INTEGRATED PEST MANAGEMENT PLAN FOR ERADICATING ELODEA FROM THE KENAI PENINSULA

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Prepared by
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KENAI PENINSULA - CWMA

Cooperative Weed Management Area

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I. ABSTRACT

Elodea, the first submerged freshwater invasive plant to become established in Alaska, has the potential to spread throughout Kenai Peninsula waterways, affecting ecological and economic values. This document outlines an integrated pest management approach to achieve the goal of making and keeping the Kenai Peninsula free of elodea. We propose four applications of fluridone, a selective systemic herbicide, during 2014-16 to eradicate elodea from Stormy, Daniels and Beck Lakes, the only waterbodies known to be infested by elodea on the peninsula. One application of diquat, a nonselective contact herbicide, is also proposed for Daniels Lake to prevent further spread of elodea in that lake. Combined with outreach, institutional/agency support, and monitoring for both efficacy (short term) and early detection of novel infestations (long term), we believe it is possible to eradicate existing elodea populations from, and to keep new infestations off, the Kenai Peninsula. Inadequate funding and/or the timing of funding are likely to affect that outcome.

II. ISSUE/PROBLEM STATEMENT

Elodea is a particularly injurious aquatic perennial. Elsewhere in North America and Europe, it has compromised water quality, grown so abundantly that boat traffic is hindered, reduced dissolved oxygen, and severely impacted native fisheries. Elodea is also insidious, in that only a plant fragment is needed to infest a water body because it reproduces vegetatively.

The Kenai Peninsula is in the early stages of infestation by a hybrid species of elodea (*Elodea canadensis X nuttallii*). Based on surveys of 68 lakes in 2013, it appears that elodea populations are constrained to three lakes (Stormy, Daniels and Beck) in two watersheds north of the community of Nikiski. Inflow and outflow of the known infested lakes are a concern as plant fragments may spread to adjacent water bodies, and from there to the connected waters of the Kenai Lowlands on the eastern peninsula. Likely initial vectors on the peninsula are aquaria (Bowmer et al. 1995) and discarded commercial lab kits. However, as these early populations of elodea become better established, motor boats, anchors, fishing gear, and float planes will become the greater risk. So the sooner Elodea is eradicated from these three lakes, the more likely it is that other waterbodies on the Kenai Peninsula will remain free of elodea.

Systemic herbicides are the preferred method to achieve eradication and prevent further spread of elodea. Contact herbicides do not kill the root system of this perennial plant. Physical or mechanical control methods are ineffective for eradicating elodea as this plant reproduces readily from small fragments. Any physical disturbance of the plant easily breaks the stems into pieces that are capable of reproducing in new locations. Elodea is difficult and expensive to eradicate, requiring sometimes multiple treatments of herbicide over two or three growing seasons so it is important that treatment begins as soon as reasonable. In the case of Stormy, Daniels and Beck Lakes, fluridone (Sonar™) is the best herbicide for eradication, a chemical that selectively kills elodea at low application rates and has low toxicity to fish and other nontarget species. Diquat (Reward™), a nonselective contact herbicide, is useful for both containing elodea temporarily and in combination with fluridone to prevent a partial-lake treatment from becoming a more expensive whole-lake treatment. An integrated approach using herbicides for eradication and containment, monitoring for both treatment efficacy and early detection of novel infestations elsewhere on the peninsula , and outreach and institutional/agency support can lead to eradicating existing elodea populations from, and keeping new infestations off, the Kenai Peninsula.

III. Status of Elodea

Taxonomy and life history

Elodea is a submerged aquatic plant within the Hydrocharitaceae or waterleaf family. Five distinct species are recognized, all native to the New World (Bowmen et al. 1995, Cook and Urmi-König 1985). *Elodea canadensis* or Canadian waterweed is native to temperate North America, originally distributed from 35°—55°N primarily in the Great Lakes region. The native range of *E. nuttallii* (Nuttall's waterweed) tends to overlap with *E. canadensis,* but the former is more prevalent further south. *Elodea bifoliata* occurs primarily in temperate western North America. *Elodea potamogeton* and *E. callitrichoides* are both native to South America.

Elodea canadensis aggressively invaded European waterways in the 19th century after it was first recorded in 1876 in an Irish pond (Josefsson 2011). Although much of Europe has seen a population decline, invasion continues at high rates in Scandinavia, northern Europe, parts of Asia and Africa, Australia, and New Zealand (Josefsson 2011, Bowmen et al. 1995). *Elodea nuttallii* was recorded as early as 1914 in Great Britain, although specimens were often incorrectly identified. This species has been observed to displace *E. canadensis* in Europe, possibly due to its ability to tolerate more turbid and nutrient-rich or polluted waters (Josefsson 2011, Bowmen et al. 1995). *Elodea callitrichoides* was introduced to Europe in 1958 (Josefsson 2011).

Where elodea has been introduced outside its native range, elodea has generally responded by a fairly explosive growth period of 5—6 years (Sand-Jensen 2000, Mjelde et al. 2012) followed by a declining (Nichols 1994) or sometimes a stable (Mjelde et al. 2012) population. Rapid growth may be initiated in areas where the sediment is iron rich; growth is terminated when iron reserves are depleted (Spicer and Catling 1988) or when the decaying biomass depletes the oxygen and lowers the pH, thereby weakening the carbon fixation and photosynthesis efficiencies of elodea (Lehtonen 2000).

Elodea grows in still or slow-moving neutral or alkaline waters (pH 6.5—10) with reduced iron and bicarbonate available as carbon sources. Elodea is tolerant of cold water and can survive freezing, with documented rapid invasion as far north as northern Finland (Heikkinen et al. 2009, Sand-Jensen 2000) and Norway (Rorslett et al. 1986). Elodea has high light requirements and occurs primarily in clear waterbodies with low or slight current. Elodea is not able to use the C4 photosynthetic pathway like many aquatic invaders, but is a facultative HCO_3^- species (Raghavendra and Sage 2011). In alkaline conditions, elodea is able to use bicarbonate as a carbon source either directly or by converting bicarbonate into carbon dioxide via acidification of the cell walls (Bowmen et al. 1995). Elodea, when biomass levels are high, can cause primary productivity to decline (Rorslett et al. 1986).

Perhaps the best case study of how non-native elodea invades and colonizes a lake is Steinsfjord in Norway (Mjelde et al. 2012). Steinsfjord is a 3,400-acre lake (average depth = 32 feet) at the same latitude as the Kenai Peninsula. *Elodea canadensis*, introduced to Norway in 1925, subsequently invaded the watercourse upstream from Steinsfjord in the early 1960s. It was first detected in Steinsfjord in 1978; by 1982, elodea occupied 72% of sites sampled in the 0—6 m depth and its spatial coverage peaked two years later. Elodea strands reached the lake surface through at least 1985-87, but then began to die-back. However, elodea continued to expand its distribution into greater depths even as elodea dominated the submerged vegetation community through at least 2004. Other native species that were sympatric with elodea in 1979-80 either shifted to deeper or shallow water, or had declined to the point that they were almost extirpated mainly through depletion of free CO_2 in the water column and/or of nutrient content in the sediment.

Plants are dioecious with separate male and female plants. Flowering is uncommon, with few records of viable seed (Bowmen et al. 1995). Reproduction is primarily vegetative. Elodea readily breaks into transportable fragments which root in sediments. Fragments can spread in water and by birds such as geese and swans, although these propagules do not withstand drying (Barnes et al. 2013, Sand-Jensen 2000).

Distribution

Alaska

Elodea is currently considered not native to Alaska based on limited distribution, sparse herbarium records, and published literature on aquatic invasives that identifies elodea as non-native within the state (Wurtz et al. 2013). The only known locations of elodea in Alaska prior to 2010 were Eyak Lake near Cordova in 1982 and Chena Slough near Fairbanks in 2009. Extensive floristic surveys across Alaska have been conducted over the past century. The University of Alaska Fairbanks herbarium (ALA) includes over 1,500 aquatic plant specimens entered in the Arctos database, only two of which are elodea (specimens from Eyak Lake and Chena Slough)(Wurtz et al. 2013). Elodea has since been found in other locations near Cordova, three lakes in Anchorage, and three lakes on the Kenai Peninsula. To date, morphological and genetic identification of Alaskan specimens have indicated *E. canadensis*, *E. nuttallii* or their hybrid. *Elodea canadensis* X *nuttallii* hybrids are known to be fertile and to produce viable seeds (cited in Cook and Urmi-König 1985).

Elodea canadensis distribution in North America includes northern portions of the contiguous U.S. and southern Canada, excepting southern Alberta and southwestern Saskatchewan. Distribution is highest in parts of Quebec, the St. Lawrence Valley, the Great Lakes region, southern British Columbia, and the Pacific West Coast. *Elodea nuttallii* distribution is similar but is more common further south (Bowmen et al. 1995, Catling and Wojtas 1985). Elodea species are absent from northern Canada including the Yukon and northern British Columbia, displaying a sizeable gap in distribution between recent discoveries of elodea in Alaska and the previously known northernmost locations in North America. The Electronic Atlas of the Flora of British Columbia (http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Elodea%20canadensis) indicates that *E. canadensis* is infrequent north of 51°N but it does occur as far north as 59°N, approximately 615 miles from

Cordova, 800 miles from Kenai-Soldotna, and 725 miles from Fairbanks, but on the east side of the Coastal Range.

Elodea nuttallii is very similar to *E. canadensis*, but has shorter and narrower leaves that are bent and folded along the midrib. *Elodea nuttallii* is generally smaller and paler green with more branches than *E. canadensis*. Characteristics often overlap making the species difficult to distinguish. Hybrids with intermediate characteristics occur naturally between the two species (Catling and Wojtas 1985, Cook and Urmi-König 1985). Taxonomic overlap due to hybridization is only further confused when parent stocks are introduced outside their native ranges; e.g., growth forms (phenotypes) of *E. nuttallii* can vary considerably in terms of leaf morphology and lateral shoot number (Thiebaut and Di Nino 2009).

The life history traits of these two species are similar in some respects (Barrat-Segretain et al. 2002). Both species are resistant to varying water current rates and have high regeneration (regrowth into viable plants) and colonization ability by fragments (establishment in sediment). In experimental tests, both species were shown to withstand strong current and survive long distance dispersal, increasing invasion capabilities (Barrat-Segretain et al. 2002). Both species grow in water temperatures of 10°—25°C. Few invertebrate species find either species to be palatable.

There are some critical differences between the two species that may affect their hybrid. Both species prefer depths ≤ 3 m, but will eventually spread to 5—6 m with some evidence that *E. nuttallii* can go deeper. *Elodea canadensis* prefers mesotrophic lakes whereas *E. nuttallii* prefers eutrophic lakes and can tolerate higher levels of pollution (oligo-mesoprobic). Both species are salt intolerant but to varying degrees: ≤ 0.25% for *E. canadensis* (Sand-Jensen 2000) and ≤ 1.4% for *E. nuttallii* (CAPM 2004); for comparative purposes, ocean water is typically 3.5% salt.

Suitable habitat for elodea may increase in response to global warming. Predictive bioclimatic models suggest that elodea will continue to aggressively colonize even further north in Europe (Heikkinen et al. 2008). *Elodea canadensis* shows high competitive ability compared to other invasive aquatic species including Brazilian waterweed (*Egeria densa*) and oxygen weed (*Lagarosiphon major*) in a variety of low to high temperature conditions and varied light availability (Riis et al. 2012).

Elodea is commonly used as an aquarium plant and is readily available in pet stores. Elodea is also used in college and high school biology labs for experiments in plant cellular structure, living protoplasm, respiration, photosynthesis and other physiological processes (Catling and Wojtas 1985). The introduction to Chena Slough is likely the result of an aquarium dump at a point at Plack and Repp Roads near Fairbanks, as the population is dense below this point, but nonexistent above (Wurtz et al. 2013).

<u>Kenai Peninsula</u>

At this time, elodea on the Kenai Peninsula appears to be restricted to Stormy, Daniels and Beck Lakes in the Bishop Creek and Swanson River watersheds (Figure 1). From the perspective of the salt-intolerant elodea, however, Stormy Lake is functionally its own watershed as the outlet passes through the tidal portion of the Swanson River (Figure 3). Genetic analysis of specimens from Stormy, Daniels and Beck Lakes indicate that populations are composed of a hybrid between *E. canadensis* and *E. nuttallii* (Dr.

