Introduction

The purpose of this report is to complete additional analysis of effects for Alternative 3 of the *North Zone Integrated Weed Management Plan Environmental Assessment*. Alternative 3 is different from Alternative 2 only with regard to the following items:

1) a higher application rate for glyphosate, imazapyr and metsulfuron methyl (Table 1), using the initial analysis completed by Rick Turner (2018) as the basis to evaluate whether effects would differ. There is no change in the application rate to aminopyralid and therefore no additional analysis.
2) herbicide would be allowed below the mean high tide line, however, this will not be included in this report as the change has no bearing on the effects to rare or sensitive plants
3) no buffer for broadcast spray to water's edge will not be included in this report as the change has no bearing on the effects to rare or sensitive plants

Table 1: Application rates for the proposed herbicides

Herbicide	Range (lbs a.e./acre)
glyphosate	0.5 – 8.0 (2.0 typical)
imazapyr	0.03 – 1.5 (0.45 typical)
aminopyralid	0.047 – 0.11 (0.078 typical)
metsulfuron methyl	0.0125 – 0.15 (0.03 typical)

Under the proposed alternative, all tools would be evaluated to determine the best approach given the Land Use Designation (LUD) management direction (e.g. wilderness or research natural area compared to a development LUD) as described in Alternative 3 of the EA. This Botany BE and Rare Plant Resource Report addendum analyzes for the change in application rates to determine if the effects determinations are different between the two alternatives that include herbicide.

Application Rates

With regard to the application rate of the four proposed herbicides selected for analysis, the biology of the target plant coupled with the timing of treatment and the application method will help determine the most effective treatment. Low to typical rates (Table 1) would be utilized in the majority of the current treatment conditions: Prior to flower, the typical rate of aminopyralid for treating hawkweed (*Hieracium* sp) and other composites is appropriate. The application rate for reed canarygrass is typically 2 lbs a.e./acre in all settings.

The higher rates commonly utilized to treat composites after they flower (aminopyralid 0.11 lbs a.e./acre) and foliar spray of knotweed (2% or 3.9 lbs a.e./acre glyphosate) follow the recommended rates listed on the label. The recommended label application rate of imazapyr for a horticultural variety of reed canarygrass – ribbongrass, and yellow flag iris, is 1 lb a.e./acre.

The only currently known use for the high rate of glyphosate (up to 8 lbs a.e./acre) would be for stem injection of large patches of knotweed in settings where community members do not approve of spray.

Analysis Methods

SERA reports were developed to evaluate herbicide movement within the environment in an agricultural setting and the risk to organisms based on existing studies. The reports are utilized to assess the risk of herbicide in the scenario where the application rate is sprayed over an entire acre. Data is presented for both sensitive and tolerant terrestrial plants. The numbers generated in the SERA report identify potential concerns. The analysis of effects based on application methods on the Tongass National Forest evaluates whether or not these areas of concern have a potential effect in the project area. This analysis utilizes the literature and local application methods.

Hazard quotients (HQ) are utilized as a metric for comparing the toxic level relative to a reference concentration. An HQ<1 indicates a negligible detection of the chemical, whereas a HQ of 1-10 indicates that the chemical was detected. Typically a HQ>10 indicates that there is a greater level of concern and implications should be critically evaluated (Shawna Bautista pers comm 2019).

The four herbicides proposed for use in the project have varying effects on terrestrial plants based on the mechanism in which the chemical interacts with the plant. In line with the initial analysis (Turner 2018), the three with adjusted application rates – glyphosate, imazapyr and metsulfulron methyl - will be evaluated based on evaluating mechanisms in which the chemical would reach non-target terrestrial plants: spray drift, surface runoff, wind erosion and soil percolation (the rate for aminopyralid is unchanged). The information provided by the SERA report, developed under specific conditions, will then be evaluated based on treatment methods and site conditions within the project area.

Project Design Features

- Forest Plan (2016) provides for a 60’ buffer around all R10 Sensitive plant species where no herbicide may be applied unless approved by the District Ranger.
- No broadcast spray within 120’ of rare or sensitive plants.
- Sensitive and rare plant surveys will be conducted as needed at the proper time of year by a qualified botanist. Any needed project design features will be specified at that time.
- Herbicide may not be applied when precipitation is expected before the treatment has dried or until after the vegetation has dried following precipitation events.
- Herbicide may not be applied when label wind speed limitations are exceeded, or if no label specification, 7 mph per State of Alaska law.
- Tank pressure and droplet size will be modified as determined by meteorological conditions to minimize drift.

