

Aquatic floristic inventory of Walker Lake and Lake Selby, Gates of the Arctic National Park and Preserve



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Introduction

The premise of this work is to survey lakes in Alaska National Park units for the aquatic non-native plant *Elodea*, commonly called waterweed, and to document the native aquatic vegetation. *Elodea* is an underwater perennial plant that lives in lakes, ponds and shallow wetlands. In Alaska, *Elodea* is considered an invasive non-native plant. *Elodea* has been found in several regions of the state including sites near Cordova, Anchorage, Kenai, Fairbanks, and Manly Hot Springs (AKEPIC 2020). It can rapidly develop dense monospecific stands that fill entire lakes and waterways and change the structure of the ecosystem (Josefsson 2011). *Elodea* species are capable of causing large-scale changes to freshwater ecosystems, including changes in stream-flow dynamics, water nutrients, dissolved oxygen content, and invertebrate assemblages (Buscemi, 1958, Pokorny et. al. 1984). Its rapid growth often results in the displacement of native plants, which can significantly alter fish and aquatic invertebrate habitat, and interfere with recreational activities. It has a high potential to invade aquatic ecosystems because it thrives in cold, slow-flowing waters and non-flowing systems where light is not limited due to turbidity.

Elodea readily reproduces through dispersal of stem fragments and vectors such as float planes, boats and trailers. Because park visitors can travel by boat, floatplane and foot from regions of Alaska with infestations, *Elodea* poses a significant threat to National Park Service (NPS) aquatic ecosystems. Known infestations occur near Alaska's National Park Units and known float plane paths visiting NPS units originate from infested waters, making transport of *Elodea* into the parks a possibility. Early detection of new infestations is key to control invasive aquatic plants. Delays in detection and rapid response greatly increase the costs of control and greatly reduce the likelihood of successful mitigation or elimination of the harmful effects of the invasion (Pfauth and Sytsma 2005).

There is currently no standardized methodology of detecting and quantifying aquatic vegetation, including *Elodea*. Most protocols adopted by regional aquatic managers rely on systematic rake toss methods, meandering surveys, or a combination of both (Hauxwell 2010, J. Morton *pers. comm.*). The National Park Service (NPS) Regional Office and the Alaska Center for Conservation Science (ACCS) entered into a cooperative agreement to develop a statistically robust method for detecting the presence of *Elodea* in lakes at-risk of infestation. As part of this funding effort, we tested and refined field methods to maximize sampling coverage and the probability of detecting *Elodea* within budget and time constraints. Additionally, the methods document the abundance and diversity of native aquatic vegetation, which is poorly studied in Alaska.

This report summarizes the methods and results used to detect *Elodea* and document the aquatic vegetation of two lakes in Gates of the Arctic National Park and Preserve (GAAR). Previous reports (Fulkerson and Shaftel 2019) and forthcoming reports focus solely on the methods and probability of detecting *Elodea*.

Methods

Lake Selection

The NPS identified lakes deemed 'at highest risk' based on a vector analysis that incorporated float plane visitation rates from *Elodea* infested regions and generalized access by the general public. For the 2019 season, the NPS highlighted the need for sampling in GAAR. Specifically, Walker Lake, Narvak Lake, and Lake Selby within GAAR. Lake Selby consists of two lakes that

are connected, the northern portion is Lake Selby while the lower portion is Narvak Lake. We denote both lakes as one sampling unit and follow the local name, Lake Selby. We accessed both lakes by float plane from Bettles. To minimize the potential risk of *Elodea* transport into GAAR, we first surveyed Bettles pond, where local aviation charters originate from.