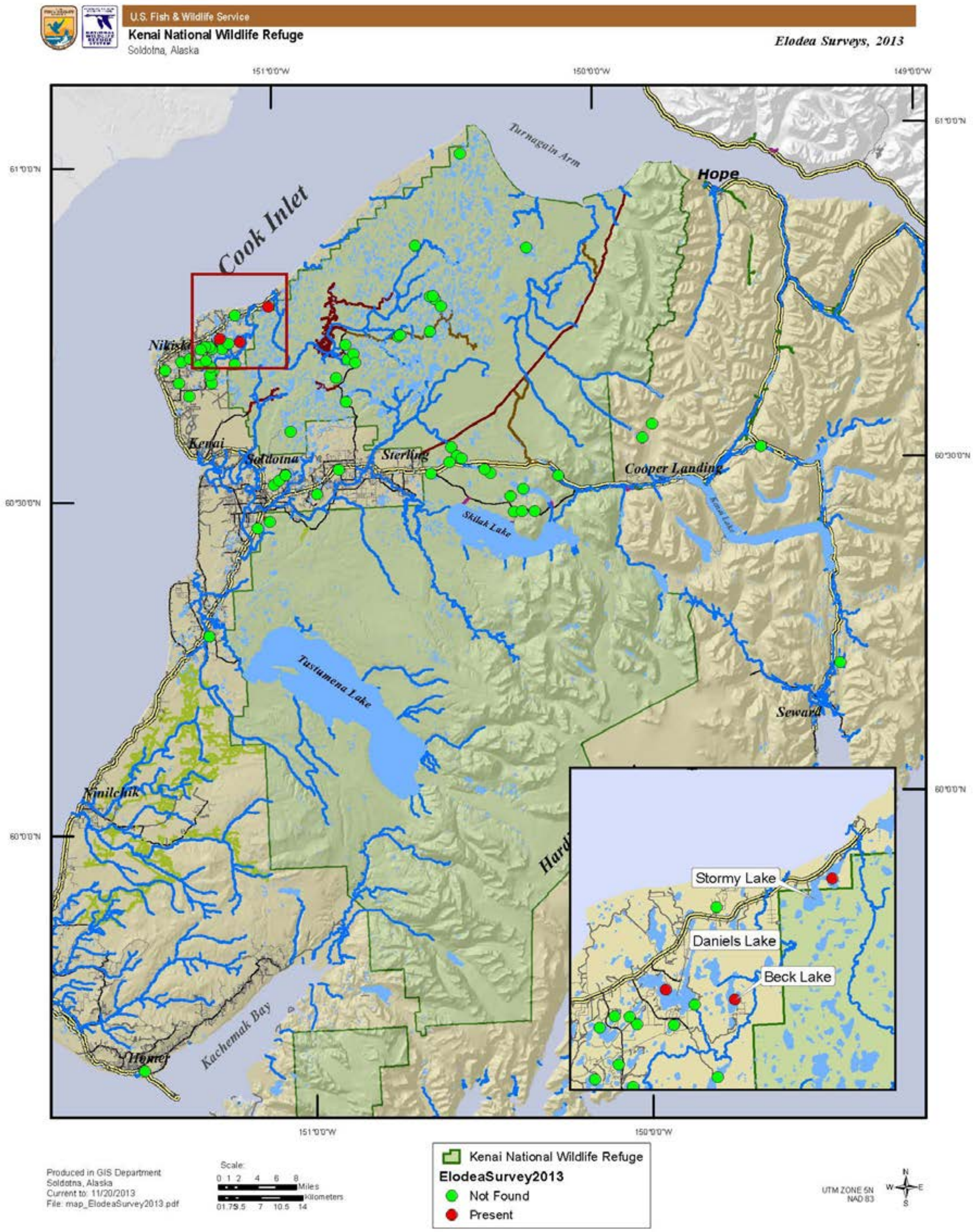

Figure 1. Elodea occurs in Beck, Daniels and Stormy Lakes. It was not found in 65 at-risk lakes on the Kenai Peninsula surved in summer 2013: Afonasi, Arc, Barabara, Barbara, Barr, Bear, Bernice, Big Merganser, Bishop, Bottenintnin, Breeze, Cabin, Cecille, Dolly Varden, Douglas, Duck, East Mackey, Engineer, Forest, Georgine (Georgina), Headquarters, Hidden, Imeri, Island, Jean, Johnson, Kelly, Kivi, Lily, Little Merganser, Longmere, Lower Ohmer, Lure, Marie, McLain, Mosquito, Paddle, Parsons, Peterson, Pond, Portage, Pot, Rainbow (Rainbow Trout), Rock, Salamatof, Scout, Spirit (Elephant), Sport, Tern, Thetis, Timberlost, Tirmore, Union, Upper Ohmer, Vogel, Watson, Weed, West Mackey, and Wik.

Donald H. Les, University of Connecticut, pers. comm.). *Elodea canadensis* X *nuttallii* samples retrieved from Stormy and Daniels Lakes were slow-growing in the lab initially compared to parental species, but that may be because it is cold water-adapted (Dr. Andrew Skibo, SePRO, pers. comm.).

Neither elodea nor other exotic submerged freshwater plants were known to occur on the Kenai Peninsula until very recently. Pfauth and Systsma (2005) did not detect elodea in Vogel, Johnson and Longmere Lakes as part of a larger regional survey of exotic aquatic plants in 2005. However, in September 2012, elodea was incidentally found while Stormy Lake was being treated with rotenone for northern pike. Shortly thereafter, ADF&G staff surveyed the distribution of elodea in Stormy Lake, detecting it at ~ 20% of 150 rake throws, mostly at 7-9 foot depths. In October 2012, ADF&G and USFWS staff found a single strand of elodea in Daniels Lake during windshield surveys of nine other lakes: Salamatof, Longmere, Island, Sport, Scout, West Mackey, East Mackey, Wik and Daniels. In February 2013, Daniels Lake was surveyed by augering through the ice at 25 sites (3 holes per site) distributed systematically around the 10-mile perimeter; elodea was detected at 2 sites adjacent to each other on the southern shore. In May 2013, immediately after ice-out, a more comprehensive survey by boat confirmed that Daniels Lake was in the early stages of infestation with elodea distribution restricted to five areas along the shoreline (Figure 5).

With the recognition that a strategic approach to elodea management could not be determined without a more comprehensive understanding of its distribution on the Kenai Peninsula, USFWS staff surveyed 64 lakes on the western peninsula during summer 2013, from Tern Lake in the east to Johnson Lake in the south to Vogel Lake in the north (Figure 1). In addition to surveying Bishop Creek and 13 other lakes (Barbara, Barr, Bishop, Cecille, Douglas, Duck, Georgine [Georgina], Kivi, Marie, Parsons, Timberlost, Tirmore and Wik) in that watershed, waterbodies targeted elsewhere were those exposed to likely routes of infection: public boat launches, multiple private homes, road accessible or floatplane charters. Other agencies surveyed Beluga Lake in Homer, Trout and Juneau Lakes on Chugach National Forest, and Bear Lake near Seward. Elodea was found in only one additional lake, the 200-acre Beck Lake in the Bishop Creek watershed (Figures 2, 4). Significantly, no other nonnative submerged aquatic plant was detected. Thirty-four species were identified (Table 1), of which 14 were pondweeds of the genus Potamogeton, including *P. robbinsii*, a species considered rare in Alaska.

At the time this plan was drafted in December 2013, neither the Swanson River nor Bishop Creek are known to have elodea. The Swanson River is not likely a concern in the short term because Stormy Lake drains into the tidally-influenced portion of the latter (and elodea is salt intolerant). However, outflows from both Daniels and Beck Lakes clearly put Bishop Creek at risk, although elodea has not yet been detected there (Figure 2). If abundance and distribution are indicative of an invasion timeline, Beck Lake was likely the first infestation and Daniels Lake the most recent. One plausible scenario is that aquaria were dumped from a small freshwater and tropical fish shop at or near the corner of Halibouty and Dragon Fly Roads that went out of business in the mid- to late-1990s. Elodea specimens from the three lakes were identified as *E. canadensis* X *nuttallii*, a hybrid common in aquarium plants (D. Les, pers. comm.). Presumably elodea has since spread to Daniels and Stormy Lake by trailered boat, float plane or waterfowl.

Figure 2. The Bishop Creek watershed, with significant sockeye, coho and rainbow trout populations, is immediately threatened by elodea infestations in Daniels and Beck Lakes. As of 2013, elodea is not known to have become established in Bishop Creek. Allowing elodea to persist threatens hundreds of waterbodies in the Kenai Lowlands as elodea can be spread by waterfowl, floatplanes and motorboats.

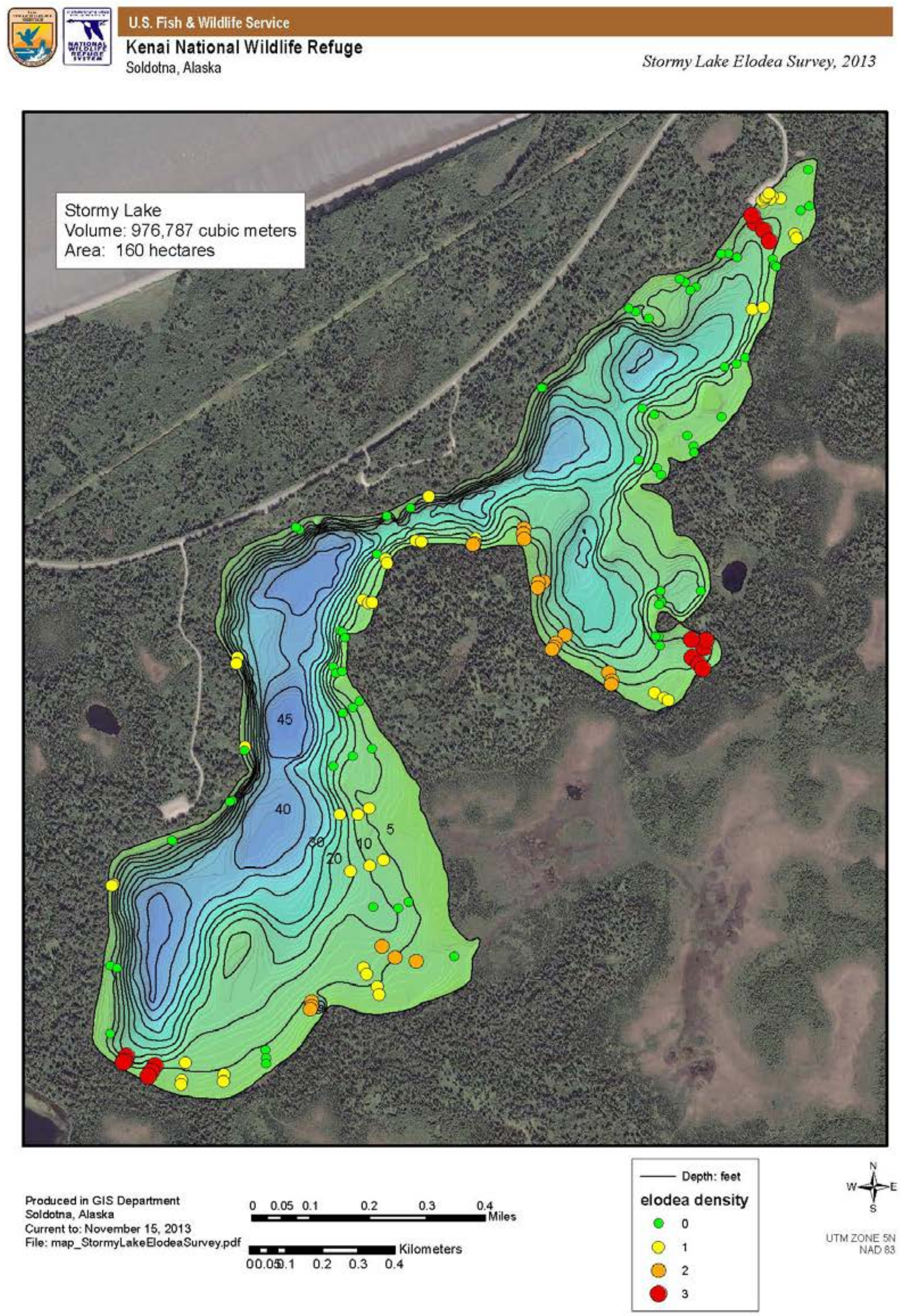

Figure 3. Distribution and relative abundance of *Elodea canadensis* X *nuttallii* in 400-acre Stormy Lake based on a boat survey with throw rakes in September 2013.

