U.S. Fish and Wildlife Service - Alaska Region
Terrestrial Invasive Plant Management Strategy

Programmatic Environmental Assessment

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Prepared by

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This Programmatic Environmental Assessment (EA) has been prepared to evaluate the effects associated with the proposed actions and complies with the National Environmental Policy Act (NEPA) in accordance with Council on Environmental Quality (QEC) regulations (40 CFR 1500-1508), the Department of the Interior (43 CFR 46; 516 DM 8) and the U.S. Fish and Wildlife Service (Service) (550 FW 3) regulations and policies. The NEPA requires examination of the effects of proposed actions on the natural and human environment. Appendix A outlines all laws and executive orders evaluated throughout this EA. This EA will help the Service select a strategy to manage terrestrial invasive plants in the Alaska Region (Region). The decision regarding a selected alternative and the reasoning for the selection is documented in a Finding of No Significant Impacts (FONSI) document.

Proposed Action

The Region is proposing to implement a region-wide integrated pest management (IPM) strategy (IPM strategy) focused on Early Detection and Rapid Response (EDRR) for terrestrial invasive plants. An invasive species is defined as "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health" (DOI 2021). The legal definition of IPM is "a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks" (7 USC § 136r-1). The Department of Interior (Department) defines EDRR as "a coordinated set of actions to find and eradicate potential invasive species before they spread and cause harm" (DOI 2016). The Department defines Early Detection further as "a process of surveying for, reporting, and verifying the presence of a non-native species before the founding population becomes established or spreads so widely that eradication is no longer feasible." Rapid response is further defined as "a process that is employed to eradicate the founding population of a non-native species from a specific location." Rapid Response efforts vary in duration to achieve eradication due to site and species specifics of an infestation.

The Region's IPM strategy analyzed in this EA focuses on managing infestations detected on Service lands and at critical access points off Service lands (e.g., trailheads, boat launches, airstrips, road corridors, waterways, private allotments), in accordance with the Service's IPM policy 569 FW 1 (USFWS 2010(a)). The Service's IPM Policy mandates the implementation of a science-based, systematic decision process for pest and invasive species management. The process incorporates 1) setting management goals, 2) consensus building with partners such as Cooperative Invasive Species Management Areas (CISMA), 3) understanding the pest (e.g., terrestrial invasive plant) biology, 4) understanding environmental factors that promote or inhibit the pest, 5) selection of the best available technology to achieve desired outcomes while minimizing effects to non-target species and the environment and preventing unacceptable levels of pest damage, and 6) post-treatment monitoring (USFWS 2010(a)). The outcome of the IPM evaluation process is a decision on the method, or combination of methods, which would be applied to manage invasive plant infestations.

In the Region, the goal of invasive species management actions whenever possible is total eradication of the infestation. Methods available to invasive plant managers may include one or more of the following management techniques: cultural, physical, biological, and chemical; however, the Region does not currently employ all these methods at this time. Some infestations may require an adaptive management approach in order to achieve eradication or maximum control, in which treatment approaches are implemented, evaluated, and modified as necessary based on the outcome of previous efforts.

The Region and partners identified two alternatives when providing technical and financial assistance to invasive plant management projects. Activities under Alternative 1 include following an IPM approach without the use of herbicides. Alternative 2 (proposed action) activities include following the IPM approach with the judicious use of the herbicides specified in this EA to manage infestations less than or equal to 20 acres (within an infested area on Service land or at critical access points off Service lands), with the active ingredients and application methods analyzed herein, with each unique infestation site receiving a single herbicide application per year for typically 3 years; timelines for achieving eradication vary based on site and plant characteristics.

The Region defines an infestation site as the specific location that an individual invasive plant is growing. An infested area is defined as one or more invasive plants or geographically separated groups (populations) of invasive plants collectively encompassed within a relatively small and geographically distinctive place. For example, an infested area may consist of a single place with an isolated population of three orange hawkweed plants. However, an infested area also may consist of 50 or more populations—each a single infestation site—of hawkweed plants collectively distributed within a geographically distinct area.

If the proposed action is adopted, the Region will implement Alternative 2 collaboratively with partners, such as Federal, Tribal, and State agencies, as well as CISMAs, to facilitate conservation of terrestrial native species of wildlife and plants, their habitats, and the dependent uses both on and off Service lands. For this IPM strategy, Service lands are considered National Wildlife Refuges (NWR) as well as NWR and Field Office (FO) infrastructure (e.g., administrative offices, warehouses, hangers, and equipment yards). In the Region it is common that Service infrastructure are located in hub communities, and not physically on an associated NWR. However, this infrastructure can be a source of introductions into other urban, rural, or remote Service and partner lands.

The Service is aware that its own activities can contribute to the spread of invasive species. Service prevention includes: internal and external education outreach; Hazard Analysis and Critical Control Point and biosecurity plans that apply best management practices such as "clean, inspect, seal" to seven common vectors of species introduction including personal belongings, gear, food, watercraft, aircraft, and heavy equipment. Invasive species management activities off Service lands would only be undertaken through consultations, with the approval of the landowner, and in accordance with Service policy and all applicable land management laws and regulations. This includes site specific consultations under the Endangered Species Act (ESA), the National Historic Preservation Act (e.g., Section 106), or Government to Government consultations.

Purpose and Need for the Action

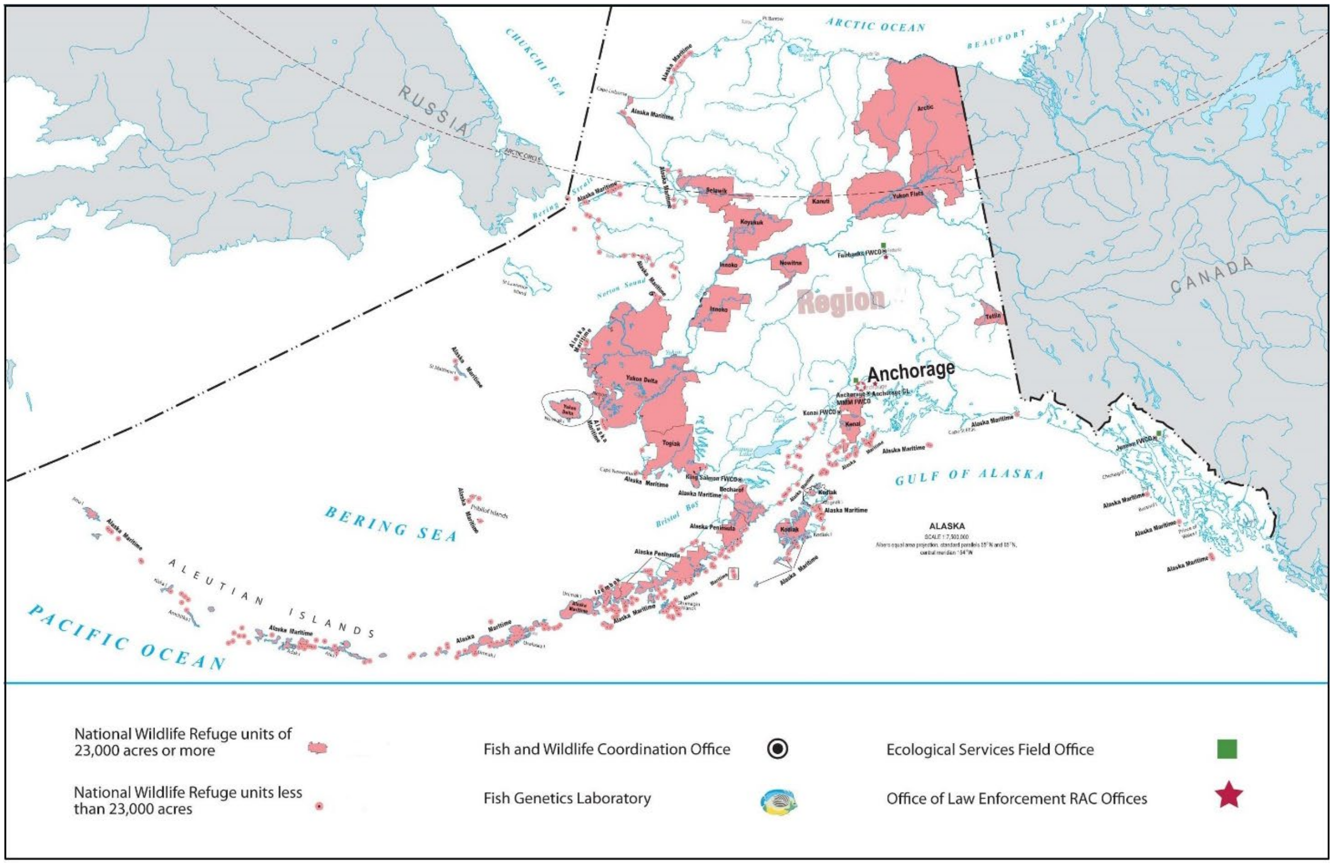
The purpose of the proposed action is to implement an IPM strategy that allows site specific eradication of invasive terrestrial plants in a consistent, feasible, and cost-effective manner across the Region with a goal of helping to maintain functional ecosystems and processes. The action is needed because terrestrial invasive plants can displace native species, alter community composition, and influencing ecosystem processes and functions (Cronk and Fuller 1995, Walker and Smith 1997, Cox 1999, Carlson et al. 2008). Additionally, the Region needs a strategy focused around urban and rural centers and access points to remote and less infested parts of Alaska. Finally, methods of prevention and EDRR to infestations utilizing IPM strategies are needed to reduce the negative impacts invasive terrestrial plants have on subsistence, cultural, recreation, economic, and agricultural resources throughout Alaska.

Background

There are 333 confirmed non-native plant species in Alaska (AKEPIC May 2021). Most of these are limited in geographic scope and impact on the ecosystem; however, at least of 104 of these non-native species are considered invasive. Region-wide IPM of invasive plant species is integral to fish, wildlife, and habitat conservation due to the ability of invasive species to out compete native species and alter the ecosystem services.

The Service has authority to work with partners to manage invasive species on and off Service lands and waters under the National Invasive Species Act, the National Wildlife Refuge System Administration Act, the National Wildlife Refuge System Improvement Act (which amended the National Wildlife Refuge System Administration Act), the ESA, and Executive Orders 13112 and 13751. The Service's IPM Policy, the Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy, and other Refuge policies direct how invasive species should be managed. The Fish and Wildlife Coordination Act and the Sikes Act also influence the Service's invasive species management. Eradication and control of invasive species to restore and maintain the ecosystems and wildlands of the Region "for all to utilize" is one way the Service complies with its mandates, mission, and policies.

The Service manages 16 NWR, totaling ~76,800,296 acres (Fowler 2019) and three Field Offices in Alaska (Figure 1). Conservation and management activities on and off Service lands is achieved through cross-programmatic coordination at the Regional and local level between programs such as the NWR program, the Fish and Aquatic Conservation program and Ecological Services program. The Service partners with Federal, State, Tribal entities, private landowners, non-governmental organizations and industry to conserve and restore habitat on and off Service lands and waters on which the IPM strategy would be applied. Historically, terrestrial invasive plants had been largely constrained to disturbed areas that included roadways, trails, construction sites, and urbanized areas, and former ranches (e.g., cattle and sheep ranching in the Aleutians; Carlson et al. 2008). However, terrestrial invasive plants are beginning to spread beyond the disturbed areas and into wildlands of Alaska due to greater human mediated pathways, increasing human disturbance, warmer annual temperatures, and longer growing seasons (Carlson and Shepard 2007, Mulder and Spellman 2019). Terrestrial invasive plant species such as orange hawkweed (*Hieracium aurantiacum)*, white sweetclover (*Melilotus albus)*, and reed canarygrass (*Phalaris arundinacea)* have been identified on Service lands and at critical access points (AKEPIC May 2021). Most infestations have been monitored and treated primarily with physical methods for multiple years, and the detection of new infestation sites or expanded infested areas requires additional effort. More aggressive invasive plants are becoming established on and near Service lands and are not contained with current management methods, which point to a need for more effective management strategy that utilizes the judicious use of all methods in a systematic way.



The Service's NWRs and FOs can be found in four distinct Ecoregions: Polar, Bering Coast, Interior Alaska, and North Pacific Coast (Woodward and Beever 2011), derived from Nowacki et al. (2002) Unified Ecoregions of Alaska. An ecoregion is designated based on the geography, climate, availability of water, and species of animals and plants present. They also support various public use, ease of access, disturbed acreage, and extent of invasive species established. The strategy employed to manage invasive species must be adaptable across the Region, flexible to accommodate the variety of conditions that may be found, specific enough to direct actions at the local level, and capable of directing both adaptive management of established populations as well as enabling rapid response to new introductions.

The Region-wide IPM strategy must include a broad range of coordinated actions, such as, environmental education and prevention activities; surveys to assess occurrence and extent of invasive plants; application of various methods to eradicate or control invasive plants; and post-treatment monitoring to evaluate effectiveness. An IPM toolbox may include one or more of the following control methods: cultural, physical, biological, and chemical. Cultural control methods can be described as management tools that modify human behavior to control invasive species. Physical control methods include things such as hand-pulling, hoeing, mowing, tilling and, prescribed fire. Biological control may include the intentional introduction of predators, parasites or pathogens that can help achieve their desired management goal. Chemical control includes the judicious use of pesticides such as herbicides, insecticides, rodenticides, or fungicides. All herbicides used in the United States must be registered by the United States Environmental Protection Agency (EPA). The EPA requires extensive scientific data on the potential health and environmental effects of an herbicide before granting a registration, which is a license to market that product in the U.S. If the full suite of IPM tools are not available, then there is a risk of losing the opportunity to prevent irreparable damage to resources across Service lands and at critical access points in Alaska.

The Region utilizes the IPM categories according to the biology of the species at hand. As experience with IPM application is acquired, the Service may modify its approach to improve success at accomplishing the management goal. The management goal in this EA is early detection and rapid response with site specific eradication of incipient infestations. Invasive plant management efforts in the Region have targeted particular species that are not yet widespread on a Service land unit and have a potential to impact Service resources. Where feasible, field employees and partners physically remove infestations with volunteer crew assistance for large infestations. For some species, root removal can maximize control effectiveness relative to cutting; therefore hand-pulling with minor digging is a prevailing management method. Species such as white sweet clover can be effectively managed by physical methods such as pulling the plant prior to it going to seed and then implementing follow-up monitoring of a site's seedbank. Alternatively, perennial invasive plants such as hawkweeds are best managed with an herbicide since the plant can reproduce by seed or vegatatively by stolons, rhizomes, and adventitious root buds. Prior to implementing any management strategy (e.g., hand pulling or herbicides) the biology of the species and efficacy of management action method is thoroughly assessed.

The Region uses invasiveness ranking as means of assessing the magnitude of threat of a species and priority of management. Carlson et al. (2008) ranked invasive plant species present in Alaska, as well as species that are likely to be introduced according to their degree of invasiveness according to the following process. A species is first screened for climate compatibility for the four Ecoregions within Alaska. If the species is present, or may potentially establish in any of these Ecoregions, it is then evaluated on a 100-point (pt) scale based on four categories: 1) known and/or potential impacts on ecosystems (40 pts); 2) biological attributes (25 pts); 3) geographic distribution (25 pts); and 4) available management measures (10 pts). A series of questions for each category was answered and weighted (See Appendix B of Carlson et al. 2008 for an example invasiveness ranking form with questions and scores). Additionally, any questions for which information is unknown are omitted from the total potential points. The scores are then calculated based on the relative potential points (the sum of points scored divided by the total points possible); species scoring from 60 to 69, 70 to 79, and 80 to 100 are considered moderately-, highly-, and extremely-invasive, respectively. The NWR staff use this ranking system along with site specific conditions and circumstances through the IPM process to prioritize targeted species.

Alternatives

The NEPA regulations state that an agency must rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives that were eliminated from detailed study, briefly discuss the reasons for their elimination (42 U.S.C. 4332(E) and 40 C.F.R. 1508.9). This EA: 1) presents and evaluates alternatives that meet the purpose and need; and 2) proposes selection of the alternative that best meets Service policy while minimizing potential unintended impacts.

In this section, the two alternatives for Service-funded management of terrestrial invasive plants within the Region are described. Implementation of each alternative would entail application of an IPM approach. The alternatives the Service has considered include the Regional IPM Strategy without Herbicide, Alternative 1, in which current management strategies - IPM with primarily physical management techniques, planned and implemented at the local level - would continue to be applied. This alternative provides a basis for comparison of the other alternative. Alternative 2, the preferred alternative, is the Regional IPM Strategy with Herbicide, which includes the potential for application of site specific physical and chemical treatment methods and adaptive management practices.

Both alternatives would occur on Service lands and critical access points that could serve as pathways for invasive species introduction and spread on Service lands. Invasive species management activities not on Service lands would only be undertaken under local consultations, approval of the landowner, and in accordance with all applicable land management laws and regulations. Access to sites would be gained on foot or vehicle (e.g., ATV, truck, plane, or boat) and staging of any equipment would take place at infestation sites and/or at the edge of access corridors (e.g., trails, roads, lakes). Both alternatives involve planning, education, and monitoring elements that are not control actions and will have no effect to the environment.

The following activities are included in the both alternatives and are covered under the Department's NEPA Categorical Exclusions (CE) (https://www.doi.gov/sites/doi.gov/files/uploads/doi_and_bureau_categorical_exclusions.pdf). This includes activities such as:

- Prevention tactics, outreach and education;
- Surveying and mapping of areas with known infestations;
- Physical control of invasive species (see Table 1);
- Operation, maintenance, and management of existing facilities and routine recurring management activities and improvements[1];
- Restoration, rehabilitation, and revegetation; and,
- Monitoring.

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[1] NEPA-Categorical Exclusion 516 DM8.5 B(2) Page 4 "The operation, maintenance, and management of existing facilities and routine recurring management activities and improvements, including renovations and replacements which result in no or only minor changes in the use, and have no or negligible environmental effects on-site or in the vicinity of the site." The Region determined this applies to invasive species management utilizing all IPM strategies as a maintenance activity. Service staff working under the CE for chemical treatments at facilities will ensure the actions have no or negligible environmental impacts and that no extraordinary circumstance apply.

In the future, additional plans to address specific invasive plant management issues may be prepared. Project-specific plans containing invasive plant treatments or having associated potential impacts that have not been considered in this analysis would require additional compliance with NEPA.

Based on past Service and partner EDRR practices, the Region considered the following scenario while analyzing the impacts of Alternative 1 and 2. Each year, the Service and partners will conduct Early Detection surveys for terrestrial invasive plants at priority locations on Service lands and critical access points. During a detection survey, crews may detect invasive terrestrial plants. The infested area will be thoroughly mapped to determine the extent of the abundance, distribution, and diversity of invasive plants. This information will then be used to develop a response plan that will likely be implemented the following year (pending logistical and financial constraints). An infested area could be one small cluster or it may be a patchwork of native and invasive plants with varying degrees of infestation (Figure 2). Response measures will vary in methodology and application type depending how widely the invasive plants are distributed and their abundance. Depending on plant and site specifics, this could mean full removal of vegetation and native species restoration actions. Response actions could also be initial treatment of the infested area with broadcast spraying at maximum label rate with subsequent physical treatments or herbicide applications at significantly reduced rates (due to less invasive plants) via more direct methods. The Service and our partners do not typically use broadcast spraying (as defined in Table 3) due to the patchiness of infested areas, especially infested areas detected in early detection surveys as these tend to be the incipient introduction.

Figure 2. Hypothetical example of an infested area (polygon) comprised of a patchwork of infestation sites (A and B) that could be collectively eradicated utilizing the full suite of tools within an IPM strategy. Images A and B illustrate the various levels of the distribution and abundance of invasive plant (in this case the flowering plant on the forest floor) can have within an infested area.

The management techniques of the two alternatives and the potential impacts are described and analyzed in the following sections.

Alternative 1: Regional IPM Strategy without Herbicide (No Action)

Under this alternative, the Service would continue to respond to terrestrial invasive plants on Service lands and critical access points determined by local staff and their partners, employing IPM methods. Alternative 1 would exclude chemical methods of management while maximizing use of non-chemical methods of management in an attempt to contain, and to the greatest extent possible, eradicate priority species. Public outreach and education and invasive plant early detection surveys and post-treatment monitoring will be important components of invasive plant management under this alternative.

The spatial scope of management actions will identify the geographic area where invasive plant management activity will occur and sets the state for what types of information should be gathered to inform a response plan (USFWS and CIPC 2018). Invasive species early detection surveys are focused on detecting the location and abundance of invasive species that are not yet established within a pre-determined area, with recognition that a potential for establishment exists (Olsen et al. 2015). Systemic surveys of this kind also occur in areas where invasive species are known to exist in order to understand change in distribution or abundance and develop management plans. It is a process of surveying for, reporting, and verifying the presence of an invasive species that will prevent the founding population to become established or spread so widely that eradication is no longer feasible (USDOI 2016). Once verified, established IPM procedures can be rapidly implemented to control newly discovered, incipient, and therefore small populations of invasive plants. Rapid response timeframes will vary with the invasive species and the environment, as well as response capacity; timelines for achieving eradication vary based on site and plant characteristics.

Physical management techniques involve blanketing, damaging, or removing invasive plants by hand or using hand tools/barrier clothes. Descriptions of the physical methods available to Service staff can be found in Table 1. The current strategies for managing invasive plant species are designed and determined by local staff, and in conjunction with their partners when working off Service lands. These strategies may prioritize simple actions (e.g., surveying, mapping) that are achievable with local staff and resources over those that may be more effective at a regional scale. In general, infestations exceeding 6.2 acres of perennial invasive plants may require enormous physical effort to eradicate or reach maximum containment, and may not be feasible with limited staff or volunteers and time available during the growing season. Due to the constraints of relying on surveying only or primarily physical treatment methods, localized response plans allow infestations to go untreated, or infestations are treated with tools that do not meet the ultimate objectives of eradication and maximum control. Using only localized responses can permit invasive species to surpass larger thresholds, negatively impact the local environment, and become more difficult and costly to manage.

Table 1. Physical management techniques and corresponding equipment used to conduct invasive plant management.

Physical Method	Description	Equipment Needed
Cutting	Lop off target plants below flower head or at ground level; remove above-ground non-target plants to provide safe access to invasive plants, and also to improve exposure of foliage of invasive plants	saws, axes, loppers, weed whacking, and machetes
Girdling	Cut away a strip of bark several inches wide around trunks of trees or woody vines to interrupt the flow of nutrients to leaves and active growing points	knife, ax, saw, or specific girdling tool
Hoeing	Scrape seedlings from the soil or cut off small plants just below the soil level	a variety of hand-held tools may be used
Mowing	Cut or shred aboveground vegetation;	mechanical mowers, weed whackers, hand-held sickles, scythes, or machetes
Mulching	Physically impede plant growth and exclude light from germinating plants	mulches may be organic such as straw, sawdust, or crop residues, or synthetic such as woven plastic or nylon
Prescribed Fire	Intentionally set and allowed to burn under a controlled set of conditions; developed by experienced fire managers and ecologists; predictable fire characteristics that produce desired results	hard hats, fire resistant shirts and pants, fire shelter, eye protection, gloves and hearing protection
Pulling (by hand)	Hand Pulling: remove the plant from the soil	work gloves
Pulling (w/tools)	Pulling tools may be used for large plants, shrubs, or trees	various pulling tools (Root Talon, Weed Wrench, etc.)
Smothering	Covering discrete patches with a bulky, decomposable material which does not necessitate eventual removal from the site	decomposable material
Soil solarization	Cover damp soil to trap heat and increase soil temperatures to levels that are lethal to plants and seeds[2]	clear or black plastic
Stabbing	Damage the underground carbohydrate storage structure (e.g., taproot, root corm, or rhizome)	spade, pruning saw, or knife

Alternative 2: Regional IPM Strategy with Herbicide (Preferred Alternative)

Due to the aggressive nature of invasive plants, unless detected very early, eradication of the majority of invasive plants is not achievable if only physical methods listed in Alternative 1 are permitted, and in some cases physical control of terrestrial invasive plants (e.g., orange hawkweed) can be counterproductive (Wilson and Callihan 1999, Seefeldt and Conn 2011). Therefore, Alternative 2 consists of using an IPM strategy, including the physical techniques listed in Alternative 1, plus a regional framework for the strategic, judicious use of three herbicides to manage invasive terrestrial plants. The IPM strategies are site- and plant-specific, include a range of treatment options, and include adaptive management in which actions are implemented,

[2] If conducted in or near a wetland and materials are not removed, this treatment method may convert the area into more of an upland site. The Service will consult with the U.S. Army Corps of Engineers when this method is being considered.

evaluated, and modified as necessary based on the outcome of previous efforts (USFWS 2010(a)). A regional approach will provide consistency in Service responses to invasive terrestrial plants, including the use of specific herbicides, for Service staff and their partners throughout Alaska.

Alternative 2 includes only actions that would be taken under an invasive species response framework – a set of coordinated actions to verify a report, map the infested area, and eradicate the species before they can spread further and cause harm. These activities are laid out in greater detail in the Region's Rapid Response Plan for Invasive Terrestrial and Emergent Plants (USFWS 2020). This approach minimizes our use of herbicides spatially and temporally, because small or incipient infested areas are treated for a relatively short amount of time, with the goal of eradication. If not eradicated, the treatment actions move from eradication to maximum containment (Figure 1) and long-term management, which may require greater amounts or different types of herbicides and IPM actions, or a longer treatment time. Containment and long-term control actions are therefore not included in this EA.

The Service will evaluate response strategies based on the invasive species and site-specific conditions. Using the best available scientific information, along with the established decision tree (Figure 3), the Service will apply appropriate physical, chemical, or both methods, using best management practices. Herbicide would be selectively applied where: physical means were deemed infeasible; or physical techniques were attempted but failed to eliminate invasive plants; and the Service and partner objectives for the area could be met while minimizing environmental impacts.

The physical methods and site access would be the same as described in Alternative 1, and therefore result in similar impacts. Under Alternative 2, the Region additionally evaluates treatment of terrestrial invasive plant infestations less than or equal to 20 acres, within a specific area on Service land or at critical access points off Service lands, with one of the specific active ingredients in Table 2 (aminopyralid, triclopyr, or glyphosate) and using application methods in Table 3, with each unique infestation site receiving a single herbicide application per year for typically 3 years; timelines for achieving eradication vary based on site and plant characteristics. The EPA defines an "active ingredient" as a chemical that prevents, destroys, repels, or mitigates a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. Active ingredients are chemicals in a pesticide product that act to control the pests and must be identified by name on the pesticide product's label together with its percentage by weight. All other ingredients are called "inert ingredients" by Federal law. They are important for product performance and usability. Inert ingredients are chemicals, compounds, and other substances, including common food commodities (e.g., certain edible oils, spices, herbs) and some natural materials (e.g., beeswax, cellulose). The name "inert" does not mean non-toxic. All inert ingredients must be approved by the EPA before they can be included in a pesticide (EPA, Accessed August 2021). Under this scenario, if the chemical component of the Regional IPM Strategy were utilized on 20 acres per NWR in the Region, up to 320 acres (out of 76,800,296 acres of Service lands in Alaska) per year could be applied. However, the Service anticipates that no more than 200 acres of land be treated per year for the entire Region, given the Region's historical use of herbicide and anticipated use as a result from the Region's expanding invasive species survey and response efforts. If a station within the Region needs to address a specific infestation greater than 20 acres, a localized NEPA analysis will be conducted.

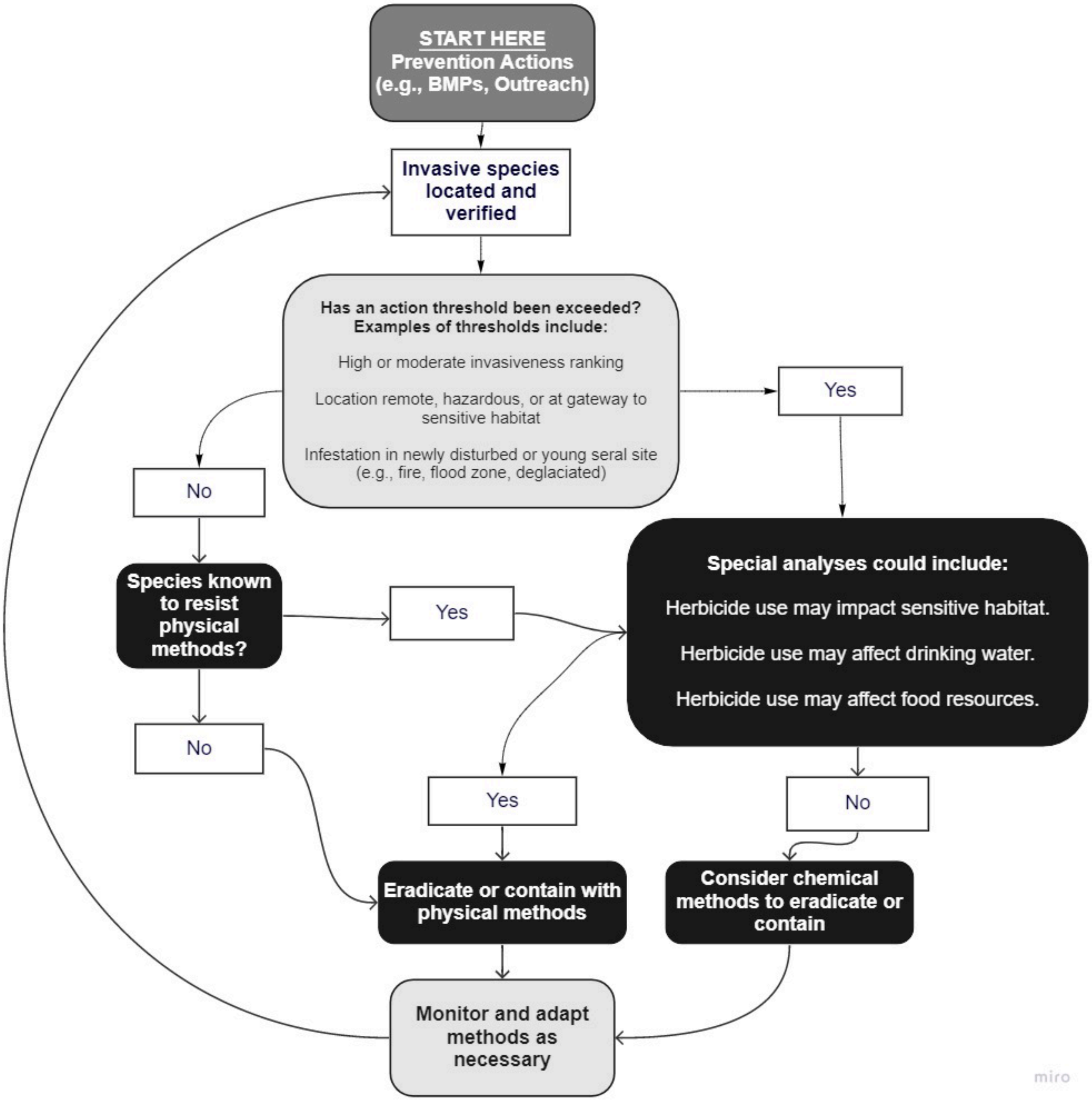

Figure 3. IPM Decision Tree, adopted and modified from the National Park Service Alaska Region's 2009 revised Environmental Assessment for Invasive Plant Management. Sensitive fish and wildlife habitat may include things such as: designated critical habitat for Endangered Species Act listed species, spawning and rearing habitat for native fish, or nesting habitat for migratory birds. In some instances, herbicide application in sensitive habitats or around drinking water or food resources may be warranted if the short-term local impacts are outweighed by the long-term benefits to the resources; this will be determined on a project specific case by case basis.

Table 2. Active ingredients in herbicides proposed for Alternative 2 - Regional IPM Strategy with Herbicide in this EA. Only herbicides registered for use by the EPA and the Alaska Department of Environmental Conservation for use in Alaska will be considered. All current Service Best Management Practices and EPA label requirements for individual herbicide products must be followed.

Active Ingredient	Example Herbicide (not inclusive)	Target Taxa	Mode of Action (MOA)	2021 USFWS BMPs (not inclusive)
Aminopyralid	Milestone Specialty	Broadleaf plants, notably thistles and knapweeds (Aster family)	Herbicide MOA Group 4 - Synthetic auxins/auxin mimics: Applied to the leaves of broadleaf plants (dicots), these synthetic growth hormones cause uncontrolled growth, foliage discoloration, and deformed new growth.	Do not apply to water, to areas where surface water is present, or to intertidal areas below the mean high-water mark. Do not use broadcast on permeable soils (sandy, sandy loam, gravel) and where distance to groundwater is <10 feet. Use only spot treatments in these areas. Potential for travel to groundwater is high (GUS = 4.8).
Triclopyr	Garlon products	Woody plants and broadleaf plants.	Herbicide MOA Group 4 - Synthetic auxins/auxin mimics: Applied to the leaves of broadleaf plants (dicots), these synthetic growth hormones cause uncontrolled growth, foliage discoloration, and deformed new growth.	Trilopyr has high potential to move to groundwater (GUS[a] = 3.69). Do not use broadcast application methods on permeable soils (sandy, sandy loam, gravel) and where distance to groundwater is <10 feet. Use only spot treatments in these areas. To minimize negative impacts to bees and other insect pollinators, if possible, treat prior to blooming in spring, or after bloom in fall, or apply in the morning or evening when pollinators are less active.
Glyphosate	Roundup Pro, Roundup Ultra, Roundup Custom (formerly Aquamaster), Rodeo, GlyPro, Accord, Glyphomax, Touchdown	Grasses, herbaceous plants (including deep rooted perennial invasive plants, brush, some broadleaf trees and shrubs, and some conifers)	Herbicide MOA Group 9 – Glycines/Enolpyruvyl Shikimate Phosphate Synthase (EPSPS) Inhibitors: EPSPS inhibition leads to depletion of the aromatic amino acids tryptophan, tyrosine, and phenylalanine that are needed for protein synthesis and new plant growth. Plants exposed to glyphosate display stunted growth, chlorosis, leaf wrinkling or malformation, and tissue death.	Do not treat within 25 feet of surface water because of aquatic plant toxicity unless specifically using a product labeled for aquatic use. Use caution where sensitive non-target plants are present. Apply aquatic labeled glyphosate formulations to aquatic habitats and to riparian habitats within 25 feet of surface water resources; ensure that surfactants are classified as practically non-toxic or slight acute toxicity (LC 50 > 10 ppm) to aquatic organisms. Slight acute toxicity surfactants include LI-700, AgriDex, Activate Plus, Big Sur 90, Sil Energy, Dyne-Amic, Freeway, Cygnet Plus, Sun-Wet, Hasten Modified Vegetable Oil, Kinetic or Class Act Next Generation.

[a] Groundwater ubiquity score (GUS): an experimentally calculated value that relates pesticide half-life and sorption potential/sorption coefficient (K_{oc}) to rank pesticide potential for movement towards groundwater. Pesticides with GUSs > 2.8 have high potential for movement to groundwater. See http://npic.orst.edu/envir/gus.html, accessed June 15, 2021.

Table 3. Herbicide application methods by percent of area covered (broadcast, spot) and type of delivery (all other methods) analyzed in this EA. Variation in interpretation of methods may occur; always refer to EPA label for appropriate application of specific herbicides.

Application Method	Definition
Broadcast[a]	Herbicide is applied uniformly (typically 100% coverage) to the infested area, using ground-based equipment.
Spot	Herbicide is targeted to infestation sites within the infested area. Total coverage is generally a small fraction of the total area.
Basal, Drench	Low-pressure spray (basal) or specific volume (drench) of water-based mixture or an herbicide-oil-penetrant mixture, directed to the lower portions of a woody plant.
Foliar	Application directly to target plant leaves.
Wiper/Rope Wick	A wick or rope soaked in pesticide. The wetted wick or rope is then rubbed onto the target plants to deliver the herbicide solution.
Hack and squirt, herbicide injection or herbicide spaced injection	Downward-angle cuts through plant bark into the cambium made with hatchet or machete, evenly spaced around the circumference of the trunk. Distance between cuts varies by species and herbicide. A small amount (up to 2 ml) of herbicide is sprayed directly in the cut, often using a 1-2 quart hand-held spray bottle. Cuts should not be made directly above or below other as that will inhibit movement of the herbicide. Can also be done using specialized combination tools that cut and inject herbicide all at once (e.g., HypoHatchet, EZ-Ject).
Cut stump, cut stems	Application of herbicide concentrates or herbicide-water mixtures to outer circumference and sides of freshly cut stumps or stems, using a spray, wick, or paint brush.

[a] Aerial broadcast applications are not included in this. Broadcast methods would be used only when the invasive species is the dominant or only plant within the treatment area.

The Service approaches herbicide use with caution; our IPM Policy mandates that the Service evaluate all potential management techniques and balances the efficacy with environmental impacts of all approaches. Before herbicides are used, Service policy requires the preparation and approval of a Pesticide Use Proposals (PUP; https://nctc:fws.gov/resources/course-resources/pesticides/IPM/PUP.pdf) (Service Manual Chapter 569 FW 1, Integrated Pest Management). A PUP fully considers all aspects of herbicide use including the qualifications of the applicator, a review of the target invasive species and their impacts on the ecosystem, a consideration of all IPM methodologies, the proposed herbicide and location to be applied, and the potential impacts on non-target and endangered species. Each PUP must be reviewed by the applicators supervisor and then approved by the appropriate agency specialist (the Service's Regional IPM Coordinator or the National IPM Coordinator). Should herbicides be used, Service applicators and cooperators must, under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1996 (7 U.S.C. §136 et seq.) follow all instructions and requirements on the most current EPA registration label, including prescribed application rates and techniques, public notification and re-entry requirements, pesticide mixing and storage best management practices, and practices that protect applicator health and safety. Label instructions can vary with active ingredient, product formulation, adjuvants, and other pesticide characteristics. These differences can result in different allowable application rates, site types, methods, and other application specifics for each product. Service applicators must also follow current Service Best Management Practices (BMPs), and outlines in chemical profiles (used for screening assessments) in the Service's PUP System (PUPS). Current chemical profiles for aminopyralid, triclopyr, and glyphosate are included in Appendix B. Any herbicide use by Service staff, seasonal workers, or volunteers would conform to requirements of Service Manual Chapter 242 FW 7, Pesticide Users Safety (USFWS 2009). While not always required by the pesticide label, the Service requires that all chemical applications be conducted or directly supervised by a pesticide applicator that has been certified by the State of Alaska. Additionally, only herbicides that are registered for use in Alaska can be considered; they are listed here: http://www.kellysolutions.com/AK/ (accessed June 15, 2021). Following all these laws, policies, and procedures means that results of toxicity and environmental persistence testing, risk assessment modeling, use of safety factors, and safe handling procedures have already factored into Service herbicide use decisions. Additionally, The Service will comply with the State of Alaska standards and requirements for IPM with herbicide involving public places, aquatic sites and state road right of ways.

Characteristics of Proposed Herbicides and Surfactants

An IPM analysis of any particular herbicide includes maximizing efficacy of management on the target plant, minimizing amounts needed, minimizing environmental persistence (in soil, sediment and water), minimizing the propensity to move through the environment, and minimizing toxicity to non-target organisms (other plants, insects including pollinators and other invertebrates, mammals, birds, fish, and reptiles/amphibians). Even though herbicide mechanisms of action (MOA) target plants, and sometimes particular kinds of plants (e.g., dicots vs. monocots), the active ingredient or other ingredients, such as in surfactants, in a formulation can be toxic to other organisms. The Service has collated environmental fate, persistence, and toxicity information in PUPS as Chemical Profiles, which are screening-level assessments and summaries of numerous characteristics of pesticide active ingredients. The current profiles for aminopyralid, triclopyr, and glyphosate (Appendix B) and citations within, are summarized by the information below.

