North Tongass Invasive Plant Management Project

Air Quality, Climate Change and Invasive Plants

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Introduction

The relationship between air quality and climate change to invasive plant management for the Northern Tongass integrated weed management project is described in this report. The Forest Plan Amendment (USDA 2016) contains a detailed description of air resources and climate change specific to the Tongass N.F. Both climate and air are of relevance in terms of the weather patterns (wind speed and direction and rain) and how they affect herbicide application methods. Air pollutants derived from herbicides are also addressed. The effects of manual and mechanical weed treatments on air quality have not been specifically studied, due to the minimal levels of soil disturbance that occur as a result of these treatment methods and will be assumed to be negligible.

Air Quality

The air quality of Southeast Alaska and the Tongass National Forest is generally good. The primary consideration of air quality related to invasive plant treatments is from herbicide application where localized air quality may be affected for short periods as either directly spraying or as a result of drift. This section will address the general air quality of Southeast Alaska and it relationship to herbicides as pollutants. The effects of manual and mechanical weed treatments on air quality have not been specifically studied, due to the minimal levels of soil disturbance that occur as a result of these treatment methods and will be assumed to be negligible.

The herbicide risk assessments developed by Syracuse Environmental Research Associates, Inc. (SERA) only address the effects of drift related to the potential of herbicides to harm non-target native plants. While herbicides may reach non-target plants through the air (as drift), in water, or on soil, the assessments do not specifically address these effects on air quality (e.g. air pollutants) per se. The overall effects of drift to harm non-target organisms is addressed in the SERA risk Assessments.

The prevalent airflow from the Pacific Ocean, the relatively small amount of industrial development in Southeast Alaska, the lack of large population centers, the absence of slash burning following harvest, and environmental regulations all contribute to maintaining clean air in southeast Alaska. Forest activities, including the activities proposed in this project, have historically had little direct effect on air quality on the Tongass (USDA Forest Service 2016). However, cruise ship emissions in certain locations and trans-Pacific pollutants such as persistent semi-volatile organic pollutants and greenhouse gases are a growing concern.

The State of Alaska Department of Environmental Conservation (ADEC) via Title 1 and Title 5 of the EPA has an approved State Implementation Plan which regulates air emission from stationary, fugitive, and mobile sources. ADEC issues air permits to industrial sources that demonstrate compliance with the Alaska Ambient Air Quality Standards, which are identical to the National Ambient Air Quality Standards (NAAQS). The primary standards were developed to protect public human health and the secondary standards to protect public welfare. Six criteria pollutants are included in the NAAQS: sulfur dioxide (SO_2), carbon monoxide (CO), lead, ozone, nitrogen dioxide (NO_2), and particulate matter with a diameter of less than 10 microns in size (PM_{10}) and less than 2.5 microns in size ($PM_{2.5}$), none of which are derived from herbicides.

Air pollutants from application of herbicides have not been reported in Southeast Alaska, primarily due to the very minor usage of these chemicals over relatively limited areas. Risk assessments for the four proposed herbicides provide information related to drift from backpack directed foliar application at distances downwind from the application site. **None of these are specifically related to air quality.**

Environmental Consequences

Direct and Indirect Effects

The effects of herbicides use on air quality were not specifically evaluated in the herbicide risk assessments. None of the alternatives considered would include broadcast burning of invasive plant infestations; therefore will not be considered in this analysis.

Cumulative Effects and Summary of Effects

Drift by definition is the portion of a sprayed chemical that is moved by wind off of a target site and therefore infers a relationship to air quality. However, off-site drift is more or less a physical process that depends primarily on droplet size and meteorological conditions rather than specific properties of the compound being sprayed. Because of the weight of chemical droplets, any airborne chemicals will eventually drop out of suspension. Thus, cumulative effects on air quality as a consequence of drift are negligible.

Climate Change and Invasive Plants

The Forest Plan Amendment (USDA 2016) provides the most recent and comprehensive description of the climate of Southeast Alaska and the anticipated short and long-term anticipated effects a changing climate will have on the ecosystems of the Tongass N.F. Southeast Alaska's climate has shown a strong warming trend since the middle of the 19th century (i.e., the end of the Little Ice Age), as has much of the Northern Hemisphere (Parson et al. 2001). A portion of this change in Southeast Alaska's average temperature is likely the result of the natural changes in the earth's climate, which are caused in part by "wobbles" in the earth's rotation around the sun resulting in changes to earth's position within its elliptical path (i.e., the precession of equinoxes) as well as the Pacific Decadal Oscillation (PDO), or the shift between two different circulation patterns that occurs every 20 to 30 years in the northern portion of the Pacific Ocean.

