Programmatic Environmental Assessment of the U.S. Fish and Wildlife Service Management Strategy for Elodea and Other Submersed Aquatic Invasive Plants in the Alaska Region.

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Summary: This Programmatic Environmental Assessment (EA) has been prepared by the U. S. Fish and Wildlife Service (Service) Alaska Region in cooperation with the Alaska Department of Natural Resources (ADNR) and the U.S. Department of Defense Joint Base Elmendorf-Richardson Natural Resources. This Programmatic EA analyzes the potential effects of the Service's management strategy for elodea and other submersed aquatic invasive plants on the human environment in the Alaska Region, in accordance with the National Environmental Policy Act (NEPA). The broad goals of the NEPA are to encourage harmony between humans and the environment and to promote efforts to prevent or eliminate environmental damage. According to the NEPA and its implementing regulation, Federal agencies must prepare and consider alternatives to major Federal actions that may significantly affect the quality of the human environment, and ensure that environmental considerations are evaluated in the decision making process.

The purpose of any submersed aquatic invasive plant management action carried out by the Service is to prevent negative impacts to native species, subsistence activities, and recreational activities throughout the Alaska Region. The only submersed aquatic invasive plants documented in Alaska to date are *Elodea* species (*Elodea canadensis*, *Elodea nuttallii*, and their hybrid). Elodea can spread quickly and negatively impact aquatic systems in areas where it becomes established outside its native range. The only known elodea infestation in Alaska prior to 2009 was in Eyak Lake near Cordova. However, during the past ten years additional elodea infestations have been discovered in the Fairbanks area, the Municipality of Anchorage, the Susitna River valley, several lakes on the Kenai Peninsula, and additional water bodies in the Copper River Delta.

As elodea spread, the State of Alaska quickly recognized the threat elodea posed. In March 2014, the ADNR issued a statewide quarantine to minimize the spread and introduction of elodea. *Egeria densa* (Brazilian waterweed), *Hydrilla verticillata* (hydrilla), and *Myriophyllum spicatum* (Eurasian watermilfoil), which have yet to be detected in Alaska, were included in the statewide quarantine. These other submersed aquatic plants are expected to have similar negative consequences to elodea if introduced in Alaska.

The Service, the ADNR, and partner organizations have been working together to manage elodea infestations in Alaska. Previously EAs have been completed for elodea management actions at specific sites in Alaska. No significant impacts were identified in these analyses. The Service and our partners have achieved eradication of elodea in the past by applying Integrated Pest Management (IPM) strategies to infested water bodies. An IPM strategy is defined as a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. The IPM strategies used in Alaska have included cultural, physical, and chemical components.

This Programmatic EA is designed to evaluate the Service's Region-wide submersed aquatic invasive plant management strategy. Five alternatives are considered in this EA: A) no action; B) cultural control; C) physical control; D) chemical control; and E) the use of an IPM strategy. The Service's preferred alternative is the use of an IPM strategy to manage elodea and other submersed aquatic invasive plants. The potentially affected environment includes all freshwater environments that could support elodea or other submersed aquatic invasive plants in the Alaska Region. The affected environment was divided into the following resources and uses for analyses: water resources; air resources; sediment and soil resources; fish and wildlife resources; vegetation and wetland resources; subsistence land use; recreational land use; commercial land use; cultural resources; and human health and safety.

Each alternative would impact the affected environment to some degree. The scale, intensity, and duration of those impacts vary by alternative. The alternative with the most negative impacts is the no action alternative. The alternative with the most beneficial impacts is the IPM alternative. The remaining alternatives fell in between these two with respect to positive and negative impacts.

Analysis of the environmental consequences of the IPM alternative identified some minor short-term negative impacts to the affected environment. Negative impacts are minimized by selecting the least environmentally damaging control methods to achieve management goals. After eradication, the long-term positive impacts to native species and current land uses would be moderate to major.

Analysis of the environmental consequences of the no action alternative identified minor to major short-term and long-term negative impacts to the affected environment. These negative impacts primarily affect native aquatic species. Although uses of native species, like subsistence and recreational fishing, would also be negatively impacted.

This document was reviewed by internal staff, partners, and the public. The comments on scope of analysis and managements actions were primarily focused on the use of chemical herbicides. Commenters identified the effectiveness of elodea management with herbicide. Commenters also indicated that the impacts of herbicide on non-target organisms, including humans, should be carefully evaluated. Consideration of a combination of management techniques including cultural, physical, and chemical methods was also suggested.

This EA will help the U. S. Fish and Wildlife Service select a strategy to manage elodea and other submersed aquatic invasive plants in the Alaska Region. The decision regarding a selected alternative and the reasoning for the selection is documented in a Finding of No Significant Impacts (FONSI) document.

Contents

Abbreviations and Acronyms

ADEC Alaska Department of Environmental Conservation

ADF&G Alaska Department of Fish & Game

ADNR Alaska Department of Natural Resources

ADOT Alaska Department of Transportation

a.i. active ingredient

AKEPIC Alaska Exotic Plants Information Clearinghouse

BIDEH Biological Integrity, Diversity, and Environmental Health

BLM U.S. Bureau of Land Management

BLS U.S. Department of Labor, Bureau of Labor Statistics

BMP Best Management Practices

CAA Clean Air Act

CDC Center for Disease Control

CEQ Council on Environmental Quality

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

CFR Code of Federal Regulations

CWA Clean Water Act

DOD U.S. Department of Defense

DOI/USDOI U.S. Department of the Interior

EA Environmental Assessment

EIS Environmental Impact Statement

EO Executive Order

EPA/USEPA U.S. Environmental Protection Agency

ESA Endangered Species Act

IPM Integrated Pest Management

JBER Joint Base Elmendorf-Richardson

KPCWMA Kenai Peninsula Cooperative Weed Management Area

LOAEL lowest observed adverse effect level

MCL Maximum Contaminant Level

mg/kg milligrams per kilogram

mg/l milligrams per liter

mg/m^3 milligrams per cubic meter

NEPA National Environmental Policy Act

NOAA National Oceanic and Atmospheric Administration

NOAEL no observed adverse effect level

NOEL no observed effect level

NPS National Park Service

NRCS Natural Resources Conservation Service

Refuge/NWR National Wildlife Refuge

OSHA Occupational Safety and Health Administration

ppb parts per billion

PPE personal protective equipment

ppm parts per million

ppt parts per trillion

RCRA Resource Conservation and Recovery Act

RMP Resource Management Plan

TLV Threshold Limit Value

USACE U.S. Army Corps of Engineers

USDA U.S. Department of Agriculture

USFS USDA Forest Service

Service/USFWS U.S. Fish and Wildlife Service

USGS U.S. Geological Survey

µg/l micrograms per liter

µg/m^3 micrograms per cubic meter

1.0 Purpose and Need for Action

This section of the document identifies the purpose of and need for action. The relationship between management actions, legal authority, and United States Fish and Wildlife Service (Service) mandates is also discussed.

1.1 Introduction

Invasive submersed aquatic plants represent a major threat to native species, recreational opportunities, subsistence harvesting, and commercial activities in Alaska. *Elodea* species, *Elodea canadensis*, *Elodea nuttallii,* and their hybrid (elodea hereafter), are the first submersed aquatic invasive plants known to be introduced in Alaska. The only known locations of elodea in Alaska prior to 2010 were Eyak Lake near Cordova, which was first recorded in 1982, and Chena Slough near Fairbanks, first recorded in 2009. However, during the past ten years additional elodea infestations have been discovered in the Fairbanks area, the Anchorage municipality, the Susitna River valley, several lakes on the Kenai Peninsula, and additional water bodies in the Copper River Delta. Elodea can negatively affect native species, recreational activities, subsistence activities, and property values (Schwoerer et al. 2019, Schwoerer 2017, Carey et al. 2016, Luzzia et al. 2016, Mjelde et al. 2012, Zhang and Boyle 2010, Horsch and Lewis 2009, Merz et al. 2008, Halstead et al. 2003).

As elodea spread, the State of Alaska (State) quickly recognized the threat elodea and similar submersed aquatic invasive plant species posed. In March 2014, the Alaska Department of Natural Resources (ADNR) issued a statewide quarantine to minimize the spread and introduction of elodea. *Egeria densa* (Brazilian waterweed), *Hydrilla verticillata* (hydrilla) and *Myriophyllum spicatum* (Eurasian watermilfoil), which have yet to be detected in Alaska, were included in the statewide quarantine (ADNR 2014). Brazilian waterweed, hydrilla and Eurasian watermilfoil are expected to have similar negative consequences to elodea if introduced in Alaska (Halstead et al. 2003, Langeland 1996, Aiken et al. 1979). Brazilian waterweed, Hydrilla and Eurasian Watermilfoil have similar habitat requirements, exhibit similar growth patterns, and methods of reproduction as elodea (Langeland 1996, Bowmer et al. 1995, Haramoto and Ikusima 1988, Nichols and Shaw 1986, Aiken et al. 1979).

The Service has been working with the State, Alaska Native tribes and Alaska Native Corporations, soil and water conservation districts, and other members of the Alaska Invasive Species Partnership to understand important vectors, develop survey techniques, manage elodea infestations, and prevent the introduction of the other submersed aquatic invasive plants in Alaska. The Service and our partners have achieved eradication of elodea in the past by applying Integrated Pest Management (IPM) strategies to infested water bodies. IPM strategies have included cultural, physical, and chemical components.

1.2 Goal and Purpose of Action

Preventing negative impacts from submersed aquatic invasive plants to native species, subsistence, and recreational activities is the Service's goal. To achieve this goal, the Service intends to continue to work with partners to implement actions that prevent the spread of elodea, eradicate new infestations of elodea, and prevent the introduction and establishment of other submersed aquatic invasive species throughout the Alaska Region. In this document the term Alaska Region refers to the Service's administrative Region 11, which is the entire state of Alaska. The Service will work to prevent negative impacts from submersed aquatic invasive plants on National Wildlife Refuges in the Alaska Region. The Service may also provide financial support to partners who wish to prevent negative impacts from submersed aquatic invasive plants on land they manage in the Alaska Region.

The Service prepared this Programmatic Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA). This EA analyzes the impacts associated with implementing rapid response management actions on and off of Service administered lands. Rapid response is defined as the process that is employed to eradicate the founding population of a non-native species from a specific location (USDOI 2016). The impacts of taking no action are also considered. If implemented, management actions would be designed to control elodea, Brazilian waterweed, hydrilla and Eurasian watermilfoil (should they be discovered in Alaska). Brazilian waterweed, hydrilla, and Eurasian watermilfoil were included in this analysis because they have been identified, by the State and others, as likely to be introduced and highly invasive (ACCS 2019, ADNR 2014). The methods used to manage elodea are also effective in the management of Brazilian waterweed, hydrilla, and Eurasian watermilfoil (SePRO 2019, SePRO 2015, Madsen et al. 2002, McCowen et al. 1979).

The Service and partner organizations have previously assessed the impacts of elodea treatment in the Alaska Region as required by the NEPA. These NEPA analyses were prepared to analyze treatment actions at specific locations and times (ADNR 2019, ADNR 2017a, ADNR 2017b, ADNR 2016, USFS 2016, ADNR 2015, ADNR 2013). No significant impacts were identified in any of the previously conducted analyses. This Programmatic EA evaluates the potential impacts of submersed aquatic invasive plant management across the Alaska Region. The selected management strategy will be subjected to constant evaluation and modified as necessary to meet management goals using the principles of adaptive management.

1.3 Need for Action

Elodea can spread quickly and negatively impact aquatic systems in areas where it becomes established in Alaska. It can reproduce vegetatively, so even a small plant fragment could generate a new infestation. Elodea is fairly hardy and somewhat tolerant of freezing, drying, and brackish water. Where elodea has become established outside of its native range it has negatively impacted native species, recreational activities, commercial activities, and property values (Schwoerer 2017, Mjelde et al. 2012, Zhang and Boyle 2010, Horsch and Lewis 2009, Merz et al. 2008, Josefsson and Andersson 2001, Bowmer et al. 1995). Elodea is predicted to have negative impacts on native organisms and land use in the Alaska Region (Schwoerer et al. 2019, Schwoerer 2017, Carey et al. 2016, Luizza et al. 2016). An elodea habitat suitability model, produced using global occurrence records, predicted the entirety of Alaska to be of either moderate or high habitat suitability (Luizza et al. 2016). Elodea habitat suitability in Alaska may increase slightly under future climate projections (Luizza et al. 2016).

Elodea represents an enormous ecological and economic threat to aquatic resources of Alaska, particularly for anadromous salmon species which spawn and rear young in freshwater habitats. Elodea has the potential to severely degrade the quality of lakes, wetlands, and slow-flowing streams used by *Oncorhynchus kisutch* (Coho Salmon), *Oncorhynchus tshawytscha* (Chinook Salmon), and *Oncorhynchus nerka* (Sockeye Salmon). *Oncorhynchus mykiss* (Rainbow Trout) habitats are also vulnerable to degradation by elodea, particularly when infestations lead to anoxic conditions. Elodea, along with other non-native aquatic plants, has affected Chinook Salmon spawning rates by reducing spawning habitat in California (Merz et al. 2008). If elodea were to spread statewide in Alaska, it could cost hundreds of millions dollars per year in lost economic opportunity to the commercial sockeye fisheries and recreational floatplane pilots (Schwoerer 2017, Schwoerer et al. 2019).

Elodea is already present, or has been present, in important salmon habitat in Alaska. Stormy Lake, Daniels Lake, Beck Lake, Sucker Lake, Alexander Lake, Chena River, Chena Slough and Little Survivor Creek are examples of water bodies that have or had elodea infestations and are listed on the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes (Catalog)(ADF&G 2019). The Catalog, managed by Alaska Department of Fish and Game (ADF&G), is a list of streams and lakes that have been documented as important for one or more life stages of anadromous fish.

In the Alaska Region, the Service is responsible for administering 16 National Wildlife Refuges that encompass an area of 76,774,229 acres. The Service's mission is to "Work with others to conserve, protect and enhance fish, wildlife and plants and their habitat for the continuing benefit of the American people." The administration of National Wildlife Refuge lands involves managing invasive species because they represent a threat to native species. Invasive species have been the most frequently mentioned threat in the National Wildlife Refuge System Threats and Conflicts database in recent years (USFWS 2014a). Submersed aquatic invasive plants (elodea, Brazilian waterweed, hydrilla, and Eurasian watermilfoil) represent a direct threat to native fish, plants, and their habitat. Managing these invasive species is consistent with the Service's mission as well as Federal law, policy and Executive Orders concerning invasive species. Federal law, policy and Executive Orders concerning invasive species are discussed in Section 1.4.

The purpose of management actions is to minimize adverse impacts from submersed aquatic invasive plants on native species and humans. Management actions are needed because preventing new infestations of submersed aquatic invasive plants and facilitating rapid response to infestations if they are discovered are effective ways to minimize impacts from submersed aquatic invasive plants. The Service, the State, and other partner organizations have recognized rapid response as a priority in managing aquatic invasive species (ADF&G 2002, KPCWMA 2019). The study of past introductions of invasive species has revealed a general relationship between time, cost, and stage of invasion. This relationship is often represented graphically with time on the x-axis and cost and area occupied by the species on the y-axis. As depicted in **Appendix A** - **Figure 1**, eradication of invasive species while infestations are relatively small and isolated can minimize impacts to native species and ecosystems while also minimizing project funding needs and effort in the future. Prevention and rapid response to newly identified infestations of submersed aquatic invasive plants is the most efficient and effective method to achieve the Service's goal in the Alaska Region.

1.3.1 Background on Submersed Aquatic Invasive Plants in the Alaska Region

The only submersed aquatic invasive plants documented in Alaska to date are elodea species. In this EA we describe their taxonomy, life history, and locations of known infestations. We then describe the taxonomy and life history of hydrilla, Eurasian watermilfoil, and Brazilian waterweed.

1.3.1.1 Taxonomy and Life History of Elodea

Elodea is a submersed aquatic plant in the Hydrocharitaceae family. Five distinct species of elodea are recognized (Bowmer et al. 1995, Cook and Urmi-König 1985). The species currently found in Alaska include: *Elodea canadensis*, *Elodea nuttallii,* and their hybrid. *Elodea* *canadensis* and *E. nuttallii* are native across the contiguous United States and Canada (Haynes 2000, Bowmer et al. 1995, Catling and Wojtas 1986). Elodea is considered not native to Alaska based on limited distribution, sparse herbarium records, and published literature on aquatic invasive species within the state (Wurtz et al. 2013).

Elodea prefers still or slow-moving neutral to alkaline waters. It is tolerant of cold water, with documented rapid invasion as far north as northern Finland and Norway (Heikkinen et al. 2009, Sand-Jensen 2000, Rorslett et al. 1986). Elodea has high light requirements and occurs primarily in clear water bodies. Plants are dioecious with separate male and female plants. Flowering is uncommon, with few records of viable seed (Bowmer et al. 1995). Reproduction is primarily vegetative. Elodea readily breaks into transportable fragments that can root in sediments.

Where elodea has been introduced outside its native range, it has generally exhibited a rapid growth period for 5 to 6 years followed by a declining or sometimes stable population (Nichols 1994, Sand-Jensen 2000, Mjelde et al. 2012). Growth tends to slow when iron reserves are depleted or when decaying biomass depletes oxygen and lowers the pH, weakening the carbon fixation and photosynthesis efficiencies of elodea (Spicer and Catling 1988).

Elodea can develop into dense, monospecific stands that prevent light from reaching other species. These dense stands also restrict water movement. Nutrient availability, pH, and oxygen level are all affected by elodea infestation, thereby affecting plant, fish, amphibian, and invertebrate populations in the waterbody. Elodea can impede recreational activities such as fishing, boating, floatplane use, and swimming. Elodea can clog water intake pipes at hydropower and industrial plants and can cause scrape damage to boats in calcium encrusted stands (Josefsson 2011).

Techniques to control elodea vary with management goals. Elodea is susceptible to biological, cultural, physical, and chemical control methods. Eradication is typically accomplished with herbicide treatment. Elodea is susceptible to, diquat dibromide, fluridone, and other broad spectrum and systemic herbicides (McCowen et al. 1979, Bowmer et al 1995, WA-ECY 2002, WA-ECY 2017). Further detail on elodea control methods is provided in Section 2.0.

1.3.1.2 Elodea Infestations in the Alaska Region

The only known locations of elodea in Alaska prior to 2010 were Eyak Lake near Cordova, which was first recorded in 1982, and Chena Slough near Fairbanks, first recorded in 2009. Extensive floristic surveys across Alaska have been conducted over the past century. The University of Alaska Fairbanks herbarium maintains a large collection of plant specimens from across Alaska, only two of which are elodea (specimens from Eyak Lake and Chena Slough) (Wurtz et al. 2013). Elodea is commonly used as an aquarium plant and was readily available in pet stores. Elodea is also used in college and high school biology labs for experiments (Catling and Wojtas 1985). It has been hypothesized that the infestation in Chena Slough resulted from an aquarium being emptied, as the population is dense below a certain point in the slough, but nonexistent above (Wurtz et al. 2013) this location.

During the past decade, elodea has continued to spread in the Fairbanks and Cordova areas. It has also been found in the Anchorage area, Susitna River valley, and several lakes/ponds on the Kenai Peninsula. The most likely sources of these new infestations are floatplanes transporting plant fragments, boats transporting plant fragments, and people improperly disposing of aquarium plants. **Appendix B** includes a list of all known current and former elodea infestations in Alaska. **Appendix A** - **Figures 2** through **6** depict the locations of all known current and former elodea Infestations in Alaska.

Early detection efforts have increased with the recent spread of elodea. Multiple detection methods are being refined including physical surveys, remote surveys, and the use of environmental deoxyribonucleic acid (eDNA) (ERDC 2017). Research on pathways and likely areas of future infestation is ongoing, which will help focus survey efforts. The University of Alaska Anchorage Center for Conservation Science is collaborating with the National Park Service (NPS) and the United States Forest Service (USFS) to develop a standardized method for elodea surveys (Fulkerson et al. 2019). The Service is currently investigating the eDNA detection probability for elodea (O. Russ personal communication). The University of Alaska Anchorage Institute of Social and Economic Research is involved in investigating the role boats and floatplanes play in the dispersal of elodea (Schwoerer 2019).

Eradication of elodea infestations has been achieved through rapid response actions on the Kenai Peninsula. Elodea was first detected on the Kenai Peninsula in Stormy Lake in September 2012. After additional survey effort, elodea was detected in Daniels Lake, Sports Lake, Seppu Lake, and Hilda Lake. After appropriate environmental analysis and planning using IPM, multi-year herbicide treatments were initiated at all infested lakes on the Kenai Peninsula. In Daniels and Sports lakes, a one-time treatment of diquat dibromide was used to reduce biomass and minimize risk of spread in conjunction with the fluridone treatment. Elodea has since been eradicated from Beck, Daniels and Stormy lakes. More recent treatments in Sports, Seppu and Hilda lakes also appear to be successful (KPCWMA 2019). **Appendix A** - **Figure 2** depicts current and former infestations of elodea on the Kenai Peninsula.

The Impacts of chemical treatment on Daniels and Beck lakes were evaluated during a multi-year study led by the U. S. Geological Survey (USGS). Physical, chemical, and biological parameters were measured over time in Daniels and Beck lakes. The same parameters were also measured in two similar untreated reference lakes, Island and Douglas lakes. The study found a lack of evidence for systematic impacts to water quality or plankton associated with the two year-long herbicide treatments of elodea in the Daniels and Beck lakes. The only negative impact of chemical treatments observed on native macrophytes was earlier onset of leaf senescence and chlorosis in lily pads as compared to untreated lakes (Sethi et al. 2017).

Rapid response actions were also employed to achieve eradication of elodea in the Municipality of Anchorage. Elodea was initially discovered in the Municipality of Anchorage in 2011. It has subsequently been discovered in and eradicated from Sand Lake, Lake Hood, Delong Lake, and Little Campbell Lake. The Lake Hood infestation was particularly worrisome because the lake is a busy floatplane base. The average annual number of flight operations on Lake Hood between 2011 and 2014 was 67,426. The largest number of annual flight operations during that period was 72,011 in 2014 (DOWL 2017). Float planes can transport plant fragments, which may initiate new infestations. Efforts to treat Jewel Lake and Little Survivor Creek in the Anchorage Municipality are ongoing.

Elodea was initially discovered in Chena Slough, near Fairbanks, in 2009. Treatment of Chena Slough with fluridone occurred in 2017, 2018, and 2019. Monitoring data, from 2019, suggests that most of the elodea had been killed and only a few individual plants remained. Similar results have been observed in Totchaket Slough, west of Fairbanks, where treatment with fluridone was initiated in 2018. These treatment results are promising because they demonstrate that elodea can be eradicated from flowing water. Two additional treatments were initiated near Fairbanks in 2019 at Chena Lake and Bathing Beauty Pond (Shenoy et al. 2019).

Elodea was first discovered near Cordova in 1982 in Eyak Lake. The USFS is leading efforts to study and manage elodea infestations in the Cordova area. Several small water bodies in the Copper River Delta have been treated with herbicide to control elodea. Large scale treatment of elodea has not occurred in the Cordova area, where most of the infested water bodies are within the Chugach National Forest.

The consequences of delaying treatment can be substantial, as experienced during response planning for Alexander Lake. Alexander Lake was the first known infestation in the Susitna River Basin, which drains the south side of the Alaska Range. At the time of the initial detection in 2014, the elodea infestation was limited to approximately 10 acres of the approximately 750 acre Alexander Lake. The initial cost for a three year eradication and effectiveness monitoring program was estimated to be $90,000. It took partners until 2016 to secure sufficient funding, obtain the necessary state and federal permits, and to complete the NEPA process. By the time treatments were initiated in 2016, the infestation had grown to over 500 acres, equating to an almost 5,000 percent increase in area requiring treatment. Since then, the Service, ADNR and other partners have worked to revise the EA and expand early detection surveys in the surrounding area, which have documented at least two new infestations in the Susitna River Basin (**Appendix A - Figure 6**). The new estimated treatment cost for Alexander Lake is approximately $1,700,000 for a three year treatment plan, and the treatment area now includes Sucker Lake, an adjacent lake that will cost $500,000 to treat (ADNR Personal communication). Alexander Lake once supported a vibrant Chinook salmon sport fishery. Unfortunately, northern pike were also introduced to this lake and have significantly reduced the salmon populations for the past 20 years. The presence of elodea in this watershed has led to further reduced recreational trout and salmon fishing opportunities and hazards to floatplanes (e.g., entanglement and fouled rudders due to mats of elodea). In 2019, the ADF&G closed fishing opportunities in Alexander and Sucker lakes to reduce the risk of elodea spreading to surrounding water bodies (ADF&G 2019a).

1.3.1.3 Potential Future Infestation

Brazilian waterweed, hydrilla, and Eurasian watermilfoil are species which have not yet been identified in Alaska but are widely distributed aquatic invasive plant species in other areas of the United States. These species are included in this analysis because of their high risk of introduction, their similarity to elodea in terms of habitat requirements, negative impact on the environment, and similarity in treatment methods. Risk assessments conducted by the Alaska Natural Heritage Program personnel and published on the Alaska Center for Conservation Science - Alaska Exotic Plants Information Clearinghouse (AKEPIC) website, have identified hydrilla and Eurasian watermilfoil as highly invasive. This invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems. A value of 70 or higher is recognized as a species of high concern that managers should respond to quickly. Hydrilla and Eurasian watermilfoil ranked 80 and 90 respectively. In comparison, elodea species ranked 79 (ACCS 2019). An invasiveness rank has not yet been assigned to Brazilian waterweed.

1.3.1.3.1 *Hydrilla verticillata* (hydrilla)
Hydrilla is a submersed aquatic plant that can form dense mats near the water surface, potentially displacing native aquatic plants. Hydrilla can reproduce vegatatively and breaks into transportable fragments that can root in sediments. Hydrilla infestations may reduce the seed production of native plant species, which would result in a reduction in the number of native plants in the community (de Winton and Clayton 1996). Hydrilla may also shift the phytoplankton composition of its habitat (Canfield et al. 1984). Hydrilla infestations may increase sedimentation rates, and increase water temperatures (Bossard et al. 2000). Hydrilla has high potential for dispersal because fragments may be transported by flowing water, human activity, and wildlife. It is known to establish in undisturbed aquatic communities (Bossard et al. 2000). Tubers can survive being ingested by waterfowl and can be transported from one body of water to another (Joyce et al. 1980).

1.3.1.3.2 *Myriophyllum spicatum* (Eurasian watermilfoil)
Eurasian watermilfoil is a submersed aquatic plant that reproduces by seeds, fragmentation, and winter buds. Eurasian watermilfoil forms dense canopies that often shade out or displace native vegetation and reduce natural diversity. Monospecific stands of Eurasian watermilfoil offer poor habitats for waterfowl, fish, and other wildlife. (DiTomaso and Healy 2003, Jacono and Richerson 2004). Dense mats of Eurasian watermilfoil can increase sedimentation by slowing water flow, which allows suspended sediment to settle. The growth and senescence of thick vegetation degrades water quality by depleting dissolved oxygen (Engel 1995). Eurasian watermilfoil has high potential for dispersal because fragments and winter buds may be transported long distances by flowing water, human activity, and wildlife.