Herbicide effects on biota are typically tested on species that are easily propagated in a laboratory setting. These species are assumed to be generally physiologically representative of taxonomically related species; for example, herbicide toxicity results from rats, mice, rabbits, and dogs are extrapolated to other mammal species (Syracuse Environmental Research Associates (SERA) 2007). Toxicity test results are grouped into generalized categories ranging from practically non-toxic to very highly toxic. A chemical could be relatively non-toxic in a laboratory setting, but if applied at high rates in the environment it could still pose a risk to non-target species. To evaluate risk, toxicity results (e.g., LC50s) are compared to Estimated Environmental Concentrations (EECS) developed from chemical persistence and maximum application rates. The resulting Risk Quotient (RQ) is compared to Levels of Concern (LOC) by taxa. If the RQ exceeds the LOC the risk to organisms in the field is presumed to be unacceptable, so use and would need to be mitigated with lower application rates, alternate application methods (e.g., spot treatments), or other BMPs that would minimize exposure and protect sensitive taxa. In analyzing effects to biota, the Service used toxicity results and worst-case ecological risk assessments (see https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-risk, accessed 6/17/21) for aminopyralid, triclopyr, and glyphosate.

Aminopyralid and Triclopyr

The herbicide active ingredients aminopyralid and triclopyr are relatively selective systemic herbicides developed for control of broadleaf weeds in rangeland, non-crop areas and grazed areas, and for some agricultural uses. Aminopyralid controls many broadleaf species in the families

Asteraceae, Fabaceae, and Solanaceae; however, it is ineffective against certain other broadleaf species such as leafy spurge *Euphorbia esula* (Euphorbiaceae family). Overall, aminopyralid has been found to be very effective against several common species of invasive plants in Alaska. For example, physical control methods have proven ineffective in controlling orange hawkweed; yet at low application rates, aminopyralid has effectively controlled it at test plots (Seefeldt and Conn 2011), as well as wildland sites (Thow and Pyle 2018). Triclopyr is effective against a larger range of broadleaf plants, including woody shrubs and trees. In Alaska, triclopyr has been used to manage invasive European bird cherry, using hack-and-squirt or injection methods. In this EA, the Region evaluated potential applications of aminopyralid and triclopyr[3] in terrestrial upland environments.

Both aminopyralid and triclopyr are not volatile and are highly water-soluble, which makes water-based formulations efficient for terrestrial use, but which also allows them to travel with water throughout aqueous environmental compartments. Both are mobile in soil, with low sorption potential/sorption coefficient (K_{oc}). They are both broken down in soil primarily by microbial degradation, with half-lives (the amount of time it takes for the active ingredient to be broken down) ranging from 31-533 days (aminopyralid) and 8-69 days (triclopyr) in aerobic soils. Breakdown in anaerobic soils takes longer. These characteristics are reflected in high Groundwater Ubiquity Scores (GUS) (4.8 and 3.69 for aminopyralid and triclopyr, respectively), indicating long half-lives, high water solubility, and low sorption potential (http://npic.orst.edu/envir/gus.html, accessed 6/15/21). In water, both aminopyralid and triclopyr are broken down by only sunlight (photolysis) so in clear, shallow water the half-life is < 1 day to several days, but in turbid or deep water, and at sediment-water interfaces, half-lives are considerably longer (months to years).

Aminopyralid received a "reduced risk" designation when it was registered by the EPA, due to its relatively favorable toxicological, Eco toxicological, and environmental fate profiles, in combination with efficacious invasive weed control (EPA 2005). Aminopyralid is effective in controlling many species of invasive plants at application rates that are much lower than other types of herbicide formulations such as picloram, dicamba, 2,4-D, and clopyralid (e.g., DiTomaso and Kyser 2006).

Triclopyr did not receive a reduced risk designation, because it has greater toxicity for some organisms. It acts on a wider variety of plants, compared to aminopyralid. It is more toxic to mammals and birds (i.e., has lower Lethal Dose (LD_{50}) and Lethal Concentration (C_{50}) values); and causes negative reproductive effects in mammals at approximately $1/10^{th}$ the concentrations that aminopyralid causes them. However, aminopyralid and the acid form of triclopyr have similar low toxicity to fish, amphibians, and aquatic invertebrates, and honey bees (*Apis* spp.), and both have variable effects on soil microorganisms (SERA 2007, SERA 2011(b), Strid et al 2018). Aminopyralid is not carcinogenic while triclopyr may be carcinogenic. Both active ingredients are not teratogenic (causing birth defects), mutagenic (causing genetic mutations), or endocrine disrupting, except in association with other ingredients (e.g., ethanol, kerosene) in certain formulations. The Service's worst-case ecological risk assessments for habitat management (like

[3] In this EA we compared environmental fate, persistence, and toxicity data of the acid form of triclopyr to aminopyralid, but data on the trimethylamine salt and the butoxyethyl ester may also be relevant and are included in Appendix B: PUP/BMPs.

invasive species response actions) formulations and application rates results in no RQs exceeding LOCs (Appendix B) for aminopyralid, but acute RQs exceed the LOC for birds and mammals. Therefore, Service users are required to complete an ESA consultation including a toxicological analysis before using triclopyr products where listed bird or mammal species occur, to use application techniques that minimize exposure (e.g., spot treatments), and to use triclopyr instead of aminopyralid only when specific advantages are enumerated. For example, European bird cherry is a woody plant and triclopyr products are more efficacious than aminopyralid for woody plant control. Specific toxicity information is on product labels and Safety Data Sheets (SDS), and in Appendix D.

Glyphosate

Glyphosate is a broad-spectrum, non-selective, post-emergence systemic herbicide controlling a wide range of annual and perennial species including both broadleaf plants and grasses (*Poaceae* family). Glyphosate is not volatile; it is soluble in water but binds strongly to soil, so there is less concern for travel to groundwater than for aminopyralid and triclopyr. Glyphosate is broken down by aerobic and anaerobic soil microorganisms, with half-life ranging from a few days to > 1 year, depending on soil characteristics (see Appendix B). Glyphosate is resistant to photolysis (NIPC 2011; http://npic.orst.edu/factsheets/archive/glyphotech.html, accessed 9/6/21). Multiple species of plants have developed resistance to glyphosate (http://weedscience.org/Summary/ResistbyActive.aspx) and it should not be used for treatment of those species. Because most applications will be using water-based formulations directly applied to leaves of target plants, and these formulations contain surfactants, Service users must ensure that any surfactants are classified as practically non-toxic or have only slight toxicity (Appendix B). SERA (2011(a)) classifies these aquatic/upland glyphosate formulations (e.g., Rodeo, Roundup Custom) as Low Toxicity/High Confidence formulations (i.e., there is enough data to determine with high confidence that these are low toxicity formulations).

Glyphosate is slightly to moderately toxic to fish, amphibians, and aquatic invertebrates (depending on formulation) and slightly toxic to birds. Currently, it is not considered carcinogenic or teratogenic; is slightly mutagenic (but not in mammals), may be genotoxic, and has unknown endocrine disruption potential (NIPC 2011; http://npic.orst.edu/factsheets/archive/glyphotech.html, accessed 9/6/21). Glyphosate products are available in numerous formulations with differing application rates. The Service's worst-case ecological risk assessment for habitat management (like invasive species response actions) formulations and application rates results in RQs exceeding LOCs for birds listed under the ESA and honey bees (Appendix B). Specific toxicity information is on product labels and SDSs, and in Appendix B.

Surfactants

A number of labeled aminopyralid and glyphosate products recommend or require the use of a non-ionic surfactant. Non-ionic surfactants (e.g., AGRI-DEX®) can increase the efficacy of herbicides (e.g., glyphosate) and use of surfactants can reduce the amount of herbicide required to control targeted plants (Singh and Sharma 2001). Only the least toxic of non-ionic surfactants (e.g., EPA acute toxicity rating of "practically non-toxic" for aquatic organisms with an acute LC50 > 100 milligrams/litter (mg/L); https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-0, accessed 6/17/2021) would be used to increase performance and efficacy of the active ingredient in the particular formulation. Toxicity is assessed using available technical reports, peer-reviewed journal articles, SDS, comparative literature reviews, and similar sources. Chemical treatments would currently use the surfactant AGRI-DEX® which has much lower aquatic toxicity than most comparable products (Monheit et al. 2004, Smith et al. 2004). In Alaska, alternative surfactants may be considered if they are effective and exhibit low toxicity (e.g., comparable to or lower toxicity than AGRI-DEX® and/or with an acute LC50 > 100 mg/L).

Formulations of the analyzed active ingredients (i.e., Aminopyralid; triclopyr, and glyphosate) will depend on site specific characteristics such as the pest, the location, and the brand name purchased. This EA is not prescribing which products can and cannot be used, only that the label directions and the BMPs for the formulation will be followed and that the surfactants be of low toxicity. A certified pesticide applicator can add the surfactants or they can already come incorporated into the product.

Alternatives Considered, But Dismissed from Further Consideration

The Service considered but dismissed several alternatives. The field use of biological management techniques to eradicate or reach maximum containment of invasive plant species is not practiced currently in Alaska. If the State of Alaska were to develop an active biological management program for invasive plants, this method would be evaluated for its potential relevance to the Service's IPMs. Consequently, the Alaska Region did not evaluate or prescribe biological management methods as part of the proposed IPM strategy in this EA. Cultural management methods were dismissed as well because of a lack of impacted agricultural land, for which this method is mainly used, in the Region.

Affected Environment and Environmental Consequences

Current Status of Invasive Species on Service Lands

The Region currently has at least 104 documented species of terrestrial invasive plants on Service lands (AKEPIC May 2021). To date, the Service has had limited capacity to conduct systematic surveys and management efforts for terrestrial invasive plants throughout much of the Region; the Kenai and Kodiak NWRs being the exception. The Service has completed four localized independent EAs and the Finding of No Significant Impacts that address use of physical and chemical control methods as part of an IPM strategy at local levels (e.g., Supplemental Environmental Assessment for Integrated Pest Management of Invasive Plants on Kodiak National Wildlife Refuge and Vicinity 2014; Integrated Pest Management of Terrestrial Invasive Plants within the Kenai Peninsula Borough of Southcentral Alaska 2017).

Between 2017 and 2021, there were an average of 181 acres of Service land under treatment, using all available IPM methods, and 48 acres under control in the Region (Service unpublished, 07/14/2021). The Service's reporting guidance for these measures defines "treatment" as an acceptable method (cultural, physical, chemical, or biological) for the specific objective of controlling the spread and/or reducing the density of invasive plant species. "Under control" is defined as reduced to a maintenance level or eradicated. A maintenance level has been achieved when a target invasive plant species within the Service-managed land unit is suppressed. Between 2017 and 2020, the Region approved 51 Pesticide Use Proposals (PUPs); with all but two for activities on or adjacent to the Kenai and Kodiak NWRs. For this time period, the Region's average chemically treated acreage was 56.5 with an average of 2.5kg of chemical per year (Table 4). The average acres chemically treated, per individually approved PUP, was 4.4 acres (range 0.01-156) during this time period.

Table 4. Total kilograms of active ingredient that was approved by the Alaska Region and sum of acres that received herbicide application between 2017 and 2020 (USFWS Pesticide Use Proposal System July 15, 2021). Approved active ingredients included aminopyralid and glyphosate herbicides.

Year	Sum of kilograms of AI Applied	Sum of Acres Treated
2017	1.5	17.7
2018	3.4	7.7
2019	1.6	157.1
2020	3.6	43.5
Average	2.5	56.5
Grand Total	**10.1**	**226.0**

The Region is expanding its terrestrial invasive plant survey and response capacity. Correspondingly the Region anticipates detecting and documenting greater distribution, diversity, and density of terrestrial plant infestations throughout the Region than what the Service is currently aware of. The following is a brief description of the extent of known surveys, findings, and management throughout the Region.

Alaska Maritime NWR – Formal terrestrial invasive plant surveys have not been performed throughout the Alaska Maritime NWR. Invasive plants have been recorded throughout the NWR, with most of the infestations occurring on islands with current or past human inhabitants, particularly those with past or current introduced ungulate populations. The Service assumes that invasive plants are more widespread than currently documented, given the NWR's history of past inhabitants raising furbearers and ungulates. Invasive plants such as common dandelion (*Taraxacum officinale*) and foxtail barley (*Hordeum jubatum*) are known to be present on the East Amatuli Island in the Barren Island group and on the Pribilof Islands. The NWR office and storage facilities in Homer have invasive plants that were treated in 2020 (e.g., ~0.01 acres of bird vetch (*Vicia cracca*). The NWR facilities such as these and on Adak Island will be priority areas for surveys and rapid response to reduce the chance of introductions occurring in the remote islands and coastlines of the NWR in concurrence with the NWR's Biosecurity Plan (Flynn and Williams 2020).

Alaska Peninsula/Becharof NWR Complex – Formal terrestrial invasive species surveys on the Alaska Peninsula/Becharof NWR Complex have not occurred. Baseline knowledge of occurrence for invasive species throughout the Complex and on neighboring National Park Service land is limited. Terrestrial invasive plants, like orange hawkweed, oxeye daisy (*Leucanthemum vulgare*), white sweetclover, and prostrate knotweed (*Polygonum aviculare*) have been documented in hub communities such as King Salmon, Naknek, and Chignik Lake. Orange hawkweed is also found around the outlet of Lower Ugashik Lake. No invasive plant management has occurred in the Complex or at the Complex office in King Salmon.

Arctic NWR – Formal terrestrial invasive plant surveys in the Arctic NWR have not occurred. The Arctic NWR has no formal roads, trails, boat launches, campsites, or other recreational facilities, which likely has limited the risk of introductions. Currently, the only known infestations of invasive plants (e.g., common plantain (*Plantago major*) and herb sophia (*Descurainia sophia*)) occur along the Porcupine River. Several other invasive plants such as white sweetclover, oxeye daisy, narrowleaf hawksbeard (*Crepis tectorum*) and prostrate knotweed have been found in access points to the Arctic NWR, and other northern Interior Alaska NWRs, such as the Dalton Highway, Arctic Village, Coldfoot, and Galbraith Lake. However, with visitors from around the world and staff/partners traveling by plane, boat, and foot from known infested areas into the Arctic NWR, the risk of introductions occurring elsewhere exists.

Kenai NWR and FO Infrastructure – Numerous invasive plant species are found in and at access points to the Kenai NWR, which likely faces the greatest risk of invasive plant establishment of any NWR in the Region due to the number of visitors, presence of numerous roads, trailheads, boat launches, and campgrounds. Some operational infrastructure (e.g., storage facilities) of the Kenai NWR and the Kenai based FO are off of the NWR in areas with numerous invasive terrestrial plants. High priority species such as reed canarygrass, oxeye daisy, orange hawkweed, and timothy (*Phleum pratense*) have been found along Skilak Lake Road, at trailheads and the campgrounds accessible from the road. Invasive plants such as meadow hawkweed and reed canarygrass have been found in the Swanson River Oil Field and along its road network. Some of these infestations have been treated physically and chemically since 2015. Incipient populations of reed canarygrass in Sucker Creek and the East Fork Moose River threaten to invade large areas downstream in these watersheds. Bird vetch and white sweetclover have been found and treated along the Sterling Highway on the eastern boundary of the NWR. True forget-me-not (*Myosotis scorpioides*) has become abundant in some areas along the Kenai River. Meadow foxtail (*Alopecurus pratensis*) and splitlip hempnettle (*Galeopsis bifida*) have spread from road crossings down the Swanson River. Multiple species of invasive Asteraceae (meadow hawkweed, fall dandelion (*Leontodon autumnalis*, and narrowleaf hawksbeard *Crepis tectorum*) have been greatly increasing in abundance in the population centers of the Kenai Peninsula and have been successfully invading the Kenai NWR. Species of lesser concern such as pineappleweed (*Matricaria discoidea*), common dandelion, common plantain, annual bluegrass (*Poa annua*), white clover (*Trifolium repens*), alsike clover (*Trifolium hybridum*), red clover (*Trifolium pretense*), and big chickweed (*Cerastium fontanum* Baumg. *ssp. Vulgare*) are established and spreading along roadways and trails.

Kodiak NWR – Scattered infestations of invasive plant species have been documented in Kodiak NWR, adjacent lands, and access points into the Kodiak NWR. The primary invasive species of concern occur primarily in coastal areas at or near sites of human habitation. Primary species of concern include orange hawkweed, reed canarygrass, creeping buttercup (*Ranunculus repens*), tall buttercup (*Ranunculus acris*), Canada thistle (*Cirsium arvense*), Bohemian knotweed (*Fallopia xbohemica*), and common tansy (*Tanacetum vulgare*). The diversity and level of infestations are greatest along the Kodiak road system, which is not within the Kodiak NWR, but provides many access points for pathways (e.g., airstrips, boat launches) of potential introduction to Service lands. Areas such as Camp Island at Karluk Lake, the Buskin River watershed, and remote communities, Service public use cabins and fishing related facilities (e.g., fish camps, canneries) are specific places of concern. The Camp Island orange hawkweed infestations have been treated and monitored annually since 2003. Similarly, Kodiak NWR staff and partners have controlled or eradicated infestations on Service lands.

Izembek NWR – Little systematic surveying for invasive plants has occurred. Common dandelion, oxeye daisy, orange hawkweed, and Canada thistle have been documented around the town of Cold Bay. No invasive plant management has occurred in Izembek NWR.

Kanuti NWR – Few formal invasive plant surveys or management actions have been performed in the Kanuti NWR. Known infestations are located near the edges of the Kanuti NWR or on adjacent land such as in Allakaket (common plantain and quackgrass (*Elymus repens*)) and Bettles (white sweetclover, Siberian peashrub (*Caragana arborescens*), and bird vetch). The Service is also concerned about downstream dispersal of terrestrial plant propagules from the heavily infested Dalton Highway corridor. Surveys for the downstream movement of white sweetclover from the Dalton Highway were done in 2017, 2019, and 2021, and white sweetclover was not detected on downstream gravel bars. Over the last 5 years, the Bureau of Land Management (BLM) mapped the spread of invasive species along the Dalton Highway. High concentrations of white sweetclover were found at snowplow turnarounds, indicating plows were a vector. In 2021 the BLM contracted with the Salcha-Delta Soil and Water Conservation District (SWCD) to begin controlling white sweetclover by using physical and chemical methods along a portion of the Dalton Highway.

Koyukuk/Nowitna/Innoko (KNI) NWR Complex – Formal surveys for terrestrial invasive plants have not been performed in the KNI NWR Complex. Most of the known infestations are located around the communities within or adjacent to the KNI NWR Complex such as the Galena, Koyukuk, and Huslia. The road system around Galena, the administrative hub of the KNI NWR Complex, is the most infested area with patches of highly invasive plants like white sweetclover, Siberian peashrub, European bird cherry (*Prunus padus*) as well as moderately invasive species such as Kentucky bluegrass (*Poa pratensis*) and oxeye daisy. The Service has worked with local communities to slow the spread of white sweetclover, via hand pulling, since at least 2005. Access points (e.g., airports/strips and boat launches) between communities and remote areas of the Complex are priorities for surveys and management to occur. While off the KNI NWR Complex, the adjacent Ruby-Poorman Road is a pathway of concern for the known infestations of moderately invasive plants like common dandelion and pineapple weed.

Selawik NWR – Formal surveys or management for terrestrial invasive plants have not been performed in the Selawik NWR. There are no known infestations within the Selawik NWR; however, small infestations of moderately invasive plants such as common dandelion, narrowleaf hawksbeard, common plantain, and foxtail barley are present in the adjacent communities of Kotzbue and Kiana, which are access points into Selawik NWR.

Tetlin NWR – Formal terrestrial invasive plants surveys in the Tetlin NWR have not occurred since the early 2000s. The majority of the known infestations occur along the 65 miles of Alaska Highway along much of the northern border. Along the Alaska Highway, there are numerous pull offs, trails, and recreation areas that access the Tetlin NWR. These locations are potential vectors for invasive species to be introduced onto Service lands. Seven highly invasive species are present such as white sweetclover, bird vetch, and oxeye daisy. In 2013, volunteers and Service staff surveyed and removed fifty-eight 55-gallon bags of sweet whiteclover from campgrounds, trails and buffer areas around creek crossings, campgrounds, and trail access points. The Nabesna Road and Northway Road networks are also pathways of concern for introduction onto Service lands.

For example, common dandelion, alsike clover (*Trifolium hybridum*), lambsquarters (*Chenopodium album*), among other moderately invasive plants, are distributed along the Nabesna Road which ends near the Nabesna River upstream of the Tetlin NWR.

Togiak NWR – Formal surveys or management for terrestrial invasive plants have not been performed in the Togiak NWR. There are no known infestations within the Togiak NWR; however, small infestations of oxeye daisy, orange hawkweed, fall dandelion (*Leontodon autumnalis*), timothy, common chickweed (*Stellaria media*), Kentucky bluegrass, alsike clover, common sheep sorrel (*Rumex acetosellal*), pineappleweed, white clover (*Trifolium repens*), and narrowleaf hawksbeard occur along the road system in and around Dillingham, which is the operational base for the Togiak NWR.

Yukon Delta NWR– Formal surveys or management for terrestrial invasive plants have not been performed on the Yukon Delta NWR. The known infestations are centered around Bethel and smaller communities such as Kwethluk, Kalskag, and Aniak. Moderately invasive plants such as oxeye daisy, common dandelion and narrowleaf hawksbeard have been recorded in these communities. Common plantain, lambsquarters, and pineapple weed have also been recorded along remote sections of the Kuskokwim River. Airstrips and boat launches throughout the Yukon Delta NWR are the primary pathways of concern for future surveys and management.

Yukon Flats NWR – Formal and informal surveys have provided a good base understanding of the distribution and diversity of invasive plants on the Yukon Flats NWR. The Service has worked with partners to survey for and manage (via physical methods) infestations on and adjacent to Service lands since 2005. Most of the infestations are within the seven communities in or near the border of the Yukon Flats NWR. For example, Fort Yukon, the largest community within the Yukon Flats NWR, has invasive plants ranging from white and yellow sweetclover (*Melilotus officinalis*), bird vetch, butter and eggs (*Linaria vulgaris*), to common dandelion and prostrate knotweed. Small infestations are also found along remote rivers and streams that are frequently used for subsistence and recreational purposes. These infestations include species of high concern such as white sweetclover upstream of Service land on the Yukon River as well as common dandelion along Beaver Creek. The Steese and Dalton Highways, which lead to access points (e.g., boat launches) to the Yukon Flats NWR, village airports, as well as wildfire breaks on and adjacent to Service lands are also pathways of concern.

Fairbanks Operational Infrastructure – The Service maintains a boatyard and storage facility adjacent to the office location of the three Fairbanks based NWRs (i.e., Arctic, Kanuti, Yukon Flats) and the Northern Alaska FO. These storage facilities are infested with the highly invasive bird vetch, white sweetclover, butter and eggs, common dandelion, pineapple weed, foxtail barley, and Siberian peashrub. Common dandelions and narrowleaf hawksbeard are common throughout the area. The Service has treated the bird vetch via physical means in the past. More treatments, monitoring and decontamination methods (for boats, trailers, and footwear) after leaving the boatyard and before heading into the field or boat launch are needed to ensure the Service is not a vector of these species when going to Service and non-Service lands.

Anchorage Operational Infrastructure – The Service utilizes rental storage facilities in Anchorage to support the operational needs of programs such as Marine Mammals Management, Migratory Bird Management, and the Southern Alaska FO. Surveys of the rental facility in 2021, currently within the Ted Steven's International Airport property, found white sweetclover, bird vetch, reed canarygrass, butter and eggs, and Canada thistle. Service staff began treatment of the area in 2021 via physical and chemical measures to reduce the likelihood of field crews introducing these invasive plants to the remote Service and non-Service lands they operate in; more treatments and monitoring will be needed.

The Service's the Southern Alaska FO is co-housed with the BLM at the BLM managed Campbell Tract Administrative Facilities (Campbell Tract). The BLM has used various IPM strategies to control bird vetch, white sweet clover, butter and eggs, orange hawkweed, and reed canarygrass around the office and storage facilities as well as the storage yard. The BLM's IPM activities were analyzed in the following Environmental Assessment: *Campbell Tract Administrative Facilities Integrated Pest Management to Control Vegetation*. The Service anticipates future collaboration with the BLM in efforts to help minimize the spread of invasive plants through Service activities and that of the public that use the Campbell Tract area for recreational purposes.

Resources Analyzed for Impacts

The purpose of this section is to identify, describe, and compare the ecological and human health impacts of the alternatives. This section is organized by affected resource categories and for each affected resource discusses both (1) the existing environmental and socioeconomic baseline in the action area for each resource and (2) the effects and impacts of the proposed action and any alternatives on each resource. The effects and impacts of the proposed action considered here are changes to the human environment, whether adverse or beneficial, that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives. This EA includes the written analyses of the environmental consequences on a resource only when the impacts on that resource could be more than negligible and therefore considered an affected resource.

The level of impact (e.g., negligible, minor, moderate, major) on resources are on the basis of the type, duration, intensity and area affected by a management practice. This EA also evaluates the potential cumulative impacts or effects of multiple management actions potentially conducted at sites over a period of years. Definitions of impact terms are provided below:

Duration:

Temporary: Impacts would last no more than a season, or for the duration of the discreet activity, such as maintenance of a road or trail segment.

Long-Term: Impacts would extend for several years up to the life of the project.

Permanent: Impacts are a permanent change to the resource that would last beyond the life of the project even if the actions causing the impacts were to cease.

Context:

Common: The affected resource is widespread and is not identified in enabling legislation as important to Service lands and waters, nor is it rare within or outside Service lands and waters. The portion of the affected resource impacted by the action does not fill a unique role within Service lands and waters or its region of Service lands and waters.

Important: The affected resource is identified by enabling legislation or is rare either within or outside Service lands and waters. The portion of the affected resource does not fill a unique role within Service lands and waters or its region of Service lands and waters.

Unique: The affected resource is identified by enabling legislation, and the portion of the affected resource uniquely fills a role within Service lands and waters and its region of Service lands and waters.

Intensity:

Low: A change in resource condition is perceptible but does not measurably alter the resource function in Service lands and waters ecosystem, cultural context, or visitor opportunity.

Medium: A change in a resource condition is measurable or observable, and an alteration is detectable to the resource function in Service lands and waters ecosystem, cultural context, or visitor opportunity.

High: A change in a resource condition is measurable or observable, and an alteration to the resource function in Service lands and waters ecosystem, cultural context, or visitor opportunity is clearly and consistently observable.

The potentially affected environment for this EA includes Service lands and areas that are critical access points. The majority of Service lands in the Region have little to no documented invasive plants (AKEPIC December 2021). The areas with the highest concentrations of invasive plants are areas with higher human traffic along roads, airstrips, trails, campsites, and cabins. Service owned lands cover approximately 77 million acres and are divided among the four Ecoregions of Alaska (Figure 4, Table 5). These regions serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems (Woodward and Beever 2011).

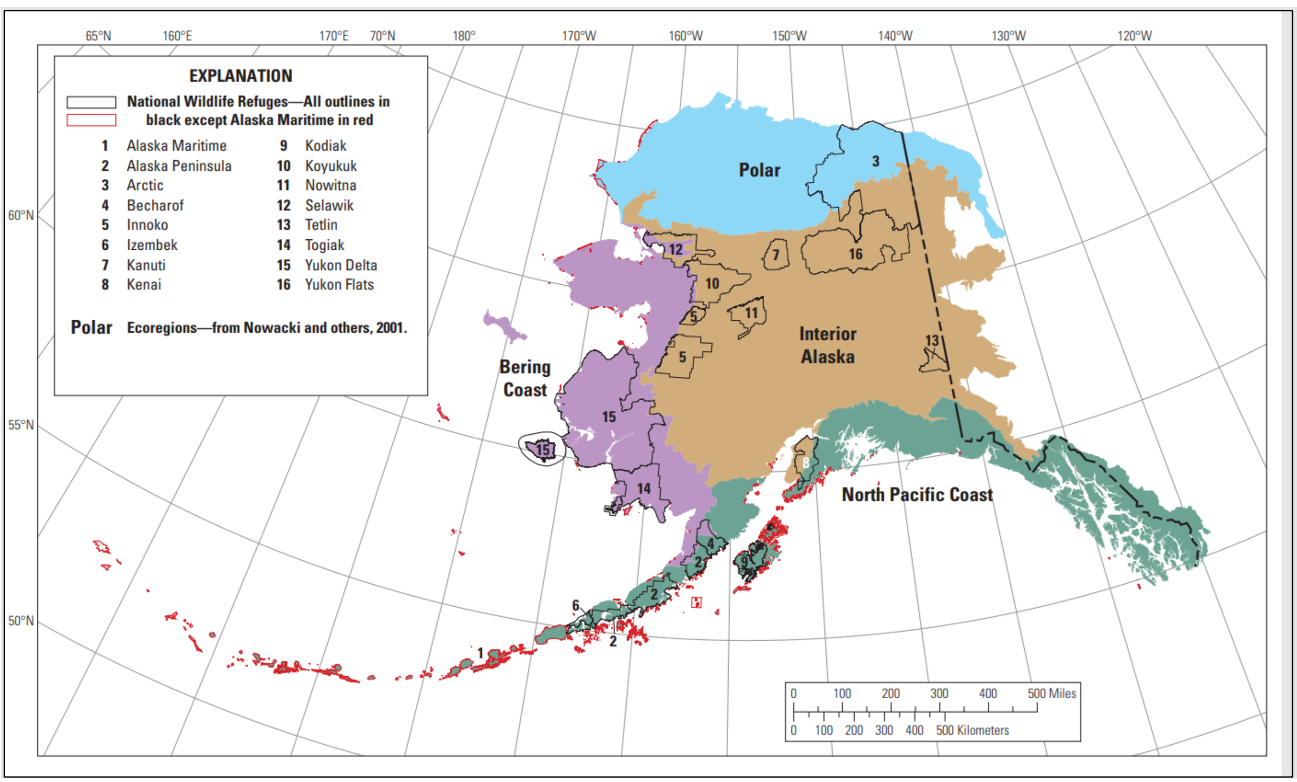

Figure 4. Map of the four Ecoregions in relation to the Service's 16 National Wildlife Refuges in Alaska.

Of the 16 NWRs, 8 predominantly (i.e., >50 percent of NWR area) are in the Interior Alaska Ecoregion, 5 in the North Pacific Coast Ecoregion, 2 in the Bering Coast Ecoregion, and 1 in the Polar Ecoregion (Woodward and Beever 2011).

Table 5. Table documenting National Wildlife Refuges with 50 percent or more land area located in one of the four Ecoregions: Polar, Bering Coast, Interior Alaska, and North Pacific Coast. The number for each NWR corresponds to Figure 4 for cross reference.

Ecoregion	Polar	Bering Coast	Interior Alaska	North Pacific Coast
NWR	3. Arctic	14. Togiak 15. Yukon Delta	5. Innoko 7. Kanuti 8. Kenai 10. Koyukuk 11. Nowitna 12. Selawik 13. Tetlin 16. Yukon Flats	1. Alaska Maritime 2. Alaska Peninsula 4. Becharof 6. Izembek 9. Kodiak

The following paragraphs are excerpts from Woodward and Beever, 2011 and give brief descriptions of the four Ecoregions.

The Polar Ecoregion can generally be characterized as a polar desert (Shulski and Wendler 2007) because it experiences a mean air temperature less than 10°C during the warmest month and mean annual precipitation less than 250 mm. This cold climate propagates continuous distribution of permafrost (Shur and Jorgenson 2007; Jorgenson et al. 2008) that may reach 650 m in depth (Gold and Lachenbruch, 1973). Winters in the ecoregion are long and cold and are dominated by high winds and blowing snow. Summers are typically cool and cloudy, although temperatures are slightly warmer inland. Precipitation falls primarily during summer with a mean annual of 102 to 127 mm.

The Bering Coast Ecoregion borders the eastern Bering and southern Chukchi Seas from Bristol Bay to Kotzebue Sound. It includes the Ahklun Mountains, the Yukon-Kuskokwim coastal plain, the Nulato Hills, the Seward Peninsula, and St. Lawrence and Nunivak Islands. This ecoregion is characterized by a maritime-influenced climate and is demarcated from the Interior Alaska Ecoregion roughly by the boundary between shrub/tundra and spruce-forest (Nowacki et al. 2001). The mean annual temperature is -6 to +2 degrees Celsius, and the mean annual precipitation ranges from 254 to 661 mm. There exists a north-to-south gradient of spatial distribution of permafrost—from continuous, to discontinuous, to sporadic (Brown et al. 1998; Jorgenson et al. 2008). By creating an impermeable barrier to water drainage and soil moisture, permafrost determines the distribution of wetlands and lakes and the growing conditions for vegetation (Bonan and Shugart, 1989).

The Interior Alaska Ecoregion is the largest ecoregion, covering the central part of Alaska south of the Brooks Range, and including the Alaska Range, the Wrangell Mountains, and the Cook Inlet and Copper River Basins. It is composed of 15 of the 32 unified Ecoregions (Nowacki et al. 2001). Other significant geographic features include the broad valleys of the Yukon and Tanana Rivers and the largest urban areas in Alaska—Anchorage and Fairbanks. The Interior Alaska Ecoregion described as a typical continental climate, resulting in large temperature variability; light and irregular precipitation; warm, sunny summers; and very long, cold winters. Precipitation falls mostly in summer and the driest locales of Alaska are the broad river valleys of the Interior. The southwest part of the Interior Alaska Ecoregion (i.e., the Cook Inlet region of Shulski and Wendler 2007) is a transition zone between the maritime climate of the southern coast and the continental climate of the interior. As such, the area experiences more moderate temperatures, discontinuous permafrost, a longer growing season, higher precipitation, and higher winds than the rest of the ecoregion.

The North Pacific Coast Ecoregion extends along the southern border of Alaska from southeast Alaska westward through the Aleutian Islands. Geologically, the area is a volcanic zone resulting from the tectonic collision of the Pacific Plate with the North American Plate. The entire ecoregion is strongly influenced by currents and weather generated in the Gulf of Alaska and by freshwater runoff; the western part of the region also is impacted by conditions in the Bering Sea to the north. The proximity of the Pacific Ocean influences more-moderate diel and seasonal temperature fluctuations and higher precipitation than other portions of Alaska (Shulski and Wendler 2007). The mean annual temperature for the North Pacific Coast ecoregion is 2 to 8 degrees Celsius, and the mean annual precipitation ranges from 589 to 5,728 mm. Important characteristics determining distribution of biota include substrate; strength and direction of currents; frontal regions; eddies; water temperature; and salinity (Piatt and Springer 2007). Many of these factors are driven ultimately by global weather patterns such as the El Nino/Southern Oscillation and the Pacific Decadal Oscillation.

Natural Resources

Air Resources

Affected Environment

The Clean Air Act (CAA) defines the EPA’s responsibilities for protecting and improving the nation's air quality and requires the EPA and states to carry out programs to assure attainment of the National Ambient Air Quality Standards (NAAQS). Under the authority of the CAA, the EPA sets primary and secondary NAAQS for the criteria pollutants sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and particulate matter (PM_{10}) (less than 10 microns in diameter) and $PM_{2.5}$ (less than 2.5 microns in diameter). The CAA identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (EPA 2021c, Accessed June 7, 2021). The broad types of air pollution observed in Alaska include particulate matter, ozone, and carbon monoxide (TALA 2019). Potential sources of this pollution include combustion engines, smoke from wildfires, smoke from woodstoves, combustion related to energy production, dust, and volcanic ash. Records accessed from the EPA Greenbook website list the Fairbanks Northstar Borough as the only borough that is in non-attainment for Alaska; Anchorage and Juneau are in maintenance attainment status. Management actions designed to address terrestrial invasive species may negligibly affect air resources but would not affect attainment status for Alaska Communities (for more information on attainment see AK State Division of Air Quality, https://dec.alaska.gov/air/anpms/communities/).

Impacts on Air Resources

Alternative 1: Regional IPM Strategy without Herbicide

Under Alternative 1, physical control methods may result in negligible adverse effects such as temporary additions of particulate matter to the air via cutting and transporting plant materials, soil disturbance during pulling and digging, and ash when using prescribed burn treatments. Best management practices would be followed to minimize dispersing particulate matter into the air. Greenhouse gas emissions may be added to the air via transportation vehicles, gas operated tools (mower, weed whacker, ATV, truck, etc.), as well as prescribed burning treatment. These sources of pollutants would be below *de minimus* standards and will not cause any changes to attainment status; therefore, they would have a temporary adverse effect to air quality. Long-term affects to air quality are not anticipated, as there is no permanent impact to air quality.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, negligible adverse impacts would be consistent with those in Alternative 1, although dust from disturbance and ash would be reduced if only chemical treatments were used. Additionally, under this alternative, treatment with herbicides on ≤ 20 acres using targeted application methods (Table 3), with a single herbicide application per year for typically three years, impacts to air resources would be negligible. Most herbicide formulations would be water-based and applied with targeted methods on limited areas to minimize spray drift or mobilization into air.

Water Resources

Affected Environment

Any terrestrial invasive species management action must comply with the Clean Water Act (CWA) implemented by the U.S. Army Corp of Engineers, the EPA, and the Alaska Department of Environmental Conservation (ADEC). The state of Alaska also manages water resources through the Alaska Water Use Act overseen by Alaska Department of Natural Resources (ADNR) – Division of Mining, Land and Water. Section 402 of the CWA may apply to activities related to invasive species management. Under Section 402 the National Pollution Discharge Elimination System (NPDES), administered by the Alaska Pollution Discharge Elimination System (APDES), regulates both point and nonpoint pollutant sources, including stormwater and stormwater runoff. Activities that involve one or more acres of ground disturbance require an APDES permit. Alaska's extensive freshwater resources support human uses and ecosystem functions. The water resources that could be most affected by invasive plants and management response actions are streams, rivers, lakes, ponds, and wetlands that are near high human traffic areas (e.g., river corridors that cross or are adjacent to highways and roads and either flow into or out of Service lands; ATV and hiking trails; and boat launches and floatplane landing areas). An APDES permit may be necessary for certain terrestrial invasive plant management actions, like chemical control within proximity of water sources. Consultations should occur with ADEC during treatment plan development to ensure actions associated with this EA are in compliance with the appropriate ADEC permits.

Alaska has more than three million lakes, over 12,000 rivers and numerous ponds, streams, and wetlands. Many of Alaska's lakes and streams are frozen, or partially frozen, for 5 to 6 months of the year. In late April and May, the snow melts, and the lakes and streams thaw. Surface water supplies approximately 75 percent, or about 300 million gallons per day, of the state's water needs for industry, agriculture, mining, fish processing, and public water use. Groundwater resources are used for most domestic needs around the state. Groundwater aquifers range from extremely small thaw bulbs in permafrost to large regional aquifers, but there are no designated sole source aquifers in Alaska. The extensive permafrost around the state provides challenges to the development of groundwater resources. In many parts of Alaska, steep topography limits the size of most aquifers, preventing large scale extraction. Groundwater is also used for bottled water export and many industrial operations (ADNR 2021). Due to trends in climate change, snowpack is melting earlier and glaciers are receding further, exposing new vulnerable areas in which invasive species can become established (Vincent et al. 2011).

Water Quality - Most of Alaska's waters are suitable for the following beneficial uses: water supply (e.g., drinking, agriculture, and aquaculture, industrial); water recreation; and growth and propagation of fish, shellfish, aquatic life, and wildlife. Some beneficial uses are limited by natural water quality conditions in Alaska such as suspended sediment in glacial water bodies; highly mineralized water bodies; microorganisms such as giardia, schistosoma, and high bacterial counts from decomposing salmon in streams. Beneficial uses may also be limited by human activities such as natural resource development, urban development, and military development. Both surface water and groundwater are used as drinking water sources in Alaska. Residents that live in population centers often get their water from a public water system regulated by the ADEC-Division of Environmental Health. Rural residents often obtain their drinking water from private wells or surface water sources.