Sample Point Selection

The sample size (points per lake) fell between minimum and maximum sampling goals that we established given our constraint of sampling each lake in one day with a crew of three observers. A field day included approximately 10 hours of lake time, with one and a half hours spent on set-up and break-down of field gear (transporting gear to the lake and inflating/deflating boats), clean-up (decontaminating all equipment), and eDNA sample processing. We developed our maximum sampling target by deciding that, on the smallest lakes (< 3 km perimeter), we could sample points spaced every 50-m using three observers in one day. For large lakes, sampling every point spaced 50-m around the lake shore was not possible as two of the largest lakes had more than 200 sampling points (Walker Lake and Lake Selby; Table 1). To sample as many points as possible with at least two observers in one field day, our minimum sampling target was defined as at least 33% of all 50-m sampling points with two observers. For the larger lakes, sampling points were spaced at 100 to 150-m intervals around the lakeshore, which equated to 50% or 33% of all sample points, respectively.

We used the Alaska Hydrography Database of lakes as the base for sample point generation. Using ArcMap, a sample site was randomly selected on the perimeter, then additional points were added based on the distance stated above. Due to unsafe weather conditions we were unable to sample 146 of 283 (51%) sample sites at Walker Lake, the northern section of the lake.

All point data were processed and are available publicly on the Alaska Exotic Plants Information Clearinghouse (AKEPIC) data portal (<http://accs.uaa.alaska.edu/invasive-species/non-native-plants/>).

Table 1. List of lakes surveyed with Elodea Occupancy modeling methods in the GAAR region.

Lake Name	Date Surveyed	Coordinates	Lake Perimeter (km)	Sample Site Distance (m)	Number of Sample Sites
Bettles pond	Aug 1, 2019	66.88°, -151.48°	4.37	100	44
Walker Lake	Aug 2-4, 2019	67.12°, -154.35°	59.62	200	283
Lake Selby	Aug 6-9, 2019	66.88°, -155.66°	42.7	200	205

Sampling at the Sample Point

Sampling occurred within the littoral zone, the defining area with suitable habitat for aquatic plants. However, the littoral zone can be variable between and within each lake, where some zones are narrow (<1m wide) or very wide and large and can span acres. Generally, the littoral zone ranges from less than 1 m and up to 4.5 m deep but also corresponds to light penetration. Rarely are lake depths readily available for Alaska lakes and sampling the entire lake is inefficient for early detection of *Elodea*. Furthermore, we have observed broken fragments of *Elodea* and other aquatic vegetation float and be pushed to the leeward sides of shores, where we assume a higher chance of establishment and survival. Additionally, *Elodea* has been easily detected when sampling closer to shore in more shallow waters (Fulkerson and Shaftel 2019).

To consistently sample the littoral zone, sample points were 10m² designated plots that originate at the edge of the shoreline. Vegetation was first observed visually by thoroughly paddling in watercraft within the plot by viewing over the side of the boat, then a rake sampling method was performed. However, visual search methods for aquatic vegetation was not always successful from our prior sampling due to light reflectance, wave action, cloudy water conditions amongst, and low accuracy of plant species identification (Fulkerson and Shaftel 2019). A sampling rake consists of two garden rake heads welded together and attached to a 30 foot rope and allows for a rapid sample over a large area at a low cost (Johnson and Newman 2011). Rake samples were completed at each sampling point within the 10m² plot by throwing the rake from shoreline or while wading at ~0.5 m depth, or to their personal comfort level. The rake was thrown three times in different directions: at 45°, 90°, and 135°, using the shoreline as the baseline (Figure 1). The rake was tossed as far as possible and retrieved, allowing the rake to scrape and sample the submerged vegetation. Vegetation brought to the surface was identified and inspected for *Elodea*.



Figure 1. Directions of rake throws within the littoral zone.

In some situations, sampling was conducted from the boat instead of the lakeshore. For example, excessive shrub growth or downed trees prevented observers from reaching the lake shore at some sample points. In other instances, snag hazards, such as high cover of submerged boulders or logs, prevented observers from dragging the rake along the lake bottom. We found the most effective alternative for retrieving submerged vegetation was to drop the rake over the side of the boat as close to the sampling point as feasible and drag the rake for approximately one meter and repeated three times in three different areas of the plot.