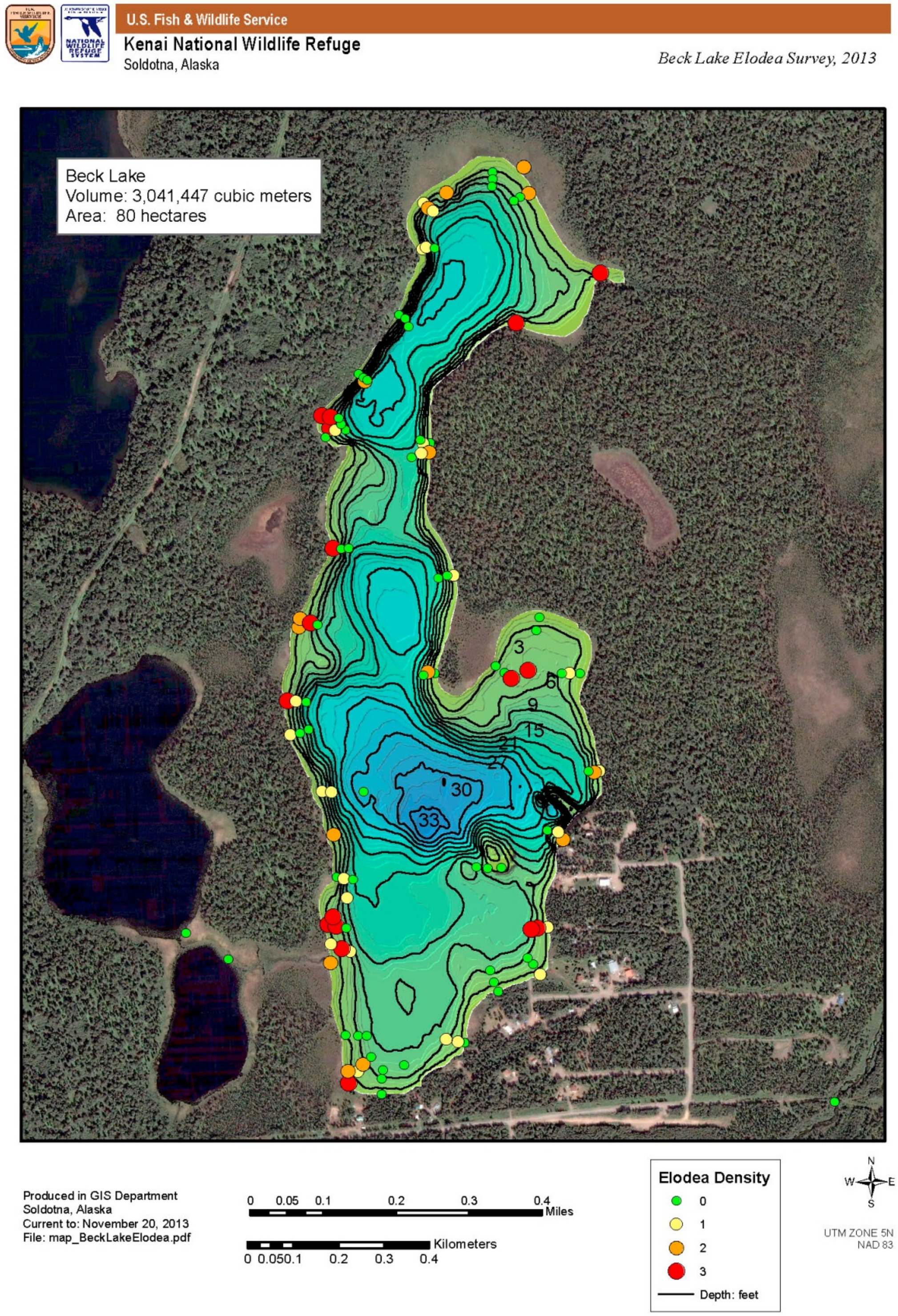

Figure 4. Distribution and relative abundance of Elodea canadensis X *nuttallii* in 200-acre Beck Lake based on a boat survey with throw rakes in July/September 2013.

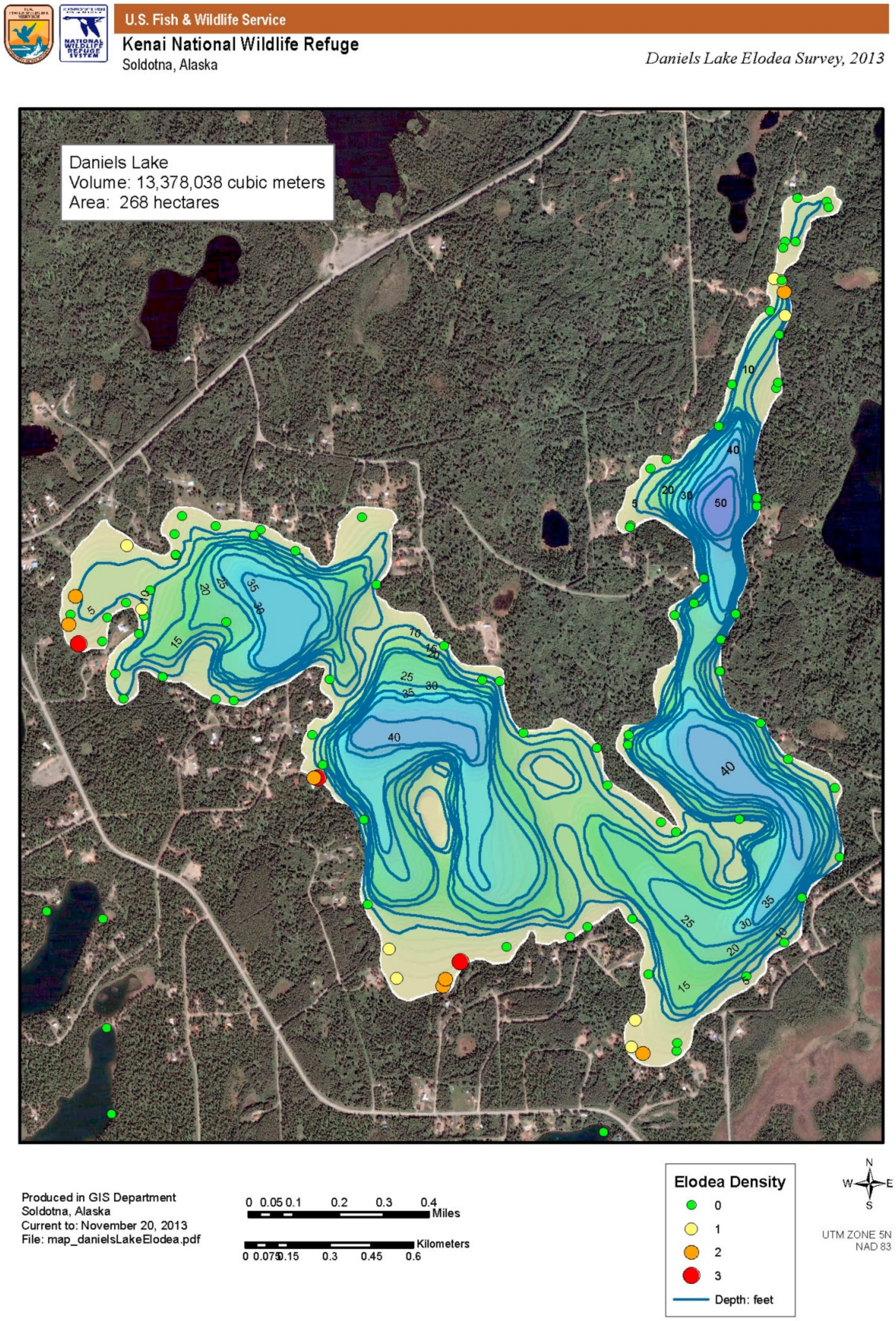

Figure 5. Distribution and relative abundance of *Elodea canadensis* X *nuttallii* in 660-acre Daniels Lake based on a boat survey with throw rakes in May 2013.

Ecological and economic effects of elodea

Elodea is a particularly injurious aquatic perennial. In most places where Elodea has been introduced outside its species-specific native ranges, it has compromised water quality (Mjelde et al. 2012), grown so abundantly that boat traffic is hindered, and reduced dissolved oxygen (Buscemi 1958, Lehtonen 2000), all of which have the potential to severely impact native fisheries. Elodea is also insidious, in that only a plant fragment is needed to infest a water body because it reproduces vegetatively. The connected waterways of the Kenai Lowlands, adjacent to Stormy, Daniels and Beck Lakes, could potentially support large infestations of elodea if plant fragments are transported to new locations. Inflow and outflow of the known infested lakes are a concern as plant fragments may spread to adjacent water bodies, and from there to the Kenai Lowlands of the western Kenai Peninsula. Likely initial vectors on the Kenai Peninsula are aquaria and discarded commercial lab kits. However, as elodea becomes more established, motor boats, anchors, fishing gear, and float planes will become the greater risk. The sooner elodea is eradicated from Stormy, Daniels and Beck Lakes, the more likely it is that other water bodies on the Kenai Peninsula will remain free of elodea.

Elodea can develop into dense, monospecific stands that prevent light from reaching other species. These dense stands limit water movement as well. Many stands experience 5—6 year growth cycles, possibly related to iron availability and depletion cycle, then collapse and cause oxygen depletion with massive amounts of decaying vegetation (Josefsson 2011). Chemical composition, pH, and oxygen level are all affected by elodea infestation, thereby affecting fish, amphibian, and invertebrate populations in the waterbody. Elodea can impede recreational activities such as fishing, boating, and swimming. Fish populations have crashed in areas in Europe with high elodea population. Elodea, along with other non-native aquatic plants, has affected Chinook salmon spawning rates by reducing spawning habitat in California (Merz et al. 2008). Elodea can clog water intake pipes at hydropower and industrial plants, or even cause scrape damage to boats in calcium encrusted stands (Josefsson 2011). In some cases, submerged aquatic vegetation communities with a mixture of non-native and native species may remain stable or even have natives increase over time, and waterfowl communities may show positive response to invaded waters (Rybicki and Landwehr 2007).

Elodea and other aquatic invasive species can reduce property values for landowners on infested lakes. Policies with successful invasion prevention have significant benefits to lakefront properties and community members. A study in New Hampshire determined 21—43% decline in property values by the presence and increase in variable milfoil, which can clog waterbodies, crowd out native aquatic species, and reduce recreational activities like boating and swimming (Halstead et al. 2003). In a study in Wisconsin on 170 lakes infested with Eurasian watermilfoil, property values were reduced by 8—13%, and spread rate increased due to the number of lakes infested (Horsch and Lewis 2009). A similar study in Vermont also with Eurasian watermilfoil showed a 1—6% decline in property values (Zhang and Boyle 2010).

Jurisdictional issues

Stormy Lake is within the Swanson River watershed. Stormy Lake drains into the Swanson River within Captain Cook State Park (Alaska Department of Natural Resources), one mile upstream from its mouth. Daniels and Beck Lakes are within the Bishop Creek watershed. Bishop Creek originates in Parson Lake, flows for 1.4 miles through Bishop Lake and then continues for 15.5 miles to the Cook Inlet. Timberlost, Daniels, Beck and several smaller lakes drain into Bishop Creek as it flows to the sea. The lower portion of Bishop Creek passes in and out of the Kenai National Wildlife Refuge before flowing under the Spur Highway at MP36 and then into the Cook Inlet; the mouth is within Captain Cook State Park, 2 miles south of the Swanson River. All three lakes are natural.

Stormy Lake is located in T8N, R10W (Sections 15,20,21,36, 37; Seward Meridian, Kenai Peninsula)(Figure 2). It is 0.3 miles east of Cook Inlet, 8.5 miles northeast of Nikiski and just off the Kenai Spur Highway. The land surrounding the lake is publicly managed by Captain Cook State Park and Kenai National Wildlife Refuge. A public boat launch is maintained by the Alaska Department of Natural Resources at MP38 of the Kenai Spur Highway. Stormy Lake drains into the tidal-influenced zone of the Swanson River via a 0.75-mile outlet steam at ~2 cubic feet per second (cfs).

Daniels Lake is located in T8N, R11W (Sections 33, 34, 35) and T7N, R11W (Sections 2, 3)(Figure 4). It is 2.2 miles south of the Cook Inlet shore and 2 miles northeast of Nikiski; access is south of the Kenai Spur Highway at MP30 (Halibouty Road). Daniels Lake is primarily surrounded by private lands with 153 parcels, although there are State (Alaska Mental Health Trust Authority, Alaska Department of Natural Resources), Kenai Peninsula Borough, and Cook Inlet Region Inc. (CIRI) parcels. The outflow from Daniels Lake is ~ 3 cfs and flows for 1.7 miles before draining into Bishop Creek 12.3 miles from the Cook Inlet.

