and soybeans that now dominate the U.S. corn and soybean markets. The herbicide industry feels the expansion beyond only glyphosate-tolerant crops is necessary because "millions of acres of weeds have developed resistance to Roundup herbicide, causing farmers to use higher quantities of Roundup" (glyphosate-based) [53]

Toxicity of 2, 4-D varies greatly, from highly toxic to moderate toxicity, depending on the specific product preparation. There are substantial numbers of peer reviewed, qualified and science-based studies, many of which link this chemical to issues from reducing honeybee reproductive numbers to a possible increase of lymphoma in dogs under certain conditions. Studies on this topic are reportedly somewhat conflicting, there are sufficient studies that make this correlation that are not flawed and cannot be disputed. One such study, published in the Journal of the National Cancer Institute, found a doubling of the rate of canine lymphoma if 2, 4-D products were applied four or more times a year.[54]

A toxicity study done on Salmonids in southeast Alaska showed that the butyl ester was the most toxic of the ester formulations and the isooctyl ester was the least toxic. 100% mortality occurred for pink, chum, and coho fry exposed to 1ppm of 2, 4-D butyl ester; 5 ppm exposure had the same fatality rate on sockeye smolts, Dolly Varden, rainbow, and Oregon coho fingerlings.[55]

The ASWCD greatly appreciates that any Alaska-specific studies have been completed (a rarity, as discussed in this report). Due to the questions surrounding some, if not all, preparations of 2, 4-D, if not the chemical itself, and the uncertainties involved, the ASWCD does not feel it can support the use of 2, 4-D products in this application.

## Fluridone / Sonar®

Fluridone works by inhibiting the formation of carotene in the plant. In the absence of carotene, chlorophyll is rapidly degraded by sunlight.[56] Reportedly, samples will need to be sent to the SePro Corporation, who, through their testing and methods assess what the level of Sonar® needs to be. As proposed, herbicide should be applied in spring 2013 and remain at constant levels through fall 2015.

Experts in the field have identified Fluridone as one of the most expensive herbicide choices. Fluridone treatment is usually to the entire lake and cannot be used in a more controlled fashion (such as with contact herbicides that can be directly applied to selected vegetation, minimizing damage to non-target species among other considerations). Further, while it is possible to use Sonar in semi-contained areas of the lake created by containment curtains used to isolate an area of the lake, because of the necessary three

[53] Reuters, Dow's Controversial New GMO Corn Delayed, Protests Continue, January 18, 2013

[54] Journal of National Cancer Institute, Case-Control Study of Canine Malignant Lymphoma: Positive Association With Dog Owner's Use of 2, 4-Dichlorophenoxyacetic Acid Herbicides, 1991

[55] William R. Meehan, USFS Forestry Sciences Laboratory Juneau, Logan A. Norris, USFS Forestry Sciences Laboratory Corvallis Oregon, and Howard S. Sears, National Marine Fisheries Service, Auke Bay Fisheries Laboratory, Toxicity of Various Formulations of 2, 4-D to Salmonids in Southeast Alaska, 1974

[56] Sonar® MSDS sheets and manufacturer information, 2013

years of treatment in each contained area, it would take more than 15 years to complete the eradication one section at a time.

Fluridone bonds with organics for an undetermined length of time. Manufacturer-produced MSDS Sheets for Sonar® also prohibit levels of Sonar® higher than 20 ppb within 1/4 mile of any functioning potable water intake.[57] Drinking water must not exceed 0.05 parts per million to meet New York state's drinking water tolerance (NYSADEC, 1994), and the label recommends waiting from 7 to 30 days before using Fluridone treated water for irrigation.[58] In addition, the manufacturer of Sonar® warns of a significant decrease in dissolved oxygen, especially at lower levels (deeper areas) of the lake, which will result in fish-kills. Trees and shrubs growing in water treated with Sonar may occasionally develop chlorosis.[59]

