Control Options for *Elodea spp.* in the Chena Slough near Fairbanks, Alaska

A compilation of potential treatments

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In September 2010 the invasive plant *Elodea spp.* was documented growing in several miles of the Chena Slough and the Chena River. Photograph by: U.S. Forest Service

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Introduction

In September 2010 aquatic plants of the genus *Elodea* were documented growing in several miles of the Chena Slough and the Chena River where it flows through Fairbanks, Alaska. This infestation of *Elodea spp.* is the first known instance of an invasive, submerged aquatic plant becoming established in Alaska. Thus, while in other areas of the U.S. many millions of dollars are spent annually to limit the ongoing impacts of invasive aquatic plants, until recently Alaska has been spared dealing with the problem. *Elodea* has had significant detrimental impacts on native ecosystems in other countries where it has been introduced. There is evidence that *Elodea* is damaging Chena Slough and that it is spreading to other Alaskan waters, where it could degrade fish habitat, reduce recreational opportunities, reduce property values, endanger safe floatplane operation, and alter freshwater habitat.

A group of concerned citizens and key agency personnel met on December 3, 2010 to discuss options for action on this pressing topic. A steering committee and action committees were formed, with efforts directed at acquiring funding, planning for surveys, public outreach, research, and consideration of control options. This document was developed by the control options subcommittee as a compilation of the range of control options that could be effective in controlling *Elodea*. We hope this document will guide the *Elodea* steering committee as they develop a plan for addressing this threat.

This document begins with a brief review of the life history characteristics of *Elodea spp.* and a short review of the efforts at habitat restoration that have been undertaken in the slough over the last ten years. In years past, Chena Slough was considered world-class rearing and spawning habitat for arctic grayling (citations). Due to a complex series of events that included the construction of an earthen dam, Fairbanks' 1967 flood and the construction of the Chena Flood Control Project, the quality of grayling habitat in the slough has declined. The most obvious features of this decline were a dramatic reduction in the volume of water flowing through the slough, a reduction in the water flow rate, and the establishment of dense beds of aquatic vegetation. Some parts of the slough essentially "filled in" with aquatic plants. A 1997 report by the US Army Corps of Engineers predicted that if these trends were not corrected, grayling habitat in the slough would continue to decline. Since 2000, a variety of agencies and citizen groups have worked together to replace eight small and perched culverts in Chena Slough (figure 1), with the goals of improving fish passage, increasing the rate of water flow, and making the slough less hospitable for the growth of aquatic vegetation. The discovery in 2010 that *Elodea*, a non-native, highly invasive genus of aquatic plants, had become the dominant vegetation in Chena Slough has further complicated this picture.

This draft report describes a variety of aquatic plant control methods, including a basic description of the method, descriptions of its advantages and disadvantages, and estimates of its cost to implement relative to the other methods described here. We include a short description of the permitting issues involved in carrying out any of these control methods.

The original goal of the control options sub-committee was to develop recommendations on the best control methods for the *Elodea* infestation by spring, 2011. However, we've learned that there are still too many unknowns to allow us to make recommendations yet. In particular, more complete information is needed on the distribution of *Elodea* in interior Alaska, and on certain aspects of the life history of *Elodea* in Chena Slough. We hope these information gaps can be filled over the summer of 2011, allowing us to reconvene in the fall of 2011 to make recommendations to the *Elodea* steering committee. Thus, this report should be considered preliminary, and should be considered direction for prioritizing work to conduct over the 2011summer.

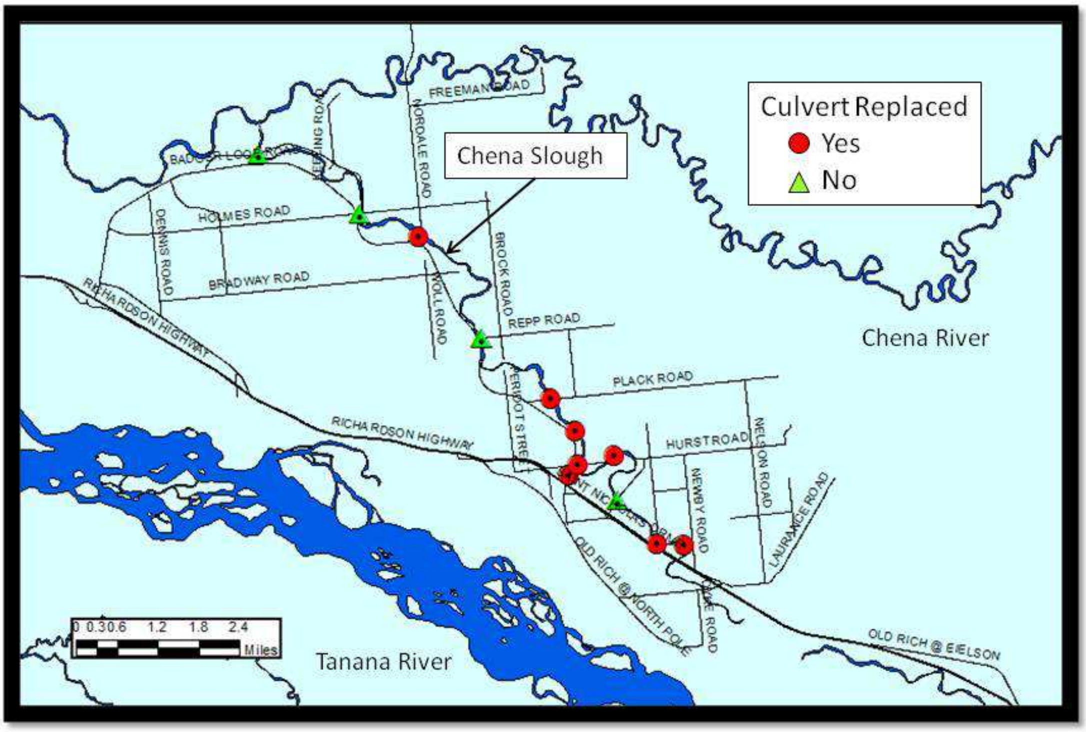

Figure 1. A map of Chena Slough indicating status of culvert replacement. In September, 2010, dense beds of *Elodea* spp. were found in the downstream third of the slough, beginning at about the Nordale Road crossing. More patchily-distributed *Elodea* was found upstream of that point and in the Chena River itself.

What is meant by "*Elodea spp.*"?

In North America, aquatic plant species of the genus *Elodea* are very morphologically variable (Cook and Urmi-König 1985). Several of the species are known to hybridize. Plants collected in Chena Slough in 2009 were identified, based on their morphological characteristics, by University of Alaska Museum of the North botanists as *Elodea canadensis*. Plants collected in the slough in January, 2011 were analyzed genetically by University of Connecticut researchers and determined to be *Elodea nuttallii*. Because of this uncertainty, we will use the term "*Elodea spp.*" to refer to the infestation in Chena Slough. It may be *E. nuttallii*, a mixture of both species, or a hybrid. More sampling and genetic analyses are needed to determine definitively what species of *Elodea* occur in the slough.