Less than 10 percent of Alaska's waterbodies have been assessed by the ADEC for water quality and reported to the EPA for CWA as of 2020 (EPA 2021(a), Accessed June 10, 2021). Of those assessed, 18 waterbodies have been reported as impaired under CWA section 303(d) (EPA 2021(b), Accessed June 15, 2021). The Alaska Clean Water Actions (ACWA) policy outlines a process to collaboratively rank and prioritize water bodies for monitoring, assessment, and restoration (ADEC 2015) and is managed under the Non-Point Source Program. Most of Alaska's water resources are in pristine condition due to Alaska's size, sparse population, and the remote character of the state (ADEC 2015). There are some cases in which water quality has been impaired due to the effects of extensive historic mining activity, forestry, logging, seafood processing, boating activity, etc. For example, the Tetlin, Kanuti, and Becharof NWRs have concerns about mining activity upstream of Service land and their possible impacts to fish habitat on Service lands downstream (Refuges Water Resource Inventory Assessments (WRIA; USFWS 2017(b)(c), USFWS 2021 Draft). The presence of terrestrial invasive plants and management actions to control them may affect water quality, but are unlikely to affect water quantity.

Wetlands – In addition to the CWA, wetlands are protected by EO 11990 – Protection of Wetlands, 42 Fed. Reg. 26961 (1977). All of Alaska's ecological regions contain extensive areas of federally recognized wetlands. Wetlands are abundant in the valleys and basins associated with large river systems including the Yukon, Kuskokwim, Susitna, and Kenai Rivers. Large lake systems, like Becharof and Tustumena, also support extensive wetlands. Treeless expanses of moist and wet tundra underlain by permafrost occur in the northern and western areas of the state. Interior Alaska contains millions of acres of black spruce muskeg and floodplain wetlands dominated by deciduous shrubs and emergent vegetation. Shrub and herbaceous bogs are a predominant feature of the landscape in southcentral and southeast Alaska. Wetlands are also present in the Brooks and Alaska Ranges (Hall et al. 1994). Wetlands provide many benefits including food and habitat for wildlife and fish species; natural products for human use and subsistence; shoreline erosion and sediment control; water storage and flood protection; and opportunities for recreation and aesthetic appreciation (Hall et al. 1994). Wetlands have also been shown to reduce pollutants in water that flows through them (Kao and Wu 2001). Not all wetlands perform all these functions, but most wetlands contribute to one or more in varying degrees (Hall et al. 1994).

Floodplains – Floodplains are regulated under E.O. 11988 – Floodplain Management, 42 Fed. Reg. 26951 (1977) and established by the Federal Emergency Management Agency (FEMA). Most of Alaska remains unmapped for flood risks, therefore FEMA has not published flood maps for these areas. However, the most densely populated areas including Anchorage, Fairbanks, Soldotna, Juneau, Nome, Kotzebue, Bethel, Togiak, and Dillingham have been mapped. Floodplains are important features of the landscape and contribute to water dispersal during heavy precipitation events and spring thaws. After disruption of these functions the landscape's natural defense against flooding is diminished, and more loss of life and property would occur.

Wild and Scenic Rivers – Alaska has approximately 365,000 miles of river, of which 3,210 miles on 25 rivers are designated as Wild and Scenic, less than 1 percent of the state's river miles. Of these 25 rivers, seven are managed by the Service: Andreafsky River (Yukon Delta NWR), Beaver Creek (Yukon Flats NWR), Nowitna River (Nowitna NWR), Selawik River (Selawik NWR), Ivishak River, Sheenjek River and Wind River (Arctic NWR). This designation was implemented to preserve outstanding natural, cultural, and recreational values of free-flowing rivers. There are three categories that range from limited access and free of impoundments (Wild), to those accessible by roads and free of impoundments (Scenic), and finally some that are readily accessible and may have had impoundments in the past (Recreational). All of the designated rivers on Service land are classified as Wild (https://www.rivers.gov/alaska.php, April 30, 2021).

Impacts on Water Resources

Alternative 1: Regional IPM Strategy without Herbicide

Under Alternative 1, negligible to minor short-term effects may occur to water quality in the form of increases in turbidity (the amount of sediment in the water column) when treating small infestations near waterbodies. This increase in turbidity would come from the potential for topsoil to erode and flow into surface waters when methods such as hoeing and pulling are employed. Increased turbidity would likely be low due to minimal soil disturbance associated with the removal of invasive plants of small infestations, even when repeated removals were required over a period of years. The impact of physical management of invasive plant species to water is dependent on infestation size and characteristics of the treatment area (e.g., distance from water, soil type, land gradients, density of vegetation following invasive removal). Treatment of infestation areas closest to water bodies and with gradients sloping toward water sources would have greatest potential to produce sediment in runoff that could affect water quality. Looser soils, and lower density of vegetation would also increase the amount of sedimentary runoff into water bodies due to the reduced stability in soils.

There would also be negligible to minor effects to wetlands and floodplains due to the removal of plants and the resulting soil erosion. Emergent invasive plant species can be present in or on the edges of wetlands, and floodplains may stretch even further away from the source of water depending on topography. The physical treatment of these species would cause temporary minor adverse effects such as destabilization of soil and sediment, changes in water flow, new flood patterns, and reduced overflow and flood protection. Revegetation with native plants would help mitigate adverse effects and restore natural wetland and floodplain functions. Negligible to minor affects to Wild and Scenic Rivers would result from treatment of terrestrial invasive species. Removal of vegetation would temporarily disturb the aesthetic value prescribed to these areas leaving dead vegetation or bare soil at the site location.

Treatment of large infestations, however, would potentially cause moderate adverse effects due to the increase of disturbance associated with removal of topsoil and invasive plant roots. Soil would need to be disturbed repeatedly over a period of years to ensure complete removal of rhizomatous perennial invasive herbs, grasses, and shrubs. This destabilization would decrease water quality, increase potential for flood hazards and delay the restoration process of native plants.

The combined applications of all physical methods to all invasive species infestations over a period of years would cause negative impacts to soils at the treatment site and to the associated physical and biological components and processes in the short-term. These impacts to soils are expected to increase over the long-term due to the projected increase in size of the largest infestations associated with the potential failure to control new and existing infestations with physical methods.

Long-term beneficial affects to water resources would occur with the revegetation of native plants and restoration of natural floodplains. The return of native plant species would improve stability in soils and reduce sediment runoff into surface water. Native plant species help clean and maintain wetlands and allow for absorption of overflow and flood water to protect surrounding areas. Wild and Scenic Rivers would be improved in the long-term as the reestablishment of natural vegetation would restore and improve the aesthetic value.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, effects of physical methods would be consistent with those under Alternative 1. The Region anticipates impacts to water quality from invasive species control actions under Alternative 2 to be negligible. Effects of herbicides on water resources are based on how likely the herbicide is to reach surface water or groundwater (from use patterns, solubility, and leach ability), and persistence in aquatic environments. Travel to surface and groundwater resources will be minimized by following label directions, including application rates and appropriate formulations; using targeted application methods under a response framework, and following Service BMPs. If any of the three herbicides do reach surface water resources, they would persist for days to weeks under sunny, shallow, aerobic conditions, and likely less than a year under anaerobic conditions in surface water or groundwater.

With herbicide use on larger infestations, the impacts of non-chemical methods could decrease from minor, short-term negative effect to a negligible, short-term effect, because soil erosion and sedimentation leading to increased turbidity would be reduced if soil and non-target vegetation were left intact. On sites where invasive species dominate ground cover, controlling the invasive species with herbicide could temporarily remove most of the protective ground cover of vegetation, and erosion potential would temporarily increase until sites were revegetated. Soil erosion potential would also likely differ with the type of herbicide used. Because aminopyralid and triclopyr are more selective (targeting broad-leaf plants) there may be less erosion potential with them compared to broad-spectrum glyphosate.

Aminopyralid and triclopyr are highly water soluble and both can leach to groundwater (GUS = 4.8 and 3.69, respectively; Table 3). Both are broken down in aerobic soils by microbes (EPA 2005; Appendix B). If significant rain events follow application, however, they can become more mobile and travel deeper, towards groundwater, so BMPs include no application if rain is in the forecast and applying only in upland areas and away from surface water. Additionally, users should not apply either of these herbicides if soils are porous (e.g., gravel, sand) or if the depth to groundwater is shallow (e.g., <10 feet). These methods, plus following the registration label, herbicide-specific BMPs and other BMPs found in PUPS (e.g., calibrated application equipment, use of drift control additives, and application with wind speeds of 7 miles per hour or less) will minimize the risk of aminopyralid and triclopyr reaching surface or groundwater.

In the unlikely event that either aminopyralid or triclopyr reach surface waters, they would be rapidly broken down (< 1 day) by photolysis. Being herbicides, they are toxic to green algae, but those effects would be temporary as green algae occurs in the photic zone, where photolysis would rapidly degrade the herbicides. Both are practically non-toxic to fish (e.g., rainbow trout (*Oncorhynchus mykiss*) 96-hr LC_{50} > 100 mg/L) (EPA 2005, Strid et al. 2018) and amphibians. In the unlikely event that either aminopyralid or triclopyr reach groundwater, they may persist for months (aminopyralid deep water half-life of 103 days used for risk assessments; EPA 2005).

A glyphosate product formulated for aquatic use, in contrast to aminopyralid and triclopyr, could be used to manage invasive species at sites that occur adjacent to surface water, as well as emergent species that occur in shallow-inundated sites at the time of application (e.g., reed canarygrass). Although highly water soluble, offsite mobility and transport of residual glyphosate would be limited by: a) following the registration label, herbicide-specific BMPs, and other BMPs found in PUPS (e.g., calibrated application equipment, application during still weather); and b) glyphosate binds strongly to soils, although residues could reach surface water bound to soil particulate matter (EPA 2008) with erosion. Therefore, targeted application methods (Table 3) will be important to minimize non-target vegetative die-off and subsequent erosion, and minimize the risk of travel to surface waters. Glyphosate is degraded primarily by microbes; if it reached surface water, its half-life in aerobic water-sediment systems is 7 days (8-199 days in anaerobic sediments) (EPA 2008). Because of the low risk of travel to surface water, and the relatively short half-life if it reached surface (aerobic) waters, when used under as outlined there will be negligible effects of glyphosate on water resources.

Soil Resources

Affected Environment

As defined by the Soil Science Society of America, a soil is the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants (USDA-NRCS 2019). Soils develop from parent materials originating from a variety of geological or vegetative sources. Soil parent materials include glacial deposits; hillslope, stream, and uplifted marine sediments; rock; volcanic ash; and deposits of decomposed plant and animal materials. The soil particles of tundra are produced almost entirely by mechanical breakup of the parent rock and have little to no chemical alteration. The continual freezing and thawing cycle of soil moisture has disintegrated the soil particles and sorted the coarse particles giving rise to patterned ground with such features as stone rings, stone polygons and stone stripes.

Soils in the Polar and Interior Alaska Ecoregions are predominantly freely draining soils with weakly differentiated horizons, and generally not very fertile. Soils in these ecoregion are characterized by wind-deposited silt loam and have developed under low rainfall and cycles of freezing and thawing typical of the tundra. River bottom and lower slope soils are generally deep with underlying sands, silts, and gravels that are only slightly weathered. Soils on north-facing slopes are shallow and poorly developed and have continuous permafrost. The mountains of the Brooks Range are underlain by folded and faulted limestone and the soils are rocky and poorly developed. Upland soils that support spruce-hardwood forests are well drained and shallow. Bog soils are comprised of peaty soils, with a deep surface layer of organic material. Soils occupying south slopes and low moraines (glacial and alluvial deposits) are well drained and loamy with permafrost and ice features. Localized areas of poorly drained clay soils occupy uplands. Soils of the lowlands are deep, wet, and silty (Bailey 1980).

Soils in the Bering and North Pacific Coast Ecoregions have developed with less wind deposition, much higher rainfall, and little to no influence of soil freezing, except at high elevations. Coastal soils are wet, cool, and well drained over silt, sand, and marine sediments. The lower Yukon and Kuskokwim valley bottoms have pockets of soils comprised of minerals that have not yet differentiated into distinct layers. Upland hardwood forest soils are mostly shallow and well drained. North-facing slopes have continuous permafrost. Alpine soils are generally shallow and poorly developed, with discontinuous to continuous permafrost. The Aleutian soils are poorly developed and may be well drained and/or consist primarily of organic materials (Bailey 1980).

Protecting prime farmland, unique farmland, and soil of statewide or local importance is part of the Farmland Protection Policy Act (FPPA). The FPPA minimizes the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. Soils of local importance are identified by a local agency or agencies, which includes soil and water conservation districts or boroughs. The soils have specific properties favorable to regional agriculture and crops. There are designated soils of local importance within the Kenai Peninsula, Matanuska-Susitna Valley, and Greater Fairbanks Area.

Soil productivity (i.e., a soil's ability to support vegetative growth), the potential loss of soils, and off-site effects from management efforts are of principle concern in invasive plant management. The productivity of soils directly or indirectly affects the productivity of other natural resources. Soil quality effects the growth of trees and plants and in extension, the quality of fish and wildlife habitat. Soil productivity, as measured by tree growth, is greatest in well drained soils. Some invasive plants for example white sweetclover, fix nitrogen which changes the soil chemistry and availability of nitrogen for native plants (Wolf et. al. 2004).

Impacts on Soil Resources

<u>Alternative 1: Regional IPM Strategy without Herbicide</u>

Under Alternative 1 there may be negligible to minor adverse impacts to soils with the use of physical methods. The level of effect would differ depending on the method of treatment applied, and size of infestation. Effects would be negligible where physical methods of cutting, girdling, mowing, mulching, soil polarization and stabbing are used. Solarization with physical barriers using plastic products and/or mulches alter moisture regimes and soil temperatures, particularly with plastics that would repel water (USNPS 2009). These methods would directly kill the invasive plants, without agitating, removing, or otherwise disturbing the soil in the process. Negligible to minor short-term impacts to soil would result from physical methods such as hoeing, prescribed fire, and pulling (by hand or tool). Hoeing and pulling agitate the soil, breaking it apart, and could increase the possibility of erosion in runoff. These methods may disturb roots of nearby non-target plants, decrease stability, especially when rhizomatous perennials require the removal of all root, tuber, and bulb parts. Topsoil removal and trampling by personnel involved in the treatment would also reduce infiltration and increase potential for erosion. Prescribed fire may destroy organics in the upper soil layer, add ash and char to the soil, which may increase soil water repellency and runoff rates. Flaming and burning techniques would kill aboveground weeds, but root systems may remain viable if burns are not hot enough (soil temperatures >118-129˚ F), which could allow some invasive species to survive and require more treatment (Knapp, Estes and Skinner 2009; DiTomaso and Johnson 2006).

There would be no long-term effects to soils caused by physical methods of cutting, girdling, mowing, mulching, soil solarization and stabbing. Once the treatment ends the soils will be left intact and seed bank reserves would allow the natural revegetation of the treatment area. However, this may include seeds of the target invasive species, and would need monitoring to ensure the undesirable plants do not repopulate the area. Long-term effects for hoeing, pulling and prescribed fire would be negligible to minor. In most cases, successful removal of invasive plant roots would require complete removal and disassociation of the topsoil with intermingled roots of all plants. The removal and disassociation of topsoil during hoeing and pulling would lead to soil desiccation, degrading the suitability of soil for native plant species and would destabilize soil, increasing sediments in runoff. Cutting and digging can modify soil thermal regime, soil moisture, soil nutrients and frost penetration (USNPS 2009). Long-term effects of prescribed fire would be negligible to moderate. Fire may consume beneficial elements of the soil, and would increase time to recover, during which the area would be vulnerable to erosion, and continued invasive infestations. These activities could affect soil organic matter, moisture and thermal characteristics, however, ash from burns could also enhance soil productivity for one or more growing seasons (USNPS 2009; Hubbert et. al. 2006).

The size of an infested areas would increase the effects of physical methods on soils especially where rhizomatous perennial invasive herbs (e.g., hawkweeds) and shrub-like herbaceous plants (e.g., knotweeds) are being removed. The number of treatment years required will influence the effect of physical methods on soils. Impacts would be negligible in small infestations comprised of a few plants. In such cases, individual plants would be dug, and the roots removed from the soil. In larger infestations impacts would be minor to moderate, more physical labor would be required to successfully remove invasive perennial herbs, grasses, and knotweeds and it would take repeated effort over multiple years to achieve control and/or halt the spread of infestations, with the distinct possibility that complete eradiation may not be achievable.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, impacts to soils, including impacts to soil microorganisms, will be negligible. Herbicides would be used primarily to manage larger infestations and infestations of species that are difficult to eradicate without herbicides. Including herbicide use may lessen physical impacts to soil structure described in Alternative 1, especially for rhizomatous invasive plants. Impacts to soils would depend on herbicide amounts reaching soils, which depends on treatment area size and application methods.

Although herbicides would be applied using targeted application methods (Table 3), most of which apply herbicide directly to plants, some herbicide residues may reach the soil surface, especially during foliar or basal/drench application methods. Little or no such potential exists for cut-stump, wiping, or injection application methods. If herbicide reaches the soil, some could leach into the soil subsurface. There, it could be immobilized or spread through soil, described by sorption potential/sorption coefficient (K_{oc}) (Table 6). At the same time, it could be metabolized by chemical or microbial processes, described by soil persistence or half-life ($t_{1/2}$) (generally a laboratory determination) and soil dissipation rate (DT_{50}) (generally a field determination; the time it takes for 50 percent of the chemical to be lost from soils via all mechanisms, including microbial action, offsite movement, volatilization or other processes). Movement within the soil would be more likely with aminopyralid and triclopyr, as they have greater soil mobility relative to glyphosate, which adsorbs strongly to soil. Therefore, should herbicides reach the soil surface or subsurface, aminopyralid and triclopyr may move with water flow through soils or to groundwater with half-lives resulting in measurable presence for < 1 year.

Glyphosate would be relatively immobile in soil with half-lives resulting in measurable presence for < 1 year. Glyphosate persistence in Alaska soils was investigated at sites near Fairbanks and the Kenai Peninsula; the latter experiences heavy rain and snowfall of approximately 2,250 mm/year (Newton et al. 2008). Soils at the Kenai site were always very wet or moist during the study, and the majority of residues detected in soil were within the first 15 cm (or 6 inches), with only 7 percent of glyphosate residues found deeper than 15 cm. Dissipation of the herbicides tested appeared to be largely due to microbial decomposition, and the authors attributed the presence of the aminomethyl phosphonate (AMPA) degradation product of glyphosate to microbial action. Within a year's time, measured glyphosate and AMPA residues in soils had declined to near the limits of detection (Newton et al. 2008). These authors concluded that four unrelated herbicides (including glyphosate) showed similar dissipation patterns, with some degradation occurring during winter months, but with most of the loss occurring during warmer months. They also noted that, within a year, residues were at or near limits of detection, were immobile, and that these dissipation rates approached those observed in warmer climates. Newton et al. (2008) suggested that microflora adapted to cold climates may be more efficient at degrading these herbicides than was previously thought.

In a study of glyphosate persistence in foliage and soils from a watershed on Vancouver Island, British Columbia, Feng and Thompson (1990) found similar results following an aerial application, with more than 90 percent of the residues of glyphosate and AMPA detected within the Oto 15 cm depth soil layer. In this study, glyphosate residues in leaf litter declined rapidly, with a DT_{50} of about 10 days, while AMPA residues in leaf litter were at or below detection limits within 29 days post application. In soils, the authors conservatively estimated a DT_{50} of 45-60 days for glyphosate. After 360 days, glyphosate residues were low (13-18 percent of initial levels) and AMAP residue concentrations had declined to 6-27 percent of initial glyphosate residue levels (Feng and Thompson 1990).

Table 6. Soil characteristics of aminopyralid, triclopyr, and glyphosate, abstracted from USFWS Chemical Profiles (Appendix B).

Herbicide	Soil Mobility (K_{oc})	Soil Persistence ($t_{1/2}$)	Soil dissipation rate (DT_{50})
Aminopyralid	1.05 – 24.3 mL/g (highly mobile)	31-355 days; 103.5 days used by EPA in risk assessments Soil photodegradation half-life = 61-72 days in shallow soils	21.1 days
Triclopyr	25-384 mL/g (relatively mobile)	8-69 days (average 32 days) in aerobic soil	18-84 days (average 46 days)
Glyphosate	884-60,000 ml/g (relatively immobile)	2-197 days, affected by soil and climate conditions. Typical half-life = 47 days	2-174 days (average 13.9 days)

The Region also considered toxic effects to soil microorganisms as impacts to soil resources. Aminopyralid and triclopyr are both metabolized by soil microorganisms. While information is limited, bioassays suggest that aminopyralid is not very toxic to soil microorganisms (SERA 2007). Triclopyr application resulted in slight structural changes in soil bacterial, but not fungal, communities (Souza-Alonso et al., 2015).
In contrast, glyphosate inhibition of the shikimic acid pathway in plants and some microorganisms results in the potential for toxic effects in soil microorganisms (SERA 2011(a)). The shikimic acid pathway does not occur in animals, including invertebrates, amphibians, fish, mammals, and birds. Some soil microorganisms do possess the shikimate pathway, and a number of laboratory studies (reviewed in SERA 2011(a)) suggest that glyphosate can inhibit microbial growth. Field studies of glyphosate are mixed, with some studies showing transient decreases of fungi and bacteria, while other studies report either no effect or an increase in soil microbes or microbial activity.

Glyphosate is readily metabolized by some soil bacteria, with AMPA as the primary metabolite. Some soil microorganisms can use glyphosate as their sole carbon source (SERA 2011(a)). AMPA is also biologically degradable, with liberation of carbon dioxide (WHO 2005). Degradation of glyphosate occurs more rapidly in aerobic than in anaerobic conditions (WHO 2005). AMPA is more persistent in soils than glyphosate; however AMPA appears to be less acutely toxic than glyphosate to freshwater fish, invertebrates and birds (EPA 2008, EPA 2009).

The Service can achieve negligible effects to soils by minimizing herbicide contact with soils by following label instructions, using targeted application methods to minimize run-off to soil, minimizing use of aminopyralid and triclopyr in porous soils and following other Service BMPs, and the small application area (< 20 acres) and short-term application period (once/year for no more than three years) under the response framework.

Vegetation Resources

Affected Environment

Vegetation – In the Polar Ecoregion sedge and tussock tundra predominate the coastal plains, and willow thickets occupy riverbanks. Vegetation of the Brooks Ranges is typically alpine tundra and barrens. The arctic treeline crosses the southern part of the ecoregion with conifer-birch forests and tall shrublands on the southern slope of the Brooks Range. The Bering Coast Ecoregion includes many types of freshwater- and brackish wetlands, shrublands, tussock and shrub tundra, riparian shrublands, and some spruce (*Picea glauca*) and (*P. mariana*), poplar (*Populus balsamifera*) and (*P. tremuloides*), and birch (*Betula spp*.) forests. A significant portion of the Togiak NWR is in the Ahklun Mountains, where shrub and forested lands are relatively more abundant. Freshwater, estuarine, and saltwater aquatic environments, as well as coastal cliffs and beaches, also are important habitats for diverse wildlife species. Because the growing season and availability of these habitats are extremely short and productive, the habitats are used by a large number of long-distance migrants. Vegetation in the Interior Alaska Ecoregion is a mosaic of boreal forest, shrubland, tundra, riparian areas, and wet meadows of varying composition and successional stage. The pattern reflects the dynamic processes of fire and flooding, which remove vegetation and return nutrients to the soil. In the west, vegetation communities in the Alaska Peninsula are typified by low shrubs of willow, birch, and alder (*Alnus crispa)* and (*A. rugose)* interspersed with ericaceous heath, lichen, and grass communities (Nowacki et al. 2001). The Aleutian Islands are primarily dominated by grasses, forbs, and crowberry (*Empetrum nigrum*). Vegetation on lands surrounding the Gulf of Alaska include temperate rainforest of western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*) mixed with open and forested wetlands on poorly drained soils (Wooward and Beever 2011).

Terrestrial invasive plants can affect areas with frequent disturbances such as fire and flooding. White sweetclover alters floodplains and creates shaded habitat that negatively impacts early successional native species that require full sun (Spellman & Wurtz 2011).

Impacts on Vegetation Resources

Alternative 1: Regional IPM Strategy without Herbicide

Vegetation may incur negligible to moderate adverse effects by application of physical methods, but the level of effect would vary primarily in relation to density and size of infestations coupled with the density of invasive and non-target plants. Physical methods applied to vegetation would have effects corresponding to infestation size, invasive plant type, and number of years requiring treatment. Adverse impacts would be negligible when physical methods are used to remove invasive trees and shrubs where infestations of invasive shrubs and trees (e.g., European mountain ash) are limited to a few individuals that minimally affected surrounding vegetation, as these species could be controlled by girdling or similar techniques. In contrast, effects on non-target vegetation may increase to moderate where physical methods are used to remove rhizomatous perennial invasive herbs (e.g., hawkweed) and shrubs (e.g., knotweed). In such cases, individual plants including roots would be dug and adjacent non-target plants would be removed or injured as needed to facilitate complete removal of invasive plants.

In larger infested areas, the effect would be moderate due to the level of disturbance, number of people required to successfully remove invasive perennial herbs at a site, and repeated effort over many years. In such cases, the Service would injure and kill some non-target plants because, in most cases, invasive plants would be intermixed with non-target plants and successful removal of invasive plant roots would require topsoil and non-target plant removal, disassociation, replacement, and trampling by personnel involved in the operation. It would take several years for non-target vegetation to recover from disturbance following treatment. Active revegetation of treated sites through seeding and transplanting would be utilized to accelerate recovery of habitat values. There is also a distinct possibility that the job would never be complete.

Physical barrier methods using plastic products and/or mulches would affect plants by blocking light, altering moisture regimes (particularly with plastics that would repel water), altering soil temperatures (USNPS 2009), and would be non-selective, impacting both target and non-target plant species. The combined applications of physical methods to an infested area or infestation site over a period of years would be expected to cause minor adverse impacts to non-target vegetation. This consequence is attributed mainly to the limited area where physical methods would be applied to manage priority invasive species. Negative impacts may increase over time as the size and density of infestations increase, requiring repeated and/or more intensive physical treatments. The repeated and/or more intensive treatments would result in continued negative impact non-target species that may be distributed within or immediately adjacent to the infestations.

Alternative 2: Regional IPM Strategy with Herbicide

Effects of physical methods would differ between Alternative 1 and the Alternative 2. Impacts would be consistent with those described in Alternative 1 where physical methods would be applied to manage infested areas comprised of a few invasive plants. Using herbicides on infestations may decrease the impacts of non-chemical methods (e.g., erosion, turbidity) although herbicides may also cause short-term negative impacts to native vegetation. Herbicides applied as part of an IPM strategy can minimize soil disturbance and reduce the number of years disturbance is required. Because soil disturbance is minimized, increases in non-target vegetation may be more rapid following treatment.

Herbicides would be used primarily to manage infestations that are not readily controlled using non-chemical methods and infestations that can be more effectively treated due to size of distribution (≤ 20 acres). In general, impacts of herbicide application would be minor and short-term to non-target vegetation in treatment areas. Impacts would be minimized by reliance on targeted herbicide application methods (Table 3) and adherence to label directions and Service BMPs (Appendix B). If herbicide were inadvertently applied to non-target plants and soil surfaces where invasive and non-target plants were intermixed, non-target effects would occur, but vary by non-target and target plant species composition, and herbicide fate, mode of action, and selectivity.

The mode of action of aminopyralid and triclopyr makes them effective at controlling broad-leaf forbs and woody plants, but not graminoids including grasses, sedges, and rushes. Non-target plants would be injured or killed if these herbicides were applied to non-target foliage or absorbed by non-target plant roots (SERA 2007). Aminopyralid exhibits some residual activity in soil, so the potential effects of both direct spray and soil exposure were evaluated (SERA 2007). This risk analysis suggested that tolerant graminoid taxa could be sprayed directly with no adverse effects anticipated; however sensitive non-target plants would be at risk across the entire range of permitted applications rates (SERA 2007). Spray drift presented the greatest risk to sensitive non-target plants (SERA 2007). Similar effects but potentially affecting more non-targets would be expected with triclopyr, which is effective at treating woody plants. However, direct foliar applications presented less potential spray drift risk to non-target plants compared with other delivery methods.

Non-selective glyphosate would injure or kill most non-target forbs as well as graminoids. Because glyphosate is relatively immobile in soil, absorption by roots of non-target plants would be unlikely. The dissipation of glyphosate residues in Alaskan vegetation occurred rapidly, with glyphosate degradation exhibiting an exponential decrease, similar to vegetation dissipation rates observed elsewhere (Newton et al. 2008).

Non-target native vegetation could also be adversely impacted inside and outside a treatment area by spray drift during herbicide application. Drift associated with backpack applications (directed foliar applications) are expected to be much less than those from ground broadcast applications, however no detailed studies are available regarding drift associated with backpack applications (SERA 2011(a)). Potential for spray drift would be minimized by adherence to herbicide label requirements and stipulations that reduce drift, and adoption of best management practices including sprayer pressure, droplet size and wand orientation when spraying, that should reduce off-site drift.

Sullivan and Sullivan (2003) reviewed 60 journal publications evaluating the broadcast spraying of glyphosate in forest and agricultural ecosystems, evaluating impacts on the diversity of terrestrial plants and animals. For terrestrial plants, Sullivan and Sullivan (2003) found that for 83 percent of studies evaluated, species richness (i.e., the number of species present in an area) and species diversity (which includes both the variety and abundance of different types of organisms in an area) either were unaffected by glyphosate application or increased, particularly herbaceous plants. One study observed changes in shrub species richness following treatment of a conifer plantation, with increased "pioneer" species, but minimal changes in overall diversity. They also noted that because glyphosate lacks long-term residual herbicidal properties (i.e., residues in soil do not generally affect plants through root uptake), seed banks within the soil were often sufficient to facilitate recovery of native species.

Sensitive species of aquatic plants would be affected by application of less toxic or aquatic glyphosate formulations near water, with hazard quotients exceeding levels of concern at application rates within the typical use rates (SERA 2011(a)). This risk assessment notes that more tolerant aquatic plants may not be affected. For example, duckweed (*Lemna* sp.) is more sensitive than eelgrass (*Zostera* sp.) to glyphosate acid.

The Region expects the effects of Alternative 2 may initially be low- to medium- intensity and temporary, especially under the rapid response scenario. Some non-target vegetation would be injured or killed and therefore adversely affected where they were intermixed with invasive plants and herbicides inadvertently reached non-target plants. However, the Region conclude that the overall scope of the impact would be negligible because of the limited spatial scope, use of targeted application methods, adherence to label directions and Service BMPs, and choosing appropriate herbicides (accounting for fate, persistence, and selectivity) for the target pest and specific location.

The degree of impacts would be expected to shift from negative, minor, and short-term to positive, moderate, and long-term in response to eliminating or severely reducing invasive plant infestations and a corresponding increase in native vegetation.

Federally Listed Threatened and Endangered Plant Species – There is only one ESA listed plant species in the Region. The Aleutian shield fern (*Polystichum aleuticum*) is listed as endangered under the ESA. The extant population of Aleutian shield fern is currently estimated at a minimum of 131 individuals all of which are found on Mt. Reed on Adak Island. Most plants occur in a narrow microhabitat, between 1,108 feet and 1,725 feet in elevation, consisting of rock grottos and moist crevices at the base of steep rock outcrops on the northeast arm of Mt. Reed (USFWS 2018(a)).

Section 7 of the ESA requires Federal agencies to ensure that actions they authorize, fund, or carry out do not jeopardize the existence of any species listed under the ESA, or destroy or adversely modify designated critical habitat of any listed species. An evaluation of federally listed species and critical habitats will be completed on a site-specific basis and any time a Service Pesticide Use Proposal application is submitted. An approved Service Pesticide Use Proposal would be necessary prior to the use of chemical control. Documentation of consultation is required if a federally listed, proposed or candidate species or critical habitat occur (or may occur) at or near the site. Physical control methods also have the potential to modify habitat and any project proposing to use these methods would require ESA consultation if a federally listed, proposed or candidate species or critical habitat occur (or may occur) at or near the site.

Impacts on ESA Listed Plant Species

Alternative 1: Regional IPM Strategy without Herbicide
Under Alternative 1 there may be negligible adverse to affect species listed under the ESA. Physical methods of invasive terrestrial plant species control would have similar effects on listed plant species as on non-listed plant species, including disturbance and displacement of individuals during treatment activities and potentially while the treatment area returns to native vegetation. Impacts would be negligible when physical methods are used to treat individual plants, with minimally invasive methods (e.g., cutting, girdling, stabbing, and pulling by hand when vegetation is spaced far enough away from ESA species.) Some methods of physical treatment may cause minor to moderate impacts, and would likely not be recommended, or be mitigated through an ESA consultation.

Site-specific determination of the presence of listed species or critical habitat will be conducted prior to any treatment of invasive species. An ESA consultation is necessary if the action may affect listed species or critical habitat. ESA consultations would likely emphasize surveys to determine presence of listed species and timing of physical control actions to seasons when listed species would not be present. The Service will minimize impacts by using targeted methods, BMPs, and mitigation recommendations received in ESA consultations. Invasive species are aggressive and have the potential to out compete highly specialized endangered species. Listed species could therefore benefit from removal of invasive species.

Alternative 2: Regional IPM Strategy with Herbicide

Based on the limited distribution of known Aleutian shield fern the Region concluded that for Alternative 2, impacts to ESA listed plant species would be negligible. Use of herbicides could affect the ESA-listed Aleutian shield fern, should either physical or chemical management actions occur where it is present. The current distribution is limited to Adak Island, and each use of a pesticide by the Service requires the user to determine if the project area contains species listed under the ESA, or any critical habitat (e.g., https://ecos.fws.gov/ipac/). If those are present, the user must determine if the pesticide use is likely to affect them; if so an ESA consultation with endangered species biologists must occur. Users must document their ESA steps and conclusions and include that documentation prior to PUP approval; and no pesticides may be applied prior to PUP approval. The results of the ESA evaluations, any project conditions resulting from the ESA consultation and requirements to for Service herbicide users to follow label directions and Service BMPs would be highly protective of species listed under the ESA.

Fish and Wildlife Resources

Affected Environment

Diverse and abundant fish and wildlife are central to the Region's ecosystems and cultures. The diversity of terrestrial and aquatic ecosystems supports over 1,000 native vertebrate species in the Region. Most of Alaska's fish and wildlife populations are considered healthy (ADF&G 2021). Federal legislation that seeks to conserve and restore fish and wildlife resources in Alaska include: the Pacific Salmon Treaty Act, the Migratory Bird Treaty Act, the ESA, the Gold and Bald Eagle Protection Act, the Dingell-Johnson Sportfish Restoration Act, the Pittman-Robertson Wildlife Restoration Act, the Fish and Wildlife Coordination Act, the Marine Mammal Protection Act, and the Alaska National Interest Lands Conservation Act (ANILCA). The ANILCA stipulates the designation of Wilderness, subsistence management, transportation, mining, archaeological sites, scientific research studies, and other activities on Federal lands. The ANILCA is discussed further in the Land Use section.

<u>*Fish*</u> – Fish species of Alaska can be divided into two dominant broad groups, resident and anadromous, based on life history. Resident species tend to occupy one waterbody for their entire life cycle. Anadromous species are born in freshwater systems, migrate to and spend a portion of their life in the ocean, then return to freshwater systems to spawn. Common resident freshwater native fish species in Alaska include Artic grayling (*Thymallus arcticus*), whitefish species (*Coregoninae spp.*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus Catostomus)*, Alaska blackfish (*Dallia pectoralis*), northern pike (*Esox Lucius*), burbot (*Lota lota*) and sculpin species (*Cottus spp.*). Common anadromous native fish species in Alaska include lamprey species (*Lampetra spp.*), pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*)*,* Chinook salmon (*Oncorhynchus tshawytscha*), rainbow trout, Arctic char (*Salvelinus alpinus*), Dolly Varden (*Salvelinus malma*)*,* rainbow smelt (*Osmerus mordax*)*,* and longfin smelt (*Spirinchus thaleichthys*) (ADF&G 2021).

Salmonids may be the most important group of Alaskan native fishes in terms of their ecological, cultural, and commercial importance. All members of this group, which include salmon, trout, char, and whitefish, require cold, clear water. This group is a popular target of recreational anglers, subsistence harvests, and commercial fisheries. Service and adjacent lands contain a substantial portion of the spawning and rearing habitat for some of the richest and most intact salmon fisheries in the world, such as Bristol Bay and the Yukon and Kuskokwim Rivers (Figure 1).

Invasive plants can have direct and indirect adverse impacts on fish and their habitats. Japanese knotweed (*Fallopia japonica*) infestations along streams reduce bank stability resulting in increased erosion and sedimentation. European bird cherry also has the potential to have adverse effects on fish and amphibian habitat along riparian edges and in very shallow water or in intermittently flooded areas (Roon et. al. 2016). Excess sediment in streams can impact spawning habitat and reduce the abundance of invertebrate prey resources. Terrestrial invasive plants like reed canarygrass in streams can: increase sedimentation; alter channel morphology; displace woody riparian shrubs and trees that serve as key sources of in-stream woody debris and fish prey items; obstruct stream flow; block fish passage; and reduces habitat quality and quantity for aquatic organisms. For example, a Columbia River study found juvenile salmon growth was stunted in habitat dominated by reed canarygrass compared to habitat with natural emergent vegetation (Klopfenstein 2016).

Impacts on Fish Resources

Alternative 1: Regional IPM Strategy without Herbicide
Under Alternative 1, the following physical methods would have none to negligible adverse effects to fisheries resources when occurring in the vicinity of infestation sites: cutting, girdling, mowing, mulching, soil solarization and stabbing. These methods can directly kill the invasive plants, without agitating, removing, or otherwise disturbing the soil, and therefore turbidity and water quality caused by soil runoff, of habitat would not be altered. Physical treatments such as hoeing, prescribed fire and pulling (by hand or by tool) would have negligible short-term effects due to the possible temporary increase of soil runoff. Hoeing and pulling agitates the soil, breaking it apart, which could increase the turbidity of aquatic habitat. Turbidity is the accumulation of suspended particles in the water column, and can affect habitat quality by reducing food supplies, smothering or otherwise degrading spawning beds, and affecting gill function). The potential for erosion and sedimentation to enter fish habitat would increase with larger infestations and a greater area subject to removal and disassociation of topsoil, as is required for the removal of roots of perennial invasive plants. These larger infestations would require multi-year treatments and may lead to increased long-term effects to fish habitat. Burning could cause ash containing, nitrogen, phosphorus, other nutrients, and possibly heavy metals to land or run off into nearby water bodies, increasing turbidity and temporarily altering the water quality that may be harmful to some fish species.

There would be no long-term effects to fisheries resources from cutting, girdling, mowing, mulching, soil solarization and stabbing. After treatment has concluded, the area would either be able to naturally re-establish vegetation, or the Service would aid the recovery by replanting the area with native species. Hoeing, prescribed fire, and pulling (by hand or by tools) methods of invasive species removal would cause negligible long-term negative impacts to fisheries resources within proximity of the infestation as long as the treatment area is relatively small, and the timeframe for treatment is relatively short. Impacts from hoeing and pulling would consist of increased potential for erosion and sedimentation associated with soil removal and disassociation required for invasive plant removal, potentially increasing the amount of runoff. Impacts after burning would include nutrient influxes, potential aquatic plant and algal blooms, and depleted oxygen levels in adjacent water systems. These effects would increase to minor and moderate in correspondence with gradually increasing area where terrestrial and riparian habitat shifts from dominance by native species to dominance by invasive plant species, and more biomass needs to be removed to successfully control invasive species. Repeated treatments would be necessary and could diminish the ability for recovery of the area. These methods may be less likely to eradicate certain invasive species (e.g., Japanese knotweed). Therefore, treatment may go on for years indefinitely, continually disturbing the area and prolonging the occurrence of high turbidity in aquatic habitats nearby making recovery near impossible.

