North Tongass Invasive Plant Management Project

Human Health and Herbicide Use Report

Prepared by:
Patricia C. Krosse

for:
Hoonah, Juneau, Sitka and Yakutat Ranger Districts and Admiralty National Monument
Tongass National Forest

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1. Introduction

This report focuses on plausible effects to humans if exposed to the herbicides proposed for use in this project: Aminopyralid, Glyphosate, Imazapyr, and Metsulfuron methyl. Effects to other non-target organisms are addressed in the wildlife, fisheries and botany resource reports.

Human health and safety are special concerns when considering an invasive plant management project due to the potential for herbicide exposure to applicators, the public, and employees. Exposure could occur via direct contact, drinking contaminated water, eating contaminated plants or fish, gathering and using special forest products, or as a result of recreational users coming into contact with contaminated vegetation. However, the likelihood of harm from such exposure is extremely low as the proposed herbicides are considered to have low toxicity levels (toxicity is defined as the degree to which a substance is able to damage an organism) and are taken up into plants quickly. Glyphosate, for example, is taken up into the plant within about 6 hours of application. Further, exposure to chemicals during and after treatment activities is extremely low. And finally, the implementation of Project Design Features (PDFs), strictly adhering to label requirements, the Pesticide Use Proposal (PUP) process, and permitting or regulatory requirements all contribute to the many layers of caution included in this project.

1.1 Current Management Direction

Federal law requires that before selling or distributing a pesticide in the United States, a person or company must obtain a registration, or license, from the U. S. Environmental Protection Agency (EPA). Before registering a new pesticide or new use for a registered pesticide, EPA must first ensure that the pesticide when used according to label directions (including any adjuvants, surfactants or other ingredients comprising the product contents), can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants (USDA 2008).

The Forest Service is authorized by the Federal Insecticide, Fungicide, and Rodenticide Act and the Cooperative Forestry Assistance Act to use pesticides for multiple-use resource management and maintenance of the quality of the environment as long as the actions comply with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) regulations. The significance of the three acts is described in the following paragraphs:

- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended (7 U.S.C. 136), is the authority for the registration, distribution, sale, shipment, receipt, and use of pesticides. FIFRA is administered by the Environmental Protection Agency (EPA) and the appropriate environmental agencies of the respective states. FIFRA requires registration for all herbicides after extensive testing to evaluate whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish, and plants, including endangered species and non-target organisms, as well as possible contamination of surface water or ground water from leaching, runoff, and spray drift.

- When registered, a label is created to instruct the applicator on the proper usage of the material and required personal protective equipment. EPA also must approve the language that appears on each pesticide label and the product can only be used legally according to the directions on the label accompanying it at the time of sale.

- The Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2101), as amended by the Food, Agriculture, Conservation, and Trade Act of 1990 (7 U.S.C. 1421) is the authority for assisting and advising States and private forest landowners in the use of pesticides and other toxic substances applied to trees and other vegetation and to wood products.
- The provisions of the NEPA (42 U.S.C. 4321) and the CEQ implementing regulations apply to pesticide management (FSM 1950; FSH 1909.15).

1.1.1 Forest Service Direction:

- The Tongass National Forest Land Management Plan (Forest Plan) provides Forest wide general direction pertaining to invasive species (pgs. 2-1, 2-3, and 2-6 USDA 2016).
- Forest Plan Standards and Guidelines for pesticide (herbicide) use are delineated in Chapter 4 of the Forest Plan (page 4-72).
- Pesticide Use Handbook (FSH 2109.14 Chapter 20) provides direction on safe use of pesticides, including direction on storage and transport and development of safety plans and emergency spill plans.

1.2 Proposed Action

The proposed action uses integrated invasive plant control methods that include hand pulling, tarping, mechanical treatments, and herbicides to reduce, contain, or eliminate populations of non-native target species on the five northern ranger districts on the Tongass National Forest. This proposed action provides the flexibility to treat future infestations that are currently undocumented utilizing an adaptive management tool called Early Detection Rapid Response (EDRR). Early Detection Rapid Response (EDRR) is an adaptive management tool allowing the Forest Service to address ever-changing invasive plant infestations and allow District staff to respond to the discovery of new or previously undiscovered infestations within the project area. Early detection and rapid containment of target invasive plant populations is the most efficient method for controlling their spread in terms of time and money and diffuses any deleterious effects to ecosystem functions.

Aminopyralid, Glyphosate, Imazapyr, and Metsulfuron methyl, four herbicides with different chemical properties and modes of action (how the herbicide kills the plant), were selected for this project and are included in the suite of control methods analyzed (see Table 1). Herbicide use is proposed using broadcast and ground-based methods, such as spot and selective hand spraying (see Section 1.9) that targets individuals and groups of plants, based on accessibility, topography, and size of infestation. No aerial application is proposed for this project.

Table 1. Herbicides considered for use in the Proposed Action, including formulations, mode of action, properties and typical and maximum application rates

Active ingredient, formulations and mode of action	Herbicide properties	General uses/type of plants it is known as an effective treatment	Lowest to Highest application rate from risk assessment (pounds of acid equivalent/acre) (lbs a.e./acre)
Glyphosate Inhibits 3 amino acids and protein synthesis.	A systemic broad-spectrum, non-selective herbicide. Translocates to roots and rhizomes of perennials. While considered non-selective, sensitivities do vary depending on species. Quickly taken up by target plants. Adheres to soil, which lessens or retards leaching or uptake by non-targets. Aquatic formulations of Glyphosate will only be used.	Most effective on perennial plants when applied in later summer and fall, when plants are entering dormancy. Used to control floating-leaved plants and shoreline plants. It does not work on underwater plants[1]. Plants can take several weeks to die and a repeat application is often necessary to remove plants missed in first application[2]. AquaPro®, Aquamaster® and Rodeo® have been approved for aquatic and terrestiral environments and can be used when surface water is present.	0.5 – 8.0 (2.0 is the central application rate and most commonly used)
Imazapyr Amino acid synthesis inhibitor.	A systemic broad-spectrum, slow-acting, non-selective, pre- and post-emergent herbicide. Most effective as a post-emergent. Low potential for leaching into ground water. Has low toxicity to invertebrates and is non-toxic to fish, mammals, and birds. It can damage non-target plants, by transfer between root networks. Aquatic formulation will only be used.	Used to treat annual and perennial grasses, vines, brambles, broadleaf species and floating-leaved plants. It does not work on underwater plants. Habitat® has been approved for aquatic environments and can be used when surface water is present.	0.03 – 1.5 (0.45 is the central application rate and the most commonly usedl)

[1] http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html (accessed 2/12/2013)
[2] http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html (accessed 2/12/2013)

Active ingredient, formulations and mode of action	Herbicide properties	General uses/type of plants it is known as an effective treatment	Lowest to Highest application rate from risk assessment (pounds of acid equivalent/acre) (lbs a.e./acre)
Aminopyralid Mimics natural plant hormones.	A selective, systemic herbicide. Post-emergent herbicide that controls the entire plant, including the roots, with soil residual activity to extend control[3]. It is absorbed by the foliage and roots of actively growing plants and translocated to the meristematic (high-growth-rate) areas of the plants, including the roots[4]. Also a pre-emergent herbicide.	Used to treat annual, biennial and perennial broadleaf species. Provisionally registered as a reduced risk herbicide[5]. Low risk to aquatic environments; avoid ground water contamination	0.078 – 0.11
Metsulfuron methyl Sulfonylurea - Inhibits acetolactate synthesis, protein synthesis inhibitor, and block formation of amino acids.	Used for the control of many broadleaf and woody species. Most susceptible crop species are in the lily family (i.e. onions). Safest sulfonylurea around non-target grasses.	More potential to kill non-target vegetation. Lower risk to aquatic organisms. (Escort XP®)	0.00125 – 0.15 (0.03 is the central application rate and the most commonly used)

The trade names mentioned above (AquaPro®, Aquamaster®, Rodeo® and Habitat®) are those currently registered in Alaska by the Alaska Department of Environmental Conservation.

Commented [KP-1]: Joni, can you make sure in this table I am not excluding or including trade names that we will not be using? Thank you.

1.2.1 Overview of Issues Addressed

During scoping the public expressed concerns about the use of herbicides and what kinds of effects they may have on human health and exposures such as direct contact by forest workers, drinking contaminated water, gathering and using special forest products, or as a result of recreationists coming into contact with contaminated vegetation. There is concern about long-term and cumulative effects to humans from the use of herbicides. The public has expressed concerns about whether glyphosate may cause cancer in people, especially since the World Health Organization recently identified this herbicide as a probable carcinogen. This concern is

[3] http://www.ipaw.org/invaders/AminopyralidFamilyBrochure.pdf (accessed 2/12/2013)
[4] http://www.ipaw.org/invaders/AminopyralidFamilyBrochure.pdf (accessed 2/12/2013)
[5] In other words, the U.S. EPA has concluded that the use of Aminopyralid as a replacement for other herbicides will decrease risk to some non-target species. http://www.fs.fed.us/foresthealth/pesticide/pdfs/062807_Aminopyralid.pdf (page 5) (accessed 2/12/2013)

addressed by examining the precautionary processes that are incorporated in the invasive plant treatment planning and implementation processes for this project, and by comparing the alternatives in terms of the potential for worker/public exposure based on the best available science in the Syracuse Environmental Research Associates (SERA) Risk Assessments.

Issue Statement Pertaining to Herbicide Toxicology/Herbicide Use: Invasive plant treatments may result in greater risks to human health through increased chance of exposure to herbicides and treated areas.

Background: This issue speaks to general concern about herbicides and the risks to people from proposed herbicide use (i.e. through the ingestion of fish, water and/or vegetation growing in an area treated with herbicides).

Issue Measures:

- Type (chemical properties) and extent (application rate - lbs. acid equivalent/acre - and method of application) of herbicide use that could result in harmful exposure to people for both long-term (chronic) and short-term (acute) scenarios.
- Qualitative assessment of the likelihood of each exposure scenario taking place and an analysis of the effectiveness of project design features to prevent harmful herbicide exposure scenarios.

Analysis of Herbicides on Human Health

Effects on human health involve three distinct steps:

1. Hazard Identification – "How toxic is it?"
2. Exposure Scenarios – "How much exposure will occur?"
3. Dose-Response – "If a human is exposed, what will happen?"

The Forest Service then prepares a "Risk Characterization" based on the above three questions to address the final question of "Are we likely to have any adverse effects when we use it?" Detailed analysis of risk are described in Environmental Consequences (Section 3).

Toxicity data is not obtained on humans directly, but rather extrapolated from laboratory animals using standardized tests required by EPA. Human susceptibility to toxic substances can vary substantially. In response to this uncertainty, standard risk assessment methodology assigns uncertainty factors to toxicity data to account for extrapolation from laboratory animals and for sensitive individuals. However, some individuals may be unusually sensitive so individual susceptibility to the herbicides proposed in this EA cannot be predicted specifically. Factors affecting individual susceptibility include diet, age, heredity, preexisting diseases, and lifestyle. In response to this uncertainty, Project Design Features (PDFs) are proposed to reduce the likelihood or amount of exposure.

1.3 Herbicide Toxicology Terminology

The following terminology is used throughout this report to describe relative toxicity of herbicides proposed for use in Alternative 2.

a.i.: active ingredient

Acute exposure: A single exposure of multiple brief exposures occurring within a short time (e.g. 24 hours or less in humans)

Acute toxicity: Any harmful effect produced in an organism through an acute exposure to one or more chemicals.

a.e.: acid equivalent

bw: body weight

Chronic Exposure: Exposures that occur over the average lifetime or for a significant fraction of the lifetime of a species. Chronic exposure studies evaluate the carcinogenic potential of chemicals and other long-term health effects.