Elodea reproductive and growth traits

Identifying appropriate options for control of *Elodea spp.* is complicated by the traits of this genus that make it both highly invasive and difficult to control. Knowledge of these traits is critical when evaluating the likely effectiveness of control options as well as during planning and implementation of selected methods to help ensure that control activities do not do more harm than good. Relevant traits include: reproduction by stem fragments and vegetative propagules including overwintering buds and turions[1], ability to continue growing under the ice and to survive frozen in ice, early growth in the spring prior to some other plant species, and ability to grow faster than other plants and quickly reach the surface and shade out other plant species (Holm et al. 1997). Bowmer et al. (1984) found 5,000 buds/m^2 of *Elodea canadensis* in sediments.

Elodea spp. have a range of reproductive and growth traits that together make the genus a highly aggressive invader. Brittle, slender stem sections are easily broken from the main plant and can be transported by drifting downstream, being caught in boat propellers or trailers, or moved by wildlife or boats (Bowmer et al. 1995, Holm et al. 1997). Dormant buds are composed of a piece of stem tissue that includes an axial bud and are released when the plant is physically disturbed, or in the fall or when conditions become unfavorable for growth. These structures are able to withstand desiccation and low temperatures. They then may be carried downstream where they sprout and form a new plant when they find suitable conditions for growth (e.g., silt/sand substrate, adequate light). This reproductive strategy gives this species a competitive advantage over other species having less aggressive colonizing strategies such as reproduction by seeds or stolons (shoots), which is common in Alaska's native aquatic plants. *Elodea* also has an advantage over some native plants due to its ability to survive and even grow under the ice. *Elodea spp.* may shed dormant buds in the fall, which then begin growing earlier in the spring than some native species.

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[1] A turion is a specialized overwintering bud produced by aquatic herbs. Turions are produced in response to unfavorable conditions such as decreasing day-length or reducing temperature. They are often rich in starch and sugars enabling them to act as storage organs.

Knowledge of these traits is important in evaluating the advantages and disadvantage of each potential control option. For example, methods that cause fragmentation may lead to the downstream movement of large numbers of propagules, unintentionally spreading the infestation. This may not matter if surveys over the summer of 2011 determine that *Elodea* is already regionally widespread or if fragments would only disperse into areas that are unsuitable habitat (Bowmer et al. 1995). Information is also needed on the timing of *Elodea spp.* winter bud production and turion production, as well as the longevity of these structures. For example, control efforts for another invasive aquatic plant, *Potamogeton crispus* (curly-leaf pondweed), target the plant with nonselective contact herbicides early in the spring to achieve control prior to the production of turions. To achieve long-term control, efforts must continue for several years to account for the longevity of the turion bank in sediments (Skogerboe et al. 2008). We have not yet been able to locate in the literature documentation of the longevity of dormant buds or turions of *Elodea spp.*

Elodea spp. ecological impacts

Infestation by *Elodea* has been documented to have a variety of ecological effects. *Elodea* can dramatically change freshwater habitats, affecting them physically as well as biologically. The presence of *Elodea canadensis* can alter dissolved oxygen levels, stream velocities, rates of sedimentation, turbidity, and nutrient availability (Buscemi 1958, Pokorny et al. 1984, Rorslett et al. 1986). Dense infestations of Elodea canadensis physically and chemically impact native vegetation (Erhard and Gross 2006), and can affect both the breeding and foraging habitat for fish and insects. One account (Merz et al. 2008) describes the invasion of a Chinook salmon spawning area in northern California by *Elodea canadensis* and other aquatic plants following a stream restoration project. As the aquatic plants invaded, water velocities and spawning activity declined rapidly and dramatically. When a flood scoured out the channel and removed the aquatic plants, salmon spawning activity resumed. *Elodea canadensis* creates foraging and breeding habitat for Northern Pike and is documented to become unfavorable only when vegetation coverage is less than 30% or exceeds 85% (McCarraher and Thomas 1972, Cassleman and Lewis 1996).

Elodea canadensis has a long history as an invasive species in the British Isles, Scandinavia, Russia, Australia, and New Zealand. It was originally introduced to Ireland, Scotland and Great Britain more than a century ago, as an aquatic ornamental. Since then, it spread throughout Britain, much of Scandinavia and all the way across Russia to Lake Baikal and the Amur River basin (i.e. from Atlantic to Pacific basins). In spreading across Russia, *Elodea canadensis* crossed two continental divides, strongly suggesting that people inadvertently played a role in its dispersal (Kozhova and Izhboldina 1993, Bazarova and Pronin 2010). It grows well in cold climates, surviving the winters under lake and river ice. As it invades, *Elodea spp.* can “fill up” slow-moving waterways with dense growths of plant material, dramatically impeding navigability and making fishing problematic or impossible (Simpson 1984, Bowmer et al. 1995, Stretton personal communication). Infestations of *Elodea* have been shown to damage the aesthetic values of waterways and reduce recreational opportunities (Catlin and Wojtas 1986, Josefsson and Andersson 2001).

The Control Options

In this document we consider a wide range of control options for the *Elodea* infestation in Chena Slough. We considered the "Do Nothing" option, engineering approaches, mechanical control, chemical control, biological control and habitat alteration. While a range of possible control options were assessed, only a relatively small number are documented in the available literature as having a high likelihood of effectively controlling *Elodea spp.*, not leading to excessive fragmentation and spread of the species, and that are consistent with the Alaska regulatory environment.

"Do Nothing" Option

The first option analyzed is one of in-action – to do nothing. If nothing is done about the *Elodea spp.* infestation in Chena Slough, it will continue to spread. *Elodea spp.* is already known to be rooted at several places in the Chena River. Since the infestation in Chena Slough was first identified, in August, 2010, several people have contacted the *Elodea* working group to report additional suspected sightings in the Chena River, in Noyes Slough, in the airport float pond, in a downstream slough of the Tanana, and in the Delta Clearwater River. Surveys planned for summer, 2011, will establish whether these identifications were correct and will determine the extent of spread that has already occurred.

Although no one can predict with certainty the future spread or ecological impacts of *Elodea spp.* in Alaska, we can make reasonable estimates based on what this plant has done in other places.