Beck Lake is located in T8N, R11W (Section 36) and T7N, R11W (Section 1)(Figure 3). It is 2.7 miles south of the Cook Inlet shore, 4.6 miles east of Nikiski and south of the Kenai Spur Highway. The southeast shoreline of Beck Lake is within private land ownership (21 parcels), but the Kenai Peninsula Borough, Alaska Mental Health Trust Authority, and CIRI have significant holdings.   Beck Lake is drained via a 0.6-mile outflow into Bishop Creek, 4 miles downstream from Daniels Lake.

In addition to multiple land ownerships, state management of elodea is complicated because aquatic invasive plants are under the jurisdiction of the AK Department of Natural Resources, fisheries resources are managed by AK Department of Fish and Game, and herbicides are permitted by AK Department of Environmental Conservation.   It is appropriate that the interagency Kenai Peninsula Cooperative Weed Management Area develop this integrated pest management plan for responding to elodea.

IV. MANAGEMENT

Goals and objectives

The management goal is to eradicate elodea from, and to prevent its reintroduction, to the Kenai Peninsula.

At this time, elodea is known to occur in only three lakes (Beck, Daniels and Stormy) on the peninsula which are part of two watersheds. Consequently, the short-term objectives (2014-2016) that this plan addresses are

1) to eradicate elodea from Beck, Daniels and Stormy Lakes, and
2) to prevent the dispersal of elodea from these lakes during their treatments.

The long-term objective that this plan acknowledges but does not address in full is

3) to prevent the reintroduction of elodea (and the introduction of other submerged freshwater invasive plants) to the Kenai Peninsula .

Treatments considered for eradication

Elodea is difficult and expensive to eradicate. The only economical, safe and effective methods for managing elodea are draining and drying the channel or waterbody, application of herbicides, or introducing herbaceous fish (grass carp) (Josefsson 2011, Bowmen et al. 1995). Mechanical methods, such as cutting, draglines or suction dredging, are not effective as they break up the plant and cause it to spread to new areas. Covering methods, such as tarping the sediment or covering live plants, may be effective in small, shallow areas (CAPM 2004). However, the only realistic option for treating large and deep waterbodies such as Daniels, Beck and Stormy Lakes are herbicides. Herbicides can be lethal to elodea, but may require a long contact time and/or multiple applications for effective control and certainly for eradication, while often imposing significant nontarget effects.

Elodea responds to a limited number of herbicides including fluridone, diquat, terbutryne, copper sulphates or chelates of copper (which also inhibits algal growth), and paraquat (Bowmen et al. 1995). The most effective herbicides have been found to be fluridone and diquat; both chemicals are rated E for Excellent, with success rates exceeding 95% for potential control of elodea species (DiTomaso et al. 2013). However, fluridone is a selective systemic herbicide that is ultimately lethal to the entire plant and can result in eradication, whereas diquat is a nonselective, quick-acting contact herbicide that kills only the above ground biomass and does not result in eradication.

We aim to eradicate elodea from Stormy, Daniels and Beck Lakes with fluridone in 2014-16. Even as the partial infestation in Daniels Lake is treated with fluridone, we will also consider applying diquat to ensure that it does not spread further throughout the lake.

Fluridone

Fluridone (Sonar™) has been used successfully to manage elodea in the Lower 48 (Dr. Lars. Anderson, UC-Davis, pers. comm). 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. Adequate concentrations must be maintained (albeit at very low concentrations) in the treated area for 45-90 days after the initial application, which is determined through periodic water monitoring.

Fluridone is a tan to off-white odorless crystalline solid, chemically formulated as 1-methyl-3-phenyl-5-[3-(trifluromethyl)phenyl]-4(1*H*)-pyridinone, and applied as either a pellet or liquid (Bartels et al. 1978, McCowen et al. 1979). Sonar by SePRO Corporation is a commercially available herbicide used to selectively manage undesirable aquatic vegetation in freshwater ponds, lakes, reservoirs, rivers, and canals. Sonar is currently approved for use by the Alaska Department of Environmental Conservation in five different formulations: two aqueous suspensions known as Sonar AS (USEPA Registration Number 67690-4) and Sonar Genesis (USEPA Registration Number 67690-54), and three time-released pellet forms known as Sonar Q (USEPA Registration Number 67690-3), Sonar PR Precision Release (USEPA Registration Number 67690-12), and SonarONE (USEPA Registration Number 67690-45).

Fluridone may be applied to an entire water body (whole-lake) or on smaller infestations within a water body (partial-lake). In the former case, fluridone is generally applied as a liquid by boat through surface or underwater drip equipment depending on the size and distribution of necessary treatment areas. In the latter case, 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. In both cases, application will take place under appropriate conditions for boating, avoiding conditions of high wind, water flow, or wave action. The herbicide will be applied following all directions on the EPA approved label and will not exceed the maximum cumulative concentration (150 ppb).

Figure 6. Augered hole shows elodea growing under 2' of ice and snow in February 2013.

Complete eradication with fluridone products generally require treatment of 45—90 days per growing season for two or more growing seasons. The ideal time for treatment is shortly after ice out (late May, early June) 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 (typically mid- to late-June) that can inhibit a uniform distribution of fluridone in the water column.

However, fluridone can be applied at any time that elodea is photosynthesizing, which appears to be year-round. Unlike most other native submerged aquatic plants, elodea does not completely senesce. In February 2013, when a joint USFWS-ADFG crew sampled elodea through two feet of ice and snow cover in Stormy and Daniels Lakes, it was obvious that elodea was green, vibrant and photosynthesizing under the ice (Figure 6). Pedlow et al. (2006) effectively treated watermilfoil in a Michigan lake with a whole-lake treatment of low-dosage fluridone, first applied in October and subsequently boosted in November, with herbicide residuals maintained through the winter. Despite relatively low uptake by plants during this time, this disadvantage may be offset by low water volume, minimal mixing (no wind due to ice cover), and reduced concerns about potential impacts to anadromous fish and human health. We will use this approach during the first year of fluridone treatments in Stormy, Daniels and Beck Lakes.

Fluridone effect on elodea

Fluridone is a slow-acting systemic herbicide used to control elodea, hydrilla, Eurasian watermilfoil and other underwater plants. Like other systemic herbicides, fluridone is absorbed from water by plant shoots and from the hydrosoil by the roots of aquatic vascular plants (Marquis et al. 1981, Westerdahl and Getsinger 1988). The susceptibility of a plant to fluridone is associated with its uptake rate and rate of translocation. Fluridone interferes with the synthesis of RNA, proteins, and carotenoid pigments in plants, and disrupts photosynthesis of targeted plants. Production of carotene is inhibited, preventing carbohydrate formulation necessary to sustain the plant. Fluridone symptoms on submersed aquatic plants appear as progressive albescence of young leaves followed by leaf necrosis, initially appearing 3—6 days after application (McCowen et al. 1979), but requiring 45—90 days for optimal lethality. Eventually, aquatic plants gradually sink to the bottom and the amount of open water increases (McCowen et al. 1979). Fluridone does not affect water quality parameters such as pH, dissolved oxygen, color, dissolved solids, hardness, nitrate nitrogen, total phosphates, and turbidity (McCowen et al. 1979).

Although fluridone is considered to be a broad spectrum herbicide, when used at very low concentrations, it can be used to selectively remove elodea, which is considered highly susceptible to the effects of fluridone (McCorkelle et al. 1992). Some native aquatic plants, especially emergent plants, are minimally affected by low concentrations of fluridone (NYSFOLA 2009). At higher concentrations, fluridone controls a broad spectrum of annual grass and broadleaf weeds, but not algae (Bartels et al. 1978, Berard et al. 1978, McCowen et al. 1979, Marquis et al. 1981). Fluridone has been field tested on a variety of invasive or non-native aquatic plants including salvinia (*Salvinia* spp.), bladderwort (*Utriculata* spp.), Eurasian watermilfoil (*Myriophyllum spicatum*), coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton* spp.), cattail (*Typha* spp.), horsetail (*Equisetum* spp.), duckweed (*Lemna* spp.), fanwort (*Cabomba caroliniana*), vallisneria (*Vallisneria* spp.), water hyacinth (*Eichornia crassipes*), hydrilla (*Hydrilla* spp.) and elodea (*Elodea* spp.)(McCowen et al. 1979). Because fluridone does not work on algae, ponds or waterbodies with high algal concentrations should not be treated with this herbicide as the algal coating on elodea can prevent herbicide absorption. Field tests in mixed invasive and native submerged aquatic vegetation showed reduction in invasive populations with native plant cover retention of approximately 70% (Madsen et al. 2002). Treatments of Michigan lakes resulted in drastic reductions in invasive Eurasian watermilfoil, increases in native submerged aquatic vegetation, and increases in size and abundance of native fish populations (Schneider 2000).

Fluridone is removed from treated water by degradation from sunlight (photolysis), adsorption to sediments, and absorption by plants. In partially-treated water bodies, dilution reduces the level of the herbicide more rapidly following application. In field studies, fluridone (various formulations) decreased logarithmically with time after treatment and approached zero detectable presence 64—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 ≤ 7—21 days (Kamarianos eta al. 1989, Osborne et al. 1989, Muir et al. 1980, McCowen et al. 1979). Fluridone can persist in hydrosoils (sediments) with a half-life exceeding one year (Muir et al. 1980). High lake turbidity also increased the half-life to ≥ 50 days in Waneta Lake in New York, and resulted in measurable fluridone concentrations several months after the initial treatment (Kishbaugh 2011).

Fluridone can persist for months (over the winter) in the water column when applied in autumn due to lower water temperatures and low light levels. This attribute has resulted in fluridone applications in the fall in the Midwest where lakes freeze (WADOE 2000).

<u>Fluridone effects on non-target animals (including humans)</u>
Any pesticide approved by the U.S. Environmental Protection Agency (USEPA) has undergone extensive testing to determine toxicity level through acute (high doses for short periods of time) and chronic (long term exposure) studies on animals (USEPA 1986). Sonar has been tested in both acute and chronic studies, as well as studies to examine genetic, cancer, and reproductive effects. Sonar was not shown to result in the development of tumors, adverse reproductive effects or offspring development, or genetic damage. Sonar has been tested extensively on target aquatic invasive plants, as well as in long-term residue monitoring studies in treated waters. Sonar is labeled with the signal world “caution” by the USEPA on the label, indicating a level of toxicity lesser than those labeled with either “danger” (more toxic) or “poison” (most toxic).

The USEPA has approved Sonar’s application in water used for drinking as long as residue levels do not exceed 0.15 parts per million (ppm) or 150 parts per billion (ppb) (USEPA 1986). For comparative purposes, 150 ppb is well below the 560 ppb set by USEPA as the MCL (maximum contaminant level). One ppm can be considered equivalent to approximately one second in twelve days or one foot in two hundred miles. Sonar applications can be made within one-fourth mile (1,320 feet) of a potable water intake. Human contact to fluridone may be through swimming in treated waters, drinking water from treated waters, by consuming fish from treated waters, or by consuming meat, poultry, eggs, or milk from livestock that were provided water from treated waters. Stormy and Daniels Lake have no commercial agricultural use, so exposure through livestock is unlikely. There are no USEPA restrictions on the use of fluridone-treated water for swimming or fishing when used according to label directions (USEPA 1986).

The maximum non-toxic dose is characterized by the "no-observed-effect-level" or NOEL for pesticides. The dietary NOEL for fluridone (the highest dose at which no adverse effects were observed in laboratory test animals fed Sonar) is approximately 8 milligrams of Sonar per kilogram of body weight per day (8mg/kg/day). A 70-kg (150 lb.) adult would have to drink over 1,000 gallons of water containing the maximum legal allowable concentration of Sonar in potable water (15 ppm) for a significant portion of their lifetime to receive an equivalent dose. A 20-kg (40 lb.) child would have to drink approximately 285 gallons of Sonar treated water every day to receive a NOEL- equivalent dose. The risk therefore is negligible even if a human were to accidentally ingest water directly after Sonar treatment. As Sonar is only applied intermittently and in limited areas, and because it disappears from the environment, continuous exposure over a lifetime for humans, mammals, and other animals is improbable.