1.3.1.3.3 *Egeria densa* (Brazilian waterweed)
Brazilian waterweed is a submersed aquatic plant that is capable of reproduction via vegetative fragmentation, similar to hydrilla and Eurasian watermilfoil (Parsons and Cuthberson 2001). It grows in thick mats of intertwining stems which alter the light and nutrients available to the biota where it occurs (Yarrow et al. 2009). Brazilian waterweed can inhibit recreational activities such as, fishing, swimming, and water skiing. It has gained widespread recognition by parks departments and local and state governments as a nuisance species (Great Lakes Panel on Aquatic Nuisance Species 2012). Brazilian waterweed has high potential for dispersal because fragments may be transported long distances by flowing water, human activity, and wildlife.

1.4 Regulatory Framework
This section describes federal laws, executive orders, and Service policies that address or affect invasive species management. The Service has authority to work with partners to manage invasive species under the National Invasive Species Act, the National Wildlife Refuge System Administration Act, the National Wildlife Refuge System Improvement Act (which amended the National Wildlife Refuge System Administration Act), the Endangered Species Act, and Executive Orders 13112 and 13751. The Service's Integrated Pest Management Policy, the Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy, and other National Wildlife Refuge System policies direct how invasive species should be managed. The Fish and Wildlife Coordination Act and the Sikes Act are important pieces of federal legislation that also impact invasive species management. The aforementioned laws, Executive Orders, and policies are discussed here in detail. Additional laws, policies, and guidance that apply to invasive species or the potential management actions are discussed in the Affected Environment Section of this document.

The National Invasive Species Act (NISA) was passed in 1996 amending the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA). The 1990 NANCPA established the Aquatic Nuisance Species (ANS) Task Force to coordinate nationwide ANS activities. The ANS Task Force is co-chaired by the Service's Assistant Director for Fisheries and Aquatic Conservation and the Undersecretary of Commerce/NOAA. The NISA furthered the ANS activities by calling for ballast water regulations, the development of State aquatic nuisance species management plans and regional panels to combat the spread of ANS, and additional ANS outreach and research. The NANPCA encourages the use of environmentally sound methods for invasive species management. In the NANPCA, environmentally sound is defined as methods, efforts, actions or programs to prevent introductions or control infestations of aquatic nuisance species that minimize adverse impacts to the structure and function of an ecosystem and adverse effects on non-target organisms and ecosystems and emphasize integrated pest management techniques and nonchemical measures.

The National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act, establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. The Act states, first and foremost, that the mission of the National Wildlife Refuge System be focused singularly on wildlife conservation. The Act provides authority for regulations and policy that are directly related to invasive species management. For example, the Act provides authority for 50 CFR 27.52 which identifies prohibited acts in the National Wildlife Refuge System, including the introduction of plants and animals. The regulations stipulate that "Plants and animals or their parts taken elsewhere shall not be introduced, liberated, or placed on any national wildlife refuge except as authorized." The Act also provides authority for the Services BIDEH policy discussed below.

The Endangered Species Act (ESA) provides for conserving endangered and threatened species of plants and animals. The ESA also requires that federal agencies consult with the USFWS and NMFS to ensure that any actions that they authorize, fund, or carry out are not likely to jeopardize the continued survival of a listed species or result in the adverse modification or destruction of its critical habitat. The goal of the ESA is the recovery of endangered and threatened species and the ecosystems on which they depend. Recovery is the process by which the decline of an endangered or threatened species is halted or reversed, and threats removed or reduced. In many instances threats to an ESA listed species may come from invasive species. They may either directly harm the species by causing mortality or may threaten a species by modifying or destroying the habitat or food source on which that species depends. A variety of methods and procedures are used to recover listed species, such as reduction of threats (including invasive species), protective measures to prevent extinction or further decline, consultation to avoid adverse impacts of Federal activities, habitat acquisition and restoration, and other on-the ground activities for managing and monitoring endangered and threatened species. It is not likely that submersed aquatic invasive species are currently impacting listed species or their habitats in Alaska, but impacts are possible in the foreseeable future.

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

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

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

The Service's Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy, 601 FW 3, provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on Refuges and associated ecosystems. Further, it provides Refuge managers with an evaluation process to analyze their Refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with the mission of the Refuge system and individual Refuge purposes, restore lost or severely degraded components. The BIDEH Policy also directs Refuges to prevent the introduction of invasive species, detect and control populations of invasive species, and provide for restoration of native species and habitat conditions in invaded ecosystems.

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

The Sikes Act recognizes the importance and value of DOD lands to natural resources. It seeks to ensure that these ecosystems are protected and enhanced while allowing the DOD lands to continue to meet the needs of military operations. The Sikes Act could provide funding to support Service invasive species survey and response efforts if those actions support goals DOD Natural Resource Management Plans. This is relevant in Alaska because the DOD administers large tracts of land in the State.

1.5 Scoping

The purpose of scoping in the NEPA process is to focus analysis on relevant issues and reasonable and prudent alternatives. The Service selected a combination of internal and targeted external scoping for this EA. External scoping is not required by the Council on Environmental Quality (CEQ) regulations for an EA level analysis. However, we solicited input from agencies that may have jurisdiction by law, entities with special expertise, and entities that may be affected by management actions to provide a broader perspective on relevant issues. We also included entities that may have an interest in submersed aquatic invasive plant management actions. These entities were identified based on interest in previous Service invasive species control efforts in the Alaska Region. A list of entities invited to participate in scoping can be found in Section 6.0.

1.5.1 **Coordination and Cooperation with other Agencies**

In its role as a natural resources manager in Alaska, the Service has developed numerous relationships at the federal, tribal, state, and local levels, as well as with conservation and environmental groups with an interest in resource management. These entities and the Service regularly coordinate and cooperate on invasive species management efforts which benefits all involved.

The Service is the lead agency on this programmatic EA. The U. S. Department of Defense Joint Base Elmendorf-Richardson Natural Resources and the ADNR have agreed to formally cooperate with the Service. The CEQ regulations define the roles and responsibilities of lead agencies and cooperating agencies and specifically allow for non-federal agencies to participate in the NEPA process as cooperating agencies.

1.5.2 Invitation to Provide Scoping Comments

The Service sent letters to interested parties in November of 2019, notifying them the Service was in the early planning stages of developing strategies (and analyzing the effects of implementing those strategies under NEPA) to manage elodea and the other submersed aquatic invasive plants in the Alaska Region. The recipients were invited to provide comments on the scope of analyses and alternatives.

In total, scoping invitation letters were sent to 28 entities (a list of entities contacted is in Section 6.0). Of the 28 entities that received an invitation, 12 responded. The 12 responses varied in content. Two responses indicated the recipients had no comment at this time. Three responses were generally supportive of management actions but did not comment on scope. The remaining seven responses provided comments on the scope of analysis, action alternatives, or the NEPA process.

The comments on scope of analysis and managements actions were primarily focused on the use of chemical herbicides. Commenters identified the effectiveness of elodea management with herbicide. Commenters also indicated that the impacts of herbicide on non-target organisms, including humans, should be evaluated. Consideration of a combination of management techniques was also suggested.

1.5.3 Issues Identified

This EA focuses on the resources most likely to be impacted by management actions. The key resources and issues identified during internal and external scoping were: surface water, groundwater, fish and wildlife, vegetation and wetlands, land use (including for subsistence, recreational/wilderness, and commercial purposes), cultural, and human health and safety. Other resources and issues that were considered include: air, soil and sediment, noise, visual, economic, and environmental justice.

2.0 Alternatives

This section describes a range of alternatives including the no action alternative (Alternative A) and the Service's preferred alternative (Alternative E). The Service's IPM Policy organizes management methods into four broad groups (biological, cultural, physical, and chemical) (USFWS 2010). Each group of management methods was selected as an alternative for individual analysis (Alternatives B through D). The combination of management methods from all groups was also selected as an alternative for analysis (Alternative E). Taking no action was included as an alternative for analysis as well (Alternative A). This section also describes those alternatives and actions that were considered but dismissed from detailed analysis. Any positive or negative aspects of alternatives discussed in this section are not meant to represent impacts associated with that alternative. The environmental consequences of each alternative are discussed in Section 4 of this document.

There are some elements that are common to each action alternative (Alternatives B through E). An integral part of any control program is monitoring and assessment. Pre and post-treatment monitoring is essential to evaluate success of the treatment and assess non-target impacts. However, comprehensive monitoring prior to treatment is not always feasible.

At minimum, an initial site assessment should be conducted before implementing alternatives C, D, or E. The initial site assessment should include measurements of the physical, chemical, and biological conditions present prior to treatment. These same parameters should also be monitored after treatment to detect any changes associated with treatment activities. An inventory and assessment of any drinking water intakes or wells in the project area should also be completed. Basic water quality parameters should be monitored before, during and after treatment, throughout the water column, to ensure conditions remain suitable for native species. Understanding and documenting the pre and post-treatment biological community would also be valuable. Submersed vegetation should be systematically sampled before, during, and after treatment to understand the effectiveness of the treatment and non-target effects. Systematically sampling macroinvertebrates, plankton, and fish should also be considered pre and post-treatment.

Action alternatives would be implemented as soon as possible after discovery of submersed aquatic invasive plants to minimize treatment area and minimize potential negative impacts from the treatment activities. In general, treatment of a smaller area would have smaller scale impacts than treatment of a larger area.

2.1 Alternative A: No Action

Under the no action alternative the Service would not actively manage elodea (and other submersed aquatic invasive plants should they be discovered) in the Alaska Region. Other agencies or entities may choose to manage elodea and other submersed aquatic invasive plants on lands that they administer or own. Funding for submersed aquatic invasive plant management provided by the Service to other land management entities, including the State of Alaska, may no longer be available. However, the funds that were previously directed towards elodea management may be available for other projects or programs.

Without Service support for elodea management it would likely continue to spread throughout Alaska's freshwater ecosystems. Areas with high human use would be infested first followed by connected water bodies. Given that elodea can be transported by floatplane, even remote areas of the state could become infested via this pathway. It would become increasingly difficult for areas actively managed to prevent establishment of elodea to accomplish this goal. Eventually most of the suitable habitat in Alaska would be colonized by elodea.

2.2 Alternative B: Cultural Control

Under the Cultural Control alternative, elodea and other submersed aquatic invasive plants would be managed using only cultural methods. Cultural control methods can be described as management tools that modify human behavior to control invasive species. Cultural control methods include regulatory measures as described in Sections 2.2.3 and 2.2.4. It is recognized that the cultural control methods analyzed in this EA represent a subset of all potential cultural control options. These control methods were selected based on their documented use for submersed aquatic invasive plant control and perceived feasibility in Alaska.

As discussed previously, prevention is the most effective way to combat invasive species. The cultural control methods presented below are focused on preventing new infestations. Cultural control of submersed aquatic invasive species can be achieved using a variety of actions including: public education, watercraft (including floatplanes) inspection, quarantines, and waterbody use restrictions.

2.2.1. Education

A commonly used cultural control method is education. This involves educating the public to increase awareness of the problem and to familiarize people with possible solutions. In this case, the potential negative impacts of submersed aquatic invasive species introduction and information regarding how the public can help to limit spread would be emphasized. Specific actions may include mass media messaging, signage at water body public access points, or outreach at schools.

2.2.1.1 Positive Features of Education

Volunteer labor and public participation are benefits of successful education efforts. Education can be relatively inexpensive depending on implementation. It is potentially useful for a wide range of species.

2.2.1.2 Negative Features of Education

Education may not be effective. It may be difficult to reach large portions of the public. Success of this alternative depends on a certain level of public engagement and initiative.

2.2.2 Inspection and Decontamination

Requiring user groups (boaters, anglers, paddlers, and floatplane pilots) to inspect and decontaminate their equipment after use is another commonly employed cultural control method. Complete removal of all water and organic material from equipment, followed by drying, is an effective way to prevent the spread of aquatic species between water bodies. This method can be encouraged through installation of wash stations at public boat ramps or other high use areas. If the existing regulatory framework allows, this method can also be enforced with mandatory inspection stations to ensure compliance. The State of Alaska does not currently have laws that allow for mandatory inspection of watercraft (boats or planes) to prevent the spread of aquatic invasive species.

2.2.2.1 Positive Features of Inspection and Decontamination

This method focuses responsibility to prevent infestation on resources users. Inspection and decontamination is potentially useful for a wide range of species.

2.2.2.2 Negative Features of Inspection and Decontamination

Even with strong regulations and inspections stations some users may not comply. Inspecting and decontaminating floatplanes can be challenging since they are not removed from the water regularly and aquatic vegetation is usually entangled while taxiing or landing. To be most effective, this method would require passage of new legislation and enforcement to ensure compliance.

2.2.3 Quarantines

Quarantines, or other regulatory methods that restrict movement of invasive species, are commonly implemented. The State of Alaska implemented a quarantine of the submersed aquatic invasive plants included in this EA in 2014. This quarantine prohibits the import, transport, sale, or distribution of elodea, Brazilian waterweed, hydrilla, and Eurasian watermilfoil. Quarantines enable regulators to reduce the number of potential introductions.

2.2.3.1 Positive Features of Quarantines

A single quarantine action can have a broad impact. They are potentially useful for a wide range of species.

2.2.3.2 Negative Features of Quarantines

Quarantines require resources to be enforced and effective outreach efforts to raise awareness. They also require political will to enact.

2.2.4 Use Restrictions

Use restrictions, designed to target probable vectors, can be effective for managing invasive species. Once the presence of elodea (or another submersed aquatic invasive species) has been confirmed, waterbody use restrictions could reduce the probability of humans moving the plant to nearby water; i.e., elodea would be contained to that waterbody. Waterbody use restrictions, like public boat launch closures, fishing season closures, or commercial use closures, could prevent additional infestations. Floatplanes, watercraft, and fishing/hunting gear are important vectors in the spread of elodea and other aquatic invasive species. Access for subsistence use has specific protections under Section 811 of the Alaska National Interest Lands Conservation Act. This must be considered prior to implementing use restrictions. Subsistence use is discussed further in Section 3.6.1 of this EA.

2.2.4.1 Positive Features of Use Restriction

Use restrictions can be a quick and inexpensive way to limit spread of a known infestation.

2.2.4.2 Negative Features of Use Restriction

Legal issues and potential for public controversy are possible with use restrictions. Use restrictions may be difficult to enforce.

2.3 Alternative C: Physical Control

Under the Physical Control alternative, elodea and other submersed aquatic invasive plants would be managed using physical control methods including bottom barriers, drawdown, hand pulling, diver operated suction, and plant fragment barriers. Each of these methods is discussed individually in Sections 2.3.1 through 2.3.4. It is recognized that these methods represent a subset of all potential physical control options. These control methods were selected based on their documented use for submersed aquatic invasive plant control and perceived feasibility in Alaska.

2.3.1 Bottom Barriers

Bottom barrier treatments are performed by covering the target aquatic vegetation with a light barrier to block sunlight and deprive plants of energy. Ideally, bottom barriers should be heavier than water but porous enough to allow gas bubbles produced by bottom sediments and decomposing plant material to pass through the barrier without "ballooning" the material off the bottom.

2.3.1.1 Positive Features of Bottom Barriers

Bottom barriers are effective at killing plants. If it is possible to install the barriers without any cutting or pulling of existing vegetation, this method could be implemented with minimal fragmentation. This method can be a good option for vegetation control in high use areas like boat launches.

2.3.1.2 Negative Features of Bottom Barriers

Bottom barriers are typically not reasonable for use over large areas due to deployment time and cost. Bottom barriers are difficult to install and maintain in flowing systems. Gas production that results from decaying organic matter under the barrier may affect the long term functionality and stability of the method (Gunnison and Barko 1992). Limited permeability of a bottom barrier has been shown to create anoxic conditions and increased ammonium concentrations beneath the barrier. This can negatively impact native aquatic macroinvertebrate communities (Eakin and Barko 1995). This method is not species-specific and could impact many non-target plants.

2.3.2 Drawdown

Lowering the water level in a water body to expose target vegetation is known as drawdown. Drawdown during the winter exposes the sediment to both freezing and loss of water. Freezing temperatures can kill aquatic plants that have no overwintering structures such as viable seeds, tubers, or winter buds. Lowering water levels in the summer can expose aquatic plants to desiccation and high temperatures, which may also be lethal. Drawdown would require the relocation of native aquatic organisms to reduce mortality. Drawdown would also require a permit from ADNR under the Alaska Water Use Act.

This management technique may only be a viable response for water bodies with existing water-control structures. For smaller water bodies, it may also be possible to pump water out to reduce water levels. In this case, water would need to be pumped into high and dry fields to prevent accidental spreading of invasive plant fragments caught in the pumping system. Lastly, temporary dams could be placed to divert water away from seasonal slough systems. Drawdown options may be effective in systems within limited groundwater influence, as groundwater inflow could replace pumped/diverted water rapidly.

2.3.2.1 Positive Features of Drawdown

Drawdown may be a very cost effective way to kill aquatic plants in water bodies with existing water control structures. Complete draining may not be necessary in deep water bodies as suitable rooted aquatic plant habitat is limited to shallower areas. However, incomplete draining is unlikely to result in eradication. Native emergent plants populations may increase after drawdown (Coops et al. 2004).

2.3.2.2 Negative Features of Drawdown

This method has limited applicability. Existing water management structures are necessary to avoid costs and logistical issues associated with pumping. This method is not species-specific and could impact many non-target organisms. Invasive plants may recolonize areas subjected to drawdowns if too little time was allotted to the treatment or if wet areas remained in the treatment area. In some studies of drawdown elodea has quickly recolonized areas after they are re-submerged (Barrat-Segretain and Cellot 2007).

2.3.3 Hand Pulling

Hand-pulling aquatic invasive plants involves removing entire plants, including roots, from the area of concern and disposing of them in an area away from the shoreline. In shallow water, no specialized equipment or training is required to perform this technique. In deeper water, hand pulling is best accomplished by divers with SCUBA equipment and bags for the collection of plant parts.

2.3.3.1 Positive Features of Hand Pulling

Hand pulling is a relatively inexpensive and low impact method. May be suitable for volunteer work crews if infestation is in shallow water and close to towns or villages.

2.3.3.2 Negative Features of Hand Pulling

Hand pulling is time and labor intensive so it would only be feasible in areas with small patches of elodea or other target plant species. Another major disadvantage of hand pulling is that it could produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of fragment barrier and monitored during and after treatment. Collection bags could release fragments unintentionally. The pulled plant material would need to be disposed of in a way that prevents additional infestations.

2.3.4 Diver-Operated Suction

Diver-operated suction, or suction dredging, is a method whereby SCUBA divers use hoses attached to small dredges to suck plant material and some sediment from the bottom of a water body. The suction dredging removes all parts of the plant including the roots. The plant material is collected and disposed of while water is returned to waterbody.

2.3.4.1 Positive Features of Diver-Operated Suction

This method is species-specific and could minimize impacts to non-target aquatic plants. Suction dredges are popular in some areas of Alaska, due to their use in mining, and may be readily available.

2.3.4.2 Negative Features of Diver-Operated Suction

The efficacy of suction dredging was evaluated in the Chena Slough in 2012 and 2013 and was found to be extremely labor-intensive. The rate of removal, based on a 0.59 acre trial with an eight person crew, was extrapolated to be approximately 400 hours for 1 acre of elodea. While suction dredging may be a good tool for removing small patches of elodea, it is unlikely to be an effective means of complete eradication in large infestations. Transportation and disposal of collected plant material may be problematic. The collected plant material would need to be disposed of in a way that prevents additional infestations. Like other mechanical control techniques, this method would produce an abundance of plant fragments. Suction dredging could mobilize any toxins present in sediment and an evaluation of sediments in the project area may be required prior to treatment.

2.3.5 Plant Fragments Barriers

The use of physical barriers to control the spread of fragments in flowing systems or partially infested water bodies is a technique used to prevent vegetative propagation in non-infested areas.

Ideally the barriers would allow water and non-target aquatic organisms to pass but prevent the movement of submersed aquatic plant material.

2.3.5.1 Positive Features of Plant Fragment Barriers

This method is a potentially low cost way to prevent spread in flowing or partially infested water bodies. Plant fragment barriers may be relatively easy to install.

2.3.5.2 Negative Features of Plant Fragment Barriers

May require constant maintenance to ensure proper function. Some non-target aquatic organisms may not be able to navigate around or through the barrier. Does not reduce the ability of submersed aquatic invasive plants to propagate inside the barrier.

2.4 Alternative D: Chemical Control

Chemical control can be an effective and efficient way to manage aquatic invasive plants. All herbicides used in the United States must be registered by the United States Environmental Protection Agency (EPA). The EPA requires extensive scientific data on the potential health and environmental effects of an herbicide before granting a registration, which is a license to market that product in the United States. The EPA evaluates the data and ensures that the label translates the results of those evaluations into a set of conditions, directions, and precautions that define who may use a pesticide or herbicide, as well as where, how, the quantity, and the frequency with which it may be used. The herbicides selected for analysis are approved for aquatic use, as specified by the product label, by the EPA. EPA approved labels are available on the Pesticide Product and Label System database (https://iaspub.epa.gov /apex/pesticides/f?p=PPLS:1::::::). In Alaska, all herbicides must also be registered with the Alaska Department of Environmental Conservation (ADEC) prior to being sold.

The evaluation of chemical control methods requires an assessment of the toxicity of each chemical proposed for use. The toxicity of herbicides is typically assessed through laboratory toxicological studies. In these studies test organisms are exposed to varying concentrations of a substance and biological endpoints are measured at predetermined time intervals. The endpoint most often used in toxicological tests is death. A common way to compare the toxicity of different substances to a specific organism is to use experimentally derived median lethal concentration (LC50) values. The term LC50 describes the concentration of a substance required to kill 50 percent of test organisms during the specified test period. Other endpoints can be used, e.g., increased gill movements indicating more rapid respiration in fish. The highest dose or concentration of a substance that produces no observable effects on test organisms is called the no observable effect level (NOEL).

Prior to the purchase of pesticides (including herbicides) with Service funds, application of herbicide on Refuges, or application of herbicide by Service personnel, a Pesticide Use Proposal (PUP) must be submitted and approved by the Service's Regional Integrated Pest Management Coordinator. The PUP includes details about management objectives, action threshold, the proposed treatment site, the target pest, the pesticide proposed for use, application rate and methods, best management practices, and non-target impacts including to species listed under the ESA, or other species of conservation concern.

A Pesticide Use Permit administered by the ADEC is required for: all applications of pesticide by aircraft; all applications of pesticides to water (regardless of who owns the surrounding land); and for a pesticide program or project by a government entity (state, borough, or city) that applies pesticide to more than one property. As of August 28, 2019, the ADEC issued a General

Permit to apply pesticides for the control of elodea. An applicant who meets the specified conditions can apply for coverage under the General Permit. If coverage is granted, the applicant can use specified herbicide products (with the active ingredients fluridone or diquat dibromide) in non-flowing water to control elodea. Other conditions of the general permit include: the project is overseen or managed by the ADNR, no application within ¼ mile of a potable water intake, and no habitat for threatened or endangered species has been identified in the treatment area. Additional stipulations require permit holder to notify the public, obtain additional permits, use pesticides as specified by the label instructions, use a certified applicator, and maintain records of pesticide use. Public notice must be published in a newspaper no less than 15 days prior to treatment and notification signs must be posted around the perimeter of the treatment area where practical. An Alaska Pollution Discharge Elimination System permit must be obtained from ADEC Division of Water. Records of pesticide use must include all records under 18 AAC 90.415 and 420, the General Permit project tracking number, assessment of success or failure, any human health or safety issues, any observed effects on the environment, and an affidavit of publication for public notices (The State of Alaska elodea General Permit is available here: (https://dec.alaska.gov/eh/pest/ elodea-and-invasive-fish-control-projects/).

The active ingredients in herbicides selected for consideration in the chemical control alternative are diquat dibromide (diquat) and fluridone. While diquat and fluridone are a subset of all potential chemical control options, they were selected for analysis based on their effectiveness on the target species, documented use protocols for submersed aquatic invasive plant control, and low risk to humans and the environment. We used risk assessments for diquat and fluridone (funded by the USFS, USBLM, and Washington Department of Ecology) in our analysis (Durkin 2008, USBLM 2005, WA-ECY 2002, ENSR 2005). It is possible that other herbicide options (such as 2,4-D, endothall, and triclopyr) for submersed aquatic invasive plant management may be considered if elodea infestations don't respond to diquat and fluridone; this would require a thorough review of safety and efficacy of alternative herbicides. Prior to adoption, the environmental impact of other chemical control methods must be analyzed in accordance with the NEPA. The Level of NEPA review would depend on predicted impacts. Diquat and fluridone are discussed below.

2.4.1 Diquat

Diquat is the active ingredient in several non-selective (affects many different plants) contact herbicides used primarily to control submerged weeds. Four different liquid formulations of diquat are currently registered by the ADEC for use in Alaska, sold under tradenames: Reward Landscape and Aquatic Herbicide (EPA Registration No. 100-1091), Littora (EPA Registration No. 67690-53), Dessicash L&A Landscape & Aquatic Herbicide (EPA Registration No. 83529-12), and Tribune Herbicide (EPA Registration No. 100-1390). The full chemical name for diquat is 6,7-dihydrodipyrido (1,2-a: 2',1'-c) pyrazinediium dibromide. It is an organic solid of colorless or yellow crystals, or dark red-brown in water solution, and is highly soluble in water. In the presence of aluminum, diquat may pose a fire and explosion hazard.

The mode of action is cell membrane disruption that is activated by exposure to sunlight which results in formation of oxygen compounds that damage cell membranes (USBLM 2005). Diquat is not typically used for algae control and most species of algae are not affected strongly by diquat (WA-ECY 2002).

2.4.1.1 Effect on Elodea and other Submersed Aquatic plants

The following plants can be controlled by diquat, according to the product labels of various formulations: *Utricularia spp*., *Hydrilla verticillata*, *Myriophyllum spp*., *Potamogeton spp*., *Ceratophyllum demersum*, *Elodea spp*., *Egeria densa*, *Najas spp*., *Typha spp., Lemna spp. Hydrocotyle spp., Salvinia spp., Eichhornia crassipes, Pistia stratiotes*, *Spirogyra spp*., and *Pithophora spp*. (Syngenta 2009, Sharda 2016, SePRO 2019). As diquat is a contact herbicide it only affects the portion of a plant that it physically contacts. It is not effective in killing a plant's root system. However, diquat herbicides are fast acting and less expensive than other herbicide options. Diquat has been used in Alaska to control elodea infestations and reduce potential for spread via fragments while funding is secured to pursue further eradication efforts. Diquat has been used on the Kenai Peninsula and in Alexander Lake.

2.4.1.2 Toxicity

Diquat exhibits low acute toxicity to mammals via oral and dermal exposure, but has moderate to severe acute toxicity by inhalation exposure (Syngenta 2015). The threshold limit value (TLV) of a chemical substance is a level to which a human worker can be exposed day after day for a working lifetime without adverse effects. Threshold limit values are developed as guidelines and do not represent legal standards or consensus standards. The TLV for diquat is 0.5 mg/m^3 for inhalable particles and 0.1 mg/m^3 for respirable particles (Syngenta 2015). Diquat may be harmful to the eyes, gastrointestinal tract, kidneys, and liver of mammals (Gosselin et al. 1984). Kidney changes and cataracts were observed in dogs during a chronic toxicity test with a dose of 12 mg/kg/day (Syngenta 2015). In chronic feeding studies, rats exhibited no adverse effects when fed 0.58 to 0.8 mg active ingredient (a.i.)/kg/day (USBLM 2005). The Maximum Contaminant Level (MCL) established by EPA for diquat in drinking water is 0.02 milligrams per liter (mg/l) or 20 ppb (USEPA 2009).