Alternative 2: Regional IPM Strategy with Herbicide
Under Alternative 2, minimizing sedimentation and runoff into aquatic environments by using herbicides instead of soil-disturbing methods (especially for rhizomatous invasive species) will reduce impacts of sedimentation on fish and their habitats. The Region anticipates negligible effects from Alternative 2 based on low active ingredient toxicity to fish, the Service's commitment to following label instructions and Service BMPs (including use of low-toxicity surfactants) and using targeted application methods to minimize run-off to water application limitations under response actions (<20 acres, once/year for no more than 3 years).

Aminopyralid and the acid form of triclopyr are of low toxicity to fish (SERA 2007; Appendix B). Risks to sensitive fish following exposure to the highest allowable aminopyralid application rate ranged from 50 to 500 times below levels of concern (SERA 2007). Triclopyr, at application rates used for habitat management in terrestrial environments with a 25-foot buffer to water, was also considered low risk to fish (Appendix B).

Some applications of glyphosate directly to water may have negative impacts on fish, especially otherwise stressed populations (SERA 2011(a)). However, using a worst-case ecological risk assessment scenario, the Service concluded that the risk to fish would be low (Risk Quotient [RQ] <0.02 less than the Level of Concern [LOC] 0.05) (Appendix B) when using glyphosate application rates suitable for habitat management. Wan et al. (1989) summarized in SERA (2011(a)), tested glyphosate toxicity on coho, chum, Chinook, and pink salmon and rainbow trout relative to expected water concentrations following application of 1.36kg of glyphosate acid equivalent (a.e.)/acre, applied directly to water. Peak water concentrations anticipated were nearly 20 times lower than acute toxicity values (specifically, 96-hour LC50) for the most sensitive salmonid species tested (chum salmon and rainbow trout) when tested under the most conservative conditions (in low pH or "soft" waters). Stehr et al. (2009) evaluated effects of glyphosate (without surfactant) on fish development and found no impairment to growth or reflexes. Although surfactants associated with some glyphosate products are toxic to fish, the Service requires that only surfactants with low aquatic toxicity be used if the product is applied within 25 feet of surface water (Table 3; Appendix B).

Amphibians and Reptiles – Amphibians present in Alaska include the wood frog *Rana sylvatica*, Columbia spotted frog (*Rana luteiventris*), roughskin newt (*Taricha granulosa*), long-toed salamander (*Ambystoma macrodactylum*), northwestern salamander (*Ambystoma gracile*), and western toad (*Bufo boreas*) (ADF&G 2021). The wood frog is the most common amphibian in Alaska and is the only frog that lives north of the Arctic Circle. The only reptiles in Alaska are rare or occasional Green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), and olive Ridley sea turtle (*Lepidochelys olivacea*). Due to the relative scarcity of primarily marine based life history, impacts to these reptiles was not analyzed.

Some amphibian species are known to utilize both wetlands and nearby uplands during their life cycle, often returning to wetlands and water sources for reproduction and spawning. The roughskin newt uses forests, woodlands, grasslands, open valleys, and ranchland, in the open or under rocks, logs, adjacent to aquatic habitat. The long-toed salamander migrates up to several hundred meters between breeding ponds and nonbreeding terrestrial habitats according to an Alaska Department of Fish and Game fact sheet citing Berven and Dfudzien 1991. Frogs have been found to decrease foraging when habitat was invaded by terrestrial invasive plants such as Japanese knotweed (Maerz et. al. 2005). This invasive plant establishes along rivers, crowds out other plants and disrupts the natural shifting of floodplains that provides nutrient replenishment to the ecosystem.

Invertebrates – Native invertebrates, or animals without backbones, found in Alaska (e.g., insects, spiders, butterflies, moths, etc.) are highly diverse and play key ecological roles in the function of terrestrial and aquatic systems. Invertebrates pollinate plants, decompose matter and cycle nutrients, and are an important food source to birds, fish, and mammals (CAFF 2021). Pielou 1994 documented that most pollination by invertebrates in the Arctic is done by flies and bumblebees. Alaska has thousands of species of invertebrates that may be affected by invasive terrestrial plants through habitat degradation and habitat loss. The displacement of native plant communities in areas by invasive plants can disrupt important ecological functions assisted by invertebrates. For example, when Japanese knotweed invades areas, communities of invertebrates have been found to be reduced by almost 50 percent (Gerber et al. 2008). Some beetle species' abundance and total beetle richness were diminished with the introduction of knotweed species (Topp et al. 2008). Plants relied on for agricultural and subsistence purposes can also be impacted by invasive plants through the displacement of native invertebrate pollinators.

Impacts on Amphibian, Reptile, and Invertebrate Resources

Alternative 1: Regional IPM Strategy without Herbicide

Under Alternative 1, negligible short-term effects to amphibians and invertebrate species would result from small infestations treated with physical methods. Cutting, girdling, mowing, mulching, and stabbing may displace, injure, or kill some organisms while work is being conducted; displaced organisms could return as soon as treatment ends. Soil solarization, hoeing, prescribed fire, and pulling (by hand or tool) would cause negligibly more disturbance to amphibian and invertebrate habitat temporarily, but the mobile nature and high reproductive rates of these taxa allow for a rapid recovery and return the area once treatment ends.

However, larger infestations have the potential to inflict long-term negligible to minor effects, through the disturbance of greater areas of soil and vegetation; and may deter or disrupt the ability of these taxa to repopulate the area. Additionally, the invasive species' root systems and seed bank resilience contribute to the return of the infestations year after year, requiring repetitive disturbances which would result in minor to moderate long-term effects on the resource. Yearly removal of large swaths of vegetation would cause various species to perish locally or seek other areas for suitable habitat.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, effects of physical actions would remain consistent with Alternative 1 and negligible adverse effects would result from limited herbicide use. Combined overall with the beneficial ecological effects of removing invasive plants, the negative effects to invertebrates including native bees would be negligible to minor. Keeping herbicide use is limited to < 20 acres, one application/year for typically 3 years, and following label directions and Service BMPs will also reduce impacts to non-target taxa.

Use of herbicides could facilitate the removal of invasive plants, which would benefit native amphibians and invertebrates. The Region has no basis to conclude that amphibian risk will exceed levels of concern; however, there is greater uncertainty with this conclusion for aminopyralid and amphibians compared to other taxonomic groups. However, Northern leopard frog (*Rana pipiens*) larvae, a test species, were not sensitive to aminopyralid, with no observed mortalities or sublethal effects observed at the highest concentration tested, 95.2 mg a.e./L, which classifies this herbicide as being practically non-toxic to amphibians (PMRA 2007; EPA 2005), and triclopyr is slightly toxic to practically non-toxic to amphibians and aquatic invertebrates (Appendix B). While no RQs have been calculated for amphibians, SERA (2007) estimated aminopyralid peak concentrations in a small stream in Glacier Bay National Park, Alaska (a high rainfall site, with applications to sandy soils) to be 0.13 mg/L, or less than 700 times the observed no-effect concentration for leopard frogs. Minimization strategies, including limiting applications to spot methods and using buffers around waterbodies will minimize aminopyralid and triclopyr environmental concentrations in water.

Risks to amphibians and aquatic invertebrates are minor for the less toxic formulations of glyphosate labeled for aquatic use (with low-toxicity surfactants; SERA 2011(a)), and these are the formulations which the Service would use near waterbodies. Henry et al. (1994) observed no mortality of study invertebrates following aerial application of glyphosate (the specific formulation used in this study was Rodeo) and a surfactant. Linz et al. (1999) found after aerial application of glyphosate to wetlands that most eastern North Dakota invertebrate populations either were not affected, or populations increased. The increases in aquatic insect populations were attributed to a reduction in non-desired cattail (*Typha latifolia*) density in the treated areas.

Glyphosate toxicity to bees and other pollinators is of concern. Although multiple RQs for acute contact exposure for bees were below the LOC of 0.4, and therefore acceptable, acute dietary exposure RQs were all above the LOC (Appendix B). Because glyphosate is not quickly metabolized by plants and can build up in plant tissues, including pollen (Golt and Wood 2021) it is especially important to use application methods that target only the invasive plant, at efficacious concentrations, to minimize survivors that may subsequently flower. It is also important to use glyphosate before flowering, as it can take days for plants to succumb to its effects as glyphosate is systemically distributed through the plant.

<u>Birds</u> – Alaska provides habitat for nearly 500 species of birds including sea birds, shore birds, waterfowl, songbirds, and raptors among others. Some of these are year-round residents, and others migrate from their southern wintering grounds. Birds utilize a variety of habitats for both nesting and foraging and can be an important source of food for other animals and subsistence hunters. Birds can be affected by terrestrial invasive plants and their management. Food resources may become scarce with the establishment of invasive plants outcompeting the native vegetation. Habitat may also become unsuitable for nesting and propagation of certain bird species. Birds also can promote establishment of terrestrial invasive species by spreading plant material (mainly seeds) to new areas increasing the negative impacts of terrestrial invasive plant species on the ecosystem.

Impacts on Bird Resources

Alternative 1: Regional IPM Strategy without Herbicide

Under Alternative 1, adverse impacts to birds would be negligible to minor. Temporary disturbance to potential nesting habitat would occur if treatment takes place in spring, and birds would have to seek other areas for foraging habitat any time of year. Cutting, girdling, mowing, mulching, stabbing, and soil solarization may displace some species while work is being conducted; many would be able to return as soon as treatment ends. However, if the infestation is small enough, and invasive species are not dominant, this may only delay the use of habitat during treatment.

Long-term effects may include the beneficial return of native vegetation, providing habitat and food sources that native birds have evolved to thrive in. This would be true for those infestations that were able to be eradicated with these methods of treatment. Hoeing, prescribed fire, and pulling (by hand or by tool) have the potential to disrupt habitat use for longer periods of time due to the level of disturbance from these methods. Fire and hoeing would often remove all vegetation present, including native species. Pulling may allow for targeting invasive species only, therefore leaving some vegetation undisturbed, however there is still ground disturbance that can weaken the stability of the surrounding soil and potentially affect the remaining vegetation. Larger infestations, and infestations dominated by species resistant to these methods would have negative long-term effects. When invasive species become established in such quantity, physical methods may not be feasibly able to eradicate, control, or even maintain a perimeter. Invasive species would decrease the diversity of vegetation and ability for the system to support some birds' ecological needs, thereby decreasing bird diversity as well.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, in addition to the benefits of removing invasive plants and other effects under Alternative 1, there may be negligible adverse effects from herbicide use. Direct toxicity of all three herbicides to birds is relatively low. Aminopyralid is practically non-toxic; triclopyr and glyphosate are slightly toxic. Under the Service's worst-case ecological risk assessment, no RQs exceed LOCs for aminopyralid used for habitat management, but triclopyr and glyphosate acute RQs for birds exceed the LOCs and result in a presumption of unacceptable risk for species listed under the ESA. To minimize this risk, Service users are directed to complete an ESA consultation, including a toxicological evaluation, before using triclopyr or glyphosate where federally listed birds may be present, in addition to following all other label instructions and Service BMPs. An ESA consultation would provide additional guidance and procedures for reducing risk to listed species.

Birds may be temporarily and indirectly affected by herbicide use through reduction in food, cover, or other habitat components. Sullivan and Sullivan (2003) reviewed seven glyphosate studies; three reported declines in some songbird species in at least the first post-treatment year. In many cases, the total number of individual birds increased, the number of species (richness) decreased, and some common species dominated. In particular residents, short-distance migrants, ground gleaners and conifer nesting species generally increased following treatment (Sullivan and Sullivan 2003). In general, some songbirds that prefer brushy deciduous cover often decreased while species preferring open habitats and conifers cover increased. They also noted that the biological significance of these shifts in species number and diversity are small when comparing changes with natural fluctuations in bird communities from untreated control areas (Sullivan and Sullivan 2003). The Region anticipates that the negative effects on bird habitat would negligible, particularly under a rapid response framework, and would be mitigated as native cover returns to the treatment area.

Impacts on Mammal Resources

Mammals – The mammals of Alaska are important food resources for each other and humans and are present in a wide variety of habitats. They may provide critical functions within habitats and ecosystems which could be affected by terrestrial invasive plant species. Many terrestrial mammal species inhabit Alaska including: large mammals like black and brown bear (*Ursus americanus*) and (*Ursus arctos*), caribou (*Rangifer tarandus granti*), plains and wood bison (*Bison bison athabascae*) and (*Bison bison bison*), muskox (*Ovibos moschatus*), moose (*Alces alces*), mountain goat (*Oreamnos americanus*); midsized mammals such as wolf (*Canus lupus*), wolverine (*Gulo gulo*), lynx (*Lynx canadensis*), North American porcupine (*Erethizon dorsatum*), river otter (*Lontra canadensis*), and beaver (*Castor canadensis*); and small mammals including Arctic fox (*Alopex lagopus*), red fox (*Vulpes vulpes*), fisher (*Pekania pennanti*), Alaska hare (*Lepus othus*), northern collared lemming (*Dicrostonyx groenlandicus*), American Mink (*Neovison vison*), collared pika (*Ochotona collaris*), Glacier Bay water shrew (*Sorex alaskanus*), and little brown bat (*Myotis lucifugus;* the only Myotis subspecies recorded north of 59°N latitude).

Mammal habitat conservation was a primary purpose for the establishment of most Refuges in the Region. For example, the Kodiak NWR was established to conserve brown bear and its native habitat. The terrestrial invasive plant orange hawkweed displaced important native forage plants of bears and therefore degraded the quality of brown bear habitat in the Karluk Lake area of the NWR as well as along the Kodiak road system. The Yukon Flats and Kenai NWRs have important moose habitat including riparian willow (*Salix* spp.) stands. Moose rely heavily on willow stands for foraging (Risenhoover 1989), this vital habitat is often reduced or possibly eliminated by various invasive species such as European bird cherry, perennial pepperweed (*Lepidium latifolium*), and bird vetch (Carlson et al. 2008).

Alternative 1: Regional IPM Strategy without Herbicide
Under Alternative 1, adverse impacts to mammals would be negligible to minor. Temporary disturbance in or displacement from foraging habitat or cover could occur. Cutting, girdling, mowing, mulching, stabbing, and soil solarization may displace some species while work is being conducted; many would be able to return as soon as treatment ends. However, if the infestation is small enough, and invasive species are not dominant, this may only delay the use of habitat during treatment. Mammals would also benefit from habitats restored to native vegetation. For example, European bird cherry can be toxic to moose and other herbivores as it produces cyanide (http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=501).

Alternative 2: Regional IPM Strategy with Herbicide
Under Alternative 2, in addition to the benefits of removing invasive plants and short-term other effects under Alternative 1, there would be negligible adverse effects because direct toxicity of all three herbicides to mammals is relatively low. Aminopyralid is practically non-toxic; triclopyr and glyphosate are slightly toxic to practically non-toxic. Under the Service's worst-case ecological risk assessment, no RQs exceed LOCs for aminopyralid or glyphosate used for habitat management, but triclopyr acute RQs for mammals exceed the LOC and result in a presumption of

unacceptable risk. To minimize this risk, in addition to all other risk-minimizing procedures (following label directions and Service BMPs; management action space and time limits) Service users are directed to complete an ESA consultation, including a toxicological evaluation, before using triclopyr or glyphosate where federally listed mammals may be present, in addition to following all other label instructions and Service BMPs. An ESA consultation would provide additional guidance and procedures for reducing risk to listed species.

For larger herbivorous mammals, responses have been more variable. For example, a study that examined glyphosate influence on deer foraging found neither aversion to glyphosate-sprayed foliage nor reduction in rate of plant consumption (Sullivan and Sullivan 1979). A study of moose in Maine, however, found decreased usage of clear-cut areas that were sprayed with glyphosate vs. untreated clear-cuts during the first 1-2 years, likely due to reduced browse availability. Moose usage was higher in sprayed areas (compared to untreated areas) at 7-11 years post-treatment however, likely due to greater presence of cover vegetation, rather than browse availability (Eschholz et al. 1996). Sullivan and Sullivan (2003) cited studies of black-tailed (*Odocoileus hemionus*) and white-tailed (*O. virginianus*) deer that did not reduce their use of treated conifer stands, presumably because the herbivorous plants they fed on had stable or increased abundance. These same authors also cited papers showing decreased populations of mountain hares following spraying of forest plantations, while long-term changes in snowshoe hare abundance, survival, growth and reproduction were not observed following glyphosate treatment.

Mammals may be temporarily and indirectly affected by herbicide use through reduction in food, cover, or other habitat components. However, these effects would not be long-lived, and would be mitigated as native cover returns or through restoration of native cover. For example, Sullivan and Sullivan (2003) observed no significant reductions in overall species richness or diversity of small mammals in glyphosate-treated areas. They did note that some vole and shrew species were reduced in abundance while deer mice and other species generally increased and the number of chipmunks (*Tamias spp.*) was generally unchanged; but the magnitude of observed changes were within the range of natural population fluctuations. There is limited knowledge on the impacts of herbicides to the little brown bat. The little brown bat is primarily an insectivore and nocturnal. As such the Region anticipates there to be negligible to minor short-term impacts (e.g., temporary displacement) to the little brown bat populations during site specific management actions.

Impacts on ESA Listed Wildlife

There are currently 40 wildlife species listed as threatened or endangered under the ESA that may occur in the Region. A table presenting the common name, scientific name, status, presence of critical habitat, and management agency for these species is included in this document as Appendix C. The majority of listed species in the Region are restricted to marine habitat and managed by the National Oceanic and Atmospheric Administration (NOAA). Most of these marine species would not be affected, directly or indirectly, by terrestrial invasive plants or management actions to control them. As such, the impacts of the two alternatives were not analyzed for the marine species.

Several ESA listed species may be impacted by terrestrial invasive plants or management actions. Endangered wildlife species in the Region include the Eskimo curlew (*Numenius borealis*). Threatened wildlife species in the Region that use freshwater environments include the Steller's eider (*Polysticata stelleri*), spectacled eider (*Somateria fischeri*), polar bear (*Ursus maritimus*), and the wood bison (*Bison bison athabascae*).

The Eskimo curlew was listed as endangered under the ESA in 1973. The species is considered possibly extinct with the last confirmed sighting in 1963. There have been reports of Eskimo curlew sighted as recently as 2006, but none of these observations have been confirmed. There is no critical habitat designated for the Eskimo curlew (critical habitat designation is not required for species listed under the ESA prior to 1978; USFWS 2016).

Designated critical habitat for the spectacled includes areas on the Yukon-Kuskokwim Delta, in Norton Sound, Ledyard Bay, and the Bering Sea between St. Lawrence and St. Matthew Islands. Designated critical habitat for the Alaska-breeding population of the Steller's eider includes breeding habitat on the Yukon-Kuskokwim Delta and four units in the marine waters of southwest Alaska, including the Kuskokwim Shoals in northern Kuskokwim Bay, and Seal Islands, Nelson Lagoon, and Izembek Lagoon on the north side of the Alaska Peninsula. Both species overwinter at sea. During the breeding season hens and broods feed in freshwater ponds and wetlands, eating aquatic insects, crustaceans, and vegetation. Males return to the marine environment after incubation begins (USFWS 2010(b), Petersen et al. 2000).

Critical polar bear habitat includes terrestrial denning lands within 32 kilometers (km) of the northern coast of Alaska between the Canadian border and the Kavik River and within 8 km of the northern coast of Alaska between the Kavik River and Barrow (USFWS 2017(a)). This terrestrial denning habitat is used in the winter, therefore terrestrial invasive plant management actions are unlikely to affect the polar bear.

Wood bison are grazers, mainly eating grasses, sedges, and forbs (herbaceous flowering plants). They can also use a variety of other plants; for example, silverberry (*Elaeagnus commutate*) and willow leaves make up part of their summer diet. Wood bison graze in meadows, around lakes and rivers, and in recent burns (ADF&G 2021). The Alaska population is listed as a nonessential experimental population under the ESA which eases the take prohibitions and consultation requirements of the ESA (USDOI 2014).

<u>*Section 7 Consultation*</u> – Section 7 of the ESA requires Federal agencies to ensure that actions they authorize, fund, or carry out do not jeopardize the existence of any species listed under the ESA, or destroy or adversely modify designated critical habitat of any listed species. An evaluation of federally listed species and critical habitats will be completed on a site specific basis and any time a Service Pesticide Use Proposal application is submitted. An approved Service Pesticide Use Proposal would be necessary prior to the use of chemical control. Documentation of consultation is required if a federally listed, proposed or candidate species or critical habitat occur (or may occur) at or near the site. Physical control methods also have the potential to modify habitat and any project proposing to use these methods would require ESA consultation if a federally listed, proposed or candidate species or critical habitat occur (or may occur) at or near the site.

<u>Alternative 1: Regional IPM Strategy without Herbicide</u>

Under Alternative 1 there may be negligible adverse to affect species listed under the ESA. Site-specific determination of the presence of listed species or critical habitat will be conducted prior to any treatment of invasive species. An ESA consultation may also occur if the action may affect listed species or critical habitat.

ESA consultations would likely emphasize surveys to determine presence of listed species and timing of physical control actions to seasons when listed species would not be present. Eskimo curlew and listed eider species breed in freshwater wetlands. This EA covers terrestrial invasive plants, therefore the overlap in time and space within actions may be minimal. The Region is unaware of studies documenting impacts to listed species in Alaska from changes in habitat quality due to invasive species but anticipate that those could occur through mechanisms such displacement of native vegetation in foraging or breeding areas. Listed species could therefore benefit from removal of invasive species. Physical methods of invasive terrestrial plant species control would have similar effects on listed birds and mammals as on non-listed species, including disturbance and displacement of individuals during treatment activities and potentially while the treatment area returns to native vegetation.

Alternative 2: Regional IPM Strategy with Herbicide

Under Alternative 2, in addition to the benefits of removing invasive plants and other effects under Alternative 1, negligible adverse effects may result because direct toxicity of all three herbicides to birds is relatively low. Aminopyralid is practically non-toxic; triclopyr and glyphosate are slightly toxic. Under the Service's worst-case ecological risk assessment, no RQs exceed LOCs for aminopyralid used for habitat management, but triclopyr and glyphosate acute RQs for birds exceed the LOC and result in a presumption of unacceptable risk. To minimize this risk, Service users are directed to complete an ESA consultation, including a toxicological evaluation, before using triclopyr or glyphosate where federally listed birds may be present, in addition to following all other label instructions and Service BMPs. An ESA consultation would provide additional guidance and procedures for reducing risk to listed species.

Listed birds in Alaska include the Eskimo curlew, spectacled eider, and Steller's eider. Eskimo curlew are so rare that if any were found the ESA consultation would likely preclude use of chemicals. Spectacled and Steller's eider or their critical habitat could be present in wetlands and ponds adjacent to terrestrial treatment areas. Their presence would likely preclude use of triclopyr and glyphosate during the breeding season. Onshore eider critical habitat would benefit from removal of invasive plants, but herbicide use may have a short-term impact on plants important for eider habitat, including emergent plants and grasses. These native plants would likely quickly revegetate the area from the surrounded none treated region or by plantings.

Onshore polar bear critical habitat is winter denning habitat. Key features of the habitat (slope and aspect) are only tangentially related to vegetation, and this habitat is occupied in the winter, months after vegetation management would occur (before bloom in early spring). Herbicides should not be used on known den sites; however, if herbicides were applied to an area subsequently used for denning, short soil half-lives (< 1 year) and relatively low mammalian toxicity would reduce risk of effects to polar bear. Because polar bears are entirely carnivorous, the Region does not expect any effects of consuming treated vegetation.

Wood bison, in contrast, similar to other large mammals, may be exposed to herbicides during foraging and daily or migratory movements. As in Alternative 1, removing invasive vegetation may result in short-term changes in forage availability, if they were eating the invasive species.

However, under this alternative, < 20 acres per site (and likely < 200 acres across the state per year) would be treated with herbicide. The treatment area of < 20 acres (or an upper estimate of 320 acres/year across all NWRs in Alaska) would be small wood bison home ranges (in Canada, 42,000 to over 300,000 acres; Larter and Gates,1994), and treatment would therefore be unlikely to result in more than negligible effects (as defined in this EA).

Each use of a pesticide by the Service requires the user to determine if the project area contains species listed under the ESA, or any critical habitat (by using a tool such as https://ecos.fws.gov/ipac/). If those are present, the user must determine if the pesticide use is likely to affect them; if so (and for all uses of triclopyr for birds and mammals and glyphosate for birds) an ESA consultation with endangered species biologists must occur (per Service BMPs; Appendix B). Users must document their ESA steps and conclusions and include that documentation prior to PUP approval; and no pesticides may be applied prior to PUP approval. The results of the ESA evaluations, any project conditions resulting from the ESA consultation and requirements to for Service herbicide users to follow label directions and Service BMPs would be highly protective of species listed under the ESA.

Summary of Impacts on Fish and Wildlife Resources

Table 7. Summary of impacts on Fish and Wildlife Resources.

	Fish	Amphibians / Reptiles / Invertebrates	Birds	Mammals	Section 7 Listed Endangered or Threatened
Alternative 1	Negligible	Negligible to minor	Negligible to minor	Negligible to minor	Negligible to minor
Alternative 2	Negligible	Negligible to minor	Negligible	Negligible	Negligible

Human Resources

Land Use Resources

Affected Environment

There are approximately 365 million acres of land in Alaska. Most of that land is public and managed by Federal or State agencies (Vincent et al. 2018). Alaska Native villages and Alaska Native Corporations, established with passage of the Alaska Native Claims Settlement Act in 1971, are the largest private landowners in the state with approximately 44 million acres. Other private land makes up less than one percent of Alaska. Most human associated development is concentrated on these private lands. Public land managed by the Service is the focus of the following section. Public land in Alaska is managed for a variety of uses including subsistence harvesting, recreation and commercial activities, as well as maintaining wilderness areas; public land. Many land use opportunities exist because of the abundant habitat and natural diversity found in the Region.

The establishment of terrestrial invasive plants may affect native species, alter natural habitats, and subsequently disrupt subsistence, recreational, and commercial uses. Land development in Alaska often involves replacement of the natural vegetative cover and underlying soils with fill material (e.g., quarry rock, gravel, and sand). Relative to native soils, fill material usually contains fewer nutrients and less moisture, organic matter, mycorrhizal fungi, and properties required by native plants. Many invasive plants are able to tolerate these poor soil conditions and, in the absence of resource competition from native species, are able to rapidly develop infestations on disturbed sites. When existing soils are retained during land development, landscaping with non-native or invasive species and soil compaction associated with the development activity can prevent native species from re-establishing. Loss of forest canopy at developed sites increases solar radiation benefiting invasive species while preventing shade-adapted native species from establishing or thriving.

Some important Federal regulations that pertain to public land use are the ANILCA and the Wilderness Act.

ANILCA - The ANILCA of 1980 created an additional nine NWRs, expanded existing NWRs, and created other public parklands in Alaska. The majority of Wilderness areas on NWRs in Alaska were designated with passage of the ANILCA, which also modified some provisions of the Wilderness Act to allow for the continuation of subsistence lifestyles and traditional activities. Wilderness lands on NWRs in the Region are managed according to the provisions of the Wilderness Act, except where there is a conflict with the ANILCA, in which case the provisions of the ANILCA prevail.

Subsistence Use – Subsistence is defined by Federal law as: "the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade" (ANILCA 1980).

The ANILCA Section 101 (c) states a purpose of the Act is to provide the opportunity for rural residents engaged in a subsistence way of life to continue to do so, consistent with recognized scientific principles to manage fish and wildlife resources and the purposes for which the conservation system units were established. Section 810(a) of the ANILCA requires that an evaluation of subsistence uses and needs be completed for any Federal determination to "withdraw, reserve, lease, or otherwise permit the use, occupancy or disposition of public lands." All ANILCA land use decisions are to include an evaluation of the effects to subsistence uses prior to making the decision. Many Alaska residents consume wild caught fish and wild game, particularly Alaska Native and rural residents, and obtain an important percentage of their calories from these wild foods. Subsistence harvest of fish and game is particularly important for rural Alaskans where commercially available food is expensive and sometimes difficult to obtain. The composition of the wild food harvest in rural Alaska is 31.8 percent salmon, 21.4 percent other fish, 22.3 percent land mammals, 14.2 percent marine mammals, 2.9 percent birds, 3.2 percent shellfish, and 4.2 percent wild plants (Fall and Kostick 2018).

Subsistence activities have the potential to increase terrestrial invasive plant species distribution and establishment. Terrestrial invasive plants could threaten subsistence use by altering habitats important for harvested plants and animals and can outcompete native plants. Prior to any Service management action, affected Alaska Native Tribes and Alaska Native Corporations will be consulted.

Wilderness Act – The Wilderness Act of 1964 established the National Wilderness Preservation System, which today is more than 104 million acres. Approximately 57 million acres are designated Wilderness in Alaska. In order to meet the NWR's wilderness purpose, the Wilderness Act provides that each agency administering wilderness areas "…shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character. Except as otherwise noted in this Act, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use."

These areas have many use restrictions enacted to maintain the land's wilderness character as required by the Wilderness Act. The Service manages 21 designated Wilderness areas totaling approximately 18.6 million acres on 10 NWRs. Other Federal agencies, like the U.S. Forest Service (USFS) and the National Park Service also manage Wilderness acres in Alaska. On a site specific basis, Regional staff will complete a Minimum Requirements Analysis (MRA) using the Minimum Requirements Decision Guide (MRDG) to ensure compliance with the Wilderness Act.

Invasive terrestrial plants have a high potential to expand into remote Service lands and have adverse impacts to native species. Without management action, invasive terrestrial plants could therefore have substantial long-term negative impacts on wilderness character within Wilderness managed by the Service (e.g., Kenai, Mollie Beattie), specifically to their natural quality. However, management actions in Wilderness under both Alternatives could also negatively impact the untrammeled, undeveloped, and natural qualities, and could temporarily reduce opportunities for primitive and unconfined recreation. The untrammeled quality would be negatively impacted as all management actions would involve manipulation of natural ecological processes.

Recreational Use – Recreational opportunities are numerous in Alaska. Service lands provide visitors with a wide range of recreational opportunities, including hunting, fishing, camping, hiking, dog mushing, cross-country skiing, boating, hang gliding, off-highway-vehicle driving, and mountain biking, birding, viewing scenery, and visiting natural and cultural heritage sites. Many of these activities require accessing NWRs at disturbed areas (e.g., roads, trailheads, airstrips, docks, etc.) where most terrestrial invasive plants can establish more easily. Recreational land use, specifically hunting, camping, hiking, off-highway-vehicle driving, mountain biking, and visiting natural and cultural heritage sites can spread terrestrial invasive plants when plant material is transported via shoes, clothing, equipment, or vehicles.

Commercial Use – Commercial use of Service land in Alaska includes a wide range of activities with varying impacts on the land. Activities that are considered a commercial use of land could be temporary and have minimal impact, like an outfitter taking clients hunting on a NWR. Commercial use may also include activities that are longer in duration and that have a larger impact on the land, such as a natural gas extraction project. Commercial land use can disturb land allowing for the establishment and spread of terrestrial invasive plants and increase their spread.

Impacts on Land Use Resources

<u>Alternative 1: Regional IPM Strategy without Herbicide</u>
Under Alternative 1 there may be temporary negligible impacts to land use resources. Short-term effects would consist of limited access during physical treatment of invasive species, negatively impacting use of the resources; displacement of animals used for subsistence from the < 20 acres treatment areas; and potential short-term physical disruptions to native plants, depending on the scope of the infestation. These effects would last the duration of the treatment and may remain in place while the ecosystem recovers from the disturbance. This could last a few days (most likely) up to a full growing cycle (least likely, but possible for areas needing extra time to allow native species to reestablish).

<u>Alternative 2: Regional IPM Strategy with Herbicide</u>
Under Alternative 2, impacts to land use resources would be negligible to minor, based on the limited duration (activities up to 3 years), following all label directions and Service BMPs, and community and tribal engagement processes and outreach. Treatment of invasive species, regardless of whether herbicides were used or not, would still result in temporary displacement of wildlife and humans from the treatment area during active treatment. Use of herbicides may extend the displacement of humans until the treatment area is safe (24 hours or until the restricted entry interval is reached (whichever amount is greater) to enter after herbicide use per Alaska regulations (18 AAC 90 – Pesticide Control). Herbicide use may also cause subsistence users to forego harvesting in the treatment area for a season or more, because chemically treated areas may be perceived as unsafe. Treated areas would be <20 acres in size, but if those acres contained an important subsistence resource proximate to a minority or low-income community, the relatively small size of the treatment area may not result in negligible impacts. Therefore, other aspects of invasive species treatments that are not analyzed here but are part of the Service's management procedures, including government-to-government tribal consultations, outreach, and meaningful stakeholder involvement would be especially important to weigh the costs and benefits of herbicide applications for invasive plant control in an area that contained important subsistence resources.

Cultural Resources

Affected Environment

Physical evidence of past human activity is collectively known as cultural resources. Cultural resources may include archeological sites, cultural landscapes, ethnographic resources, and historic structures. Land in Alaska contains evidence of 14,000 years of human habitation from the earliest settlers of the New World to Euro-American homesteaders and miners (Tremayne 2018). Cultural resources in Alaska include prehistoric camps and villages, natural features of spiritual importance to Alaska Natives, gold rush ghost towns, roadhouses, trapping camps, and Alaska's first producing oil well. Other cultural resources include Russia's first settlement in Alaska at Three Saints Bay, the Iditarod National Historic Trail, and well-preserved World War II remains in the Aleutian Islands.

Federal laws passed with the aim of protecting historical sites with cultural significance include: the Antiquities Act of 1906, Archaeological Resources Protection Act of 1979, Archeological and Historic Preservation Act, Historic Sites Act of 1935, National Historic Preservation Act (NHPA) of 1966, the Archeological Resources Protection Act of 1979, The American Indian Religious Freedom Act of 1978, and the Native American Graves Protection and Repatriation Act of 1990, Executive Order 13007 – Indian Sacred Sites, and Executive Order 11593 – Protection and Enhancement of the Cultural Environment. Any management action to control terrestrial invasive plants will comply with these Acts and Orders.

Under Section 106 of the NHPA the Service is required to review potential impacts to historical resources when an activity or project the Region is performing, managing, licensing, permitting, or providing Federal assistance for meets the NHPA's definition of an undertaking. Determination of a property as historic (any "prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records, and material remains related to such a property or resource." The NHPA [54 U.S.C. § 300308]) should be made by a qualified subject matter expert and adhere to 36 CFR §800.4. If no historic properties are identified, Service staff would document that finding and conclude the Section 106 process. If a historic property is identified, Service staff must assess the effect of the undertaking (invasive plant species treatment method) on the property and complete the Section 106 process. To comply with NHPA (614 FW 3) consultation with State Historic Preservation Officers (SHPO) and Tribal Historic Preservation Officers (THPO) for affected federally recognized Tribes and Alaska natives may be required.

Impacts on Cultural Resources

Alternative 1: Regional IPM Strategy without Herbicide
Under Alternative 1, effects to cultural resources would vary by site and treatment method as a result of potential surface ground disturbance during physical treatments (e.g., pulling, digging). These effects will be determined by a Secretary of Interior qualified subject matter expert. This should take place at the beginning of planning for all treatment sites in accordance with NHPA Section 106.

Alternative 2: Regional IPM Strategy with Herbicide
Under Alternative 2, there will be no additional impacts from herbicide use to abiotic cultural resources; use of herbicides may reduce impacts to abiotic cultural resources by minimizing ground disturbance.

Health and Safety

Affected Environment

Federal regulations that protect human health from possible negative effects of terrestrial invasive plant management actions include: the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); the Resource Conservation and Recovery Act (RCRA); and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Occupational Safety and Health Act of 1970 (OSHA). The FIFRA establishes procedures for the registration, classification, and regulation of all pesticides. Before any pesticide may be legally sold, the EPA must register it. The EPA may classify a pesticide for general use if it determines that the pesticide is not likely to cause unreasonable adverse effects to applicators, or the environment, or for restricted use if the pesticide must be applied by a certified applicator and in accordance with other restrictions. The RCRA regulates the disposal of toxic wastes, including the disposal of unused herbicides, and provides authority for toxic waste cleanup actions when there is a known operator. The CERCLA regulates how to clean up spills of hazardous materials and when to notify agencies in case of spills. The OSHA sets and enforces protective workplace safety and health standards. For the purposes of this section, the Region details potential effects of the proposed alternatives on safety, health, and access of workers as well as the public, e.g., visitors to Service lands engaged in subsistence or recreational use.

Impacts on Health and Safety

Alternative 1: Regional IPM Strategy without Herbicide

Effects on human health and safety from Alternative 1 would be negligible and temporary. Potentially impacts to individuals may include Service staff, partners, volunteers, or the general public. Actions associated with physical methods of invasive plant management may include digging, cutting, sawing, scything, stooping, and lifting. Actions associated with physical methods of invasive plant management may include use of specialized hand tools and motorized weed trimmers. Potential physically induced injuries could include sprains, strains, blisters, and cuts to hands, arms, knees, and backs. Direct hazards associated with physical methods are readily predicted and controlled but may never be fully eliminated. Worker safety would be enhanced by job hazard analyses, use of appropriate safety equipment, adherence with manufacturer product safety standards, and training of workers in equipment use.

Alternative 1 would have a negligible temporary effect on human safety resulting in limitations to access and uses. This alternative involves the same type and scope of management activities and related potential hazards as described for worker safety with the exception of field transportation concerns. The potential for injury to humans would be limited to workers involved in the management activity. To further minimize potential safety risk, entry and access to infested sites would be temporarily closed during implementation of invasive plant management activity. Areas will be marked/flagged/signed as necessary following the management activity - both to facilitate human safety and to help ensure public access does not increase erosion or disturb re-vegetation projects.

A negligible long-term effect would result from the use of physical methods of management over a period of years. In contrast to workers directly engaged in management activities, the public would not be at risk from physical hazards associated with non-chemical control measures, as they would have no role in these operations. However, access and use of the land would be repeatedly interrupted while treatment continued to be needed year after year. Safety and health risk would be minimized by notifying the public and nonpublic of site management plans, and by closing or signing/posting of sites during management operations. Public access likely will be discouraged for an extended period of time at some sites to minimize erosion potential and/or to foster successful re-vegetation. Long-term beneficial effects would occur when small infestations were removed during early stages of introduction. Most notably would be the benefits from protection of native plants that provide food and shelter for animals used by subsistence hunters, and that provide fruit and berries to subsistence gatherers.

Alternative 2: Regional IPM Strategy with Herbicide

The combined applications of the IPM approach allowing for herbicide use to all invasive species infestations over a period of years could cause minor temporary negative impacts to human health and safety. This assessment includes consideration of potential injuries and hazards involved with physical techniques. It also considers potential effects related to herbicide use. The herbicides proposed for use have low mammalian toxicity and consequently the inherent level of human health risk is minimal and readily mitigated through effective communication (e.g., signage, notices), and full compliance with worker training requirements, herbicide label stipulations, and agency standards for safe herbicide storage, transportation, use, and disposal. Effects described in Alternative 1 would also apply to Alternative 2 if management includes physical methods. Although these non-chemical control methods also would be applied to manage large infestations, the scope would be more limited primarily to removal of invasive plants (i.e., pulling); mowing invasive plant stands; clearing dead standing non-target vegetation from the vicinity of invasive plants; and cutting non-target shrubs to facilitate access to invasive plants growing amidst shrubs.