Fluridone has been tested for acute and chronic toxicity, as well as reproductive effects, on mammals (rats, mice, guinea pigs, rabbits, dogs), birds (bobwhite quail, mallard duck), insects (honey bee, amphipods, daphnids, midge, chironomid), earthworms, fish (fathead minnows, catfish, mosquitofish, rainbow trout), and other aquatic animals (Hamelink et al. 2009, Kamarianos et al. 1989, Muir et al. 1982, McCowen et al. 1979).

Exposure of test animals dermally (skin contact) has shown minimal toxicity to mammals by acute, concentrated contact. Chronic dermal exposure in mammals showed no signs of toxicity and slight skin irritation. Mammals were shown to excrete fluridone metabolites within 72 hours of varying doses of up to 1400 ppm/day (McCowen et al. 1979). A dietary NOEL was established for birds that may feed on aquatic plants or insects in treated waters. The risk to birds via diet was considered negligible. The acute median lethal concentrations of fluridone were 4.3 +/- 3.7 mg/L for invertebrates and 10.4 +/- 3.9 mg/L for fish. Fish in treated ponds have shown no fluridone metabolites after treatment (Kamarianos et al. 1989). Chronic studies showed no effects on daphnids, midge larvae, fathead minnows, or channel catfish and rapid rates of metabolic excretion (Hamelink et al. 2009, Muir et al. 1982). Insects that fed on bottom sediment had higher rates of fluridone intake and persistence than others (Muir et al. 1982). Honeybees and earthworms were not considered particularly sensitive to fluridone, even when directly dusted or placed in treated soil.

Fluridone has low bioaccumulation potential in fish, bird, or mammal tissues. Irrigation of crops using water treated with fluridone lead to only trace amounts detected in forage crops. Livestock consumption of Sonar-treated water resulted in negligible levels of Sonar in lean meat and milk. Sonar manufacturer recommendations indicate the livestock can be watered immediately from Sonar-treated water. The tolerance for milk is the same as for water (0.15 ppm).

Fluridone effects on non-target vegetation

The desired outcome is the eradication of elodea, but native submerged aquatic plants will be impacted as well. As opposed to Daniels Lake, where we propose partial-lake treatment, impacts to native aquatic plants will be more noticeable in Beck and Stormy Lakes, both of which will be whole-lake treated with fluridone. Madsen et al. (2002) evaluated nontarget plant effects in three lakes in southern Michigan that were treated with low-dosages of fluridone (Sonar AS®) to control Eurasian watermilfoil. Despite achieving >93% reduction in the frequency of watermilfoil, native plant cover (composed of mostly of

Ceratophyllum demersum, Chara spp., *Heteranthera dubi, Potamogeton* spp., and *Vallisneria americana*)was maintained at >70% in the year of treatment and 1-year post treatment. Floating leaf plants (such as yellow pond lily) exhibiting chlorosis (due to lack of chlorophyll) usually recover within the year of treatment or become re-established within the following year (Kenaga 1992).

In Stormy, Daniels and Beck Lakes, elodea grows both alone in monotypic stands and in mixed assemblages with other native aquatic species. At the low concentrations applied (≤ 150 ppb) fluridone is expected to be only lethal to elodea. The aquatic plant community is expected to shift back to one comprised entirely of native species if eradication is successful. There may be a time period when elodea is decaying that light and dissolved oxygen may be temporarily reduced. As the plant continues to decay, water clarity and dissolved oxygen as well as nutrient levels are expected to return to normal water quality levels.

Table 1. Native freshwater plant species found in the three lakes on the Kenai Peninsula infested with *Elodea* sp.

Scientific Name	Common Name	Beck Lake	Stormy Lake	Daniels Lake
Calla palustris	wild calla	x		
Callitriche hermaphroditica L.	northern water starwort	x		
Eleocharis palustris	common spikerush	x		
Elodea canadensis x nuttallii	waterweed hybrid	x	X	X
Equisetum fluviatile	water horsetail	x		
Fontinalis antipyretica	common water moss	x	X	X
Hippuris vulgaris	common mare's-tail	x		
Myriophyllum sibiricum	shortspike watermilfoil	x	X	X
Nuphar lutea	yellow pond lily	x	X	X
Potamogeton spp. (P. epihydrous, P. friessii, P. gramineus, P. praelongus, P. pusillus, P. richardsonii)	pondweeds	x	X	X
Ranunculus aqualtilis	water crowfoot		X	
Schoenoplectus tabernaemontani	bulrush		X	
Sparganium angustifolium	marrowleaf burreed	x	X	X
Sparganium natans	small bur-reed	x	X	X
Utricularia intermedia	flatleaf bladderwort	x	X	X

Treatment with diquat may affect non-target native species as it is a nonselective contact herbicide. However, since only parts of the lake will be treated, propagules of native aquatic plants are expected to recolonize any areas where elodea has been eliminated. Reduction of biomass using diquat may create a more favorable environment in which native plants can compete with elodea, or may have no effect on native plant populations in the short term (Rybicki and Landwehr 2007).

Minimal trampling of shoreline vegetation is expected from operations. Stormy Lake has one concrete ramp boat launch with an adjacent gravel parking lot that will serve as the project storage and operating base. Basing operations from the boat launch area should prevent trampling of vegetation around the lake. Access to Daniels and Beck Lakes will be via private boat ramps will prevent vegetation tramping on this lake.

In terms of physical damage to emergent vegetation, a large bed of emergent aquatic vegetation (bulrushes) occurs in the south basin of Stormy Lake that may require the use of an airboat or mud-buddy (specialized outboard) to apply the pesticide because the vegetation is too dense for a typical outboard boat to operate in. It is anticipated that the bulrushes will sustain some damage near the waterline which may result in visible (but temporary) boat swaths through the vegetation.

Diquat (in combination with fluridone)

Growth suppression of elodea infestations in the nearshore littoral zone (<10' depth) may be accomplished with diquat bromide (diquat), sold as Reward™, to minimize plant fragmentation and decrease the likelihood of further spread within infested lakes and to lakes elsewhere on the peninsula. In combination with fluridone, we specifically plan to apply diquat to the five infested areas within Daniels Lake to prevent further spread within that lake. Diquat is a nonselective, contact algicide, defoliant, desiccant and herbicide that is best applied when plant biomass and turbidity are low. Consequently, diquat will be applied at the maximum application rate of 2 gallons of Reward™ per surface acre within these five areas in early summer, either by underwater boom or spot treatment depending on abundance.

Reward Landscape and Aquatic Herbicide (USEPA Registration No. 100-1091) contains the active ingredient diquat dibromide and is currently approved for use by the Alaska Department of Environmental Conservation. Diquat is formulated as 6,7-dihydrodipyrido (1,2-a: 2',1'-c) pyrazinediium dibromide (Cochrane at al. 1994). It is a general use herbicide typically used to control broadleaf and grassy weeds in non-crop and aquatic areas (USEPA 2002). 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 strong oxidizers, diquat may pose a fire and explosion hazard. Diquat is a quick-acting herbicide, causing injuring only to the parts of the plant to which it is applied (Hayes and Laws 1990). Diquat is absorbed by plant leaves where it interferes with cell respiration and prevents update of oxygen.

Diquat is considered a moderately toxic material, labeled with the USEPA signal word "warning" (USEPA 2002). Diquat exhibits low acute toxicity via oral and inhalation exposure, but has moderate to severe acute toxicity by dermal exposure. Humans drinking water containing diquat in excess of the maximum contaminant level (MCL) over many years could get cataracts. Diquat can cause eye irritation, and can cause serious burns and scarring of the cornea (Sax 1984). Diquat may be harmful to the gastrointestinal tract, kidneys, and liver of mammals, causing severe congestion and ulceration of stomach and gastrointestinal tract (Gosselin et al. 1984).

Diquat is not known to cause genetic changes and is therefore not considered a mutagen in acute tests with mice. Diquat does not cause tumors in rat studies both acute and chronic. Tests have been conducted on mice, rats, guinea pigs, rabbits, dogs, and cows (Cochrane et al. 1994, Hayes and Law 1990). Diquat causes cataracts in dogs and rats, and developmental effects in rats and rabbits (Cochrane et al. 1994). Oral diquat doses are metabolized mainly in the intestines with excretion in feces, in tests with rats, hens, and cattle. Minute traces (0.004—0.015% of oral doses) of diquat were found in cow milk, and cows are considered sensitive to diquat exposure. Diquat is considered moderately toxic to practically nontoxic to birds, depending on the species. In mallards acute toxicity (LD50 or lethal dose fifty in which half of the subjects are killed with that dose) was 564 mg/kg. For hens, oral LD50 was 200-400 mg/kg, for rats 120/mg/L, for mice 233 mg/kg, and 188 mg/L in rabbits. Chronic exposure at the 4-week no-observed-effect-level (NOEL) for increased relative liver weight in rats from dietary exposure to diquat was 7.2 mg/kg-day (Cochrane et al. 1994).

Diquat is slightly toxic to fish. The LC50 (lethal concentration fifty, in which half of the experimental subjects are killed when exposed to that concentration) was 12.3 ppm for rainbow trout and 28.5 in Chinook (king) salmon at eight hours, and 16 ppm at 96 hours for northern pike and 20.4 ppm for fingerling trout. Some species of fish may be harmed but not killed by sublethal levels of diquat, including suffering respiratory stress (yellow perch) (Bimber et al. 1976). There is no bioconcentration of diquat in fish. Diquat is toxic to aquatic invertebrates, which display varying levels of sensitivity. Diquat has shown to be 300 more times toxic to amphipods than mayfly, with caddisfly, damselfly, and dragonfly less sensitive in that order (Nicholson and Clerman 1974, Wilson and Bond 1969).
The Maximum Contaminant Level (MCL) is 0.02 milligrams per liter (mg/L) or 20 ppb for diquat (USEPA 2002). Diquat residue studies suggest that diquat is not persistent in water, as it binds to suspended particles in the water, which are then taken up by plants. The half-life is less than 48 hours in water. Affected plants decompose and release diquat, which is then degraded by microbes, photodegraded by sunlight (within 1 to 3 weeks), or adsorbed to sediment particles. Adsorbed sediment diquat is also degraded by microbial activity, although diquat has been found in the bottom soil of pools and ponds four years after application. Adsorption rates are highest in loam, sandy clay loam, and sandy loam (Cochrane et al. 1994). Granular activated carbon can be used to remove diquat to below MCL.

A 14-day interval between treatment of water and use of treated water for domestic, livestock, or irrigation purposes is required (USEPA 2002). Swimming, fishing, and domestic animal watering should not be allowed for 14 days after application.

Lake-specific prescriptions

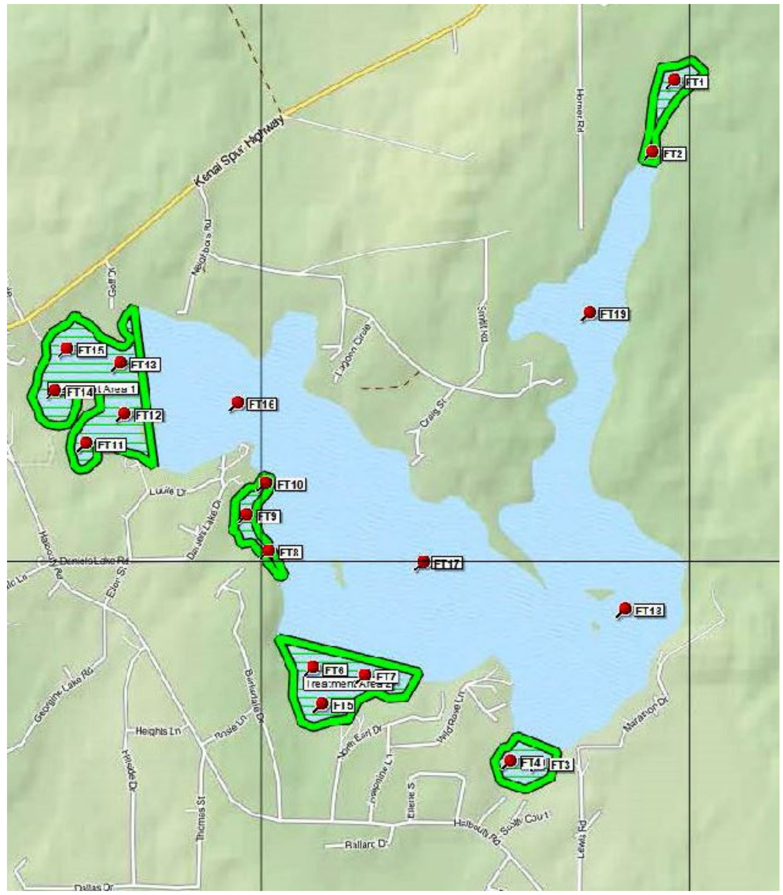

Figure 7. Five treatment areas and their 18 FasTEST sample sites for determining fluridone concentrations within Daniels Lake.