For reference, diquat containing herbicide label specified treatment concentrations, in a four foot deep lake assuming complete mixing and a half lake treatment, range from less than 0.046 mg/l (at 0.5 gallons or 453 g a.i. per acre) to 0.18 mg/l (at 2 gallons or 1,814 g a.i. per acre). Environmentally relevant applications of diquat may be lower, as diquat is typically used to spot treat specific areas within a lake; the total treatment area would rarely or never be half of the waterbody. Further, the concentration of diquat in water drops quickly after treatment as it is removed by sorption to sediments and taken up by plants (Mackay et al. 1997).

A review of the toxicity literature for diquat, in Paul et al. 1994, indicates that diquat is highly toxic to some aquatic invertebrates and vertebrates. *Hyalella azteca*, an amphipod, is one of the most sensitive aquatic organisms tested with a 96-h LC50 of 0.048 mg/L (Wilson and Bond 1969). Gilderhus (1967) found a 96-h LC50 of 35 mg/l to bluegills *(Lepomis macrochirus*). The reported LC50s for early life stage walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*) range from 0.75 mg/l to 110 mg/l (Paul et. al. 1994). Laboratory exposure of coho salmon to diquat concentrations of 3.0 ppm diquat produced histopathological effects on eyes, kidney, gills, and liver (Lorz et al. 1979).

Diquat containing herbicide labels indicate no more than one half of a waterbody should be treated at one time and a waiting period of 14 days should occur between treatments. At the maximum application rate of 2 gallons per surface acre, diquat containing aquatic herbicide labels specify the following water use restrictions after treatment: zero days for fishing and swimming, one day for consumption by livestock and domestic animals, three days for drinking, and five days for irrigating food crops and production ornamentals (Syngenta 2009, SePRO 2019).

2.4.1.3 Persistence

In general diquat is not persistent in water but may persist for long periods in sediment (WA-ECY 2002, Langeland and Warner 1986). Diquat concentration in water decreased logarithmically after application to irrigation ponds in the southeastern United States, nearing non-detectable levels 35 hours post-application (Langeland and Warner 1986). It is primarily removed from water by sorption to sediments and uptake by plants (Simsiman et al. 1976). When bound to sediment in aquatic systems it is not biologically active (BLM 2005). Sediment sorption rates are highest in clay, loam, sandy clay loam, and sandy loam sediments (BLM 2005, Cochran et al. 1994). Little to no change was observed in sediment diquat concentration 180 days after treatment of a lake in Wisconsin (Simsiman and Chesters 1976). Microbial degradation has been reported (Simsiman et al. 1976, Funderburk and Bozarth 1967). It can also be degraded by sunlight (Smith et al. 1976, USEPA 1995). However, diquat was very stable in buffered water shielded from all light sources. Sampling to determine diquat concentration at periodic intervals after application should be part of any treatment plan.

2.4.1.4 Positive Features of Diquat

It is a quick-acting contact herbicide. Diquat can be used for targeted applications to reduce biomass thereby reducing risk of spread. It has been used in Alaska to control elodea with success.

2.4.2.5 Negative Features of Diquat

Diquat is toxic to some non-target organisms and may persist in sediments for extended periods of time. It does not kill the entire plant and additional methods must be used for complete eradication.

2.4.2 Fluridone

Fluridone is the active ingredient in several aquatic herbicide formulations used to control submersed weeds. The full chemical name of fluridone is 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1H)-pyridinone. Five different formulations of fluridone are currently registered by the ADEC for use in Alaska: two aqueous suspensions known as Sonar AS (EPA Registration Number 67690-4) and Sonar Genesis (EPA Registration Number 67690-54), and three time-released pellet forms known as Sonar Q (or SRP) (EPA Registration Number 67690-3), Sonar X PR Precision Release (EPA Registration Number 67690-12), and SonarONE (EPA Registration Number 67690-45). Fluridone is a selective systemic aquatic herbicide which inhibits the formation of carotene, a plant pigment, causing the rapid degradation of chlorophyll by sunlight, which then prevents the formation of carbohydrates necessary to sustain the plant (SePRO 2015, SePRO 2017, SePRO 2019a, SePRO 2019b, SePRO 2019c).

Like other systemic herbicides, fluridone is absorbed from water by plant shoots and by the roots of aquatic vascular plants (Marquis et al. 1981). The susceptibility of a plant to fluridone is associated with its uptake rate and rate of translocation. Fluridone symptoms in submersed aquatic plants appear as progressive albescence of young leaves followed by leaf necrosis, initially appearing three to six days after application (McCowen et al. 1979), but requiring 45 to 90 days for optimal lethality. Fluridone does not directly affect water quality parameters such as pH, dissolved oxygen, color, dissolved solids, hardness, nitrate nitrogen, total phosphates, and turbidity (McCowen et al. 1979). Although vegetative die-off of large infestations may temporarily lower dissolved oxygen concentration.

2.4.2.1 Effect on Elodea and other Submersed Aquatic Plants

Although fluridone is considered to be a broad spectrum herbicide, it is highly effective at killing elodea at relatively low concentrations of less than 150 parts per billion (ppb) because elodea is highly susceptible to its effects. Target levels across treatment areas in Alaska have been approximately 5 to 20 ppb (ADNR 2015, ADNR 2016). These levels have been successfully maintained in treatments across Alaska to date. Monitoring has shown that maintaining fluridone concentrations of 4 to 15 ppb over several growing seasons has proven effective in Alaskan elodea eradication efforts (KPCWMA 2019, Shenoy et al. 2019).

Fluridone controls a broad spectrum of vascular plants, but not algae (Bartels et al. 1978, Berard et al. 1978, McCowen et al. 1979, Marquis et al. 1981). The product labels of various formulations list the following plants as controlled by fluridone: *Utricularia spp., Ceratophyllum demersum*, *Elodea canadensis*, *Egeria densa*, *Cabomba caroliniana*), *Hydrilla verticillata*, *Najas spp*., *Potamogeton spp*. (except Illinois pondweed), *Myriophyllum spp*., (including *M. spicatum* x *sibiricum* hybrids), *Ruppia maritima*, *Nuphar luteum*, *Nymphaea spp*., *Brasenia schreberi*, *Lemna minor*, and *Salvinia spp*. Fluridone containing herbicides are labeled as partially controlling additional species (SePRO 2015, SePRO 2017, SePRO 2019a, SePRO 2019b, SePRO 2019c). Fluridone does not work on algae so water bodies with high algal concentrations should not be treated with this herbicide as the algal coating on plants can prevent herbicide absorption.

Fluridone may be applied to an entire waterbody or on smaller infestations within a waterbody. For the former, fluridone is generally applied as a liquid to the water surface or subsurface by boat or to the subsurface using a drip station. For partial waterbody treatments, fluridone is typically applied as time-release pellets. A targeted, partial-lake treatment will result in less herbicide to the lake, reduced treatment costs, and fewer non-target impacts. The ideal time for treatment is shortly after ice out when plant biomass is low, turbidity is low, water volume is low, and the plant is actively growing, but before a thermocline is established in the lake. Formation of a thermocline prevents uniform distribution of fluridone in the water column. However, fluridone can be applied at any time that target plants are photosynthesizing. The maximum allowable concentration, according to the product label, is 150 ppb (SePRO 2015, 2017, 2019a, 2019b, 2019c). However, fluridone concentrations of 4-15 ppb have proven effective in Alaskan elodea eradication efforts (KPCWMA 2019, Shenoy et al. 2019). Periodic water sampling and analysis are required to ensure effective concentrations are maintained and the maximum is not exceeded.

2.4.2.2 Toxicity

Based on a toxicological endpoint review conducted by the Service, fluridone is practically non-toxic to birds and mammals and slightly to moderately toxic to fish and aquatic invertebrates. According to the product label, the following uses can occur immediately after treatment: swimming, drinking, consuming fish from treated waters, consuming meat, poultry, eggs, or milk from livestock that were provided water from treated waters. There are restrictions on using treated water for irrigation. If fluridone concentrations are less than 10 ppb, there are no irrigation precautions for irrigating established tree crops, plants, row crops or turf. If measured fluridone concentrations are greater than 5 ppb, do not use to irrigate tobacco, tomatoes, peppers or other plants within the Solanaceae family and newly seeded crops or newly seeded grasses (SePRO 2015, SePRO 2017, SePRO 2019a, SePRO 2019b, SePRO 2019c).

Fluridone is toxic to fish and invertebrates at concentrations which are higher than the maximum allowable treatment concentration. A review of toxicological testing indicated the lowest LC50 observed in fish species tested was 1800 ppb (for early life stage walleye exposed for 96 hours) (Paul et al 1994). The lowest NOEL observed in aquatic invertebrates was 600 ppb (for juvenile *Penaeus duorarum* exposed for 96 hours) (Hamelink et al 1986). The maximum allowable concentration, according to fluridone products labels, is 150 ppb which is one fourth of the lowest reported NOEL for aquatic organisms.

2.4.2.3 Persistence

Fluridone is removed from treated water by degradation from sunlight, adsorption to sediments, and absorption by plants. In partially-treated water bodies, dilution reduces the level of the herbicide rapidly following application. In field studies, fluridone decreased logarithmically with time after treatment and approached the lower limit of detection 64 to 69 days after treatment (Langeland and Warner 1986). In other studies, fluridone levels decreased rapidly to a value below detection limits after 60 days in various parts of the water column, with a half-life ranging from 7 to 21 days (USBLM 2005, WA-ECY 2002, Muir et al. 1980, McCowen et al. 1979). Fluridone can persist in sediments with a half-life exceeding one year (Muir et al. 1980). Fluridone can persist for longer periods in the water column when applied in autumn due to lower water temperatures and low light levels. Sampling to determine fluridone concentration at periodic intervals after application is standard practice to ensure the target concentration has been achieved.

2.4.2.4 Positive Features of Fluridone

Fluridone is a highly selective and effective systemic chemical for elodea. It exhibits low non-target toxicity. Most uses of treated water bodies are not restricted. It can be used for whole waterbody treatment for large infestations, or spot treatment.

2.4.2.5 Negative Features of Fluridone

Long treatment time is required when using fluridone for eradication (several growing seasons in Alaska). Some non-target plants may be affected, but not typically at concentrations used for elodea. Use of fluridone treated water for irrigation may be restricted for the duration of treatment.

2.4.3 Combination of Fluridone and Diquat

Treatment of elodea with a combination of diquat and fluridone has been successful in Alaskan eradication projects. An initial diquat dose is combined with longer-term application of fluridone, to first reduce biomass and decreases risk of spread (diquat) while killing the remaining portions of the plant (fluridone). Management of dispersal risk is especially important in areas with high human use to prevent new infestations in nearby water bodies. When eradication is the management goal, the combination of fluridone and diquat can be an effective treatment strategy. This method may be particularly useful in water bodies with human vectors such as public boat launches, resident floatplanes, or high fishing and hunting use.

2.4.3.1 Positive Features of the Combination of Fluridone and Diquat

The combination of herbicides can increase the likelihood of containing an infestation quickly (diquat) while eradication treatment (fluridone) is ongoing. Other positive features of this method are described in Sections 2.4.1.5 and 2.4.2.5.

2.4.3.2 Negative Features of the Combination of Fluridone and Diquat
The negative features of this method are described in Sections 2.4.1.5 and 2.4.2.5.

2.5 Alternative E: IPM Strategy (preferred alternative)
Under this alternative, management of elodea and other submersed aquatic invasive plants would be guided by an IPM strategy that includes a range of management options which could be used alone or in combination. The IPM strategy is a sustainable approach to managing aquatic invasive plants that uses available tools to minimize health, environmental, and economic risks. Important aspects of a sound IPM strategy include: clear management goals, science based decision making, and monitoring.

The IPM strategy alternative provides decision makers more flexibility in selecting appropriate tools to accomplish management goals. The proposed management tools can be grouped into three broad categories, cultural control, physical control, and chemical control.

2.5.1 Cultural Control
Refer to Section 2.2 for a discussion of cultural control techniques included in this alternative.

2.5.2 Physical Control
Refer to Section 2.3 for a discussion of physical control techniques included in this alternative.

2.5.4 Chemical Control
Refer to Section 2.4 for a discussion of chemical control techniques included in this alternative.

2.6 Alternatives Considered but Dismissed
This section describes alternatives that were considered but ultimately dismissed from detailed analysis. They are generally methods that have been used to control submersed aquatic invasive species in other locations. These methods were determined to not meet the purpose and need, were not legal to implement in Alaska, or were perceived as not feasible.

2.6.1 Biological Control
Case studies of biocontrol programs for submerged aquatic invasive plants show mixed success. Non-target effects and other unforeseen consequences of biocontrol efforts are major risks that must be considered when using this control method (Messing and Wright 2006, Louda and Stiling 2004). Biological control options considered in this EA include herbivorous fish, herbivorous insects, and plant pathogens. New biological control options, such as precise genome editing, may be available in the near future. Precise editing of plant genomes has been accomplished in laboratory experiments with CRISPER/Cas9 technology (Belhaj et al. 2014). However, widespread use of bioengineering methods poses technical, ecological, and ethical questions that have yet to be addressed.

2.6.1.1 Herbivorous Fish
One biological control method in widespread use against aquatic invasive plants is the herbivorous grass carp (*Ctenopharyngodon idella)*. Fish that have been modified to have three sets of chromosomes (triploid) are typically used because they are not able to reproduce. Diploid grass carp are a highly invasive species which are causing problems throughout the Mississippi River drainage. The grass carp is a fish native to rivers in China and Siberia. (Bain 1993). Stocking Alaska lakes is regulated by Alaska Statute 16.05.251(a)(9), which states "The Board of Fisheries may adopt regulations it considers advisable in accordance with AS 44.62 (Administrative Procedure Act) for prohibiting and regulating the live capture, possession, transport, or release of native or exotic fish or their eggs." Acquiring a permit to stock triploid

carp in Alaska would likely be challenging. No permits for stocking with triploid grass carp have been issued to date in Alaska. Introducing grass carp would have serious consequences for native vegetation as they do not feed selectively. The resulting reduction or elimination of aquatic vegetation would impact all aquatic organisms (Bain 1983). Introducing non-native species is against Service policy and legislative mandates and is not considered a reasonable alternative.

2.6.1.2 Herbivorous Insects

There are not any insects currently used to control invasive elodea infestations. However, the use of insects in Eurasian watermilfoil control has been investigated (Sheldon and Creed 1995). Weevils that prey on the closely related *Myriophyllum sibiricum* (northern milfoil) often occur naturally where northern milfoil grows in the United States. The milfoil weevil feeds on the upper leaves and reproduces on the milfoil plant by burrowing into the stems. Further damage to the plant may be caused by collapsing the stems, forcing the upper canopy of the plant out of the well-lit water. It is beneficial to stock weevils as early in the season as possible to increase the number of generations. A general guideline is to stock 3,000 insects per acre for effective control within two seasons (Sheldon and Creed 1995). There is not a permit available for weevil stocking in Alaska at this time. Additionally, no permits for stocking lakes with weevils have been issued to date. This method would likely impact native milfoil species and possibly other plant species the weevils may find attractive. This method is unproven, would affect native species, and does not result in eradication.

2.6.1.3 Plant Pathogens

The use of the fungus species in the genus Fusarium to control elodea and other submersed aquatic invasive plants has been investigated in small scale studies (Andrews and Hecht 1981, Borges-Neto and Pitelli 2004). This biological control would not be available for use in Alaska until it successfully goes through the United States Department of Agriculture Animal and Plant Health Inspection Service - Plant Protection and Quarantine (PPQ) biological control testing program. It is unlikely that PPQ would select this as a testing candidate as elodea is native to the contiguous United States.

2.6.1.4 Current Barriers to Use of Biological Control

Herbivorous fish, herbivorous insects, and plant pathogens, are not currently viable options for control of elodea and other submersed aquatic invasive plants in the Alaska Region for legal and ecological reasons. Biological control options should continue to be considered as a control strategy. If, in the future, reasonable biological control options become available then they should be evaluated at that time. Prior to adoption, the environmental impact of other biological control methods must be analyzed in accordance with NEPA. The Level of NEPA review would depend on predicted impacts.

3.0 Affected Environment

The potentially affected environment for this EA is the Alaska Region (**Appendix A - Figure 7**). This section of the document is meant to describe baseline conditions. The impacts, or deviations from baseline conditions, associated with each alternate are discussed in Section 4. The Alaska Region covers an area of approximately 365 million acres, which is about one fifth the size of the contiguous United States. Approximately 61 percent (224 million acres) of the Alaska Region is U. S. Government owned public land. Federal land management agencies in Alaska include: Service (77 million acres), Bureau of Land Management (72 million acres), NPS (52 million acres), USFS (22 million acres), and the Department of Defense (0.7 million Acres) (Vincent et al. 2017). The state of Alaska manages approximately 90 million acres. The largest private landowners in Alaska are Native Regional Corporations and Native Village Corporations with combined ownership of approximately 44 million acres (ADNR 2000).

The majority of Refuges within the Alaska Region are within two bands across the state. One extends diagonally from northeast to southwest between the Brooks Range and the Alaska Range; the second extends east to west along the Alaskan and Seward Peninsulas and the Aleutian island chain. Additionally, the Arctic Refuge extends north of the Brooks Range to the arctic coastal plain. Many Refuges were established in part for the conservation of migratory birds, and thus typically exist at lower elevations in the Alaska Region than lands managed by other agencies like the NPS and the USFS (Woodward and Beaver 2011).

The Alaska Region is a large and diverse geographic area. A useful method for understanding and discussing large geographic areas is to divide them into smaller areas with similar climate, soils, and vegetation called ecological regions. Ecological regions are areas of general similarity in the type, quality, and quantity of environmental resources. They serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems. The coarsest division are known as Level 1 Ecological Regions. Alaska can be divided into four Level 1 Ecological Regions called the Tundra, Taiga, Northwestern Forested Mountains, and Marine West Coast Forest (Commission for Environmental Cooperation Working Group 1997, Wiken 1986, and Omernik 1987). These four Level 1 Ecological Regions are discussed below.

The area of Alaska that lies north of the Brooks Range is predominately classified as tundra. The tundra ecological region is underlain by granitic and sedimentary bedrock. The terrain consists largely of broadly rolling uplands and lowlands. The climate is characterized by long, cold winters and short, cool summers. Mean annual temperature ranges from –17 degreesCelsius (ºC) to –7°C. The summer growing season is short but is enhanced by long periods of daylight. The annual precipitation varies from 100 millimeters (mm) to 500 mm. Snow may fall any month of the year and usually persists on the ground for at least 10 months. Vegetation is characterized by dwarf shrubs that decrease in size moving north. River valleys support scattered spruce trees and shrubs including dwarf birch and willows. Wetlands are common in the low-lying areas, mainly supporting sedge and moss species (Commission for Environmental Cooperation Working Group 1997). Much of the Alaskan Peninsula and Aleutian Islands can also be classified as tundra. This maritime tundra generally exhibits higher mean temperatures and more precipitation than tundra found in more interior regions of Alaska.

The area of Alaska that lies south of the Brooks Range and north of the Alaska Range is predominately classified as taiga. The taiga ecological region is underlain by horizontal sedimentary rock creating a nearly level to gently rolling plain covered with organic deposits, hummocky moraines and lacustrine deposits. Many lakes and wetlands occupy glacially carved depressions and permafrost is widespread. The climate is characterized by relatively short summers with prolonged periods of daylight and cool temperatures. Winters are typically long and cold. Mean annual temperatures range from –10°C to 0°C. Mean annual precipitation ranges from 200 to 500 mm. Snow and freshwater ice may persist for six to eight months annually. Vegetation is characterized by wetlands and forests mixed with open shrublands and sedge meadows. Common species include dwarf birch, Labrador tea, willow, bearberry, mosses, sedges, spruce, jack pine, alder, willow and tamarack (Commission for Environmental Cooperation Working Group 1997).

Portions of the Brooks Range and the Alaska Range are classified as northwestern forested mountains. The northwestern forested mountains ecological region consists of extensive mountains and plateaus separated by valleys and lowlands. Soils vary from shallow and nutrient poor in alpine areas to deeper nutrient rich soils in valley bottoms. The climate varies with elevation and can be sub-arid to arid and mild in lower valleys while humid and cold at higher elevations. Moist Pacific air controls the precipitation pattern so that both rain shadows and wet areas can exist in close proximity to each other. Mean annual temperatures range between –6°C in the north to 10°C in south. Annual precipitation varies considerably with elevation and geographic location (Commission for Environmental Cooperation Working Group 1997).

Much of Alaska's southern Pacific coastline can be classified as marine west coast forests. The marine west coast forests ecological region is dominated by mountainous terrain and glacial valleys bordered by coastal plains. The soils are generally composed of colluvium and glacially deposited material. The temperature is moderated by the Pacific Ocean. The annual precipitation ranges from as little as 600 mm to over 5,000 mm. The vegetation varies with elevation from coastal rain forest to cool boreal forests and alpine species at higher elevations (Commission for Environmental Cooperation Working Group 1997).

Although the entire Alaska Region is under consideration in this analysis, the resource descriptions will be focused on resources and uses that occur in suitable habitat for submersed aquatic invasive plants. Elodea and other submersed aquatic invasive plant habitat is characterized by still or slow moving, relatively clear, fresh water. All of Alaska's ecological regions contain suitable habitat for submersed aquatic invasive plants. Terrestrial resources and uses are also discussed because management actions targeting those plants may have impacts that extend to the surrounding terrestrial environment. Marine environments were not included in the analysis because the invasive plants considered in this EA cannot survive in salt water.

3.1 Water Resources

Alaska has extensive fresh water resources. Quantity and quality of these resources could be affected by submersed aquatic invasive plants. Any submersed aquatic invasive species management action must comply with the Clean Water Act, the Alaska Pollutant Discharge Elimination System Program (APDES), and the Alaska Water Use Act.

The Clean Water Act regulates discharges into waters of the United States, including wetlands. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. In 2008, the State of Alaska applied to implement the NPDES Program. The EPA approved the application and agreed to transfer program authority to the State over four phases. Full transfer of authority to Alaska's NPDES equivalent program, APDES, was completed in 2012. An APDES permit is necessary for certain submersed aquatic invasive plant management actions, like chemical control.

The Alaska Water Use Act regulates the diversion, impoundment, or withdraw of water for a specific use. The act is administered by ADNR, which is the state agency that grants water rights. A water right is a legal right to use surface or groundwater under the Alaska Water Use Act. A water right or exemption may be necessary for certain submersed aquatic invasive plant management actions, such as drawdown.

3.1.1 Water Quantity

Alaska contains vast quantities of fresh water with more than 40% of the nation's surface water resources. Approximately 75 percent of all fresh water in Alaska is stored as glacial ice. Alaska has more than three million lakes, over 12,000 rivers and numerous ponds, streams, and wetlands. Many of Alaska's lakes and streams are frozen, or partially frozen, for five tosix months of the year. In late April and May, the snow melts, and the lakes and streams thaw. Surface water supplies approximately 75 percent, or about 300 million gallons per day, of the state's water needs for industry, agriculture, mining, fish processing, and public water use. Hydroelectric power plants use approximately 1,400 million gallons per day of surface water to generate 20 percent of the state's electricity (ADNR 2019b). Submersed aquatic invasive plants may affect water quantity by reducing flow in natural channels, irrigation channels, water supply intakes, and hydroelectric infrastructure.

Alaska has the greatest groundwater resources of any state in the United States. Groundwater resources are used for most domestic needs around the state. Groundwater supply aquifers range from extremely small thaw bulbs in permafrost to large regional aquifers. The extensive permafrost around the state provides challenges to the development of groundwater resources. In many parts of Alaska, steep topography limits the size of most aquifers, preventing large scale extraction. Groundwater is also used for bottled water export and many industrial operations (ADNR 2019c).

3.1.2 Water Quality

Most of Alaska's waters are suitable for the following beneficial uses: water supply (e.g., drinking, agriculture, aquaculture, industrial); water recreation; growth and propagation of fish, shellfish, aquatic life, and wildlife. Some beneficial uses are limited by natural water quality conditions in Alaska such as suspended sediment in glacial water bodies; highly mineralized water bodies; microorganisms such as giardia, schistosoma, and high bacterial counts from decomposing salmon in streams. Beneficial uses may also be limited by human activities such as natural resource development, urban development, and military development. The presence of submersed aquatic invasive plants and management actions to control them may affect water quality.

3.2 Air Resources

Alaska has variable air quality. Human caused and natural air pollution can be hazardous at times, especially to sensitive portions of the population. The broad types of air pollution observed in Alaska include particulate matter, ozone, and carbon monoxide (TALA 2019). Potential sources of this pollution include combustion engines, smoke from wildfires, smoke from woodstoves, combustion related to energy production, dust, and volcanic ash. The Clean Air Act defines the EPAs responsibilities for protecting and improving the nation's air quality. The Clean Air Act requires the EPA and states to carry out programs to assure attainment of the National Ambient Air Quality Standards. Management actions designed to control submersed aquatic invasive species may affect air resources.

3.3 Sediment and Soil Resources

As defined by the Soil Science Society of America, a soil is the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants (NRCS 2019). Areas are not typically considered to have soil if they are covered by water too deep for the growth of rooted plants. The material that is covered by water too deep for the growth of rooted plants is called sediment. Sediment is solid material that is or has been transported by water to a lower landscape position.

Soils found in the same areas as submersed aquatic invasive plants would be considered hydric. A hydric soil is defined as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (NRCS 2018). Since these soils contain very little oxygen the breakdown of organic matter is slower than in oxygen rich environments. The presence of submersed aquatic invasive plants and management actions to control them may affect hydric soil and sediment.

3.4 Fish and Wildlife Resources

Diverse and abundant fish and wildlife are central to Alaska's economy and people. Over 1,000 native vertebrate species are found in the state, sometimes in huge numbers. Combined sockeye salmon runs to Bristol Bay have recently averaged 33 million fish per year (Baker et al. 2006). On the Copper River Delta alone, five to eight million shorebirds stop to forage and rest each spring on their way to arctic breeding grounds. Alaska has 32 species of carnivores and, many of them feed on fish and other aquatic organisms. Most of Alaska's fish and wildlife populations are considered healthy (ADF&G 2019b). The following discussion of fish and wildlife resources will be focused on species that utilize habitats which are also suitable for submersed aquatic invasive plants.

Important pieces of federal legislation that impact fish and wildlife resources in Alaska include: the Pacific Salmon Treaty Act, the Migratory Bird Treaty Act, the Gold and Bald Eagle Protection Act, the Dingell-Johnson Sportfish Restoration Act, the Pittman-Robertson Wildlife Restoration Act, the Fish and Wildlife Coordination Act, and the Marine Mammal Protection Act. Even though these Acts do not have an obvious connection to invasive species management, they should be considered in any Service submersed aquatic invasive plant management strategy.

The Alaska National Interest Lands Conservation Act (ANILCA) also affects fish and wildlife resources in Alaska. The ANILCA stipulates the designation of Wilderness, subsistence management, transportation, mining, archaeological sites, scientific research studies and other activities on federal lands. The ANILCA is discussed further in Section 3.6 of this document because of its effects on land use. A brief discussion of the remaining legislation is presented below.