Human health and safety during herbicide application would be ensured by routine application of standards for transportation, storage, and use described in: Labels and Safety Data Sheets (SDS) for commercial herbicide formulations; Job Hazard Analyses; Integrated Pest Management Plans; and Pesticide Use Proposals. Potential hazards would further be minimized by routine maintenance of application equipment, certified pesticide applicator training, applicator use of personal protective equipment (PPE) that meets or exceeds label requirements, and provision of first aid equipment at treatment sites. Under Alternative 2 the Region would adopt the same suite of operational standards and practices to minimize exposure and risk of herbicide storage, transportation, and use. Service employees and partners who apply herbicides to manage invasive species are trained and certified, or directly supervised by someone who is trained and certified, in pesticide use by the State of Alaska. The types of worker activities associated with herbicide use would include: Transportation between the headquarters storage site and a field storage site (e.g., administrative units) or between the headquarters storage site and the field mixing site; mixing chemicals with water in a spray tank; walking over uneven terrain with a loaded backpack sprayer weighing between nine and 16.3 kilograms (kg) (i.e., weight of one to four gallons plus equipment); applying herbicides to vegetation, cleaning, calibrating and maintaining application equipment; and handling and proper disposal of disposable PPE such as Tyvex® coveralls, commercial herbicide containers, and broken application equipment. Potential risks associated with the handling and use of aminopyralid, triclopyr, and glyphosate were evaluated extensively in USFS risk assessments (SERA 2007, 2003, and 2011(a), respectively). Notable conclusions from these assessments are summarized below.

Aminopyralid Impacts to Human Safety and Health

A USFS risk assessment found no concern for adverse human health effects even at maximum application rates (SERA 2007). Aminopyralid is considered to have low toxicity to mammals including humans (SERA 2007). The lethal oral dose of aminopyralid has not been determined because aminopyralid did not cause any mortality at the EPA's highest dosing limits for acute oral toxicity studies. Similarly, subchronic and chronic toxicity studies failed to demonstrate any clear signs of systemic toxic effects (SERA 2007). Aminopyralid has been classified as "not likely" to be carcinogenic to humans (EPA 2005). Based on chronic bioassays and subchronic bioassays in mice, rats, dogs, and rabbits, "... there is no basis for asserting that aminopyralid will cause adverse effects on the immune system or endocrine function ..." (SERA 2007), or that dermal exposure resulted in adverse systemic effects (EPA 2005).

Short- and intermediate-term oral and inhalation risks were evaluated based on the results of a rabbit developmental toxicity study. The EPA (2005) concluded that the highest potential human exposure was to Mixer-Loaders working on aerial applications involving the treatment of 1,200 acres per day. Margin of Exposure (MOE) for these activities is 40,000. For context, the EPA generally considers MOE's greater than a value of 100 to not be of concern.

The primary hazard to workers involves potential aminopyralid exposure to skin, eyes, and lungs through direct contact with liquid or inhalation of vapors. Skin and lung exposure are not known as health risks. Aminopyralid is a severe eye irritant (EPA 2005), however eye contact with the mixed end-use formulation will cause moderate irritation. Tests of accidental oral ingestion indicated that most of the aminopyralid was rapidly excreted in unchanged form.

Use of best management practices and PPE (e.g., boots, long-sleeved shirt, impermeable gloves, goggles, face protection, and other equipment) can minimize dermal and inhalation exposure would be done by Service personnel and our partners, who follow all label directions and SDS precautions.

Triclopyr Impacts to Human Safety and Health

Multiple human health risk assessments have been done for triclopyr (in multiple chemical forms) (Dost 2003, SERA 2003). SERA (2003, p. xvii) concluded, “There is no indication that workers will be subject to hazardous levels of triclopyr at the typical application rate of 0.45kg/acre and under typical exposure conditions.” The most common application method is by backpack sprayer (SERA 2003). Triclopyr is considered slightly toxic under acute exposure conditions.

Inhalation and dermal absorption are two potential routes of exposure for workers. Triclopyr is not easily absorbed through the skin (i.e., dermally) and is not volatile. Forestry workers using triclopyr from backpacks and boom sprayers were analyzed for triclopyr exposure after five 8-11 hour-long days, with long pants, rubber boots, and a helmet as PPE. Their total absorbed dose of a 20:80 solutions of Garlon 4®: mineral oil (backpack) or 12.6 l powdered Garlon 4®:1800 l of water (boom) were estimated to be 13.3 percent less than the rat No Observed Effect Level (NOEL), but higher than the recommended daily dose for humans, as that is 100 times less than the rat NOEL (Gosselin et al. 2005).

Once in the body, high doses of triclopyr (like other organic acids) can harm the kidneys and liver (SERA 2003), but it is relatively rapidly excreted unchanged (i.e., most triclopyr was not metabolized). This is important because the primary metabolite of triclopyr, 3,5,6-trichloro-2-pyridinol (TCP), is also toxic (SERA 2003). Triclopyr was classified as “not classifiable as to human carcinogenicity” because of conflicting information on tumor formation in experimental animals (SERA 2003, Dost 2003).

Triclopyr products can irritate the skin and eyes; the degree of irritation was dependent upon the chemical form (e.g., acid, TEA, or BEE) (SERA 2003). Eye irritation would be a “clear concern for occupational exposures” of the TEA formulation (SERA 2003, p. 29).

Use of PPE that includes long, impermeable gloves, rubber boots, goggles, face protection, and other equipment that will minimize dermal and inhalation exposure would be done by Service personnel and our partners, who follow all label directions and SDS precautions. For example, a current SDS (for Garlon 3A®) recommends protective gloves, eye protection, and face protection, among other measures.

Glyphosate Impacts to Human Health and Safety

Information on the toxicity of glyphosate is extensive, including standard toxicity tests required during the pesticide registration process and published studies. Glyphosate is not readily absorbed by humans or other mammals, with limited dermal (i.e., through the skin) absorption. Once in the body, glyphosate is not extensively metabolized, with more than 95 percent of the chemical excreted unchanged (SERA 2011(a)). Exposure scenarios within SERA's (2011(a)) risk assessment evaluated dermal exposure by immersion and accidental spills. Most occupational exposure for workers and some exposure to members of the public would involve dermal contact.

Glyphosate is considered to be of low toxicity to mammals including humans, and potential risks to applicators appear to be low. Glyphosate underwent a registration review in 2019 (https://www.epa.gov/sites/default/files/2020-01/documents/glyphosate-interim-reg-review-decision-case-num-0178.pdf). The EPA concluded that glyphosate is not likely to be carcinogenic to humans and that there were "no risks to human health from the current registered uses," of glyphosate. "Registered uses" assumes that label directions, including for personal protective equipment, are followed.

The SERA (2011(a)) notes that the EPA has stated in past assessments that glyphosate is neither mutagenic (i.e., causing heritable mutations) or clastrogenic (i.e., causing chromosome breakage). The SERA (2011(a)) risk assessment further discusses a published study of technical grade glyphosate that suggests mutagenic activity in exposed fruit flies; however, the threshold for mutations was considerably higher than concentrations the Region expects following field applications.

Technical glyphosate causes slight skin irritation and is classified as Category IV (least hazardous category). Formulations which contain primarily only glyphosate and water with no surfactants are classified as either non-irritating or only slightly irritating to skin. Even when not required by the label, the Service recommends best management practices that include wearing protective clothing (e.g., Tyvex coverall, gloves, and boots) to avoid potential dermal contact.

The EPA has classified technical glyphosate as mildly irritating to the eyes (Category Ill), and surfactants are probably the cause of eye irritation that is associated with some glyphosate formulations (SERA 2011(a)). As a precaution, the Service typically require that workers wear eye protection when mixing and loading backpack sprayers, to reduce risks from splash when handling the concentrated formulations.

Due to its very low vapor pressure, inhalation exposure levels for workers applying glyphosate are low, relative to dermal exposure (SERA 2011(a)). Their analysis compares potential effects concentrations (from toxicity testing) vs. maximum measured concentrations found in the air during glyphosate applications. In this comparison, levels of concern were a factor of 20,000 higher than measured air concentrations (SERA 2011(a)).

The SERA (2011(a)) reviewed the literature associated with endocrine disruption and glyphosate, including both the technical product and formulations. In reviewing the various studies presented in this risk assessment it appears that in general, formulated products with surfactants had more potential for endocrine effects, relative to technical glyphosate. Glyphosate itself generally appears to have low or equivocal potential for endocrine disruption. Further, where endocrine effects were observed, they were observed at concentrations well above our expected exposure rates and/or were associated with formulated products containing proprietary surfactants which are not proposed for use under this EA.

The SERA (2011 (a)) evaluated accidental exposures to workers using reasonably conservative assumptions, including immersion of a worker's hand in glyphosate for one hour, and a spill on a worker's leg with no cleanup for one hour. Potential risks to workers were well below levels of concern for accidental exposures by a factor of 100 or more.

Occupational exposures related to normal spray operations were also well below levels of concern. For example using the maximum aquatic application rate of 1.7 kg/acre, a worker would need to spray more than 250 acres in a single day to exceed the occupational level of concern (SERA 2011(a)). While the exposure assessment for workers is based on modeled calculations, the document compares calculated exposure rates vs. the results from three different published studies that determined exposure via biomonitoring of workers that had applied glyphosate using backpack equipment.

Environmental Justice

Affected Environment

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Many communities in Alaska, especially remote communities within or near NWRs, have minority and low-income populations (https://headwaterseconomics.org/tools/usfws-indicators/). Because many rural communities in Alaska live a subsistence lifestyle, which provides significant economic inputs and food security, the Region evaluated this under Land Use Resources and repeat our conclusions here. The Region anticipates no other benefits or impacts to minority and low-income communities in the Region beyond benefits and impacts to subsistence.

Impacts on Environmental Justice

Alternative 1: Regional IPM Strategy without Herbicide

Under Alternative 1, negligible effects to environmental justice may include limitations on land and plants used for subsistence. Short-term effects would consist of limited access during physical treatment of invasive species, negatively impacting public use of the resource; displacement of animals used for subsistence from the < 20 acres treatment areas; and inadvertent short-term physical disruptions to native plants. These effects would last the duration of the treatment and may remain in place while the area recovers from the disturbance. This could last a few days (most likely) up to a full growing cycle (least likely, but possible for areas needing extra time to allow native species to reestablish).

Alternative 2: Regional IPM Strategy with Herbicide
Based on the limited duration (activities up to three years), following all label directions and Service BMPs, and community and Tribal engagement processes and outreach, the Region anticipates that the effects of Alternative 2 to environmental justice would be negligible to minor on human use of resources within the treatment areas. Under Alternative 2, treatment of invasive species, regardless of whether herbicides were used or not, would still result in temporary displacement of wildlife and humans from the treatment area. Use of herbicides may extend the displacement of humans until the treatment area is safe to enter after herbicide use (either 24 hours, or the restricted entry interval on the label; whichever is greater). Herbicide use may also cause subsistence users to forego harvesting in the treatment area for a season or more, because chemically treated areas may be perceived as unsafe. Treated areas would be <20 acres in size, but if those acres contained an important subsistence resource proximate to a minority or low-income community, the relatively small size of the treatment area may not result in negligible impacts. Therefore, other aspects of invasive species treatments that are not analyzed here but are part of the Service's management procedures, including government-to-government Tribal consultations, outreach, and meaningful stakeholder involvement would be especially important to weigh the costs and benefits of herbicide applications for invasive plant control in an area that contained important subsistence resources.

Summary of Analysis

Alternative 1 - Regional IPM Strategy without Herbicide

As described above, the purpose and needs of the project would be partially met under Alternative 1. Some infestations of invasive plants would be eradicated via physical treatment methods, but infestations would require extensive physical labor to manage and more aggressive invasive plants would not be managed to the fullest extent. Air quality will have negligible adverse effects which will be localized to the project area and transportation corridor to get to the sites when vehicles are used. There may be negligible to minor short-term effects to Water Resources in the form of increases in turbidity when treating infestations near waterbodies. Soils may be minimally and temporarily impacted by physical treatment methods, but would return to pre-infestation levels as the native species recolonize the area via natural dispersal and active restoration actions. There will be negligible adverse effects to fisheries resources in the vicinity of treatment activities. Removing terrestrial invasive plants near waterbodies can lead to increased prey sources for fish and has been shown to restore fish habitat connectivity and quality. Negligible short-term effects to amphibians and invertebrate species would result from small infestations treated with physical methods. Adverse impacts to birds and mammals would be negligible to minor. Temporary disturbance to potential habitat used for nesting, foraging, or shelter could occur depending on treatment timing. Long-term effects may include the beneficial return of native vegetation, providing habitat and food sources that native birds and mammals have evolved to thrive in. Vegetation may incur negligible to moderate adverse effects by application of physical methods, but the level of effect would vary primarily in relation to density and size of infestations coupled with the density of invasive and non-target plants. Under Alternative 1 there may be temporary negligible impacts to land use resources that would occur periodically and possibly in perpetuity, depending on the aggressiveness of invasive plant, to achieve suppression of the plant. The purpose and needs would be partially met under this alternative. While eradication could be achievable for some invasive plants, restoration of the habitat for native fish, wildlife, and vegetation would be less certain, as multiple direct and indirect factors could influence achieving eradication and preventing recolonization.

Alternative 2 - Regional IPM Strategy with Herbicide

As described above, Alternative 2 would maximize the likelihood of eradicating site-specific invasive plant infestations and restore the native habitat for fish, wildlife, and plants. Maximizing the potential treatment methods applied during adaptive management of invasive terrestrial plants would hasten the restoration trajectory of native fish, wildlife, and plant communities, especially when managing highly aggressive invasive plants. Under Alternative 2, impacts to air would be negligible and largely consistent with Alternative 1, although dust and ash from disturbance could be reduced if only chemicals were used. Impacts to water quality from invasive species control actions under Alternative 2 would be negligible. Pesticides traveling to surface and groundwater resources will be minimized by following label directions, including application rates and appropriate formulations; using targeted application methods under a response framework, and following Service BMPs. Under Alternative 2, minimizing sedimentation and runoff into aquatic environments by using herbicides instead of soil-disturbing methods (especially for rhizomatous invasive species) will reduce impacts of sedimentation on fish and their habitats. The Region anticipates negligible effects from Alternative 2 based on low active ingredient toxicity to fish, the Services commitment to following label instructions and Service BMPs (including use of low-toxicity surfactants) and using targeted application methods to minimize run-off to water during response actions. Combined overall with the beneficial ecological effects of removing invasive plants, the negative effects to invertebrates including native bees would be negligible to minor. Case studies from outside of the Region have illustrated invertebrate populations being positively impacted after herbicide applications were used to remove riparian invasive plants. Birds and mammals would benefit from the removal of invasive plants, and there would be negligible adverse effects to birds and mammals because direct toxicity of all three herbicides is relatively low. Birds and mammals may be temporarily and indirectly affected by herbicide use through reduction in food, cover, or other habitat components. Under Alternative 2, using herbicides as part of the IPM strategy may decrease the impacts of non-chemical methods (e.g., erosion, turbidity) although herbicides may also cause short-term negative impacts to native vegetation. Herbicides applied as part of an IPM strategy can minimize soil disturbance and reduce the number of years disturbance is required. Because soil disturbance is minimized, restoration of vegetation may be more rapid following treatment. Under Alternative 2, impacts to land use and resources for human use would be negligible to minor, based on the limited duration, following all label directions and Service BMPs, and community and Tribal engagement processes and outreach. Treatment of invasive species, regardless of whether herbicides were used or not, would still result in temporary displacement of wildlife and humans from the treatment area during active treatment.

This alternative helps meet the purpose and needs of the Service as described above because it would restore native plant communities and sustain or restore subsistence and recreation opportunities for native fish, wildlife, and plants. The Service has determined that the proposed action is compatible with the purposes of Service lands in Alaska and the mission of the Service.

List of Sources, Agencies and Persons Consulted

Federal Agency Contacts

Amy Tippery, U.S. Army Corps of Engineers
Casey Burns, Bureau of Land Management
Laurie Cadzow, Bureau of Land Management
Aliza Segal, Bureau of Land Management
Betty Charnon, U.S. Forest Service
Charlene Johnson, U.S. Department of Defense, Joint Base Elmendorf-Richardson
Scott Ayers, U.S. Fish and Wildlife Service
Matt Bowser, U.S. Fish and Wildlife Service
Steve Delehanty, U.S. Fish and Wildlife Service
Cindy Hall, U.S. Fish and Wildlife Service
Delia Vargas Kretsinger, U.S. Fish and Wildlife Service
Ryan Mollnow, U.S. Fish and Wildlife Service
Bill Pyle, U.S. Fish and Wildlife Service
Ella Wagner, U.S. Fish and Wildlife Service

State Agency Officials

Dan Coleman, Alaska Department of Natural Resources, Division of Agriculture
Jim Renkert, Alaska Department of Natural Resources, Division of Forestry
Susan Magee, Alaska Department of Natural Resources, Office of Project Management and Permitting Anchorage

Native Organizations

To be completed in Final EA.

Local Organizations/Media

Blythe Brown, Kodiak SWCD
Annie DuBois, Anchorage Parks and Recreation
Katherine Schake, Homer SWCD

Local Conservation Organizations

Katherine Schake on behalf of the Kenai Peninsula CISMA and the Anchorage CISMA
Tim Stallard, Alien Species Control, LLC

Private Landowners

Eddie Clark, Naknek, Alaska
Linda Starr, Location Unknown

List of Preparers

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Angela Matz, Regional IPM Coordinator, U.S. Fish and Wildlife Service
Darcie Webb, Contract Ecologist, U.S. Fish and Wildlife Service

State Coordination

The Region received feedback on the initial scoping in February 2021 from the Alaska Department of Natural Resources Division of Agriculture and Division of Forestry. Initial input was also provided by two SWCD which are legal subdivisions of the Alaska Department of Natural Resources, authorized under Alaska State Statute Chapter 41.10, Soil and Water Conservation Law. The Region also provided status updates on the Draft EA during monthly Alaska Invasive Species Partnership which is comprised of State of Alaska staff as well as representatives from Tribal organizations, non-governmental organizations, industry, and private citizens.

The Region received a joint agency letter from the State of Alaska dated October 7, 2021, expressing support for Alternative 2. The State of Alaska stated, "This also matches closely with the IPM strategy found in the Alaska Department of Environmental Conservation's Pesticide Control regulations." Similar comments were provided by the Kodiak SWCD and the Homer SWCD through their role in the Kenai Peninsula CISMA.

Tribal Consultation

The Region invited 238 Tribal organizations for comment on the initial scoping and 228 Tribal organizations for scoring of the Draft EA utilizing the most updated contacts on the U.S. Bureau of Indian Affairs website. The Service did not receive any responses during either comment period. See Appendix D for the Draft EA scoping letters sent for Alaska Native Claims Settlement Act consultation.

Public Outreach

An initial scoping period was opened for 15 days in February 2021 to gather input from the public, other organizations and agencies. A 30-day public comment period on the Draft EA was open from September 8, 2021, to October 8, 2021. The Draft EA was posted to the Region's website with a brief description of the proposed action and how to provide comments or have questions addressed. The Region solicited input of interested stakeholders on the Draft EA in a scoping letter to over 270 stakeholders via email. Additionally, input from the public was solicited via publishing a scoping public notice in the Anchorage Daily News for 2 weeks during the 30-day comment period. The Region also solicited input via the Region's social media platforms. Staff from the Region were also invited by the Kenai Peninsula and the Anchorage CISMAs to discuss the EA and hear comments from those partnerships. The Region received comment letters from eight entities with comprising 40 unique comments. See Appendix E for summary of public comments on Draft EA during the second comment period.

Determination

X The Service's action will not result in a significant impact on the quality of the human environment. See the attached **"Finding of No Significant Impact".**

The Service's action **may significantly affect** the quality of the human environment and the Service will prepare an Environmental Impact Statement.

Signatures

Submitted By:

AARON MARTIN Digitally signed by AARON MARTIN
Date: 2022.03.10 16:08:24 -09'00'

Fisheries and Ecological Services Assistant Regional Director Signature:

Date:

Concurrence:

PETER FASBENDER Digitally signed by PETER FASBENDER
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National Wildlife Refuge System Assistant Regional Director Signature:

Date:

Concurrence:

BRIAN GLASPELL Digitally signed by BRIAN GLASPELL
Date: 2022.03.23 14:46:32 -08'00'

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Appendix A: Laws, Orders, and Policies

This appendix describes federal laws, executive orders, and Service policies that address or affect invasive species management.

Fish and Wildlife

The Service has authority to work with partners to manage invasive species under the National Invasive Species Act, the National Wildlife Refuge System Administration Act, the National Wildlife Refuge System Improvement Act (which amended the National Wildlife Refuge System Administration Act), the ESA, and Executive Orders 13112 and 13751. The Service's Integrated Pest Management Policy, the Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy, the Kenai National Wildlife Refuge (NWR) Comprehensive Conservation Plan, and other National Wildlife Refuge System policies direct how invasive species should be managed. The Fish and Wildlife Coordination Act is also an important federal legislation that impacts invasive species management. The aforementioned laws, Executive Orders, and policies are discussed here in detail. Additional laws, policies, and guidance that apply to invasive species or the potential management actions are discussed in the Affected Environment Section of this document.

The National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act, establishes a unifying mission for the NWR system, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. The Act states, first and foremost, that the mission of the NWR program be focused singularly on wildlife conservation. The Act provides authority for regulations and policy that are directly related to invasive species management. For example, the Act provides authority for 50 CFR 27.52 which identifies prohibited acts in the National Wildlife Refuge System, including the introduction of plants and animals. The regulations stipulate that "Plants and animals or their parts taken elsewhere shall not be introduced, liberated, or placed on any national wildlife refuge except as authorized." The Act also provides authority for the Services BIDEH policy discussed below. The Endangered Species Act (ESA) provides for conserving endangered and threatened species of plants and animals. The ESA also requires that Federal agencies consult with the Service) and the National Marine Fisheries Service to ensure that any actions that they authorize, fund, or carry out are not likely to jeopardize the continued survival of a listed species or result in the adverse modification or destruction of its critical habitat. The goal of the ESA is the recovery of endangered and threatened species and the ecosystems on which they depend. Recovery is the process by which the decline of an endangered or threatened species is halted or reversed, and threats removed or reduced. In many instances threats to an ESA listed species may come from invasive species.

Executive Order (EO) 13112, signed in 1999 by President Clinton, directed Federal agencies to conduct, as appropriate, activities related to invasive species prevention; early detection, rapid response, and control; monitoring; restoration, research; and education. This EO also directed Federal agencies to not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States unless the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

Executive Order 13751, signed in December of 2016, amended EO 13112. Executive Order 13751 directs continued coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council); expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.

The Service's Integrated Pest Management (IPM) Policy, 569 FW 1, establishes strategies, procedures, and responsibilities for pest management activities on and off Service lands. This IPM Policy directs the Service to manage pest species when the following conditions are met: a) the pest causes a threat to human or wildlife health or private property; action thresholds for the pest are exceeded; or Federal, State, or local governments designate the pest as noxious; b) the pest is detrimental to site management goals and objectives; and c) the planned pest management actions will not interfere with achieving site management goals and objectives (USFWS 2010(a)). Invasive plants meet the definition of a pest and have met each of the aforementioned conditions.

The Service's BIDEH Policy, 601 FW3, provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on Refuges and associated ecosystems. Further, it provides Refuge managers with an evaluation process to analyze their Refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with the mission of the Refuge system and individual Refuge purposes, restore lost or severely degraded components. The BIDEH Policy also directs Refuges to prevent the introduction of invasive species, detect and control populations of invasive species, and provide for restoration of native species and habitat conditions in invaded ecosystems.

The Fish and Wildlife Conservation Act encourages federal agencies to conserve and promote the conservation of non-game fish and wildlife species and their habitats. Native non-game species can be affected by terrestrial invasive plants.

The ESA enables the protection and recovery of imperiled species (e.g., threatened and endangered) and the ecosystems on which they depend. On a site-specific basis, Service staff will complete Section 7 reviews and consultations to ensure compliance with the Endangered Species Act of 1973, as amended, 16 U.S.C. 1531-1544; 36 CFR Part 13; 50 CFR Parts 10, 17, 23, 81, 217, 222, 225, 402, 450. Best management practices, mitigation measures and recommendations from the respective governing agencies (e.g., the Service, National Oceanic and Atmospheric Administration will be applied to projects as needed.

The Lacy Act was the first Federal law protecting native wildlife. The Lacey Act regulates the import of any species identified as an injurious species and prevents the spread of invasive, or non-native species into the U.S. The Service complies with the Lacey Act, as amended, 16 U.S.C. 3371 et seq.; 15 CFR Parts 10, 11, 12, 14, 300, and 904 by detecting, treating, and monitoring invasive species infestations to prevent the spread.

The Migratory Bird Treaty Act prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service. By using Best Management Practices, the Service will not alter or affect any flyways protected under the Migratory Bird Treaty Act, as amended, 16 U.S.C. 703-712; 50 CFR Parts 10, 12, 20, and 21.

Cultural Resources

On a site specific basis, Service staff will complete Section 106 clearance to ensure compliance with the following regulations pertaining to cultural resources:

- American Indian Religious Freedom Act, as amended, 42 U.S.C. 1996 - 1996a; 43 CFR Part 7
- Antiquities Act of 1906, 16 U.S.C. 431-433; 43 CFR Part 3
- Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa-470mm; 18 CFR Part
- 1312; 32 CFR Part 229; 36 CFR Part 296; 43 CFR Part 7
- National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470-470x-6; 36 CFR Parts 60, 63, 78, 79, 800, 801, and 810
- Paleontological Resources Protection Act, 16 U.S.C. 470aaa-470aaa-11
- Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001-3013; 43 CFR Part 10
- Executive Order 11593 – Protection and Enhancement of the Cultural Environment, 36 Fed. Reg. 8921 (1971)
- Executive Order 13007 – Indian Sacred Sites, 61 Fed. Reg. 26771 (1996)

Natural Resources

On a site specific basis, Service staff will complete Minimum Requirements Analysis using the Minimum Requirements Decision Guide to ensure compliance with the following regulations pertaining to wilderness:

- Wilderness Act, 16 U.S.C 1131 et seq.

Clean Air Act, as amended, 42 U.S.C. 7401-7671q; 40 CFR Parts 23, 50, 51, 52, 58, 60, 61, 82, and 93; 48 CFR Part 23. The Service will follow all applicable BMPs to reduce the likelihood of air quality impacts during field activities including driving to sites and applying pesticides.

Appendix B: Service Chemical Profiles with Best Management Practices (BMPS) for aminopyralid, triclopyr, and glyphosate

Aminopyralid Chemical Profile

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

Justification for Use:	Control of many noxious and invasive weed species in the Aster family notably thistles and knapweeds.
Specific Best Management Practices (BMPs):	• Do not treat within 25 feet of surface water intended for irrigation of sensitive cultivated crops. • Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. • May leach to groundwater, degrades slowly in soil, and is persistent. Do not use as broadcast on permeable soils (sand, sandy loam, loamy sand) and where distance to groundwater is <10 ft. (GUS = 4.8 = very high potential for movement to groundwater). Combination products used on Service lands: U**se the more restrictive BMPs**. *Capstone Specialty, Milestone VM Plus* = Aminopyralid + Triclopyr *Chaparral, Opensight* = Metsulfuron-methyl + Aminopyralid *ForeFront HL, ForeFront R&P, GrazonNext, GrazonNext HL, PasturAll, PasturALL HL* = 2,4-D + Aminopyralid *Milestone VM Plus* = Aminopyralid + Triclopyr
Endangered Species Compliance:	• Before use a section 7 ESA consultation must be completed, including a toxicological analysis. This is especially important if the use situation includes areas where federally listed plant species occur.
Known Resistance:	As of Nov. 2018, the following plant(s) in the United States have been reported as resistant to metribuzin. For the most current status, please go to: http://weedscience.org/Summary/ResistbyActive.aspx

Common Name	Species	State	Year	Other Herbicides
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	NE	2009	Y

Date:	3/26/19				
Pesticide Class:	Pyridine carboxylic acid	**Common Chemical Name(s):**	Aminopyralid	**Pesticide Type:**	Herbicide, Group 4
Trade Name(s):	Milestone Speciality, Milestone VM,	**EPA Registration Number:**	62719-519, 62719-537	**CAS Number:**	566191-89-7, 566191-89-7
Other Ingredients:	**Milestone Specialty (triisopropanolaammonium salt of 2-pyridine carboxylic acid, 4-amino-3,6-dichloro-[AMP]):** 40.6% AMP, 59.4% other (1a); **Milestone VM:** 40.6% AMP, 59.4% other (1b).				

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

Mammalian LD_{50}:	**AMP Tech:** *Rat*: > 5,000 mg/kg (oral in males and females) (1,2,3,4,6,7,8); NOAEL (90-day feeding) = 520 mg/kg/day (8). **Milestone:** *Rat* = 5,000 mg/kg bw (7).
Mammalian LC_{50}:	**AMP Tech:** *Rat*: NOEL = > 1,000 ppm (6).
Mammalian Reproduction:	**AMP Tech:** *Rabbit*: NOAEL = (dam) 250 mg/kg/day, = (fetus) 500 mg/kg/day (2,8), LOAEL = (dam) = 500 mg/kg/day; NOAEL = 1,000 mg/kg/day (2); *Rat*: 2-generation NOEL (dam & fetus) = 1,000 mg/kg/day (2,5,8). **Milestone**: *Rabbit*: NOAEL = (dam) 104 mg/kg/day, = (fetus) 260 mg/kg/day (2,4,8), LOAEL = (dam) 260 mg/kg/day, = (fetus) 520 mg a.e./kg/day (2,8); *Rat*: NOAEL (dam & fetus) = 520 mg a.e./kg/day (4,8).
Avian LD_{50}:	**AMP Tech**: *Bobwhite*: > 2,250 mg a.e./kg bw (2,3,6).
Avian LC_{50}:	**AMP Tech**: *Bobwhite*: NOEC = 5,556 ppm a.e. (2,5,7). *Mallard*: NOEC = 5,496 ppm a.e. (2,5,7).
Avian Reproduction:	**AMP Tech**: *Bobwhite*: LOEC = 640 mg a.e./kg diet (2). *Mallard*: NOEC = 2,623 mg a.e./ kg diet (2,7).
Fish LC_{50}:	**AMP Tech.**: *Bluegill*: 96-hour > 100 ppm a.e. (2,3,5). *Rainbow Trout*: 96-hour > 100 ppm a.e. (2,3,5,6). *Sheepshead Minnow*: 96-hour > 120 ppm a.e. (2,3,5).
Fish ELS/Life Cycle:	**AMP Tech.**: *Fathead Minnow*: NOEC = 1.36 ppm a.e., LOEC = 2.44 ppm a.e. (2,5).
Amphibians/Reptiles:	**AMP Tech.**: *Northern Leopard Frog*: 96-hour LC50 > 95.2 mg a.e./L (2,5).
Invertebrates/Plants:	**AMP Tech.**: *Blue-green Algae*: 120-hour EC50 = 27 ppm a.e. (3). *Daphnia magna*: 48-hour EC50 > 98.6 ppm a.e. (2,5); 21-day NOEC = 100 ppm a.e. (6), LOEC = >102 ppm a.e. (3,5). *Duckweed*: 14-day EC50 > 88 ppm a.e. (2,3,5), NOEC = 44 ppm a.e. (2,5). *Earthworm*: 14-day LC50 > 1,000 mg a.e./kg soil (3,6). *Eastern Oyster*: 48-hour EC50 > 89 ppm a.e. (2,5). *Green Algae*: 72-hour ErC50 = 30 ppm a.e., NOEC = 23 ppm a.e. (3,5). *Honey Bee*: 48-hour LD50 (contact) 100 µg a.e./bee = dose per bee of 1075 mg a.e./kg bw (2,3,5); LD50 >117 µg a.e./bee (10), 6-h NOAEL (oral) = 120 µg/bee = dose per bee of 1290 mg a.e./kg bw (7). *Midge*: NOEC = 130 ppm a.e. (3). *Mysid Shrimp*: 96-hour LC50 > 100 ppm a.e. (2,3,5).
Other Endpoints:	Carcinogenic: Negative (1), Teratogenic: Negative (1); Mutagenic: Negative (1); Endocrine disruption: Negative (8)

Ecological Incident Reports

No incident reports in references.

Environmental Fate

Foliar dissipation (RL50):*	AMP: = 13.4 days with 95% confidence interval of 10.5 days to 16.3 days (7).
Water solubility (S_w):	= 203 g/L (pH 5 @ 20°C), 205 g/L (pH 7 @ 20°C, and 212 g/L @ 20°C (2,4,8); = 2.48 g/L @ 18°C (3,5,8).
Soil Mobility (K_{oc}):	= 1.05 to 24.3 mL/g (2,5); =10.8 mL/kg (3).
Soil Persistence ($t_{½}$):	*Aerobic degradation*: Aerobic microbial degradation is the primary route of breakdown in soils. Aerobic soil half-life (across range of 5 soil types) = 31.5 - 533.2 days; USEPA assumes half-life = 103.5 days (2,3,5) for risk assessments, however, persistence may be up to 5x longer (5). *Photolysis*: Soil photodegradation half-life = 61 days (3); = 72.2 days (2,5).
Soil Dissipation (DT_{50}):	*Terrestrial field dissipation*: surface soil = 20 days, total soil =26 days (CA); surface soil = 32.1 days, total soil =34 days (MS) (5); DT_{50} =21.1 days (6).
Aquatic Persistence ($t_{½}$):	*Aerobic degradation*: Aerobic sediment-water degradation (aquatic metabolism) half-life = 462 to 990 days (2). Water-sediment DT_{50} =712 days (6). *Anaerobic degradation*: Anaerobic aquatic metabolism ½ life = stable (4). Anaerobic sediment-water degradation half-life = stable (2,5). *Hydrolysis*: = Stable (3). *Photolysis*: Primary route of degradation is photolysis (2); Half-life = 0.6 days (2,3,5,6) in clear/shallow water, considerably longer in turbid/deep water (5).
Aquatic Dissipation (DT_{50}):	Water = 250 days (6).
Potential to Move to Groundwater (GUS score):	= 4.8 (high probability of leaching) (6).
Vapor Pressure (mm Hg):	7.14×10^{-11} mm Hg @ 20°C (2,3,5); 1.92×10^{-10} mm Hg @ 25°C (2).
Octanol-Water Partition Coefficient (K_{ow}):	Log Kow = 0.201 (unbuffered water), -1.75 (pH 5), -2.87 (pH 7), -2.96 (pH 9) @ 20°C (2,4,5,6); Kow = 1.58 @ 20°C (5).
Bioaccumulation/Biocentration:	**BAF:** No information in references. **BCF:** = 100 (7).

*Foliar dissipation half-life is required to run T-Rex. The default is 35 d, which should be used unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d (11).

Worst Case Ecological Risk Assessment

Max Application Rate	**Habitat Management:** 0.11 lbs. a.e./acre or 0.37 a.i./acre **Croplands/Facilities Maintenance:** 0.11 lbs. a.e./acre or 0.37 a.i./acre
EECs	**Terrestrial (Habitat Management):** 26.4 ppm (a.e) or 88.8 ppm (a.i.) **Terrestrial (Croplands/Facilities Maintenance):** 26.4 ppm (a.e) or 88.8 ppm (a.i.) **Estimated concentrations in pollen and nectar**: 12.1 ppm **Aquatic (Habitat Management):** 0.04 ppm (a.e) or 0.1359 ppm (a.i.) **Aquatic (Croplands/Facilities Maintenance):** 0.00037 ppm (a.e.) or 0.01241 ppm (a.i).

Habitat Management Treatments:

Presumption of Unacceptable Risk[a]		**Risk Quotient (RQ)**[b]	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	<0.01/0.02 [0.1]	<0.01/0.02 [0.5]
	Mammals[c]	<0.01/=0.01 [0.1]	<0.01 /=0.01[0.5]
	Bees (acute contact) [d]	0.003/0.01	0.003/0.01
	Fish	<0.01/<0.01 [0.05]	<0.01/<0.01 [0.5]
Chronic	Birds	=0.05/0.17 [1]	=0.05/0.17 [1]
	Mammals	=0.02/=0.07 [1]	=0.02/=0.07 [1]
	Fish	=0.3/0.01 [1]	=0.30.01 [1]
	Bees (chronic dietary) [d]	0.03/0.1	0.03/0.1

[a] First RQ value from T-Rex using 0.11 ppm a.e.; second RQ value using 0.37 ppm a.i. as the salt.
[b] Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (11).
[c] No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available. All other RQs are dietary-based.
[d] The LOC for acute = 0.4 and chronic exposure = 1.0 respectively (9).

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk[a]		**Risk Quotient (RQ)**[b]	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	<0.01/0.02 [0.1]	<0.01/0.02 [0.5]
	Mammals[c]	<0.01/=0.01 [0.1]	<0.01 /=0.01[0.5]
	Bees (acute contact) [d]	0.003/0.01	0.003/0.01
	Fish	<0.01/<0.01 [0.05]	<0.01/<0.01 [0.5]
Chronic	Birds	=0.05/0.17 [1]	=0.05/0.17 [1]
	Mammals	=0.02/=0.07 [1]	=0.02/=0.07 [1]
	Fish	<0.1/<0.01 [1]	<0.01/<0.01 [1]
	Bees (chronic dietary) [d]	0.03/0.1	0.03/0.1

[a] First RQ value from T-Rex using 0.11 ppm a.e.; second RQ value using 0.37 ppm a.i. as the salt.
[b] Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (11).
[c] No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available. All other RQs are dietary-based.
[d] The LOC for acute = 0.4 and chronic exposure = 1.0 respectively (9).

References:

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1b______. 2010 & 2015. Milestone VM and Milestone VM MSDS. Dow AgroSciences LLC, Indianapolis, IN. 8 & 10 pp.
2______. 2005. Pesticide fact sheet – aminopyralid. USEPA, Office of Prevention, Pesticides and Toxic Substances, Washington, D.C. 56 pp.
3______. 2005. Aminopyralid – technical bulletin. Dow AgroSciences, LLC. Indianapolis, IN. 19 pp.

[4]_____. 2007. Regulatory note – aminopyralid. Pest Management Regulatory Agency, Health Canada, Ottawa, Canada. 87 pp.
[5]_____. 2005. Environmental fate and ecological risk assessment for the registration of aminopyralid. Office of Pesticide Programs, Environmental Fate and Effects Division, USEPA, Washington, D.C. 151 pp.
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[7]___. 2007. Aminopyralid: Human Health and Ecological Risk Assessment – Final Report. Prepared by USDA Forest Service and National Park Service by Syracuse Environmental Research Associates, Inc (USDA Contract#: AG-3187-C-06-0010).
[8]_____. 2005. Aminopyralid: Aggregate Human Health Risk Assessment for the Proposed Uses on Wheat, Grasses, Non-cropland Areas, and Natural Areas. USEPA Health Effects Division, Scientific Data Reviews, Series 361, File R112051, 61 pp.
[9] US Environmental Protection Agency. Office of Pesticide Program's Guidance for Assessing Pesticide Risks to Bees: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment; Last accessed 17 Dec. 2018.
[10] US Environmental Protection Agency. 2005. Pesticide Fact Sheet: Aminopyralid. Office of Pesticide Programs. 56 pp.
[11] US Environmental Protection Agency. Office of Pesticide Program's T-Rex User's Guide: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/t-rex-version-15-users-guide-calculating-pesticide#convertnoaelcPesticide; Last accessed 17 Dec. 2018.