Exposure Scenario: The mechanism by which an organism (person, animal, fish) may be exposed to an herbicide's active ingredients or additives. The application rate and method influences the amount of herbicide to which an organism may be exposed.

Threshold of Concern: A level of exposure below which there is a low potential for adverse effects to an organism. Effects on humans, wildlife and other organisms are considered insignificant and discountable when herbicide exposure is below the threshold of concern.

Hazard Quotient (HQ): A "toxicity threshold" was established for each herbicide to indicate the point below which adverse effects would not be expected for a variety of organisms (e.g. people, wildlife, fish). The predicted level of exposure from herbicide use is compared to the toxicity threshold and expressed in terms of a "hazard quotient (HQ)". The HQ is the result (quotient) of the exposure estimate divided by the toxicity threshold. Toxicity thresholds are based on extrapolated laboratory results and accepted scientific protocols. An HQ less than or equal to 1 indicates an extremely low level of risk. An HQ above 1 does not necessarily indicate a level where adverse effects are likely, however, the probability of harmful effects increases with HQ. When an HQ is above 1, a further qualitative analysis of the exposure scenario is evaluated given the likelihood for the scenario to occur during forest treatment activities.

LD_{50} (lethal dose, 50 percent): Is the dose of a chemical calculated to cause death in 50 percent of a defined experimental animal population over a specified observation period. The observation period is typically 14 days.

LOAEL: Lowest observable adverse effect level

NOEL or NOEC: No observed effect level/concentration: exposure level at which there are no statistically or biological significant differences in the frequency or severity of adverse effects between the exposed populations and its appropriate control.

RfD: Reference Dose

Toxicity index: The benchmark dose used to determine a potential adverse effect when it is exceeded. Usually a NOEL, but when data are lacking other values may be used. For example a value equal to $1/20^{th}$ of the known LD_{50} may be used as a toxicity index.

1.4 Herbicide as a method of invasive plant control

The objective of herbicide use is to control invasive plant infestations where manual or mechanical means would be less effective, cost-prohibitive, or create more disturbance and promote further spread of the infestation (e.g. Japanese knotweed). The proposed herbicides were selected based on their effectiveness and low toxicity to humans and non-target organisms. While there may be herbicides with greater effectiveness on the market, some have negative environmental effects or other properties that are undesirable. All herbicides proposed for use in this project are approved by the U.S. Environmental Protection Agency (EPA) and are available without a special permit. Generally, there would be one or more chemical application per site per year with follow-up monitoring and any follow-up treatment in subsequent years. The timing of treatments would vary by species in order to avoid negative impacts on non-target species, and to avoid high periods of human use in proposed treatment areas. All herbicides would be applied according to label directions.

Descriptions of the four herbicides proposed for use are provided in the Affected Environment Section 2.3.

1.5 Herbicide Risk Assessments

Information from laboratory and field studies of herbicide toxicity, exposure, and environmental fate was used to estimate the risk of adverse effects to humans and non-target organisms. Formal risk assessments were done by Syracuse Environmental Research Associates, Inc. (SERA) using peer-reviewed articles from the open scientific literature and current Environmental Protection Agency (EPA) documents, including Confidential Business Information. They considered worst-case scenarios including accidental exposures and application at maximum label rates. These risk assessments meet the requirements of the Pesticide Use Handbook, FSH 2109.14 Chapter 20.

The risk assessments consider a variety of exposure scenarios including accidental exposures and application at maximum rates over relatively large areas. Although the risk assessments have limitations (see USDA 2005 pages 3-95 through 3-97), they represent the best science available. Some of the primary limitations of the exposure scenarios for this project is that they are based on agricultural field conditions which are notably different than scenarios typical of forest treatment activities. In cases where exposure scenarios indicate potential risks, our analysis describes how these scenarios differ from what will be implemented under forest application methods.

The risk assessments provide a range of human health and ecological impact results including lower, central and upper estimates. The upper value in the range would generally correspond to a "worst-case" value unlikely to actually occur for this project. For instance, workers would have to be exposed to maximum rates over the course of an 8-hour day; 200 gallons of herbicide would have to be spilled into a pond for accidental drinking water exposure scenarios; a woman would have to eat a pound of contaminated fruit; an animal would have to feed on nothing but contaminated vegetation over the course of a day; a fish would be exposed to herbicide following 10 acres of broadcast spray at maximum rates directly adjacent to a small stream. The central estimates also include assumptions that are unlikely to actually occur given the PDFs associated with this project and the scattered nature of invasive plant applications.

Risk assessments have a high degree of uncertainty in interpretation and extrapolation of data. Uncertainty may result from a study design, questions asked (and questions avoided), data collection, data interpretation, and extreme variability associated with aggregate effects of natural and synthesized chemicals on organisms, including humans, and with ecological relationships. Due to data gaps, assessments rely heavily on extrapolation from laboratory animal tests (USFS 2005).

Regardless of disadvantages and limitations of ecological and human health risk assessments, risk assessments can determine (given a particular set of assumptions) whether there is a basis for asserting that a particular adverse effect is possible. The bottom line for all risk analyses is that absolute safety can never be proven and the absence of risk can never be guaranteed (USDA 2005). Limited information on surfactants, adjuvants, and inert ingredients is available in Bakke 2007 and various risk assessments. Since risk assessments have not been completed for most surfactants, adjuvants and inert ingredients, information regarding the toxicity and effects of these chemicals is largely unavailable.

Herbicide risk assessments are available online at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml and herbicide labels are available at http://www.fs.fed.us/foresthealth/pesticide/labels.shtml. Table 1 displays herbicides considered for use in Alternatives 2 and 3, including formulations, mode of action, properties and central and maximum application rates. Table 2 displays the risk assessment references associated with each herbicide proposed for use. All herbicide data worksheets were updated for the above risk assessments in July 2019.

Table 2. Risk Assessments for Project Herbicides

Herbicide	Date Final	Risk Assessment Reference
Glyphosate	March 25, 2011	SERA TR-052-22-03b
Imazapyr	December 16, 2011	SERA TR 052-29-03a
Aminopyralid	June 28, 2007	SERA TR-052-04-04a
Metsulfuron methyl	December 9, 2004	SERA TR 04-43-17-01b

1.5.1 Risk of Impurities, Metabolites, Inert Ingredients, and Adjuvants

In addition to the analysis of potential hazards to human health from every herbicide active ingredient, Forest Service/SERA Risk Assessments evaluated available scientific studies of potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. There is usually less toxicity data available for these substances (compared to the herbicide active ingredient) because they are not subject to the extensive testing that is required for the herbicide active ingredients under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act). EPA has not classified any of the inerts as toxic. Some of the inerts are approved food additives (for instance, glacial acetic acid, monoethanolamine and isopropyl alcohol).

Information on adjuvants and surfactants is contained within the R6 PNW FEIS (USDA 2005) and incorporates updated information from Analysis of Issues Surrounding the Use of Spray Adjuvants with Herbicides, and the Summary of Aquatic Acute Toxicity Data for Spray Adjuvants Allowed for Use on Aquatic Sites in Washington.

The SERA risk assessments also include information about additives that are part of herbicide formulations. NPE-based surfactants would not be used for this project, however alkylphenol ethoxylate ingredients may be used in oil and/or silicone blends. POEA surfactants would not be used.

1.6 Incomplete and Unavailable Information Related to Herbicides

Any project involving herbicide use in a natural setting will contain many sources of uncertainty. The range of invasive plant species to be managed is large and compounded by the number of non-target species and diversity of ecological conditions in areas where treatment may occur. Data on herbicide toxicity and environmental fate is limited to those conditions and species tested for registration purposes and investigated by independent researchers. Available data on surfactants, inert ingredients, and dyes is even more limited. It is not possible to obtain all the data necessary to substantially reduce this information gap. For example, the sheer number of species and single herbicide test combinations would be overwhelming.

Each rigorous laboratory test conducted to determine the toxicity of a chemical to an animal is extremely expensive. If we add to this data required to more adequately address synergistic, additive, or antagonistic effects from chemical combinations, it is not possible to obtain all data that would be relevant to making a decision. In addition, invasive and native plants, wildlife, soil and water bodies are dynamic resources that change locations and characteristics depending upon time, season, weather patterns, land use activities, random events, and other influences. This limits our ability to precisely predict effects (e.g. amount and duration of herbicide exposures, spread and impact of invasive plants, nature and amount of background contamination, etc.) even if more toxicity information was available.

For risk assessments considering adjuvants, surfactants and inert ingredients in herbicide mixtures, the information within the risk assessment may not be complete. SERA (2007) discussed how the risk assessments apply generally accepted scientific and regulatory methodologies to encompass these uncertainties in predictions of risk. SERA risk assessments identify and evaluate incomplete and unavailable information that is potentially relevant to human health and ecological risks. Each risk assessment identifies and evaluates missing information for that particular herbicide and its relevance to risk estimate. Such missing information may involve any of the three elements needed for risk assessments: hazard, exposure, or dose-response relationships. A peer-review panel of subject matter experts reviewed the assumptions, methodologies and analysis of significance of any such missing information. The SERA Risk Assessments incorporate the findings of this peer review.

The Forest Service responds to this uncertainty by:

1. Assuming adverse effects to organisms occur at doses well-below lethal levels.
2. Using the best available models for predicting herbicide concentrations in water.
3. Using worst case scenarios.
4. Relying on widely used and accepted risk assessment methodology.
5. Including PDFs that restrict certain applications.
6. Monitoring effects of higher risk treatments.

1.7 Where to find additional herbicide information

The Forest Service maintains a Pesticide Management and Coordination website that contains human health and ecological risk assessments; pesticide use policy information; pesticide labels; material safety data sheets; and reports on pesticide use across National Forest System lands: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

This resource report refers to currently registered products (trade names such as Aquamaster®) in its analysis. These products, which contain the proposed herbicides, are currently registered with the State of Alaska Department of Environmental Conservation (ADEC). ADEC maintains a pesticide control program that is designed to protect public health and the environment by regulating pesticide use, sale, and distribution in Alaska. Registration of these products is updated yearly, and products registered for use may change.

Products currently registered for use in Alaska can be found at:
http://www.kellysolutions.com/ak/

1.8 Herbicide Risk Reduction Framework

The use of herbicides would be according to label requirements, with further restrictions from project design features (PDFs) described in Section 3.7. For example, PDF-HH-1 requires application be performed or directly supervised by a certified applicator; PDF-HH-6 includes precautions on tank mixtures; and PDF-HH-8 requires timely public notification of treatment areas.

Alternatives 2 and 3 incorporate a risk reduction framework adopted from Region 6 of the USDA-Forest Service (Oregon and Washington States) to ensure the safe and effective use of herbicides. Figure 1 below displays the layers of caution that are integrated into risk reduction framework for herbicide use in the United State Department of Agriculture (USDA) Forest Service, Pacific Northwest Region.

First, label requirements, federal and state laws, and the EPA approval process provide an initial level of caution regarding herbicide use. Next, the Syracuse Environmental Research Associates (SERA) Risk Assessments (2007, 2011a and 2011b) determine the hazards associated with worst-case herbicide scenarios (maximum exposure allowed by the label). These scenarios are compared to toxicity levels for each chemical (see Table 3 in Section 2.3). The Tongass N.F. also includes a margin of safety by reducing the level of herbicide exposure considered to be of concern to humans, fish and wildlife. At the project level, we eliminate higher risk application methods such as aerial spray, and specific herbicide ingredients and additives (e.g., triclopyr BEE, POEA surfactant) to further abate risk, noting that we could still have an effective spray program without them.