Direct and Indirect Effects

Direct effects include potential direct spray. Indirect effects include potential surface runoff, percolation through the soil, drift and a change in plant communities. The analysis serves the purpose of comparing the effects of Alternatives 2 and 3.

The indirect effect of changing plant community composition by restoring native plants is beneficial in the long-term for any and all treatment types and the appropriate application rates. The goal of invasive plant treatments is to move plant communities toward the desired future condition where “viable populations of native and desired non-native species and their habitat are maintained and are not threatened by invasive species…” (USDA Forest Service 2008 p. 2-1). What follows is an evaluation of effects by herbicide treatment type.

Hand/selective and spot spray methods

For the hand/selective and spot spray application methods, direct and indirect effects are expected to be similar for all herbicides because of the focused small-scale treatment. Alternative 2 was determined to have negligible to minor direct and indirect effects (Turner 2018), as was Alternative 3. What follows is the rationale.

1. Direct contact: Direct effects are largely limited to the target plant(s) for hand/selective methods and expected to be negligible. Spot spray may include non-target plants, and a higher concentration of herbicide correlates with a higher lethality for those non-target plants susceptible to the herbicide active ingredient. The risk, however, is small given the localized application. Effects are expected to range from negligible to minor.
2. Drift: With respect to indirect effects, drift is negligible for hand/selective methods (zero spray methods are used) and negligible to minor with spot spray techniques. Drift is less likely the closer to the ground the application the less likely to experience drift, whereas applications to taller plants such as reed canarygrass may contact adjacent non-target plants. Drift is easily controlled by managing droplet size and pressure controls as well as monitoring meteorological conditions.
3. Surface runoff: The indirect effects of surface water runoff moving the chemical and impacting non-target plants for hand/select methods would be negligible because small quantities of the herbicide are applied directly to the plant, either into the stem, onto the cut stump or onto the leaves. Spot spray has the potential for some droplets to reach the ground; however, the quantity is small. Moreover, application would not occur when rainfall/moisture would wash the chemical off the plants; therefore, effects to non-target plants from runoff are expected to be negligible.
4. Wind erosion: Movement of the chemicals through wind erosion were addressed by Turner (2018). The SERA report evaluates soil movement along the order of 2 tons/acre annually (Durkin 2011), conditions which are not applicable to the temperate rainforest ecosystem. Little exposed mineral soil exists, and the topography and vegetation limits soil movement. Applying herbicide at a higher rate will have no additional indirect effects, and for each herbicide the effect to non-target plants is negligible.
5. Soil percolation: The amount of herbicide that would be introduced into the rooting zone (percolation in soil) would be small for wicking, wiping, foliar application, bark treatment, frilling, hacking, cut-stump methods or spot spray because the density of the target plant is relatively low in a given area. Target plants would move little herbicide into the soil through their roots so effects to non-target plants are expected to be negligible. Stem injection techniques, however, could occur where stem density is high in the case of knotweed. This is rarely the tool of choice, yet if utilized in this scenario, glyphosate may move from the knotweed roots into the rooting zone. This may or may not injure non-target plants, with studies finding no effects ranging to up to 10% of non-target plants injured ranging to rare instances of injury leading to mortality (Hagen and Dunwiddle 2019). Glyphosate is known to adhere to the soil and to be degraded by microbial action (Zhan et al. 2018) which decreases uptake by non-target plants. Because of the soil-glyphosate interaction and the uncertainty regarding potential injury to non-target plants, effects could be minor.

Broadcast spray

Alternative 2 was determined to have negligible to minor direct and indirect effects (Turner 2018), as was Alternative 3. The rationale follows.