USFWS feels this is an emergency situation, that herbicide is the only recourse, and adamantly supports the use specifically of Sonar® (Fluridone), though it has not been previously used or tested in Alaska.[4]

The fact that Fluridone bonds to organics becomes a significant concern because of the amount of organics present on the bottom of Sand Lake, but also because of the Class A wetlands present between Sand Lake and Sundi Lake. Research also finds that "lake managers contemplating possible treatment of eutrophic lakes with Fluridone to control milfoil should carefully weigh the benefits of reducing Eurasian watermilfoil with the risks of reducing water clarity and decreasing the distribution and abundance of submersed plants."[60]

The limitations on proximity to potable water intake becomes a significant issue as there are private drinking wells within this distance around Sand Lake.

The ASWCD does not support Fluridone as a viable option for application in Sand Lake at this time. Qualified research into Fluridone products (as well as all other products) to learn more about their function, half-life, and other applicable testing parameters, and testing specific to Alaskan conditions is the prudent approach. Additionally, the potential liability and unintended impacts need to be assessed and addressed prior to consideration of use. As discussed several times in this report, the characteristics of Sand Lake, its present condition, and other factors eliminate whole-lake herbicide use at this time.

It may be found that Fluridone can be a key to future eradication projects with physical and other conditions not similar to Sand Lake's current status.

[57] Sonar® MSDS sheets and manufacturer information, 2013

[58] Cornell University Cooperative Extension, Fluridone: Herbicide Treatment FAQ, November 2012

[59] Sonar® MSDS sheets and manufacturer information, 2013

[60] Effects of a Low-dose Fluridone Treatment on Submersed Aquatic Vegetation in a Eutrophic Minnesota Lake Dominated by Eurasian Watermilfoil and Coontail, Ray D. Valley, W. Crowell, C.H. Wellding, and N. Proulx, 2006

## 7.10 Herbicides in Alaska

### Fluridone / Sonar®

The Alaskan Non-Native Plant Community is fortunate to have a relatively new employee that is the only known agency-person in Alaska to have experience with freshwater aquatic plants, and is lending his expertise to the Non-Native Plant Community. This staff of USFWS points to a project in Indiana he completed while employed by the State of Indiana's DNR, Griffey Lake, as the project example that this Sand Lake project should follow. In Griffey Lake, the herbicide Sonar® was used; however, it should be noted Sonar® has not been used in Alaska, nor is there any Alaska-specific data or testing regarding Sonar®. Further, the Griffey Lake issue was to address 'Brazilian Elodea.' While it is called 'Brazilian Elodea' it is not actually an Elodea, but an Egeria. Elodea and Egeria are within the same family of flowering aquatic plants, as are lily pads, but possibly closely enough related that this example can be correlated to Sand Lake.

While on the surface it may seem that because of the species difference, differences between Indiana and Alaska in climate, landscape, temperatures, Alaska's longer daylight hours in the summer time, cooler and different soils, etc. the Indiana Griffey Lake project is not comparable to Sand Lake in many ways, it is however an interesting case study. In investigating Griffey Lake it was discovered the local government had planned a drawdown and freeze of Griffey Lake to rid it of unwanted vegetation, however, the Indiana DNR stepped in and utilized Fluridone instead. Ironically, Griffey Lake (an artificially constructed reservoir) was drained in the last couple of years for repairs to the dam.

However, the push to only consider the option of whole=lake herbicide with Fluridone is not realistic. There are other chemical applications that are better suited for the Sand Lake application.

## 7.11 Discussion and Level of Stake holder Support for Chemical Options

One question that became a cornerstone of the discussion was "Can Elodea be 100% eradicated from Sand Lake and not re-establish itself?" Answers received were “no,” because there is no possible way to get herbicide/chemical into 100% of the muck on the bottom of the lake or to reach *every* centimeter of elodea present and there is a high recurrence rate within 3-4 years of treatment. Without reaching every fragment of elodea or root mass, elodea will not be eradicated. However, if the lake health is addressed as discussed below, the result will be a decrease to elodea-suitable conditions, thereby dramatically decreasing or eliminating the elodea, the residues and smaller infestation can be reached by chemical/herbicide if necessary.