Glyphosate Profile

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

Justification for Use:	Efficacious non-selective annual, biannual and perennial broadleaf and grass weed control.
Specific Best Management Practices (BMPs):	• For treatment sites where federally listed birds occur, before use seek the assistance of an Environmental Contaminants Specialist / toxicologist and complete ESA consultation including a toxicological analysis before use. • Do not treat within 25 feet of surface water because of aquatic plant toxicity unless specifically using a product labeled for aquatic use. • Use caution where sensitive non-target plants are present. • Apply aquatic labeled glyphosate formulations to aquatic habitats and to riparian habitats within 25 feet of surface water resources; ensure that surfactants are classified as practically non-toxic or slight acute toxicity (> 10 ppm) to aquatic organisms. Slight acute toxicity surfactants include LI-700, AgriDex, Activate Plus, Big Sur 90, Sil Energy, Dyne-Amic, Freeway, Cygnet Plus, Sun-Wet, Hasten Modified Vegetable Oil, Kinetic or Class Act Next Generation. Combination products used on Service lands: **Implement the most restrictive BMPs**. *EsplAnade EZ* = Indaziflam + Diquat bromide + Glyphosate *Extreme, Tackle* = Imazethapyr + Glyphosate *Flexstar* = Glyphosate + Fomesafen *Groundclear, OneStep* = Glyphosate + Imazapyr *Halex GT* = s-Metolachlor + Glyphosate + Mesotrione *Journey* = Imazapic + Glyphosate *Landmaster II* = Glyphosate + 2,4-D amine *QuikPRO, Roundup Weed & Grass Killer Concentrate Plus* = Glyphosate + Diquat bromide *Roundup Concentrate Extended Control* = Glyphosate + Imazapic + Ammonium salt + Diquat *Roundup Ready-to-Use Extended Control Weed Preventer II* = Glyphosate + Pelargonic acid + Imazapic *Roundup Ready-to-Use Plus* = Glyphosate + Pelargonic acid *Spartan Advance* = Sulfentrazone + Glyphosate
Resistance:	• If you think you may be seeing resistance: 1) contact the county extension agent or Regional USFWS IPM Coordinator; 2) check your timing of application, choice/use of adjuvant, plant growth stage at time of application, and application rate. These can influence efficacy. **Check the list below for weeds with known resistance.** • If resistance is noted, use a broad spectrum herbicide with a Mechanism of Action that differs from glyphosate. • Difficult to control weeds may require sequential applications of herbicides with alternative Mechanisms of Action. • If used in crop fields, rotate crops to allow the use of herbicides with alternative Mechanisms of Action.

	• Consider increasing rates within the label recommended range for difficult to control weeds (full rate of this herbicide may be required for the most difficult to control weed in the field). • Applications should be made when weeds are at the correct size (see the label) to minimize weed escapes. • Do not use more than two applications of glyphosate or an herbicide with the same Mechanism of Action within a single growing season unless mixed with another Mechanism of Action herbicide with overlapping spectrum for the difficult to control weeds. • Report incidence of non-performance of this product against a particular weed species to the registrant, county extension agent, & Regional FWS IPM Coordinator.
Endangered Species Compliance:	• Before use, a section 7 ESA consultation must be completed, including an ecotoxicological analysis. Additional best management practices, conservation recommendations, or terms and conditions for use near listed species may be required based on site-specific consultation.
Known Resistance:	• If you are treating one of the following weeds, consult the list at the end of this document to determine if resistance is documented in the state: annual bluegrass, common ragweed, common sunflower, giant ragweed, goosegrass, hairy fleabane. horseweed, Italian ryegrass, Johnsongrass, junglerice, kochia, Palmer amaranth, ragweed parthenium, rigid ryegrass, Russian thistle, spiny amaranth, and tall waterhemp. • For the most current status, please go to: http://weedscience.org/Summary/ResistbyActive.aspx:

Date:	3/27/19				
Pesticide Class:	EPSP synthase inhibitor	**Common Chemical Name(s):**	Glyphosate	**Pesticide Type:**	Herbicide Group 9
Trade Name(s):	Abundit Edge, Abundit Extra, Accord Concentrate, Accord SP, Accord XRT, Accord XRT II, Alecto 41S, Aqua Star, AquaMaster, AquaNeat, AquaPro, Buccaneer, Buccaneer Plus, Bullzeye, Cornerstone, Cornerstone 5 Plus, Cornerstone Plus, Cornerstone Plus with Advanced Surfactant, Credit 41 Extra, Credit Systemic Extra, CropSmart Glyphosate 41% Extra,	**EPA Registration Number:**	524-549, 71368-20, 62719-324, 62719-322, 62719-517, 62719-556, 9468-33, 42750-59, 524-343, 228-365, 62716-324, 524-445, 55467-9, 4787-23, 524-445, 1381-241, 1381-192, 74530-43, 71368-20, 71368-20, 85945-1, 42750-61,	**CAS Number:**	70907-12-1, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 34494-04-7, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0, 38641-94-0,

	CropSmart Glyphosate 41 Plus,		62719-556,		34494-04-7,
	Durango DMA,		71995-7,		38641-94-0,
	Eliminator Weed & Grass Killer Super Concentrate,		89168-17,		38641-94-0,
	Envy,		42750-59,		38641-94-0,
	Eraser AQ,		53883-59,		38641-94-0,
	Eraser Systemic Weed & Grass Killer,		71368-43,		38641-94-0,
	Extra Credit 5,		83220-1,		38641-94-0,
	EZ-Ject Diamondback Herbicide Shells,		86068-4,		38641-94-0,
	Farmworks 41%				38641-94-0,
	Glyphosate Grass & Weed Killer,		228-381,		38641-94-0,
	Foresters' Non-selective Herbicide,		42750-59,		38641-94-0,
	Gly Star 5 Extra,		42750-60,		38641-94-0,
	Gly Star Original,		42750-61,		38641-94-0,
	Gly Star Plus,		42750-61,		38641-94-0,
	Gly Star Pro,		4787-34,		38641-94-0,
	Glyfos Aquatic,		4787-23,		38641-94-0,
	Glyfos X-TRA,		2217-847,		38641-94-0,
	GlyphoMate 41,		81927-9		38641-94-0,
	Glyphosate 4 Plus,		81927-8,		38641-94-0,
	Glyphosate 5.4,		66222-176,		38641-94-0,
	Glyphosate Plus,		72112-4,		38641-94-0,
	Glyphosate Pro 4,		73220-6,		38641-94-0,
	Glyphosate T&O,		62719-324,		38641-94-0,
	Glypro,		62719-322,		38641-94-0,
	Glypro Plus,		74530-43,		38641-94-0,
	Helosate Plus Advanced,		19713-526,		38641-94-0,
	Hi-Yield Kill-Zall II,		524-445,		38641-94-0,
	Honcho,		524-454,		38641-94-0,
	Honcho Plus,		19713-526,		38641-94-0,
	Imitator Plus,		4-484,		38641-94-0,
	KleenUp 41% Concentrate,		34704-890,		38641-94-0,
	KleenUp Pro,		34704-889,		38641-94-0,
	Mad Dog,		34704-890,		38641-94-0,
	Mad Dog Plus,		34704-890,		38641-94-0,
	Makaze,		524-445,		38641-94-0,
	Mirage,		524-454,		38641-94-0,
	Mirage Plus,		2217-844,		38641-94-0,
	Misty Glypho Kill 2,		42750-6,		38641-94-0,
	Pronto Big N' Tuf,		228-366,		38641-94-0,
	Prosecutor,		524-517,		38641-94-0,
	Ranger Pro,		62719-556,		38641-94-0,
	RapidFire,		1381-192,		38641-94-0,
	Rascal Plus,		228-366,		38641-94-0,
	Razor,		228-366,		38641-94-0,
	Razor Pro,		100-1362,		39600-42-5,
	Refuge,		228-366,		38641-94-0,
	Remuda Full Strength,		62719-324,		38641-94-0,
	Rodeo,		524-343,		38641-94-0,

	Roundup Custom,		524-445,		38641-94-0,
	Roundup Original,		524-539,		70901-12-1,
	Roundup Original MAX,		524-549,		70901-12-1,
	Roundup Power MAX,		524-475,		38641-94-0,
	Roundup Pro,		524-529,		38641-94-0,
	Roundup PRO Concentrate,		524-579,		70901-12-1,
	Roundup ProMax,		524-475,		38641-94-0,
	Roundup Ultra,		524-504,		114370-14-8,
	Roundup UltraDry,		524-537,		70901-12-1,
	Roundup WeatherMAX,		71995-25,		70901-12-1,
	Roundup Weed & Grass Killer Super Concentrate,		524-544,		38641-94-0,
	RT 3,		71368-25,		38641-94-0,
	Showdown,		81142-3,		38641-94-0,
	StrikeOut Extra,		33270-18,		38641-94-0,
	Tomahawk 4,		33270-15,		38641-94-0,
	Tomahawk 5,		100-1117,		1071-83-6,
	Touchdown,		100-1182,		39600-42-5,
	Touchdown HiTech,		100-1121,		1071-83-6,
	Touchdown Pro,		100-1169,		1071-83-6,
	Touchdown Total,		100-1169		1071-83-6
	Traxion				
Other Ingredients:	**Abundit Edge (glyphosate N-(phosphonomethyl) glycine, potassium salt (K)):** 48.7% K, 51.3% other ingredients (1a); **Abundit Extra (glyphosate N-(phosphonomethyl) glycine, isopropylamine salt (IPA)):** 41% IPA, 59% other (1b); **Accord Concentrate:** 53.8% IPA, 46.2% other (1c); **Accord SP:** 41% IPA, 59% other (1d); **Accord XRT:** 53.6% IPA, 46.4% other (1e); **Accord XRT II (glyphosate N-(phosphonomethyl) glycine, dimethylamine salt (DMA):** 50.2% DMA, 49.8% other (1f); **Alecto 41S:** 41% IPA, 59% other (1g); **Aqua Star:** 53.8% IPA, 46.2% other (1h); **AquaMaster:** 53.8% IPA, 46.2% water (1i); **AquaNeat:** 53.8% IPA, 46.2% other (1j); **AquaPro:** 53.8% IPA, 46.2% water (1k); **Buccaneer:** 41.0% IPA, 59.0% other (1l); **Buccaneer Plus:** 41.0% IPA, 59.0% other (1m); **Bullzeye:** 41.0% IPA, 59.0% other (1n); **Cornerstone:** 41.0% IPA, 59.0% other (1o); **Cornerstone 5 Plus:** 53.8% IPA, 46.2% other (1p); **Cornerstone Plus:** 41.0% IPA, 59.0% other (1q**)**; **Cornerstone Plus with Advanced Surfactant:** 41.0% IPA, 59.0% other (1r); **Credit 41 Extra:** 41.0% IPA, 59.0% other (1s); **Credit Systemic Extra:** 41.0% IPA, 59.0% other (1t); **CropSmart Glyphosate 41 Extra:** 41.0% IPA, 59.0% other (1u); **CropSmart Glyphosate 41 Plus:** 41.0% IPA, 59.0% other (1v); **Durango DMA:** 50.2% DMA, 49.8% other (1w); **Eliminator Weed & Grass Killer Super Concentrate:** 41.0% IPA, 59.0% other (1x); **Envy:** 41.0% IPA, 59.0% other (1y); **Eraser AQ:** 41.0% IPA, 59.0% other (1z); **Eraser Systemic Weed & Grass Killer:** 41.0% IPA, 59.0% other (1aa; **Extra Credit 5:** 50.6% IPA, 49.4% other (1bb); **EZ-Ject Diamondback Herbicide Shells:** 83.5% IPA, 16.5% other (1cc); **Farmworks 41% Glyphosate Grass & Weed Killer:** 41.0% IPA, 59.0% other (1dd); **Foresters' Non-selective Herbicide:** 53.8% IPA, 46.2% other (1ee); **Gly Star 5 Extra:** 53.8% IPA, 46.2% other (1ff); **Gly Star Original:** 41.0% IPA, 59.0% other (1gg); **Gly Star Plus:** 41.0% IPA, 59.0% other (hh); **Gly Star Pro:** 41.0% IPA, 59.0% other (1ii); **Glyfos Aquatic:** 53.8% IPA, 46.20% other (1jj); **Glyfos XTRA:** 41.0% IPA, 59% other (1kk); **GlyphoMate 41:** 41.0% IPA, 59.0% other (1ll); **Glyphosate 4 Plus:** 41.0% IPA, 59.0% other (1mm); **Glyphosate 5.4:** 53.8% IPA, 46.2% other (1nn); **Glyphosate Plus:** 41.0% IPA, 59.0% other (1oo); **Glyphosate Pro 4:** 41.0% IPA, 59.0% other (1pp); **Glyphosate T&O:** 41.0% IPA, 59.0% other (1qq); **Glypro:** 53.8% IPA, 46.2% other (1rr); **Glypro Plus:** 41.0% IPA, 59.0% other (1ss); **Helosate Plus Advanced:** 41.0% IPA, 59.0% other (1tt); **Hi-Yield Kill-Zall II:** 41.0% IPA, 59.0% other (1uu); **Honcho:** 41.0% IPA, 59.0% other (1vv); **Honcho Plus:** 41.0% IPA, 59.0% other (1ww); **Imitator Plus:** 41.0% IPA, 59.0% other (1xx); **KleenUp 41% Concentrate:** 41.0% IPA, 59.0% other (1yy); **KleenUp Pro:** 41.0% IPA, 59.0% other (1zz); **Mad Dog:** 41.0%				

	IPA, 59.0% other (1ba); **Mad Dog Plus:** 41.0% IPA, 59.0% other (1bc); **Makaze:** 41.0% IPA, 59.0% other (1bd); **Mirage:** 41.0% IPA, 59.0% other (1be); **Mirage Plus:** 41.0% IPA, 59.0% other (1bf); **Misty Glypho Kill 2:** 2% IPA, 98% other (1bg); **Pronto Big N' Tuf:** 41.0% IPA, 59.0% other (1bh); **Prosecutor:** 41.0% IPA, 59.0% other (1bi); **Ranger Pro:** 41.0% IPA, 59.0% other (1bj); **RapidFire:** 50.2% DMA, 49.8% other (1bk); **Rascal Plus:** 41.0% IPA, 59.0% other (1bl); **Razor:** 41.0% IPA, 59.0% other (1bm); **Razor Pro:** 41.0% IPA, 59.0% other (1bn); **Refuge:** 52.3% K, 47.7% other (1bo); **Remuda Full Strength:** 41.0% IPA, 59.0% other (1bp); **Rodeo:** 53.8% IPA, 46.2% other (1bq); **Roundup Custom:** 53.8% IPA, 46.2% other (1br); **Roundup Original:** 41.0% IPA, 59.0% other (1bs); **Roundup Original MAX:** 48.7% K, 51.3% other (1bt); **Roundup Power MAX:** 48.7% K, 51.3% other (1bu); **Roundup Pro:** 41.0% IPA, 59.0% other (1bv); **Roundup PRO Concentrate:** 50.2% IPA, 49.8% other (1bw); **Roundup ProMax:** 48.7% K, 51.3% other (1bx); **Roundup Ultra:** 41.0% IPA, 59.0% other (1by); **Roundup UltraDry (glyphosate N-(phosphonomethyl) glycine, ammonium salt (NH3):** 71.4% NH3, 28.6% other (1bz); **Roundup WeatherMAX:** 48.8% K, 51.2% other (1ca); **Roundup Weed & Grass Killer Super Concentrate:** 50.2% IPA, 49.8% other (1cb); **RT3:** 48.8% K, 51.2% other (1cd); **Showdown:** 37.54% IPA, 3.42 (NH3), 59.04% other (1ce); **StrikeOut Extra:** 41.0% IPA, 59.0% other (1cf); **Tomahawk 4:** 41.0% IPA, 59.0% other (1cg); **Tomahawk 5:** 53.8% IPA, 46.2% other (1ch); **Touchdown:** 28.3% NH3, 71.7% other (1ci); **Touchdown HiTech:** 52.3% K, 47.7% other (cj); **Touchdown Pro:** 28.3% NH3, 71.7% other (1ck); **Touchdown Total:** 44.9% K, 55.1% other (1cl); **Traxion:** 36.5% glyphosate acid, 63.5% other (1mn).

Toxicological Endpoints	Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.
Mammalian LD_{50}:	**Glyphosate Tech 95.0-98.7%**: *Dog*: NOEL = 500 mg/kg/day (11). *Goat* (female): 96-h = 3,500 mg/kg bw (3). *Mice*: 96-h = 1,568 mg/kg bw (3); NOAEL = 3,125 mg/kg diet (10). *Rabbit*: 96-h = 3,800 mg/kg bw (3); 21-d NOAEL = 175 mg ae/kg/day (20). *Rat*: 96-h > 4,320 mg/kg (2,7,11); 96-h = 4,873 mg/kg bw (3); 96-h > 2,000 mg/kg (6); 96-h > 4,770 mg ae/kg bw (8), NOAEL < 3,125 mg/kg diet (10); Systemic Toxicity LOEL males = 940 mg/kg/day, females = 1,183 mg/kg/day (11); Systemic Toxicity NOELs: males = 362 mg/kg/day, females = 457 mg/kg/day (11); = 2,047 mg ae/kg/day (20). **Glyphosate Tech 88.0%:** *Rat*: 96-h > 4,440 mg ae/kg bw (8). **Glyphosate Tech 76.0%:** *Rat*: 96-h > 3,800 mg ae/kg bw (8). **AMPA 95.4-97.2%**: *Dog*: 90-d NOEL = 263 mg/kg/day (20). *Rat*: > 1,920 mg ae/kg bw (3); > 4,750 mg ae/kg bw (3); > 4,770 mg ae/kg bw (3); > 4,800 mg ae/kg bw (3); > 4,860 mg ae/kg bw (3); 90-d NOEL = 400 mg/kg/day, LOEL = 1,200 mg/kg/day (20). **AMPA 88.0%**: *Rat*: > 4,400 mg ae/kg bw (3). **AMPA 76.0%**: *Rat*: > 3,800 mg ae/kg bw (3). **IPA 62.0%:** *Rat*: > 5,000 mg/kg (1c).

	Mouse: > 5,000 mg/kg (1c). **IPA 53.8%**: *Rat*: > 5,000 mg/kg (1a). **IPA 41.0%**: *Rat*: > 5,000 mg/kg (1i,m,o,r), = 5,108 mg/kg bw (1t). **K:** No information in references.
Mammalian LC_{50}:	**Glyphosate Tech (95.0-98.7%):** *Rat*: NOEL (diet) = 150 ppm (6).
Mammalian Reproduction:	**Glyphosate Tech:** *Rabbit*: Maternal toxicity NOEL = 175 mg/kg/day, LOEL = 350 mg/kg/day (2,8,10); Developmental toxicity NOEL > 175 mg/kg/day (1c,e,f,h,m,n,r-v,2,8). *Rat*: Maternal & developmental toxicity NOEL = 1,000 mg/kg/day, LOEL = 3,500 mg/kg/day (2,3); 3-generation: Systemic & reproductive toxicity NOEL < 30 mg/kg/day (1c,e,f,2,8,10,20); Developmental toxicity NOEL = 10 mg/kg/day, LOEL = 30 mg/kg/day (2); 2-generation: Systemic & developmental toxicity NOEL = 500 mg/kg/day, LOEL = 1,500 mg/kg/day (2,3,8); Reproduction NOEL = 1,500 mg/kg/day (1m,n,r-v,2,3); 21-d dietary NOEL = 400 mg/kg/day (20). **AMPA 98.7%**: *Rat*: Systemic & Reproductive NOEL = 740 mg/kg/day, LOEL = 2,268 mg/kg/day (3). **IPA:** No information in references. **K:** No information in references.
Avian LD_{50}:	**Glyphosate Tech 95.6-99.0%:** *Bobwhite*: > 3,851 mg ae/kg diet (1c,s,v,20); 96-h > 1,912 mg/kg bw, NOAEL = 1,912 mg/kg bw (8); 8-d dietary = 4,000 ppm (11); 8-d dietary > 4,640 mg ae/ kg diet (7,20). *Mallard*: 8-d dietary = 4,000 ppm (11); 8-d dietary > 4,640 mg ae/kg diet (7,20). **Glyphosate Tech 83.0%**: *Bobwhite*: 96-h > 2,000 mg/kg (2,11); 96-h > 3,196 mg ae/kg bw (8). **AMPA:** *Bobwhite*: > 3,800 mg/kg (1b,i); > 1,912 mg ae/kg bw (3); 8-d dietary > 5,620 mg/kg diet, NOEC = 5,620 mg/kg diet (20); (Single Dose LC50) > 2,250 mg ae/kg diet (20). *Mallard*: 8-d dietary > 5,620 mg/kg diet, NOEC = 5,620 mg/kg diet (20). **AMPA 87.8%**: *Bobwhite*: 96-h > 1,976 mg ae/kg, NOAEL = 1,185 mg ae/kg (8). **IPA 41.0%**: *Bobwhite*: > 3,800 mg/kg (1g). *Japanese Quail*: 5-d dietary > 5,000 ppm (1k,4). **K:** No information in references.
Avian LC_{50}:	**Glyphosate (95.6-98.5%)**: *Bobwhite*: 5-d > 5,620 ppm diet (1t); 8-d > 4,500 ppm (1d,p); 96-h > 4,570 ppm ae, NOAEC = 4,570 ppm ae (3,8); 96-h > 4,971.2 ppm ae, NOAEC = 4,971.2 ppm ae (3); 5-d LC50 (14-d old) > 4,640 ppm (22). *Mallard*: 5-d > 5,620 ppm diet (1t); 8-d > 4,500 ppm (1d,p); 96-h > 4,570.4 ppm ae, NOAEC = 4,770.4 ppm ae (3,8); 96-h > 4,971.2 ppm ae, NOAEC = 4,971.2 ppm ae (3); 5-d LC50 (14-d old) > 4,640 ppm, NOEL = 1,000 ppm (22).

	AMPA (87.8%): *Bobwhite*: >4,934 ppm, NOAEC = 4,934 ppm (3,8). *Mallard*: >4,934 ppm, NOAEC = 4,934 ppm (3,8). **IPA (Unk. % AI)**: *Mallard*: 8-d LC50 > 4,640 ppm (4). *Bobwhite*: 8-d LC50 > 4,640 ppm (4). **K:** No information in references.
Avian Reproduction:	**Glyphosate Tech (94.4-98.5%):** *Bobwhite*: 8-d > 4,640 ppm diet (1c,s,v,2). *Mallard*: 5-d > 4,640 ppm diet (1c,s,v,2). **Glyphosate Tech (90.4%)**: *Mallard*: No effects up to 30 ppm (2); NOAEC = 27 ppm, LOAEC >27 ppm (3,8). **Glyphosate Tech (83.0%)**: *Mallard*: No effects up to 1,000 ppm (2,11); NOAEC = 830 ppm (3,8), LOAEC > 830 ppm (8). *Bobwhite*: No effects up to 1,000 ppm (2); NOAEC = 830 ppm (3,8), LOAEC > 830 ppm (8). **IPA:** No information in references. **K:** No information in references. **AMPA:** No information in references.
Fish LC_{50}:	**Glyphosate Tech. (95.4-99.7%)**: *Bluegill*: 96-h > 24 ppm (2,20); 96-h = 43 ppm ae (3,5,8), NOAEC = 30.6 ppm (3,8); 96-h LC50 (pH 6.5 @ 22ºC) = 140 ppm (3,4,5,14); 96-h LC50 (pH 9.5 @ 22ºC) = 220 ppm (4,5,14); 96-h = 78 ppm (7); 96-h = 100.2 ppm ae (8); 96-h, static water = 34.0 ppm (10); 96-h flow-through water = 5.8 ppm (10); 96-h = 150 ppm (11); 96-h = 120 ppm (12,20). *Channel Catfish*: 48-h = 140 ppm (2); 96-h LC50 @ 22ºC = 130 ppm (4,5,11,14); 96-h = 93 ppm ae (8); 96-h = 39 ppm (10). *Chinook*: 96-h = 20 ppm (10). *Coho*: 96-h = 22 ppm (10). *Fathead Minnow*: 48-h = 97 ppm (2,11); 96-h LC50 @ 22ºC = 97 ppm (4,5,14), NOAEC = 25.7 ppm ae (8); 96-h = 69.4 ppm ae (8); 96-h = 23 ppm (10). *Pink*: 96-h = 14 to 33 ppm (10). *Rainbow Trout*: 96-h > 1,000 ppm (1b); 96-h = 128.1 ppm, NOAEC = 30.6 ppm (dark coloration observed at 53.6 ppm) (3,8); 96-h LC50 (pH 6.5 @ 12ºC) = 140 ppm (3,4,5,11,14); 96-h LC50 (pH 9.5 @ 12ºC) = 240 ppm (4,5,14); 96-h LC50 = 38 ppm (6,7); 21-d NOEC = 25 ppm (6); 96-h = 100.2 ppm ae (8); 96-h = 128.1 ppm ae (8); 96-h (static water) = 15 to 26 ppm (10); 96-h (flow-through water) = 8.2 ppm (10). **Glyphosate Tech (83.0-87.3%)**: *Bluegill*: 96-h = 99.6 ppm, NOAEC = 83 ppm (3,8); 96-h = 120 ppm (1d,5); 48-h = 120 ppm (2). *Fathead Minnow*: 48-h = 84.9 ppm (2). *Rainbow Trout*: 96-h = 86 ppm (1d,3,5,12,20); 96-h NOEC = 42 ppm (20); 96-h = 71.4 ppm ae (8). **AMPA (94.4-95.6% AI)**: *Species Unknown*: 96-h = 499 ppm, NOAEC = 174 ppm (3,8); 96-h LC50 = 520 ppm, NOEC = 33 ppm (20). *Bluegill*: 96-h > 1,000 ppm (1b).

	IPA (% AI Unk): *Rainbow Trout*: 21-d NOEC = 52 ppm (20). **IPA (62.0%)**: *Bluegill*: 96-h > 461.8 ppm ae (3). *Rainbow Trout*: 96-h > 461.8 ppm ae (3). **IPA (53.6-53.8%)**: *Channel Catfish*: 96-h = 130 ppm (4,14,20). *Fathead Minnow*: 96-h NOEC = 1,000 ppm (3,5); 96-h =97 ppm (4,14,20). *Rainbow Trout*: 96-h > 2,500 ppm (1a,l,q), NOEC = 1,000 ppm (3,20). **IPA (41% w/ 15% POEA surfactant)**: *Bluegill*: 96-h @ 22ºC = 5 ppm (5,14); 96-h @ 17ºC = 7.5 ppm (5,14); 96-h @ 22ºC = 5 ppm (14); 96-h @ pH 6.5 = 4.2 ppm (14); 96-h pH 7.5 = 2.4 ppm (4,5,14); 96-h = 6.4 ppm (11). *Channel Catfish*: 96-h @ 22ºC = 13 ppm (11,14). *Fathead Minnow*: 96-h @ 22ºC = 2.3 ppm (5,14); 96-h = 2.4 ppm (11). *Rainbow Trout*: 96-h @12ºC = 8.3 ppm (4,5,11,14); 96-h @ 7ºC = 14 ppm (4,5,14); 96-h @ 12ºC = 7.5 ppm (4,5,14); 96-h @ pH 6.5 = 7.6 ppm (4,5,14); 96-h @ pH 7.5 = 1.6 ppm (4,5,14); behavioral LOEC = 13.5 ppm (4,5); 21-d NOEC = 2.4 ppm (20). **K:** No information in references.
Fish ELS/Life Cycle:	**Glyphosate Tech (% AI unk.)**: *Coho*: NOEC (15.5-16.9 g smolts, plasma Na concentrations) = 2.78 ppm ae (3). **Glyphosate Tech (87.3-99.7%)**: *Bluegill*: Av. wt. 0.4-0.9g @ 22ºC, = 44 ppm $CaCO_3$; LC50s: @ pH 6.5: 24-h = 240 ppm; 96-h = 140 ppm (4,5); @ pH 7.4: 24-h = 150 ppm; 96-h = 135 ppm (4,5); @ pH 9.5: 24-h = 230 ppm; 96-h = 220 ppm (4,5). *Channel Catfish*: Av. wt. 2.2g @ 22ºC: 24 & 96-h = 130 ppm (4,5). *Chinook*: Av. wt. 0.3-0.7g: creek (soft) water LC50s: 24-h = 55 ppm; 96-h = 30 ppm (4,5,15,20): lake (hard) water LC50s: 24-h = 220 ppm; 96-h = 211 ppm (4,5,15,20). *Chum*: Av. wt. 0.3-0.7g: creek (soft) water LC50s: 24-h = 26 ppm; 96-h = 22 ppm (4,5,15,20); lake (hard) water LC50s: 24-h = 202 ppm; 96-h = 148 ppm (4,5,15,20). *Coho*: Av. wt. 0.3-0.7g: creek (soft) water LC50s: 24-h = 55 ppm; 96-h = 36 ppm (4,5,15,20); lake (hard) water LC50s: 24-h = 210 ppm; 96-h = 174 ppm (4,5,15,20). *Fathead Minnow*: MATC >25.7 mg/l (2); Av. wt. 0.6g @ 20C, LC50s: 24 & 96-h = 97 ppm (4,5). *Pink*: Av. wt. 0.3-0.7g: creek (soft) water LC50s: 24-h = 63 ppm; 96-h = 23 ppm (4,5,15,20); lake (hard) water LC50s: 24-h = 380 ppm; 96-h = 190 ppm (4,5,15,20). *Rainbow Trout*: Av. wt. 0.3-0.7g: creek (soft) water LC50s; 24-h = 32 ppm; 96-h = 22 ppm (4,5,15,20); lake (hard) water LC50s: 24-h = 220 ppm; 96-h = 197 ppm (4,5,15,20); Av. Wt. 0.7-0.8 g @12C, soft water, LC50s: @ pH 6.5: 24-h = 240 ppm; 96-h = 140 ppm (4,5); @ pH 7: 24 & 96-h = 130 ppm (4,5); @ pH 9.5: 24 & 96-h = 240 ppm (4,5). **Glyphosate Tech (41.% AI):** *Bluegill*: Av. wt. 0.7g @ 22ºC @ pH 7.4 @ 44 ppm $CaCO_3$, LC50s: 24-h = 6.8 ppm; 96-h = 5.6 ppm (4,5); Av. wt. 0.5g @ pH 7.4 @ 44 ppm $CaCO_3$, LC50s: @17ºC: 24-h = 9.6 ppm; 96-h = 7.5 ppm (4,5): @22ºC: 24-h = 6.4 ppm; 96-h = 5 ppm (4,5); @27ºC: 24-h = 4.3 ppm; 96-h = 4 ppm (4,5); Av. wt. 0.3g @ 22ºC @ 44 ppm $CaCO_3$, LC50s: @pH 6.5: 24-h =7.6 ppm; 96-h = 4.2 ppm (4,5); @pH 7.5 24-h = 4 ppm; 96-h = 2.4 ppm (4,5); @pH 8.5: 24-h = 3.9 ppm; 96-h = 2.4 ppm (4,5); @pH 9.5: 24-h = 2.4 ppm; 96-h = 1.8 ppm (4,5); degradation (degr.) study (av. wt. 0.5g, 12ºC, pH 7.4, 44 ppm $CaCO_3$): LC50s: 0-d degr.: 24-h = 4.3 ppm; 96-h = 4 ppm (4,5); 1-d degr.: 24-h = 6.6 ppm; 96-h = 6 ppm (4,5); 3-d degr.: 24-h = 8 ppm; 96-h = 7 ppm, (4,5); 7-d degr.: 24-h = 6.2 ppm; 96-h = 5.6 ppm (4,5); Av. wt. 1.3g, 20ºC, 272 ppm $CaCO_3$: LC50: 96-h = 5.5 ppm (4,5).

	Channel Catfish: Av. wt. 0.2g, 20ºC: 24 & 96-h = 4.4 ppm (4,5); Av. wt. 0.6 g, 22ºC: 24 & 96-h = 13 ppm (4,5); Eyed eggs (20ºC): LC50 96-h = 43 ppm (4,5); 225ºC, LC50s: swim-up fry: 24-h = 3.7 ppm 96-h = 3.3 ppm (4,5); yolk-sac fry: 24 & 96-h = 4.3 ppm (4,5). *Fathead Minnow*: Av. wt. 0.6-0.9 g, pH 7.4, 44 ppm $CaCO_3$, LC50s: @15ºC: 24-h = 7 ppm; 96-h = 4.8 ppm (4,5); @20ºC: 24-h = 4.1 ppm; 96-h = 2.9 ppm (4,5); @22ºC: 24-h = 2.4 ppm; 96-h = 2.3 ppm (4,5); @25ºC: 24-h = 6.4 ppm: 96-h = 4.3 ppm (4,5). *Rainbow Trout*: @12ºC, pH 7.4, 44 ppm CaCO3, LC50s: Av. wt. 0.4 g: 24-h = 12 ppm; 96-h = 7.6 ppm (4,5); Av. wt. 0.5 g: 24-h = 5.2 ppm; 96-h = 1.3 ppm (4,5); Av. wt. 1.0 g: 24 & 96-h = 8.3 ppm (4,5); Av. wt. 0.7g @pH 7.4, 44 ppm CaCO3, LC50s: @7ºC: 24 & 96-h = 14 ppm (4,5); @12ºC: 24-h = 14 ppm; 96-h = 7.5 ppm (4,5); @17ºC: 24-h = 7.5 ppm; 96-h = 7.4 ppm (4,5); Av. wt. 0.4g, @12ºC, 44 ppm CaCO3, LC50s: @pH 6.5: 24-h = 14 ppm; 96-h = 7.6 ppm (4,5); @pH 7.5: 24-h = 2.4 ppm; 96-h = 1.6 ppm (4,5); @pH 8.5 & 9.5: 24-h = 2.4 ppm; 96-h = 1.4 ppm (4,5); degradation (degr.) study (av. wt. 0.5g, 12ºC, pH 7.4, 44 ppm $CaCO_3$, LC50s: 0-d degr.: 24-h = 19 ppm; 96-h = 9 ppm (4,5); 1-, 3- & 7-d degr.: 24-h = 14 ppm; 96-h = 7.6 ppm (4,5); yolk-sac fry (10ºC), LC50s: 24-h = 11 ppm; 96-h = 3.4 ppm (4,5). **AMPA:** *Fathead Minnow*: NOEC (life-cycle) = 25.7 ppm (3). **IPA (96.7%):** *Bluegill*: 96-h LC50, av. wt. 1g = 120 ppm, NOEL = 100 ppm (22). *Channel Catfish*: 96-h LC50, av. wt. 2.2g = 130 ppm (22). *Fathead Minnow*: 96-h LC50, av. wt. 0.6g = 97 ppm (22). **IPA (83.0-87.3%):** *Fathead Minnow*: Life Cycle (LOEL) > 25.7 ppm, (NOEL) = 25.7 ppm (22). *Rainbow Trout*: 96-h LC50, av. wt. 0.8g = 140 ppm (22). **IPA (62.4%):** *Rainbow Trout*: 96-h LC50, av. wt. 0.22) > 1,000 ppm (22). **IPA (53.6-53.8%):** *Striped Bass*: Av. wt 1g: 1-h = 131 ppm, 6-h = 50 ppm, 96-h = 23.5 ppm (4,5). **IPA (40.7-41.8%)**: *Bluegill*: 96-h LC50, av. wt. 0.45g = 14 ppm, NOEL = 8.7 ppm (22); 96-h LC50, av. wt. < 2.5g = 2.4 ppm (22); 96-h LC50, av. wt. 0.25g = 5.8 ppm, NOEL = 2.2 ppm (22); 96-h LC50, av. wt. 0.11g = 134 ppm, NOEL < 100 ppm (22); 96-h LC50, av. wt. 0.5g = 4.0 ppm (22). *Channel Catfish*: 96-h LC50, av. wt. 0.6g = 13 ppm (22); 96-h LC50, av. wt. 3.0g = 16 ppm, NOEL = 9.4 ppm (22). *Fathead Minnow*: 96-h LC50, av. wt. 0.6g = 9.4 ppm, NOEL = 5.6 ppm (22). *Rainbow Trout*: 21-d NOEC = 0.43-0.81 ppm (1k); 96-h LC50, av. wt. 0.5g = 1.3 ppm (22); 96-h LC50, fingerling = 8.3 ppm (22); 96-h LC50, av. wt. 0.4g = 150 ppm, NOEL = 100 ppm (22); 96-h LC50, av. wt. 2.4g = 8.2 ppm, NOEL = 5.8 ppm (22); 96-h LC50, av. wt. 0.5g = 120 ppm (22). **IPA (7.03%):** *Bluegill*: 96-h LC50, av. wt. 0.18g = 830.8 ppm, NOEL = 180 ppm (22). *Rainbow Trout*: 96-h LC50, av. wt. 1.0g = 240 ppm, NOEL =180 ppm (22). **IPA (41% w/10% POEA surfactant)**: *Coho*: Av. wt. 0.3-0.7g: creek (soft) water: 24-h = 54 ppm, 96-h = 51 ppm (4,5,15), lake (hard) water: 24 & 96-h = 25 ppm (4,5,15). *Chum*: Av. wt. 0.3-0.7g: creek (soft) water: 24-h = 62 ppm, 96-h = 58 ppm (4,5,15), lake (hard) water: 24-h = 25 ppm, 96-h = 23 ppm (4,5,15); Av. wt. 0.3-0.7g: creek (soft) water: 24-

	h = 31 ppm, 96-h = 19 ppm (4,5,15), lake (hard) water: 24-h = 17 ppm, 96-h = 11 ppm (4,5,15). *Rainbow Trout*: Av. wt. 0.3-0.7g: creek (soft) water: 24-h = 33 ppm, 96-h = 31 ppm (4,5,15), lake (hard) water: 24-h = 31 ppm, 96-h = 17 ppm (4,5,15), 96-h (av. wt 0.37 g): (dechlorinated city water, pH 6.1) = 26 ppm, (lake water, pH 7.7) = 15 ppm (4,20). **IPA (41% w/ 15% POEA surfactant)**: *Channel Catfish*: 96-h, sac fry = 4.3 ppm (4,14), swim-up fry = 3.3 ppm (4,14), Av. wt 2.2g) = 13 ppm (14). *Chinook*: Av. wt. 0.3-0.7g: Creek (soft) water: 24-h = 41 ppm, 96-h = 27 ppm (4,5,15,20), Lake (hard) water: 24 & 96-h = 17 ppm (4,5,15,20), Av. wt. 4.6g, dechlorinated city water, pH 6.1: 96-h = 20 ppm (4,20). *Chum*: Av. wt. 0.3-0.7g: creek (soft) water: 24-h = 31 ppm, 96-h = 19 ppm (4,5,15,20), lake (hard) water: 24-h = 17 ppm, 96-h = 11 ppm (4,5,15,20). *Coho*: Av. wt. 0.3-0.7g: Creek (soft) water: 24 & 96-h = 27 ppm (4,5,15,20), lake (hard) water: 24-h = 14 ppm, 96-h =13 ppm (4,5,15,20), 96-h, av. wt. 0.3g @ 15ºC = 42 ppm (4,5,16,20); Av. wt. 11.8g, dechlorinated city water @ pH 6.2: 96-h = 22 ppm (4,20). *Pink*: Av. wt. 0.3-0.7g: creek (soft) water: 24-h = 33 ppm, 96-h = 31 ppm (4,5,15,20), lake (hard) water: 24-h =17 ppm, 96-h =14 ppm (4,5,15,20). *Rainbow Trout*: 96-h, eyed eggs = 16 ppm (4,5,14), sac fry = 3.4 ppm, swim-up fry = 2.4 ppm (4,5,14); 96-h, av. wt. 1g = 1.3 ppm (4,5,14), 96-h, av. wt. 2g = 8.3 ppm (4,5,14); Av. wt. 0.3-0.7g: creek (soft) water: 24-h =21 ppm, 96-h =15 ppm (4,5,15,20), lake (hard) water: 24-h = 17 ppm, 96-h = 14 ppm (4,5,15,20); 96-h, av. wt. 0.33g, 15ºC = 28 ppm, av. wt. 0.6g, 14.5ºC = 25.5 ppm (4,5,16). *Sockeye*: 96-h, av. wt. 3.8 g, 4.2ºC) = 26.7 ppm (4,5,16,20), Av. wt. 0.25 g, 4.5ºC = 28.8 ppm (4,5,16).
Amphibians/ Reptiles:	**Glyphosate Tech (95.0% +):** *Gray Tree Frog*: 26-d NOEL, metamorphosis, growth & survival = 0.0069 ppm (4,5). *Green Frog*: 24-h & 96-h LC50s, embryo > 38.9 ppm (4,11); 7-d & 14-d NOEL, mortality =3.7 ppm (4,5); 15-d LOEL, immunological = 3.7 ppm (4,5). *Leopard Frog*: 40 to 45-d NOEL, metamorphosis, growth & survival = 0.0069 ppm (4,5); NOAEC =1.8 ppmae (8). *Xenopus laevis*: 96-h LC50 @ pH 7.6 = 7,297 ppmae; 96-h LC05 @ pH 7.6 = 5,516 ppmae (3). **AMPA:** No data in references. **IPA (53.8%)**: *African Clawed Frog*: 96-h LC50, embryo = 7,296.8 ppmae (4,5); 96-h LC10, embryo = 5,867.2 ppmae (4); 96-h LC05, embryo = 5,515.5 ppm ae (4); 96-h LOEL, growth = 6,000 ppm ae (4,5), NOEL, growth 4,000 ppmae (4,5); 96-h LC50, embryo @ pH 6.5 = 4,341.6 ppmae (4,5); 96-h LC10, embryo @ pH 6.5 = 3,023.4 ppm ae (4); 96-h LC50, embryo @ pH 8.0 = 645.2 ppm ae (4,5); 96-h LC10, embryo @ pH 8.0 = 395.2 ppmae (4). **IPA (25.2%)**: *American Bullfrog*: 16-d NOEL, growth & survival = 1 ppm (4,5), LOEL growth & survival = 2 ppm (4,5); 16-d LC50 = 2.07 ppm (5,17). *American Toad*: 16-d NOEL growth & survival =1 ppm (4,5), LOEL = 2 ppm (4,5); 16-d LC50 = 2.52 ppm (5,17). *Gray Tree Frog*: 16-d NOEL growth & survival = 2 ppm (4,5); 16-d LC50 = 1.35 ppm (5,17). *Green Frog*: 16-d NOEL growth & survival = 1 ppm (4,5), LOEL = 2 ppm (4,5); 16-d LC50 = 2.17 ppm (5,17). *Leopard Frog*: 16-d NOEL growth & survival = 2 ppm (4,5); 16-d LC50 = 2.46 ppm (5,17). *Wood Frog*: 16-d NOEC = 1 ppm (4,5); 16-d LC50 w/o predator = 1.32 ppm (5,17), LC50 w/ predator [red-spotted newt (RSN)] 0.55 ppm (5,17).