We aim to begin a partial-lake treatment of Daniels Lake and whole-lake treatments of Beck and Stormy Lakes with fluridone in 2014. Based on our current knowledge of water quality parameters and elodea distributions, SonarONE® (pellet) and Sonar Genesis® (liquid) are the preferred products for treating Stormy, Daniels and Beck Lakes. The SonarONE formulation does not require mixing and is applied directly as pellets. The Sonar Genesis formulation does not require pre-mixing; however, water is drawn into the hose during application as a carrier (4 gallons of water per gallon of Sonar Genesis).

As the goal is eradication, not simply control, four treatments over three years are planned, although not all four may be needed pending our post-treatment assessment of herbicide efficacy after the second year (third treatment). For Beck and Stormy Lakes, which are whole-lake treatments, we will apply an initial treatment of Sonar Genesis (8 ppb) to ensure a rapid uptake in the spring 2014, followed by a second treatment with SonarONE (6 ppb) in spring 2014 to ensure that concentrations remain at lethal dosages over the summer; a late season (before ice) boost of SonarONE will maintain fluridone concentrations through winter 2014-15. Spring treatments of SonarONE are proposed in 2015 (8 ppb) and 2016 (6 ppb)(Tables 2, 3).

For Daniels Lake, which is a partial-lake treatment, all four treatments will be with the pelleted SonarONE to minimize dilution, but the concentration needs to be higher to maintain lethal concentrations. Consequently, the initial treatments of the five different infestations (108.5 acres total) vary from 60—90 ppb, with subsequent treatments varying from 30—45 ppb (Table 4). In addition, we plan to apply diquat dibromide (Reward®) either immediately before (preferred) or immediately after the first application of fluridone in spring 2014 with the goal of preventing further spread of the infestation in Daniels Lake. It will be applied at the recommended rate of 2 gallons per surface acre mixed with 50 gallons of water as a carrier.

In addition, we are working with SePRO Corporation (http://www.sepro.com/default.php) to further optimize treatment concentrations based on laboratory studies being conducted in Colorado and North Carolina on elodea samples taken from Stormy and Beck Lakes. Lastly, if elodea is detected in out-flowing streams below either of the two lakes, a one-time application of fluridone in pelleted form at a rate of 5—8 ppb is likely.

Table 2. Prescribed whole-lake treatments of Beck Lake with liquid (Sonar Genesis®) and pelleted (SonarONE°) fluridone formulations in 2014-16.

BECK LAKE (196.8 acres, mean depth = 12.5 ft, volume = 2,466 acre-ft)								
TREATMENT		**PRESCRIPTION**						**COST**
No.	Target Date	Sonar Genesis®			SonarONE®			
		ppb	gal	$	ppb	lbs	$	
1	July 2014	8	107	27,400	6	799	22,400	$49,800
2	Sept 2014				4	533	14,950	$14,900
3	June 2015				8	1065	29,900	$29,900
4	June 2016				6	799	22,400	$22,400
∑			**107**			**3196**		**$117,000**

Table 3. Prescribed whole-lake treatments of Stormy Lake with liquid (Sonar Genesis®) and pelleted (SonarONE°) formulations of fluridone in 2014-16.

STORMY LAKE (395.1 acres, mean depth = 17.6 ft, volume = 6,936 acre-ft)								
TREATMENT		**PRESCRIPTION**						**COST**
No.	Target Date	Sonar Genesis®			SonarONE®			
		ppb	gal	$	ppb	lbs	$	
1	July 2014	8	300	77,000	6	2247	63,000	$140,000
2	Sept 2014				4	1498	42,000	$42,000
3	June 2015				8	2996	84,000	$84,000
4	June 2016				6	2247	63,000	$63,000
∑			**300**			**8989**		**$329,000**

Table 4. Prescribed partial-lake treatments of Daniels Lake with pelleted (SonarONE®) formulation of fluridone in 2014-16. In addition, a one-time treatment of diquat bromide (Reward®) will be applied in June 2014 to prevent elodea from continuing to spread in Daniels Lake.

PARTIAL LAKE TREATMENTS					SonarONE® PRESCRIPTIONS								
					July 2014		Sept 2014		June 2015		June 2016		Σ
Treatment Area	Acres	Depth (ft)	Mean volume (ac-ft)	% lake volume	ppb	lbs	ppb	lbs	ppb	lbs	ppb	lbs	
1	52.1	8	416.8	3.8	60	1350	30	675	30	675	30	675	3375
2	29.1	5	145.5	1.3	60	471	30	236	30	236	30	236	1179
3	10.1	4	40.4	0.4	90	196	45	98	45	98	45	98	490
4	9.2	3	27.6	0.3	90	134	45	67	45	67	45	67	335
5	8.0	8	64.0	0.6	90	311	45	156	45	156	45	156	779
TOTAL PRODUCT (lbs)						2,151		1,076		1,076		1,076	**6,158**
COST						$69,100		$34,500		$34,500		$34,500	**$172,600**
Theoretical lake-wide concentration (ppb)						4.21		2.10		2.10		2.10	
Theoretical in-water concentration (ppb)						2.52		1.26		1.26		1.26	

Preventing spread from the three infested lakes

A key measure in preventing elodea spread is to inform the media, schools, and public about the risk associated with dispersal and spread. Restriction of movement of boats, fishing gear, or other vectors between waters could help in preventing spread, along with disinfection of gear (Josefsson 2011).

Outreach with private landowners

Private landowners with property affected by the infestations at Stormy, Daniels, and Beck Lakes will be kept informed during planning and field implementation. We held one well-attended public meeting at the Nikiski Community Recreation Center in February 2013. There will be other public meetings scheduled to gather input from, and provide information to, the relevant landowners and any concerned citizens. The Alaska Department of Natural Resources will work with property owners on Daniels and Beck Lakes to prevent contact during and after the treatment period. As a precaution, signage discouraging human contact with treated waters would be posted until all waters are determined to be safe for human contact.

Stormy Lake closure

The Alaska Department of Natural Resources, Division of Parks and Recreation, administers public access including the boat launch to Stormy Lake. In summer 2013, the Stormy Lake boat launch was closed to prevent elodea from being spread to other waterbodies. The Division will again be asked to collaborate with the KP-CWMA to temporarily close the Stormy Lake public boat launch during the treatment preparation, application, and follow-up (up to 14 days total), and possibly for the entire season to prevent spread of elodea to new areas. Contact with treated waters will be discouraged after treatment using appropriate signage and public notices.

Nets at lake outlets

Escape of elodea fragments from the outlets of Beck, Daniels, and Stormy Lakes clearly threaten Bishop Creek and, to a much lesser extent, the Swanson River (the latter is within the brackish tidal zone). Particularly during herbicide application, increased motor-boat activity in shallow waters will almost certainly fragment and uproot elodea. The Alaska Department of Fish and Game has maintained staggered fyke net panels at the Stormy Lake outlet that allows for fish passage while successfully intercepting elodea fragments. We plan on using fyke nets to intercept

Figure 8. Example of fyke net surrounded by poly-coated poultry fencing installed by ADF&G on Soldotna Creek drainage(R. Massengill).

elodea fragments dispersing from Daniels and Beck Lakes as well (Figure 8). During and for 10 days post-treatment, the nets will completely block the outlet to prevent elodea escaping but also fish passage; at all other times during 2014-16, staggered fyke net panels will be kept in place but open for fish passage. The Cook Inlet Aquaculture Association will broker whatever landowner agreements and permits are necessary, install and maintain the fyke nets.

Preventing reintroduction to the Kenai Peninsula

<u>Outreach to KPB public, schools and aquaria retailers</u>

- Media Outlets – CWMA representatives will engage T.V., radio, and print news outlets in conversation that supports reporting on the Elodea eradication project on the Kenai Peninsula.
- Information about the Elodea eradication project, the environmental assessment, the prescribed herbicides, and any other relevant public information will be accessible on the CWMA website (www.kenaiweeds.org) on a dedicated Elodea page. Partners and community websites with any interest will be encouraged to link to the CWMA website for more information.
- An accessible publication will be developed and produced to explain elodea and the eradication process. This publication will be available to members of the public.
- CWMA representatives will contact pet shop supply businesses to discuss the use of Elodea as an aquarium plant in our area and seek to educate them on the importance of offering a suitable substitution and discontinuing their use of Elodea.
- CWMA representatives will contact float plane operators in the Southcentral region to educate them on the risks and impact of Elodea and how to recognize the plant. They will be encouraged to collect samples that look suspicious and contact a CWMA representative to provide positive identification of the plant.
- CWMA representatives will contact school science teachers and educate them on the risks of utilizing Elodea as a classroom aid. Science teachers will be encouraged to utilize alternative plants for those lesson objectives, as well as an educational component discussing the invasive potential of Elodea. CWMA representatives will provide material as necessary and guest speakers when feasible.

<u>Petition KPB school district and municipalities to discourage sale and purchase</u>

V. Monitoring

Maintaining fluridone concentrations

The treatment goal is to maintain a lethal dosage in the eradication zone for 45—90 days. To ensure that concentrations are maintained, water samples will be collected from 2—4 sites in the target area, two subsamples per site at the mid and bottom depths (to ensure that lake stratification is not affecting water mixing). For the whole lake treatments of Stormy and Beck Lakes, water samples will be collected at 2, 4, 8, 12, and 16 week intervals from six sites in each of the lakes (Table 5). In the case of Daniels Lake, more sites need to be sampled, proportional to the volume of each of the five application areas (Figure 7), because of the increased concern about dilution in a partial-lake treatment. Consequently, 19 sites will be sampled, including 4 nontarget sites to measure whole-lake concentrations over the same intervals as Stormy and Beck Lakes. All water samples will be collected using FasTEST protocols (Appendix 1) established by, and sent by overnight delivery to, SePRO Corporation's analytical laboratory in Carmel, IN for immunoassay following the techniques described by Netherland et al. (2002). Approximately ~10% of water samples (n = 10) will be duplicated and sent to an independent lab for verification.

Lake	FasTEST Site	15-Jun 2 WAT	1-Jul 4 WAT	1-Aug 8 WAT	1-Sep 12 WAT	1-Oct 16 WAT	Latitude	Longitude
Daniels Lake	1	X	X	X	X	X	60.7516372	-151.167864
Daniels Lake	2	X	X				60.7489173	-151.169602
Daniels Lake	3	X	X	X	X	X	60.7255421	-151.1783782
Daniels Lake	4	X	X				60.7256261	-151.1806742
Daniels Lake	5	X	X				60.727812	-151.1953083
Daniels Lake	6	X	X	X	X	X	60.7291887	-151.1959735
Daniels Lake	7	X	X				60.728905	-151.1919609
Daniels Lake	8	X	X				60.7336754	-151.1994711
Daniels Lake	9	X	X	X	X	X	60.7350518	-151.2011555
Daniels Lake	10	X	X				60.7362653	-151.199675
Daniels Lake	11	X	X				60.7377676	-151.2136654
Daniels Lake	12	X	X	X	X	X	60.7389127	-151.2107042
Daniels Lake	13	X	X				60.7408561	-151.2110261
Daniels Lake	14	X	X				60.7397951	-151.2160472
Daniels Lake	15	X	X	X	X	X	60.7413813	-151.2151459
Daniels Lake	16	X	X				60.733263	-151.1874602
Daniels Lake	17	X	X	X	X	X	60.7314558	-151.1717532
Daniels Lake	18	X	X				60.742802	-151.1744997
Daniels Lake	19	X	X				60.7393565	-151.2018797
Beck Lake	1	X	X	X	X	X	60.7408472	-151.1300189
Beck Lake	2	X	X				60.7378211	-151.1344396
Beck Lake	3	X	X	X	X	X	60.7336602	-151.1353409
Beck Lake	4	X	X				60.7325465	-151.128903
Beck Lake	5	X	X				60.7300037	-151.1332379
Beck Lake	6	X	X	X	X	X	60.7263682	-151.134783
Stormy Lake	1	X	X				60.7874167	-151.0327008
Stormy Lake	2	X	X	X	X	X	60.7840311	-151.0400868
Stormy Lake	3	X	X				60.7797427	-151.0402846
Stormy Lake	4	X	X	X	X	X	60.7794847	-151.0560459
Stormy Lake	5	X	X				60.7716495	-151.0532762
Stormy Lake	6	X	X	X	X	X	60.7696181	-151.0627725
	Total Samples	**31**	**31**	**13**	**13**	**13**		
	Grand Total	**101**						

Table 5. Proposed sites for monitoring fluridone concentrations in target areas at 2, 4, 8, 12 and 16 week intervals after treatment in Daniels, Beck and Stormy Lakes.