To increase efficiency and to sample all of the designated sampling points, we implemented a visual observation only where no rakes were tossed when certain criteria were met. Specifically, when the lake substrate was identifiable (definitions below), aquatic vegetation was less than 10% vegetation cover, and all vegetation could be identified to genus level. This allowed for rapid and efficient sampling when there was high water visibility and low vegetation cover.

We included a meandering search at strategically-selected locations along the lakeshore using best professional judgement and including, but not limited to, access points, boat launches, float plane docks, private property, and the leeward side of each lake. It is assumed these areas would have the highest probability of harboring incipient *Elodea* populations since they are vector points. The search method involved boating slowly, less than 3 knots, around the areas while viewing over the side of the boat to inspect vegetation. Drop or full rake tosses were used to inspect suspicious vegetation or areas.

Habitat Covariates

The probability of *Elodea* occurrence in lakes is influenced by several water quality parameters, such as light, temperature, pH, and nutrients (Mielecki and Pieczynska 2006, Carey et al. 2016). We collected a suite of physical habitat and water quality parameters that we hypothesized would affect the detection and occurrence of *Elodea* but also characterize suitable habitat for aquatic plants.

Physical habitat parameters were collected at each sampling point. The lake physical parameters include: underwater wood cover, floating vegetation cover, submersed vegetation cover, dominant substrate, littoral lake depth, bottom visibility, rake pull effort (Table 2). Cover for wood, floating vegetation, and submersed vegetation were ocular estimated using five cover classes: 0: absent, 0% cover; 1: sparse, 1–25% cover; 2: moderate, 26–50%; 3: heavy, 51–75% cover; and 4: very heavy, >75% cover. The dominant substrate was selected from five categories: fines (less than 0.06 mm, not gritty), sand (0.06 – 2 mm, gritty between fingers), gravel (2 – 64 mm, ladybug to tennis ball size), cobble (64 – 250 mm, tennis ball to basketball size), and boulder (250 – 4000 mm, basketball to car). Littoral lake depth was measured ten meters from the shoreline using a handheld digital depth sounder. Visibility to the lake bottom was recorded as yes or no ten meters from the shoreline.

Table 2. Physical lake parameters collected for covariate association

Physical Parameter	Values	Covariate Type
Wood Cover	0—4	Detection
Floating vegetation cover	0—4	Detection
Submersed vegetation cover	0—4	Detection
Dominate substrate	Fines, sand, gravel, cobble, small boulder, boulder	Occupancy
Littoral lake depth	feet	Occupancy
Visibility to bottom	Yes/No	Detection

Native Aquatic Vegetation and Data Synthesis

We documented aquatic vegetation using a presence/absence method as this was a time efficient and information rich approach compared to our previous efforts of ocular estimation in 10 m² sample grids. Presence/absence survey methods have become a reliable method for quantifying aquatic vegetation and can be consistently repeated for monitoring as they don't rely on subjective cover estimation (Titus 1993, Madsen 1999, Capers et al 2007, Mikulyuk 2010, Madsen and Wersel 2017). This approach can allow for detection of species richness, species dominance/rareness, associations, and changes over time for monitoring needs.

Vegetation was notably sparse at GAAR lakes, allowing us to use the presence/absence approach at every sample site. At Eyak Lake, we recorded vegetation at 50% of sites due to limited botanist availability. At each point location submerged and floating vegetation was quantified with the rake fullness effort (Hauxwell et al. 2010, Johnson and Newman 2011, Madsen and Wersel 2017). New floating, emergent, or submerged species encountered traveling between points were documented. Water clarity was clear at the majority of sites allowing botanists to do an additional ocular survey to find additional submerged species. Some species, such as *Isoetes* sp., *Eleocharis* sp., and

Equisetum fluvatile, were not caught in the rake as they were typically found in shallow areas closer to the bank or were rare.