IPA (13.0%):
Leopard Frog: 23-d LOEL, 29% reduction in survival w/out predation by red-spotted newts (RSN) = 1.3 ppm (4), (23-d LOEL, w/ predation by RSN, additional 21% reduction in survival = 1.3 ppm (4,5).
Gray Tree Frog: 23-d NOEL 0% reduction in survival = 1.3 ppm (4,5), LOEL 0% survival = 1.3 ppm (4); red-spotted newt: 23-d NOEL, survival =1.3 ppm (4,5).

IPA (41.0% w/15% POEA surfactant):
African Clawed Frog: 96-h LC50, embryo = 9.3 ppm ae (4,5); 96-h LC10, embryo = 8.0 ppm ae (4); 96-h LC05, embryo = 7.7 ppm ae (4); 96-h LC50, embryo @ pH 6 15.6 ppm ae (4,5,8); 96-h LC10, embryo @ pH 6 = 6.2 ppm ae (4); 96-h LC50, embryo @ pH 7.5 = 7.9 ppm ae (4,5,8); 96-h LC10 embryo @ pH 7.5 = 4.0 ppm ae (4); 96-h LC50, larvae @ pH 6 = 2.1 ppm ae (4,5,8); 96-h LC10 larvae @ pH 6 = 1.99 ppm ae (4); 96-h LC50 larvae @ pH 7.5 = 0.88 ppm ae (4,5,8); 96-h LC10 larvae @ pH 7.5 = 0.85 ppm ae (4); 96-h LOEL growth = 10 ppm ae (4), NOEL growth) = 8 ppm ae (4).
American Bullfrog: 96-h LC50 larvae = 1.55 ppm ae (9).
American Toad: 24-h LC50 embryo = 13.5 ppm (4); 96-h LC50 embryo <12.9 ppm (3,4,5,8); 96-h LC50 embryo @ pH 6 = 4.8 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 = 2.2 ppm ae (4); 96-h LC50 embryo @ pH 7.5 = 6.4 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 = 4.3 ppm ae (4); 96-h LC50 larvae @ pH 6 = 2.9 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 = 2.1 ppm ae (4); 96-h LC50 larvae @ pH 7.5 = 1.7 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 = 1.2 ppm ae (4); 96-h LC50 larvae <4 ppm ae (9); 16-d LC50 larvae = 1.89 ppm ae (9).
Gray Tree Frog: 96-h LC50 larvae = 1.0 ppm ae (9).
Green Frog: 96-h LC50 embryo = 6.5 ppm (3,4,5,8); 96-h LC10 larvae = 3.9 ppm (4); 96-h LC50 larvae = 8.7 ppm (4); 96-h LC50 embryo @ pH 6 = 5.3 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 = 2.6 ppm ae (4); 96-h LC50 embryo @ pH 7.5 = 4.1 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 = 2.8 ppm ae (4); 96-h LC50 larvae @ pH 6 = 3.5 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 = 2.1 ppm ae (4); 96-h LC50 larvae @ pH 7.5 = 1.4 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 = 0.89 ppm ae (4); 96-h LC50 larvae = 2.0 ppm ae (4,5,9); 16-d LC50 = 1.63 ppm ae (4,5,9); field enclosure studies (tadpoles) 96-h LC50s: Site A = 4.34 ppm ae (4,5,9), Site B = 2.70 ppm ae (4,5,9).
Northern Leopard Frog: 24-h LC50 embryo = 11.9 ppm (4); 96-h LC50 embryo = 9.2 ppm (3,4,5,8); 96-h LC10 larvae = 10.5 ppm (4); 96-h LC50 larvae = 13.7 ppm (4); 96-h LC50 embryo @ pH 6 = 15.1 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 6 = 13.1 ppm ae (4); 96-h LC50 embryo @ pH 7.5 = 7.5 ppm ae (4,5,8,9); 96-h LC10 embryo @ pH 7.5 = 6.7 ppm ae (4); 96-h LC50 larvae @ pH 6 = 1.8 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 6 = 1.1 ppm ae (4); 96-h LC50 larvae @ pH 7.5 = 1.1 ppm ae (4,5,8,9); 96-h LC10 larvae @ pH 7.5 = 0.83 ppm ae (4); 96-h LC50 larvae = 2.9 ppm ae (4,5,9); 16-d LC50 = 1.85 ppm ae (9); field enclosure studies (tadpoles) 96-h LC50s: Site A = 11.47 ppm ae (4,5,9), Site B= 4.25 ppm ae (4,5,9).
Wood Frog: 24-h LC50 embryo = 18.1 ppm (4); 96-h LC50 embryo = 16.5 ppm (4,5,8); 96-h LC50 larvae = 16.5 ppm (3,5); 96-h LC50 larvae = 5.1 ppm ae (9); 16-d LC50, w/o predator = 1.0 ppm ae (9); 16-d LC50 w/predator = 0.41 ppm ae (9).

K (48.8%):
Roundup WeatherMAX: New Mexico spadefoot & Great Plains toad: 48-h NOEC survival = 1.301 L/acre (21).

K (48.7% AI w/unk % POEA surfactant – Roundup Original MAX:
American Bullfrog: 96-h LC50 larvae = 0.8 ppm ae (3,18); 96-h LC10 & LC90 larvae = 0.5 & 1.2 ppm ae (18).
American Toad: 96-h LC50 larvae = 1.6 ppm ae (3,18); 96-h LC10 & LC90 larvae = 1.2 & 2.1 ppm ae (18).
Blue-spotted Salamander: 96-h LC50 larvae = 3.2 ppm ae (3,18); 96-h LC10 & LC90 larvae = 2.7 & 3.7 ppm ae (18).

	Cascades Frog: 96-h LC50 larvae = 1.7 ppmae (3,18); 96-h LC10 & LC90 larvae = 1.2 & 2.1 ppmae (18). *Gray Tree Frog*: 96-h LC50 larvae = 1.7 ppmae (3,18); 96-h LC10 & LC90 larvae = 1.4 & 2.0 ppmae (18). *Green Frog*: 96-h LC50 larvae = 1.4 ppm ae (3,18); 96-h LC10 & LC90 larvae = 1.0 & 1.8 ppmae (18). *Leopard Frog*: 96-h LC50 larvae = 1.5 ppm ae (3,18); 96-h LC10 & LC90 larvae = 1.2 & 1.8 ppmae (18). *Northwestern Salamander*: 96-h LC50 larvae = 2.8 ppmae (3,18); 96-h LC10 & LC90, larvae = 2.4 & 3.3 ppmae (18). *Spotted Salamander*: 96-h LC50 larvae = 2.8 ppmae (3,18); 96-h LC10 & LC90 larvae = 2.4 & 3.3 ppmae (18). *Spring Peeper*: 96-h LC50 larvae = 0.8 ppmae (3,18); 96-h LC10 & LC90 larvae = 0.1 & 1.6 ppmae (18). *Red-spotted Salamander*: 96-h LC50 larvae = 2.7 ppm ae (3,18); 96-h LC10 & LC90, larvae = 2.3 & 3.1 ppm ae (18). *Western Toad*: 96-h LC50 larvae = 2.0 ppmae (3,18); 96-h LC10 & LC90 larvae = 1.7 & 2.4 ppmae (18). *Wood Frog*: 96-h LC50 larvae = 1.9 ppm ae (3,18); 96-h LC10 & LC90 larvae = 1.3 & 2.8 ppmae (18).
Invertebrates/ Plants:	**Glyphosate Tech (95.0-99.7%)**: *Daphnia magna*: (48-h EC50) = 930 ppm (1c,7), (48-h EC50, immobilization) = 40 ppm (6), (21-d NOEC) = 30 ppm (6), NOAEC = 49.9 ppmae (8), (48-h EC50, w/aeration) = 37 ppm (10), (48-h EC50, w/o aeration) = 24 ppm (10), (48-h EC50) = 13 ppm (10). *Duckweed*: 7-d EC50 phytotoxicity = 21.5 ppm (2); 7-d EC50 biomass = 12 ppm (6); 7-d EC50 = 10 ppmae (20); 14-d EC50 growth = 25.5 ppmae, NOEC = 16.6 ppm ae (20). *Earthworm*: 14-d LC50 >5,000 mg kg dry soil (1c); 14-d LC50 >480 mg/kg (6), NOEC reproduction >28.8 mg/kg (6); 14-d LC50 >3,750 mg/kg soil, NOEC = 118.7 (20). *Eastern Oyster, eggs*: 48-h LC or EC50 >10 ppm ae (20). *Fatmucket Clam*: 48-h LC50, larvae >200 ppmae (3,4,5); 96-h LC50 juvenile >200 ppm ae (3,4,5); 21-d LC50 >200 ppm ae (3,4,5). *Fiddler Crab*: 96-h LC50 = 934 ppm (2,11,20). *Grass Shrimp*: 96-h LC50 = 281 ppm (2,11,20). *Green Algae*: 96-h EC50 phytotoxicity = 12.5 ppm (2); 72-h EC50 growth inhibition = 166 ppm (1c); 72-h EC50 growth = 4.4 ppm (6). *Honeybee*: 48-d contact LD50 >100 µg/bee (1c,2,4); 48-h LD50, oral & contact ≥100 µg/bee (6,7,8,10,11,20). *Midge*: 48-h LC50 = 55 ppm (2,3,5); 48-h LC50 = 53.2 ppm ae (8); 48-h LC50 = 53.2 ppmae (8). *Mysid Shrimp*: 96-h LC or EC50 > 1,000 ppm ae (20). **Glyphosate Tech (83.0%)**: *Daphnia magna*: 48-h LC50 = 780 ppm (1d,2); 21-d, life cycle NOEC = 49.9 ppm, LOEC = 95.7 ppm (3). **Glyphosate Tech (41.0% AI):** *Buzzer midge*: 3rd instar, 22°C, hard water, LC50s: (48-h) >10 ppm @ pH 7.4); (48-h) = 55 ppm @ pH 7.4; 48-h > 56 @ pH 6.6 (4,5). *Daphnia magna*: 1st instar, 22°C, hard water, LC50s: (24-h) = 5.3 ppm; 48-h = 2.95 ppm (4,5). **AMPA (94.4-98.5%):** *Daphnia magna*: 48-h EC50 = 683 ppm, NOAEC = 320 ppm (3,8); 48-h LC or EC50 = 690 ppm (20). *Duckweed*: 7-d EC50 growth = 46.9 ppmae (3); 7-d EC10 growth = 3.78 ppmae (3). *Honeybee*: 48-h LD50 contact > 100 µg/bee (3).

	Green Algae: 48-h EC50 growth = 270 ppm (3); 48-h EC10 growth = 92.5 ppm (3); 96-h EC50 growth = 55.9 ppmae (3); 96-h IC50 growth = 24.7 ppm (3). **AMPA (83.0%)**: *Ceriodaphnia dubia*: 48-h LC50 = 147 ppm ae (3). *Daphnia magna*: 48-h EC50 = 647.4 ppmae, NOAEC = 464.8 ppmae (3,8); 48-h EC50 = 128.1 ppm ae, NOAEC = 95.6 ppm ae (3). **IPA (Unk % AI):** *Daphnia pulex*: 48-h EC50 < 24 h old = 7.9 ppm (22). *Duckweed*: 48-h EC50 growth = 2.0 ppm (22); 48-h EC50 growth > 16.91 ppm, NOEL = 16.91 ppm (22). *Honeybee*: 48-h LD50 contact >100 µg/bee (22). **IPA (95.0-99.7%)**: *Daphnia magna*: 21-d early life LOEC = 96 ppm, NOEL = 50 ppm (22). *Eastern Oyster*: 48-h LC50 embryo-larvae > 10 ppm (22). *Fatmucket Clam*: 48-h LC50 larvae = 5.0 ppmae (4,5); 96-h LC50 juvenile = 7.2 ppmae (4,5). *Fiddler Crab*: 96-h LC50 = 934 ppm, NOEL = 650 ppm (22). *Midge*: 48-h LC50 4^{th} instar = 55 ppm (22); 48-h LC50 juvenile = 18 ppm (22). *Shore Shrimp*: 96-h LC50 = 281 ppm, NOEL = 210 ppm (22). **IPA (83.0%):** *Daphnia magna*: 48-h EC50 = 780 ppm, NOEL = 560 ppm (22). **IPA (62.4%):** *Daphnia magna*: 48-h EC50 = 401.3 ppmae, NOAEC = 147.8 ppmae (3); 48-h LC50 1^{st} instar = 869 ppm, NOEL = 320 ppm (22). **IPA (53.5-56.8%)**: *Ceriodaphnia dubia*: 48-h LC50 = 415 ppm ae (3,4,5); 24-h LC50 = 707 ppmae (4). *Daphnia magna*: 48-h LC50 = 218 ppm (3,4,5); 48-h LC50 = 35.5 ppm, NOEC immobility = 13 ppm (3); 48-d LC50 = 130 ppm (4). *Duckweed*: growth inhibition = 24.4 ppm (1a,l,q). *Earthworm*: LC50 > 1,000 ppm (1a,l,q). *Fatmucket Mussel*: 48-h EC50 larvae >148 ppm ae (3,4,5); 96-h LC50 juvenile > 148 ppmae (3,4,5); 28-d LC50 = 43 ppm ae (3,4,5). *Green Algae*: growth inhibition = 127 ppm (1a,1l,1q); 96-h IC50 growth = 41.0 ppm (3). *Honeybee* contact LD50: > 100 µg/bee (1a,l,q). *Midge*: 48-h EC50 immobilization = 5,600 ppm (3,4,5,20); 48-h LC50 = 1,216 ppm (3,5); 24-h EC50 immobilization = 5,900 ppm (4,5). **IPA (40.7-41.4% AI):** *Crayfish*: Adult, 22ºC, hard water, 96-h LC50 = 7 ppm (4,5,22). *Daphnia magna*: 48-h EC50 = 21.6 ppm (1k); 48-h LC50 = 11.0 ppm (1t); 21-d NOEC = 1.5 ppm (1k,5); 48-h EC50 immobility, first instar, w/o suspended sediments @ 22ºC = 3 ppm (5,19); 48-h EC50, 1^{st} instar = 3 ppm (22); 48-h EC50, < 24-h old = 310 ppm, NOEL = 56 ppm (22); 48-h EC50, < 24-h old = 72 ppm (22); 48-h EC50 < 24-h old = 5.3 ppm, NOEL = 1.9 ppm (22). *Daphnia pulex*: 48-h EC50 immobility, w/o suspended sediments @ 15ºC = 7.9 ppm (4,5,19); 48-h EC50 immobility, w/suspended sediments (50 mg clay/L) @ 15ºC = 3.2 ppm (5,19)**;** 48-h EC50 < 24 h old = 242 ppm, NOEL < 60 ppm (22). *Duckweed*: 7-d EC50 = 27.0 ppm (1k). *Earthworm*: 14-d EC50 > 1,000 ppm (dry soil) (1k); 14-d EC50 > 1,250 mg/kg soil (1t). *Green Algae*: 72-h IC50 = 17.4 ppm (1k); 96-h IC50 = 2.2 ppm (1k).

	Honeybee: 24-h LD50 contact) > 20 µg/bee (1k). **IPA (25.2%)**: *Pouch Snail*: 13-d NOEL = 3.8 ppm (4,5). *Marsh Pond Snail*: 13-d NOEL = 3.8 ppm (4,5). *Marsh Rams-Horn*: 13-d NOEL = 3.8 ppm (4,5). **IPA (7.03%):** *Daphnia magna*: 48-h EC50 1st instar >1,000 ppm, NOEL = 560 ppm (22). **IPA (41% w/ 10-20% POEA surfactants)**: *Ceriodaphnia dubia*: (24-h LC50) = 6.0 ppm ae (4,5), (48-h LC50) = 5.7 ppm ae (4,5). **IPA (41% w/ 15% POEA surfactants)**: *Daphnia pulex*: 96-h EC50 = 25.5 ppm (4,5,12,16). *Duckweed*: 7-d EC50 growth = 15.1 ppm ae (20); 14-d EC50 growth = 4.9 ppm ae (20). *Earthworm*: 14-d LC50 > 5,000 mg ae/kg soil (20), NOEC = 500 mg ae/kg soil (20). *Midge*: 48-h LC50 = 16 ppm (11). **K:** No information in references.
Other:	**Glyphosate Tech:** Carcinogenic: Negative (2,6,11); Teratogenic: Negative (10,11); Mutagenic: Slightly, but not in mammals (3,11); Genotoxic: Potential; however, the research that raised the largest concerns involved the use of a formulation marketed in S. America (w/ EPA Registration No. 524-424) (3); Endocrine disruption: Unknown (5,6), Negative in mammals (11). **AMPA:** Unknown (5); Teratogenic: Negative (10,11); Mutagenic: Negative (10); Endocrine disruption: Unknown (5), Negative in mammals (11).

Glyphosate: 1st-order degradate of glyphosate salts (e.g. isopropylamine (IPA) and potassium (K)) (1d);
Aminomethylphosphonic Acid (AMPA): 2nd-order degradate of glyphosate salts (7,12).

Ecological Incident Reports

No incident reports in references.

Environmental Fate

Foliar dissipation (RL50):*	**Glyphosate:** 3.28-4.84 d (23).
Water solubility (S_w):	**Glyphosate:** Highly water soluble (2,12); = 11,600 ppm at 25ºC (7); = 12,000 ppm at 25ºC (8); = 10,500 ppm at 20ºC (10); = 10,500 ppm at pH 1.9 (11); = 900,000 ppm (12); = 1.2 x 10^4 at 25ºC (13); = 10,000 to 15,700 mg/L at 25ºC (20). **IPA:** =786,000 ppm at pH 4.06 (11).
Soil Mobility (K_{oc}):	**Glyphosate:** =884-60,000 L/kg, absorbs strongly to soil (1c,e,f,h,m,n,r-v,2); = 1435 (slightly mobile) (6); sand = 58,000 mL/g (8); sandy loam = 3,100 – 13,000 mL/g (8), silty clay loam = 33,000 – 47,000 mL/g (8); = 2,640; 2,100 & 500 (12).
Soil Persistence ($t_{½}$):	**Glyphosate:** Primary degradation mechanism is biotic metabolism to AMPA (2,7,11,12). *Aerobic degradation*: sandy loam = 1.85 d (2), silt loam = 2.06 d (2); = 96.4 d (7); sandy loam = 1.8 & 5.4 d, silt loam = 2.6 d (8), remained in pond sediments at ≥1 ppm at 1 year post-treatment (8); = 2 to 197 d (11), Av. = 47 d (11,12); Av. = 0.9 d (0.6 to 1.1 d) (13). *Anaerobic degradation*: = 22.1 d (7). *Photolysis*: Stable to photodegradation on soil (2); = stable (for at least 30 d) (8).

	AMPA: *Aerobic degradation*: = max. of 29% at 40 d (8).
Soil Dissipation (DT_{50}):	**Glyphosate:** = 2-174 d (1c,1e,1f,1h,1m,1n,1r- v,13); Av. =13.9 days (2.6 d in TX to 140.6 d in IA) (2), half-lives are longer in colder climes (28.7 d in MN, 127.8 d in NY) (2), = av. 100 d (35 – 158 d) (2); field (aerobic) = 12 d (6), lab at 20ºC = 49 d (6); =44 to 60 d (7); =7.3 d (OH), = 1.7 d (TX), = 17 d (AZ), = 114 d (NY), = 25 d (MN), = 8.3 d (GA), = 13 d (CA) (8); forest soil = 14.8 & 24.2 (13); = 27.3 to 55.5 d (20); = 1.7 to 141.9 d (20). **AMPA:** = 119 d (OH), = 131 d (TX), = 142 d (AZ), = 240 d (NY), = 302 d (MN), = 958 d (GA), = 896 d (CA) (2,8); = av. 118 d (71 to 165 d) (2).
Aquatic Persistence ($t_{½}$):	**Glyphosate:** <7 d (1c,1e,1f,1h,1m,1n,1r- v). *Aerobic degradation*: Silty clay loam incubated in dark at ~25ºC for 30 days = 7 d (2); water-silty clay loam = 14.1 d (8); = 3 to 91 d (11). *Anaerobic degradation*: Silty clay loam sediment = 8.1 d (2); water-silty clay loam = 208 d (8). *Hydrolysis*: Stable to hydrolysis at pH 3, 6, and 9 @ 5 & 35ºC. *Photolysis*: Stable to photodegradation in pH 5, 7, and 9 under natural sunlight (2,7,10,11); = stable (for at least 30 d) (8). **AMPA:** *Aerobic degradation*: = 19-25% at 7-30 d (8), = 7 to 14 d (20), considered comparable to glyphosate (20). *Anaerobic degradation*: = max. of 25% at 15 d (8).
Aquatic Dissipation (DT_{50}):	**Glyphosate:** = 7.5 d (irrigation water) (2,8); = 120 d (pond in MO) (2); >35 d (av. across several temperatures and pH levels) (7); = stable at pH 5 to 8 at 25ºC (6); water-sediment DT50 = 87 d (6); = 7 & 14 d (20). *Hydrolysis*: DT50 = stable at pH 7, 20ºC (6). *Photolysis*: DT50 = 33 d (pH 5), = 69 d (pH 7), 77 d (pH 9) (6).
Potential to Move to Groundwater (GUS score):	**Glyphosate:** Low potential (2,7,11,12). **AMPA:** Low potential (2).
Vapor Pressure (mm Hg):	**Glyphosate:** Low (2,7), = 7.5×10^{-8} (6), = 1.84×10^{-7} at 45ºC (11). **IPA:** = 1.58×10^{-8} at 25ºC (11).
Octanol-Water Partition Coefficient (K_{ow}):	**Glyphosate:** Low (2,7), = 6.31×10^{-4} at pH 7, 20ºC, low, (6), = 0.00033, very low (7), <6×10^{-4} at pH 5, 7 & 9 (10), = 0.02512 (12), = 2.57×10^{-5} to 0.01995 (20).
Bioaccumulation/ Biocentration:	**Glyphosate:** BCF (Bluegill) <1 for whole fish (1c,e,f,h,m,n,r-v), = 0.52x (whole fish) (2), BCF = 0.5 (6).

*Foliar dissipation half-life is required to run T-Rex. The default is 35 d, which should be used unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d (25).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 1.5 lb. a.e./acre, 30 day interval with maximum 5 applications/ 2.25 a.e./acre, 30 day interval with maximum 2 applications/3.75 a.e./acre with 1 application. **Croplands/Facilities Maintenance:** 1.5 lb. a.e./acre, 30 day interval with maximum 5 applications/ 2.25 a.e./acre, 30 day interval with maximum 2 applications/3.75 a.e./acre with 1 application.
EECs	**Terrestrial (Habitat Management):** 762.45 ppm/838.1 ppm/900 ppm **Terrestrial (Croplands/Facilities Maintenance):** 762.45 ppm/838.1 ppm/900 ppm **Estimated concentrations in pollen and nectar**: 165 ppm/ 247.5 ppm / 412.5 ppm **Aquatic (Habitat Management):** 0.5516 ppm/ 0.8276 ppm/1.3795 ppm; no buffer for aquatic use labeled formulations. **Aquatic (Croplands/Facilities Maintenance):** 0.00503 ppm/0.00754 ppm/0.01257 ppm; assumes 25 ft buffer for non-aquatic labeled formulations.

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)[a]**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	=0.17/0.18/0.2 [0.1]	=0.17/0.18/0.2 [0.5]
	Mammals[b]	=0.08/0.08/0.09 [0.1]	=0.081/0.08/0.09 [0.5]
	Bees (acute contact)[c]	=0.041/0.061/0.101	=0.041/0.061/0.101
	Bees (acute dietary)[c]	=0.48/0.72/1.20	=0.48/0.72/1.20
	Fish	<0.02/<0.02/<0.02 [0.05]	<0.02/<0.02/<0.02 [0.5]
Chronic	Birds	=0.92/0.68/1.08 [1]	=0.92/0.68/1.08 [1]
	Mammals	=0.22/0.24/0.26 [1]	=0.22/0.24/0.26 [1]
	Fish	<0.02/<0.02/<0.02 [1]	<0.02/<0.02/<0.02 [1]

(a) Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (25).
(b) No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available. All other RQs are dietary-based.
(c) The LOC for acute = 0.4 and chronic exposure = 1.0, respectively (24).

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	=0.17/0.18/0.2 [0.1]	=0.17/0.18/0.2 [0.5]
	Mammals[b]	=0.08/0.08/0.09 [0.1]	=0.081/0.08/0.09 [0.5]
	Bees (acute contact)[c]	=0.041/0.061/0.101	=0.041/0.061/0.101
	Bees (acute dietary)[c]	=0.48/0.72/1.20	=0.48/0.72/1.20
	Fish	<0.02/<0.02/<0.02 [0.05]	<0.02/<0.02/<0.02 [0.5]
Chronic	Birds	=0.92/0.68/1.08 [1]	=0.92/0.68/1.08 [1]
	Mammals	=0.22/0.24/0.26 [1]	=0.22/0.24/0.26 [1]
	Fish	<0.02/<0.02/<0.02 [1]	<0.02/<0.02/<0.02 [1]

(a) Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (25).

(b) No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available. All other RQs are dietary-based.
(c) The LOC for acute = 0.4 and chronic exposure = 1.0, respectively (24).

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Known Resistance:

- If you are treating a weed listed below in a state that is listed, we recommend you contact the local county extension agent to determine if resistance is known in the county in which you'll be working and follow the resistance BMPs. As of May 2017, the following plants in the United States have been reported as resistant to glyphosate. For the most current status, please go to: http://weedscience.org/Summary/ResistbyActive.aspx:

Common Name	Species	State	Year	Other Herbicides*
Annual Bluegrass	*Poa annua*	CA	2013	NR
Annual Bluegrass	*Poa annua*	TN	2011	NR
Common Ragweed	*Ambrosia artemisiifolia*	AL	2013	NR
Common Ragweed	*Ambrosia artemisiifolia*	AR	2004	NR
Common Ragweed	*Ambrosia artemisiifolia*	IN	2007	NR
Common Ragweed	*Ambrosia artemisiifolia*	KS	2007	NR
Common Ragweed	*Ambrosia artemisiifolia*	KY	2006	NR
Common Ragweed	*Ambrosia artemisiifolia*	MD	2016	Y
Common Ragweed	*Ambrosia artemisiifolia*	MO	2004	NR
Common Ragweed	*Ambrosia artemisiifolia*	MN	2010	Y
Common Ragweed	*Ambrosia artemisiifolia*	MS	2014	NR
Common Ragweed	*Ambrosia artemisiifolia*	NC	2015	Y
Common Ragweed	*Ambrosia artemisiifolia*	ND	2007	NR
Common Ragweed	*Ambrosia artemisiifolia*	NE	2013	NR
Common Ragweed	*Ambrosia artemisiifolia*	NJ	2016	Y
Common Ragweed	*Ambrosia artemisiifolia*	OH	2006	Y
Common Ragweed	*Ambrosia artemisiifolia*	PA	2008	NR
Common Ragweed	*Ambrosia artemisiifolia*	SD	2007	NR
Common Ragweed	*Ambrosia artemisiifolia*	WI	2017	NR
Common Sunflower	*Helianthus annuus*	TX	2015	NR
Giant Ragweed	*Ambrosia trifida*	AR	2005	NR
Giant Ragweed	*Ambrosia trifida*	IA	2009	NR
Giant Ragweed	*Ambrosia trifida*	IN	2005	NR
Giant Ragweed	*Ambrosia trifida*	KS	2006	NR
Giant Ragweed	*Ambrosia trifida*	KY	2005	NR
Giant Ragweed	*Ambrosia trifida*	MN	2008	Y
Giant Ragweed	*Ambrosia trifida*	MO	2011	Y
Giant Ragweed	*Ambrosia trifida*	MS	2010	NR
Giant Ragweed	*Ambrosia trifida*	NE	2010	NR
Giant Ragweed	*Ambrosia trifida*	OH	2006	Y
Giant Ragweed	*Ambrosia trifida*	OH	2004	NR
Giant Ragweed	*Ambrosia trifida*	TN	2007	NR

Giant Ragweed	*Ambrosia trifida*	WI	2011	NR
Goosegrass	*Eleusine indica*	MS	2010	NR
Goosegrass	*Eleusine indica*	TN	2011	NR
Hairy Fleabane	*Conyza bonariensis*	CA	2009	Y
Horseweed	*Conyza canadensis*	AL	2013	NR
Horseweed	*Conyza canadensis*	AR	2003	NR
Horseweed	*Conyza canadensis*	CA	2014	Y
Horseweed	*Conyza canadensis*	DE	2010	Y
Horseweed	*Conyza canadensis*	IA	2011	NR
Horseweed	*Conyza canadensis*	IL	2005	NR
Horseweed	*Conyza canadensis*	IN	2002	NR
Horseweed	*Conyza canadensis*	KS	2005	NR
Horseweed	*Conyza canadensis*	KY	2001	NR
Horseweed	*Conyza canadensis*	MD	2002	NR
Horseweed	*Conyza canadensis*	MI	2007	NR
Horseweed	*Conyza canadensis*	MO	2002	NR
Horseweed	*Conyza canadensis*	MS	2007	Y
Horseweed	*Conyza canadensis*	MT	2015	NR
Horseweed	*Conyza canadensis*	NC	2003	NR
Horseweed	*Conyza canadensis*	NE	2006	Y
Horseweed	*Conyza canadensis*	NJ	2002	NR
Horseweed	*Conyza canadensis*	OH	2003	Y
Horseweed	*Conyza canadensis*	OK	2009	NR
Horseweed	*Conyza canadensis*	PA	2003	NR
Horseweed	*Conyza canadensis*	SD	2010	NR
Horseweed	*Conyza canadensis*	TN	2001	NR
Horseweed	*Conyza canadensis*	VA	2005	NR
Horseweed	*Conyza canadensis*	WI	2013	NR
Horseweed	*Conyza canadensis*	WV	2007	NR
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	AR	2008	NR
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	CA	2016	Y
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	LA	2014	NR
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	MS	2005	NR
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	NC	2009	NR

Italian Ryegrass	*Lolium perenne ssp. multiflorum*	OR	2010	Y
Italian Ryegrass	*Lolium perenne ssp. multiflorum*	TN	2012	NR
Johnsongrass	*Sorghum halepense*	AR	2007	NR
Johnsongrass	*Sorghum halepense*	LA	2010	NR
Johnsongrass	*Sorghum halepense*	MS	2008	NR
Junglerice	*Echinochloa colona*	CA	2008	NR
Kochia	*Kochia scoparia*	CO	2012	NR
Kochia	*Kochia scoparia*	ID	2014	NR
Kochia	*Kochia scoparia*	KS	2013	Y
Kochia	*Kochia scoparia*	MT	2013	Y
Kochia	*Kochia scoparia*	ND	2012	NR
Kochia	*Kochia scoparia*	NE	2011	NR
Kochia	*Kochia scoparia*	OK	2013	NR
Kochia	*Kochia scoparia*	OR	2014	NR
Kochia	*Kochia scoparia*	SD	2009	NR
Kochia	*Kochia scoparia*	WY	2014	NR
Palmer Amaranth	*Amaranthus palmeri*	AL	2008	NR
Palmer Amaranth	*Amaranthus palmeri*	AR	2016	Y
Palmer Amaranth	*Amaranthus palmeri*	AZ	2012	Y
Palmer Amaranth	*Amaranthus palmeri*	CA	2015	NR
Palmer Amaranth	*Amaranthus palmeri*	DE	2014	Y
Palmer Amaranth	*Amaranthus palmeri*	FL	2013	Y
Palmer Amaranth	*Amaranthus palmeri*	GA	2010	Y
Palmer Amaranth	*Amaranthus palmeri*	IL	2016	Y
Palmer Amaranth	*Amaranthus palmeri*	IN	2012	NR
Palmer Amaranth	*Amaranthus palmeri*	KS	2011	NR
Palmer Amaranth	*Amaranthus palmeri*	KY	2010	NR
Palmer Amaranth	*Amaranthus palmeri*	LA	2010	NR
Palmer Amaranth	*Amaranthus palmeri*	MD	2014	Y
Palmer Amaranth	*Amaranthus palmeri*	MI	2011	NR
Palmer Amaranth	*Amaranthus palmeri*	MO	2008	NR
Palmer Amaranth	*Amaranthus palmeri*	MS	2008	Y
Palmer Amaranth	*Amaranthus palmeri*	NC	2005	NR
Palmer Amaranth	*Amaranthus palmeri*	NE	2016	Y
Palmer Amaranth	*Amaranthus palmeri*	NJ	2014	NR

Palmer Amaranth	*Amaranthus palmeri*	NM	2007	NR
Palmer Amaranth	*Amaranthus palmeri*	OH	2010	NR
Palmer Amaranth	*Amaranthus palmeri*	OK	2018	NR
Palmer Amaranth	*Amaranthus palmeri*	PA	2013	NR
Palmer Amaranth	*Amaranthus palmeri*	SC	2010	Y
Palmer Amaranth	*Amaranthus palmeri*	TN	2015	Y
Palmer Amaranth	*Amaranthus palmeri*	TX	2011	NR
Palmer Amaranth	*Amaranthus palmeri*	VA	2011	NR
Palmer Amaranth	*Amaranthus palmeri*	WI	2013	NR
Ragweed Parthenium	*Parthenium hysterophorus*	FL	2014	NR
Rigid Ryegrass	*Lolium rigidum*	CA	1998	NR
Russian-thistle	*Salsola tragus*	MT	2015	NR
Russian-thistle	*Salsola tragus*	OR	2016	NR
Spiny Amaranth	*Amaranthus spinosus*	MS	2012	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	AR	2015	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	IA	2011	Y
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	IL	2009	Y
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	IN	2009	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	LA	2015	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	KS	2006	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	KY	2010	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	MN	2016	Y
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	MO	2009	Y
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	MS	2010	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	ND	2010	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	NE	2016	Y
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	OH	2008	NR

Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	OK	2011	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	SD	2010	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	TN	2011	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	TX	2006	NR
Tall Waterhemp	*Amaranthus tuberculatus (=A. rudis)*	WI	2013	NR

***Other Herbicides** – Y=Resistance to other herbicides, NR=Resistance to other herbicides not reported. Other herbicides listed at: http://weedscience.org/Summary/ResistbyActive.aspx. Heap, I. The International Survey of Herbicide Resistant Weeds. Online. Internet. Tuesday, March 26, 2019. Available at: http://weedscience.org

Triclopyr Pesticide Profile (acid, amines, salts)

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

Justification for Use:	Control of woody plants, including salt cedar, and herbaceous weeds. (**NOTE:** Some products are registered for aquatic habitat use. However, for situations where there are listed aquatic vertebrate species, the Service recommends use of other products for weed control due to the toxicity of this active ingredient.
Specific Best Management Practices (BMPs):	• To reduce risk to listed T&E species, use spot treatment application techniques. • **For terrestrial use triclopyr products:** - Triclopyr has the potential to move to groundwater due to high leachability. Do not use broadcast tractor boom application method if depth to groundwater is <10 ft. and soil types are sandy or sandy loam (GUS = 3.69 = high potential for movement to groundwater). Spot treatment applications are acceptable. • **For riparian and aquatic use:** Use products labeled for aquatic/riparian use (triclopyr TEA-based products). • To minimize negative impacts to bees and other insect pollinators: if possible, treat prior to blooming in spring, or after bloom in fall, or do control work in the morning or evening when pollinators are less active. Combination products used on Service lands: U**se the more restrictive BMPs**. *4-Speed XT* = 2,4-D + Triclopyr + Dicamba + Pyraflufen ethyl *Aquasweep, Crossbow, Crossroad, Everett, Turflon II Amine* = Triclopyr + 2,4-D *Brazen, Confront, Redeem R&P* = Triclopyr + Clopyralid *Capstone, Milestone VM Plus* = Aminopryalid + Triclopyr *Cool Power, Weed B Gon Max* = MCPA + Triclopyr + Dicamba *Foundation* = Triclopyr + Sulfentrazone + 2,4-D + Dicamba *PastureGard, PastureGard HL* = Triclopyr + Fluroxypyr *Vengeance Plus* = MCPA + Triclopyr + Dichlorprop-P
Endangered Species Compliance:	• Before use a section 7 ESA consultation must be completed, including an ecotoxicological analysis. Additional best management practices, conservation recommendations, or terms and conditions for use near listed species may be required based on site-specific consultation. • Terrestrial exposure modeling indicates risks to threatened and endangered bird and mammals. May be applied up to maximum labeled application rates except for amine varieties where federally listed threatened or endangered bird or mammals occur, then limit **broadcast application rate to 3.33 pints per acre**. Can be applied at maximum labeled application rates where federally listed species occur when using spot treatment application techniques.
Known Resistance:	As of May 2020, no plants in the United States have been reported as resistant to triclopy. For the most current status, please go to: http://weedscience.org/Summary/ResistbyActive.aspx

Date:	5/28/2020				
Pesticide Class:	Pyridine carboxylic acid	**Common Chemical Name(s):**	Triclopyr TEA Triclopy Choline	**Pesticide Type:**	Herbicide
Trade Name(s):	Element 3A, Garlon 3A, Grandstand R, Poison Ivy and Tough Brush Killer Concentrate, Renovate 3, Renovate OTF, Tahoe 3A, Triclopyr 3, Triclopyr 3A, Triclopyr 8.8.% Concentrate, Trycera, Vastlan		62719-37, 62719-37, 62719-215, 239-2491, 62719-37, 67690-42, 228-520, 81927-13, 42750-127, 92564-6, 5905-580, 62719-687	**CAS Number:**	57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1, 57213-69-1 57213-69-1, 55335-06-3, 1048373-85-8
Other Ingredients:	**Element 3A (triclopyr triethylamine (TEA):** 44.4% TEA salt, 3.0% triethylamine , 2.1% ethanol , 50.5% inerts (proprietary compounds) (1a); **Garlon 3A (TEA):** 44.4% TEA salt, 3.0% triethylamine, 2.1% ethanol, 50.5% inerts (1b); **Grandstand R (TEA):** 44.4% TEA salt, 3.0% triethylamine, 2.1% ethanol, 50.5% inerts (1c); **Poison Ivy and Tough Brush Concentrate (TEA):** 8.0% TEA salt, 92.0% inerts (1d); **Renovate 3 (TEA):** 44.4% TEA salt, 3.0% triethylamine, 2.1% ethanol, 50.5% inerts (1e); **Renovate OTF (TEA):** 14.0% TEA salt, 86.0% inerts (1f); **Tahoe 3A (TEA):** 44.4% TEA salt, 55.6% inerts (1g); **Triclopyr 3 (TEA)**: 44.4% TEA salt, 55.6% inerts (1h); **Triclopyr 3A (TEA)**: 44.4% TEA salt, 55.6% inerts (1i); **Triclopyr 8.8% (TEA)**: 44.4% TEA salt, 55.6% inerts (including 16.25% triethylamine, 2.5% EDTA, 1.0% ethylene glycol) (1j); **Trycera (acid)**: 29.4% acid, 70.6% inerts (1k); **Vastlan (choline salt (TCL))**: 54.72% TCL, 45.28% inerts (1l).				