Efficacy and nontarget effects of fluridone treatments

Pre- and post- treatment survey design will consist of a point-intercept method to determine presence/absence and the diversity of aquatic macrophytes, macro-invertebrates and fish at each of the three elodea invested lakes pre- and post-treatment. Water quality data will also be collected at each sampling location. Sample locations will be selected using a grid technique and geographical information system (Madsen 1999, Madsen et al. 2002). A non-elodea infested reference lake will be selected to allow for a comparison of natural changes unrelated to the fluridone treatment. The reference lake will be selected based on its proximity to the other three lakes, and similarities in aquatic vegetation, lake morphometry and substrate.

At each sampling location, the aquatic macrophyte community will be surveyed from a boat/canoe with a throw- rake (Figure 9) using a point-intercept sampling design following the procedures described by Hauxwell et al. (2010). This method will survey sites distributed on a grid throughout the littoral zone of the lake to characterize species presence/absence. We will characterize presence/absence rather than biomass or percent cover, as it is more rapid and less costly to implement and is less sensitive to temporal variations in plant abundance (Madsen 1999)**.**

Figure 9. A throw-rake sample of *Elodea canadensis* X *nuttallii* collected on Daniels Lake in May 2013.

At each sampling location, water quality data will be collected including temperature, pH, dissolved oxygen, specific conductivity, turbidity, and alkalinity. Data will be collected throughout the water column at each location using a Quanta Hydrolab™. Water transparency will be measured using a secchi disc.

An Ekman dredge will be used to collect bottom sediment from sample sites; sediments will be screened to extract any macro-invertebrates. Kick nets will be used to collect invertebrates along vegetated shorelines at sample locations. Attempts will be made to visually locate and collect freshwater mussels and snails. All specimen samples collected will be preserved in 90% ETOH, labeled with the date, collector initials and site location then archived for later quantification and identification to family.

Effects on fish will be inferred indirectly from the water quality data. Results of each parameter will be compared with fish life-stage needs to ensure fish needs are being met.

Underwater surveys

During subsequent efficacy monitoring, after both the third and fourth treatments, we will conduct fine-scale sampling by SCUBA in addition to surveying with a throw-rake. Any elodea found during these dives will be hand-pulled and placed in a 6.4mm mesh bag; we may also consider using a portable suction dredge at that time.

Long-term monitoring for early detection on the Kenai Peninsula

The eventual desired outcome is the successful eradication of elodea from all waterbodies on the Kenai Peninsula. This outcome will be determined by annual surveys of these waterbodies both during treatment and for at least three years post-treatment. In addition, 10 high public use lakes on the Kenai Peninsula will be selected for annual monitoring as early warning indicators of elodea being transported to the peninsula by boat or floatplane from other infested areas in mainland Alaska. For future long-term monitoring, we will investigate the possibility of eDNA to detect elodea species in lakes.

Two bald eagle nests currently exist on Daniels Lake. These two nests will be observed for activity in the spring and monitored for any disturbance related to treatment activities. It is not known if other bald eagle nests exist on Stormy or Beck lakes. We will observe these lakes as well for any bald eagle nests and take appropriate precautions to comply with the Bald and Golden Eagle Protection Act.

VI. FIELD IMPLEMENTATION

Materials and equipment will be transported to the site by truck. Herbicide dispersal will be directly into the lake by DEC-certified applicators from outboard motorboats. Boats will be equipped with apparatus to deliver either liquid (Sonar Genesis, Diquat) or pellet (SonarONE) herbicide to the water body to be treated. Regardless of formulations, applications will take place under appropriate conditions for boating, avoiding conditions of high wind, water flow, or wave action. The herbicide will be applied following all directions on the EPA approved label and will not exceed the maximum cumulative concentration of 150 ppb. During treatment, signage will be placed at all access locations in compliance with all applicable legal requirements related to the fluridone or diquat treatment. All residents of Daniels and Beck Lakes will be notified directly in compliance with all applicable legal requirements related to treatments.

Liquid formulations

The first application of fluridone in Beck and Stormy Lakes in 2014 includes Sonar Genesis, a liquid formulation intended for rapid uptake by elodea. We are also proposing to treat Daniels Lake in spring 2014 with diquat, a liquid contact herbicide, to help ensure that elodea does not continue to spread in Daniels Lake. Although both products are liquid herbicides and are mixed with water via a pump system, they have different technical considerations for application. Sonar Genesis is a low volume application (1 gal product per 4 gal water) that simply needs to be well distributed in the water column; consequently, we will use small electric pumps with a 30-50 gal mixing tank (Figure 10) and PVC booms extending on either side of the boat hull. If it is applied later in the summer after a thermocline is established, we may need to a boom system that can be extended into the water column (Figure 11).

Table 6 provides an example of how Sonar Genesis would be calibrated for application, in this case, in Beck Lake.

In contrast, Diquat is a high volume application (2 gal product per 50 gal water) that needs to be applied as close to the vegetation stratum as possible; consequently, larger gas-powdered Honda™ trash or Gorman-Rupp™ high-pressure pump systems currently used by the Alaska Department of Fish & Game to apply rotenone (for northern pike eradication)(R. Massengill, pers. comm.). These liquid pump systems have a forked intake line that draws lake water (large diameter line) and herbicide (smaller diameter line) separately to be mixed for application to the lake. A valve on the smaller line controls the siphon rate of the herbicide which affects the water/herbicide mixed ratio. The intake ratios are calibrated by running both intakes independently and wide open with untreated water to measure total pump discharge/minute and total herbicide discharge/minute; the mix ratio (gallons of water:gallons of herbicide) is calculated from these values. For example, a 1:10 ratio of herbicide to water being discharged at 50 gal/min will deliver 5 gal/min of herbicide (50/10=5). Application routes will be determined based on swath width (width of application dispersal) and then programmed into onboard GPS equipment to be followed by the operator of the application vessel. The speed of the boat will be set to cover the given route in the amount of time calculated to deliver the prescribed volume of herbicide.

Table 6. Example of how Sonar Genesis would be calibrated for application in Beck Lake.

Lake Size	196.8	
Application rate: Sonar Genesis (ppb)	8	
Gallons of Sonar Genesis	107	
Gallons per acre product	0.543699	
Tank Gallons (1 part Sonar:4 parts water)	535	16.2 acres covered per tank
Gallons per acre tank mix	2.718496	12.2 tanks to cover Beck lake
Swatch width example (feet)	20	
Boat Speed (mph)	8	
Boat Speed feet per minute	704	
Acres/minute = swath X speed (ft/min) /43560	0.323232	
gallons tank mix needed per minute	1	
gallons tank mix per nozzle (2 nozzzles)/minute	0.5	
Tank Size (gallons)	50	
Minutes per tank	50	

Figure10. 12-volt electric pump system with 30-50 gallon tank will be used with PVC boom to apply Sonar Genesis below the water surface.

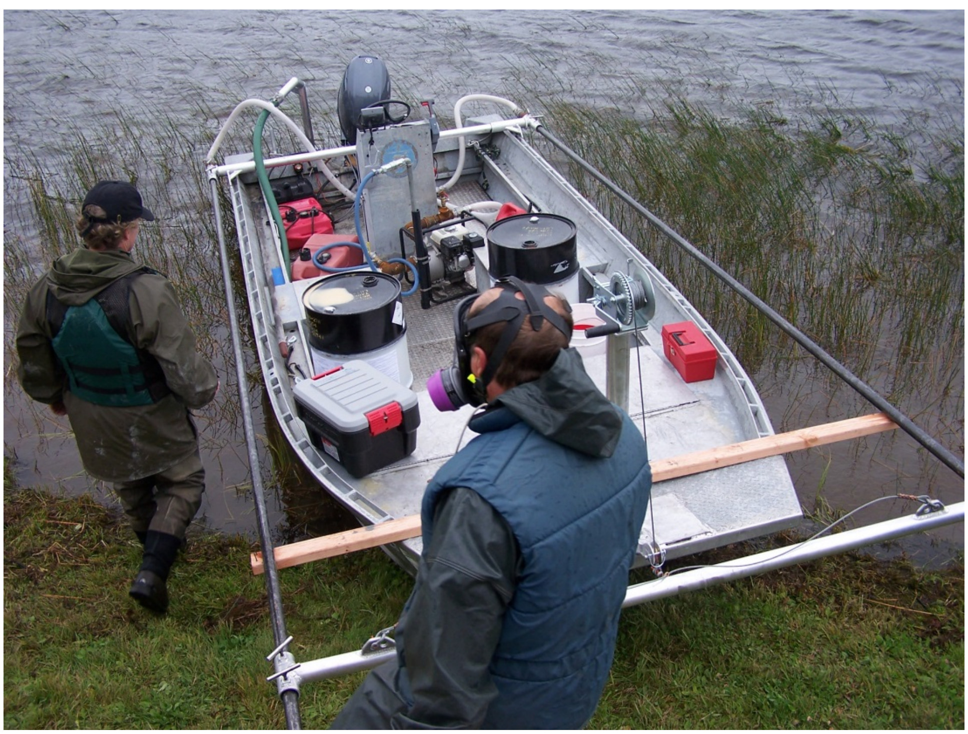

Figure 11. Motorboat and a well-pipe boom system currently used by the Alaska Department of Fish & Game for deep-water application of rotenone. It may be used if Sonar Genesis is applied in mid- to late-summer when thermoclines may develop in Beck and Daniels Lakes.

Pelleted formulation

SonarONE will be applied using the Vortex TR-A (http://www.vortexspreader.com/tra.php), a forced-air blower system mounted to a motorboat. These are not heavy units only weighing 95 lbs. empty that can hold up to 250 lbs of pelleted fluridone in the hopper and can put out ≤ 15 lbs of product per minute. Each TR-A delivery system (at least two) will be calibrated independently by using SePRO training pellets (clay blanks), which are the same weight and size as SonarONE. The critical parameter to estimate, as each TR-A is slightly different, is the throughput in minutes. We will pass 20 lbs of training pellets through each system twice with the system wide open to estimate the number of minutes required to deliver all 20 lbs; the average of the two trials will be used as a calibration value. In a GIS, we will determine the area to be treated, application swath width, and the total number of minutes needed to deliver the prescribed pounds of product so that we can estimate boat speed. We will use onboard GPS to navigate swath paths and ensure appropriate speed is maintained.

Prescriptions shown in Tables 3, 4 and 5 are based on the following calculations:

Beck Lake – 196.8 acres X 12.53 feet mean depth = 2,466 acre-feet
2,466 acre-feet X 8 ppb X 0.0054 (label constant) = 107 gallons (106.53) Sonar Genesis
2,466 acre-feet X 6 ppb X 0.054 (label constant) = 799 (798.98) pounds of SonarOne

Stormy Lake – 395.1 acres X 17.6 (17.55) feet mean depth = 6,936 acre-feet
6,936 acre-feet X 8 ppb X 0.0054 (label constant) = 300 gallons Sonar Genesis
6,936 acre-feet X 8 ppb X .054 (label constant) = 2,247 pounds of SonarOne

Daniels Lake – Area 1: 416.8 acre-feet X 60 ppb X 0.54 (label constant) = 1,350 pounds of SonarOne
Area 2: 145.5 acre-feet X 60 ppb X 0.054 (label constant) = 471 pounds of SonarOne
Area 3: 40.4 acre-feet X 90 ppb X 0.054 (label constant) = 196 pounds of SonarOne
Area 4: 27.6 acre-feet X 90 ppb X 0.054 (label constant) = 134 pounds of SonarOne
Area 5: 64 acre-feet X 90 ppb X 0.054 (label constant) = 311 pounds of SonarOne

Prescribed fluridone concentrations need to be maintained in the water column for 45—90 days. If average fluridone concentrations fall below the target amount for two consecutive samples (based on FasTEST results; Appendix 1), then supplemental fluridone will be added. For example, if the average concentration of fluridone from the six sites in Beck Lake based on the average of the 1st and 2nd samples is 5 ppb when the target is 6 ppb, the following calculations are used to calculate the amount of SonarONE that needs to be added to increase the total concentration by 1 ppb:

2,466 acre-feet X 1 ppb X 0.054 (label constant) = 133 pounds of SonarOne

Under no circumstance will cumulative applications exceed 150 ppb per year per lake.