The next layer of caution is to establish the project specific Project Design Features (PDF, referred to as Project Design Criteria in this figure (see Section 3.7) which limit the type and method of herbicide application, further reducing the risks associated with herbicide treatments. PDFs are often based on the findings of the SERA assessments or other studies, or upon site-specific resource conditions within the treatment areas. These resource conditions include, but are not limited to, the location of known invasive plant sites, the presence of threatened, endangered, or sensitive species and their habitats, potential for herbicide delivery to water, and the social environment.

Figure 1. Layers of Caution Integrated into Herbicide Use adopted from R6

1.9 Herbicide Treatment Types

1.9.1 Broadcast spray

When using this application method, herbicide is sprayed over an entire area; non-target plants are avoided but may be more affected than by using spot spraying (see definition below). The applicators range from motorized rigs with spray hoses to backpack sprayers, all of which can target plants that are more densely populated within a larger area. Drift may be of greater concern because the applicator spray is directed over a larger area; however drift effects are avoided by adhering to label instructions related to wind speed limits during application. The difference between broadcast spraying and spot spray (see below) is the area treated is often greater than 1 acre in size. In both treatment methods, application of the herbicide may be carefully targeted by the applicator.

1.9.2 Spot spray

When using this application method, herbicide is sprayed directly onto small patches or individual target plants; non-target plants are avoided. The applicators range from motorized rigs with spray hoses to backpack sprayers to hand-pumped spray or squirt bottles, all of which can target very small plants or parts of plants. Drift is even less of a concern than broadcast spray because the applicator ensures that spray is directed immediately toward the target plant.

1.9.3 Hand/Selective

Hand/selective methods treat individual target plants, reducing the potential for herbicide to impact soil or non-target organisms. Hand/selective methods include wicking and wiping; foliar application; basal bark treatment; frill, hack, and squirt, stem injection, and/or cut-stump methods. Descriptions of these methods follow.

- *Wicking, wiping, and other stem and leaf application* - Involves using a sponge, spray bottle, paint brush, cloth and/or a wick on a long handle to wipe herbicide onto foliage and stems. Use of a wick eliminates the possibility of spray drift.

- *Stem injection* - Herbicides can be injected into herbaceous stems using a hand held injection system with an attached needle. Herbicide pellets can also be injected into the trunk of a tree using a specialized tool. Higher concentrations of active ingredients are often needed for effective stem injection, for instance, the maximum label rate of aquatic labeled glyphosate was used to effectively kill knotweed by stem injection (Lucero presentation, May 2005).

- *Cut-stump* - This method is often used on woody species that normally re-sprout after being cut. The tree or shrub is cut down and herbicide is immediately sprayed or squirt on the exposed cambium (living inner bark) of the stump. The herbicide must be applied to the entire inner bark (cambium) within minutes after the trunk is cut. The outer bark and heartwood do not need to be treated since these tissues are not alive, although they support and protect the tree's living tissues. The cut stump treatment allows for a great deal of control over the site of herbicide application, and therefore, has a low probability of affecting non-target species or contaminating the environment. It also requires only a small amount of herbicide to be effective.

2 Affected Environment

2.1 Existing Condition

Field inventories have identified 144 non-native plant species, both invasive and other non-invasive (approximately 1430 acres of infestation) within the boundaries of the 8.3 million-acre project area. Undeveloped lands on the five northern districts have relatively few weeds, and current infestations are small and in the early stages of invasion. Known infestations are primarily in areas that receive high use, such as along roads, recreation sites, some riparian areas and cabin sites. Alaska has been relatively insulated from the introduction and subsequent problems that have impacted other states due in part to its remoteness and low population.

No threats to human health from past or ongoing herbicide use are known to exist in the project area. Most people are subject to some background level of chemical exposure; the most common known exposure is use of herbicide based products for personal use (i.e. the use of Roundup, which is a glyphosate based, commercially available herbicide, in gardening), or consumption of fruits or vegetables containing herbicide residue.

Currently the Alaska Department of Transportation (ADOT) is not using herbicides for vegetation management along the roads they maintain.

2.2 Desired Condition

The Tongass National Forest 2016 Amendment to the Land and Resource Management Plan (USDA Forest Service 2016) provides direction to reduce population sizes and/or limit the spread of invasive plants on the Tongass National Forest using an integrated pest management approach, which includes the use of herbicides.

The Forest-wide desired condition for biodiversity specifically states, "Viable populations of native and desired non-native species and their habitat are maintained and are not threatened by invasive species" (Forest Plan, page 2-1).

2.3 Overview of Proposed Herbicides

As previously mentioned, description of the four herbicides proposed for use in this project were taken directly from the Risk Assessments by Syracuse Environmental Research Associates, Inc. (SERA). SERAs risk assessments use peer-reviewed articles from the open scientific literature and current Environmental Protection Agency (EPA) documents, including Confidential Business Information. Risk assessments are linked to the hazard indicators and toxicity levels identified for each scenario on human health. These hazard indicators and toxicity categories are shown in Table 3.

Table 3. General summary of hazard indicators and acute toxicity categories.

Hazard Indicators/Signal Word	I (Danger)	II (Warning)	III* (Caution)	IV (None Required)
Oral LD_{50}	Up to and including 50 mg/kg	50-0.2-2 mg/L 500 mg/kg	500-5,000 mg/kg	Greater than 5,000 mg/kg
Inhalation LD_{50}	Up to and including 0.2 mg/L	0.2-2 mg/L	2 to 20 mg/L	Greater than 20 mg/L
Dermal (skin) LD_{50}	Up to and including 200 mg/kg	200-2,000 mg/kg	2,000-20,000 mg/kg	Greater than 20,000 mg/kg
Eye Effects	Corrosive; corneal opacity not reversible within 7 days	Corneal opacity reversible within 7 days; irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours

*The EPA classifies the end use products (e.g. trade names Habitat and Aquamaster) containing imazapyr and glyphosate as category III and aminopyralid based products (e.g. Milestone) as category IV.

2.3.1 Aminopyralid[6]

Aminopyralid is registered by the US EPA for the control of invasive plants. It is a selective, systemic, post-emergent herbicide that controls the entire plant, including the roots. Residual soil activity helps extend its ability to control target plants.

The US EPA has judged that aminopyralid is a reduced risk herbicide[7]. It would be applied at a lower rate when compared with other comparable herbicides[8]. Its residual action should reduce the need for repeat applications, resulting in a reduction in the amount of herbicides applied to the environment for the control of the project's targeted weed species (OPP-EPA 2005a). The full range of the labeled rates (i.e., 0.03 to 0.11 pound of active acid equivalents[9] per acre [lb a.e./acre]) was considered as the lower and upper bounds on application rates in the SERA risk assessment (2007b) with the central application rate at 0.078 lb a.e./acre or about 5 ounces formulation per acre. The application range proposed in this project considered the full range of legal application rates, from 0.078-0.11 lb a.e./acres.

Science indicates that aminopyralid has low toxicity via oral (mouth), dermal (skin), and inhalation (breathing) routes of exposure. The toxicity categories for all hazard indicators are IV (OPP-EPA 2005a). The weight-of-evidence suggests that aminopyralid may not have any remarkable systemic toxic effects. The effects that are most commonly seen involve effects on the gastrointestinal tract after oral exposure and these may be viewed as portal of entry effects rather than systemic toxic effects. Aminopyralid is rapidly absorbed and excreted and is not substantially metabolized in mammals.

The SERA risk assessment (2007b), along with US EPA, have determined there is no basis for asserting that aminopyralid is a carcinogen (aminopyralid is classified as "not likely" to be carcinogenic to humans [OPP-EPA 2005a]). There is also no basis for asserting that aminopyralid would cause adverse effects on the nervous system, immune system or endocrine function. Based on studies completed on reproduction and development, US EPA concluded that there is no evidence of increased qualitative or quantitative susceptibility of the fetuses to aminopyralid (OPP-EPA 2005).

The Office of Pesticide Programs of the US EPA (US EPA/OPP) has derived a chronic (long-term) reference dose (RfD)[10] of 0.5 milligram of acid equivalent per kilogram body weight per day (mg a.e./ kg bw/day or mg/kg/day) for aminopyralid. For incidental (acute, short-term and intermediate exposures), the US EPA has proposed an RfD of 1.0 mg a.e./kg bw/day or incident. Based on the highest application rate for the various scenarios analyzed in the risk assessment (USFS 2010a), no adverse effects are likely in either workers or members of the general public (SERA 2007b). All plausible scenarios and related to implementation of this project are below the level of concern.

[6] Information in this section is from the aminopyralid risk assessment (SERA TR-052-04-04a) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/062807_Aminopyralid.pdf.

[7] A reduced risk herbicide is one that poses less risk to human health and the environment than existing conventional alternatives.

[8] Comparable herbicides include picloram, clopyralid, 2,4-D, dicamba, monosodium methanearsonate and metsulfuron methyl.

[9] Acid equivalent (a.e.) is the active part of the acid herbicide being used.

[10] Reference dose (RfD) is a numerical estimate of a daily exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or minimum dose for producing effects.

The direct and indirect human health and safety hazard and risk for aminopyralid is negligible. This conclusion is based on the hazards (i.e., formulated end-use products highest toxicity category is IV; "not likely" to be carcinogenic; and no basis to assert aminopyralid would cause an adverse effect on nervous system, immune system, endocrine functions, reproduction and development) and dose response and risk characterization longer-term and short-term exposure calculations were below the level of concern. Complying with the label instructions and design features incorporated in this project would further lower these negligible risks.

2.3.2 Glyphosate[11]

Glyphosate is a systemic, broad-spectrum, non-selective herbicide. It is quickly taken up by target plants and adheres to the soil which lessens or slows leaching and uptake by non-target plants.

There are currently 35 commercial formulations of glyphosate that are registered for forestry applications. This project would utilize only aquatic formulations of Glyphosate which are also effective in terrestrial conditions. The most commonly used application rate would be about 2 lbs a.e./acre, with application rates occurring over a range of 0.5 lb a.e./acre to 8 lbs a.e./acre.

The available experimental studies indicate the primary hazard to humans would involve potential contact of liquid to skin and eyes, and inhalation of vapors. Exposure may cause moderate irritation—in the case of eye exposure the irritation level is similar to detergent exposure. Reviews conducted by SERA (2011) concluded that there was very little indication of any potential risk at the central application rate of 2 pound of active ingredient per acre. Even at the upper range of plausible exposures in workers, most hazard quotients are below the level of concern. The available experimental studies indicate that glyphosate is not completely absorbed after ingestion and is poorly absorbed after skin exposure.

There is no clear pattern suggestive of a specific neurotoxic action for glyphosate or its commercial formulations. The weight of evidence suggests that any neurologic symptoms associated with glyphosate exposures are secondary to other toxic effects. No studies are reported that suggest an effect on the immune system. Glyphosate has not undergone an extensive evaluation for its potential to interact or interfere with the estrogen, androgen, or thyroid hormone systems but tests show no potential effects of glyphosate on the endocrine system.

Many recent articles have circulated announcing that in March 2015, the International Agency for Research on Cancer (IARC) has categorized glyphosate as “probably carcinogenic to humans.” This is not based on new studies; the studies that were used in IARC’s designation have been out a long time. The SERA 2011 Glyphosate Risk Assessment thoroughly discusses the carcinogenic, mutagenic, and genotoxic potential for glyphosate, using many of the same studies reviewed by the IARC.

In 2014, EPA reviewed over 55 epidemiological studies conducted on the possible cancer and non-cancer effects of glyphosate. Their review concluded that this body of research does not provide evidence to show that glyphosate causes cancer, and it did not warrant any change in EPA’s cancer classification for glyphosate.

According to the risk assessment (SERA 2003a), there is no basis for asserting that glyphosate is likely to pose a substantial carcinogenic risk. Hardell and Erikson (1999a as referenced in SERA

[11]Information in this section is from the glyphosate risk assessment (SERA TR-052-22-03b) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/Glyphosate_SERA_TR-052-22-03b.pdf.