Extent of future spread

The single fragment of *Elodea* collected in 2010 floating through Fairbanks on the surface of the Chena River illustrates that *Elodea spp.* is being dispersed in Alaska by flowing water. *Elodea spp.* fragments readily sprout roots when they come in contact with silt substrate in areas of slow water flow (Bowmer et al. 1995, Barrat-Segretain et al. 2002). Downstream from Chena Slough are the Chena River, the Tanana River and the Yukon River. Portions of those river systems that are fast-flowing, or that carry a heavy silt load, are unlikely to be colonized, but will still serve to spread plant fragments. Reaches that are slower and clearer are vulnerable to being colonized. In time, *Elodea* could colonize slow-moving reaches of the Chena, and the sloughs and oxbows of the Tanana and Yukon drainages. It could also colonize the mouths of slow-moving rivers that empty into the lower Yukon. *Elodea* could be spread upstream by boats if it gets caught on boat propellers or in jet units. If it gets caught in boat trailers, it could be spread to any water body on Alaska's road system. If it gets caught on airplane floats, *Elodea* could be spread to lakes all over the state.

Lost opportunity

The major implication of the "do nothing" option would be the loss of the opportunity to prevent the spread of *Elodea* in Alaska. An extensive survey of interior Alaska waterways is planned for the summer of 2011. If the survey determines that the distribution of *Elodea* is limited to Chena Slough and Chena River, the opportunity still exists to control it in those locations and prevent it from spreading beyond those locations. Each year of doing nothing will give the existing infestation time to spread, and will reduce the opportunity for prevention. At some point, *Elodea* will become so widely distributed in the state that there will be no reasonable means of preventing its further spread or limiting its detrimental ecological and economic impacts.

Engineering Options

Two “engineering options” for *Elodea spp.* control in Chena Slough have been discussed by the control options sub-committee: (1) drawdowns (temporarily lowering the water level enough to cause the *Elodea* to dry out / freeze) and, (2) temporarily partitioning the slough so that herbicides or other chemicals might be applied in a still-water environment. The drawdown option is discussed here, while the temporary partitioning option is discussed in the chemical control options section. In addition, in 1997 the Army Corps of Engineers developed a list of four engineering options with the purpose of preventing further degradation of fish habitat in Chena Slough and improving habitat that has already been degraded (USACE 1997). Those options are discussed here in light of the *Elodea* infestation.

Drawdown

Lowering the water level of a lake or reservoir can have a dramatic impact on some aquatic weed problems. Water level drawdown can be used where there is a water-control structure that allows a manager to drop the water level in the waterbody for extended periods of time. Water level drawdown often occurs regularly in reservoirs for power generation, flood control, or irrigation; a side benefit being the control of some aquatic plant species. However, regular drawdowns can also make it difficult to establish native aquatic plants for fish, wildlife, and waterfowl habitat in some reservoirs.

Advantages

Lowering the water level during the winter exposes the sediment to both freezing and loss of water. Freezing can have a dramatic impact on aquatic plants (such as Eurasian watermilfoil or *Egeria densa*) that have no overwintering structures such as viable seeds, turions, tubers, or winter buds. Prolonged exposure to freezing temperatures can be fatal to some aquatic plants. Lowering the water levels in the summer can expose the sediments to desiccation and high temperatures (depending on the climate). These conditions can also kill some aquatic plants. Drawdowns that expose greater areas of sediment (and plant beds) will be most effective in controlling aquatic plants. However, plants may recolonize and reestablish in areas subjected to drawdowns. To prevent reestablishment, some water bodies are drawn down on a regular basis (WA-ECY).

Disadvantages

Freezing of the sediments can also impact species like frogs and invertebrates that may over-winter in the drawn down area. Drawdowns may impact aquatic mammals such as beavers and muskrats. While drawdowns may work well in some situations, it seems unlikely that this control method would be feasible in Chena Slough. The substrate of Chena Slough is highly permeable, with an unconfined aquifer. “The aquifer of an alluvial plain between the Tanana River and the Chena Rivers… generally consists of highly transmissive sands and gravels under water-table conditions” (Glass et al. 1986). “Depths to water in the alluvial plain were within 10 feet of land surface in most areas, but were within 5 feet of land surface in many low-lying areas….Water levels in wells within about half a mile of either river responded rapidly to changes in river stage” (Glass et al. 1986). “The high water table in the area keeps much of the soil profile saturated” (USACE 1997). Put another way, the water table in the area of Chena Slough is extremely shallow, and water is continually moving into the slough from sub-surface ground water flow at many places along its length, and continually moving out of the slough into ground water as well (C. Everett, personal communication, March 14, 2011). This situation would make drawdowns infeasible. If the water in the slough was pumped out, groundwater would readily seep in. In addition, an unknown number of domestic wells occur near Chena Slough (C. Everett, personal communication, March 14, 2011) and the potential effects of a drawdown on these wells would need to be considered.

Costs
Costs associated with this control method are not easily estimated and probably highly variable.

Permitting

Army Corps of Engineers Options
In 1997, the Army Corps of Engineers published the "Chena River Watershed Study – Reconnaissance Report." "The focus of the study effort is on problems and opportunities that correspond to a hydrological zone of influence within the watershed." Among the problems mentioned are "degraded arctic grayling and other fisheries habitat on Noyes and Badger (Chena) Sloughs."

In section 4.1: "The purpose of this section is to determine the Federal interest in continuing investigations to restore important arctic grayling habitat by modifying the hydrology of Badger (Chena) Slough in the Chena River watershed." The study cited the work of Wuttig (1996) in Chena Slough extensively and mentioned that "the Alaska Department of Fish and Game also noted a decline in the quality of grayling habitat with an increase in aquatic vegetation growth and the accumulation of fine-grained materials and organics in once productive habitats" (USACE 1997).

"The following measures were developed to address the loss of gravel riffle habitat in Badger (Chena) Slough: (1) introduce flushing flows of $8m^3/s$ into Badger (Chena) Slough for a 3-day period once a year; (2) modify the culverts at road crossings on Badger (Chena) Slough; and (3) introduce a steady state flow into Badger (Chena) Slough. These measures were devised to slow the accumulation of algae mats and sediment fines on the gravel riffle areas."

At the time this report was written, the proposed method for dealing with the excess aquatic vegetation in the slough was simply to increase water flow. This would uproot the vegetation and wash it downstream into the Chena. The ongoing steady state flow would make the slough less hospitable to being recolonized by dense growths of aquatic vegetation. Since then, however, *Elodea spp.* has come to dominate the vegetation in the slough, adding a new and significant problem. If the large standing biomass of *Elodea spp.* that now exists in Chena Slough were washed into the Chena, it could transfer the *Elodea spp.* infestation there.

The Army Corps of Engineers Reconnaissance report was published in 1997. None of the options described in it were acted upon immediately, although elements of this report likely influenced the next period in the history of Chena Slough restoration efforts.
Four engineering alternatives were considered in the 1997 report.