Toxicological Endpoints	Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.
Mammalian LD_{50}:	**Acid:** *Rat*: = 1,915 mg/kg (male), > 2,000 but < 5,050 mg/kg (female) (6); = 729 mg/kg/day (male), = 630 mg/kg/day (female) (2). **TEA (64.7% AI):** *Rat*: Acute oral, time of test not specified, 8-9 weeks old > 5,000 mg/kg bw (2). **9** **TEA (44.4% AI):** *Rat*: = 2,574 mg/kg (male) (1g,1k,6); = 1,847 mg/kg (female) (1g,1k,6,11).
Mammalian LC_{50}:	No information available
Mammalian Chronic / Reproduction:	**Acid (% AI):** *Rabbit*: development/reproduction NOAEL (dam) = 10 mg/kg bw/day, NOAEL (fetus) = 25 mg/kg bw/day (6). *Rat*: 2 generation reproduction study, LOAEL=250 mg/kg/day, NOEL = 25 mg/kg/day (2,9); development/reproduction NOEL (dam) = 5 mg/kg bw/day, NOEL (fetus) = 25 mg/kg bw/day (6). **TEA (46.5% AI)**: *Rabbit*: NOEL (dam) = 10 mg/kg/day, NOEL (fetus) = 100 mg/kg/day (6). *Rat*: dietary NOEL = 3 mg/kg (3); NOAEL (dam) = 22 mg/kg bw/d, NOAEL (fetus) = 72 mg/kg bw/d (6).

Avian LD_{50}:	**Acid (Tech):** *Mallard*: Single dose, 3-6 mo old, 14-d observation period = 1,698 mg/kg (2,3,6,8,13); NOEL, mortality = 464 mg/kg bw (6). **TEA (Tech)**: *Mallard*: Single dose, 3-6 mo old, 14-d observation period = 1,698 mg/kg (6,13). **TEA (64.7% AI)**: *Mallard*: = 2,055 mg/kg (1l,2,6); Single dose, 14 d old, 14-d observation period = 3,175 mg/kg, 14-d NOEL < 215 mg/kg (13). **TEA (62.9% AI)**: *Bobwhite*: Single dose, 3-6 mo old, 14-d observation period: = 849.2 mg/kg (6,13); NOEL < 183.7 ppm (13).
Avian LC_{50}:	**Acid (99%):** *Bobwhite*: 5-d = 2,934 ppm, NOEC, mortality = 1,000 ppm (2,6,9). *Japanese Quail*: 5-d, juvenile = 3,272 ppm (13); LOAEC, lethargy) = 2,000 ppm, NOAEC, no observable signs of toxicity = 1,000 ppm (6,9). *Mallard*: 5-d = 5,620 ppm (2,3,6,13), 5-d = 5,000 (9). **TEA (64.7% AI):** *Bobwhite*: 5-d, 14 d old > 10,000 ppm (1l,5); 5-d, 14 d old = 11,622 ppm, NOEL = 1,000 ppm (13); NOAEC, mortality = 2,150 ppm (2,5,6,9). *Mallard*: 5-d dietary > 10,000 ppm (1l,2,6,9,13); 5-d NOEL < 4,640 ppm (13). **TCP (99.9% AI):** *Mallard*: > 5,620 ppm, LOAEC = 562 ppm (6).
Avian Chronic / Reproduction:	**Acid (98.9% AI)**: *Bobwhite*: 19 wk reproductive LOEL > 500 ppm (2,6,9,13); NOEL = 500 ppm (13); 22 wk reproductive LOEL = 200 ppm, NOEL = 100 ppm (13). *Mallard*: 22 wk reproductive LOEL = 200 ppm, NOEL = 100 ppm (2,6,9,13). **TEA (64.7% AI):** *Bobwhite*: 5-d, 14 d old, dietary > 10,000 ppm (1l,5); 5-d, 14 d old = 11,622 ppm, 5-d NOEL = 1,000 ppm (13); NOAEC, mortality = 2,150 ppm (2,5,6,9). *Mallard*: 5-d dietary > 10,000 ppm (1l,2,6,9,13); 5-d NOEL < 4,640 ppm (13).
Fish LC_{50}:	**Acid (Tech):** *Bluegill*: 96-h = 148 ppm (1l,2,5,6,9,13). *Rainbow Trout*: 96-h = 117 ppm (1l,2,3,5,6,8,9,13). **TEA (44.9-47.8% AI)**: *Bluegill*: 96-h = 471 ppm (2,9,13); 48-h = 295.6 ppm (6); 96-h = 286.1 ppm (6). *Channel Catfish*: 96-h = 109.5 ppm (4,5); 96-h = 447 ppm, NOAEC = 103 ppm ae, LOAEC lethargy = 141 ppm ae (6). *Coho*: 96-h = 400 ppm (6). *Fathead Minnow*: 96-h, age unk. = 279 ppm (2,9,13); 96-h NOEL = 98 ppm (13); 8-d = 101 ppm (4); LOEC < 162 ppm, NOEC > 104 ppm (9). *Rainbow Trout*: 96-h = 240 ppm (2,9); 96-h, age unk. = 240 ppm (13). **TCP (99.7-99.9% AI)**: Bluegill: 96-h = 12.5 ppm (2,9). Rainbow Trout: 96-h = 1.5 ppm (2,4,6,9).
Fish ELS/Life Cycle:	**Acid (99.2% AI)**: *Chinook* (av. wt. 2.7g): 24-h & 96-h = 9.7 ppm (5,6). *Chum* (av. wt. 0.5g): 24-h = 7.9, 96-h = 7.5 ppm (5,6).

	Coho (av. wt. 0.5g): 24-h = 9.9 ppm, 96-h = 9.6 ppm (5,6). *Pink* (av. wt. 0.5g): 24-h = 13.3, 96-h = 5.3 ppm (5). *Sockeye* (av. wt. 0.5g): 24-h = 7.8, 96-h = 7.5 ppm (5,6). **TEA (64.7% AI):** *Bluegill* (av. wt. 0.6 g): 96-h LC50 = 891 ppm, 96-h NOEL = 560 ppm (13). *Fathead Minnow* (av. wt. 0.54 g): 96-h LC50 = 947 ppm (13). *Rainbow Trout* (av. wt. 0.24 g): 96-h LC50 = 552 ppm, 96-h NOEL = 240 ppm (13). **TEA (44.7-47.8% AI)**: *Channel Catfish*, juveniles (5.1-7.6 cm long): 24-h = 384.3 ppm, 96-h = 344.3 ppm (6). *Chinook* (av. wt 2.7g): 24-h = 472 ppm, 96-h = 275 ppm (4,5,6). *Chum* (av. wt. 0.5g): 24-h = 316 ppm, 96-h = 267 ppm (4,5,6). *Coho* (av. wt. 0.5g): 24-h = 498 ppm, 96-h = 463 ppm (4,5,6). *Fathead Minnow*: LOEC < 162 ppm, NOEC > 104 ppm (2); 28-d early study LOEC = 162 ppm, NOEC = 104 pm (13); 96-h LC50 (av. wt. 0.21 g) = 370-546 ppm (13); 96-h (av. wt. 0.22g) = 120 ppm (6). *Inland Silverside* (av. wt. 0.1 g): 96-h LC50 = 130 ppm, NOEL = 61 ppm (13). *Rainbow Trout* (av. wt 0.7g): 24-h = 457 ppm, 96-h = 420 ppm (4,6); fry (av. FL 4.0 cm) 96-h = 400 ppm (4,6). *Sockeye* (av. wt 0.5g): 24-h = 353 ppm, 96-h = 311 ppm (4,5,6). **TCP (99.7-99.9% AI):** *Chinook* (av. wt. 2.7g): 24-h & 96-h = 2.1 ppm (2,4,5,6,9). *Chum* (av. wt. 0.5g): 24-h & 96-h = 1.8 ppm (2,4,5,6,9). *Coho* (av. wt. 0.5g): 24-h & 96-h = 1.8 ppm (2,4,5,6,9). *Sockeye* (av. wt. 0.5g): 24-h & 96-h = 2.5 ppm (2,4,5,6,9). *Pink* (av. wt. 0.5g): 24-h & 96-h = 2.7 ppm (2,4,5,6,9).
Amphibians/Reptiles:	**TEA (Tech):** *Bullfrog*: 96-h LC50, tadpoles = 814.1 ppm (14). **TEA (44.4% AI)**: *Clawed Frog*: 96-h LC50 = 750 ppmae, 96-h LC05 = 84 ppmae (6). **Garlon 3A (44.4% AI):** *Bullfrog*: 96-h LC50, tadpoles = 174.5 ppm (14).
Invertebrates/Plants:	**Acid (~98.0% AI)**: *Daphnia magna*: 96-h EC50 = 132.9 ppm (1l,2,6,9); 48-h EC50, 1st instar = 132.9 ppm, NOEL = 32 ppm (13). *Earthworm*: 14-d LC50 > 521 mg/kg (3). *Green Algae*: 5-d EC50 = 32.5 ppm (2,6,13); 5-d NOEC = 7.0 ppm (2,13); 7-d EC50, biomass = 0.8 ppm (3); 72-h EC50 growth = 75.8 ppm (3). *Honey Bee*: 48-h contact LD50 > 100 µg/bee (2,13); 48-h contact NOEL = 100 µg/bee (13). **TEA (64.7% AI):** *Daphnia magna*: 48-h EC50, < 24 h old = 775 ppm, 48-h NOEL < 100 ppm (13). **TEA (43.8-46.1% AI):** *Daphnia magna*: 48-h EC50 = 1,496 ppm (1l,2,5,6,9,11,13); 48-h LC50 = 1,110 ppm (6); life cycle toxicity 21-d LOEC = 149.0 ppm, NOEC = 80.7 ppm (2,4,9,13). *Duckweed*: 14-d EC50 = 8.8 ppm ai (2,6); NOEC, EC05 = 3.5 ppm ai (2,6,9);

	14-d EC50, growth = 19.5 ppm (13); 14-d EC50 = 24.4 ppm, 14-d NOEL = 7.8 ppm (13). *Eastern Oyster*: 96-h EC50 shell deposition = 58 ppm (2,5,9,13); 96-h NOEL = 23 ppm (13); 48-h EC50 embryo/larvae development LOEL < 87 ppm, NOEL = 56 ppm (2,5,9,13). *Fiddler Crab*: 96-h LC50 > 1,000 ppm, 96-h NOEL = 1,000 ppm (13). *Grass Shrimp*: 96-h EC50 = 326 ppm (2,6,13), 96-h NOEL = 132 ppm (13). *Green Algae*: EC50 = 7.6 ppm (2); NOEC EC50 = 11.3 ppm ai (2,9); 7-d EC50 abundance = 5.9 ppm (4); 5-d EC50, growth = 39.1 ppm, 5-d NOEL = 25 ppm (13). *Honey Bee*: 48-h LC50 = 100 µg/bee (5,11). *Pink Shrimp*: 96-h LC50, juvenile = 895 ppm, 96-h NOEL < 750 ppm (13). **TCP (98.97-99.7%AI):** *Daphnia carinata*: 48-h LC5 = 0.20 ppm (4). *Duckweed*: 14-d EC50, growth = 8.2 ppm, 14-d NOEL = 1.02 ppm (13). *Green Algae*: 96-h EC50, growth = 2.9 ppm, 96-h NOEL = 0.0958 ppm (13).
Other:	Carcinogenic: Marginal (not entirely negative, but not yet sufficient convincing evidence) (2,9); Teratogenic: Negative for Triclopyr, Ethanol - some positive results (1b); Mutagenic: Negative for Triclopyr (2,9), Ethanol - some positive results (1b); Endocrine disruption: Negative for triclopyr alone, mixture with R-11 surfactant resulted in elevated levels of plasma vitellogenin in juvenile rainbow trout (6)

Triclopyr Acid (Acid): 1st- order degradate; **Trichlororpyridnol (TCP):** 2nd - order degradate (8).

Ecological Incident Reports

Nothing reported.

Environmental Fate

Foliar dissipation (RL_{50}):*	No information found.
Water solubility (S_w):	**Acid:** 430 mg/L (high) (2,9,11). **TEA:** 1.2 x 10^4 mg/L at pH 5 (25°C), 4.12 x 10^5 mg/L at pH 7 (25°C), 1.28 x 10^6 mg/L at pH 9 (25°C), (high) (2,6). **TCP:** 49,100 mg/L at pH 7 (6,9).
Soil Mobility (K_{oc}):	**Acid:** = 25-384 mL/g (high) (2,9). **TCP:** = 14-86 mL/g (high) (2,9).
Soil Persistence ($t_{½}$):	**Acid:** Primary degradation mechanism is biotic metabolism, = 8-18 d in aerobic soil (2); aerobic = av. 13 d, anaerobic = av. 27 d (4); av. = 32 days (range 8 – 69 days) in aerobic soil (12). **TEA:** aerobic = av. 13 d, anaerobic = av. 1,600 d (4). **TCP:** (pond sediment in CA, pH 7.8-8.1) = 5.6 d (9); detected up to 36 wks after treatment in vegetated soil, detected at 0.131 ppm at 63 wks after treatement in bare soil (persistent and mobile in soil) (2); = 46 days, = 30 – 90 days (11,12).
Terrestrial Field Dissipation (DT_{50}):	**Acid:** = 30 (moderately persistent) (3); = 7.6 – 10.6 d (6); 142 d in silty clay soil (24-26°C) (6); av. = 46 days (range 18-84 days) in GA, ND, OR, TX, WV, WY (12).

	TEA: = 10.6 d (6); = 139 d (8). **TCP**: = 3.8-13.3 d (9); = 46 days, = 30–90 days (11,12).
Aquatic Persistence ($t_{½}$):	**Acid:** Primary degradation mechanism is photolysis, = 1 d in natural waters yielding primarily TCP, = 0.5-3.5 d in Lake Seminole, GA, = 5 d in pond water, = 1.7 d in river water, stable to hydrolysis (2,6,9); Water-sediment DT_{50} = 29.2 days (fast) (3); aerobic = 142 d, anaerobic = 1300 d (9). **TEA:** 0.5 – 3.4 d (lake), 6.9 h (river) (6). **TCP**: = 2 h (6,9); stable to hydrolysis, up to 5.9 d in pond water (pH 7.9-9.4) in MO, = 5.7 d (TX ponds, pH ~ 8), = 4.2-10 d (9).
Aquatic Dissipation (DT_{50}):	**Acid:** = 0.5-3.5 d in Lake Seminole, GA, = 5 d in pond water, = 1.7 d in river water, stable to hydrolysis (2,6). **TCP**: = 4.2-10.0 d (9).
Potential to Move to Groundwater (GUS score):	**Acid:** Potential to degrade groundwater (2); = 3.69 (high leachability) (3). **TEA:** Readily degrades to acid/TCP, no potential (2). **TCP:** Potential to degrade groundwater (2).
Vapor Pressure (mm Hg):	**Acid:** 1.26 x 10^{-6} at 25°C (2,9). **TEA:** = 3.60 x 10^{-7} (8).
Octanol-Water Partition Coefficient (K_{ow}):	**Acid:** =2.95 (6). **TEA**: = 0.35 (6); = 1.23 (8). **TCP**: 1,000 (6).
Bioaccumulation/ Bioconcentration:	**BAF**: < 10x (slight) for **Acid** and **TCP** (2); = 0.77 for **Acid** (low potential) (3). **BCF**: Low for **Acid** (3). **TEA** salt < 100 (low) (1b,1d,1g,1k).

*Foliar dissipation half-life is required to run T-Rex. The default is 35 d, which should be used unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are >35 d (16).

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** 2 lbs. a.e./acre[1]; 6 lbs. a.e./acre[2] **Croplands/Facilities Maintenance:** 2 lbs. a.e./acre[1]; 6 lbs. a.e./acre[2]
EECs	**Terrestrial (Habitat Management):** 480 ppm **Terrestrial (Croplands/Facilities Maintenance):** 480 ppm **Aquatic (Habitat Management):** 0.736 ppm[1]; 2.21 ppm[2] **Aquatic (Croplands/Facilities Maintenance):** 0.0067 ppm[1]; 0.0489 ppm[2]

[1]Triclopyr acid used in terrestrial environments at 2 lbs a.e./ac with 25 ft buffer from wetland.
[2]Triclopyr TEA (e.g. Renovate 3) used in aquatic environments at 6 lbs a.e./ac with 0 buffer.

Habitat Management Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)[(a)]	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.16 [0.1]	=0.16 [0.5]
	Mammals[(b)]	=0.25 [0.1]	=0.25 [0.5]
	Bees (acute contact)[(c)]	0.054	0.054
	Fish	<0.01[d] [0.05] =0.02[e] [0.05]	=0.01[d] [0.5] =0.02[e] [0.5]
Chronic	Birds	=0.96 [1]	=0.96 [1]
	Mammals	=0.96 [1]	=0.96 [1]
	Fish	<0.01[d] [1] =0.02[e] [1]	<0.01[d] [1] =0.02[e] [1]

[(a)] Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are > 35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (16).
[(b)] No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available (16). All other RQs are dietary-based.
[(c)] The LOC for acute = 0.4 and chronic exposure = 1.0 respectively (17).
[(d)] Triclopyr acid used in terrestrial environments at 2 lbs a.e./ac with 25 ft buffer from wetland.
[(e)] Triclopyr TEA (e.g. Renovate 3) used in aquatic environments at 6 lbs a.e./ac with 0 buffer. RQ calculations used TEA early life stage values as done in EPA's RED for assessing chronic impacts to fish when using triclopyr in aquatic habitats.

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)[(a)]	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	=0.16 [0.1]	=0.16 [0.5]
	Mammals[(b)]	=0.25 [0.1]	=0.25 [0.5]
	Bees (acute contact)[(c)]	0.054	0.054
	Fish	<0.01[d] [0.05] <0.01[e] [0.05]	<0.01[d] [0.5] <0.01[e] [0.5]
Chronic	Birds	=0.96 [1]	=0.96 [1]
	Mammals	=0.96 [1]	=0.96 [1]
	Fish	<0.01[d] [1] <0.01[e] [1]	<0.01[d] [1] <0.01[e] [1]

[(a)] Avian and mammal RQs are calculated using EPA's T-Rex model, which uses the default foliar dissipation rate of 35 d unless chemical-specific foliar dissipation half-lives (at least three) are readily available and values are > 35 d for the specific chemical, to estimate pesticide residue on food items. The model assumes that the initial pesticide residue on plants are representative of residues on insects (16).
[(b)] No LC50 value is available for mammals so an acute dietary-based RQ using T-Rex cannot be calculated. Instead, the acute mammalian RQ is dosed-based on a 15g small mammal and is more conservative than if a dietary-based LC50 value was available (16). All other RQs are dietary-based.
[(c)] The LOC for acute = 0.4 and chronic exposure = 1.0 respectively (17).
[(d)] Triclopyr acid used in terrestrial environments at 2 lbs a.e./ac with 25 ft buffer from wetland.
[(e)] Triclopyr TEA (e.g. Renovate 3) used in aquatic environments at 6 lbs a.e./ac with 0 buffer. RQ calculations used TEA early life stage values as done in EPA's RED for assessing chronic impacts to fish when using triclopyr in aquatic habitats.

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Appendix C: Listed Threatened and Endangered Species in Alaska

Common Name	Scientific Name	Status	Critical Habitat in Alaska	Management Agency
Mammals				
Bowhead Whale	*Balaena mysticetus*	Endangered	No	NOAA
Sei Whale	*Balaenoptera borealis*	Endangered	No	NOAA
Blue Whale	*Balaenoptera musculus*	Endangered	No	NOAA
Fin Whale	*Balaenoptera physalus*	Endangered	No	NOAA
Cook Inlet DPS Beluga Whale	*Delphinapterus leucas*	Endangered	Yes	NOAA
Western North Pacific DPS Gray Whale	*Eschrichtius robustus*	Endangered	No	NOAA
North Pacific Right Whale	*Eubalaena japonica*	Endangered	Yes	NOAA
Mexico DPS Humpback Whale	*Megaptera novaeangliae*	Threatened	No	NOAA
Western North Pacific DPS Humpback Whale	*Megaptera novaeangliae*	Endangered	No	NOAA
Sperm Whale	*Physeter macrocephalus*	Endangered	No	NOAA
Arctic Ringed Seal	*Phoca hispida hispida*	Threatened	No	NOAA
Beringia DPS, Bearded Seal	*Erignathus barbatus nauticus*	Threatened	No	NOAA
Western DPS Steller Sea Lion	*Eumetopias jubatus*	Endangered	Yes	NOAA
Northern Sea Otter SW DPS	*Enhydra lutris kenyoni*	Threatened	Yes	USFWS
Polar Bear	*Ursus maritimus*	Threatened	Yes	USFWS
Wood Bison	*Bison bison athabascae*	Threatened	No	USFWS
Birds				
Eskimo Curlew	*Numenius borealis*	Endangered	No	USFWS
Short-Tailed Albatross	*Phoebastria albatrus*	Endangered	No	USFWS
Spectacled Eider	*Somateria fischeri*	Threatened	Yes	USFWS
Steller's Eider	*Polysticta stelleri*	Threatened	Yes	USFWS
Reptiles				
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	No	NOAA
Green Sea Turtle	*Chelonia mydas*	Threatened	No	NOAA
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	No	NOAA
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened	No	NOAA
Fish				

Common Name	Scientific Name	Status	Critical Habitat in Alaska	Management Agency
Green Sturgeon (Southern DPS)*	*Acipenser medirostris*	Threatened	No	NOAA
Hood Canal Summer-run Chum Salmon*	*Oncorhynchus keta*	Threatened	No	NOAA
Lower Columbia River Coho Salmon*	*Oncorhynchus kisutch*	Threatened	No	NOAA
Lower Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Middle Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Snake River Basin Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Upper Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Upper Willamette River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Snake River Sockeye Salmon*	*Oncorhynchus nerka*	Endangered	No	NOAA
Lower Columbia River Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Puget Sound Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Snake River Fall Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Snake River Spring/Summer-run Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Upper Columbia River Spring Chinook Salmon*	*Oncorhynchus tshawytscha*	Endangered	No	NOAA
Upper Willamette River Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Plants				
Aleutian shield fern	*Polystichum aleuticum*	Endangered	No	USFWS

*These species spawn on the West Coast of the Lower 48, but may occur in Alaskan waters during the marine phase of their life cycles

Appendix D: Tribal consultation letter.

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Alaska Region
1011 East Tudor Road
Anchorage, Alaska 99503-6199

September 8, 2021

Dear Tribal Representative:

The U.S. Fish and Wildlife Service (Service), in accordance with the National Environmental Policy Act, has prepared a Draft Environmental Assessment (EA) of the Service's management strategy for terrestrial invasive plants in the Alaska Region. Terrestrial invasive plants have negative impacts on native fish, wildlife, and plants. For over 20 years, the Service has worked with the State of Alaska, tribes, and other partner organizations to manage infestations to protect subsistence, recreational, and commercial natural resources. This EA analyzes the impacts of various management strategies that may occur on Service lands, critical points of access to Services lands, or through projects the Service contributes funding to.

We recognize the inherently sovereign status of federally recognized tribal governments and our unique government-to-government relationship with Alaska Native tribes. By way of this letter, the Service is seeking your input on the Draft EA. Tribal entities will have additional opportunities to provide input prior to any Service management action that may affect their lands or subsistence resources. Those wishing to submit comments on the Draft EA are encouraged to do so by October 8, 2021, by any one of the following methods:

- Electronic Mail –
  - Darcie Webb at: darcie_webb@fws.gov
- U.S. Postal Mail – Comments should be sent to:
  - Aaron Martin, U.S. Fish and Wildlife Service, Fisheries and Ecological Services, 1011 East Tudor Road, Anchorage, Alaska 99503

For further information, please contact:

- Ms. Darcie Webb at 518-495-9323 or darcie_webb@fws.gov
- Mr. Aaron Martin at 907-378-0568 or aaron_e_martin@fws.gov

We look forward to your comments and response to this request to participate.

Sincerely,

Aaron Martin

Aaron Martin, Alaska Regional Invasive Species Program Coordinator

Appendix E: Summary of Public Comments to Draft EA and Responses

Summary of Public Comments on Draft EA

Topic 1: General Support
Comments were received supporting the comprehensive use of the Integrated Pest Management process as the most effective means to eradicate or reach maximum containment of invasive plants. Commenters recognized the benefits of the U.S. Fish and Wildlife Service's (Service) past and current prevention efforts, proactive response planning, judicious implementation of IPM, and the goal of eradicating infestations as early as possible on Service lands and at critical control points in coordination with landowners and other resource management agencies. The Service also received multiple comments suggesting if an IPM tool (such as herbicide) is not available, there is a risk of losing the opportunity to prevent irreparable damage to resources across Alaska.

Service Response:
The Service appreciates the general support that was provided from Federal and State agencies as well as private businesses and individuals. Throughout the Environmental Assessment, the Service reiterates our commitment to conserving and restoring habitat through preventing or minimizing the impacts of invasive species and the management of them. The Service included additional language about working with partners to develop strategies during the IPM process (e.g., Proposed Action, Background).

Eradication is the ultimate goal when possible, and IPM allows for multiple tools to be used in the efforts. With adaptive management, moving from one tool to another can prove necessary and effective. More importantly, utilizing knowledge from partners and prior experience will be key to reducing the resources expended. The Serviced added "If a tool (such as herbicide) is not available, then there is a risk of losing the opportunity to prevent irreparable damage to resources across Alaska." to paragraph five of the background section, on page 5-6.

Topic 2: General Concern: National Environmental Policy Act (NEPA) process, Invasive Species Policy and Management
Comments about the decision making process stated concern with the language expressing preference for Alternative 2 (IPM Strategy with Herbicide Use). One commenter wanted reassurance that the choice in method was not made due to the simplicity of not needing more people than with manual eradication.

There was concern about fiscal responsibility, knowing that change is a part of the natural world and wondering if trying to prevent effects of environmental change a waste of effort. This was coupled with questions about the research and evaluation of target species. Suggestions were made for other ways to remove plants with public assistance through a pay-per-pound system for collecting invasive species. One comment asked about beneficial impacts of invasive species.

Service Response:
The Service appreciates the constructive comments and questions about the NEPA and IPM planning process. The Service manages resources under multiple mandates and policies that provide direction to prevent and minimize the impacts of invasive species to conserve habitat for

trust species with the judicious use of the IPM process. The Services adheres to all Federal processes identified in mandates and policies, see page 3, and ensures that staff follow necessary state and local requirements. The purpose of the proposed action is to implement an IPM strategy that allows site specific eradication of invasive terrestrial plants in a consistent, feasible, and cost-effective manner across the Region with a goal of helping to maintain functional ecosystems and processes. Federal and State funds could be wasted in the long run if the Service and our partners do not use the full suite of tools to respond to an infestation.

An initial scoping period was opened for 15 days in February 2021 to gather input from the public, other organizations and agencies. A 30-day public comment period on the Draft EA was open from September 8, 2021, to October 8, 2021. The Draft EA was posted to the Region's website with a brief description of the proposed action and how to provide comments or have questions addressed. The Region solicited input of interested stakeholders on the Draft EA in a scoping letter to over 270 stakeholders via email. Additionally, input from the public was solicited via publishing a scoping public notice in the Anchorage Daily News for 2 weeks during the 30-day comment period. The Region also solicited input via the Region's social media platforms. Staff from the Region were also invited by the Kenai Peninsula and the Anchorage Cooperative Invasive Species Management Areas (CISMA) to discuss the EA and hear comments from those partnerships. The Region received comment letters from eight entities with comprising 40 unique comments. See Appendix E for summary of public comments on Draft EA during the second comment period. See pages 62-64 for an overview of the NEPA process and the entities that were involved.

Topic 3: Critical Access Points

Comments encouraged increasing language about working with local partners on and near Service lands as part of a successful IPM Strategy.

Service Response:

Language in the Proposed Action section (paragraph 4, page 2) was clarified to convey that lands do not have to be adjacent to Service land in order to count as critical access points.

The Service acknowledges the importance of our partnerships with the State, Tribes, and CISMAs throughout Alaska on page 1 (paragraph 3 of the Proposed Action).

Topic 4: Other IPM Tools: Surveys, Public Outreach and Education, Monitoring

Requests were made for more early detection, rapid response, and monitoring programs on Service lands and critical access points off Service lands, as well as support for research at local universities to ensure ongoing efforts are supported. It was noted that these actions are an important part of EDRR along with public outreach and education. The public's ability to identify and report invasive plants is an important tool for effectively implementing Early Detection Rapid Response (EDRR) and limiting the amount of herbicide application over time.

Service Response:

The Service is committed to working with others to conserve fish, wildlife and their habitats. The Service works closely with other landowners and the general public to amplify the limited resources for EDRR work through the Region. Additional language was added to the Final EA about working with Cooperative Invasive Species Management Areas, and others, as part of the

IPM planning and implementation (e.g., page 1).

Topic 5: Other IPM Tools: Biological Control

Comments were received encouraging the use of what was considered biological treatment methods via planting native shrub stakes or native conifers to specifically discourage the establishment of invasive plants.

Service Response:

The Service acknowledges the various tactics partners use to manage invasive plants. Partners have taken initiative in using various treatment methods to address the issue of invasive plants. As to the matter of biological controls, the method described by Joint Base Elmendorf-Richardson is something the Service considers a Cultural tool. Biological Control consists of the strategic introduction of natural predators, parasites and pathogens that negatively impact a specific invasive species in their native habitat (Background section, paragraph 5, pages. 4-5).

Topic 6: Alternative 2: Herbicide Application and Parameters

Practitioners noted that some of the definitions included in Table 3 were more specific than necessary and may limit applicators unnecessarily. Suggested edits were made, as well as recommendations for label requirements of individual products be the main source of guidance. It was also noted that a number of methods such as basal bark, wiper/rope wick, and injection have a much lower risk of affecting non-target species or accumulating in soils.

A number of comments were concerned with the underlying assumptions utilized in the analysis of the Draft EA, and in the determination of scope for the proposed action. Commenters wanted more clarification on the differences between broadcast spray and spot spray applications, and for it to be made clear that broadcast spray is rarely used. For projects in Alaska, it is unlikely that 100 percent of an infested area will be treated with herbicides at the maximum label rate each year. The distinction between gross infested acres (Infested Area) and surface acres treated (Infestation sites treated) was not clear, and that Table 4 in the Draft EA needed to clarify which measurement of acreage was being displayed. Practitioners noted that often less than 50 percent of an infested area is treated with herbicide, with each follow up treatment requiring significantly less herbicide. Supporting data on specific examples were provided by multiple commenters.

Service Response:

Definitions in Table 3 and throughout the document were adjusted. Furthermore, the Service follows the label requirements and EPA standards for each individual product. This was emphasized throughout the document (e.g., page 7 and page 13)

To be more transparent about any assumptions that the Service was using to analyze effects in this EA, a hypothetical scenario has been added to the Alternatives section (paragraph 6, pages 6-7) to help illustrate potential site differences within a single infested area, and better represent typical conditions in the field. Clarification on terminology, such as "Infested Area" and "Infestation Site", has been included in the Prosed Action section (paragraph 4 and 5, page 2) to aid in interpreting potential field conditions and scenarios. Definitions in Table 3 for broadcast spray and spot spray were reviewed, and an emphasis on the total coverage of broadcast spray methods was added. Language was also added requiring users to follow EPA label application instructions specific to the herbicide being used. In Table 4, additional text was added to the caption, clarifying that the total acreage was acres treated with herbicide, not initial infestation areas.

Topic 7: Alternative 2: Herbicide Applications/Year and Years of Treatment

These comments spoke to the proposed action scope of work, specifically regarding timing of treatment, and length of projects. It was noted that the limits set forth in the EA (one treatment and 3 years) would result in many sites where eradication will not be obtained. A common thread among commenters was that some plants require 2-3 treatments in the same growing season for several reasons (e.g., continuous emergence, missed individual plants, etc.). "Follow-up spot spray herbicide application of target plants emerging from the seedbank is necessary to ensure eradication in subsequent years." Practitioners gave evidence that even with the multiple visits to infested areas, they were not coming close to reaching the maximum label application rate.

The second concern with this topic was how many years were expected to have treatment. A request was made for the treatment time period to be as long as needed for eradication to be achieved. The comments submitted rejected the maximum 3 year time period for eradication, noting that it may be possible to treat an area in 3 or less years, but from experience, the infestations they were managing took 5-6 or more years to eradicate. It was also noted that during the latter years, minimal herbicide is actually used to spot treat rogue plants that would otherwise reestablish and prevent eradication. The comments refuted soil accumulation of the analyzed chemicals with citations and research, indicating minimal accumulation under typical field conditions would be likely, and that limiting control to 3 years is not necessary. One practitioner noted that achieving a partial reduction, due to a 3 year limit, was "discouraged and arguably an irresponsible use of chemicals" providing opportunity for recolonization by invasive plants. It was stressed that years 3-6, where a few residual plants need to be removed, are sometimes the most important for ensuring eradication. In addition to the evidence provided in these comments, the reasoning behind the selection of three years (to minimize the unintended effects of the analyzed chemicals) was brought into question, asking if data had been used to analyze the timeframe.

Service Response:

The Service follows all EPA and label requirements in the application of herbicides and recognizes that some response periods to achieve eradication vary. Thus, it would be disadvantageous to native species restoration if the suite of IPM tools were not available after 3 years, but a few plants still remained that would not respond to non-herbicide methods. The language in the Draft EA was changed in the Final EA to "each unique infestation site receiving a single herbicide application per year for typically three years; timelines for achieving eradication vary based on site and plant characteristics" (Proposed Action, Alternative 2).

Language was also clarified to recognize that "Response actions could also be initial treatment of the infested area with broadcast spraying at maximum label rate with subsequent physical treatments or herbicide applications at significantly reduced rates (due to less invasive plants) via more direct methods. The Service and our partners do not typically use broadcast spraying (as defined in Table 3) due to the patchiness of infested areas, especially infested areas detected in early detection surveys as these tend to be the incipient introduction" (Alternatives).

Topic 8: Sensitive Habitat

Comments were received on the IPM flow chart possibly being misleading in regards to the special analysis step. Often, sensitive habitat can be a reason to implement all IPM methods, including herbicide to ensure eradication and protect habitat from harmful invasive plants. Sensitive habitats can also be addressed through herbicide application techniques such as wick or wiper applications that prevent the herbicide from contacting the ground. This must be evaluated on a case-by-case basis. The KP-CISMA highly encourages Service to incorporate local planning and prioritization of species and vulnerable sites/areas into rapid response considerations."

Service Response:
Figure 3 has been edited and is on page 11. The language in the Special Circumstances box has been edited to show that this is a dynamic analysis and will vary depending on many factors, such as invasive species, Effects to resources, etc.

Topic 9: Alternative 2: Herbicide Analysis and Research
Commenters provided additional references to support the use of the three herbicides analyzed in the Draft EA. It was noted that out of the three, only one (aminopyralid) had a residual persistence in soil, and that it was minimal. Mitigation strategies were shared to minimize the accumulation of aminopyralid in soils. Suggestions to include additional information on some of the chemicals, such as land use restrictions and effectiveness toward plant types, was provided for supporting the variety of chemicals chosen. One comment noted the chemicals analyzed are “practically non-toxic” to “slightly toxic” in most cases and felt this supported the negligible effects conclusion to birds, fish and wildlife.

There is a desire for the Service to support more research on herbicide accumulation and persistence, specifically in Alaska’s soils, and continue research on other “herbicides for use prevent plants from developing resistances and provide other options for increased control (e.g., imazapyr for reed canarygrass)”.

Service Response:
Following the label requirements and EPA guidance helps ensure that actions of the Service or Service funded actions of our partners have negligible or minimal impacts. The Final EA includes additional references and information on the three analyzed herbicides.

The Service is dedicated to working with partners to improve the collective understanding of herbicide accumulation and persistence, but identifying and pursuing research for that is outside of the scope of this NEPA document.

Topic 10: Affected Environment
The commenter provided elements for consideration in the analysis of impacts for the treatment alternatives regarding European bird cherry (Prunus padus), Japanese knotweed, and reed canarygrass that the Draft EA did not adequately capture. Concerns were expressed that these species can have adverse impacts on fish, amphibians, and wildlife and their habitat along riparian edges and in very shallow water or in intermittently flooded areas.

Service Response:
Added European bird cherry as an impactful invasive in the Fish and Mammals Affected

Environment section (pages 41 and 46) and references were added.

Topic 11: Human Safety

These comments spoke mostly to human safety around the herbicides being used. Concern was expressed that the analysis the Service provides is inconsistent with the interpretation of cautions and restrictions on a Roundup label, which speak to an implied danger. It was noted that glyphosate has been banned by some countries, is associated with lawsuits in cancer cases, and that the EPA may have been influenced by production corporations. One comment feared the proposed action would be poisoning the ground, and that herbicide use was the easier method of treating but maybe not the smartest. Additional concern over the chance of the public coming into contact with the herbicides used at trailheads and access points was stated.

Service Response:
Following the label requirements, EPA guidance, and Service safety practices helps ensure that actions of the Service or Service funded actions of our partners have negligible or minimal impacts to environmental and human resources.

Topic 12: Permitting

Comments were related to concerns about invasive plant management near water under Alternative 1. Some terrestrial invasive plants may colonize a waterbody at or below the ordinary high water mark, under which removal of significant quantities of any material may constitute 'dredging'. Dredging is an activity which must be permitted in a Section 10 waterbody. Alternative 1 may also use smothering/light suppression as a non-herbicide tactic for invasive species suppression to eradicate discrete patches under a bulky, decomposable material which does not necessitate eventual removal from the site; this can include burials in-place with soil in some situations. Such actions could result in activities which may need a U.S. Army Corps of Engineers permit because they could effectively convert a water of the U.S. into an upland site with the addition of significant amounts of fill materials"

Service Response:
This NEPA analysis is for terrestrial invasive plants on Service lands and at critical access points. The Service does not anticipate physical removal of invasive terrestrial plants using equipment that would equate to removing significant amounts of wetland or soil at or below ordinary high water mark. The Service will consult with USACE and a separate NEPA analysis will be conducted if that situation arises. An internal guidance document has been developed for managers, and the text provided by USACE was incorporated to alert managers when consultation and permits may be needed.

Smothering was added to Table 1 as a physical treatment method similar to soil solarization that was in the Draft EA. The Service will consult with the USACE if an IPM strategy includes the use of smothering near wetlands and this has been added to the Final EA.