2003a) reported an increased cancer risk of non-Hodgkin lymphoma (NHL) in individuals in Sweden who have a history of exposure to glyphosate. The US EPA - Office of Pesticides Programs Health Effects Division has reviewed the journal article entitled "A Case-Control Study of Non-Hodgkin Lymphoma and Exposure to Pesticides" and concluded that the study does not change EPA's risk assessment for the currently registered uses of glyphosate. It was determined this type of epidemiologic evaluation does not establish a definitive link to cancer. Furthermore, the information had limitations because it is based solely on unverified recollection of exposure to glyphosate-based herbicides (OPP-EPA 2002 as referenced in SERA 2003a). Best available science indicates that glyphosate proposed for use in this project would not increase anyone's risk of cancer.

2.3.3 Imazapyr [12]

The most common and effective applications for imazapyr are post-emergent when the vegetation to be controlled is growing vigorously. The central application rate for imazapyr would be about 0.45 lb a.e./acre with rates up to 1.25 lbs a.e./acre. Addition of a non-ionic surfactant is recommended to enhance efficacy of the imazapyr based end product (Habitat®). The lowest risk surfactants available would be used in (e.g. Agri-Dex®, Class Act® NG®, Dyne-Amic®, Competitor®).

Although the mode of action of imazapyr in humans or other mammals is unclear, this is partly due to the apparently low and essentially undetectable acute and chronic (short or longer-term) systemic toxicity of this compound. An adequate number of multi-generation reproductive and developmental studies have been conducted and the studies show no adverse effects on reproductive capacity or normal development. Tests of carcinogenic and mutagenic activity are consistently negative, and the US EPA has categorized the carcinogenic potential of imazapyr as Class E: evidence of non-carcinogenicity. There have been many long-term animal studies. Though none focused on the immune system, the results do not indicate imazapyr would adversely affect the immune system. The weight of evidence suggests that imazapyr is not directly neurotoxic, and the available data do not show systemic toxic effects after skin or inhalation exposures to imazapyr.

RfD of 2.5 mg/kg/day is used to characterize the risks of both short-term (acute) and longer-term (chronic) exposures and is the basis of determining the level of concern. Upper level exposures at the highest application rate estimated for Alternative 3 do not lead to estimated doses that exceed a level of concern for workers (SERA 2011).

Imazapyr and imazapyr formulations can be mildly irritating to the eyes and skin. Mild irritation to the eyes can result from exposure to relatively high levels of imazapyr. From a practical perspective, eye irritation is likely to be the only overt effect as a consequence of mishandling imazapyr. This effect can be minimized or avoided by prudent industrial hygiene practices (e.g., exercising care to reduce splashing and wearing goggles) during the handling of the compound. These measures are included in the design features for this alternative (e.g., personal protective equipment, spill kit).

Based on this analysis, the human health and safety hazard and risk for imazapyr is low. This conclusion is based on the hazards (i.e., formulated end-use products highest toxicity category is III, caution, no basis to assert imazapyr is carcinogenic or that it would cause an adverse effect on

[12] Information in this section is from the imazapyr risk assessment (SERA TR-052-29-03a) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf

nervous system, reproduction and development) and dose response and risk characterization (i.e., all scenarios for workers and public, chronic and acute exposures were below the level of concern). Complying with the label instructions and design features incorporated in this project would further lower the minimal risks.

2.3.4 Metsulfuron methyl[13]

Metsulfuron methyl is a selective pre-emergence and post-emergence sulfonyl urea herbicide used primarily to control many annual and perennial weeds and woody plants. The Forest Service uses only one commercial formulation of metsulfuron methyl, Escort® XP. Escort is manufactured by Du Pont as a dry flowable granule. The composition of the product is 60% metsulfuron methyl and 40% inert ingredients.

Metsulfuron methyl is used in Forest Service programs primarily for the control of noxious weeds. Minor uses include rights-of-way management. The most common methods of ground application for Escort XP involve backpack (selective foliar) and boom spray (broadcast foliar) operations. For this risk assessment, the most common rate of 0.03 lbs/acre, with a range 0.0125 to 0.15 lbs/acre, is used to reflect Forest Service practices. This range is based on lowest and highest labeled application rates recommended on the manufacturer's label.

In experimental mammals, the acute oral LD_{50} for metsulfuron methyl is greater than 5000 mg/kg, which indicates a low order of toxicity. In addition, non-lethal signs of toxicity were apparent after single oral doses as low as 50 mg/kg. The most common sign of acute, subchronic, and chronic toxicity is decreased body weight gain. The only other commonly noted effect involves changes in various hematological parameters as well as changes in absolute and relative organ weights. None of these changes, however, suggest a clear or specific target organ toxicity. There is speculation that the effects of metsulfuron methyl on the blood might be related to saccharin, which is a metabolite of metsulfuron methyl. At very high doses, saccharin caused hematological effects in mice. Appropriate tests have provided no evidence that metsulfuron methyl presents any reproductive risks or causes malformations or cancer. Metsulfuron methyl also is irritating to the skin and eyes, but does not produce sensitizing effects following repeated dermal exposure.

Skin absorption is the primary route of exposure for workers. Data regarding the dermal absorption kinetics of metsulfuron methyl are not available in the published or unpublished literature. For this risk assessment, estimates of dermal absorption rates—both zero order and first order—are based on quantitative structure-activity relationships. These estimates of dermal absorption rates are used in turn to estimate the amounts of metsulfuron methyl that might be absorbed by workers, which then are used with the available dose-response data to characterize risk. The lack of experimental data regarding dermal absorption of metsulfuron methyl adds substantial uncertainties to this risk assessment. Uncertainties in the rates of dermal absorption, although they are substantial, can be estimated quantitatively and are incorporated in the human health exposure assessment.

The inhalation toxicity of metsulfuron methyl is not well documented in the literature. Available studies indicate that metsulfuron methyl induces irritant effects at very high exposure levels. Regardless, the potential inhalation toxicity of metsulfuron methyl is not of substantial concern to

[13] Information in this section is from the Metasulfuron methyl risk assessment (SERA TR 04-43-17-01c) and can be found online at: https://www.fs.fed.us/foresthealth/pesticide/pdfs/120904_Metsulfuron.pdf

this risk assessment because of the implausibility of inhalation exposure involving high concentrations of this compound.

Typical exposures to metsulfuron methyl do not lead to estimated doses that exceed a level of concern. For workers, no exposure scenarios, acute or chronic, exceeds the RfD even at the upper ranges of estimated dose. For members of the general public, all upper limits for hazard quotients are below a level of concern. Thus, based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from longer-term exposure to metsulfuron methyl.

Irritation to the skin and eyes can result from exposure to relatively high levels of metsulfuron methyl. From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling metsulfuron methyl. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of the compound.

2.3.5 Adjuvants, Inert Ingredients, Impurities and Defoamers

Herbicides generally need to be applied with an adjuvant, compounds added to the herbicide formulation to improve its performance. They can either enhance the activity of an herbicide's active ingredient (activator adjuvant) or offset any problems associated with its application (special purpose or utility modifiers).

Adjuvants are not under the same registration guidelines as pesticides and the US EPA does not register or approve the labeling of adjuvants. The State of Alaska DEC also does not have an approved adjuvant list. This project references the adjuvants approved for aquatic use in the State of Washington. See link: http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html

Adjuvants are compounds added to the herbicide formulation to improve its performance. They can either enhance the activity of an herbicide's active ingredient (activator adjuvant) or offset any problems associated with its application (special purpose or utility modifiers).

Surfactants are one type of adjuvant that makes the herbicide more effective by increasing absorption into the plant. Surfactants may also improve an herbicide's efficiency so that the concentration or total amount of herbicide required to achieve a given effect is reduced, sometimes as much as five or ten-fold (Tu et al. 2001). In this way, adding an appropriate surfactant can decrease the amount of herbicide applied and lower total costs for weed control (Tu et al. 2001). In some cases, the herbicide would already have the surfactant included, but in other cases, it would be necessary to add one.

This project will use only low-risk aquatically approved surfactants (e.g. Agri-Dex®, Class Act® NG®, Competitor®).

Many of the inert ingredients in adjuvants, compounds intentionally added to the formulation to facilitate its handling, stability or mixing, are proprietary in nature and also have not been tested on laboratory species. However, confidential business information (i.e., the identity of proprietary ingredients) was used in the preparation of the herbicide risk assessments and adjuvants were considered in the overall effects reported for this project.

Impurities are inadvertent contaminants in the herbicide, usually present as a result of the manufacturing process. The risk assessments also describe these and their risks.

Other adjuvants include defoamers and colorants. Deformers are used to reduce the foaming that might occur during agitation of the spray mixture. Colorants can be added to herbicide solutions to enable spray crews to see where they have sprayed after initial evaporation of the solution.

3 Environmental Consequences

3.1 Methodology

This analysis incorporates information from the scientific risk assessments completed by SERA. The risk assessments include peer-reviewed articles from the open scientific literature and current EPA documents, including Confidential Business Information. Along with active ingredients, the assessments also reviewed herbicide additives, inert ingredients, and impurities, where information was available.

Additional information incorporated into this analysis is based on:

- Herbicide product labels;
- State of Washington, Department of Ecology aquatic pesticide website (http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html); and
- State of Alaska, Department of Environmental Conservation (DEC) pesticide use website (http://www.dec.state.ak.us/eh/pest/index.htm).

To assess human health risks this analysis compares the dose of herbicide received by a worker or a member of the public under each exposure scenario with the corresponding herbicide "Reference Dose" (RfD) established by EPA or by the Forest Service/SERA risk assessment for acute and/or chronic exposures. Reference Doses established by SERA risk assessments for acute and chronic exposures for human health (e.g. toxicity threshold) are provided in Table 4. If doses from estimated exposures for a specific Forest Service herbicide application are less than the RfD's, there would be no indication of a risk of health effects. RfDs are established by taking the no observable adverse effect level (NOAEL) for each herbicide and then adjusting it to compensate for uncertainty. Most frequently, a RfD is 1/100th of the lowest NOAEL, but it may be even lower in some cases. The RfD is also referred as the toxicity threshold or threshold of concern. The Hazard Quotient (HQ) is the ratio of the estimated level of exposure compared to the RfD. When a predicted dose is less than the RfD, then the HQ (dose/RfD) is less than 1, and toxic effects are unlikely for that specific herbicide application (i.e., the use is presumably safe). No chemical is studied for all possible effects and the use of data from laboratory animals to estimate hazard or the lack of hazard to humans of other species is an uncertain process. Thus, prudence dictates that normal and reasonable care should be taken in the handling of any chemical.

Table 4. Reference Doses established by SERA risk assessments for acute and chronic exposures for human health (e.g. toxicity threshold).

Herbicide	Human Acute Toxicity Threshold	Human Chronic Toxicity Threshold	Worksheet Version and Date
---mg/kg of body weight--------------------------------------			
Aminopyralid	**1.0**	**0.5/day**	**7.02.19** **July 7, 2019**

Glyphosate Aquatic	**2.0**	**2.0/day**	**7.02.19** **July 2, 2019**
Imazapyr Aquatic	**2.5**	**2.5/day**	**7.02.19** **July 2, 2019**
Imazapyr Terreistrial	**2.5**	**2.5/day**	**7.02.19** **July 2, 2019**
Metsulfuron methyl	**0.25**	**0.25/day**	**7.02.19** **July 2, 2019**

The risk assessments and worksheets quantify expected exposures and calculate the HQ's. These worksheets provide a range of values (lower, central and upper) rather than rely on a single estimate. The upper exposure estimates are based on the maximum estimate for every exposure factor that is considered, which is very unlikely to occur in our operations (e.g., maximum application volume, maximum concentration in field solution, maximum volume of a spill, maximum residue rates on food items, maximum exposure rates, maximum hours worked). The upper exposure estimates do not represent the way herbicides would be used in this project and the probability of maximum exposures occurring is very low. Using the quantitative information provided in the SERA risk assessments is the first screen in evaluating effects. We use the best science in combination with professional judgement to further evaluate any scenario that may indicate possible risks (based on the quantitative information). We then evaluate the risk scenario and compare it to how well it fits the actual treatment method we are implementing. The quantitative analysis is useful for highlighting potential risks. Qualitative evaluation further provides a "real life" scenario to that risk and provides context to how the herbicide will actually be applied.