Aquatic plant vouchers were collected and curated. Vouchers are stored at the University of Alaska Anchorage Herbarium with associated data and images available online at www.pnwherbaria.org. We summarized vegetation data by habitat type with descriptive statistics and made comparison with median boxplots.

eDNA

Sampling environmental DNA (eDNA) has been successful in detection of *Elodea* and other invasive plant species (Gantz et al. 2018). Though recent NPS efforts show *Elodea* eDNA occurs at very low rates that detection is not as sensitive compared to animal taxa (T. Simmons pers. comm.). The efficacy and detection rates are currently under a controlled study by the USFWS that will provide guidance on the best time of year, location, and sample size needed for *Elodea* detection.

We followed eDNA sampling guidelines provided by T. Simmons at the National Park Service and D. Menning at the USGS Alaska Science Center. Samples were only collected from NPS water bodies. Water samples were collected from two sample sites at Walker Lake and Lake Selby, specifically one sample near the outlet and if possible, one sample in the area of the primary public access point. With water flowing out of the lake, it is reasonable to assume eDNA would accumulate in these areas. Three replicates were collected from each sample site with 500 mL of water from the middle of the water column and topped off to the bottle lip with Longmire Buffer solution. Samples were delivered to the USGS Alaska Science Center after the field work for filtration and analysis. Collection of eDNA samples in 2018 required the filtration in the field by using a filter flask and a peristaltic pump and. This required up to 45 minutes to sample one lake. The new approach was simpler and allows the lab analysis to perform the filtration through more fine filters. Locations of eDNA samples are summarized in Table 3.

Table 3. List of eDNA water samples and replicates by lake

Lake Name	Replicate Sample IDs	Coordinates	Location Type
Walker Lake	WAL 1-A, WAL 1-B, WAL 1-C	67.12572, -154.33263	outlet
Walker Lake	WAL 2-A, WAL 2-B, WAL 2-C	67.0587, -154.315968	Popular camping area
Lake Selby	NAR 3-A, NAR, 3-B, NAR 3-C	66.8555, -155.6883	outlet
Lake Selby	NAR 4-A, NAR 4-B, NAR 4-C	66.85337, -155.6866	outlet

Diatom Diversity

As part of our work documenting aquatic vegetation in Lake Selby and Walker Lake, we collected diatoms along the lake margins and in small inlet streams (Table 4). Diatoms are single-celled algae that live in every body of water, with cell walls made of opaline silica. They are a diverse group, and have been used in monitoring programs because of their tolerance ranges for a number of environmental variables (eg. pH, nutrients, suspended sediment).

Most samples were collected by scrubbing large gravel and cobble with a small brush and rinsing the algal layer into a centrifuge tube and preserving with 10% formalin. One sample from Walker Lake was collected from a dense mat of macroalgae. In the lab, samples were homogenized and then heated in concentrated nitric acid to digest diatom protoplasm and other organic material,

thereby clearing the diatom frustules for easier identification. Diatoms were then neutralized through a series of rinses with deionized water, concentrated by settling, and then mounted on microscope slides using NAPHRAX mounting medium. Diatoms from each slide were viewed at 1000x magnification under oil immersion and differential interference contrast (DIC), and were identified to species. Relative numbers of each taxon were recorded from slide. Most taxa were imaged with the intention of including them in the University of Alaska Anchorage Herbarium online database.

Table 4. Diatom collection localities in GAAR.

