woman swimming in herbicide drift-affected waters would be 0.0000003 and for a child consuming water would be 0.02, both of which are well below the threshold level of 1*.

Indeed, for the general public, the only non-accidental exposure scenario of concern for glyphosate is for consumption of contaminated vegetation shortly after application (SERA 2011a). For this exposure scenario, the HQ reaches a level of concern (HQ=1) at an application rate of about 1.4 lbs a.e./acre (SERA 2011a). At the maximum labeled application rate of about 8 lbs a.e./acre, the resulting HQ value would be about 5.6 with a corresponding dose of about 10.8 mg/kg bw (SERA 2011a). A HQ of 5.6 would raise concerns for adverse health effects in pregnant women (SERA 2011a). Based on the more recent study by Moxon (1996b *in* SERA 2011a) which notes a LOAEL for fetotoxicity of 300 m/kg bw, a HQ in the range of 5 might raise concern for fetotoxicity (SERA 2011a). Again, this assumes consumption of contaminated European beachgrass or iceplant, which is extremely unlikely.

Imazapyr is the other herbicide proposed for use. The USEPA classifies imazapyr as practically non-toxic to mammals, birds, honeybees, fish, and aquatic invertebrates (SERA 2011b), and SERA (2011b) states that, “this classification is clearly justified.” None of the expected (non-accidental) exposures to these groups of animals raise substantial concern; indeed, most accidental exposures raise only minimal concern (SERA 2011b). The reported signs and symptoms of imazapyr poisoning include vomiting, impaired consciousness, and respiratory distress requiring intubation: There are no reports of human fatality due to imazapyr ingestion (SERA 2011b). An adequate number of multi-generation reproductive and developmental studies have been conducted with imazapyr, none of which indicated adverse effects on reproductive capacity or normal development (SERA 2011b). Also, the results of assays for carcinogenicity and mutagenicity are consistently negative (SERA 2011b). Accordingly, the USEPA categorizes the carcinogenic potential of imazapyr as Class E: evidence of non-carcinogenicity (SERA 2011b). Based on studies, imazapyr also does not appear to be neurotoxic (SERA 2011b). Imazapyr and imazapyr formulations can be mildly irritating to the eyes and skin (SERA 2011b).

According to the USFS risk assessment prepared by SERA (2011b), toxicity information for imazapyr is reasonably complete and unambiguous. The USEPA derived a chronic RfD of 2.5 mg a.e./kg/day based on a dog study that documented a NOAEL of 250 mg a.e./kg/day with an uncertainty factor of 100 (SERA 2011b). The NOAEL selected by the USEPA “appears to be the most appropriate and is supported by additional NOAELs in rats and mice, as well as a number of studies on potential reproduction and developmental effects” (SERA 2011b). Consistent with the USEPA’s approach, no acute RfD is derived in the current USFS risk assessment, with the chronic RfD of 2.5 mg a.e./kg/day being used to characterize the risks of both acute and long-term exposure (SERA 2011b). The only adverse effects associated with exposure to imazapyr, albeit at very high doses, are those documented in developmental toxicity studies, so young women were selected as the most sensitive individuals for this assessment (SERA 2011b).

No data are available on dermal transfer rates for imazapyr specifically, but, as noted earlier, dermal transfer rates are reasonably consistent for numerous pesticides (Durkin et al.

DISTRIBUTION LIST

List of agencies and organizations to which copies of Notice of the EA have been sent. Approximately 416 individuals were also mailed notices.

Federal Agencies
U.S. Army Corps of Engineers
U.S. Geological Survey
U.S. Fish and Wildlife Service
U.S. National Marine Fisheries Service
U.S. National Park Service – Denver Service Center
U.S. Environmental Protection Agency

Federal Advisory Groups
Advisory Council for Historic Preservation

Elected Officials
Marin County Supervisor Steve Kinsey
California State Assemblyperson *Marc Levine*
U.S. Representative Jared Huffman
U.S. Representative Lynn Woolsey
U.S. Senator Barbara Boxer
U.S. Senator Dianne Feinstein

State Agencies
Bay Area Air Quality Management District
California Coastal Commission
California Coastal Conservancy
State of California Department of Fish and Wildlife
State of California Department of Health Services
State of California Department of Parks and Recreation
State of California Office of Planning and Resources State Clearinghouse
State Historic Preservation Office
State Lands Commission
University of California, Davis, Bodega Marine Laboratory
University of California Cooperative Extension

Regional, County, and Municipal Agencies
Bolinas Community Public Utility District
Inverness Public Utilities District
Marin County Community Development Agency
Marin County Fire Department
Marin County Open Space
Marin County Sheriff's Office
Marin County Resource Conservation District
North Marin Water District
San Francisco Regional Water Quality Control Board
Sonoma County Agriculture Preservation and Open Space District

Non-Governmental Organizations, Non-Profit Organizations, etc.
Audubon Canyon Ranch & Cypress Grove Preserve
Bay Institute
Bluewater Network

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