3.2 Spatial and Temporal Context for Effects Analysis

3.2.1 Direct/Indirect/Cumulative Effects

The direct, indirect and cumulative effects from the use of any herbicide depends on the type (its toxic properties/hazards), and extent (the level of exposure to the herbicide at any given time, and the duration of the exposure). The spatial context for the analysis of effects of herbicides and herbicide treatment methods on human health includes the project area, which includes all non-national forest lands. The temporal context is seasonal for direct and indirect effects for cumulative effects.

The herbicides and herbicide treatment methods proposed in Alternatives 2 and 3 present similar worker and general public safety risks in the short term (seasonally) and long-term (10 years or greater). Some of the activities considered in the effects analysis are:

1. The accidental, incidental or general exposure that could occur during herbicide application by workers (possibility of direct contact or ingestion);

2. The potential for short-term or acute exposure by the general public due to consumption of water, fish, fruit or vegetation coming into contact with sprayed foliage after application; and
3. The potential for long-term or chronic exposure by the general public due consumption of water, fish, fruit or vegetation coming into contact with sprayed foliage after application; and
4. The potential for long term or chronic (repeated/cumulative) exposure due to any herbicide use outside of Forest Service lands (e.g., people treating weeds on their own property, or other weed eradication projects that could potentially utilize herbicides).

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

The analysis of past, present, and reasonably foreseeable activities in the project area consider management actions that may cumulatively affect human health. Examples may include any known proposal to treat invasive plants within the communities of Sitka, Hoonah, Juneau, Angoon, and Yakutat. These activities may be associated with organized Cooperative Weed Management Areas or Groups, or may be independently driven by interested parties and organizations.

All the projects evaluated for this analysis have been consolidated into a Catalog of Events, located in the project record, and available upon request.

3.3 Herbicide Exposure and Risk Assessments

The risk assessments referenced in this analysis conducted exposure assessments for both workers and members of the general public for each of the herbicides proposed for use. The consequences of using the maximum application rate, based on past Forest Service weed treatments, are discussed in the risk characterization using typical or worst-case exposure assumptions. These scenarios include the effects of aerial application of herbicide which are not being considered as application methods for this project. A summary of this information is provided below for each proposed herbicide for this project.

The exposure scenarios consider activities such as: direct spray, accidental spills, consumption of contaminated vegetation and water, oral exposure to contaminated fish, and terrestrial and aquatic application methods.

Three of the herbicides proposed in this project (aminopyralid, imazapyr and metsulfuron methyl) did not have any HQ values greater than 1, even for the upper estimates. Even considering central or lower HQ estimates, many of the exposure scenarios for the general public are implausible or extremely conservative. The general public is unlikely to be directly exposed to treated areas because these areas will be posted and because applicators would avoid directly spraying people.

Estimates of longer-term consumption of contaminated water are based on estimated application rates throughout a watershed; however, only small portions of a watershed would be treated. Exposure scenarios based on longer-term consumption of contaminated vegetation assume that an area of edible plants is inadvertently sprayed and that these plants are consumed by a person over a 90-day period. While such inadvertent contamination might occur, it is extremely unlikely to happen as a result of directed applications (e.g., backpack applications). Even in the case of boom (broadcast) spray operations the spray is directed at target vegetation and the possibility of inadvertent contamination of cultivated or edible vegetation would be low. In addition, for herbicides and other phytotoxic compounds, it is likely that the contaminated plants would show obvious signs of damage over a relatively short period of time and would therefore not be consumed (SERA 2007).

3.3.1 Aminopyralid [14]

The risk characterization for both workers and members of the general public is reasonably simple and unambiguous: based on a generally conservative and protective set of assumptions regarding both the toxicity of aminopyralid and potential exposures to aminopyralid, there is no basis for suggesting that adverse effects are likely in either workers or members of the general public even at the maximum application rate that might be used in Forest Service.

For workers, no exposure scenarios, acute or chronic, exceeds the RfD at the upper bound of the estimated dose associated with the highest application rate of 0.11 lb a.e./acre. The hazard quotients for directed ground spray and broadcast ground spray are below the level of concern by factors of 33 to 200 over the range of application rates considered in this risk assessment.

For members of the general public, upper bounds of hazard quotients at the highest application rate are below a level of concern by factors of 100 to 125,000 for longer term exposures. The upper bounds of acute exposure scenarios for contaminated vegetation or fruit are below the level of concern by factors of 10 to 50. Acute non-accidental exposure scenarios for members of the general public that involve contaminated water are below the level of concern by factors of about 50 to 500.

Sensitive Subgroups: There is no information to suggest that specific groups or individuals may be especially sensitive to the systemic effects of aminopyralid. Due to the lack of data in humans, the critical effect of aminopyralid in humans, if any, cannot be identified.

3.3.2 Glyphosate[15]

For this project, the Forest Service will only be using the aquatic version of Glyphosate, since the terrestrial version contains POEA surfactant and the aquatic version does not.

The risk characterization for both workers and members of the general public are reasonably consistent and unambiguous. For both groups, there is very little indication of any potential risk at the highest application rate of 8 lbs a.e./acre. Even at the upper range of plausible exposures in workers, most hazard quotients are below the level of concern.

For workers, the highest hazard quotient – i.e., 0.2, the upper range for workers involved in broadcast ground spray – is below the level of concern by a factor of about 5. The highest hazard quotient for any accidental exposure scenario for workers - i.e., 0.006 for the upper range of the hazard quotient for spill over the lower legs for one hour - is lower than the level of concern by a factor of over 150. Confidence in these assessments is reasonably high because of the availability of dermal absorption data in human as well as worker exposure studies. The Forest Service may apply glyphosate at a maximum rate of 8 lbs a.e./acre, a factor of 3.5 higher than the central

[14] Information in this section is from the aminopyralid risk assessment (SERA TR-052-04-04a) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/062807_Aminopyralid.pdf.

[15] Information in this section is from the glyphosate risk assessment (SERA TR-052-22-03b) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/Glyphosate_SERA_TR-052-22-03b.pdf.

application rate of 2 lbs a.e./acre. This has essentially no impact of the risk characterization for workers.

The highest hazard quotient for an application rate of 8 lb a.e/acre is 8 for the unlikely scenario of an accidental acute exposure of a child consuming water where the herbicide was spilled. This exposure scenario is highly arbitrary. The accidental spill scenario assumes that a young child consumes contaminated water shortly after an accidental spill of a field solution into a small pond. Because this scenario is based on the assumption that exposure occurs shortly after the spill, no dissipation or degradation is considered. Since this exposure scenario is based on assumptions that are somewhat arbitrary and highly variable, it may overestimate exposure. The actual chemical concentrations in the water will vary according to the amount of compound spilled, the size of the water body into which it is spilled, the time at which water consumption occurs relative to the time of the spill, and the amount of contaminated water consumption. To reflect the variability inherent in this exposure scenario, a spill volume of 100 gallons (range of 20-200 gallons) is used to reflect plausible spill events. The glyphosate concentrations in the field solution are also varied to reflect the plausible range of concentrations in field solutions—i.e., the material that might be spilled. Based on these assumptions, the estimated concentration of glyphosate in a small pond ranges from about 0.36 to about 18 mg/L,with a central estimate of about 4.5 mg/L. Glyphosate may be extensively bound to some types of soils. This binding is not considered in the accidental spill scenario and thus the concentrations that might be seen following a spill could be overestimated for some types of soils. Estimates of longer-term consumption of contaminated water are based on estimated application rates throughout a watershed; however, only small portions of a watershed would be treated. This exposure scenario is extreme to the point of limited plausibility. This sort of scenario is routinely used in Forest Service risk assessments as an index of the measures that should be taken to limit exposure in the event of a relatively large spill into a relatively small body of water. For glyphosate, as well as for most other chemicals, this exposure assessment indicates that such an event would require measures to ensure that members of the general public do not consume contaminated water.

At the highest application rate that might be used in Forest Service programs, the accidental spill scenario is the only other scenario that results in a hazard quotient above unity. At this application rate, the associated dose is about 14 mg/kg, which is still below the dose of 184 mg/kg associated with no apparent overt effects in humans by a factor of over 10.

From a practical perspective, the most likely accidental exposure for workers that might require medical attention involves accidental contamination of the eyes. Glyphosate and glyphosate formulations are skin and eye irritants. Quantitative risk assessments for irritation are not normally derived, and, for glyphosate specifically, there is no indication that such a derivation is warranted. Glyphosate with the POEA surfactant is about as irritating as standard dish washing detergents, all-purpose cleaners, and baby shampoos. As with the handling of any chemical, including a variety of common household products, reasonable care should be taken to avoid contact of skin and eyes.

For members of the general public, none of the longer-term exposure scenarios exceed or even approach a level of concern, with the exception of consuming contaminated vegetation (HQ 5) for the upper limits of exposure. That scenario assumes the vegetation is completely soaked in the herbicide and immediately eaten. Because this scenario is highly implausible combined with the project design features which specifically alert the public to areas that are treated (see PDF-HH-8), the level of concern for this scenario is considered low.

Although there are several uncertainties in the longer-term exposure assessments for the general public, the upper limits for hazard indices are below a level of concern by factors of about 25 (longer term consumption of contaminated fruit) to over two million (2,500,000 for longer-term consumption of fish by the general population). The risk characterization is thus relatively unambiguous: based on the available information and under the foreseeable conditions of application and exposure, there is no route of exposure or exposure scenario suggesting that the general public will be at risk from longer-term exposure to glyphosate. As with the hazard characterization for workers, an application rate of 8 lbs a.e./acre makes no difference in the assessment of potential risks.

Sensitive Subgroups: No reports were encountered in the literature leading to the identification f sensitive subgroups. There is no indication that glyphosate causes sensitization or allergic responses, which does not eliminate the possibility that some individuals might be sensitive to glyphosate as well as many other chemicals.

3.3.3 Imazapyr[16]

For both workers and members of the general public, the chronic 10 RfD of 2.5 mg a.e. /kg bw/day is used to characterize risks associated with both acute and longer-term exposures. All exposure assessments for terrestrial applications are based on the unit application rate of 0.45 lb a.e./acre and for aquatic imazapry an application rate of 1.0 lb a.e./acre.

Imazapyr is somewhat unusual in that doses which may cause adverse effects have not been determined. Thus, the interpretation of HQs that exceed a value of 1 would be unclear. This is not a practical concern in this risk assessment on imazapyr because none of the HQs exceed a value of 1 at an application rate of 1 lb a.e./acre and no exposures substantially exceed the HQ of 1 at the 20 maximum application rate of 1.5 lb a.e./acre. Consequently, there is no basis for asserting that imazapyr is likely to pose any identifiable risks associated with systemic toxic effects to either workers or members of the general public.

Irritation to the eyes can result from exposure to concentrated solutions of imazapyr. From a practical perspective, eye irritation is likely to be the only overt toxic effect as a consequence of mishandling imazapyr, and these risks are likely to be greatest for workers handling concentrated solutions of imazapyr during cut surface treatments. The potential for eye irritation can be minimized or avoided by prudent industrial hygiene practices, including, exercising care to reduce splashing and wearing goggles, during the handling of the compound.