The option of whole-lake herbicide use in Sand Lake has been met with nearly unanimous opposition by both property owners and scientists. The exception, ironically, is the

enthusiastic promotion of this specific chemical by the Non-Native Plant Community in Alaska. Further, this community has prematurely, in our view, fixated on a specific herbicide when it has not been sufficiently studied or verified this particular chemical is the "right" one to use, if chemical methods are to be utilized.

The most common concern being that this chemical (Fluridone) has never been used or tested in Alaska.

Further, the Alaska Department of Environmental Conservation has recently adopted changes to applicable Regulations that will require any state agency applying herbicide to have an Integrated Pest Management Plan (IPMP) in place for the specific species being targeted. This IPMP will have to undergo a full public process before adoption. Additionally, permitting and the requirements for permitting, will add considerable cost to this project. DEC personnel have said the new regulations are only applicable to herbicide applications on land, not in water.

During the consideration of this option the ASWCD has had many discussions and spent considerable time in the research and investigation of the option of herbicide use, either alone or in combination with other alternative(s).

There are significant and justified concerns with this option, such as impacts to non-target species, macro invertebrates, phytoplankton, and a very possible likelihood of further damage/degradation to the lake due to the additional biomass that would be added due to the application of herbicide without removal of the biomass. Additionally, Sand Lake is adjacent to Class A Wetlands, residential and recreational uses, and an elementary school. Water from Sand Lake feeds the wetlands between Sand and Sundi Lakes and Sand Lake is directly connected to Campbell Lake through a culvert.

Treatment of the entire lake brought on concerns of a possible 5-10 year lake recovery time if at all, given the lake health elements will continue to be the same and/or compounded due to the added dead plant material and hindrance of the natural ecosystem that would be impeded. Herbicides could have an adverse affect on the whole food-chain starting with bacteria & benthic detritivores, primary producers, herbivores, planktivores, and piscivores. Not to mention the possible leaching into human residential properties. Additionally, all herbicides investigated do not allow for use in waters near drinking water sources (wells), and many of the herbicides do not allow use in waterbodies that are used for recreational purposes. The lake would most likely have to be closed for the duration of the treatment.

While Fluridone can be effective in suitable situations, in the case of Sand Lake it is not suitable. If herbicide is to be used in Sand Lake, it should be granulated so it can be selectively applied to only the target plants/areas in a controlled fashion and with an herbicide with a track record in Alaska or other viable data so we can predict its behavior and when it will be completely gone from the water and sediment/lakebed.

Another concern to be carefully monitored and actively avoided if possible, is plant species becoming tolerant to herbicides. Much study, information and data is available on this subject. In some areas, land managers have herbicide-tolerant aquatic vegetation and are now attempting to find other treatment alternatives.

**Figure 17. Condensed Chart of Options**

| | Acceptable to stakeholders | Legal and can be permitted | Selective, no negative non-target effects on wetlands or water bodies | Fish and food web safe | Sustainable for long-term viability/ control | Reasonable and practicable in implementation and cost | Immediate control, management, or eradication |
|---|---|---|---|---|---|---|---|
| **No change** | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| **Restoration** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Management or Eradication |
| **Alum** | ? | ✓ | ✓ | ✓ | Management Only | ✓ | Management |
| **Drawdown/freezing** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Management or Eradication |
| **Tarping/shading** | ✓ | ✓ | ✓ | ✓ | No | ✓ | Management or Eradication |
| **Microbe removal of sediment** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Management or Eradication |
| **Suction dredging** | ✓ | ✓ | ✓ | ✓ | Somewhat | Somewhat | Eradication |
| **Mechanical removal of plants and sediment** | ✓ | ✓ | Somewhat | Somewhat | Somewhat | Somewhat | Management |
| **Biological introductions** | ? | Questionable | Somewhat | ✓ | - | - | Management or Eradication |
| **Diquat** | No | ✓* | No | No | No | ? | Management |
| **Endothall** | Possibly | ✓* | ✓ | ✓ | ✓ | ✓ | Eradication |
| **Glyphosphate** | Possibly | ✓* | ✓ | Moderate | No | ✓ | Eradication |
| **2, 4-D** | No | ✓* | ✓ | No | No | ? | Eradication |
| **Fluridone** | No | ✓* | No | No | No | No | Eradication |