The potential impacts of accelerated climate change on the ecosystems of Southeast Alaska may include acidification of ocean waters; increasing the temperatures of ocean and streams; altering water input sources; changing precipitation rates and patterns; increasing the rate of glacier retreat; increasing storm intensities; altering ecosystem composition and structure; altering species distributions; and altering fire regimes.

Most recent studies on the interaction between climate change and invasive plants conclude that climate change is likely to favor invasive plant species to the detriment of native plant species for individual ecosystems. Although Alaska has not yet experienced the same extensive rate of establishment by invasive plant species that has historically occurred in rest of the U.S., the current and predicted milder winter temperatures and the longer growing season in Southeast Alaska have created opportunities for the spread and establishment of invasive plant species within this region.

In some of the studies mentioned above, invasive plant species have demonstrated increased growth rates, size, seed production, and carbon content in the presence of elevated CO2 levels. Warming climates may remove elevational barriers to invasive plant distribution that currently exist. For instance, cheatgrass is becoming established in dry forests in the Intermountain West, particularly after wildfires and fuels reduction projects. After these events, native perennial grasses are lost, leaving potential cheatgrass habitat, which can increase fire frequency.

Climate change may affect invasive species differently. Rather than imply enhancing invasion risk, climate change may also reduce invasive plant competitiveness if conditions become climatically unsuitable. Climate change could result in both range expansion and contraction for some invasive plants in the western United States (potentially introducing invasive species that thrive in warmer conditions). Likely future conditions may also make management of invasive species more difficult. Treatments used on invasive plants may be less effective under various climate change scenarios and/or elevated CO_2.

Predicting how climate change will affect invasive plants, and invasive plant management, at the local or even regional scale is more difficult to deduce than are these general indications. Anticipated changes in the climate for the Pacific Northwest (e.g. more rain, less snow, warmer temperatures) or elevated CO_2 may not be realized at a local area, particularly within the time frame of this analysis. Growth of invasive plants under elevated CO_2 conditions will also be influenced by environmental conditions such as soil moisture, nutrient availability, and the plant community in which the invasive species occurs. The complex interaction of multiple and uncertain variables make site-specific predictions speculative.

Current science is insufficient to precisely determine a cause and effect relationship between climate change and the various invasive plant treatment methods proposed for the project area. A general conclusion, based on the preponderance of current literature, suggests that "most of the important elements of global change are likely to increase the prevalence of biological invaders" (Dukes and Mooney 1999, Bradley et al. 2010). Although Alaska has not yet experienced the same extensive rate of establishment by weed species as the rest of the U.S., the current and predicted milder winter temperatures and the longer growing season in Southeast Alaska have created opportunities for the spread and establishment within this region (Wolken et al. 2011). The Forest will likely become more vulnerable to the establishment of invasive plant infestations, actual acreage affected by invasive plants could increase, and control strategies may become more difficult. Recommended management responses to these predictions are early detection (resulting from regularly scheduled monitoring) followed by a rapid response to eradicate initial infestations (Hellmann et al. 2008, Joyce et al. 2008, Tausch 2008). This early detection and rapid response strategy is specifically addressed in Alternative 2 and 3. Alternative 1 does not necessarily address the rapid response mechanism that should be in place for effectively ameliorating the potential increase invasion of non-native plants as a consequence of a warming climate.

Many of the invasive species on the Forest have originated in Eurasia and tend to thrive in warm sunny microsites (e.g. species in the sunflower family, *Asteraceae*). Given that Alternatives 2 and 3 includes control of invasive plants with an early detection/rapid response component, and the large uncertainties regarding effects of climate change at any specific location over the time frame of this project, there is insufficient information to discern any meaningful differences between alternatives. Alternatives 2 and 3 best addresses recommendations for management response in the face of potential influences of climate change on invasive plants. Alternatives 1would not provide as active a response to potential changes in climate compared to Alternatives 2 and 3.

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