The risk characterization for workers is simple and unambiguous: there is no basis for asserting that workers are likely to be at risk in applications of imazapyr. The highest HQ for general exposures—i.e., exposure levels anticipated in the normal use of imazapyr —is 0.06, the upper bound of the HQ for workers involved in ground broadcast applications of imazapyr. If the RfD of 2.5 mg/kg bw/day (HQ=1) is taken as the level of concern, this HQ is associated with a dose which is below the level of concern by a factor of about 17. The highest accidental HQ is 0.01, the upper bound of the HQ for a worker wearing contaminated gloves for 1 hour.

Some cut surface applications may involve handling highly concentrated solutions of imazapyr (i.e., up to about 480 mg a.e./L), which are more concentrated than imazapyr solutions used in

[16] Information in this section is from the imazapyr risk assessment (SERA TR-052-29-03a) and can be found online at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf.

foliar applications (24 mg a.e./L) by a factor of about 20. The highest HQ for workers involved in foliar or aquatic applications is 0.01 associated with wearing contaminated gloves for 1 hour. If a worker involved in hack and squirt applications were to apply a 480 mg a.e./L solution of imazapyr and wear contaminated gloves for 1 hour, the corresponding HQ would be about 0.2, below the level of concern by a factor of 5. Because the exposure period is directly proportional to the HQ, the HQ for gloves contaminated by a 480 mg a.e./L solution of imazapyr would reach a level of concern (HQ=1) at 5 hours. However extreme this exposure scenario may seem, it would seem prudent to caution workers who use highly concentrated solutions of imazapyr to exercise particular caution to prevent prolonged skin contact with the concentrated solutions.

The risk characterization for members of the general public is essentially identical to the risk characterization for workers: there is no basis for asserting that members of the general public are likely to be at risk due to applications of imazapyr. Based on the RfD of 2.5 mg/kg bw/day, the highest HQs are those associated with an accidental spill of imazapyr into a small pond and the subsequent consumption of contaminated water by a small child. For this exposure scenario the HQs are 0.07 (0.002 to 0.8) for both terrestrial and aquatic applications. This accidental spill scenario is used consistently in Forest Service risk assessments simply to serve as a guide in the case of a substantial accidental spill. For imazapyr as well as most other chemicals, a large spill into a small body of water should lead to steps to prevent the consumption of the contaminated water. Nonetheless, the current risk assessment suggests that only very severe accidental spills would approach a level of concern. The dose of imazapyr that might actually pose a risk to humans has not been determined. The RfD of 2.5 mg/kg bw/day may be regarded as a dose that will not lead to adverse effects in humans; however, the same may be said for higher doses of imazapyr. The RfD of 2.5 mg/kg bw/day is used as a convenience to quantitatively illustrate that the use of imazapyr is not likely to pose any identifiable risk to humans.

The highest HQ for members of the general public associated with expected (i.e., non-accidental) exposure scenarios is 0.5, the upper bound of the acute HQ for the consumption of contaminated vegetation. For any pesticide applied directly to vegetation, this is an extraordinarily conservative exposure scenario which typically leads to HQs that exceed the level of concern. For imazapyr, no risks can be identified.

Sensitive Subgroups: No hazards to members of the general population associated with exposure to imazapyr have been identified. Because no mechanism of toxicity for imazapyr in humans can be identified, subgroups within the human population that might be sensitive to imazapyr cannot be identified.

3.3.4 Metsulfuron methyl[17]

Typical exposures to metsulfuron methyl do not lead to estimated doses that exceed a level of concern. For workers, no exposure scenarios, acute or chronic, exceeds the RfD even at the upper ranges of estimated dose. For members of the general public, all upper limits for hazard quotients are below a level of concern. Thus, based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from acute or longer term exposures to metsulfuron methyl.

[17] Information in this section is from the Metasulfuron methyl risk assessment (SERA TR 04-43-17-01c) and can be found online at: https://www.fs.fed.us/foresthealth/pesticide/pdfs/120904_Metsulfuron.pdf

Irritation to the skin and eyes can result from exposure to relatively high levels of metsulfuron methyl. From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling metsulfuron methyl. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of the compound.

Exposures and the subsequent hazard quotients are based on the typical application rate of 0.03 lb a.e./acre and the "level of concern" is one – i.e., if the hazard quotient is below 1.0, the exposure is less than the RfD. For all exposure scenarios, the estimated dose scales linearly with application rate. Thus, at an application rate of 0.15 lb a.e./acre, the highest application rate contemplated by the Forest Service, the level of concern would be 0.2 – i.e., 0.03 lb/acre ÷ 0.15 lb/acre. The highest hazard quotient for workers is 0.02 – the upper range for directed ground spray. Thus, even at the highest application rate that might be used in Forest Service programs, the upper range of hazard quotients is below the level of concern. It should be noted that confidence in these assessments is diminished by the lack of a worker exposure study and the lack of experimental data on the dermal absorption kinetics of metsulfuron methyl. Nonetheless, the statistical uncertainties in the estimated dermal absorption rates, both zero-order and first-order, are incorporated into the exposure assessment and risk characterization.

While the accidental exposure scenarios are not the most severe one might imagine (e.g. complete immersion of the worker or contamination of the entire body surface for a prolonged period of time) they are representative of reasonable accidental exposures. None of these hazard quotients approach a level of concern at the upper ranges, even when considering the level of concern associated with an application rate of 0.15 lbs a.e./acre – i.e., a level of concern of 0.2. The simple verbal interpretation of this quantitative characterization of risk is that under the most protective set of exposure assumptions, workers would not be exposed to levels of metsulfuron methyl that are regarded as unacceptable so long as reasonable and prudent handling practices are followed.

Like the quantitative risk characterization for workers, the quantitative risk characterization for the general public is expressed as the hazard quotient using the acute RfD of 0.25 mg/kg/day for acute/short term exposure scenarios and the chronic RfD of 0.25 mg/kg/day chronic or longer term exposures. Although there are several uncertainties in the longer-term exposure assessments for the general public, the upper limits for hazard quotients associated with the longer-term exposures at an application rate of 0.03 lbs/acre are sufficiently below a level of concern. Thus, the risk characterization is relatively unambiguous: based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that the general public will be at any substantial risk from longer-term exposure to metsulfuron methyl even if the level of concern is set to 0.2 – i.e., that associated with the maximum application rate of 0.15 lbs/acre that will be used in Forest Service programs.

For the acute/accidental scenarios, none of the central estimates representing typical exposures exceed the RfD. Exposure resulting from the consumption of contaminated water is of greatest concern. The estimate of the upper range of exposure resulting from the consumption by a child of contaminated water from a small pond immediately after an accidental spill is below the level of concern at the maximum application rate of 0.15 lbs/acre– i.e., a hazard quotient of 0.1 and a level of concern of 0.2. This is an extremely conservative scenario that typically results in an excursion above the RfD. This is not the case with metsulfuron methyl.

Sensitive Subgroups: There is no information to suggest that specific groups or individuals may be especially sensitive to the systemic effects of metsulfuron methyl. Due to the lack of data in humans, the likely critical effect of metsulfuron methyl in humans cannot be identified clearly. In animals the most sensitive effect of metsulfuron methyl appears to be weight loss. However, there is some suggestion that metsulfuron methyl may influence blood glucose levels and cholesterol regulation. If exposure levels were sufficient to induce decreases in serum glucose, individuals taking medication to lower serum glucose could be at increased risk. Nonetheless, this exposure scenario is highly implausible.

3.4 Alternative 1 – No Action - No Herbicides

3.4.1 Direct, Indirect and Cumulative Effects

No herbicide treatments are proposed with Alternatives 1 with the exception of very minor (less than 20 acres per year) at administrative sites and recreation sites as approved by a Decision Memo signed in October 2016 for Categorical Exclusions (36 CFR 220.6 (d)) on the four ranger districts and one national monument; therefore, there would be a very limited direct, indirect, or cumulative effects to human health related to herbicide use. Any effects to this minor use are analyzed in Alternatives 2 and 3.

3.5 Alternatives 2 and 3 – Adaptive Management Strategy, Herbicide Use

These alternatives proposes an integrated pest management approach, using all available treatment methods (manual, mechanical and chemical) in combination with an early detection and rapid response (EDRR) system of treatment within the project area. Early detection-rapid response is part of both action alternatives, and is considered in this direct, indirect and cumulative effects analysis.

Herbicide treatments would be applied in accordance with label advisories, USDA Forest Service policies, Forest Plan management direction, human health and ecological risk assessments, and applicable project design features (PDFs) identified in this document to minimize or eliminate the potential for invasive plant management to adversely affect human health.

The effects analysis for these alternatives are specific to the use of herbicides.

The difference between Alternative 2 and 3 is that Alternative 2 proposes to use the lowest and central application rates, according to label advisories. Alternative 3 proposes to use the full range of application rates per the label advisory, from the lowest to the highest. The effects of these two alternatives are the same for both alternatives.

3.5.1 Direct and Indirect Effects

The SERA Herbicide Risk Assessments include analysis for both workers and the general public. None of the four herbicides proposed for use in this project pose risk to workers and the public, based on the risk assessment quantitative analysis.

Direct and Indirect Effects to Workers

This section focuses on the risks of proposed herbicide application to applicators themselves. Herbicide applicators are more likely than the general public to be exposed to herbicides, and may handle undiluted herbicide concentrate during mixing and loading. In routine broadcast and spot applications, workers may contact and internalize herbicides mainly through exposed skin, but also through the eyes, mouth, nose or lungs. Worker exposure is influenced by the application rate selected for the herbicide, the number of hours worked per day, the acres treated per hour, and variability in human dermal absorption rates.

All herbicides can cause irritation and damage to the skin and eyes if mishandled. Eye or skin irritation would likely be the only overt effect because of mishandling these herbicides. These effects can be minimized or avoided by prudent industrial hygiene practices during handling. Worker exposure can be effectively managed through ordinary prudent practices and use of personal protective equipment (PPE) required for applicators.

Appendix A - Human Health Risk Assessment for the four proposed herbicides summarize risks for backpack and broadcast spraying under the full range of application rates and typical exposures. Exposure levels that were evaluated range from predicted average exposure to worst-case exposure. Risks from accidental/incidental exposures are also displayed. Backpack spray exposures assume that workers on average treat a little more than four acres per day (ranging from 1.5 to 8 acres per day) and broadcast spray exposures assume that workers average 112 acres per day (ranging from 66 to 168 acres per day). For all scenarios, it is assumed that the workers do not receive any protection from exposure provided by clothing. Both of these assumed scenarios are represent atypical treatment scenarios for this project. In all cases, personal protection clothing will be used and in most cases, applications by both spot spray and broadcast spray will be far less per day for the average treatment scenario in the northern Tongass.

Accidental worker exposures are most likely to involve splashing a solution of herbicides into the eyes or on the skin. Two general types of exposure are modeled: one involving direct contact with a solution of the herbicide and another associated with accidental spills of the herbicide concentrate onto the surface of the skin. Exposure scenarios involving direct contact with herbicide solutions are characterized by immersing unprotected hands for 1 minute or wearing contaminated gloves for 1 hour. Workers are not likely to immerse their hands in herbicide; however, the contamination of gloves or other clothing is possible.

Exposure scenarios involving chemical spills onto the skin are characterized by a spill onto the lower legs as well as a spill onto the hands. In these scenarios, it is assumed that a solution of the chemical is spilled onto a given surface area of skin and that a certain amount of the chemical adheres to the skin. Surfactants or other adjuvants could be used according to label and PDF-HH-9. Many surfactants could cause eye irritation.