Repp Road Ditch
"The Repp Road Alternative would divert 8m3/s of water from the Chena River through a ditch running parallel to Repp Road to provide flushing flows in Badger (Chena) Slough. The 8m3/s flow is the volume estimated to be needed to clear algae mats and sediment fines from gravel riffles. A gated weir at the Chena River allows operational flexibility with this alternative. …The timing of the flushing flow will need to be arranged to meet specific parameters. Stream temperatures between the Chena River and Badger Slough could be matched, or flushing flows could be introduced during the absence of fishes or during a particular life-history phase of the targeted species."

Modify Culverts
'The existing culverts at the Badger (Chena) Slough road crossings cause water to pond on the upstream side….Ponding on the upstream side of the culverts decreases water velocities for a considerable stretch upstream. …In this alternative, culverts downstream of Plack Road would be replaced with two…5 x 7 foot culverts. An additional …arch culvert would be place at each crossing at and upstream of Plack Road. …It is estimated that this would reduce ponded areas by 50 percent." (page 4-30).

Piledriver Slough
"The stretch from Repp Road to Mission Road has the potential for excellent grayling habitat. This stretch of slough would not be improved by the Repp Road alternative. … Providing additional water from Piledriver Slough is a potential solution for improving the habitat of upper Badger Slough. …. An additional 1.4 m3/s of water could be diverted from near the mouth of Piledriver Slough into the upper reaches of Badger (Chena) Slough. A gated structure would regulate the amount of water that would be diverted."

Piledriver Slough plus Modify Culverts
This is a combination of options 2 and 3.

Recent Habitat Restoration Efforts in the Slough
The Chena Slough Neighborhood Restoration Committee and the advisory Chena Slough Technical Committee were formed in 2000. In 2001, the Alaska Department of Fish and Game conducted an assessment of all culverts and other blockages in Chena Slough, and prioritized them in a report (citation). After discussions with the U.S. Army Corps of Engineers about the next step in a project cost-shared with them, it was determined it would be most cost effective to work to modify the culverts through other funding sources. Since that time, culverts have been replaced with bridges at the four non-DOT road crossings, in cooperation with the USFWS Partners for Fish and Wildlife Program. These include Spruce Branch Road, Doughchee Avenue, Outside Hurst Blvd, and Airway Drive. A dam was also breached just downstream of Mission Road. ADOT&PF replaced culverts at Dawson Road, Hurst Road, Plack Road and Nordale Road with 10-12' fish passage culverts, in partnership with the Chena Slough Neighborhood Restoration Committee. There are plans to replace the culverts at Persinger Drive in summer, 2011. That would leave undersized culverts at Repp, Mission and Peede Roads.

Mechanical Control

Much of the information in this section was collected from the State of Washington Department of Ecology's Aquatic Plant Management Handbook and the U.S. Army Corps of Engineers – Engineer Research and Development Center's Aquatic Plant Control Research Program (WA-ECY, USACE).

It is recognized that the implementation of any of the mechanical controls described in this section could result in the release of an abundance of *Elodea* fragments. Any mechanical control implemented in the Chena Slough should include careful containment measures around the treatment area to limit the plant fragments that are released into the system.

Hand Pulling

Hand-pulling aquatic plants is similar to pulling weeds from a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep, no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. In deeper water, hand pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant parts. Some sites may not be suitable for hand pulling. For example, areas with deep flocculent sediments may cause a worker to sink deeply into the sediment.

Advantages

This method could be effective in small areas. It could be used in areas of limited infestation, shallow water, close to town, and where it is considered safe for participants. It might be suitable for volunteer work crews. Depending on the extent of the *Elodea* infestation in the Chena River, hand-pulling might be an appropriate control method there. Training of participants in plant identification, methods for minimizing spread of the plant, and safety would be necessary.

Disadvantages

Hand pulling could produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier. Hand-pulling would likely be slow and labor intensive. If done in deep water it would be expensive. There would be a short-term increase in water turbidity which could impact the effectiveness of any SCUBA operation.

Costs

If accomplished with a volunteer labor force the only cost would be the purchase of any related equipment (silt or fragment barrier, bags, gloves, etc). If contract SCUBA divers are employed in deeper areas the costs would increase to anywhere from $500 to $2,400 per day.

Permitting

Based on a personal communication, hand pulling would be considered by DNR to be a generally allowed use and no permit would be required by ADF&G.

Hand Cutting

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool into the water. A non-mechanical aquatic weed cutter is commercially available. Two single-sided stainless steel blades (razor sharp) forming a "V" shape are connected to a handle which is tied to a long rope. The cutter can be thrown about 20 - 30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch wide swath. If cut plant material rises to the surface, it can be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access. Any vegetation that is cut would need to be immediately removed from the treatment area.

Advantages

May be more effective in appropriate areas when used to prepare a section for other methods such as bottom barriers or suction dredges if fragments from the treatment can be effectively contained. The idea being that the application of secondary methods would be more efficient if the majority of infestation is previously removed.

Disadvantages

Hand cutting would likely produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier. The V-shaped blade might become hung-up on rocks or submerged sticks. Hand cutting would only provide short-term control of the above-sediment portions of aquatic plants and would not be feasible in extensive infestations or deep water.

Costs

Costs for this method could vary anywhere from $100 to $1,000 for both equipment and labor.

Permitting

Based on a personal communication, hand cutting would be considered by DNR to be a generally allowed use and no permit would be required by ADF&G.

Bottom Barriers

Bottom-barrier treatments are intended for small areas of a pond or lake. Bottom barriers are most commonly installed in high-use areas such as along the shallow shore lines, docks and boat ramps. 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. Timing of bottom barrier installation depends on the annual growth cycle of the aquatic plant species. For species that grow each year from the sediment bud bank, bottom barrier installation is easiest before the plants are well established or after any above sediment biomass is removed through hand pulling, cutting, or dredging. According to literature from Nebraska (Barrow 2010), bottom barriers could kill the plants under them within 1 to 2 months, after which the barriers may be removed or moved to other areas. Barrier material can be stapled to frames constructed of 2" x 2" lumber. The corners of the frames are then anchored with bricks or sandbags and left in place for 1 to 2 months to achieve effective control of the vegetation (Barrow 2010).

Advantages
If it is possible to install the barriers without any cutting or pulling of existing vegetation, this method could be implemented with minimal fragmentation.

Disadvantages
Gas production that results from decaying organic matter under the sheeting may affect the long-term functioning 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 sheeting. This can result in the elimination of native aquatic macroinvertebrate communities (Eakin and Barko 1995). This method is not species-specific and could impact benthic organisms

Costs
For materials: $26,775 per acre. For SCUBA installation: $10,890 to $21,780/ per acre.

Permitting

Harvesting
Mechanical harvesters are machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal on shore. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested aquatic vegetation can be disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites.