3.4.1 Fish

Fish species that in live in suitable submersed aquatic invasive plant habitat can be divided into two broad groups, resident and anadromous, based on life history. Resident species tend to occupy one waterbody for their entire live cycle. Anadromous species usually spend a portion of their life in a lake or ocean then migrate up a freshwater stream to spawn. Common resident freshwater native fish species in Alaska include Artic grayling (*Thymallus arcticus*), whitefish species (*Coregoninae sp.*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus catostomus*), Alaska blackfish (*Dallia pectoralis*), northern pike (*Esox lucius*), burbot (*Lota lota*) and sculpin species (*Cottus sp.*). Common anadromous native fish species in Alaska include lamprey species (*Lampetra sp.*), pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*Oncorhynchus keta*), coho salmon, sockeye salmon, Chinook salmon, rainbow trout, Arctic char (*Salvelinus alpinus*), dolly varden (*Salvelinus malma),* rainbow smelt *(Osmerus mordax),* and longfin smelt *(Spirinchus thaleichthys)* (ADF&G 2019b).

In Alaska, the Salmonid family may be the most important group of native fishes in terms of their ecological, cultural, and commercial importance. All members of this group, which include salmon, trout, char, and whitefish, require relatively pristine, cold freshwater habitats during part or all of their life cycles. This group is a popular target of recreational anglers, subsistence harvests, and commercial fisheries.

3.4.2 Amphibians and Reptiles

Amphibians present in Alaska that may utilize suitable submersed aquatic invasive plant habitat include the wood frog (*Rana sylvatica*), Columbia spotted frog (*Rana luteiventris*), roughskin newt (*Taricha granulosa*), long-toed salamander (*Ambystoma macrodactylum*), northwestern salamander (*Ambystoma gracile)*, and western toad (*Bufo boreas*) (ADF&G 2019b). The wood frog is the most common amphibian in Alaska and is the only frog that lives north of the Arctic Circle. There are no reptiles in Alaska that utilize freshwater habitat.

3.4.3 Aquatic Invertebrates

The term aquatic invertebrate encompasses a wide range of organisms, from fresh water sponges to planktonic crustaceans. It also includes insects that spend all or portions of their lives in water. Aquatic invertebrates are often important in the diet of fish, birds, and some mammals. For example zooplankton are the primary food resource for many juvenile salmonids (e.g., sockeye salmon). Mussels are also considered aquatic invertebrates. There are three native freshwater mussels in Alaska: *Anodonta beringiana*, *Anodonta kennerlyi*, and *Margaritifera falcate* (Smith et al. 2005). Freshwater mussels such as these help clean water and have been used as food resources. Aquatic environments also typically contain aquatic insects from multiple orders including: Diptera, Ephemeroptera, Odonata, Plecoptera, and Trichoptera.

3.4.4 Birds

Waterfowl and shorebirds utilize the suitable submersed aquatic invasive plant habitat across Alaska. Many bird species that utilize aquatic habitat are migratory and spend the summer in Alaska to nest and raise their young. Other species, like the tundra swan (*Cygnus columbianus*) on Izembek National Wildlife Refuge, are non-migratory. Waterfowl and shorebirds use aquatic environments in different ways. Some species, like the surf scoter (*Melanitta perspicillata*), dive underwater to feed on crustaceans and fish. Other waterfowl species, like the northern pintail (*Anas acuta*), feed on plant material and insects from the surface of the water. Shorebirds, like the western sandpiper (*Calidris mauri*), often feed on aquatic invertebrates at the edge of shallow water (BNA 2019).

3.4.5 Mammals

Many mammal species inhabit Alaska but only some of those species regularly utilize aquatic habitat. beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*), mink (*Neovison vison*), moose (*Alces alces gigas*), and the brown bear (*Ursus arctos*) are common mammal species that utilize the suitable submersed aquatic invasive plant habitat across all of Alaska (ADF&G 2019b).

Some of these mammals that use aquatic habitat are important game species in Alaska. Hunting and trapping are popular activities. The State manages these species to provide hunting and trapping opportunities.

3.4.6 Federally Listed Threated and Endangered Species

There are currently 40 species listed as threatened or endangered under the ESA that may occur in the Alaska Region. A table presenting the common name, scientific name, status, presence of critical habitat, and management agency for these species is included in this document as **Appendix C**. The majority of ESA listed species in the Alaska Region are restricted to marine habitat and managed by the National Oceanographic and Atmospheric Administration (NOAA). Most of these marine species would not be affected, directly or indirectly, by freshwater submersed aquatic invasive plants or management actions to control them. Indirect impacts to marine species, like the Cook Inlet beluga whale (*Delphinapterus leucas*) that rely heavily on anadromous fish for food (NMFS 2016), are possible if submersed aquatic invasive plant infestations become much more widespread and negatively impact anadromous fish populations. There is no overlap between current elodea infestations and ESA listed species managed by NOAA. However, Critical Habitat for the Cook Inlet beluga whale and Steller sea lion (*Eumetopias jubatus*) exists in marine environments near current elodea infestations. If the scale of submersed aquatic invasive plant infestations and associated treatment actions required to manage them increases this would constitute new information revealing that the effects of the action may affect NOAA managed species or designated critical habitat in a manner or to an extent not previously considered and consultation with NOAA should be initiated.

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

The Eskimo curlew was once an abundant shorebird in North America, but unrestricted harvest in the late 1800s decimated the population. Loss of habitat and important prey species contributed to the population decline. The species was listed as endangered under the ESA in 1973. The species is considered possibly extinct with the last confirmed sighting in 1963. There have been reports of Eskimo curlew sighted as recently as 2006, but none of these observations have been confirmed. There is no critical habitat designated for the Eskimo curlew. Critical habitat is not required for species listed under the ESA prior to 1978 (USFWS 2016).

Designated critical habitat for the spectacled eider is present in the western portion of Yukon Delta Nation Wildlife Refuge. Coastal wetlands from the Kokechik River south to the Kinia River are part of the designated critical habitat. Designated critical habitat for the Steller's eider is present in the western portion of Yukon Delta Nation Wildlife Refuge and in areas along the norther edge of the Alaskan Peninsula. Some of this designated critical habitat may overlap with suitable submersed aquatic invasive plant habitat. This habitat is primarily used for breeding and fledging. Both species overwinter at sea. During the breeding season hens and broods feed in freshwater ponds and wetlands, eating aquatic insects, crustaceans, and vegetation. Males return to the marine environment after incubation begins (USFWS 2010, Petersen et al. 2000).

Critical polar bear habitat includes terrestrial denning lands within 32 kilometers (km) of the northern coast of Alaska between the Canadian border and the Kavik River and within 8 km of the northern coast of Alaska between the Kavik River and Barrow (USFWS 2017). This terrestrial denning habitat may be adjacent to suitable submersed aquatic invasive plant habitat. However, polar bear use this habitat when water is frozen so impacts from submersed aquatic invasive plant management actions are unlikely.

Wood bison were present in Alaska for nearly 10,000 years but disappeared from the State approximately 200 years ago. Populations of wood bison continued to survive in portions of Canada. An experimental population was established in the lower Innoko/Youkon River area in 2015 (AWBMPT 2015). As of 2015, the wild wood bison population in Alaska was approximately 120 to 130 individuals. Wood bison are grazers that sometimes feed on hydrophytic vegetation (ADF&G 2019). This population is listed as a nonessential experimental population under the ESA which eases the take prohibitions and consultation requirements of the ESA (USDOI 2014). Wood bison habitat may overlap with suitable submersed aquatic invasive plant species habitat.

3.4.6.1 Section 7 Consultation

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

3.5 Vegetation and Wetland Resources

As with other groups of organisms, the plant species that are most likely to be affected by management actions are those that utilize the same habitat as submersed aquatic invasive plants. A useful resource for understanding which aquatic plants might be found in Alaska is the United States Army Corps of Engineers (USACE) Regional Wetland Plant List. The USACE has developed extensive regional lists of plants, which are further divided into categories based on likelihood of being found in a wetland. The obligate wetland plant category almost always occur in wetlands. These plants are found in standing water or seasonally saturated soils (Lichvar et al. 2012).

There are 261 species of obligate wetland plants listed on the USACE Regional Wetland Plant List for Alaska (Lichvar et al. 2016). These obligate wetland plants fall into four categories, submersed, floating, floating leaved, and emergent, depending on where they are found. Submersed plants conduct nearly all of their growth and reproductive activity under water. Examples of native submersed plants in Alaska include shortspike watermilfoil (*Myriophyllum sibiricum)* and flat-stem pondweed (*Potamogeton zosteriformis).* Floating plants most often grow with the leaves and other vegetative and reproductive organs floating on the water surface. Examples of native floating plants in Alaska include common duckweed *(Lemna minor)* and Pacific azolla (*Azolla filiculoides)*. Floating-leaved plants are rooted in sediment but also have leaves that float on the water surface. Examples of floating-leaved plants in Alaska include pond lily (*Nuphar polysepala*), and pygmy waterlily (*Nymphaea tetragona*). Emergent plants grow with their bases submerged and rooted in inundated sediment or seasonally saturated soil and their upper portions, including most of the vegetative and reproductive organs, growing above the water level. Examples of emergent plants include *Carex spp*., duck potato (*Sagittaria cuneata*), and broadleaf cattail (*Typha latifolia*) (Lichvar et al. 2012, CLR 2009).

3.5.1 Wetlands

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

3.5.2 Federally Listed Threated and Endangered Plant Species

There is only one ESA listed plant species in the Alaska. The Aleutian shield fern (*Polystichum aleuticum*) is listed as endangered under the ESA. The extant population of Aleutian shield fern is currently estimated at a minimum of 131 individuals all of which are found on Mt. Reed on Adak Island. Most plants occur in a narrow microhabitat, between 1,108 feet and 1,725 feet in elevation, consisting of rock grottos and moist crevices at the base of steep rock outcrops on the northeast arm of Mt. Reed (USFWS 2018). It is highly unlikely that suitable habitat for submersed aquatic invasive plants is present in the vicinity of this species.

3.6 Land Use

There are approximately 365 million acres of land in Alaska. Most of that land is public and managed by the State or the Federal government (Vincent et al. 2017, ADNR 2000). Federal and State administered lands are depicted in **Appendix A - Figure 8**. Alaska Native villages and native corporations, established with passage of the Alaska Native Claims Settlement Act in 1971, are the largest private land owners in the state with approximately 44 million acres. Other private land makes up less than one percent of Alaska. Most human associated development is concentrated on these private lands. Public land in Alaska is managed for a variety of uses including subsistence harvesting, recreation, and commercial activities. Many of these use opportunities exist because of the abundant native species and natural diversity found in Alaska. The establishment of submersed aquatic invasive plants may affect native species and subsequently subsistence, recreational, and commercial uses. Public land use will be the focus of this section. Some important federal regulations that pertain to public land use are the Wilderness Act and the ANILCA.

The Wilderness Act of 1964 established the National Wilderness Preservation System, which today has grown to more than 104 million acres. Approximately 57 million acres are designated Wilderness under the Wilderness Act in Alaska. These areas have many use restrictions enacted to maintain the lands wilderness character as required by the Wilderness Act. The Service manages 21 designated Wilderness areas totaling approximately 18.6 million acres on 10 National Wildlife Refuges units in Alaska. Other federal agencies, like the USFS and the NPS also manage Wilderness acres in the State.

The ANILCA of 1980 created nine National Wildlife Refuges, expanded existing National Wildlife Refuges, and created other public parklands in Alaska. The majority of Wilderness areas on Refuges in Alaska were designated with passage of the ANILCA, which also modified some provisions of the Wilderness Act to allow for the continuation of subsistence lifestyles and traditional activities. The ANILCA stipulates the designation of Wilderness, subsistence management, transportation, mining, archaeological sites, scientific research studies and other activities on Refuges and national parklands. Wilderness lands on Alaska Refuges are managed according to the provisions of the Wilderness Act, except where there is a conflict with the ANILCA, in which case the provisions of the ANILCA prevail.

Performing management actions in designated Wilderness can be present unique challenges due to use restrictions imposed on Wilderness. Invasive species, pests, and diseases may be controlled in wilderness areas when at least one of the following three conditions is met: 1) A high probability exists that they will degrade the biological integrity, diversity, environmental health, or character of a wilderness area.; 2) There is a significant threat to the health of humans.; or 3) There is a significant threat to the health of wildlife and habitat. In 2019, elodea was found in Sandpiper Lake which lies in designated Wilderness in the Kenai National Wildlife Refuge.

3.6.1 Subsistence Use

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

With the passage of ANILCA, Alaska became the only state where the subsistence use of fish and game is given the highest-priority for consumptive use. ANILCA Section 101 (c) states a purpose of the Act is to provide the opportunity for rural residents engaged in a subsistence way of life to continue to do so, consistent with recognized scientific principles to manage fish and wildlife resources and the purposes for which the conservation system units were established. All ANILCA land use decisions are to include an evaluation of the effects to subsistence uses prior to making the decision.

Section 810(a) of ANILCA requires that an evaluation of subsistence uses and needs be completed for any federal determination to "withdraw, reserve, lease, or otherwise permit the use, occupancy or disposition of public lands." As such, an evaluation of potential impacts to subsistence under ANILCA § 810(a) must be completed for each alternative.

Subsistence harvests may provide a majority of calories consumed per year for some Alaskans. Subsistence harvest of fish and game is particularly important for rural Alaskans where commercially available food is expensive and sometimes difficult to obtain. Subsistence use activities could spread elodea and other submersed aquatic species. Submersed aquatic invasive plants could also threaten subsistence use by making travel challenging if waterways become overrun, and also threaten important subsistence resources like salmon. Prior to any Service management action, affected Alaska Native tribes and Alaska Native Corporations will be consulted.

3.6.2 Recreational Use
Recreational opportunities are numerous in Alaska. Public lands provide visitors with a wide range of recreational opportunities, including hunting, fishing, camping, hiking, dog mushing, cross-country skiing, boating, hang gliding, off-highway-vehicle driving, mountain biking, birding, viewing scenery, and visiting natural and cultural heritage sites. Many of these activities take place on or near water like fishing, boating, hunting, camping, and wildlife viewing.

Recreational land use, specifically floatplane use, boating, fishing, and hunting can spread aquatic invasive plants. These uses may also be negatively impacted by aquatic invasive plants.

3.6.3 Commercial Use
Commercial use of public land in Alaska includes a wide range of activities with varying impacts on the land. Activities that are considered a commercial use of land could be temporary and have minimal impact, like an outfitter taking clients hunting on a Refuge. Commercial use may also include activities that are longer in duration and that have a larger impact on the land, such as development of a mine. Commercial uses of public land may also involve hydroelectric power generation.

Commercial land use, specifically floatplane use and boating, can spread aquatic invasive plants. These uses may also be negatively impacted by aquatic invasive plants. Hydroelectric power generation may also be negatively impacted by aquatic invasive plants.

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

Federal laws passed with the aim of protecting historic sites with cultural significance include: the Historic Sites Act National Historic Preservation Act, the Archeological Resources Protection Act, The American Indian Religious Freedom Act of 1978, and the Native American Graves Protection and Repatriation Act of 1990. Any management action to control submersed aquatic invasive plants must comply with these Acts.

3.7.1 Documented Cultural Resources
Cultural resources have been identified throughout Alaska. Identified cultural resources are typically in terrestrial environments. Cultural resources that once were in terrestrial environments may now be present in aquatic environments due to geologic process and changes in climate. Little research has focused on identifying cultural resources underwater in Alaska (Dixon and Monteleone 2014). Undocumented cultural resources may be present in aquatic environments.

3.8 Human Health and Safety
People living in Alaska are exposed to a variety of risks common to the United States as a whole, including: contaminants in the air, water, soil, and food; automobile accidents and other injuries; and various diseases. Federal regulations that protect human health from possible negative

effects of submersed aquatic invasive plant management actions include: the Federal Insecticide, Fungicide and Rodenticide Act; the Resource Conservation and Recovery Act (RCRA); and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The Federal Insecticide, Fungicide and Rodenticide Act establishes procedures for the registration, classification, and regulation of all pesticides. Before any pesticide may be sold legally, the EPA must register it. The EPA may classify a pesticide for general use if it determines that the pesticide is not likely to cause unreasonable adverse effects to applicators, or the environment, or for restricted use if the pesticide must be applied by a certified applicator and in accordance with other restrictions. The RCRA regulates the disposal of toxic wastes, including the disposal of unused herbicides, and provides authority for toxic waste cleanup actions when there is a known operator. The CERCLA regulates how to clean up spills of hazardous materials and when to notify agencies in case of spills.

3.8.1 Drinking Water

Both surface water and groundwater are used as drinking water sources in Alaska. Residents that live in population centers often get their water from a public water system regulated by the ADEC- Division of Environmental Health. Rural residents often obtain their drinking water from private wells or surface water sources.

3.8.2 Fish and Wildlife Consumption

Many Alaska residents consume wild caught fish and wild game. Portions of the population, particularly Alaska Native and rural residents, obtain most of their calories from wild foods. Some herbicides have the potential to bioaccumulate in fish and wildlife species. The potential for bioaccumulation of herbicides used in submersed aquatic invasive plant management is discussed in Section 4.4 of this document.

3.8.3 Agriculture

In 2017 (the most recent year data was available), Alaska ranked 49th in the United States in value of crops sold. The top five crops produced, in order of acres planted, were forage, barley, vegetables, oats, and potatoes (USDA National Agricultural Statistics Service 2017). Water treated with herbicides may not be used for irrigation of crops in some instances. Restrictions on irrigation water use after submersed aquatic invasive plant management actions are discussed in Section 4.4 of this document.

3.8.4 Livestock

In 2017 (the most recent year data was available), Alaska ranked 49th in the United States in value of livestock and poultry products sold. The four most common types of livestock were: chickens, cattle, goats, and pigs (USDA National Agricultural Statistics Service 2017). The use of herbicide treated water for livestock drinking may be restricted depending on the specific herbicide used. Herbicide can be transferred to animal tissue and milk after ingestion (Stevens and Walley 1966). Restrictions on livestock water use after submersed aquatic invasive plant management actions are discussed in Section 4.4 of this document.

4.0 Environmental Consequences

This section discloses and analyzes the environmental effects that may result from selection and implementation of the alternatives described in Section 2.0 of this EA; these effects are presented in a summary table in Section 4.6. In this EA, an environmental impact or effect is any change from the present condition of any resource or issue that may result as a consequence of implementation of one of the alternatives. The NEPA requires federal agencies to examine and disclose the potential impacts on the human environment of proposed projects or activities that require federal approval. Impacts were analyzed by considering the effect of each alternative on each of the resources described in Section 3.0 Affected Environment. The impact analyses and conclusions were based on the review of peer reviewed scientific literature, other published literature, information provided by partner organizations, agency and partner staff professional judgment, and public input.

The effects on resources and uses are analyzed on the basis of the duration, context, and intensity of the impacts. Summary impact levels are used to describe effects on each resource analyzed. The following summary impact level definitions were adapted from the Service's NEPA for National Wildlife Refuges Handbook and the NPS Alaska Region Invasive Plant Management Plan EA (USFWS 2014, NPS 2009).

- *Negligible* impacts would tend to be low intensity, temporary, and would not affect unique resources.
- *Minor* impacts would tend to be low intensity and short duration, but common resources may sustain medium intensity and long-term effects.
- *Moderate* impacts on common resources would tend to be medium to high intensity and long-term. Moderate effects to important and unique resources would tend to be affected by medium to low intensity and short-term to temporary impacts, respectively.
- *Major* impacts would tend to be medium to high intensity, long-term to permanent, and affect important to unique resources.

It is important to note that environmental consequences in this section apply to the entire state of Alaska. However, the impacts will be primarily in freshwater ecosystems because that is where submersed aquatic invasive plants are found.

4.1 Alternative A: No Action

Under the no action alternative it is likely that water bodies with active pathways of introduction and suitable habitat would become infested with submersed aquatic invasive plants. These infestations would not be limited to areas near population centers or roads because floatplanes and boats have been identified as important vectors in their spread in Alaska. The impacts discussed below are expected to occur only where elodea, or other submersed aquatic invasive plants, become established.

4.1.1 Water Resources

4.1.1.1 Water Quantity

Negligible to moderate impacts to water quantity are expected under Alternative A. Elodea prefers environments with little or no water flow (lentic). In these lentic environments, no impacts to water quantity are expected. In flowing water environments, dense stands of elodea and other submersed aquatic invasive plants can reduce water velocity (Kubrak et al. 2013). This reduction in velocity may result in increased sedimentation in areas of infestation. Flow patterns may be altered in some locations. Reductions in irrigation channel capacity of up to 60 percent have been caused by elodea infestations (Bowmer et al. 1979).

4.1.1.2 Water Quality

Minor to moderate impacts to water quality may occur under Alternative A. Elodea and other submersed aquatic invasive plants can produce large amounts of biomass which, upon decay, can increase microbial activity and reduce dissolved oxygen. Many stands experience 5 to 6 year growth cycles, possibly related to an iron availability and depletion cycle, then collapse and cause oxygen depletion with massive amounts of decaying vegetation (Josefsson 2011). Submersed aquatic invasive plants remove phosphorus from water (Eugelink 1998) thereby reducing phosphorus availability for native aquatic plants.

4.1.2 Air Resources

Negligible impacts to air resources are expected under Alternative A.

4.1.3 Soil and Sediment Resources

Negligible to moderate impacts to soil and sediment resources are expected under Alternative A. The dense growth pattern of elodea and other submersed aquatic invasive plants may stabilize sediments to some degree. Reduction in flowing water velocity may lead to increased sediment deposition in some areas. Stands of submersed aquatic invasive plants may deplete nutrients in sediment. Reduced phosphorus levels in sediment were correlated with elodea invasion in a Japanese lake (Nagasaka 2004).

4.1.4 Fish and Wildlife Resources

The primary impact to fish and wildlife resources under Alternative A is modification of habitat after the establishment of submersed aquatic invasive plants. The resulting changes in habitat are likely to negatively impact native species. Non-native species that are generalists or adapted to habitat created by submersed aquatic invasive plants may benefit.

4.1.4.1 Fish

Moderate to major impacts to some fish species are expected under Alternative A. Changes in aquatic plant species would affect fish habitat. Some species, like the ambush predator northern pike, may benefit while other species may decline. Elodea, along with other non-native aquatic plants, has affected Chinook salmon spawning rates by reducing spawning habitat in California. Spawning rates were reduced by over 93% after spawning habitat was colonized by submersed aquatic plants like elodea (Merz et al. 2008). Research indicates that intermediate densities of macrophytes tend to support the greatest species richness of fish and the greatest growth and survival rates (Savino and Stein 1989, Ferrer and Dibble 2005, Strakosh et al. 2009). The dense growth pattern of elodea and other submersed aquatic invasive plants could, change prey availability, and reduce fish foraging efficiency (Schultz and Dibble 2012). In laboratory experiments the presence of dense macrophytes reduced fish foraging success (Valley and Bremigan 2002). In other laboratory experiments, aquatic invertebrate herbivores experienced higher mortality when feeding on elodea than when feeding on native species (Erhard et al. 2007). In Canada, invasive aquatic plants have been identified as negatively affecting imperiled salmonid species (Dextrase and Mandrak 2006). Stormy Lake, Daniels Lake, Beck Lake, Sucker Lake, Alexander Lake, Chena River, Chena Slough and Little Survivor Creek are examples of water bodies that have or had elodea infestations and are listed on the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes (ADF&G 2019).

4.1.4.2 Amphibians

Negligible impacts to amphibians are expected under Alternative A. Published information on the effects of submersed aquatic invasive plants on amphibians was not available for analysis.

4.1.4.3 Aquatic Invertebrates

Moderate to major impacts to aquatic invertebrates are expected under Alternative A. The change in aquatic invertebrate habitat, particularly species composition and vegetation structure, may benefit some species and harm others. This change is likely to influence aquatic invertebrate species composition and abundance in affected water bodies.

4.1.4.4 Birds

Moderate impacts to birds are expected under Alternative A. Change in aquatic vegetation and invertebrate populations may affect the diet of waterfowl and shorebirds (Krull 1970). Dense patches of elodea may reduce the area where diving waterfowl species can effectively forage. The nutritional value of elodea and the other submersed aquatic invasive plants for waterfowl is unknown. Therefore, the effects on dabbling waterfowl, or those that feed on aquatic plants, are unknown. The effect of elodea and other submersed aquatic invasive plants on shorebirds food availability and prey capture success is also unknown.

4.1.4.5 Mammals

Negligible to moderate impacts to mammals are expected under Alternative A. Mammals that eat aquatic vegetation, like the moose, may be impacted. In diet preference study, conducted in Ontario Canada, moose showed clear preferences for certain species of submersed aquatic plants (*Myriophyllum verticillatum, Utricularia vulgaris*, and *Potamogeton spp.*) over other available aquatic species (Fraser et al. 1984). Elodea was not among the species included in the experiment. Elodea infestations would reduce the availability of native submersed aquatic vegetation available to mammals. The nutritional value of elodea compared to native vegetation is unknown. The willingness of mammals to switch their diet from native species to invasive species is also unknown.

4.1.4.6 Federally Listed Species under the ESA

Negligible to moderate impacts to ESA listed species are expected under Alternative A. Spectacled eider and Steller's eider designated critical habitat overlaps with suitable submersed aquatic invasive plant habitat. This habitat is primarily used for breeding and fledging. Both species overwinter at sea. During the breeding season, hens and broods feed in freshwater ponds and wetlands, eating aquatic insects, crustaceans, and vegetation (USFWS 2010, Petersen et al. 2000). Changes in aquatic vegetation and aquatic insect populations may impact food availability for hens and broods. Impacts to Cook Inlet beluga whales are also possible if anadromous fish, an important component of their diet, in the Cook Inlet are negatively impacted by elodea infestations.

4.1.5 Vegetation and Wetland Resources

Moderate to major impacts to native aquatic vegetation are expected under Alternative A. Invasive species typically outcompete native species. A reduction in abundance and diversity of native aquatic plant species would be likely. Studies of elodea infestation in a Norway lake show that native submersed plant species declined to the point of near expatriation over a 26 year period (Mjelde et al. 2012).

4.1.5.1 Wetlands

Minor to moderate impacts to wetlands are expected under Alternative A. Changing water velocity and species composition in wetlands would alter their structure and function. Infestation by submersed aquatic invasive species could impact many processes such as nutrient cycling and food-web dynamics (Rejmankova 2011).

4.1.6 Land Use

4.1.6.1 Subsistence

Moderate to major impacts to subsistence land use are expected under Alternative A. Travel to traditional hunting or fishing areas by boat or float plane may be prevented by dense mats of aquatic vegetation (Spicer and Catling 1988). Changes in fish habitat may influence the availability of some species.

4.1.6.2 Recreation

Moderate to major impacts to recreation are expected under Alternative A. Elodea and other submersed aquatic invasive plant species can form dense mats of vegetation on water bodies. This vegetation can discourage some recreational activities like fishing, hunting, swimming, boating, float plane travel, and snorkeling (Spicer and Catling 1988).

4.1.6.3 Commercial

Moderate to major impacts to commercial land use are expected under Alternative A. Commercial air transport services often use float planes to carry customers to their destinations in Alaska. Dense mats of aquatic vegetation, commonly produced by elodea and other submersed aquatic invasive species, can prevent float planes from landing safely (CH2MHILL 2005). Elodea and other submersed aquatic invasive species may render shallow water bodies inaccessible by floatplane. These dense mats of vegetation may also clog hydroelectric power and public water system intakes.

4.1.7 Cultural Resources

Negligible impacts to cultural resources are expected under Alternative A.

4.1.8 Human Health and Safety

4.1.8.1 Drinking Water

Negligible impacts to human drinking water are expected under Alternative A. No human health or safety related impacts are expected. The quantity of water available from surface water intakes may be reduced due to excessive aquatic plant growth.