Figure 22. A Vortex™ TR-Aquatic for blowing pelleted formulations of fluridone (SonarONE®) at known rate; calibration is based on application swath width, vessel speed, and throughput of the blower assembly.

Available boats

Vessel	Length	Motor	HP	Configuration
Magnum (KENWR)	16	4 stroke outboard	35-50	Open skiff w/ console
Achilles (KENWR)	14	4 stroke outboard	30	Open inflatable
Zodiac (KENWR)	14	4 stroke outboard	30	Open inflatable
Hewes (KENWR)	16	4 stroke outboard	35-50	Open skiff w/ windshield and top
Workskiff (KENWR)	22	twin 4 stroke outboard	90,90	Open skiff w/ canopy over console
Marian (KENWR)	22	4 stroke outboard	90	Open skiff w/ console
ARK (KENWR)	26	twin 4 stroke outboard	225,225	Open landingcraft with cabin
Lowe(KENWR)	16	2 stroke outboard (JET)	90	Open skiff w/ console
Willie Legend (ADF&G)	18	outboard	50	
Willie Predator (ADF&G)	15.5	outboard	50	
Jon boat (ADG&G)	16	mudbuddy (surface drive)		

Storage and handling of herbicides

Materials and equipment would be transported to the site by truck. Pesticide dispersal will be directly into the lake by DEC-certified applicators from outboard motorboats. Boats would be equipped with gas-powered pumping systems that would mix lake water with Sonar (if applied in liquid form) and sprayed on the lake surface. Alternatively, pelleted formulations will be distributed on the lake surface by an electric disk-driven spreader or a high-velocity blower applicator; in either case, the application rate will be calibrated. The target concentration for fluridone will be formulated by calculating area of infestation, volume of water in infested areas, and desired persistence time but is generally expected to be in the range of 5-15 ppb, with no single application exceeding 90 ppb and the sum of all applications in a given season not to exceed 150 ppb. For complete eradication, both lakes will have to be treated for at least two seasons.

Applicators of Sonar will experience risks from exposure. Applicators must avoid breathing spray mist, or any contact with skin, eyes, or clothing. They must wash thoroughly with soap and water after handling and should wash exposed clothing before reuse. Sonar used according to label instructions minimizes risk to applicators. A fluridone Material Data Safety Sheet (MSDS) is available in Appendix 3, and a Sonar AS label is available in Appendix 4.

Applicators of Reward will experience risks from exposure. Applicators must avoid breathing spray mist, or any contact with skin, eyes, or clothing. They must wash thoroughly with soap and water after handling and should wash exposed clothing before reuse. Sonar used according to label instructions minimizes risk to applicators. Applicators must wear protective clothing when handing the concentrated produce to reduce skin exposure. Splashes should be immediately washed from eyes and skin. Applicators should avoid drift contact to skin or eyes. Breathing diquat spray or mist should also be avoided, and respiratory equipment is recommended. A diquat Material Data Safety Sheet (MSDS) is available in Appendix 5, and a Reward label is available in Appendix 6.

VII. Budget

The proposed action will be supported primarily by funding through, and/or services of, the U.S. Fish and Wildlife Service, the Alaska Department of Natural Resources, the Alaska Department of Fish and Game, and the Kenai Peninsula Borough.

Annual Fluridone Treatments and Product Costs to Eradicate Elodea from Kenai Peninsula								
LAKE	**2014**		**2015**		**2016**		**TOTAL**	
	ppb	$	ppb	$	ppb	$	ppb	$
Beck	18	64,700	8	29,900	6	22,400	32	117,000
Stormy	18	182,100	8	84,000	6	63,000	32	329,100
Daniels	5.51	90,500	1.84	30,200	1.84	30,200	9	150,900
∑		337,300		144,100		115,600		**597,000**

VIII. Permits and Certifications Required

The following permits and approvals will need to be obtained prior to herbicide use:
Federal: NEPA, USFWS Pesticide Use Permit
State: DEC, DNR (Division of Mining), ADF&G (Division of Habitat)
Alaska Pollution Discharge Elimination System (APDES) Permit #AKG870001

IX. Administrative Record

Sep 2012	Elodea detected in Stormy Lake
Oct 2012	Elodea detected in Daniels Lake
Feb 2013	1st public landowner meeting in Nikiski Preliminary survey of Daniels Lake
Mar 2013	1st face-to-face meeting of Elodea technical working group
Apr 2013	DEC permit application submitted for Diquat Live elodea samples sent to SePRO
May 2013	DEC permit application submitted for Fluridone Enhanced survey of Daniels Lake Presentation/petition to KPB Assembly
Jun 2013	Begin surveys of other lakes on the Kenai Peninsula ($55K) DEC permit to apply diquat approved (#13-AQU-01) APDES approved for Stormy, Daniels Lakes (AKG870000) $40K received from KBP
July 2013	Elodea detected in Beck Lake
Aug 2013	EA approved (AK-DNR/USFWS)
Sep 2013	Complete survey of other lakes on the Kenai Peninsula (n=68)
Dec 2014	First draft of IPM completed
Jan 2014	$40K received from National Fish & Wildlife Foundation
Feb 2014	DEC permit application for fluridone formally resubmitted APDES modification to include Beck Lake approved (AKG870001)
Mar 2014	2nd face-to-face meeting of Elodea technical working group
Apr 2014	2nd public landowner meeting in Nikiski 2-hr special session at KP-CWMA annual conference
Jun 2014	Pre-treatment surveys 1st herbicide treatments (Diquat in Daniels Lake)

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APPENDICES

APPENDIX 1. FasTEST Forms and Sampling Protocols for Monitoring Fluridone Concentrations

SRTC — SePRO Research & Technology Campus — SePRO

FasTEST® Monitoring — **Chain of Custody**

Company Name:* ______________________ Contact Person:* ______________________

Billing Address:* ______________________

Telephone:* ______________________ E-mail Address:* ______________________

*Required fields

Project/Reference Name: ______________________

SePRO Aquatic Specialist Name: ______________________

Sampler: ______________________

Number of samples to be analyzed: ______________________

Will water from treatment site be used for irrigation or potable purposes? If so, please describe: ______________________

Check Payment Method: ☐ PO Number________ ☐ VISA ☐ MasterCard Card No.________ CCV Code:______ Expiration Date: ______

☐ Check here if you would like us to keep this credit card information on file for future lab analysis orders.

(To establish a secure credit card file for future billing, please contact the SePRO Accounting Department at 317-580-8291).

Draw a map of water body or enclose a copy of a prepared map identifying the following:

- **Sample locations by Sample Numbers as listed on the *other side of this form*.**
- **Treatment area, if not the whole lake.**
- **Irrigation or potable water intake locations**

Field Notes:

Direct all inquiries about your sampling and FasTEST results to your SePRO Aquatic Specialist.

Ship samples to:
SePRO SRTC
Attn: Haywood Perry
16013 Watson Seed Farm Road
Whitakers, NC 27891-9114
E-mail: haywoodp@sepro.com
Tel: (252) 437-3282

SRTC — SePRO Research & Technology Campus — SePRO

Water Body Name: ______________ Water Body Size (acres): ______________ State: ______________

Depth Average and Depth Collected (feet): ______________ Target Plant Species: ______________

Formulations Applied (Place an "X" in the boxes of analysis desired) — One form for each water body and formulation

Sonar® (fluridone) ☐ A.S. ☐ PR ☐ Q ☐ SRP ☐ One ☐ Genesis | Renovate® (triclopyr) ☐ 3 ☐ OTF | Renovate® MAX G (triclopyr & 2,4-d) ☐ | Sculpin® G (2,4-d) ☐

Galleon® (penoxsulam) ☐ | Nautique® (copper) ☐ | Komeen® (copper) ☐ | SeClear® (copper) ☐ | K-Tea® (copper) ☐ | Captain® (copper) ☐ | Captain® XTR (copper) ☐

Habitat® (imazapyr) ☐ | Clearcast® (imazamox) ☐ | Oasis® (topramezone) ☐

Client Sample Site I.D. (Required field)	Date(s) Treated	Date Sample Collected (Required field)	Application Rate(s)	Treated Area (In Acres)	Sample Location – Identify sites on map (GPS coordinates preferred)	Lab Use Only - Notes
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						

FasTEST results will be reported 48 hours from receipt of samples by laboratory. Inaccurate or incomplete information on this form may delay analysis and reporting.

Shipped by: ______________________ Date/Time: ______________________

To be filled out by laboratory

Received by: ______________________ Date/Time: ______________________

SRTC **SePRO Research & Technology Campus** **SePRO**

Sampling Collection Procedures for FasTEST*

FasTEST provides rapid and accurate analysis of aquatic herbicide concentrations in water. FasTEST assay services are available for monitoring the following SePRO aquatic products: Sonar*, Renovate® 3, Renovate® OTF, Renovate® MAX G, Galleon* SC, Sculpin* G, Captain*, K-Tea*, SeClear*, Komeen*, Nautique*, Clearcast®, Habitat®, Oasis® and Littora*. It is extremely important to maintain a contamination free environment during water sample collection. Do not collect water samples from a boat that was used to apply the SePRO aquatic product you are monitoring. All equipment and clothes used during sampling should be completely free of the aquatic herbicide.

Follow these collection steps in sequence

1. **Complete FasTEST Chain of Custody (COC) and enclose with sample(s). This is included with sampling bottles, or may be downloaded from the SePRO website. Appropriate billing information MUST be completed before analysis.**
2. Draw a map, or attach a map, of the water body and location of each water collection on accompanying Chain of Custody. Number each sample location and transfer to page one of the Chain of Custody.
3. Complete accompanying sample water bottle labels and affix labels to sample bottles. Number each sample water bottle with corresponding sample location number from COC form. Include date and name of water body on label.
4. At the collection site, remove the bottle cap from the designated bottle, triple rinse the bottle with water from this site and submerge the bottle upside down until elbow deep. Should your program require sampling at depth, utilize the proper device to collect water from the target depth or depths. ***Note: For Littora (diquat) sample collection and analysis, contact the SRTC lab (srtclab@sepro.com) to receive preserved bottles and specific sample collection protocols.***
5. Turn the bottle upright and allow filling as you slowly bring the bottle toward the surface.
6. When the bottle is full, yet still underwater at the targeted collection depth; screw the cap back on the bottle. It is recommended to secure cap with tape to prevent the cap loosening during shipment.
7. Place the sample bottle(s) in a cooler and close the lid to prevent exposure to sunlight.
8. Refrigerate samples if they will not be shipped within 24-hours of collection to keep samples cool until shipment. Do not ship samples collected on a Friday, refrigerate and ship Monday.
9. Do not ship samples in loose ice.
10. We request that samples are overnighted and ice packs are used when outdoor temperatures reach 90 plus degrees. Shipping via FedEx is recommended. Note, shipments by U.S. mail typically require additional time in transit to the SRTC.
11. Ship samples to: **SePRO Research & Technology Campus**
    Attn: Haywood Perry
    16013 Watson Seed Farm Road
    Whitakers, NC 27891-9114
    E-mail: haywoodp@sepro.com
    Tel: (252) 437-3282
12. If you have questions pertaining to sample collection, please contact your SePRO Aquatic Specialist. If you need to order FasTEST sample bottles, please contact the SRTC at **(252) 437-3282** or by e-mail **srtclab@sepro.com**. COC forms are available on our web site **www.sepro.com** (Professional Aquatic Products/Laboratory Services).

FAQs

Q. Why ship Chain of Custody (COC) in a plastic bag?

A. When the Chain of Custody is not protected from moisture, it may become wet and thus very difficult to read…if we can't read or salvage the COC, the sample cannot be analysed until we establish where the sample originated. This may result in later turnaround than our 48-hour policy for water analysis.

Q. Why ship overnight?

A. Shipping overnight ensures that your watersample is not left in an environment (such as the back of a delivery truck or warehouse) in which external factors may affect sample integrity.

Q. Why ship samples on ice?

A. We know that water samples maintain their integrity if kept on ice or in a cold environment; we do not know the same about samples that arrive warm or hot, this leaves the potential for skewed results.

Q. Why send water samples in an opaque Nalgene® bottle?

A. The herbicides we test for are broken down by photolysis (absorption of light), so translucent bottles may promote additional breakdown before analysis is complete.