Advantages
Recreational users of the slough could see an immediate improvement. If an *Elodea*-free channel was established in Chena Slough, boaters might avoid heavy infestations and the possibility of spreading the weed to other water bodies would be reduced.

One aspect of this method is the reduction of nutrients that may be a contributing part of the problem. Removing 4,000 pounds of *Elodea spp.* per acre is equivalent removing 800 pounds of 10-10-10 fertilizer (Gerloff and Krombholz 1966). Although mechanical harvesting of plant material has the potential to lessen excessive growth of aquatic plants through reducing the quantity of nutrients in a waterbody, harvesting alone is unlikely to solve an excess nutrient problem and should be combined with efforts to reduce nutrient loading from the watershed (Cooke et al. 2005). Excess plant material could be made available to gardeners for composting.

Harvesting *Elodea spp.* in the fall may prevent ice rafting of propagules during break-up.

Disadvantages
Mechanical harvesting could produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier.

Initial cost of a mechanical harvester could be prohibitive.

Costs
$600/acre – although this may vary with transport costs and if a harvester is already available.

Permitting

Rotovation/Cultivation

A rotovator is similar to under-water rototiller. The equipment has rototiller-like blades which turn seven to nine inches below the bottom to dislodge and remove roots.

Advantages
Rotovation would have the same advantages as harvesting. Smaller hand operated devices are available that may be useful in targeted areas as long as any fragments are effectively contained.

Disadvantages
Rotovation would likely produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier.

Initial cost of such a machine could be highly prohibitive, as would operating costs.

The morphology of *Elodea spp.* is not conducive to the success of this method. Plant removal works best when the plants are shorter since longer plants tend to wrap around the spinning blades and may damage the equipment (USACE).

This treatment method would have a high amount of sediment disturbance and an associated increase in turbidity.

Costs
$1,000 to $1,700 per acre depending on plant density and area of treatment. This does not include the initial purchase of the machine.

Permitting
Based on a personal communication, ADF&G has serious concerns about the application of this method and may be hesitant to issue a permit. Details on what the serious concerns are were not made clear. DNR would defer to the expertise of ADF&G.

Diver-Operated Suction Dredge

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material and some sediment from the bottom of a water body. The purpose of diver dredging is to remove all parts of the plant including the roots. The cost of operating a suction dredge is actually fairly inexpensive it is the SCUBA diving part of the equation that is driving up the total. In many parts of the slough, an operator may be able to work the dredge by either walking along in shallow water or by standing on the dredge where walking is impractical. In some areas, SCUBA would be required.

Advantages
This is another opportunity for local entrepreneurs. Because of the popularity of suction dredges in the area, in association with mining, there are a lot of these devices that could be put to use. A large number of suction dredges get permitted to operate throughout the State of Alaska through the use of the Alaska Placer Miners Application for Suction Dredging. This Multi-agency permitting process is administered by the DNR Mining Section. Their Multi-Purpose Land Permit could be modified to work for the suction dredging of *Elodea spp.* and stipulations could be inserted to address the concerns associated with toxins, if ADF&G is amenable to that since management of aquatic plants falls under their jurisdiction.

Disadvantages
Like all mechanical controls, this method would produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier.

A problematic issue associated with this method is the presence of toxic substances documented to occur in the sediment of Chena Slough (Kennedy and Hall 2009). Suction dredging would remobilize the any toxins present in the disturbed sediment into the water column and they would spread downstream. A method to control the toxins would be to operate the dredge within screened off areas by using silt barriers. In this manner, any toxins disturbed by the dredge would be re-deposited within the confines of the barrier mitigating the problem.

Costs
$1,100 to $2,000 per acre depending on plant density and area of treatment. This does not include the initial purchase of the machine.

Permitting
Based on a personal communication, ADF&G would be able to permit suction dredging if the use of silt screens were employed. DNR would also be able to issue a permit and would charge a fee if the *Elodea spp.* was commercial sold.

Cutter-head dredge
Steel cutting edge, augers, and water vacuum, similar to a suction dredge are used to dislodge the rooted plant. Pumps and hoses then deliver the plant material to the river's edge. This method may be particularly useful and effective in areas of heavy *Elodea* infestation within the Chena Slough and in other areas that are identified by survey.

Advantages
A cutter-head dredge exists in Fairbanks and has been successfully employed throughout the State to remove excess vegetation and solids from village sewage lagoons.

Disadvantages
Cutter-head dredges would likely produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier.

Costs
The cost of operating a cutter head dredge is also inexpensive. No SCUBA diving is required. The machinery is operated remotely and the dredge is cable guided.

Permitting

Hydraulic Jets

High velocity jet systems are used to direct streams of water to dislodge and uproot submerged aquatic plant material. This type of system can also bury heavy debris or glass and may be helpful around swimming areas (Livermore and Wunderlich 1969). It can also be used to assist in the installation of streambank erosion control measures (Allen 2001).

Advantages

This option was found on the internet and there is little information available. The advantages and disadvantages probably would be a mix between rotovation and suction dredging.

Disadvantages

Hydraulic jets would likely produce an abundance of plant fragments. The treatment area would have to be carefully contained with some sort of silt or fragment barrier.

A problematic issue associated with this method is the presence of toxic substances documented to occur in the sediment of Chena Slough (Kennedy and Hall 2009). Using jets to uproot vegetation would remobilize the any toxins present in the disturbed sediment into the water column and they would spread downstream. A method to control the toxins would be to operate the dredge within screened off areas by using silt barriers. In this manner, any toxins disturbed by the dredge would be re-deposited within the confines of the barrier mitigating the problem.

Costs

$1,000 to $1,700 per acre depending on plant density and area of treatment. This does not include the initial purchase of the machine.

Permitting

Chemical Control

Aquatic herbicides are chemicals specifically formulated for use in water to kill or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and are considered compatible with the aquatic environment when used according to label directions (WA-ECY).

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and potentially capable of regrowth (think chemical mowing). Non-selective, broad spectrum herbicides will generally affect all plants contacted by herbicide. Selective herbicides will affect some plants and not others (WA-ECY).

This section only addresses those herbicides which are registered for aquatic use in Alaska, would effectively control in a submerged environment, and would effectively control monocots. Several aquatically approved herbicides were investigated for this document that are only effective on emergent aquatic plants (glyphosate and imazapyr) or are only selective for broad-leaved plants – dicots (2,4 D and triclopyr). This is particularly important to consider as *Elodea spp.* is a submerged aquatic monocot (NRCS 2011). As these chemicals would not be effective in controlling *Elodea spp.* they are not summarized here.