4.1.8.2 Fish and Wildlife Consumption

Minor human health related impacts are expected under Alternative A. The quantity of fish available for consumption may change as discussed in Section 4.1.4.2. Access to traditional hunting and fishing areas may be reduced as discussed in Section 4.1.6.

4.1.8.3 Agriculture

Negligible to minor impacts to agriculture are expected under Alternative A. No human health or safety related impacts are expected under Alternative A. The quantity of water available from surface water intakes or through irrigation canals may be reduced due to excessive plant growth (Bowmer et al. 1979).

4.1.8.4 Livestock

Negligible impacts to livestock drinking water are expected under Alternative A. No human health or safety related impacts are expected under Alternative A.

4.2 Alternative B: Cultural Control

The consequences of the cultural control alternative are expected to be similar to the no action alternative except that predicted impacts would occur more slowly and be limited spatially. Cultural controls are expected to slow the spread of submersed aquatic invasive species but not stop them. Eradication using only cultural control is not possible so impacts associated with submersed aquatic invasive plants would still occur. Impacts would likely occur at a slower rate and smaller scale as compared to impacts predicted under the no action alternative.

Another important difference between the no action alternative and the cultural control alternative is the possibility of use restrictions under the cultural control alternative. Alternative B may result in minor impacts to subsistence, recreational, or commercial use if waterbody use restrictions are enacted. The impacts from these use restrictions would likely be less severe than impacts to subsistence, recreational, or commercial use predicted under the no action alternative.

4.3 Alternative C: Physical Control

The consequences of the physical control alternative are variable and depend on the specific method selected. In general, drawdown would have the most impact on resources and uses while hand pulling would have minimal impacts. Bottom barriers and diver operated suction fall somewhere in between drawdown and hand pulling with respect to impacts on resources and uses.

It is important to note that it is unlikely physical control methods would result in eradication, especially if used to control large infestations. If these methods were used exclusively to control submersed aquatic invasive plants then the area infested within Alaska would likely increase slowly. The slow increase in infested area would eventually lead to large scale negative impacts similar to those described under Alternative A and Alternative B.

4.3.1 Water Resources

4.3.1.1 Water Quantity

Negligible to moderate impacts to water quantity are expected under Alternative C. Impacts would depend on the physical method selected and size of the water body. Bottom barriers, hand pulling, and diver operated suction are not expected to impact water quantity. Drawdown would temporarily impact water quantity. To be effective, drawdown requires that most to all water in a shallow waterbody be removed. This water would presumably be released down gradient if an adequate water control structure was present or pumped to another location. If the water was pumped to another location it would need to be contained or discharged in a way that prevents groundwater recharge of the target waterbody. Drawdown may not be an option where existing water rights are present.

In flowing systems, water movement would no longer be impeded by dense aquatic vegetation immediately after treatment. However these methods may not result in eradication so additional treatments would be necessary to maintain benefits.

4.3.1.2 Water Quality

Minor impacts to water quality may occur under Alternative C. The use of bottom barriers could lead to excessive amounts of dead and decaying vegetation under the barrier. The microbial activity associated with decaying vegetation can reduce dissolved oxygen to levels which are lethal to some aquatic organisms.

Hand pulling is expected to have a minimal impact on water quality except for increase suspended sediment for the duration of treatment. In flowing water this could lead to mobilization of any contaminants present in the sediment.

Diver operated suction is expected to substantially increase suspended sediment for the duration of treatment. In flowing water this could lead to mobilization of any contaminants present in the sediment.

Hand pulling and diver operated suction would remove submersed aquatic vegetation reducing the risk of low dissolved oxygen during cyclic die-off observed in elodea populations.

4.3.2 Air

Negligible impacts to air resources are expected under Alternative C. Physical control methods will likely involve the use of vehicles and boats equipped with combustion engines. The emissions from these combustion engines during treatment activities will be negligible.

4.3.3 Soil and Sediment Resources

Negligible to minor impacts to soil and sediment resources are expected under Alternative C. Removal of rooted vegetation could lead to changes in sediment deposition or erosion patterns.

4.3.4 Fish and Wildlife Resources

The primary impact to fish and wildlife resources under Alternative C would be temporary disturbance of individual organisms during treatment. Species or life stages that are less mobile may experience individual mortalities from hand pulling, bottom barriers, and diver operated suction. More extensive individual mortality is expected if drawdown is employed. Timing of physical control treatments could be adjusted to minimize impacts to certain fish and aquatic invertebrate species. Native fish and wildlife would benefit from removal of submersed aquatic invasive plants. However, eradication using only physical control is unlikely so benefits would be temporary.

4.3.4.1 Fish

Minor impacts to some fish species are expected under Alternative C. Drawdown may result in extensive mortality unless individuals are transplanted to another waterbody temporarily. Bottom barriers would temporarily alter fish habitat by killing all rooted aquatic vegetation. Diver operated suction may result in individual mortalities during treatment. Removal of submersed aquatic invasive plants would likely benefit native fish species. Eradication is unlikely with physical control so benefits would be temporary.

4.3.4.2 Amphibians

Minor impacts to amphibians are expected under Alternative C. Drawdown may result in mortality through desiccation or predation unless individuals are transplanted to another waterbody temporarily. The limited areas where drawdown could be employed would reduce the scale of its impact. Bottom barriers would alter habitat by killing all rooted aquatic vegetation. Bottom barriers may also trap individuals or egg masses leading to mortality. Diver operated suction may result in individual mortalities.

4.3.4.3 Aquatic Invertebrates

Minor to moderate impacts to aquatic invertebrates are expected under Alternative C. Drawdown may result in mortality through desiccation or predation unless individuals are transplanted to another waterbody. The limited areas where drawdown could be employed would reduce the scale of its impact. Bottom barriers would temporarily alter habitat by killing all rooted aquatic vegetation. Diver operated suction or hand pulling may result in individual mortalities during treatment.

4.3.4.4 Birds

Negligible to minor impacts to birds are expected under Alternative C. Human activity and noise associated with physical treatments may cause birds to temporarily avoid treatment areas. Reduction in aquatic vegetation may temporarily result in less available food (aquatic plants and macroinvertebrates) for some species (Kroll 1970).

4.3.4.5 Mammals

Negligible to minor impacts to mammals are expected under Alternative C. Human activity and noise associated with physical treatments may cause mammals to temporarily avoid treatment areas. Drawdown would temporarily remove aquatic mammal habitat. For mammals, such as moose and beaver, this may cause increased competition in surrounding areas if population densities are high. These impacts would be temporary.

4.3.4.6 Federally Listed Species under the ESA

Negligible to minor impacts to ESA listed species are expected under Alternative C. Impacts to aquatic vegetation could alter brooding and rearing habitat of the spectacled eider or Steller's eider. Treatments in spectacled eider or Steller's eider habitat should be conducted outside the breeding season to avoid directly disturbing birds. Human activity and noise associated with chemical treatments may disturb wood bison. Treatments in wood bison habitat should be timed to avoid the animals. Negligible impacts to the Eskimo curlew and polar bear, are expected. Consultation is required under Section 7 of the ESA if a treatment is likely to adversely modify the habitat of a listed species or impact a listed species.

4.3.5 Vegetation and Wetland Resources

Minor to moderate impacts to native vegetation are expected under Alternative C. Drawdown may result in native species mortality through desiccation unless individuals are transplanted to another waterbody. Bottom barriers would kill all aquatic vegetation under them. Diver operated suction and hand pulling may result in some individual mortality if they are inadvertently targeted.

4.3.5.1 Wetlands

Negligible to minor impacts to wetlands are expected under Alternative C. Drawdown would alter the hydrology of a wetland and may prevent it from functioning during treatment. These impacts would be limited to the area of drawdown. Removal of vegetation with bottom barriers may temporarily alter wetland structure and function.

4.3.6 Land Use

4.3.6.1 Subsistence

Negligible to minor impacts to subsistence land use are expected under Alternative C. Hand pulling, bottom barriers, and diver operated suction are not expected to impact subsistence uses. Drawdown may temporarily reduce area available for subsistence harvesting of fish, mammals, or other aquatic organisms. It is likely that similar resources would be available nearby.

4.3.6.2 Recreation

Negligible to minor impacts to recreation are expected under Alternative C. Hand pulling, bottom barriers, and diver operated suction are expected to impact recreational uses only during the treatment period (hours to several weeks). Drawdown may temporarily reduce area available for water based recreation. It is likely that similar resources would be available nearby.

4.3.6.3 Commercial
Negligible to minor impacts to commercial land use are expected under Alternative C. Hand pulling, bottom barriers, and diver operated suction are expected to impact commercial uses only during the treatment period (hours to several weeks). Drawdown may temporarily reduce area available for water based commercial land use. It is likely that similar resources would be available nearby.

4.3.7 Cultural Resources
Negligible impacts to cultural resources are expected under Alternative C. Most identified cultural resource sites are in terrestrial habitat and therefore would not be impacted by activities in aquatic habitats. Cultural resources may be present in aquatic environments due to geologic process and changes in climate. Little research has focused on identifying cultural resources underwater in Alaska (Dixon and Monteleone 2014). Physical methods have the potential to impact submerged cultural resource sites.

4.3.8 Human Health and Safety
The human health and safety concerns of this alternative are generally negligible. The primary human health and safety consequences of this alternative are injury to workers performing physical control treatments.

4.3.8.1 Drinking Water
Negligible to minor impacts to human drinking water are expected under Alternative C. No human health or safety related impacts are expected unless disturbance of sediment mobilizes contaminants.

4.3.8.2 Fish and Wildlife Consumption
No human health or safety related impacts are expected under Alternative C. No human health or safety related impacts are expected unless disturbance of sediment mobilizes contaminants.

4.3.8.3 Agriculture
Negligible impacts to agriculture are expected under Alternative C. No human health or safety related impacts are expected under Alternative C. The quantity of water available from surface water intakes or irrigation canals may be reduced due to drawdown. If existing water rights would be impacted it is unlikely drawdown would be selected as a management option.

4.3.8.4 Livestock
Negligible impacts to human drinking water are expected under Alternative C. No human health or safety related impacts are expected under Alternative C. The quantity of water available from surface water intakes or irrigation canals may be reduced due to drawdown. If existing water rights would be impacted it is unlikely drawdown would be selected as a management option.

4.4 Alternative D: Chemical Control
The consequences of chemical control are variable and depend on the specific active ingredient, formulation, and application strategy selected. Chemical treatments may last from several days to several years depending on specifics of the waterbody being treated, treatment strategy, and effectiveness. In general, fluridone would have negligible impacts when applied according to product labels. Some non-target plants may be impacted by fluridone. Diquat may have minor impacts to non-target organisms, specifically aquatic invertebrates and vegetation. The nature and extent of impacts from chemical treatment are discussed below. These impacts can be minimized by following product labels and complying with State and Federal regulations and

policy. All impacts discussed in this section are based on application of fluridone or diquat at rates or concentrations specified on EPA approved product labels. Actual application rates or concentrations are likely to be much lower than maximum approved rates because application at lower rates has proved effective in previous submersed aquatic invasive plant control efforts in Alaska.

4.4.1 Water Resources

4.4.1.1 Water Quantity

Negligible impacts to water quantity are expected under Alternative D. Chemical control methods are not expected to affect water quantity. In flowing systems, water movement would no longer be impeded by dense aquatic vegetation.

4.4.1.2 Water Quality

Negligible to minor impacts to water quality may occur under Alternative D. The main impact to water quality from the chemical control alternative is the potential for temporarily decreased dissolved oxygen from the decay of aquatic vegetation after treatment. This would be more likely with the use of diqaut due to its ability to kill vegetation very quickly. No major changes in water quality parameters (dissolved oxygen, conductivity, water clarity) could be attributed to chemical treatment in Beck Lake and Daniels Lake on the Kenai Peninsula (Sethi et al. 2017). Once invasive submersed aquatic vegetation is eradicated the risk of low dissolved oxygen from cyclic die-off observed in elodea populations would be removed.

Neither fluridone nor diquat are persistent in water when applied in natural systems. Fluridone readily breaks down when exposed to light and has a half-life ranging from four days to 97 days (Muir et al 1980, Fox et al. 1996). Diquat is more persistent but typically adsorbs to sediments in a relatively short period of time (WA-ECY 2002). The concentration of diquat in water decreased by 40% to 60 % over four days in the presence of sediment, as measured in laboratory studies (Paul et al. 1994, Hiltibran et al. 1972). A microcosm study using natural lake water (Lake Mendota in Madison Wisconsin), and sediment augmented with a heavy growth of *Myriophyllum spicatum* and *Elodea canadensis* investigated the persistence of diquat in the environment. After 22 days, the majority of diquat had broken down into volatile components (48%) and water soluble degradation products (32%). The remaining diquat was associated with the sediment (19%) with only small amounts remaining in the water (Simsiman and Chesters 1976).

Movement of herbicides into groundwater, as a result of elodea treatments, has not been documented in Alaska. In Chena Slough, elodea treatment with fluridone has occurred from 2017 through 2019. Five groundwater wells, located within 200 feet of the Chena Slough treatment area, have been sampled for fluridone throughout the treatment period. Fluridone has not been detected in any groundwater sample to date (FSWCD 2019).

4.4.2 Air

Negligible impacts to air resources are expected under Alternative D. Chemical control methods will likely involve the use of vehicles and boats equipped with combustion engines. The emissions from these combustion engines during treatment activities will be negligible.

Spray drift is a potential issue if herbicides are applied above the water surface. The most effective way to control spray drift is to apply herbicide at or below the water surface. Herbicide product labels contain additional information about spray drift management. Spray drift is discussed further in Section 4.4.8.

4.4.3 Soil and Sediment Resources

Minor impacts to soil and sediment resources are expected under Alternative D. Fluridone does not persist in sediment. However diaquat has been shown to bind tightly to sediments, especially those containing clay minerals, and persist for long periods of time (WA-ECY 2002). Diquat adsorbed to sediment will not be biologically available to plants or microorganisms (WA-ECY 2002). This would prevent diqaut from inhibiting plant growth but also slows its microbial degradation.

In flowing systems, removing dense patches of submersed aquatic invasive plants would increase velocity and decrease sediment deposition.

4.4.4 Fish and Wildlife Resources

4.4.4.1 Fish

Negligible to moderate impacts to fish species are expected under Alternative D. Fluridone is not expected to impact fish as the anticipated treatment concentration is less than one hundred times lower than the lowest LC50 observed in fish species tested (1800 ppb for walleye that had recently hatched and were exposed for 96 hours)(Paul et al. 1994).

Diquat is not expected to impact fish species if used as specified by the product label. In toxicology studies using salmonid species, 24-hour to 96-hour LC50s ranged from 10 ppm to 30 ppm. (WA-ECY 2002). These concentrations are more than 50 to 150 times higher than concentrations achieved during a treatment. However, warm water fish species are more sensitive to diquat than cold water species. Acute toxicity tests on warm water fish species revealed 96-hr LC50s as low as 0.75 mg a.i./L (Paul et al. 1994). Treatment concentrations could approach 0.18 mg/l if applied at the maximum rate (two gallons per surface acre) in a shallow lake. Decreased dissolved oxygen associated with decay of vegetation after treatment may temporarily impact individual fish.

Minor to moderate positive impacts to some fish species may occur. Returning fish habitat to the pre-invasion condition is expected to benefit native species. Chemical treatments in Michigan lakes resulted in drastic reductions in invasive Eurasian watermilfoil, increases in native submerged aquatic vegetation, and slight increases in size of native bluegill. The increases in size were attributed to improved growth rates due to modified food chains and predator-prey relationships (Schneider 2000). After removal of dense patches of submersed aquatic invasive plants, more foraging and spawning habitat may be available for some species.

4.4.4.2 Amphibians

Negligible impacts to amphibians are expected under Alternative D. Outside of southeast Alaska, the only amphibian of concern is the wood frog. No information is available on the effect of fluridone exposure on amphibians. Based on fluridone's low toxicity to other non-plant organisms it is unlikely that amphibians will be negatively affected. Limited information on diquat's toxicity to amphibians is available. In a 16-day exposure, northern leopard frogs (*Rana pipiens*) were adversely affected by diquat concentrations as low as 5 mg/L, while no adverse effects were observed at 2 mg/L (Dial and Bauer-Dial 1987). These concentrations are 10 to 25 times higher than initial maximum treatment concentrations. In a natural lake, diquat concentrations in water would rapidly diminish as it is taken up by plants and bound to sediment (Simsiman et al. 1976, Cochran et al. 1994). Decreased dissolved oxygen associated with decay of vegetation after treatment may temporarily impact early life stage amphibians.

4.4.4.3 Aquatic Invertebrates

Negligible to moderate impacts to aquatic invertebrates are expected under Alternative D. The effects of fluridone on aquatic invertebrates, when applied according to the product label, are expected to be negligible. The lowest NOEL observed in aquatic invertebrates was 600 ppb (for juvenile pink shrimp exposed for 96 hours) (Hamelink et al. 1986). The maximum allowable concentration, according to fluridone products labels, is 150 ppb which is one fourth of the lowest reported NOEL for aquatic organisms.

The effects of diquat on aquatic invertebrates, when applied according to the product label, are expected to be minor to moderate. Several species of invertebrates are extremely susceptible to the effects of diquat. Diquat can be classified as highly toxic to the amphipod *Hyalella azteca*, to the pocket shrimp (*Mysidopsis bahia*), and to *Daphnia pulex* (LC50 =0.048 ppm, 0.42 ppm, and 0.16 ppm respectively). Individual aquatic invertebrate mortalities may occur during treatment with diquat. However, for other species of invertebrates diquat is much less toxic. The LC50 ranges from >1.0 to 100 ppm for mayflies (*Callibaetis spp*.), *Crassostrea virginica*, *Daphnia magna*, *Diapotomus spp*., *Eucyclops spp*., various odonates, and caddisfly (*Limnephilus spp*.) (WA-ECY 2002).

No major changes in zooplankton metrics (richness, density, and biomass) were observed after chemical treatment in Beck Lake and Daniels Lake on the Kenai Peninsula (Sethi et al. 2017).

4.4.4.4 Birds

Negligible to minor impacts to birds are expected under Alternative D. Returning bird habitat to the pre-invasion condition is expected to provide long term benefits to native species. Human activity and noise associated with chemical treatments may cause individual birds to temporarily avoid treatment areas. Fluridone is not considered toxic to birds at environmentally relevant concentrations. In laboratory studies diquat was not found to be toxic to birds at potential treatment concentrations, with oral LD50s of 564 mg/kg in mallards (*Anas platyrhynchos*), and 200-400 mg/kg in domestic hens (*Gallus gallus domesticus*) (Cochrane et al. 1994). These doses were administered orally and are hundreds of times higher than diquat concentrations achieved during an herbicide treatment.

4.4.4.5 Mammals

Negligible impacts to mammals are expected under Alternative D. Human activity and noise associated with chemical treatments may cause individual mammals to temporarily avoid treatment areas. Diquat exhibits low acute toxicity to mammals via oral and dermal exposure, but has moderate to severe acute toxicity by inhalation exposure (Syngenta 2015). Inhalation of diquat by mammals is unlikely as it is typically applied at or below the water surface. Fluridone is not toxic to mammals at environmentally relevant concentrations. Observed oral LD50s in rats have been greater than 10,000 mg/kg in laboratory studies (Durkin 2008). Mammals were shown to excrete fluridone metabolites within 72 hours of varying doses of up to 1400 ppm/day (McCowen et al. 1979).

4.4.4.6 Federally Listed Species under the ESA

Negligible to minor impacts to ESA listed species are expected under Alternative D. Impacts to aquatic vegetation and invertebrates could temporarily alter brooding and rearing habitat of the spectacled eider or Steller's eider. Treatments in spectacled eider or Steller's eider habitat should be conducted outside the breeding season to avoid directly disturbing birds. Human activity and noise associated with chemical treatments may disturb wood bison. Treatments in wood bison habitat should be timed to avoid the animals. Negligible impacts to the Eskimo curlew and polar bear are expected. Consultation is required under Section 7 of the ESA if a treatment is likely to adversely modify the habitat of a listed species or impact a listed species.

4.4.5 Vegetation and Wetland Resources

Minor to moderate impacts to native vegetation are expected under Alternative D. Since both fluridone and diquat are herbicides they are both expected to negatively impact susceptible native vegetation to some degree. However, moderate positive impacts to native aquatic vegetation are expected after removal of submersed aquatic invasive plants. The temporary impacts of chemical treatment must be weighed against the long term impacts of submersed aquatic invasive species under the no action alternative.

Floridone is selective but has the potential to impact the following common native vegetation: *Lemna minor, Ruppia maritima, Nuphar luteum, Nymphaea spp., Utricularia spp*., *Myriophyllum spp*., *Potamogeton spp*., *Ceratophyllum demersum*, and *Najas spp*. (SePRO 2015, SePRO 2017, SePRO 2019a,b,c). Fluridone treatment may result in removal of these species from a treated waterbody. Seeding or transplanting native species to treated water bodies may be necessary if monitoring indicates that removal of native species has occurred.

Diquat is non-selective and has the potential to impact all vegetation it contacts. It is most likely to negatively impact the following common native vegetation: *Lemna spp., Typha spp*., *Utricularia spp*., *Myriophyllum spp*., *Potamogeton spp*., *Ceratophyllum demersum*, and *Najas spp*. (Syngenta 2009). Diquat is never applied to an entire waterbody and does not typically kill rooted vegetation. In the event native species are negatively impacted during treatment it is likely that they will recover or be replaced by native species that were outside the treatment area and not impacted.

Minor impacts to non-target macrophytes were observed after chemical treatments in Beck Lake (fluridone only treatment) and Daniels Lake (fluridone and targeted diquat treatment). *Nuphar spp.* exhibited earlier onset of leaf senescence and chlorosis than plants in untreated lakes. However, the abundance of other native macrophytes increased after treatment (Sethi et al. 2017). Field tests in mixed invasive and native submersed aquatic vegetation, conducted in Michigan lakes treated with approximately 5 ppb fluridone and spot treated with diquat, showed reduction in invasive populations with native plant cover retention of approximately 70%. Submersed plant species diversity also increased after treatment (Madsen et al. 2002).

4.4.5.1 Wetlands

Minor impacts to wetlands are expected under Alternative D. As discussed in Section 4.4.5, impacts to susceptible native species may temporarily alter species composition in wetlands. However, native plant species abundance and diversity has been shown to increase after chemical treatment (Sethi et al. 2017, Madsen et al. 2002).

4.4.6 Land Use

4.4.6.1 Subsistence

Negligible impacts to subsistence land use are expected under Alternative D. Fishing and swimming are allowed immediately after chemical treatment with fluridone or diquat (Syngenta 2009, SePRO 2017, SePRO 2019).

4.4.6.2 Recreation
Negligible impacts to recreation are expected under Alternative D. Fishing and swimming are allowed immediately after chemical treatment with fluridone or diquat (Syngenta 2009, SePRO 2017, SePRO 2019). Drinking is restricted for three days after application of diquat at the maximum rate (Syngenta 2009, SePRO 2019).

4.4.6.3 Commercial
Negligible impacts to commercial land use are expected under Alternative D. The chemical control alternative is not expected to impact commercial land use. This alternative may impact agricultural operations that use surface water for irrigation. Treated waters cannot be used to irrigate turf and landscape ornamental for one to three days after treatment with diquat. Irrigation wait time range from 7 to 30 days (or longer for newly seeded crops or areas to be seeded) after fluridone application. Commercial irrigation impacts are discussed further in Section 4.4.7.3.

4.4.7 Cultural Resources
Negligible impacts to cultural resources are expected under Alternative D. Cultural resources may be present in aquatic environments due to geologic process and changes in climate. Little research has focused on identifying cultural resources underwater in Alaska (Dixon and Monteleone 2014). Chemical methods are not expected to impact submerged cultural resource sites.

4.4.8 Human Health and Safety
The human health and safety concerns of this alternative are negligible to minor. The primary human health and safety impacts of this alternative are related to the handling of undiluted diquat and fluridone containing products. These undiluted products are dangerous if ingested, inhaled, or if they contact eyes or skin. Accidental spills, improper handling, or improper storage of these products could result in human health impacts. The use of engineering control, googles, respirators, chemical resistant gloves, coveralls, and chemical resistant footwear may be appropriate if handling these products. Product labels contain suggestions for personal protective equipment and other exposure control measures.

Herbicide spray drift is also a potential human health issue if herbicides are applied above the water surface. The most effective way to control spray drift is to apply herbicide at or below the water surface. Herbicide product labels contain information on management of spray drift. No humans should be present, other than the applicators, during an herbicide treatment. Following product label instructions and excluding unnecessary people from the treatment area will minimize the potential effects of herbicide spray drift.

4.4.8.1 Drinking Water
Negligible impacts to human drinking water are expected under Alternative D. Fluridone is approved for application in water used for drinking as long as residue levels do not exceed 150 ppb. Applications can occur within one-fourth mile (1,320 feet) of a potable water intake if application rates are below 20 ppb (SePRO 2015, SePRO 2017, SePRO 2019a,b,c).

Drinking water use is restricted for one to three days after application of diquat depending on application rate. The MCL for diquat in drinking water is 0.02 mg/l or 20 ppb (USEPA 2009). The MCL could be exceeded during a treatment while following product label application instructions, depending on application rate and water depth. Diquat does not persist in water and if drinking water use restrictions are observed no human health impacts are expected.

4.4.8.2 Fish and Wildlife Consumption
Negligible impacts to fish and wildlife consumption are expected under Alternative D. Fluridone has been shown to accumulate in catfish tissue when fish were exposed for 60 days to concentrations ranging from 120 ppb to 2,000 ppb (Hamlink et al 1985). Concentrations of fluridone in fish muscle tissue were found to be approximately 0.6 times the concentration of fluridone in water that the fish were exposed to, in other laboratory assessments (Muir et al 1982). However, fluridone is considered to have very low toxicity to mammals (Durkin 2008). The lowest recorded NOEL in a chronic exposure test for a mammal was 8 mg/kg in rats (USBLM 2005 from Probst 1980b). If we assumed fish tissue concentration to be 150 ppb (or 0.15 ppm which is the highest concentration allowed according to product labels) then a 75 kg human would have to eat 4,000 kg (8,800 pounds) of fish to consume the equivalent dose.

Diquat is considered moderately toxic to mammals with oral LC50s ranging from 121 to 262 mg/kg, for rabbits and rats. However diquat is not persistent in water and is not known to bioaccumulate (USBLM 2005).

4.4.8.3 Agriculture
Negligible to minor impacts to agriculture are expected under Alternative D. No human health or safety related impacts are expected under Alternative D. If fluridone concentrations are less than 10 parts per billion, there are no restrictions for irrigating established tree crops, plants, row crops or turf. If measured fluridone concentrations are greater than 5 ppb, do not use to irrigate tobacco, tomatoes, peppers or other plants within the Solanaceae family and newly seeded crops or newly seeded grasses. Furthermore, when rotating crops, do not plant members of the Solanaceae family in land that has been previously irrigated with fluridone concentrations in excess of 5 ppb in the previous year (SePRO 2015, SePRO 2017, SePRO 2019a, b, c).

Irrigation use restrictions after treatment with diquat range from one to three days for turf and landscape ornamentals, depending on treatment application rate. A five day irrigation use restriction is required for food crops and production ornamentals for all application rates (Syngenta 2009, SePRO 2019).