Collection Site	Date	Latitude	Longitude
Walker Lake southeast corner	8/2/2019	67.06917739	-154.276
Walker Lake, East side of lake, north side of peninsula opposite of Swan Island.	8/3/2019	67.12656425	-154.331
Tributary to Walker Lake	8/4/2019	67.1381	-154.405
Walker Lake: west side about 5km north of Swan Island.	8/4/2019	67.13377118	-154.389
Walker Lake southwest corner	8/5/2019	67.06504217	-154.347
Lake Selby: southwest corner of lake.	8/7/2019	66.89693389	-155.664
Lake Selby: Tributary to Narvak Lake, north end of lake.	8/7/2019	66.96645792	-155.614
Lake Selby Outlet	8/8/2019	66.8555593	-155.688
Lake Selby: lower southwest corner of lake.	8/8/2019	66.85278908	-155.705
Lake Selby: north side of lake.	8/9/2019	66.89128155	-155.676

Results and Discussion

Aquatic Vegetation

For descriptive and summary statistics, we lump *Potamogeton alpinus* and *P. gramineus* together, all *Stuckenia* species together, and *Callitriche hermaphroditica* and *C. heterophylla* together. These taxa were not easily differentiated in the field but are differentiated in vouchered material. The alga *Chara* sp. is typically not identified to the species level and left as such. Taxa found at Lake Selby and Walker Lake are summarized in Table 5. A complete list of vouchered aquatic plants is listed in Appendix B.

We relied on characters described by Hultén (1968) and Haynes and Helquist (2000) for identification, but found the characters of leaf tip, fruits, color, and floating leaves to be inconsistent in the field. *Potamogeton alpinus* and *P. gramineus* are difficult to distinguish when young or when fruits are absent. They are also known to hybridize (= *P. xnericius* Hagström), though the frequency of such occurrence in Alaska is unknown. Without fruits, the two taxa are distinguished by leaf vein number and stipule shape where *P. alpinus* has 7–9 veins and blunt stipules compared to *P. gramineus* having 3–9 veins and acute to obtuse stipules. These character traits are not easily seen in the field and better viewed under magnification. Other features to distinguish the two, though not always present, are floating leaves and a reddish tinge in submerged leaves of *P. alpinus*.

Similarly, *Stuckenia* species are difficult to differentiate, where leaf tip shape and fruiting features have been heavily relied on to separate the taxa by notable experts (e.g., Hultén 1968, Haynes and

Helquist 2000). However, we found leaf tip shape to be an unreliable character with the shape being acute to obtuse within a single plant and a majority of plants observed were not fruiting. We separate the taxa in vouchered material following Kaplan (2008). Of the three *Stuckenia* species to occur in Alaska, we found two at both lakes: *S. filiformis* and *S. vaginata*.

Compared to past floristic collections at Walker Lake, we documented all but three species and documented two new species (Table 5). *Callitriche heterophylla*, *P. praelongus*, and *Ranunculus trichophyllus* have been documented at the northern end of Walker Lake. We did not find these taxa in our survey likely because we were unable to survey the north end of the lake. New taxa to Walker Lake were *Chara* sp. and *Isoetes echinospora* (Table 5). There are ten new records of aquatic plants for Lake Selby (Table 5). As with Walker Lake, *P. praelongus* was previously documented in Lake Selby but not detected in this study. *Potamogeton praelongus* is usually associated with deeper water and we may not have thoroughly sampled deeper parts of the lake. Taxa such as *I. echinospora*, *Myriophyllum sibiricum*, *P. foliosus*, *P. pusillus* appear to be new records for GAAR. The *P. pusillus* and *I. echinospora* vouchers currently stand as the northern most distribution of the species.

Table 5. Summary of taxa found at Lake Selby and Walker Lake with 'X'. Asterisk (*) denote taxa that have been documented by others not from this study. Shaded occurrences are new records for the targeted lake.