Fluridone

Fluridone is a broad-spectrum systemic herbicide registered for use in Alaska as an aquatic herbicide under the trade name Sonar, which according to the label, can be used for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals, irrigation canals, and rivers (AK-DEC). According to the label and pertinent studies, *Elodea spp.* is effectively controlled with fluridone (Cooke et al. 2005). This herbicide comes in pellet form.

Fluridone is a slow-acting systemic herbicide used to control underwater plants such as Eurasian watermilfoil and is applied as a pellet or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for treatment. Its use is most applicable where dilution can be minimized. According to the State of Washington, Department of Ecology website fluridone is not effective for spot treatments of areas of lakes less than five acres unless it is possible to use “herbicide tents” to enclose the area to help maintain the concentration of the chemical. It is slow-acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil in Washington, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Granular formulations of fluridone are proving to be effective when treating areas of higher water exchange or when applicators need to maintain low levels over long time periods (WA-ECY).

Advantages

As a systemic herbicide, Fluridone would travel through the vascular tissue of the affected vegetation and kill the root system as well as any above sediment biomass.

Formulations of Sonar are not highly toxic to fish or aquatic invertebrates. Testing showed LC50 levels (lethal concentration levels to 50% of the test population) to be 11.7 ppm (parts per million) for rainbow trout and 6.3 ppm for *Daphnia magna* (USACE). Sonar is labeled for application rates ranging from 16 to 90 ppb (parts per billion) (SePRO 2009).

There are no water use restrictions for drinking, fishing, or swimming following an application of Sonar (SePRO 2009).

Fluridone is strongly adsorbed to organic matter in soil, meaning that it does not easily move with water through a soil column. Fluridone exhibits a half-life in water of approximately 21 days (Extoxnet).

Disadvantages

Under optimum conditions 30 to 90 days are required before the desired level of aquatic weed management is achieved with Sonar PR (SePRO 2009). Due to this requirement and the water flow rates of the Chena Slough, fluridone might not be effective. This product is likely most effectively used in low-flow or stagnant water bodies such as ponds and lakes. Engineers would need to be consulted to determine if the flow of the slough is at a rate that would allow fluridone to extended period of time and whether more herbicide would periodically need to be added to account for groundwater seeping into the slough and outflow of water into the Chena.

Additional disadvantages of this product are its potential to kill desirable aquatic vegetation and potential to impact other non-target organisms through alterations in dissolved oxygen and nutrients (WA-ECY and Gibbons et al. 1994).

Costs

A 30-pound container of Sonar PR ranges in prices from $1,029 to $1,174 (Herman Brothers and Skip's Aquatic). The amount of product applied to the water depends on the application rate and the average depth of the water. If it is assumed that there is an average depth of four feet across a treatment area, the 30-pound container would treat anywhere from 1.5 to 8.7 surface acres, depending on which recommended application rate is selected (SePRO 2009). This translates to a cost range of $118 to $783 per acre.

In addition to the cost of the herbicide there would be the added cost of application personnel and a boat – both of which could be borrowed from project partners.

Permitting

Applying herbicides directly to water in Alaska requires a DEC Pesticide Water Use Permit. However, there may be an added requirement in the near future of completing a National Pollution Discharge Elimination System Pesticide General Permit.

Diquat

Diquat is a broad-spectrum contact herbicide registered for use in Alaska as an aquatic herbicide under the trade name Reward which, according to the label, can be used for management of aquatic vegetation in areas such as freshwater ponds, lakes, reservoirs, drainage canals, irrigation canals, and rivers (AK-DEC). This herbicide comes in liquid form.

Contact herbicides only affect the portion of a plant that physically comes into contact with the chemical. They do not move through a plant's vascular tissues the way systemic herbicides do. As such, they are not effective in killing a plant's root system. As a contact herbicide, diquat is typically used to control the above-sediment biomass of a variety of submersed aquatic plants. According to the State of Washington, Department of Ecology website: "Diquat is very fast-acting and is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness." Glomski et al. (2005) indicates that diquat was exceedingly effective at controlling the above-sediment biomass of *Elodea spp.*

While the Reward product label stipulates 24-36 hours of contact time are required for control, Glomski et al. (2005) demonstrated 4 hours of diquat contact time severely injured *Elodea spp.* in aquaria. It is possible that the flow rate within the slough is slow enough that significant dilution of this product may not occur in 4 hours. Another control option for much smaller infestations (~100 square feet) would involve placing "herbicide tents" around an infestation to keep diquat in contact with vegetation for 4+ hours. These tents are being used for control of Eurasian watermilfoil (*Myriophllum spicatum*) in a lake in Washington that has significant ground and subsurface flow (WA-ECY).

Advantages

The main advantage of this product is that it may require a relatively short contact time to be effective, around 4 hours (WA-ECY and Glomski et al. 2005).

When diquat comes in contact with soil, it becomes strongly adsorbed to clay particles or organic matter in the soil for long periods of time (California Environmental Protection Agency 2005). The strong chemical bonds formed by diquat adsorption to soil particles make the herbicide biologically and chemically inactive. Diquat is removed from the water column in 10 to 14 days, when soil particles drop to the bottom. Twenty-two days after a weed infested artificial lake was treated, only 1% of the applied diquat remained in the water and 19% was adsorbed to sediments (Howard 1989). Soil capacity for adsorption of diquat is so high in comparison to the rates at which it is applied that there is little possibility that leaching or groundwater contamination will occur (Extoxnet). Field and laboratory tests show that diquat usually remains in the top inch of soil for long periods of time after it is applied (Tucker 1980).

Disadvantages

Since diquat is a contact herbicide it may only suppress, not eradicate, populations of *Elodea spp.* (Syngenta 2010). Additional disadvantages of this product are its potential to kill desirable aquatic vegetation and potential to impact other non-target organisms through alterations in dissolved oxygen and nutrients (WA-ECY and Gibbons et al. 1994).

The EPA requires a 14-day interval between treatment of water with diquat and use of treated waters for domestic, livestock, or irrigation purposes. Swimming, fishing and watering of domestic animals should not be allowed for at least 14 days after application of the herbicide to water.

Although diquat is strongly adsorbed to soil particles, the adsorbed diquat has been found to persist in soil for many years with very little degradation. There is also evidence that diquat has the ability to eventually use up, or saturate, all the available adsorption sites on soil clay particles

(Tucker 1980). Groundwater quality can be affected if soil adsorption sites become totally saturated because water moving down through the soil can carry any non-adsorbed herbicide into the groundwater. More research is needed for a better understanding of the potential effects on groundwater of long-term, repeated use of diquat (Extoxnet).