4.4.8.4 Livestock
Negligible impacts to livestock are expected under Alternative D. Drinking of treated water by livestock is permissible immediately after treatment with fluridone (SePRO 2015, SePRO 2017, SePRO 2019a, b, c). Drinking of treated water by livestock is permissible one day after treatment with diquat (Syngenta 2009, SePRO 2019). EPA established human dietary exposure tolerances for diquat in cattle, goats, hogs, horses, poultry and sheep eggs and milk are 0.02 ppm (USEPA 2002).

4.5 Alternative E: IPM Strategy
The IPM strategy alternative allows managers to select from all discussed cultural, physical, and chemical control options. The impacts of this alternative depend on the specific treat methods selected. Impacts of cultural, physical and chemical control are discussed in Sections 4.2, 4.3, and 4.4 of this document.

4.5.1 Cumulative Effects
Cumulative effects are impacts on the human environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes the actions. This cumulative effects analysis assumes that the Service and other entities in Alaska will utilize an IPM strategy (consisting of

cultural, physical, and chemical control methods) to manage submersed aquatic invasive plants. The Services focus on prevention, early detection, and rapid response under Alternative E will limit the number and size of treatments. This will result in fewer negative impacts associated with treatment and increased positive impacts associated with absence of submersed aquatic invasive plants. The cumulative impacts of cultural control, physical control, and chemical control are discussed below.

If cultural control techniques were applied across Alaska, the effects would be negligible to minor. Use restrictions could impact subsistence, recreational, and commercial land uses. However, use restrictions would not be practical, feasible, or effective in many locations. This would naturally limit the impact of use restrictions.

If physical control methods were utilized across Alaska, the cumulative effects would be minor. Some birds and mammals would be temporarily displaced during treatment activities. Individual mortality of some aquatic organisms, including fish, amphibians, and invertebrates, is likely in treated water bodies. The use of drawdown across a large geographic area could have cumulative effects on aquatic species. However, drawdown is usually not a practical method in water bodies that do not have water level control infrastructure. Most water bodies in Alaska do not have water level control infrastructure.

If chemical control methods (fluridone and diquat) were applied in freshwater systems, as specified by law, across Alaska the cumulative impacts would be minor. Native aquatic plant populations, susceptible to fluridone and diquat at treatment concentrations, may decline temporarily. However, those native plant populations would experience greater negative impacts under the no action alternative. Some birds and mammals would be temporarily displaced during treatment activities. Other resources and uses are not likely to experience long term cumulative effects from this action and related actions.

A possible cumulative impact of multiple chemical treatment actions is the potential for fluridone and diquat concentrations in the target water body to be influenced by treatments in connected water bodies. The hydrologic connections in a treatment area would be investigated during the site assessment, prior to treatment. In both flowing and non-flowing systems, herbicide concentration would be consistently monitored. A hydrologically connected water body in a non-flowing system (e.g., adjoining lakes) would likely be treated in conjunction with the infested water body to reduce cost and ensure effectiveness. Hydrologically connected water bodies in flowing systems (e.g., slough and stream) would be monitored to ensure target concentrations were not exceeded in or down gradient of the treatment area. In flowing systems dilution is expected to rapidly reduce fluridone and diqaut concentrations as distance from the treatment site increases.

4.6 Summary of Environmental Consequences by Alternative

	Environmental Consequences Summary
Alternative A: No Action	Most resources and uses in the affected environment, native species in particular, would experience minor to major negative impacts. These impacts would be both short-term and long-term. Section 4.1 provides a detailed analysis of the environmental consequences of this alternative.
Alternative B: Cultural Control	Most resources and uses in the affected environment, native species in particular, would experience minor to major negative impacts. These impacts would increase over time because cultural controls do not result in eradication and are not completely effective at containment. Section 4.2 provides a detailed analysis of the environmental consequences of this alternative.
Alternative C: Physical Control	Most resources and uses in the affected environment, native species in particular, would experience minor to moderate negative impacts. These impacts would be both short-term and long-term because physical control typically does not result in eradication and is not completely effective at containment. After treatment, short-term positive impacts to native species and current land uses are expected. Section 4.3 provides a detailed analysis of the environmental consequences of this alternative.
Alternative D: Chemical Control	Some resources and uses in the affected environment may experience minor short-term negative impacts. These impacts would remain short-term because chemical control of submersed aquatic invasive plants typically results in eradication. After eradication, the long-term positive impacts to native species and current land uses would be moderate to major. Section 4.4 provides a detailed analysis of the environmental consequences of this alternative.
Alternative E: IPM	Some resources and uses in the affected environment may experience minor short-term negative impacts. Negative impacts would be minimized by selecting the least environmentally damaging control methods to achieve management goals. After eradication, the long-term positive impacts to native species and current land uses would be moderate to major. Sections 4.2, 4.3, and 4.4 provide detailed analysis of the environmental consequences of components this alternative.

5.0 List of Preparers

Name	Organization	Regional Position
Benjamin Schmitt	Integrated Statistics/ USFWS	Contract Ecologist
Aaron Martin	USFWS	Invasive Species Program Coordinator
Anna Peterson	Integrated Statistics/ USFWS	Contract Ecologist
Michael Buntjer	USFWS	Regional Fish and Wildlife Biologist
Mary Colligan	USFWS	Assistant Regional Director
Sarah Conn	USFWS	Field Supervisor
Drew Crane	USFWS	Regional Endangered Species Coordinator
Steve Delehanty	USFWS	Wildlife Refuge Manager
Angela Matz	USFWS	Spill Response/Contaminants/IPM Coordinator
Emily Munter	USFWS	Fish and Wildlife Biologist
Mary Price	USFWS	Fish and Wildlife Biologist
Ronnie Sanchez	USFWS	Refuge Supervisor
Tamara Zeller	USFWS	Outreach Biologist
Ryan Mollnow	USFWS	Natural Resource Division Branch Chief
David Wigglesworth	USFWS	Deputy ARD/Fish & Aquatic Conservation

6.0 List of Agencies, Organizations, and Persons Contacted

Entity	Contact Name	Responded to Scoping Invitation	Provided Comments on Draft EA
Federal Agencies			
Army Corps of Engineers	Ellen Lyons	yes	
Bureau of Indian Affairs	Rosalie Debenham	no	
Bureau of Land Management	Matt Varner	yes	yes
Department of Defense JBER Natural Resources	Charlene Johnson	yes	yes
U.S. Forest Service	Lauren McChesney	no	
U.S. Geological Survey	Chris Zimmerman	no	
National Park Service	Chris Overbaugh	yes	
Natural Resource Conservation Service	Ryan Maroney	no	
Native Alaskan Entities			
Tanana Chiefs Conference	Brian McKenna	no	
Tyonek Tribal Conservation District	Nicole Swenson	yes	
Sun'aq Tribe of Kodiak	Tom Lance	no	
State Agencies			
Department of Fish and Game	Tammy Davis	yes	
Department of Environmental Conservation	Karin Hendrickson	no	
Department of Natural Resources	Dan Coleman	yes	yes
Department of Transportation	Katrina LeMieux	no	
Municipality and Local Entities			
Anchorage Municipality	Tom Korosei	yes	
Anchorage Cooperative Weed Management Area	Tim Stallard	no	
Fairbanks Soil and Water Conservation District	Aditi Shenoy	no	
Homer Soil and Water Conservation District	Kyra Wagner	yes	
Kenai Peninsula Cooperative Weed Management Association	Katherine Schake	yes	
Kodiak Soil and Water Conservation District	Blythe Brown	no	
Salcha - Delta Soil and Water Conservation District	Toni Smith	yes	
Other Entities			
Alien Species Control LLC	Tim Stallard	no	
Anchorage Waterways Council	Cherie Northon	no	yes
Community Action on Toxics	Pamela K. Miller	no	
SeaPlane Pilots Association	Steve McCaughey	no	
The Nature Conservancy	Steven Cohn	no	
Wilderness Society	Jason Leppi	yes	

7.0 References Cited

Aiken, S. G., P. R. Newroth, and I. Wile. 1979. The biology of Canadian weeds. 34. *Myriophyllum spicatum* L. Canadian Journal of Plant Science 59: 201-215.

Alaska Center for Conservation Science (ACCS). Alaska Exotic Plants Information Clearinghouse (AKEPIC) website. Accessed November 11, 2019. Available at: https://accs.uaa.alaska.edu/invasive-species/non-native-plants/

Alaska Department of Fish and Game (ADF&G) Division of Subsistence. 2018. Subsistence in Alaska: A Year 2017 Update. Published in December 2018. Available at: https://www.adfg.alaska.gov/static/home/subsistence/pdfs/subsistence_update_2017.pdf

Alaska Department of Fish and Game (ADF&G). 2002. Alaska Aquatic Nuisance Species Management Plan. RIR 5J02- 10, Juneau, Alaska. 103 pp.

Alaska Department of Fish and Game (ADF&G). 2019a. Region 2 – Southcentral News Release: Alexander and Sucker Lakes Closed to Sport Fishing to Reduce Spreading of Invasive Elodea. April 29, 2019. Available at: https://www.adfg.alaska.gov/sf/EONR/index.cfm?ADFG=region.NR&Year=2019&NRID=2728

Alaska Department of Fish and Game (ADF&G). 2019b. "Species" webpage. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=species.main . Accessed November 14, 2019.

Alaska Department of Natural Resources (ADNR). 2013. Stormy and Daniels Lake Elodea Eradication Project: Environmental Assessment.

Alaska Department of Natural Resources (ADNR). 2014. Exterior Quarantine of Aquatic Invasive Weeds.

Alaska Department of Natural Resources (ADNR). 2015. Anchorage Lakes Elodea Eradication Project: Environmental Assessment.

Alaska Department of Natural Resources (ADNR). 2016. Alexander Lake Elodea Eradication Project: Environmental Assessment.

Alaska Department of Natural Resources (ADNR). 2017a. Interior Alaska Elodea Eradication Project: Environmental Assessment.

Alaska Department of Natural Resources (ADNR). 2017b. Supplemental Environmental Assessment- Stormy and Daniels Lake Elodea Eradication Project: *Proposed fluridone and diquat treatment for the purpose of eradicating the invasive aquatic Elodea population and maintaining ecological integrity of waterways on the Kenai Peninsula (August 2013)*.

Alaska Department of Natural Resources (ADNR). 2019a. Alexander Creek Watershed Elodea Eradication Project: Environmental Assessment.

Alaska Department of Natural Resources (ADNR). 2019b. Division of Mining, Land and Water: Water Resources Program: Surface Water. Accessed on November 13, 2019. Available at: http://dnr.alaska.gov/mlw/water/hydro/components/surface-water.cfm

Alaska Department of Natural Resources (ADNR). 2019c. Division of Mining, Land and Water: Water Resources Program: Well Surveying and Groundwater Facts. Accessed on November 13, 2019. Available at: http://dnr.alaska.gov/mlw/water/hydro/components/groundwater.cfm

Alaska National Interest Lands Conservation Act (ANILCA). 16 USC 410hh-3233, 43 USC 1602-1784. Public Law 96-487. December 1980.

Alaska Wood Bison Management Planning Team (AWBMPT). 2015. Wood bison management plan for lower Innoko/Yukon River in Westcentral Alaska, 2015-2020. Alaska Department of Fish and Game, Division of Wildlife Conservation, Wildlife Management Plan ADF&G/DWC/WMP-2015-1, Fairbanks.

Andrews, J. H. and E. P. Hecht. 1981. Evidence for pathogenicity of Fusarium sporotrichioides to Eurasian water milfoil, Myriophyllum spicatum. Canadian Journal of Botany Vol. 59, No. 6: pp. 1069-1077

Bain, M. B. 1993. Assessing Impacts of Introduced Aquatic Species: Grass Carp in Large Systems. Environmental Management Vol. 17, No. 2, pp. 211-224.

Baker, T. T., L. F. Fair, R. A. Clark, and J. J. Hasbrouck. 2006. Review of salmon escapement goals in Bristol Bay, Alaska, 2006. Alaska Department of Fish and Game, Fishery Manuscript No. 06-05, Anchorage.

Barrat-Segretain, M. and B. Cellot. 2007. Response of invasive macrophyte species to drawdown: The case of Elodea sp. Aquatic Botany, Volume 87, Issue 4, Pages 255-261.

Bartels, P. and C. Watson. 1978. Inhibition of carotenoid synthesis by fluridone and norflurazon. Weed Science. 26(2):198-203.

Beattie, L., C. Everett, L. Jacobs, B. Million, C. Rich, J. Rogers, B. Spellman, and T. L. Wurtz. 2011. Control Options for Elodea spp. in the Chena Slough near Fairbanks, Alaska.

Belhaj K., A. Chaparro-Garcia, S. Kamoun, N. J. Patron, and V. Nekrasov. 2015. Current Opinion in Biotechnology, 32:76–84.

Berard, D., D. Rainey, and C. Lin. 1978. Absorption, translocation, and metabolism of fluridone in selected crop species. Weed Science. 26(3):252-254.

The Birds of North America (BNA) (P. Rodewald, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North America: https://birdsna.org; January 2020.

Bole, J. B. and J. R. Allan. 1978. Uptake of phosphorus from sediment by aquatic plants, Myriophyllum spicatum and Hydrilla verticillata. Water Research 12: 353-358.

Borges-Neto, C.R. and R. A. Pitelli. 2004. Adjuvants and herbicides and the infectivity of Fusarium graminearum, a potential biocontrol agent of Egeria densa and Egeria najas. Planta Daninha vol.22 no.1 Jan/Mar 2004

Bossard, C. C., J. M. Randall, and M. C. Hoshovsky. 2000. Invasive plants of California's wildlands. Pp. 218-221.

Bowmer, K. H., S. W. L. Jacobs, and G. R. Sainty. 1995. Identification, biology and management of Elodea canadensis, Hydrocharitaceae. Journal of Aquatic Plant Management 33:13-19.

Bowmer, K. H., G. R. Sainty, G. Smith, and K. Shaw. 1979. Management of Elodea in Australian Irrigation Systems. Journal of Aquatic Plant Management 17:4-12.

California State Parks. 2014. Public Notice: DBW begins 2014 *Egeria densa* control program in Delta. California State Parks, Division of Boating and Waterways. Available at http://www.dbw.parks.ca.gov/PressRoom/2014/140604EDCP.aspx. Accessed.

Canfield Jr., D. E., J. V. Shireman, D. E. Colle, W. T. Haller, E. E. Watkins, and M.J. Maceina. 1984. Prediction of chlorophyll a concentration in Florida Lakes: importance of aquatic macrophytes. Canadian Journal of Fisheries and Aquatic Science 41: 497-501.

Carey, M., S. A. Sethi, S. Larsen, and C. Rich. 2016. A primer on potential impacts, management priorities, and future directions for Elodea spp. in high latitude systems: Learning from the Alaska experience. Hydrobiologia 777: 1–19. https://doi.org/10. 1007/s10750-016-2767-x.

Catling, P. M. and W. Wojtas. 1986. The waterweeds (Elodea and Egeia, Hydrocharitaceae) in Canada. Canadian Journal of Botany 64: 1525-1541.

Center for Lakes and Reservoirs at Portland State University (CLR). 2009. Introduction to Common Native & Potential Invasive Freshwater Plants in Alaska. Prepared for ADF&G and USFWS in December 2009. Available at: http://dnr.alaska.gov/ag/Index/IntroductiontoCommonNativeInvasiveFreshwaterPlantsinAlaska.pdf

CH2MHILL. 2005. Aquatic Vegetation Management Plan: Ted Stephens Anchorage International Airport. Prepared for the State of Alaska Department of Transportation and Public Facilities, Anchorage Alaska.

Cochran, R. C. (principal) et al. 1994. Diquat dibromide risk characterization document. Medical Toxicology and Worker Health and Safety Branches, Department of Pesticide Regulation, California Environmental Protection Agency.

Commission for Environmental Cooperation Working Group. 1997. Ecological regions of North America – toward a common perspective: Montreal, Commission for Environmental Cooperation, 71 p.

Coops, H., J. T. Vulink, and E. H. van Nes. 2004. Managed water levels and the expansion of emergent vegetation along a lakeshore. Limnologica, Volume 34, Issues 1–2, Pages 57-64.

Cook, C. D. K. and K. Urmi-Konig. 1985. A revision of the genus *Elodea* (Hydrocharitaceae). Aquatic Botany 21:111-156.

De Winton, M. D. and J. S. Clayton. 1996. Impact of invasive submerged weed species on seed banks in lake sediments: Aquatic Botany, Vol. 53, No. 1-2, pp. 31-45.

Dextrase, A. J. and N. E. Mandrak. 2006. Impacts of alien invasive species on freshwater Fauna at risk in Canada. Biological Invasions 8: 13–24.

Dial, N. A. and C. A. Bauer Dial. 1987. Lethal Effects of Diquat and Paraquat on Developing Frog Embryos and 15- day-old Tadpoles, Rana pipiens. Bulletin of Environmental Contamination and Toxicology 38:1006-1011.

DiTomaso, J. M. and E. A. Healy. 2003. Aquatic and riparian weeds of the West. California: University of California, Agriculture and Natural Resources; Pp. 96-105.

Dixon, J. E. and K. Monteleone. 2014. Gateway to the Americas: Underwater Archeological Survey in Beringia and the North Pacific. In: Evans A., Flatman J., Flemming N. (eds) Prehistoric Archaeology on the Continental Shelf. Springer, New York, NY.

DOWL. 2017. Lake Hood Seaplane Base Master Plan Update. Prepared for the State of Alaska Department of Transportation and Public Facilities Ted Stevens Anchorage International Airport. Anchorage, Alaska.

Durkin, P. R. 2008. Fluridone: Human Health and Ecological Risk Assessment –Final Report. Prepared for the USDA Forest Service by Syracuse Environmental Research Associates, Inc (Forest Service Contract#: AG-3187-C-06-0010).

Eakin, H. L., and J. W. Barko. 1995. Evaluation of the effect of benthic barrier placement on sediment physical and chemical conditions. Technical Report A-95-2. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.Engel, S. 1995. Eurasian watermilfoil as a fishery management tool. Fisheries 20(3):20-27.

ENSR International (ENSR), "Fluridone Ecological Risk Assessment, Final Report" .2005. All U.S. Government Documents (Utah Regional Depository). Paper 147. https://digitalcommons.usu.edu/govdocs/147

Erhard, D., G. Pohnert, and E. M. Gross. 2007. Chemical defense in Elodea nuttallii reduces feeding and growth of aquatic herbivorous Lepidoptera. Journal of Chemical Ecology 33: 1646–1661.

Eugelink, A. H. 1998. Phosphorus uptake and active growth of Elodea canadensis Michx. and Elodea nuttallii (Planch.) St. John. Water Science and Technology; London Volume 37, Issue 3: 59-65.

Fairbanks Soil & Water Conservation District (FSWCD). Elodea in Interior Alaska. Accessed December 18, 2019. Available at: https://www.fairbankssoilwater.org/

Ferrer, O. J. and E. D. Dibble. 2005. Effect of aquatic plants and associate microhabitats on early life stages of fish. Ciencia 13: 416–428.

Fox, A. M., W. T. Haller, and D. G. Shilling. 1996. Hydrilla Control With Split Treatments of Fluridone in Lake Harris, Florida. Hydrobiologia. 340 (1-3): 235-239

Fraser, D., E. R. Chavez, and J. E. Paleheimo. 1984. Aquatic feeding by moose: selection of plant species and feeding areas in relation to plant chemical composition and characteristics of lakes. Canadian Journal of Zoology, 62(1), 80-87.

Fulkerson, J. R., R. Shaftel, and N. Konig, “Survey Design and Methodology for Elodea Detection in Alaska Lakes.“ Annual Invasive Species Workshop, October 22, 2019. Pike’s Waterfront Lodge, Fairbanks, AK. Oral Presentation.

Funderburk Jr., H. H. and G. A. Bozarth. 1967. Review of the metabolism and decomposition of diquat and paraquat. Journal of Agricultural and Food Chemistry, 15:563-567.

Gilderhaus, P.A. 1967. Effects of Diquat on Bluegills and Their Food Organisms. Progressive Fish Culturist 29(2): 67-74.

Great Lakes Panel on Aquatic Nuisance Species. 2012. Prohibited species in the Great Lakes region. Available at http://www.michigan.gov/documents/deq/wrd-ais-regulated-species_390473_7.pdf. Accessed.

Gosselin, R. E., R. P. Smith, and H. C. Hodge. 1984. Clinical toxicology of commercial products. Fifth edition. Baltimore, MD: Williams and Wilkins.

Gunnison, D. and J. W. Barko. 1992. Factors influencing gas evolution beneath a benthic barrier. Journal of Aquatic Plant Management 30: 23-28.Hall J. V., W. E. Frayer, and B. O. Wilen. 1994. Status of Alaska Wetlands. U.S. Fish and Wildlife Service, Alaska Region, Anchorage, Alaska.

Haller, W. T., D. L. Sutton, and W. C. Barlowe. 1974. Effect of salinity on growth of several aquatic macrophytes. Ecology 55: 891-894.

Halstead, J. M., J. Michaud, S. Hallas-Burt, and J. P. Gibbs. 2003. Hedonic Analysis of Effects of a Nonnative Invader (Myriophyllum heterophyllum) on New Hampshire (USA) Lakefront Properties. Environmental Management 32, 391-398.

Hamelink J. L., D. R. Buckler, F. L. Mayer, D. U. Palawski, and H. O. Sanders. 1986. Toxicity of Fluridone to Aquatic Invertebrates and Fish. Environmental Toxicology and Chemistry 5 (1): 87-94.

Haramoto, T. and I. Ikusima. 1988. Life cycle of Egeria densa planch., an aquatic plant naturalized in Japan. Aquatic Botany. Vol 30, Issue 4, May 1988, Pages 389-403.

Hayes, W. J. and E. R. Laws (ed.). 1990. Handbook of Pesticide Toxicology, Vol. 3, Classes of Pesticides. Academic Press, Inc., NY.

Haynes, R. 2000. Elodea canadensis Michaux. In: Flora of North America Editorial Committee, eds.1993. Flora ofNorth America North of Mexico. 12 vols. New York and Oxford. Vol. 22, p. 33.

Hearnden, M. N. and B. H. Kay. 1997. Importance of Hydrilla verticillata (Hydrocharitaceae) as habitat for immature mosquitoes at the Ross River Reservoir, Australia. Journal of the American Mosquito Control Association 13: 164-170.

Heikkinen, R. K., N. Leikola, S. Fronzek, R. Lampinen, and H. Toivonen. 2009. Predicting distribution patterns and recent northward range shift of an invasive aquatic plant: *Elodea canadensis* in Europe. BioRisk 2:1-32.

Horsch, E. and D. Lewis. 2009. The Effects of Aquatic Invasive Species on Property Values: Evidence from a Quasi-Experiment. Land Economics, 85(3): 391-409. 2009.

Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA. 1008 p.

Indiana Department of Natural Resources. 2013. Aquatic Invasive Species: Brazilian Elodea. Available at http://www.in.gov/dnr/files/BRAZILIAN_ELODEA.pdf. Accessed.

Jacono, C. C. and M. M. Richerson. 2004. Nonindigenous Aquatic Plants. Myriophyllum spicatum L. U.S. Department of the Interior. Geological Survey. Biological Resources Division. Center for Aquatic Resource Studies. http://nas.er.usgs.gov

Jones, W. 2006. Invasive plants close ramps on two Indiana Lakes. Water Column 18(3): 1-4.

Jones, C., J. Lawton, and M. Shachak. 1994. Organisms as ecosystem engineers. Oikos 69: 373-386.

Josefsson, M. and B. Andersson. 2001 The Environmental Consequences of Alien Species in the Swedish Lakes Mälaren, Hjälmaren, Vänern and Vättern. AMBIO: A Journal of the Human Environment, 30(8) : 514-521.

Josefsson, M. 2011. Invasive Species Fact Sheet. Elodea canadensis, Elodea nuttallii and Elodea callitrichoides. From: Online Database of the European Network on Invasive Alien Species (NOBANIS), www.nobanis.org, Access Date: 10/10/2019.

Joyce, J. C., W. T. Haller and D. E. Colle. 1980. Investigation of the presence and survivability of hydrilla propagules in waterfowl. Aquatics 2: 10-14.

Kao, C. M. and M. J. Wu. 2001. Control of non-point source pollution by a natural wetland. Water Science and Technology, Vol 43, No 5, pp. 169–174.

Kenai Peninsula Cooperative Weed Management Area (KPCWMA). 2019. Integrated Pest Management Plan for Eradicating Elodea from the Kenai Peninsula. Available at http://www.plants.alaska.gov/invasives/InvasivesNews.htm

Krull, J. N. 1970. Aquatic Plant-Macroinvertebrate Associations and Waterfowl. The Journal of Wildlife Management, Vol. 34, No. 4 (Oct., 1970), pp. 707-718.

Langeland, K., S. Enole, and L. Gettys. 2016. Hydrilla Management in Florida Lakes. University of Florida IFAS Extension. Document SS-AGR-361. Revised January 2016. Available at http://edis.ifas.ufl.edu.

Langeland, K. A. 1996. Hydrilla verticillata (L.F.) Royle (Hydrocharitaceae), "The perfect aquatic weed". Castanea 61: 293-304.

Langeland, K. A. and J. P. Warner. 1986. Persistence of Diquat, Endothall and Fluridone in Ponds. Journal of Aquatic Plant Management 24: 43-46.

Lichvar, R. W., D. L. Banks, W. N. Kirchner, and N. C. Melvin. 2016. The National Wetland Plant List: 2016 wetland ratings. Phytoneuron 2016-30: 1-17. Published 28 April 2016. ISSN 2153 733X

Lichvar, R. W., N. C. Melvin, M. L. Butterwick, and W. N. Kirchner. 2012. National Wetland Plant List Indicator Rating Definitions. Technical Note Published July 2012. Report Number ERDC/CRREL TN-12-1.

Lorz, H. W., S. W. Glen, R. H. Williams, C. M. Kunkel, A. Logan, L. A. Norris and B. R. Loper. 1979. Effects of Selected Herbicides on Smolting of Coho Salmon. United States Environmental Protection Agency. EPA-600/3-79-071.

Luizza, M. W., P. H. Evangelista, C. S. Jarnevich, A. West, and H. Stewart. 2016. Integrating subsistence practice and species distribution modeling: assessing invasive elodea's potential impact on Native Alaskan subsistence of Chinook salmon and whitefish. Environmental Management DOI 10.1007/s00267-016-0692-4.

Mackay, D., S. Wan-Ying, and M. Kuo-ching. 1997. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III. Pesticides. Lewis Publishers. Chelsea, Michigan.

Madsen, J. D., K. D. Getsinger, R. M. Stewart and C. S. Owens. 2002. Whole lake fluridone treatments for selective control of Eurasian watermilfoil: II. Impacts on submersed plant communities. Lake and Reservoir Management 18(3):191-200.

Marquis, L., R. Comes and C. Yang. 1981. Absorption and translocation of fluridone and glyphosate in submersed vascular plants. Weed Science. 29(2):229-236.

McCowen, M., C. Young, S. West, S. Parka, and W. Arnold. 1979. Fluridone, a new herbicide for aquatic plant management. Journal of Aquatic Plant Management 17:27-30.

Merz, J. E., J. R. Smith, M. L. Workman, J. D. Setka, and B. Mulchaey. 2008. Aquatic macrophyte encroachment in Chinook salmon spawning beds: lessons learned from gravel enhancement monitoring in the Lower Mokelumne River, California. North American Journal of Fisheries Management 28:1568-1577.

Mjelde, M., P. Lombardo, D. Berge, and S. W. Johansen. 2012. Mass invasion of non-native Elodea canadensis Michx. In a large, clear-water, species-rich Norwegian lake – impact on macrophyte biodiversity. Annals of Limnology- International Journal of Limnology, 48. Pp. 225-240.