Taxa	Lake Selby	Walker Lake
<i>Arctophila fulva</i>	X	
<i>Callitriche heterophylla</i>	X	*
<i>Callitriche hermaphroditica</i>	X	
<i>Chara</i> sp.	X	X
<i>Equisetum fluvatile</i>	X	X
<i>Hippuris vulgaris</i>	X	X
<i>Isoetes echinospora</i>	X	X
<i>Myriophyllum sibiricum</i>	X	
<i>Potamogeton foliosus</i>	X	
<i>Potamogeton alpinus</i>	X	X
<i>Potamogeton gramineus</i>	X	X
<i>Potamogeton pusillus</i>	X	
<i>Potamogeton praelongus</i>	*	*
<i>Potamogeton richardsonii</i>	X	X
<i>Ranunculus reptans</i>	X	X
<i>Ranunculus trichophyllus</i>	X	*
<i>Sparganium angustifolium</i>	X	X
<i>Stuckenia filiformis</i>	X	X
<i>Stuckenia vaginata</i>	X	X
<i>Subularia aquatica</i>	X	

Aquatic vegetation was observed more frequently in Lake Selby compared to Walker Lake (Figure 2). Nearly 75% of the sites at Walker Lake contained no aquatic vegetation compared to 47% of Lake Selby sites. Species richness ranged from one to seven species at each site at Walker Lake and one to eight species at Lake Selby. When aquatic vegetation was present, the majority of sites

(17%) at Walker Lake had less than three taxa present compared to 41% of sites at Lake Selby (Figure 2).

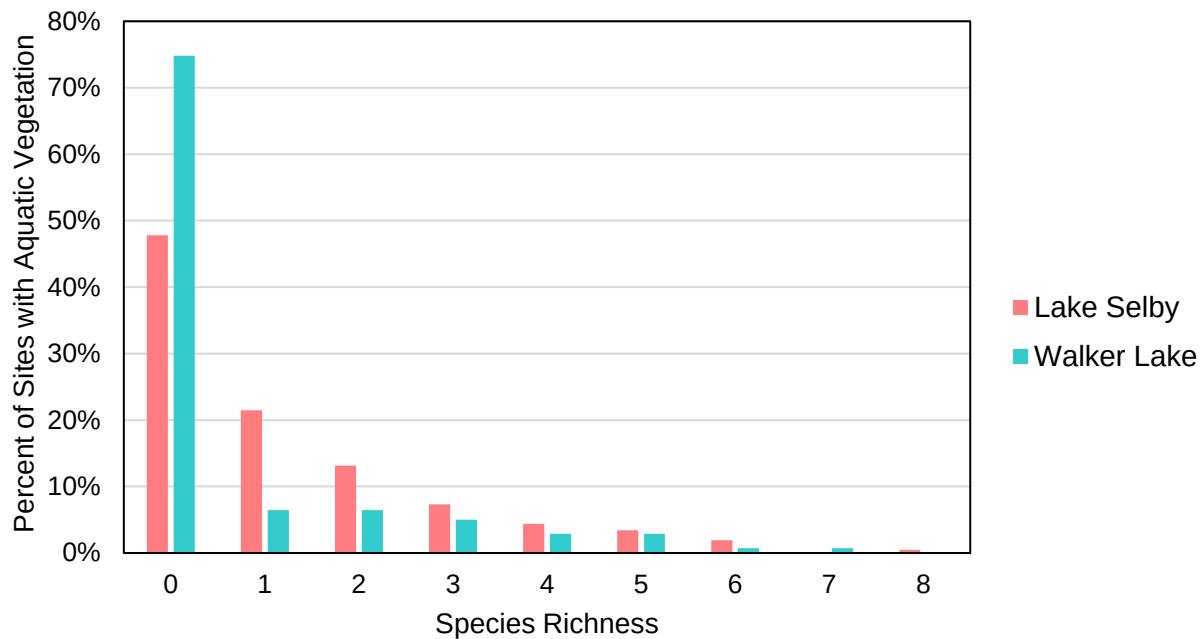


Figure 2. Frequency of aquatic vegetation at Lake Selby and Walker Lake.

The most frequently observed species at Walker Lake were *Stuckenia* spp. (18%), *P. gramineus/alpinus* (12%), and *Chara* sp. (12%; Figure 3). Other taxa were moderately rare and occurring less than 9% to 1.4% of the time. Similarly, *P. gramineus/alpinus* was found most frequently at Lake Selby, with nearly 30% of sites being occupied (Figure 3). *Callitriche* and *Stuckenia* species were the next most commonly observed at 21 and 15% respectively. The remaining taxa were observed at or less than 8% of sites.