1. Direct contact: The direct effects of direct application of a higher concentration correlates with a higher lethality for those non-target plants susceptible to the herbicide active ingredient. The extent of contact with non-target plants increases with the size of the application equipment, ranging from backpack sprayers to truck and trailer mounted equipment. Application techniques can minimize effects to non-target vegetation. Examples include timing treatments *that will be effective* when non-target vegetation is senesced, or during windows when the target species is most sensitive which allows lower application rates that are unlikely to affect most non-target vegetation, or using more intensive practices whereby the foliage of non-target plants is removed prior to herbicide treatment to prevent injury. Direct effects are expected to be minor due to the potential for contact with non-target vegetation combined with techniques that can minimize impacts to non-target vegetation.
2. Drift: An increase in the application rate is positively correlated with an increased range of lethality for all three herbicides – glyphosate, imazapyr and mesulfuron methyl (Durkin 2011, Mistretta 2011, Klotzbach and Durkin 2004). Under the agricultural scenario, all three herbicides did not have negligible HQ's for known sensitive plants within 900' from the application site (ibid). Metsulfuron methyl and glyphosate had measurable concentrations with a HQ <10 outside of 300' while imazapyr did not reach a HQ<10 until 900' (ibid). Tolerant plants reached a HQ <1 for all three chemicals at 25' from the application site (ibid). Kotzbach and Durkin (2004) completed calculations that determined drift from broadcast spray via backpack at 23' under 5 mph wind conditions and 68' under 15 mph wind conditions (100 micron droplet size and a pre-determined 3 second fall rate). This hypothetical scenario is more similar to methods that would be utilized within the project area. Region 6 conducted an informal drift card study when testing the National BMP monitoring protocol for chemical use with back applications. Results found 3-4 droplets within seven feet of target plants (Shawna Buatista pers comm July 18, 2019). Drift can easily be controlled for by droplet size and pressure controls as well as monitoring meteorological conditions. Backpack broadcast spray when correctly applied should have little drift; indirect effects are expected to be minor.
3. Surface runoff: Indirect effects to non-target plants due to surface runoff following broadcast spray are expected to be negligible because of the scale at which application occurs within the project area, the project design features as well as the low level of concern generated from the agricultural-scale SERA report analysis. Movement of the chemicals via surface runoff are largely controlled for by correct application methods. Project design features restrict application of herbicide when there is the risk of herbicide being washed off of leaves and into the soil. Greater than 250" of annual rainfall was modeled in the agricultural setting with metsulfuron methyl to reach a Hazard Quotient greater than one and No Observed Effect Concentration (NOEC) was reached at the higher application rates. Similarly, NOEC was reached for glyphosate or imazapyr at the higher rate. Note that the average annual precipitation for Petersburg is 109", Kake 54", Wrangell is 79" (Western Regional Climate Center 2019).
4. Wind erosion: Indirect effects to non-target plants as a result of wind erosion would be the same as for hand/selective or spot spray methods - negligible. Broadcast applications involve spraying over a heavily infested area and may contact non-target plants or the soil. Wind erosion is minimal in the project area. Moreover the HQ was <1 for all herbicides with 2 tons of

soil/acre moved in the agricultural setting. With regard to surface runoff, correct application and project design features restrict treatment when there is the risk of herbicide being washed off the plant.

5. Soil percolation: Indirect effects to non-target plants as a result of the chemical moving through the soil range from negligible to minor. Glyphosate adheres to soil particles and is degraded rapidly by microbes; therefore indirect effects are expected to be negligible (see hand/select spot spay description). Both metsulfuron methyl and imazapyr are known to remain available for uptake by plants over time; therefore indirect effects are expected to be minor. Metsulfuron methyl degrades more rapidly in acidic conditions and higher moisture content, with a half-life of 14-180 days (EXTOXNET 1993). The chemical adheres to more acidic soils, becoming more mobile with greater alkalinity (ibid). Imazapyr moves through the soils with a pH <5 because it is a weak acid; however, in soils above pH5 increasing amountsof imazapyr bind with the soil and remain available for plants (Tu et al. 2004). Imazapyr is primarily degraded by microbes in the soil (half-life of 1-5 months) and via photodegradation in the water (half-life of 3-5 days, all of rates are controlled by pH and other environmental conditions (WDNR 2012). Turner (2018) also reported that imazapyr may be secreted by the roots,

Cumulative effects

Because direct and indirect effects are expected to range from negative to minor under Alternative 3 and do not differ from Alternative 2, there are no additional cumulative effects to disclose. Restoring plant communities to their natural condition, or preventing the spread into natural settings by controlling invasive infestations along road corridors, trails and developed recreation sites, will have a beneficial effect over the long-term.

Table 2: Summary of Alternative 3 effects

	Glyphosate		Imazapyr		Metsulfuron Methyl	
Herbicide Effect	select/spot	broadcast	select/spot	broadcast	select/spot	broadcast
Direct Spray	negligible to minor	minor	negligible to minor	minor	negligible to minor	minor
Drift	negligible to minor	minor	negligible to minor	minor	negligible to minor	minor
Wind Erosion	negligible	negligible	negligible	negligible	negligible	negligible
Surface Runoff	negligible	negligible	negligible	negligible	negligible	negligible
Soil Percolation	negligible to minor	negligible	negligible	minor	negligible	minor

Sensitive Plant Determinations

The “may effect” determination provided by Turner’s analysis (2018) is unchanged with the increase in application rate under Alternative 3.

/s/ *Joni Johnson* 19 June, 2019
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