Muir D. C. G., N. P. Grift, A. P. Blouw, and W. L. Lockhart. 1980. Persistence of Fluridone in Small Ponds. Journal of Environmental Quality 9 (1): 151-156.

Nagasaka, M. 2004. Changes in biomass and spatial distribution of Elodea nuttallii (Planch.) St. John, an invasive submerged plant, in oligomesotrophic Lake Kizaki from 1999 to 2002. Limnology (2004) 5: 129–139.

National Marine Fisheries Service (NMFS). 2016. Recovery Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*). National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

National Park Service Alaska Region (NPS). 2009. Alaska Region Invasive Plant Management Plan Revised Environmental Assessment. August 2009. Alaska Regional Office Anchorage, Alaska.

Natural Resources Conservation Service (NRCS). 2018. Field Indicators of Hydric Soils in the United States, Version 8.2. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

Natural Resources Conservation Service (NRCS). Soils. Accessed December 10, 2019. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054280

Nichols, S. A. and B. H. Shaw. 1986. Ecological life histories of the three aquatic nuisance plants, Myriophyllum spicatum, Potamogeton crispus and Elodea Canadensis. Hydrobiologia 131, 3-21.

Omernik, J. M. 1987. Ecoregions of the conterminous United States (map supplement): Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125, scale 1:7,500,000.

Parkinson, H. L, J. Mangold, J. Jacobs, J. Madsen, and J. Halpop. 2010. Biology, Ecology, and Management of Eurasian Watermilfoil (Myriophyllum spicatum L.). Montana State University Extension. EB0193. March 2010.

Parsons, W. T. and E. G. Cuthbertson. 2001. Noxius weeds of Australia, 2nd Edition, pp. 61-63. CSIRO Publishing, Collingwood VIC, Australia.

Paul E. A., H. A. Simonin, J. Symula, and R. W. Bauer. 1994. The Toxicity of Diquat, Endothall, and Fluridone to the Early Life Stages of Fish. Journal of Freshwater Ecology 9(3): 229-239.

Peterson, M. R., J. B. Grand, and C. Dau. 2000. Spectacled Eider (Somateria fischeri). In The Birds of North America, No. 547 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Rejmánková, E. 2011. The role of macrophytes in wetland ecosystems. Jouranl of Ecology and Field Biology 34(4): 333-345, 2011.

Rorslett, B., D. Berge, and S. W. Johansen. 1986. Lake enrichment by submersed macrophytes: a Norwegian whole-lake experience with *Elodea canadensis*. Aquatic Botany 26:325-340.

Rybicki, N. B. and J. M. Landwehr. 2007. Long-term changes in abundance and diversity of macrophyte and waterfowl populations in an estuary with exotic macrophytes and improving water quality. Limnology and Oceanography 52(3): 1195-1207.

Sand-Jensen, K. 2000. An introduced vascular plant - the Canadian waterweed (*Elodea canadensis*). Pp. 96-100 in: Weidema, I. (ed.). Introduced species in the Nordic countries. Norden (The Nordic Council), Copenhagen, Denmark.

Savino, J. F. and R. A. Stein. 1989. Behavior of fish predators and their prey—habitat choice between open water and dense vegetation. Environmental Biology of Fishes 24: 287–293.

Schneider, J. C. 2000. Evaluation of the effects of the herbicide Sonar on sport fish populations in Michigan lakes. Michigan Department of Natural Resources, Fisheries Technical Report No. 2000-2. 35 pp.

Schultz, R. and E. Dibble. 2012. Effects of invasive macrophytes on freshwater fish and macroinvertebrate communities: the role of invasive plant traits. Hydrobiologia 684: 1–14.

Schwoerer, T. 2017. Invasive elodea threatens remote ecosystem services in Alaska: a spatially-explicit bioeconomic risk analysis. Dissertation Submitted to University of Alaska Fairbanks, May 2017.

Schwoerer, T., J. M. Little, and M. D. Adkison. 2019. Aquatic Invasive Species Change Ecosystem Services from the World's Largest Wild Sockeye Salmon Fisheries in Alaska. Journal of Ocean and Coastal Economics: Vol. 6: Iss. 1, Article 2.

Schwoerer, T. “Human Dimensions of Aquatic Invasive Species in Alaska: A Participatory Geographic Pathway Analysis of Watercraft.” Annual Invasive Species Workshop, October 22, 2019. Pike’s Waterfront Lodge, Fairbanks, AK. Oral Presentation.

SePRO Corporation (SePRO). 2015. Sonar® A.S. (EPA Reg. No. 67690-4). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

SePRO Corporation (SePRO). 2017. Sonar® Genesis (EPA Reg. No. 67690-54). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

SePRO Corporation (SePRO). 2019. Littora (EPA Reg. No. 67690-53). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

SePRO Corporation (SePRO). 2019a. SonarOne (EPA Reg. No. 67690-45). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

SePRO Corporation (SePRO). 2019b. Sonar® Q (EPA Reg. No. 67690-3). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

SePRO Corporation (SePRO). 2019c. Sonar® X PR (EPA Reg. No. 67690-12). Product Label. 11550 North Meridian Street Suite 600 Carmel, IN 46032.

Sethi, S. A., M. P. Carey, J. M. Morton, E. Guerron-Orejuelad, R. Decinoe, M. Willettee, J. Boersmaf, J. Jablonskif, and C. Andersonf. 2017. Rapid response for invasive waterweeds at the arctic invasion front: Assessment of collateral impacts from herbicide treatments. Biological Conservation 212 300–309.

Sharda USA LLC (Sharda). 2016. Dessicash Landscape and Aquatic Herbicide (EPA Reg. No. 83529-12). Product Label. P.O. Box 640 Hockessin, DE 19707.

Sheldon, S. P. and R. P. Creed, Jr. 1995. Use of a Native Insect as a Biological Control for an Introduced Weed. Ecological Applications. Vol. 5, No. 4, pp. 1122-1132.

Shenoy A., C. McKenzie, and M. Mastri. "Elodea Management in Interior Alaska." Annual Invasive Species Workshop, October 22, 2019. Pike's Waterfront Lodge, Fairbanks, AK. Oral Presentation.

Simsiman, G. V. and G. Chesters. 1976. Persistence of Diquat in the Aquatic Environment. Water Research 10: 105-112.

Simsiman, G. V., T. C. Daniel, and G. Chesters. 1976. Diquat and endothall: their fates in the environment. Residue Review, 62:131-174.

Sinha, S., R. Saxena, and S. Singh. 2000. Fluoride removal from water by Hydrilla verticillata (l.f.) Royle and its toxic effects. Bulletin of Environmental Contamination and Toxicology 65: 683-690.

Smith, S .N., A. J. E. Lyon, and I. B. Sahid. 1976. The Breakdown of Paraquat and Diquat by Soil Fungi. New Phytologist 77:735-740.

Smith, Steve C., Foster, Nora, and Gotthardt, Tracey. 2005. The Distribution of Freshwater Mussels *Anodonta spp*. and *Margaritifera falcata* in Alaska: 2005 Final Report: Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage: Anchorage, AK, p. 26-26.

Spencer, D. F. and M. Rejmanek. 1989. Propagule type influences competition between two submersed aquatic macrophytes. Oecologia 81: 132-137.

Spicer, K. W. and P. M. Catling. 1988. The biology of Canadian weeds. 88. Elodea canadensis Michx. Canadian Journal of Plant Science 68: 1035-1051.

Stevens, M. A. and J. K. Walley. 1966. Tissue and milk residues arising from the ingestion of single doses of diquat and paraquat by cattle. Journal of the Science of Food and Agriculture Volume 17 Issue 10 pages 472-475.

Steward, K. K. 1992. Survival and growth of stem fragments from various hydrilla races. Florida Scientist 55: 129-135.

Strakosh, T. R., K. B. Gido, and C. S. Guy. 2009. Effects of American water willow establishment on density, growth, diet, and condition of age-0 largemouth bass in Kansas reservoirs. Transactions of the American Fisheries Society 138: 269–279.

Syngenta Crop Protection Inc. (Syngenta). 2009. REWARD® Landscape and Aquatic Herbicide (EPA Reg. No. 100-1091). Product Label. Post Office Box 18300, Greensboro, NC 27419.

Syngenta Crop Protection Inc. (Syngenta). 2015. Safety Data Sheet. REWARD® Landscape and Aquatic. Post Office Box 18300, Greensboro, NC 27419.

The American Lung Association (TALA). 2019. State of the Air® 2019. Available at: https://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2019-full.pdf

Tremayne, A. 2018. A Survey of Human Migration in Alaska's National Parks through Time. Alaska Park Science Volume 17, Issue 1 p.5-14.

Twilley, R. R. and J. W. Barko. 1990. The growth of submersed macrophytes under experimental salinity and light conditions. Estuaries 13: 311- 321.

U.S. Army Engineer Research and Development Center Environmental Laboratory (ERDC). 2017. Monitoring Invasive Species on Joint Base Elmendorf-Richardson, Alaska Using eDNA Technology. Prepared for Joint Base Elmendorf-Richardson. 20 March 2017. Vicksburg, MS.

U. S. Bureau of Land Management (USBLM), "Diquat Ecological Risk Assessment, Final Report" (2005). All U.S. Government Documents (Utah Regional Depository). Paper 107. https://digitalcommons.usu.edu/govdocs/107

U. S. Census Bureau (USCB). 2018. Population Estimates by County. Retrieved from https://www.census.gov/search-results.html?q=Alaska+population&page=1&stateGeo= none&searchtype =web&cssp=SERP&_charset_=UTF-8

U.S. Department of Agriculture, Forest Service (USFS). 2016. Elodea Herbicide Treatment Environmental Assessment, Cordova Ranger District, Chugach National Forest, Alaska

U. S. Department of Agriculture (USDA), NRCS. 2020. The PLANTS Database. (http://plants.usda.gov, accessed January 2020). National Plant Data Team, Greensboro, NC 27401-4901 USA.

U. S. Department of Agriculture (USDA) National Agricultural Statistics Service. 2017. Census of Agriculture State Profile: Alaska.

U.S. Department of the Interior (USDOI). 2016. Safeguarding America's lands and waters from invasive species: A national framework for early detection and rapid response, Washington D.C., 55p.

U. S. Department of the Interior (USDOI) Fish and Wildlife Service. 2014. 50 CFR Part 17 [Docket No. FWS–R7–ES–2012–0033; 70120–1113–0000–C3] RIN 1018–AW57, Endangered and Threatened Wildlife and Plants; Establishment of a Nonessential Experimental Population of Wood Bison in Alaska. Federal Register Vol. 79, No. 88, Wednesday, May 7, 2014.

U. S. Environmental Protection Agency (USEPA). 2009. National Primary Drinking Water Regulations. EPA 816-F-09-004, MAY 2009.

U. S. Environmental Protection Agency (USEPA). 1995. Reregistration Eligibility Decision (RED) Diquat Dibromide. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-016. July. U.S. Environmental Protection Agency. Washington D.C.

U. S. Environmental Protection Agency (USEPA), Office of Pesticide Programs. 2004. Acute and Chronic Dietary Exposure Assessments for the Reregistration Eligibility Decision [on Fluridone]. Report dated August 12, 2004.

U. S. Environmental Protection Agency (USEPA), Office of Pesticide Programs. 2002. Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED): Diquat Dibromide. Report dated April 25, 2002.

U. S. Fish and Wildlife Service (USFWS). 2019. Alaska Region, Endangered Species. Updated June 18, 2019. Accessed November 18 2019. Available at: https://www.fws.gov/alaska/pages/endangered-species

U. S. Fish and Wildlife Service (USFWS). 2019. Alaska-breeding population of Steller's eiders (*Polysticta stelleri*) 5-Year Review: Summary and Evaluation. Fairbanks Fish and Wildlife Field Office Fairbanks, Alaska.

U. S. Fish and Wildlife Service (USFWS). 2018. Aleutian shield fern (*Polystichum aleuticum*) 5-Year Review: Summary and Evaluation. Anchorage Fish and Wildlife Field Office, Anchorage, Alaska

U. S. Fish and Wildlife Service (USFWS). 2016. Eskimo Curlew (*Numenius borealis*) 5-Year Review: Summary and Evaluation. Fairbanks Fish and Wildlife Field Office Fairbanks, Alaska.

U. S. Fish and Wildlife Service (USFWS). 2014a. Invasive Species: National Wildlife Refuge System. Website updated January 23 2014. Available at https://www.fws.gov/invasives/nwrs.html

U. S. Fish and Wildlife Service (USFWS). 2014b. NEPA for National Wildlife Refuges: A Handbook. Available at https://www.fws.gov/policy/NEPARefugesHandbook.pdf

U. S. Fish and Wildlife Service (USFWS). 2010. Integrated Pest Management. 569 FW1 August 3, 2010. Available at: https://www.fws.gov/policy/569fw1.html

U. S. Fish and Wildlife Service (USFWS). 2017. Polar Bear (*Ursus maritimus*) 5-Year Review: Summary and Evaluation. Marine Mammals Management Anchorage, Alaska.

U. S. Fish and Wildlife Service (USFWS). 2014. Short-tailed Albatross (*Phoebastria albatrus*) 5-Year Review: Summary and Evaluation. Anchorage Fish and Wildlife Field Office, Anchorage, Alaska.

U. S. Fish and Wildlife Service (USFWS). 2010. Spectacled Eider (*Somateria fischeri*) 5-Year Review: Summary and Evaluation. Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska.

U. S. Fish and Wildlife Service (USFWS). 2013. Southwest Alaska DPS of the Northern Sea Otter (*Enhydra lutris kenyoni*) 5-Year Review: Summary and Evaluation. Marine Mammals Management Anchorage, Alaska.

U. S. National Park Service (NPS). 2009. National Park Service Alaska Region Invasive Plant Management Plan Revised Environmental Assessment August 2009. Accessed November 20, 2019. Available at: https://parkplanning.nps.gov/projectHome.cfm?projectID=15850

Valley, R. D. and M. T. Bremigan, 2002a. Effects of macrophyte bed architecture on largemouth bass foraging: Implications of exotic macrophyte invasions. Transactions of the American Fisheries Society 131: 234–244.

Vincent C. H., L. A. Hanson, and C. N. Argueta. 2017. Federal Land Ownership: Overview and Data. Congressional Research Service. 7-5700 R42346. Available at: www.crs.gov

Washington State Department of Ecology (WA-ECY). 2003. Non-Native Freshwater Plants. Eurasian Watermilfoil. http://www.ecy.wa.gov/programs/wq/plants/we eds

Washington State Department of Ecology (WA-ECY). 2002. Supplemental environment impact statement assessments of aquatic herbicides. Washington State Department of Ecology, Olympia, Washington. Available from http://www.ecy.wa.gov/programs/wq/pesticides/seis/copperrisk.pdf (accessed 18 October 2019).

Washington State Department of Ecology (WA-ECY). 2017. Supplemental Environment Impact Statement for State of Washington Aquatic Plant and Algae Management. Washington State Department of Ecology, Olympia, Washington. Available from https://fortress.wa.gov/ecy/publications/SummaryPages/1710020.html (accessed 20 November 2019).

Wiken, E. B. 1986. Terrestrial ecozones of Canada: Ottawa, Ontario, Environment Canada, Ecological Land Classification Series no. 19, 26 p.

Wilson, D. C. and C. E. Bond. 1969. The Effects of the Herbicide Diquat® and Dichlobenil (Casoron®) on Pond Invertebrates Part I. Acute Toxicity. Transactions of the American Fisheries Society 98(3): 438-443.

Woodward, A. and E. A. Beever. 2011. Conceptual ecological models to support detection of ecological change on Alaska National Wildlife Refuges: U.S. Geological Survey Open-File Report 2011–1085, 136 p.

Wurtz, T. L., N. Lisuzzo, A. Batten, and A. Larsen. 2013. Request for analysis of native status of Elodea in Alaska. Internal letter dated April 8th. USDA Forest Service, Alaska Region State and Private Forestry, Forest Health Protection, Fairbanks, AK.

Yarrow, M., V. H. Marín, M. Finlayson, A. Tironi, L. E. Delgado, and F. Fischer. 2009. The ecology of *Egeria densa* Planchon (Liliopsida: Alismatales): a wetland ecosystem engineer? Revista Chilena de Historia Natural 82: 299-313.

Zhang, C. and K. J. Boyle. 2010. The effect of an aquatic invasive species (Eurasian watermilfoil) on lakefront property values. Ecological Economics 70, 394-404.

8.0 Glossary

Alaska Region - the Service's administrative Region 11, which is the entire state of Alaska.

Alien Species - with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.

Biological Control – intentional release of a living exotic organism to control an invasive species.

Chemical Control – the use of herbicide or pesticide to suppress or kill an invasive species.

Cultural Control – modification of human behavior to control invasive species.

Integrated Pest Management (IPM) - is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. (FIFRA, 7 U.S.C. 136r-1)

Invasive Species - an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

LC50 - the concentration of a substance required to kill 50% of test organisms during the specified test period.

LD50 - the dose of a substance required to kill 50% of test organisms during the specified test period.

Monitoring - a survey repeated through time to determine changes in the status and demographics of abiotic resources, species, habitats, or ecological communities (701 FW 2 Policy on Inventory and Monitoring).

NOEC/NOEL - the highest dose or concentration of a substance that produces no observable effects on test organisms.

Pathway – the means and routes by which invasive species are introduced into new environments.

Persistence – the ability of a compound to remain unchanged in the environment.

Pest - are living organisms, including invasive plants and introduced or native organisms that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety.

Physical Control - management methods that either involve manipulation of environmental variables (light, water, etc.) or mechanical action (cutting, pulling, etc.).

Rapid Response - the process that is employed to eradicate the founding population of a non-native species from a specific location.

Submersed Aquatic Plant – are plants that are rooted in sediment and have underwater leaves. The majority of the plant is found underwater but leaves, flowers, and fruits may rise above the water surface.

Toxicity – the extent to which something is poisonous or harmful.

Vector - biological pathway for a pest.

9.0 Appendices

Appendix A: Figures

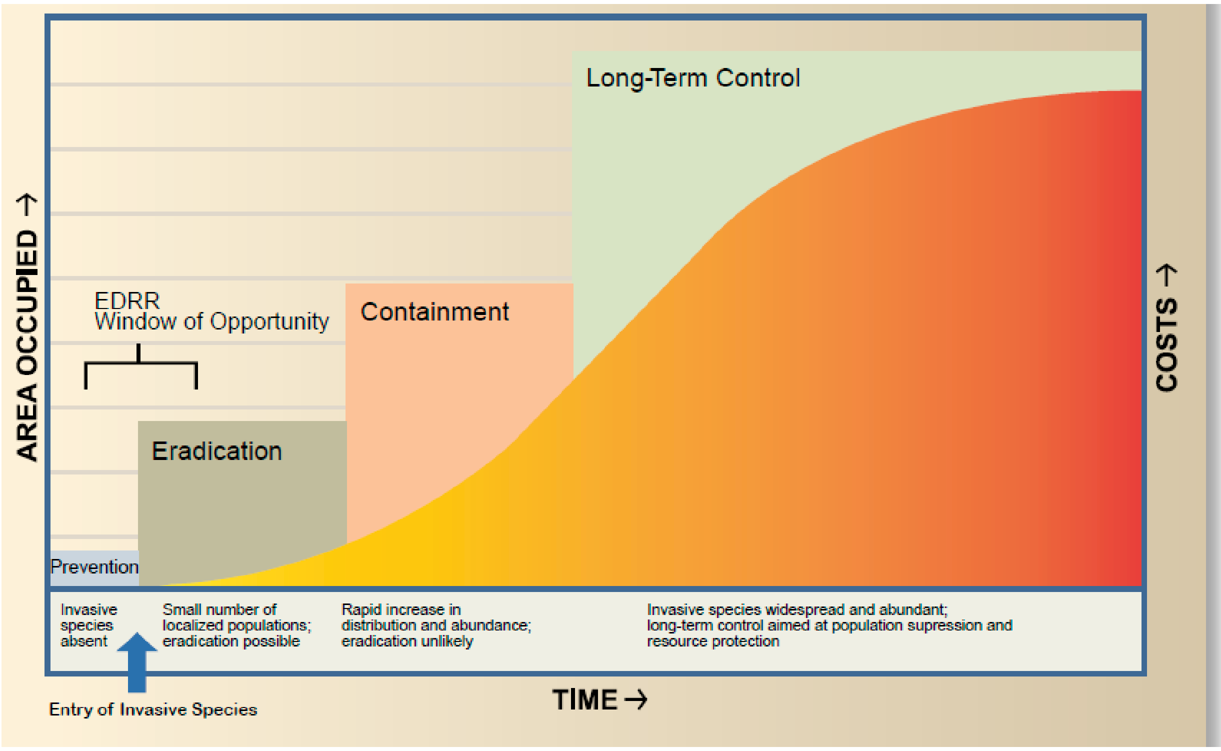

Figure 1: This invasion curve depicts the increases in area occupied and cost of treatment over time once an invasive species becomes established (adapted from USDOI 2016).

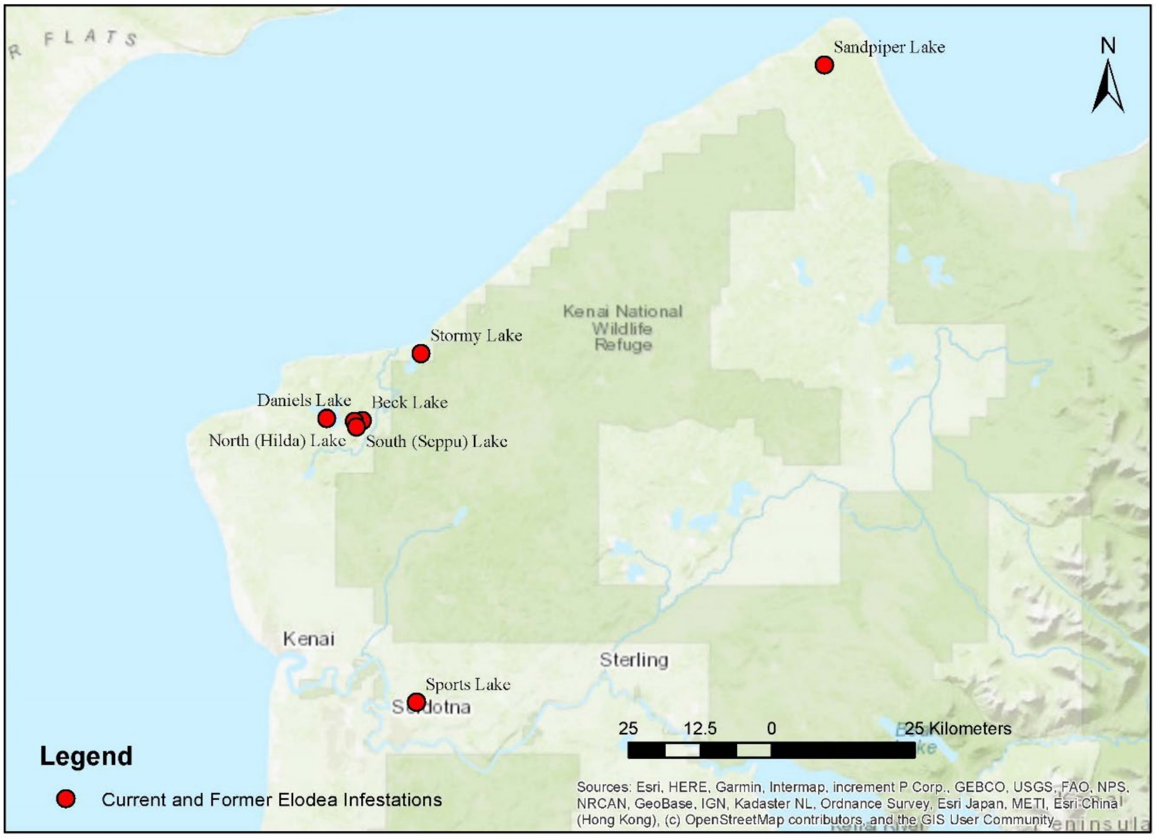

Figure 2: This map depicts current and former elodea infestations on the Kenai Peninsula. The labels indicate the water body where elodea was found.

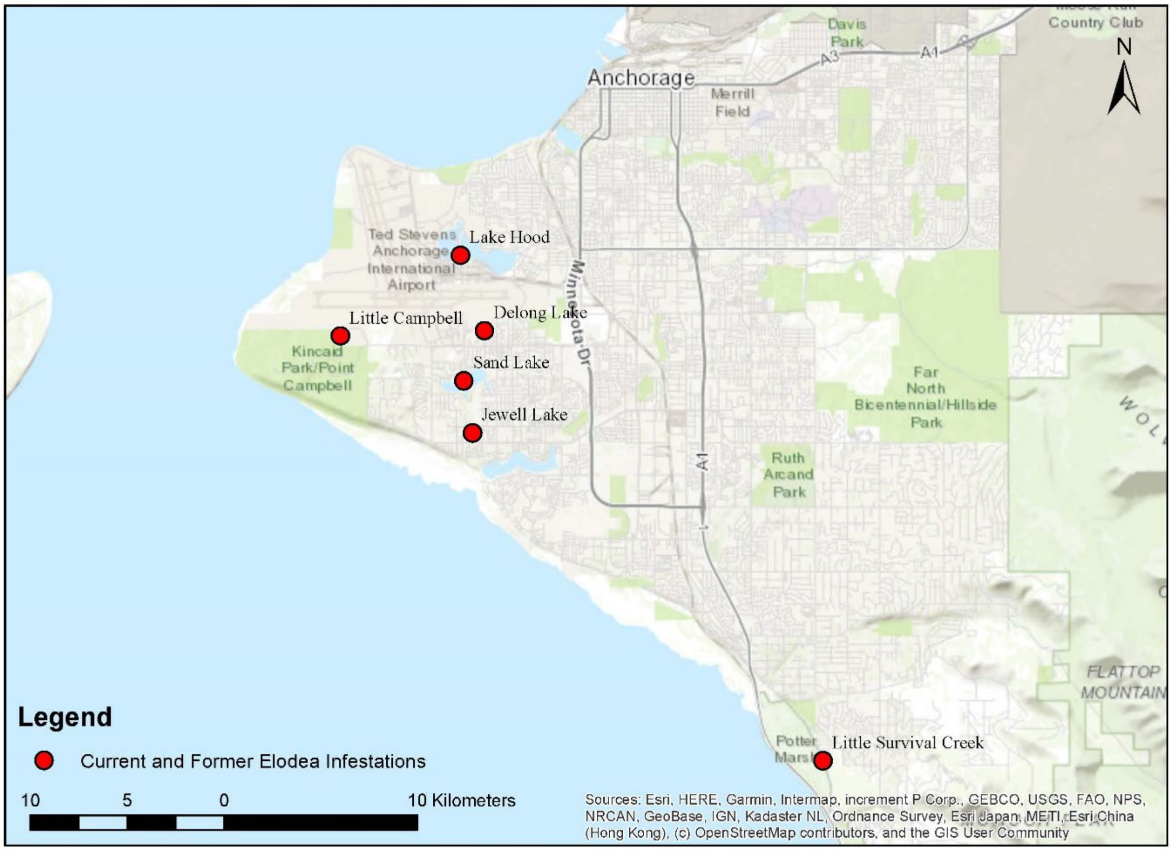

Figure 3: This map depicts current and former elodea infestations in the Municipality of Anchorage. The labels indicate the water body where elodea was found.