* Possibly permittable with an IPMP and public process that includes discussion of least toxic option(s), and only after a full procurement process.

# 8 Findings and Recommendations

The ASWCD, pursuant to a full public process and an opportunity for property owners to give meaningful input regarding the options for proceeding forward, makes the following findings and recommendations.

Sand Lake would seem to be entering early to mid-stages of eutrophication. Eutrophication is a process of waterbodies receiving excess nutrients which causes an excessive plant growth. Studies[61] in 1981 predicted a low potential of this given the calculations at the time, and if those input levels remained constant. Preliminary wintertime and summertime sampling and testing has been done, laboratory results indicate elevated nutrients. This, in combination with the lake's physical condition, would indicate Sand Lake is nearing or has entered the eutrophic stage (the stage where plant life takes over the lake due to an unhealthy ecosystem, a condition under which plants thrive). The sampling protocol needs to continue over the next two years, revealing a full set of data. We also continue to monitor vegetation population, which appears to be declining as some of the excess nutrients present are depleted.

In healthy amounts, Elodea provides high amounts of oxygen and absorbs things such as heavy metals, improving the water quality of its host-lake. However, when overgrown it can interfere with recreational uses of the waterbody such as fishing, the thick mats of Elodea become too dense for medium to large fish to navigate and minnows can get trapped and die. The dead elodea plants add to the biomass which further exacerbates the loading issue.

Due to the water quality and sedimentation issues of Sand Lake, caused by a myriad of contributing factors, the Elodea population has exploded. The purpose of this population explosion is because the lake's ecosystem is attempting to process all the nutrients, sediment, and other inputs. In a healthy lake, the lake's vegetation and ecosystem are able to process all biomass, dead and decaying matter, etc. as it is created; Sand Lake cannot keep up with the inputs, hence sediment is accumulating. The sediment, combined with high nutrient levels, has created a perfect habitat for Elodea to grow and flourish.

Elodea thrives best in shallow conditions. Diminished water levels in the summer may increase the area that is hospitable to Elodea at some point during the year. Improvement of stormwater detention and infiltration may help regulate water levels in Sand Lake by reducing the volume of stormwater lost as “flooding” above the weir crest at 86.5 feet, and reduce the zone hospitable to Elodea. Any capital improvements to stormwater management within the basin also provide an opportunity for additional storm water treatment. Reducing the flow of nutrients into Sand Lake may also impact and decrease Elodea growth/spread.

[61] Sand Lake Area Drainage and Water Quality Management Study, Phase 2 draft, Quadra Engineering

There is cause to doubt the knee-jerk declaration that Elodea in Sand Lake is not a native or, at the very least, naturalized species. Given this, the prudent approach would be to include Elodea management in the overall holistic management of Sand Lake, with the goal of restoring lake health. Massive use of herbicides is expensive, time consuming, has potentially severe impacts on property owners and unknown impacts on adjacent wetlands and downstream lakes.

The ASWCD, through the process of this plan and the public's input, recommends a holistic, broad-view of this problem, with the goal to restore Sand Lake to its healthy state, as prior to the 1990s, when this problem started to build, utilizing the least toxic, safest methods possible.