The maximum rates proposed for use in the project were evaluated for this EA (Risk Assessment Worksheets, tabs E02 and E04). All of the herbicides proposed for use have low potential to harm workers. In all cases, even when maximum rates and upper exposure estimates were considered, HQ values were below the threshold of concern (HQ values below 1).

Direct and Indirect Effects to the Public

The general public is unlikely to be exposed to high levels of any herbicides used in the implementation of this project. The SERA Risk Assessments considered several exposure scenarios including direct contact, consumption of sprayed vegetation, consumption of drinking water adjacent to a spray operation, and consumption of fish in water adjacent to a spray operation. Accidental exposures including drinking water from a pond contaminated by a large spill were also considered. No reportable spills have occurred on similar projects in Region 10. An additional level of caution is the requirement for usage of herbicides in this project is a District-level Herbicide Safety Plan which prevents spills from occurring or becoming large.

Direct Contact: Exposure is quantified from direct spray and contact with sprayed vegetation scenarios. At the maximum application rates proposed in any alternative, low risk to human health are indicated from direct contact. No scenarios for direct spray or contact with sprayed vegetation resulted in HQs greater than 1. PDF-HH-8 include specific notification and posting requirements for administrative and recreation sites to further reduce the possibility of inadvertent direct spray of a member of the public.

Indirect Contact: Quantitative estimates of exposure were conducted for an adult female swimming for 1 hour in water contaminated by runoff from a treated 10-acre slope. All herbicides had HQs orders of magnitude below 1 for this scenario, indicating no plausible risk to the public from this exposure.

Eating Contaminated Vegetation or Fruit: The public could be exposed to herbicide if they eat contaminated vegetation or fruit after spraying, such as berries, mushrooms, or other plants. Directly sprayed plant materials would likely show signs of either dye or herbicide damage, reducing the likelihood they would be consumed. Non-target berries or mushrooms could also be contaminated by drift or uptake from the soil, which would result in lower herbicide residues than direct spraying. The risk assessments considered both one-time acute exposure (eating 1 pound) and chronic 90 day consumption scenarios for eating contaminated vegetation and fruit. These scenarios also approximate the effects of eating other contaminated products, such as mushrooms (Durkin and Durkin 2005). Only under the highest exposure scenario for eating contaminated vegetation (a highly implausible scenario) did HQ exceed 1 for glyphosate (HQ 5) at the highest application rate. This scenario (e.g. eating one pound or more of contaminated vegetation) is highly improbable considering the contaminated vegetation will show signs of either dye or herbicide damage, thus a typical adult female will not likely choose to eat vegetation showing these characteristics. All other calculated HQs were many orders of magnitude below the threshold of concern.

Drinking Contaminated Water: Acute and long-term exposures from consumption of contaminated water were evaluated in the risk assessments. Risks from drinking contaminated water were evaluated for an accidental spill as well as water contaminated by runoff. The risk assessments also evaluated an accidental exposure scenario where a small child drinks 1 liter of water from a quarter acre pond, into which the contents of a 200-gallon tank that contains herbicide solution is spilled, immediately following a spill. The District-level Herbicide Safety Plan is the mechanism which prevents spills from occurring or becoming large.

No herbicides resulted in HQs greater than 1 for drinking contaminated water in either acute or chronic scenarios at typical exposures. Only under the central and highest application rate for this exposure scenario for a child drinking contaminated water (a highly implausible scenario) did HQ exceed 1 for glyphosate (HQ 2.0 and 8.0, respectively). All other calculated HQs were many orders of magnitude below the threshold of concern.

Consuming Contaminated Fish: Both acute and long-term exposure scenarios involving the consumption of contaminated fish were evaluated using the herbicide concentrations in the contaminated water scenarios described above. Acute exposure was based on the assumption that an angler consumes fish taken from contaminated water shortly after an accidental spill into a pond. Chronic exposures were assumed to occur over a lifetime of eating contaminated fish. People who subsist on fish (for example Native American Indians) could have higher exposure rates than recreational anglers. However, based on a lifetime of subsistence fish consumption, no HQ values greater than 1 are associated with the herbicide use proposed in any alternative.

Glyphosate and Cancer: Many recent articles have circulated announcing that in March 2015, the International Agency for Research on Cancer (IARC) has categorized glyphosate as “probably carcinogenic to humans.” This is not based on new studies; the studies that were used in IARC’s designation have been out a long time. The SERA 2011 Glyphosate Risk Assessment thoroughly discusses the carcinogenic, mutagenic, and genotoxic potential for glyphosate, using many of the same studies reviewed by the IARC.

In 2014, EPA reviewed over 55 epidemiological studies conducted on the possible cancer and non-cancer effects of glyphosate. Their review concluded that this body of research does not provide evidence to show that glyphosate causes cancer, and it did not warrant any change in EPA's cancer classification for glyphosate. There are no known recent epidemiological studies since 2015 that refute the studies reviewed in the SERA risk assessment.

Glyphosate is currently approved for continued use under the No Action alternative and is not a first choice in the action alternatives. Best available science indicates that glyphosate proposed for use in this project would not increase anyone's risk of cancer.

Endocrine Disruption

The potential for the proposed herbicides to cause endocrine disruption effects was addressed in each risk assessment. The United States Environmental Protection Agency has determined that there is no evidence to suggest that metsulfuron methyl has an effect on the endocrine system (SERA 2004). Based on the chronic bioassays and several additional subchronic bioassays in mice, rats, dogs, and rabbits, there is no basis for asserting that aminopyralid would cause adverse effects on the immune system or endocrine function (SERA 2007).

The glyphosate risk assessment (SERA 2011) stated that "some recent studies raise concern that glyphosate and some glyphosate formulations may be able to impact endocrine function through the inhibition of hormone synthesis (Richard et al. 2005; Benachour et al.2007a, b), binding to hormone receptors (Gasnier et al. 2009), or the alteration of gene expression (Hokanson et al. 2007)" (all references as cited in SERA 2011). Evaluation of the studies indicates that endocrine disruption effects were indicated for surfactants in the formulations rather than glyphosate itself. A commercial surfactant would be added to glyphosate when preparing the solution for application, but the surfactant type of choice is methylated seed oil/crop oil concentrate, which is typically a corn oil derivative and not implied in causing endocrine effects. No POEA or NPE based surfactants would be used – these being the culprit in terrestrial glyphosate formulations.

In the review of the mammalian toxicity data on imazapyr, U.S. EPA Office of Pesticide Programs concluded that "there was no evidence of estrogen, androgen and/or thyroid agonistic or antagonistic activity shown." SERA found that this conclusion was reasonable, based on their review of current information in the 2011 imazapyr risk assessment.

While the potential for the proposed herbicides to cause endocrine disruption effects is a current data gap, the potential for these effects are to actually occur are greatly reduced by measures such as required use of proper protective equipment, public notification, use of licensed applicators, and limited application rates (PDFs).

Multiple Chemical Sensitivity

The following information was adapted from USDA 2012, Gypsy Moth Management in the United States, a Cooperative Approach. Some people feel that they suffer from Multiple Chemical Sensitivity (MCS), which is sometimes referred to as Idiopathic Environmental Intolerances (IEI). In general, individuals with MCS report that they experience a variety of adverse effects as a result of very low levels of exposure to chemicals (including herbicides) that are generally tolerated by individuals who do not have MCS.

Forest Service risk assessments incorporate an uncertainty factor of 10 to account for sensitive individuals, which may or may not eliminate risk that an individual may suffer symptoms. However, the uncertainty factor for sensitive individuals addresses variability in tolerances within a normal population.

Individuals reporting MCS assert, either explicitly or implicitly, that they are atypically sensitive. There is no current consensus on the diagnosis and cause of MCS. Until the etiology and pathogenesis of MCS has been clarified, an organic cause of the MCS-associated symptoms and symptom complexes cannot be entirely ruled out. The Forest Service has no way to resolve concerns for MCS at the project level.

3.5.2 Cumulative Effects

Workers and the public may be exposed to the herbicides used to treat invasive plants under all alternatives in this project. Cumulative doses are possible within the context of this project, or when combined with herbicide use on adjacent lands or home use by a worker or member of the general public. However, the risk is very small that a person would receive additive exposures during the time period in which the herbicide remained in their body.

The PDF and label restrictions for all Alternatives would apply to any herbicide use on the Forest, whether as a stand-alone project or in conjunction with other land uses (for instance treatment along a road intended to be used for a vegetation management project). The SERA Risk Assessments evaluated chronic exposure scenarios that would involve the public, including repeated drinking of contaminated water, repeated consumption of contaminated berries, and repeated consumption of contaminated fish.

The potential for cumulative human health effects from any herbicide use proposed in this EA, combined with other potential herbicide applications in the analysis area, would be encompassed in the health risks estimated for chronic exposure scenarios. These herbicides do not bio-accumulate in people and are rapidly eliminated from the body. Chronic (daily over 90-days) worker exposure was considered in SERA.

Risk Assessments did not result in HQ values greater than 1 for any "central"[18] estimate of chronic exposure for any of the proposed herbicide. The central application rate would be used for most treatments, with very few exceptions.[19] Of the known herbicide use on adjacent lands, some may pose greater risk to workers or the public than the herbicide use proposed for this project, especially on State Highways. However, the State of Alaska Highway Division in Southeast Alaska is not currently using herbicides for vegetation management along road corridors (per. com. DOT 2017). Therefore, the potential contribution to cumulative pesticide use by any alternative is not significant. The small and scattered nature of the infestations make it unlikely that exposures exceeding a level of concern would occur from simultaneous herbicide treatments on Forest Service and other lands.

In the R6 2005 FEIS they considered the potential for synergistic effects of exposure to two or more chemicals: "Combinations of chemicals in low doses (less than one tenth of RfD) have rarely demonstrated synergistic effects. Review of the scientific literature on toxicological effects and toxicological interactions of agricultural chemicals indicate that exposure to a mixture of

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[18] The "central" estimate represents the typical application rare.

[19] Use of the highest application rate would primarily occur when treating Japanese knotweed using stem injection or when treating oxeye daisy during flowing using spot spray or broadcast methods.

pesticides is more likely to lead to additive rather than synergistic effects (ATSDR, 2004; U.S.EPA/ORD, 2000). Based on the limited data available on chemical combinations involving the twelve herbicides considered in this EIS, it is possible, but unlikely, that synergistic effects could occur as a result of exposure to the herbicides considered in this analysis. Synergistic or additive effects, if any, are expected to be insignificant."(R6 2005 FEIS p. 4-3).

Workers may be exposed to typical hazards from working in the woods from all treatment methods, especially those using chain saws and other motorized tools. Accidents are correlated with hours worked.

Cumulative effects from the use of herbicides on human health include the potential use of herbicides proposed on non-national forest lands recommended by the weed management plan for the community of Sitka or as part of the yearly activities of special interest groups, such as the Juneau Cooperative Weed Management Area. Additionally workers and the general public within the project area could use some of the proposed herbicides outside the project area for personal activities (e.g., treating weeds on their own property).

Glyphosate likely has the highest risk for cumulative effects because it is the most common herbicide sold to the general public to treat weeds. Currently the Alaska Department of Transportation (ADOT) in Southeast Alaska uses mowing as their treatment method, not herbicides, along the roads they maintain.

To avoid the synergism between glyphosate and adjuvants, Alternatives 2 and 3 propose only aquatically labeled formulations of glyphosate (e.g. Aquamaster®) and low-risk aquatically approved surfactants (e.g. Agri-Dex®, Class Act® NG®, Competitor®.) This feature would eliminate potential impacts from surfactants that have high levels of POEA (since high levels of this chemical also has adverse effects to aquatic wildlife species).