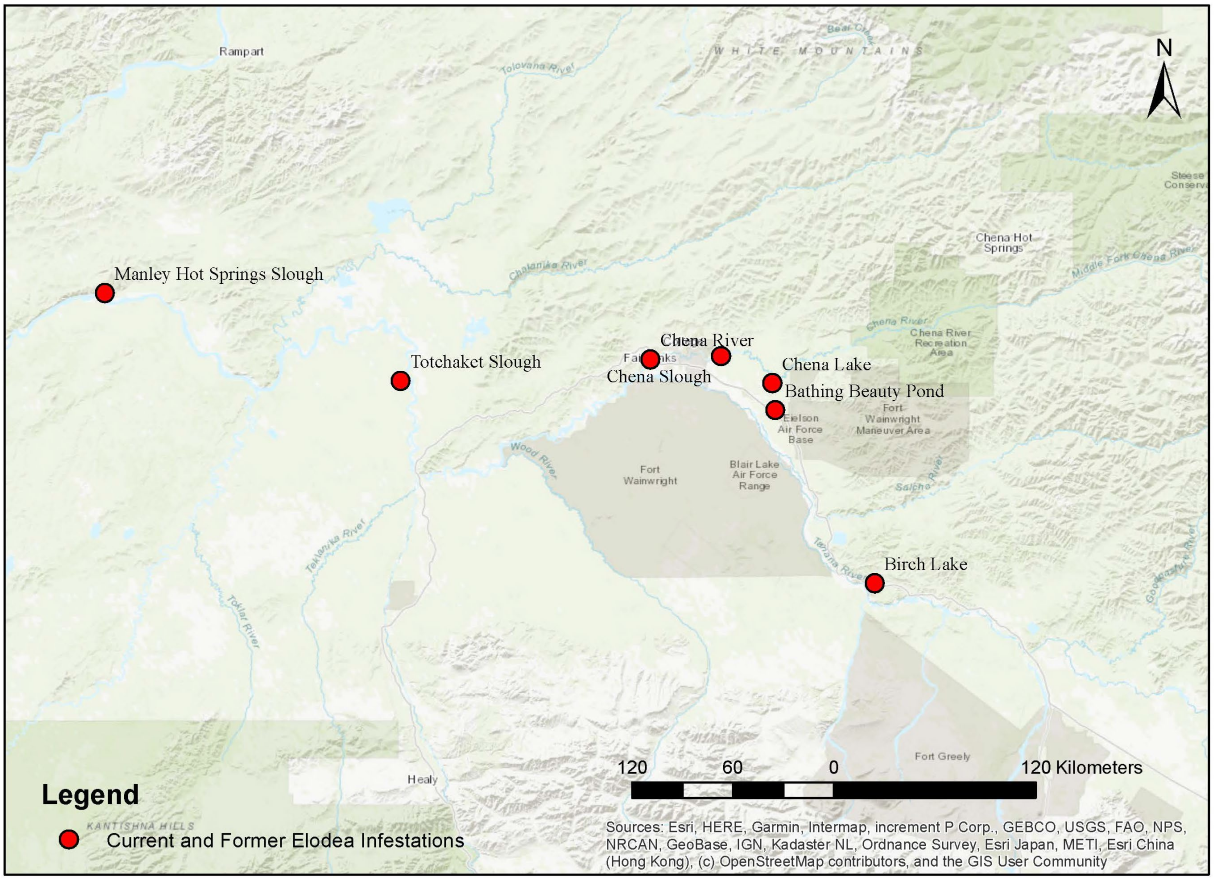

Figure 4: This map depicts current and former elodea infestations near Fairbanks. The labels indicate the water body where elodea was found.

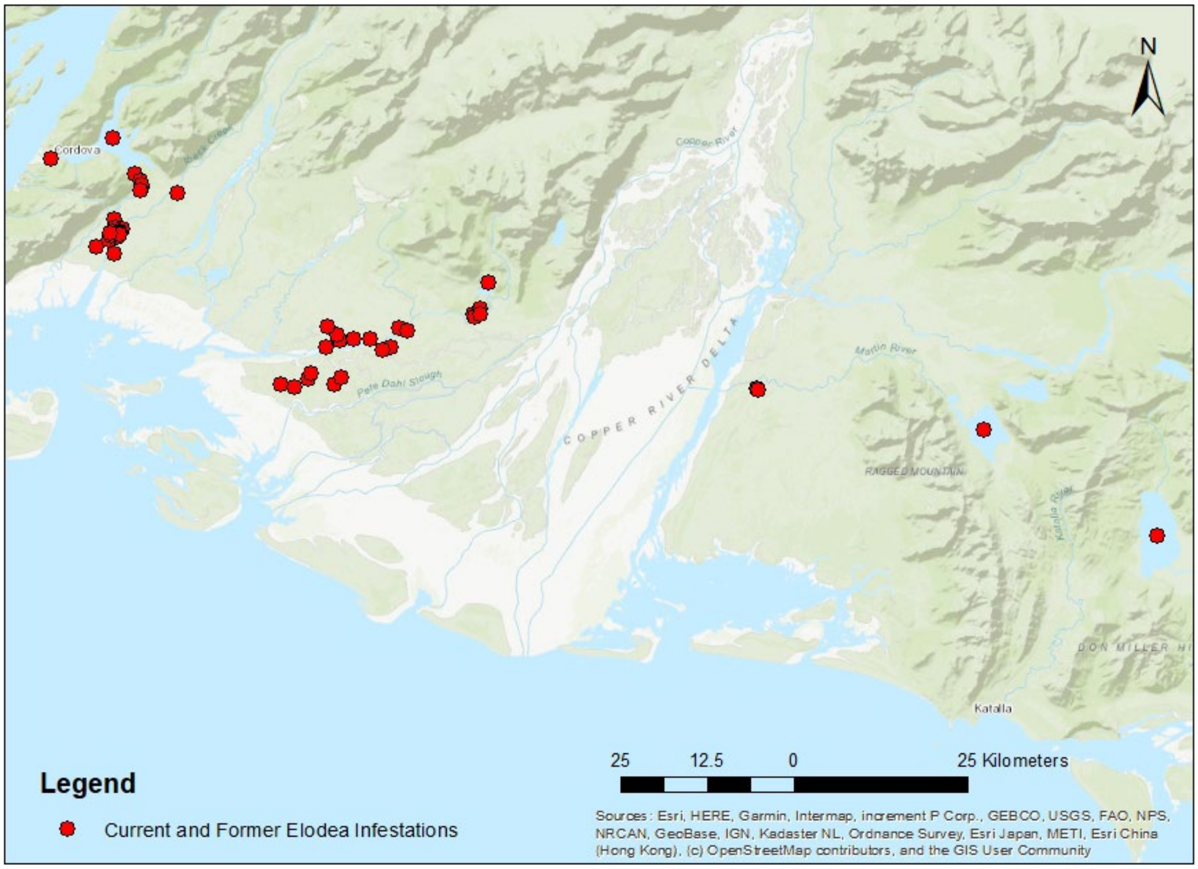

Figure 5: This map depicts current and former elodea infestations near Cordova. A list of infested water bodies is provided in **Appendix B**.

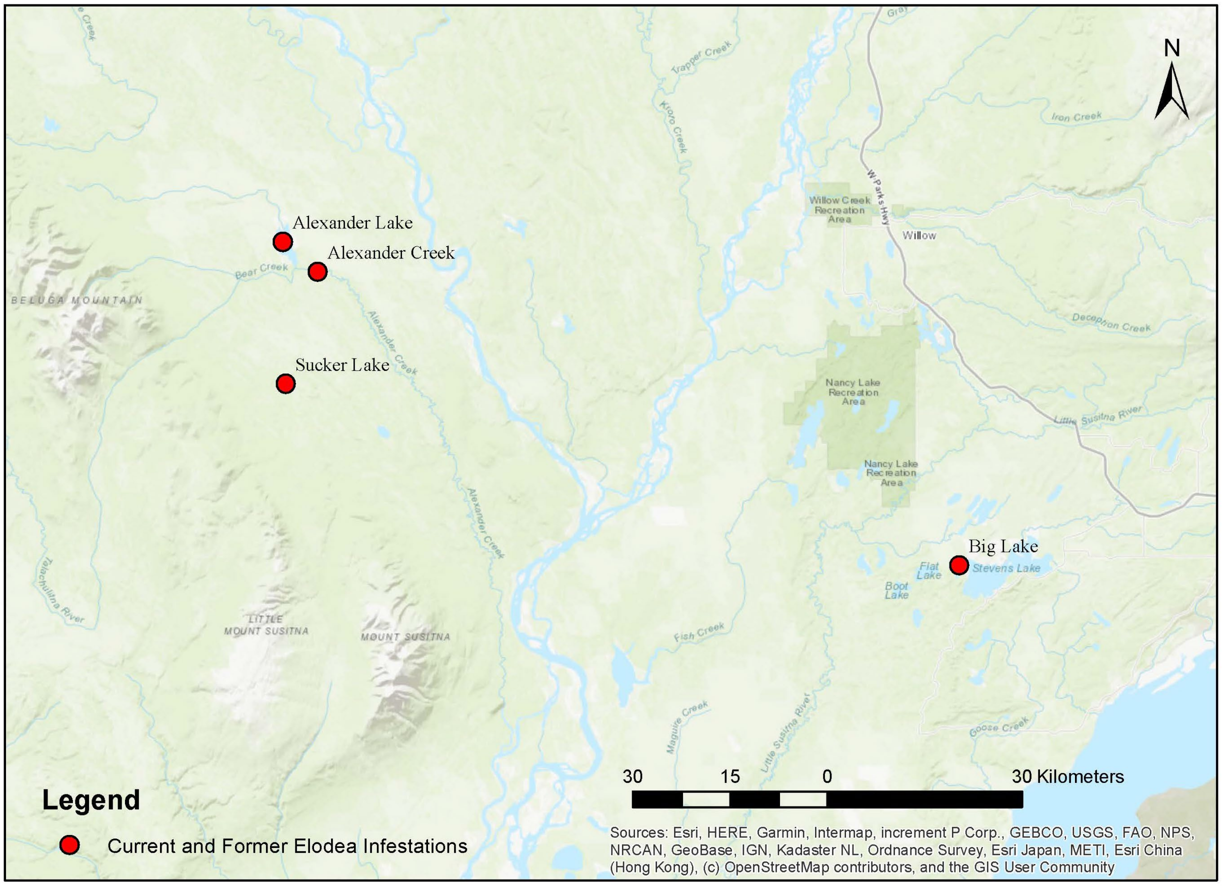

Figure 6: This map depicts current elodea infestations in the Susitna River Basin. The labels indicate the water body where elodea was found.

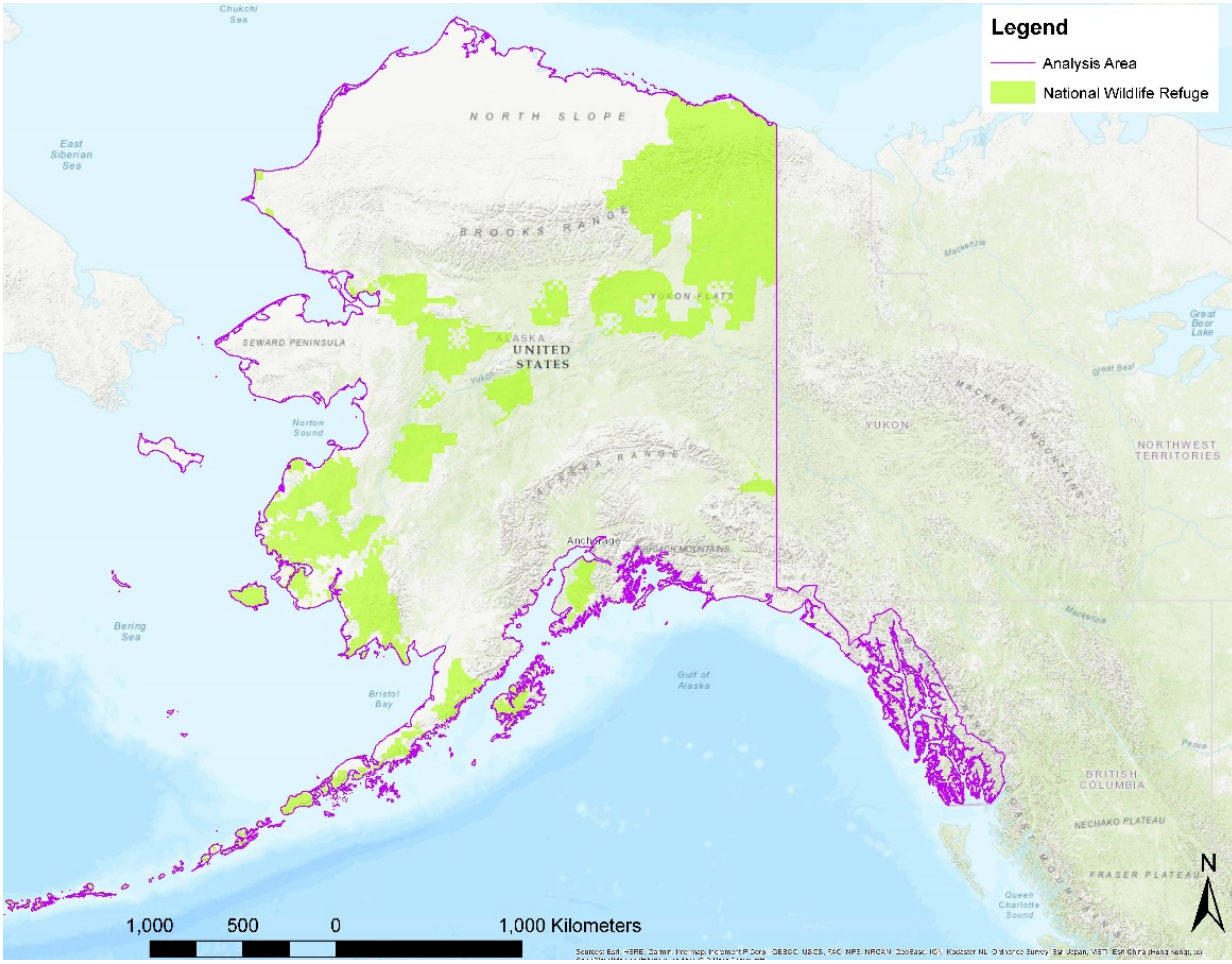

Figure 7: This map depicts the potentially affected environment analyzed in this EA. The area considered affected environment in this EA is the entire Alaska Region.

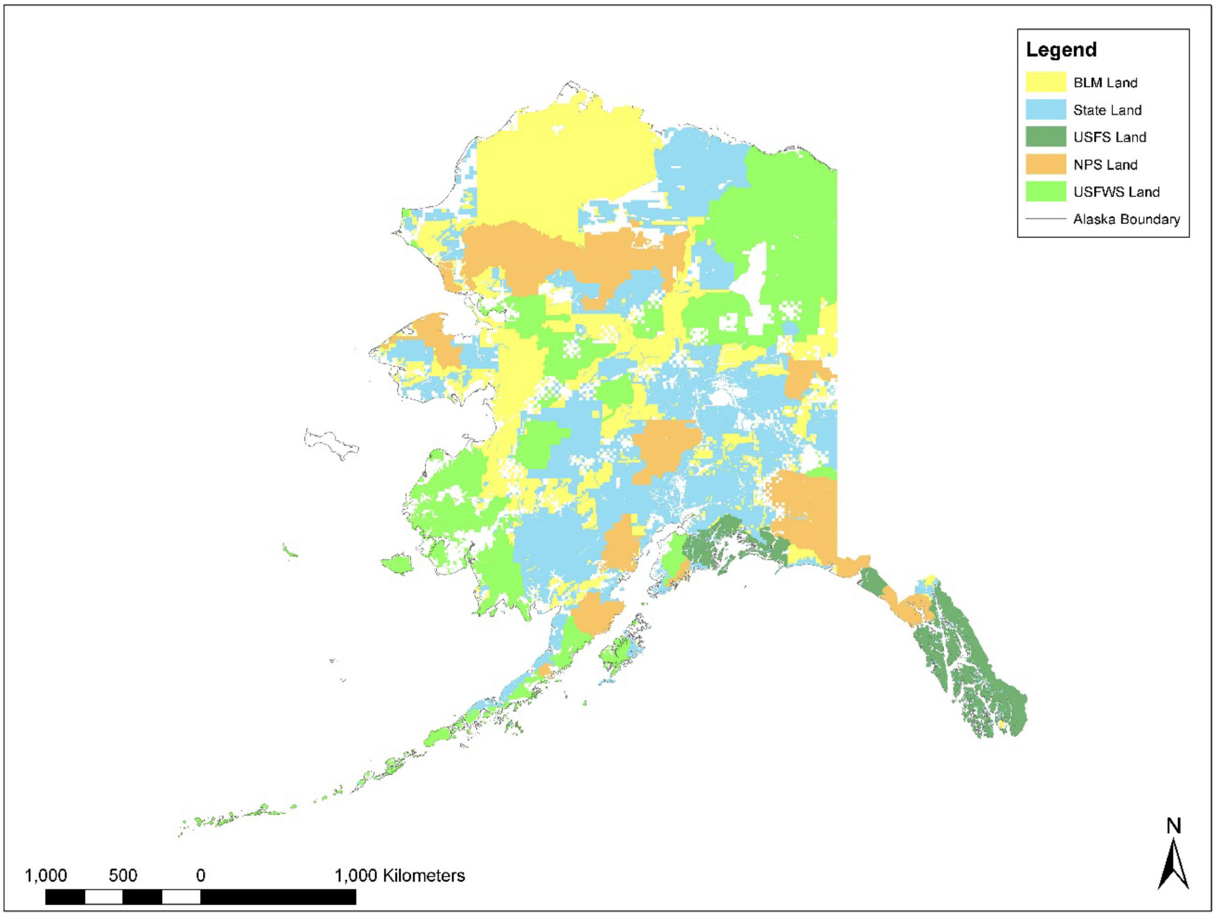

Figure 8: This map depicts the location of Federal and State administered public land in Alaska. Private land is shown in white.

Appendix B: **Current and Former Elodea Infestations in Alaska**

Region	Waterbody Name	Status	Approximate Location (Lat, Long)
Interior	Chena River	3	64.830001N, 147.862920W
Interior	Chena Slough	2	64.837228N, 147.485866W
Interior	Chena Lake	2	64.775639N, 147.211972W
Interior	Totchaket Slough	2	64.781145N, 149.195762W
Interior	Manley Hot Springs Slough	1	64.980390N, 150.775390W
Interior	Birch Lake	1	64.316343N, 146.665372W
Interior	Bathing Beauty Pond	2	64.713984N, 147.196456W
Anchorage & Mat-Su	Little Campbell	4	61.161333N, 150.024364W
Anchorage & Mat-Su	Sand Lake	4	61.151330N, 149.967002W
Anchorage & Mat-Su	Delong Lake	4	61.162572N, 149.957453W
Anchorage & Mat-Su	Lake Hood	4	61.179417N, 149.968697W
Anchorage & Mat-Su	Jewell Lake	2	61.139670N, 149.963139W
Anchorage & Mat-Su	Little Survival Creek	2	61.066239N, 149.800475W
Anchorage & Mat-Su	Alexander Lake	2	61.748206N, 150.900596W
Anchorage & Mat-Su	Alexander Creek	1	61.728663N, 150.851816W
Anchorage & Mat-Su	Sucker Lake	2	61.654912N, 150.896455W
Anchorage & Mat-Su	Big Lake	2	61.535258N, 149.962500W
Kenai Peninsula	Stormy Lake	4	60.782414N, 151.041724W
Kenai Peninsula	Sports Lake	4	60.513633N, 151.049273W
Kenai Peninsula	Daniels Lake	4	60.732720N, 151.189933W
Kenai Peninsula	Beck Lake	4	60.731108N, 151.133742W
Kenai Peninsula	North (Hilda) Lake	4	60.730311N, 151.146445W
Kenai Peninsula	South (Seppu) Lake	4	60.726072N, 151.143054W
Kenai Peninsula	Sandpiper Lake	1	61.003081N, 150.408296W
Copper River Delta	Eyak Lake	1	60.552886N, 145.671968W
Copper River Delta	*Eyak Wier*	1	60.530194N, 145.643391W
Copper River Delta	Eyak River	1	60.525431N, 145.636282W
Copper River Delta	Eyak River	1	60.521840N, 145.635017W
Copper River Delta	Eyak River	1	60.522962N, 145.634920W
Copper River Delta	Eyak River	1	60.519896N, 145.637353W
Copper River Delta	Eyak River	1	60.501272N, 145.670860W
Copper River Delta	*Slough off Eyak River*	1	60.478921N, 145.670142W
Copper River Delta	*Pond north of Eyak River*	1	60.495750N, 145.669907W
Copper River Delta	*Pond near Ibeck Creek*	1	60.517753N, 145.588601W
Copper River Delta	*Eyak Slough*	1	60.495104N, 145.660235W
Copper River Delta	*Cannery Pond*	1	60.489861N, 145.675318W
Copper River Delta	*South Cannery Pond*	3	60.490180N, 145.668067W
Copper River Delta	*Cannery Pond West*	3	60.493204N, 145.671755W

Region	Waterbody Name	Status	Approximate Location (Lat, Long)
Copper River Delta	*Cannery Pond East*	3	60.492964N, 145.663921W
Copper River Delta	*Cannery Slough*	3	60.488472N, 145.678411W
Copper River Delta	*Cannery Slough*	3	60.483612N, 145.694018W
Copper River Delta	*Cannery Slough*	3	60.490971N, 145.675149W
Copper River Delta	*Cannery Slough*	3	60.492327N, 145.663272W
Copper River Delta	*Cannery Slough*	3	60.491413N, 145.663814W
Copper River Delta	*West Cannery Pond*	3	60.492137N, 145.676376W
Copper River Delta	*Pond off Alaganik*	1	60.431637N, 145.302549W
Copper River Delta	*Pond off Alaganik*	1	60.424194N, 145.378029W
Copper River Delta	*Slough off Alaganik*	3	60.429885N, 145.291007W
Copper River Delta	*Slough off Alaganik*	3	60.424596N, 145.360032W
Copper River Delta	*Slough off Alaganik*	3	60.427122N, 145.382796W
Copper River Delta	*Slough south of Alaganik*	1	60.395881N, 145.386332W
Copper River Delta	*Slough south of Alaganik*	1	60.395893N, 145.455479W
Copper River Delta	*Slough south of Alaganik*	1	60.394049N, 145.438077W
Copper River Delta	*Slough off Alaganik*	1	60.419497N, 145.312902W
Copper River Delta	*Slough off Alaganik*	1	60.417683N, 145.323984W
Copper River Delta	*Slough off Alaganik*	1	60.432986N, 145.394989W
Copper River Delta	*Slough south of Alaganik*	1	60.399200N, 145.419162W
Copper River Delta	*Slough north of Alaganik*	1	60.425039N, 145.339563W
Copper River Delta	*Slough south of Alaganik*	1	60.403201N, 145.416698W
Copper River Delta	*Slough south of Alaganik*	1	60.400273N, 145.377142W
Copper River Delta	*Pond off Clear Martin Creek*	1	60.393072N, 144.838457W
Copper River Delta	*Pond off Clear Martin Creek*	1	60.391954N, 144.837014W
Copper River Delta	McKinley Lake	1	60.460877N, 145.186312W
Copper River Delta	Martin Lake	1	60.366871N, 144.544472W
Copper River Delta	Bering Lake	1	60.298477N, 144.320065W
Copper River Delta	Wooded Pond	1	60.440912N, 145.205103W
Copper River Delta	*Wooded Creek*	1	60.439053N, 145.204560W
Copper River Delta	Wrong Way Pond	2	60.443960N, 145.197378W
Copper River Delta	*Wrong Way Creek*	1	60.440338N, 145.197114W
Copper River Delta	Odiak Lagoon	1	60.540075N, 145.752043W

1) Italicized water bodies have no formal names
2) "Status": 1= untreated, 2= treated (ongoing), 3=post-treatment monitoring, 4= eradicated (ongoing monitoring)

Appendix C: Threatened and Endangered Species Listed under the Endangered Species Act in Alaska

Common Name	Scientific Name	Status	Critical Habitat in Alaska	Management Agency
Mammals				
Bowhead Whale	*Balaena mysticetus*	Endangered	No	NOAA
Sei Whale	*Balaenoptera borealis*	Endangered	No	NOAA
Blue Whale	*Balaenoptera musculus*	Endangered	No	NOAA
Fin Whale	*Balaenoptera physalus*	Endangered	No	NOAA
Cook Inlet DPS Beluga Whale	*Delphinapterus leucas*	Endangered	Yes	NOAA
Western North Pacific DPS Gray Whale	*Eschrichtius robustus*	Endangered	No	NOAA
North Pacific Right Whale	*Eubalaena japonica*	Endangered	Yes	NOAA
Mexico DPS Humpback Whale	*Megaptera novaeangliae*	Threatened	No	NOAA
Western North Pacific DPS Humpback Whale	*Megaptera novaeangliae*	Endangered	No	NOAA
Sperm Whale	*Physeter macrocephalus*	Endangered	No	NOAA
Arctic Ringed Seal	*Phoca hispida hispida*	Threatened	No	NOAA
Beringia DPS, Bearded Seal	*Erignathus barbatus nauticus*	Threatened	No	NOAA
Western DPS Steller Sea Lion	*Eumetopias jubatus*	Endangered	Yes	NOAA
Northern Sea Otter SW DPS	*Enhydra lutris kenyoni*	Threatened	Yes	USFWS
Polar Bear	*Ursus maritimus*	Threatened	Yes	USFWS
Wood Bison	*Bison bison athabascae*	Threatened	No	USFWS
Birds				
Eskimo Curlew	*Numenius borealis*	Endangered	No	USFWS
Short-Tailed Albatross	*Phoebastria albatrus*	Endangered	No	USFWS

Common Name	Scientific Name	Status	Critical Habitat in Alaska	Management Agency
Spectacled Eider	*Somateria fischeri*	Threatened	Yes	USFWS
Steller's Eider	*Polysticta stelleri*	Threatened	Yes	USFWS
Reptiles				
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	No	NOAA
Green Sea Turtle	*Chelonia mydas*	Threatened	No	NOAA
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	No	NOAA
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened	No	NOAA
Fish				
Green Sturgeon (Southern DPS)*	*Acipenser medirostris*	Threatened	No	NOAA
Hood Canal Summer-run Chum Salmon*	*Oncorhynchus keta*	Threatened	No	NOAA
Lower Columbia River Coho Salmon*	*Oncorhynchus kisutch*	Threatened	No	NOAA
Lower Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Middle Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Snake River Basin Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Upper Columbia River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Upper Willamette River Steelhead*	*Oncorhynchus mykiss*	Threatened	No	NOAA
Snake River Sockeye Salmon*	*Oncorhynchus nerka*	Endangered	No	NOAA
Lower Columbia River Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Puget Sound Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Snake River Fall Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Snake River Spring/Summer-run Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA
Upper Columbia River Spring Chinook Salmon*	*Oncorhynchus tshawytscha*	Endangered	No	NOAA
Upper Willamette River Chinook Salmon*	*Oncorhynchus tshawytscha*	Threatened	No	NOAA

Common Name	**Scientific Name**	**Status**	**Critical Habitat in Alaska**	**Management Agency**
Plants				
Aleutian shield fern	*Polystichum aleuticum*	Endangered	No	USFWS

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