Yes there is Elodea present and overtaking the lake, but this is only a symptom of the underlying real issue of water quality, over-abundance of nutrients, and a significant accumulation of biomass on the lake floor. It is these conditions that have created the perfect growing conditions for this population explosion of Sand Lake's Elodea.

Investigation has conclusively shown that complete and permanent eradication of Elodea is improbable; further, if Elodea is supposed to be part of the water body's ecosystem, eradication would be damaging to that ecosystem, possibly aggravating the situation further, leading to a continuation of the deterioration of lake health.

After review and investigation of all factors discussed in this report, it is the opinion of the ASWCD, and corroborated by its project team, that the lake's nutrient and sediment levels must be addressed. This will not only improve the health of Sand Lake, but will also lessen and/or eliminate suitable habitat for Elodea, along with removal and/or lessening of the nutrients coming into the lake.

During interviews and work between the project team, experts have also noted that unless the water quality and sedimentation issues are dealt with, the Elodea will return.

The chart below illustrates potential cost difference between several of the options:

| Method | Location | Total Cost |
|---|---|---|
| Microbes, CWR in lake and canal (includes extensive monitoring throughout the process, efficacy evaluation and documentation) | Lake & Canal | $ 100,000 - 120,000 |
| Large-Scale Suction Dredging | Canal | $ 35,000 - 50,000 |
| Large-Scale Suction Dredging | Lake (shoreline) | $ 75,000 - 200,000 |
| Selective suction dredging with diver | Canal | $ 100,000 - 150,000 |
| Selective suction dredging with diver | Lake | $ 200,000 - 275,000 |
| Heavy Equipment Dredging | Canal | $ 100,000 - 175,000 |
| Heavy Equipment Dredging | Lake (shoreline) | $ 250,000 - 500,000 |
| Alum, Plant Control Only | Canal | $ 15,000 - 20,000 |
| Alum, Plant Control Only | Lake | $ 35,000 - 50,000 |
| Fluridone, whole-lake herbicide | Canal | $ 75,000 - 100,000 |
| Fluridone, whole-lake herbicide | Lake | $ 250,000 - 350,000 |
| Granulated, selective application herbicide, no restoration activities | Canal | $ 10,000 - 15,000 |
| Granulated, selective application herbicide, no restoration activities | Lake | $ 20,000 - 40,000 |
| Drawdown and freeze, spring cleanup | Lake & Canal | $ 40,000 - 60,000 |
| *****Costs are estimation, final costs to be ascertained after proper procurement process(es) - Cost is only for treatment and does not include permitting or public process costs** | | |

## 8.1 Management Plan: Short Term

Short-term there are several methods that will be utilized to keep the Elodea under control, not interfering with the floatplanes, and begin restoration of the lake.

1. The ASWCD is currently assessing costs and hoping to find a way to cost-effectively use a suction dredge as early in spring as possible. If we are able to secure volunteers and equipment for this task, we would start at the outlet and remove material throughout the canal. If this proves cost-effective and effective in application, work would continue out into the lake, along the shoreline from approximately mid-point of the lake. It is in these sections of shoreline that there are elodea populations that are creating dense mats and interfering with use of the lake.

2. The ASWCD is evaluating the option of lowering the level of the lake to expose the elodea 'hotspots' to freezing over the winter. The pros and cons of lowering the level of the lake 6-feet needs to be discussed with the property owners:

- The lake level would be lowered by mid-October which would allow muck to freeze over the winter. In spring or Chinook Winds weather, the ASWCD, property owners, and volunteers can easily remove the dead elodea or more easily clean their slips. This is a benefit because it kills the entire plant and root system, removes all of that biomass rather than it being added to the biomass/sediment in the lake already. Sand Lake is 100% stocked fish, there are no reproducing fish in the lake, aside from the pike formerly present, which were able to reproduce in part because of their love of overgrown vegetation. In the most drastic extreme, the entire fishery can be eliminated and be rebuilt, as ADF&G fully accomplished after the Rotenone® treatment. In a more realistic scenario, the fish will be virtually unharmed, they will live within the temporarily lowered lake. The ASWCD's Fisheries Biologist confirms this (see appendices).