Effective control of *Elodea spp.* occurred with 4 hours of exposure at 0.37 ppm of diquat. Diquat's 8-hour LC50 in rainbow trout is 12.3 ppm and 28.5 ppm in Chinook salmon (Glomski et al. 2005 and Extoxnet). A lethal dose of diquat for salmonids appears to be 33-77 times stronger then what is needed to effectively treat *Elodea spp.* The following was taken directly from the Cornell University Cooperative Extension website (Extoxnet):

> Diquat dibromide is slightly toxic to fish. Its toxicity to fish, and food organisms on which fish survive, has been reported in many studies. It appears to be less toxic in hard water. The lethal concentration fifty (LC50) is that concentration of a chemical in air or water that kills half of the experimental subjects exposed to it for a specific time period. The 8-hour LC50 for diquat in rainbow trout is 12.3 ppm, and 28.5 ppm in Chinook salmon. The 96-hour LC50 in northern pike is 16 ppm and 20.4 ppm in fingerling trout. The shell growth of eastern oysters was not noticeably affected with exposure to 1 ppm of diquat for 96 hours. Some species of fish may be harmed, but not actually killed, by sublethal levels of diquat dibromide. Oxygen can become depleted in diquat-treated water by decaying aquatic plants. This decreases the amount of oxygen available for fish survival. Research indicates that yellow perch suffer significant respiratory stress when herbicide concentrations in the water are similar to those normally present during aquatic vegetation control programs. Strip application of the herbicide over water is recommended to prevent large-scale fish kills. There is little or no bioconcentration of diquat dibromide in fish. Bioconcentration is the buildup or accumulation of a chemical in plants and/or animals. One investigation into the persistence of diquat in fish showed that one half of the herbicide was lost in less than three weeks.

Costs

A four-gallon pack of Reward ranges in price from $596 to $618 (Herman Brothers and Skip's Aquatic). The amount of product applied to the water depends on the selected application rate and the average depth of the water. If it is assumed that there is an average depth of four feet across a treatment area, the four gallon pack would treat anywhere from 2 to 4 surface acres, depending on which recommended application rate is selected (Syngenta 2010). This translates to a cost range of $149 to $309 per acre.

In addition to the cost of the herbicide there would be the added cost of application personnel and a boat – both of which could be borrowed from project partners.

Permitting

Applying herbicides directly to water in Alaska requires a DEC Pesticide Water Use Permit. However, there may be an added requirement in the near future of completing a National Pollution Discharge Elimination System Pesticide General Permit.

Chelated-Copper Compounds

Copper carbonate is a broad-spectrum contact herbicide registered for use in Alaska as an aquatic herbicide under the trade name Nautique which, according to the label, can be used for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals, irrigation canals, and rivers (AK-DEC). This herbicide comes in liquid form.

Contact herbicides only affect the portion of a plant that physically comes into contact with the chemical. They do not move through a plant's vascular tissues the way systemic herbicides do. As such, they are not effective in killing a plant's root system. As a contact herbicide, Nautique is typically used to control the above sediment biomass of a variety of submersed aquatic plants (SePRO 2006). To increase its effectiveness, chelated-copper compounds are often tank-mixed with systemic herbicides such as diquat (USACE).

Following treatment, aquatic plants and weeds will typically drop below the surface within 4 - 7 days after treatment. The complete results of treatment will be observed in 3 - 4 weeks in most cases. In heavily infested areas a second application may be necessary after 10 - 12 weeks (SePRO 2006).

Due to this product's persistence in aquatic substrates and potential toxic affects to fish in alkaline waters, copper compounds are disallowed for use in the majority of water bodies of Washington State (WA-ECY and WA-ECY 2002). Prior to use, the Steering Committee would need to contact DEC to determine the likelihood of being permitted to use Nautique in the Chena Slough.

Advantages

There are no water use restrictions following the use of chelated copper-based herbicide, which makes it a popular choice for lakes used for irrigation or drinking water (SePRO 2006).

Disadvantages

Since Nautique is a contact herbicide, it may only suppress, not eradicate, populations of *Elodea spp.* (SePRO 2006).

Additional disadvantages of this product are its potential to kill desirable aquatic vegetation and potential to impact other non-target organisms through alterations in dissolved oxygen and nutrients (WA-ECY and Gibbons et al. 1994).

Nautique can be toxic to fish depending on the application rate and hardness of the water. In soft water, trout and other species of fish may be killed at application rates recommended on the label. It should not be used in waters containing trout or other sensitive species if the carbonate hardness of the water is less than 50 ppm.

The signal word for Nautique is Danger. This herbicide is corrosive; causes irreversible eye damage and skin burn; and may be fatal if absorbed through skin (SePRO 2006).

Costs

A 2.5 gallon jug of Nautique ranges in price from $105 to $125 (Skip's Aquatic and eVegetation). The amount of product applied to the water depends on the selected application rate and the average depth of the water. If it is assumed that there is an average depth of four feet across a treatment area, 2.5 gallons would treat anywhere from 0.2 to 0.4 surface acres, depending on which recommended application rate is selected (SePRO 2006). This translates to a cost range of $263 to $625 per acre.

In addition to the cost of the herbicide there would be the added cost of application personnel and a boat – both of which could be borrowed from project partners.

Permitting
Applying herbicides directly to water in Alaska requires a DEC Pesticide Water Use Permit. However, there may be an added requirement in the near future of completing a National Pollution Discharge Elimination System Pesticide General Permit.

Options Considered but Eliminated from Analysis

Several other treatment options were considered for this document, however they are all illegal in the State of Alaska and not an option for use in Chena Slough. These options are briefly summarized here solely for information's sake. They are not recommended for use in the State of Alaska.

Biological Control

Biological control is a method of controlling a target species using predation, herbivory, or other natural enemies. It can be a useful and important tool in the integrated pest management toolbox.

Triploid Grass Carp

The only biological control method in widespread use against aquatic invasive plants is triploid grass carp. Importation of grass carp has been banned in Alaska. There are no reported introductions in Alaska. The grass carp, or white amur, is a fish native to rivers in China and Siberia. They can live for 25 years and grow to 60 pounds. They can survive in brackish water (salinity of up to 10 ppt). Fertilized eggs are treated to produce infertile triploid grass carp. Un-treated, diploid grass carp are a highly invasive species which are causing problems throughout the Mississippi River and throughout the Midwest. The triploid grass carp are considered to be infertile and therefore notable to reproduce/invasive, although there is still a potential threat of diploid introduction. It is legal to use triploid grass carp to control aquatic plants in closed water bodies in 35 states, most of which require permits.

Fusarium spp.

Other countries have begun field trials of the fungus *Fusarium ssp* to control *Elodea spp.*. This biological control would not be available for use in Alaska until it successfully goes through the USDA-APHIS Plant Protection and Quarantine (PPQ) biological control testing program. It is unlikely that PPQ would select this as a testing candidate as *Elodea spp.* is native to the continental United States.