Overall, herbicide use associated with Alternative 2 or 3, even at full implementation, would contribute no measurable effects when combined with the effects of other past, present and reasonably foreseeable future activities. To further minimize the cumulative risk of herbicide use on human health and safety PDFs have been developed and will be implemented as necessary.

3.5.3 Herbicide Treatment Conclusions

The types of herbicide proposed for use are considered to have low toxicity levels and consequently the inherent level of health risk is minimal and readily mitigated through full compliance with worker training requirements, herbicide label stipulations, and PDFs for safe herbicide storage, transportation, use, and disposal.

Herbicide use has no direct beneficial effects to human health and safety. While herbicide use in Alternatives 2 and 3 carry a greater risk of effects than Alternatives 1, it provides an more effective form of treatment for many weed populations and through time its use would decrease as the number of infestations decrease. Combining the EDRR treatment strategy with herbicide while populations are small and scattered is expected to reduce overall treatment costs with less chemical use over the life of the project, and less disturbance due to fewer entries than may be necessary with manual and mechanical treatments.

Potential adverse direct and indirect impacts are addressed for each herbicide and adjuvants (generally). Cumulative effects are addressed for the herbicides generally based on projects that would utilize pesticides nearby and also for individuals that may be exposed to herbicides from other sources. Numerous design features have been added to this alternative to minimize risk and potential harm to human health and safety for workers and the public. Table 4 provides a summary of the ratings of risk to human health and safety based on this analysis.

Table 4. Rating of risk to human health and safety for each herbicide and adjuvants (in general) considered in Alternatives 2 and 3.

Rating of Risk	
Negligible	**Low**
Aminopyralid	Glyphosate
Metasulfuron methyl	Adjuvants
Imazapyr (aquatic and terrestrial)	

3.5.4 Early Detection / Rapid Response (EDRR)

The effect of herbicide treatments on human health under EDRR would not exceed the minimal effect predicted for the average yearly treatment scenario and would be sufficiently minimized by the PDFs regardless of when the treatments occurred. If effective treatments of new infestations required herbicide treatments outside the scope of the project, or if PDFs could not be applied without a significant loss of effectiveness, further analysis would be required.

3.6 Consistency Findings

All alternatives comply with standards, policies, and laws aimed at protecting worker safety and public health. Invasive plant treatments on the Forest are implemented in partnership with the local cities, boroughs and private land owners. Crews generally live in the communities in and around the Forest and are not associated with any discrete minority or low-income population. Herbicide treatment applicators are well trained in safe herbicide handling and transportation practices. The worker health analysis above applies to any herbicide applicator.

Effects to minority groups (such as Native Alaskans) who gather or use plants, animals or are the same as those evaluated above for public herbicide exposure. These groups are unlikely to be more affected by herbicide exposure than the results provided for the general public, given the assumptions in the public health analysis. Chronic exposures to some of the herbicides proposed for use exceeded a threshold of concern, and HQ values were less than 1 for all but unlikely upper estimates (which are not realistic even for people who spend the most time gathering forest projects).

Posting of treatment sites would be especially important in areas of special forest product or wild food gathering. Thus, this project would not result in disproportionate impacts to low income or minority groups.

3.7 Design Features and Mitigation Measures for Alternatives 2 and 3

The Project Design Features (PDFs) listed below apply to the use of herbicides and constrain the rate and method of herbicide use to such a degree that the likelihood of adverse effects occurring is low. Adverse effects from acute, multiple or chronic exposures are unlikely. Chronic exposures do not exceed thresholds of concern because the proposed herbicides are excreted from organisms so rapidly that they do not accumulate over time, or are used at such low application rates, in a selective manner, that overexposure if unlikely.

The PDFs limit the mechanisms by which workers, the public, non-target plants, wildlife and fish may be exposed to herbicides. The PDFs were developed considering the risks and properties of the herbicides proposed for use. Herbicide selection and/or methods are restricted depending on the toxicity, mobility, and persistence of each chemical applied to a range of site conditions. The PDFs sufficiently minimize risks to compensate for inherent uncertainty about the impacts of herbicide use on neighboring lands.

1. At a minimum, only certified personnel or those under the supervision of a certified applicator will be allowed to use restricted-use pesticides (FSM 2154.2; USFS 1994b).
2. The Herbicide Transportation, Handling, and Emergency Spill Response Plan and spill kit will be on-site when herbicide treatments occur. This Plan will include reporting procedures, project safety planning, methods of clean-up of accidental spills, and information including a spill kit's contents and location as noted in Forest Service Manual (FSM) 2150, Pesticide-Use Management and Coordination and Handbook (FSH) 2109.14 (USFS 1994a).
3. No more than daily use quantities of herbicides will be transported to the project site. The exception is for crews staging in remote locations. Under these circumstances, crews can bring sufficient quantities of herbicides to last for the planned duration of the field work (i.e., multiple days).
4. Equipment used for transportation, storage, or application of herbicides will be maintained in a leak-proof container.
5. Herbicide containers must be secured to prevent tipping during transport.
6. To reduce the potential for spills, impervious material, such as a bucket or plastic, will be placed beneath mixing areas to contain any spills associated with mixing/refilling.
7. Immediate control, containment, and cleanup of fluids and herbicides due to spills or equipment failure (broken hose, punctured tank, etc.) will be implemented. All contaminated materials will be disposed of promptly and properly to prevent contamination of the site. All hazardous spills will be reported immediately to the Forest Hazardous Spill Coordinator.
8. Herbicide spray equipment will not be washed or rinsed within 150 feet of any body of water or stream channel. All herbicide containers and rinse water will be disposed of in a manner that would not cause contamination of waters.
9. This project will use only low-risk aquatically approved surfactants (e.g. Agri-Dex®, Class Act® NG®, Competitor®).
10. Mixing and loading of herbicide(s) will take place a minimum of 150 feet from any body of water or stream channel unless prior approval is obtained from a Forest Service hydrologist or biologists.
11. Timely public notification of treatment areas will be provided to the public through news releases and/or postings at treatment sites.

3.8 Cost Effectiveness

Cost analysis for each alternative is addressed in a separate resource report (Krosse 2018a).

3.9 Summary of Effects

Herbicide use in Alternatives 2 and 3 has no direct beneficial effects to human health and safety. While herbicide use does carry a greater risk of effects than Alternatives 1, it provides an effective form of treatment for many invasive plant populations. By treating the project area infestations early, while populations are small and scattered, and by allowing the use of the most effective and efficient treatment methods, overall treatment costs are reduced with less chemical use over the life of the project, and less disturbance by avoiding repeated treatments necessary with manual and mechanical methods.

Potential adverse direct and indirect impacts are addressed for each herbicide and adjuvants (generally). There would be indirect beneficial impacts by successfully removing invasive and non-native plants that could encroach on native plant habitat reducing wildlife forage, and could cause the impairment of watershed health. Cumulative effects are addressed for the herbicides generally based on projects that would utilize pesticides nearby and also for individuals that may be exposed to herbicides from other sources. Numerous design features have been added to this alternative to minimize risk and potential harm to human health and safety for workers and the public.

4 Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

- All projects involving applications of herbicide on Forest Service land require approval of a Pesticide Use Proposal (PUP). The PUP process ensures compliance with Forest Service policy and applicable laws. It also may identify additional site- or project-specific requirements.
- Where a project evaluation indicates potential for over-water application (including seasonally flooded, temporarily flooded, or saturated riparian wetland sites), the Forest Service would be required to apply for a permit with the Alaska Department of Environmental Conservation (ADEC) per regulation 18 AAC 90.505 (ADEC 2013). Additionally, implementation of any herbicide applications to and near waters of the U.S. would require approval of a Pesticide General Permit by the EPA.
- Forest Plan Standards and Guidelines for Pesticide Use and Vegetation Management (USDA Forest Service 2008, p 4-75)
- Pesticide use is not prescribed in the Forest Plan, but may be considered on a case-by-case basis. Biological, environmental, and economic costs and benefits of pesticide use are to be identified and weighed prior to Forest Service use of pesticides on the Forest.
- Pesticides will be employed only after such use has been evaluated in an environmental analysis and approved by the Forest Service officer with delegated authority.
- When pesticide use is judged necessary, selection and application will be based on the following guidelines:
    - Those application methods and formulations will be used that are most effective in suppressing the pest, most specific to the target organisms, and least harmful to non-target components of the environment.
    - In operational pest management programs, only those pesticides that are registered in accordance with the federal Insecticide, Fungicide and Rodenticide Act, as amended, will be used, except as otherwise provided in regulations issued by the Environmental Protection Agency or the Department of Agriculture.

- Application will be restricted to the minimal effective dosage that, when precisely applied to the target area at optimum times, will accomplish the resource management objectives.

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Appendix A - Exposure scenario results from Forest Service analysis for humans using typical application rates.

Human Health Hazard Quotients (HQs) associated with various exposures to herbicides.

Symbol meanings are as follows:
-- Exposure scenario results in a dose below the toxicity index.
★ Exposure scenario results in a dose that exceeds the toxicity index.

Human/Scenario	**Aminopyralid (0.078 lb. – 0.11 a.e./acre)**	**Glyphosate – Aquatic (0.5 - 8 lb. a.e./acre)**	**Imazapyr (0.03 – 1.5 lb .a.e./acre)**	**Imazapyr Aquatic (0.03 – 1.5 a.e./acre)**	**Metsulfuron methyl (0.00125 – 0.15lb. a.e./acre)**
ACUTE EXPOSURES					
Worker: Contaminated Gloves, 1 min.	--	--	--	--	--
Worker: Contaminated Gloves, 1 hour	--	--	--	--	--
Worker: Spill on Hands, 1 hour	--	--	--	--	--
Worker: Spill on lower legs, 1 hour	--	--	--	--	--
Direct Spray of Child, whole body	--	--	--	--	--
Direct Spray of Adult Female, feet and lower legs	--	--	--	--	--
Water consumption of Child (spill)*	--	--	--	--	--
Fish consumption of Adult Male (spill)	--	--	--	--	--
Fish consumption of Subsistence Populations (spill)	--	--	--	--	--
ACUTE EXPOSURES					
Worker	--	--	--	--	--

Human/Scenario	Aminopyralid (0.078 lb. – 0.11 a.e./acre)	Glyphosate – Aquatic (0.5 - 8 lb. a.e./acre)	Imazapyr (0.03 – 1.5 lb .a.e./acre)	Imazapyr Aquatic (0.03 – 1.5 a.e./acre)	Metsulfuron methyl (0.00125 – 0.15lb. a.e./acre)	
ACUTE EXPOSURES						
Vegetation Contact on Adult Female, shorts and T-shirt	--	--	--	--	--	--
Contaminated Fruit eaten by Adult Female	--	--	--	--	--	--
Contaminated Vegetation eaten by Adult Female	--	**	--	--	--	--
Swimming, one hour by Adult Female	--	--	--	--	--	--
Water consumption by Child	--	**	--	--	--	--
Fish consumption by Adult Male	--	--	--	--	--	--
Fish consumption by Subsistence Populations	--	--	--	--	--	--
CHRONIC/LONG TERM EXPOSURE						
Contaminated Fruit eaten by Adult Female	--	--	--	--	--	--
Contaminated Vegetation eaten by Adult Female	--	--	--	--	--	--
Water consumption by Adult Male	--	--	--	--	--	--
Fish consumption by Adult Male	--	--	--	--	--	--
Fish consumption by Subsistence Populations	--	--	--	--	--	--

*HQ for accidental water consumption of a child is 8 at the highest application rate. HQ for this scenario is <1 for lowest and 1.4 for the central application rates as shown here. HQ for non-accidental consumption of contaminated vegetation by a female is <1 for the lowest and central application rates and 5 for the highest application rate.