- Planes and boats in the canal would have to use slips within the lake itself for September and October, but as soon as freeze-up and adequate snow accumulation, their planes on skis could easily 'move back home', requiring cooperation and support between property owners.

- The lowering of the level is low-tech and inexpensive, but will take a significant amount of time (see the calculations within the options section re: drawdown), the lake would be lowered 6-feet so the lowering of the level would have to start by September 1, 2013.

- The recharging of the lake to full 86.5-foot depth again can happen in one breakup season, but also may not be fully recharged until after the following year's breakup season, depending on snow pack. Normally, Sand Lake's only recharge periods are during breakup and once the rainy season begins, the rest of the year there is generally enough water-loss through natural losses such as evaporation that precipitation and use are near equal or less which may cause the lake to not fill to its maximum of 86.5 feet.

## 8.2 Management Plan: Long Term

The ASWCD in partnership with the stakeholders, make the following determination for a long-term and maintenance plan for Sand Lake:

- ***Implement a Lake Association***, which the ASWCD can facilitate.
- Employ regular monitoring of lake health.
- Work with ADEC to establish a TMDL for sediment/nutrient loads.
- Educate and incentivize property owners to reduce nutrient load.
- Work with MOA to reduce nutrient load.
- Work with MOA to increase or modulate storm water flow into the lake.

## 8.3 Action/ Management Plan

The ASWCD will proceed with the above management plan immediately after reaching consensus in the community and a clear path forward, subject to funding availability. The Lake Association should be formed as soon as property owners are able, this is the single most important factor going forward and the fulfillment of the lake's need for monitoring and maintenance on a regular basis.

## 8.4 Ongoing Monitoring and Maintenance

The ASWCD will continue to monitor Sand Lake closely with what funds are made available. At the completion of this project, and in partnership with the Lake Association, it would be prudent for the ASWCD or the Lake Association to set up a restricted fund, to be made available for maintenance and any issues that may arise with the lake over the next decade.

Lake associations or other property owner-based lake groups are a productive way to establish ongoing maintenance and monitoring of lake health. The ASWCD can partner with the association or group to provide training in all elements the association or group should know. The association or group will have the ability to mobilize the association or group and the ASWCD quickly to address any issue that arises in the future, and the association or group, will be responsible to monitor and coordinate for the long-term care of the lake.

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## 10 Appendices

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2. DOWL HKM, Drainage Systems to Sand Lake

3. DOWL HKM Watershed w/Topo, Watershed, and ADF&G Monitoring Sites

4. David Kaplan, Fisheries Biologist, Report with Attachments

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2. Wildlife Observations Data, 2010

3. Biological Sampling, 2009-2010

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5. Mapping of Monitoring Sites / GPS Points

6. Environmental Assessment, Pike/Rotenone® Effort, 2009

7. Rotenone® Monitoring Data, 2009-2010

8. Sand Lake Historic Stocking Records

9. Freshwater Invertebrates Information

10. Area Management Report for the Recreational Fisheries of Anchorage, 2009 and 2010

11. Region 2 Stocking Plan

12. Anchorage Lake Fish Species

13. Landowner's Guide to Fish Habitat Conservation and Restoration Practices

14. Lake Stocking Policy

15. Salmon Hatcheries in AK

**D: Historical Hydrology and Soils Information**

1. USGS Water Quality & Bathymetry of Sand Lake, 1976

2. Kincaid Estates Hydrology Study, 2004

3. Sand Lake Groundwater Survey, 2010

4. USGS Hydrology & Water Quality Reports

5. Alaska Dept. of Natural Resources Hydrologic Reports

6. NRCS Soils Report, 2012

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