Habitat Alteration

The basic concept of this approach is to modify the chemistry of a given waterbody to create an environment unfavorable to *Elodea spp*. Because of the rapid and aggressive growth characteristics common to *Elodea spp.* and other nuisance plants, they typically have higher than average nutrient requirements. By altering the water chemistry of a stream or lake it may be possible to shift the growth conditions to favor native vegetation, or to kill or reduce *Elodea spp.* without destroying much of the native flora and fauna. The most extreme example of this concept found was the use of highly concentrated (95%) sulfuric acid to remove *Elodea spp.* from streams and ponds. A less drastic approach would be to use one of the common chemicals added to ponds to adjust the pH, such as Pond Down.

Miscellaneous Related Issues

Similar Projects in Alaska

To our knowledge the State of Alaska has, at the time of this report, not permitted the use of herbicides to control submerged aquatic plants in water bodies of Alaska. However, the Department of Fish and Game has applied the pesticide rotenone to five lakes in Alaska to eradicate invasive fish species (ADF&G). There are unconfirmed reports of a mechanical aquatic weed cutter being used on native aquatic plants at a floatpond in the Anchorage area.

Contamination of Sediment in Chena Slough

In 2003 the U.S. Geological Survey conducted streambed sediment analysis of samples collected in the Chena River and Chena Slough. Overall the slough had higher concentrations of selected nutrients and trace elements than the Chena River. Concentrations of arsenic in Chena Slough samples ranged from 11 to 70 mg/kg and concentrations in most of the samples exceeded the probable-effect guideline for arsenic of 17 mg/kg. The background level for arsenic in the lower Chena River watershed is naturally elevated because of significant concentrations of arsenic in local bedrock and ground water. Relatively low concentrations of DDT or its degradation products, DDD and DDE, were detected in all Chena Slough samples. Concentrations of total DDT (DDT+DDD+DDE) in two Chena Slough sediment samples exceeded the effects range median aquatic-life criteria of 46.1 micrograms per kilogram (Kennedy and Hall 2009).

Elodea spp. is a rooted, submerged aquatic plant. As such any treatment that attempts to remove the root system of the plant could disturb streambed sediment – releasing any potentially dangerous compounds stored therein into the water column. It is important to note that there are no statutory regulations for streambed sediment concentrations. Guidelines for sediment contaminant levels are available through the National Oceanic and Atmospheric Administration (NOAA). These guidelines are open to interpretation by various agencies concerning site specific applicability (B. Kennedy, personal communication, 17 March 2011).

Norum Plan for Pilot Restoration Project

A pilot restoration project, proposed by resident Jerry Norum, is also currently being evaluated in the reach upstream of the Persinger Road crossing. The purpose of this effort would be to remove aquatic vegetation and attempt to reconfigure the existing stream channel of Chena Slough into a form more consistent with the current flow. A copy of Norum's original permit application is attached as appendix A.

Tanana Valley Watershed Association

Chena Slough has elevated levels of nutrients associated with fertilizers, improperly functioning septic systems, and other urban runoff issues. The Tanana Valley Watershed Association was formed in 2006 with a mission to promote and improve the health of the Tanana Valley watershed through education, restoration, collaborative research, and diverse community involvement. In partnership with the Fairbanks Stormwater Advisory Committee and the Fairbanks Soil and Water Conservation District they have implemented an Adopt-A-Stream program to educate the general public and encourage better stewardship of the watershed. There are several elements of the program, including volunteer water quality monitoring, litter removal, riparian management, management of beaver dams and other flow obstructions, and bioassessments. In addition, these organizations all provide education on the importance of watershed management for the health of our waters, our fish and our communities.

Land Ownership

The actual ownership boundaries of the Chena Slough basin are under some dispute. Because the water course has narrowed so much in the last 50 years, there is disagreement between private property owners along the slough banks and the State of Alaska on where the property boundaries are. The Fairbanks – North Star Borough plat maps treat this issue inconsistently (C. Everett, personal communication, March 14, 2011).

Recommendations for 2011

The control options sub-committee recognizes the need for additional information before it can make recommendations on the best control options for Chena Slough. The following is a list of information that should be developed over summer, 2011 to close these information gaps.

1. How widespread is *Elodea spp*. in interior Alaska? In particular, how heavily is the Chena River infested? Is Noyes Slough infested? What is the full extent of the infestation in Chena Slough? This is the primary responsibility of the survey committee.

2. Does the *Elodea* occurring in Chena Slough die back to the sediment surface over the winter, then resprout from below-sediment parts each spring? Or does it sprout from prostrate stems that grew in summer 2010 and sank to the slough bottom over the winter? A clearer understanding of its annual growth cycle is important for properly assessing different control options. A member of the control options subcommittee (Wurtz) agreed to try to collect general observations on *Elodea* phenology over the summer 2011.

3. Is there a bank of turions or dormant buds of *Elodea* in the sediment of Chena Slough? A member of the control options subcommittee (Wurtz) agreed to try to determine this over the summer with a small field sampling effort.

4. How does the *Elodea* growing in Chena Slough respond when the plant material is cut off at the sediment surface and removed? Does *Elodea* resprout from below-sediment parts? A member of the control options subcommittee (Wurtz) agreed to try to determine this over the summer with a small field trial.

5. It would be valuable to confirm the potential for diquat to kill the whole *Elodea spp.* plant in the Chena Slough environment, rather than only affect the portion of the plant above the substrate. There is anecdotal evidence that Brazilian elodea was suppressed by diquat to the point of being able to control the remaining infestation manually (Parsons et al. 2007, Simon and People 2006). Due to the close relation of these two species, *Elodea spp.* may act in a similar manner when treated with diquat. No plan was made to determine this information.

6. What are the typical flow rates of Chena Slough? Would it be feasible to maintain a concentration of fluridone or diquat for the length of time required for effective control of *Elodea spp*.? No plan was made to determinine this information.

7. Several people have recommended that we begin the process of submitting a pesticide use permit application to DEC now, rather than waiting for every question about Diquat and Fluridone to be answered. Prior to submitting a permit application to DEC, we'll need to receive a "Landowner letter of non-objection" from the Alaska Division of Lands and a "Letter of non-objection" from ADF&G. A control options sub-committee member (Spellman) agreed to contact ADF&G to begin the discussion of the issue.

8. Conduct field trials of at least two mechanical control methods over the summer of 2011. We are in the process of submitting permit applications for a permit from Alaska Division of Lands for a suction dredging trial and a cutter-head dredge trial. Two members of the steering

committee (Scharfenberger and Etchevery) are working with Alaska Division of Lands to submit this permit application. One member of the control options sub-committee is organizing the two mechanical control trials.

9. Conduct field trials of hand-pulling. Two members of the control options sub-committee (Wurtz and Everett) will conduct a small hand-pulling trial.

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