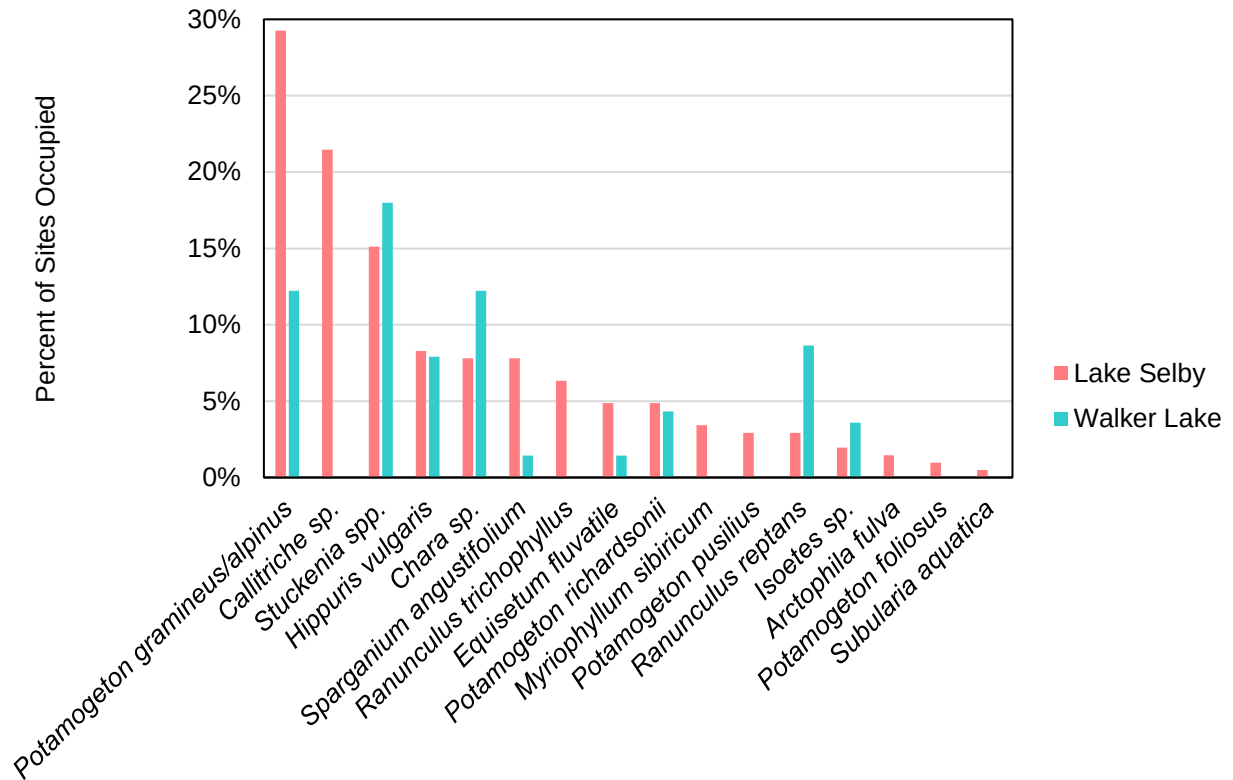


Figure 3. Frequency of observed aquatic plant species at Lake Selby and Walker Lake.

Depth did not have a significant explanatory factor in aquatic vegetation presence/absence, species richness, or submerged vegetation cover at the GAAR lakes (Figure 4; Figure 5). Aquatic vegetation was found between 2 and 17.5 ft water depth at 10m from shore, though the median depth was approximately 3 ft. While more shallow sites would have a larger littoral zone than deeper sites, the number of species or abundance of vegetation did not increase with larger littoral zones (Figure 4; Figure 5).

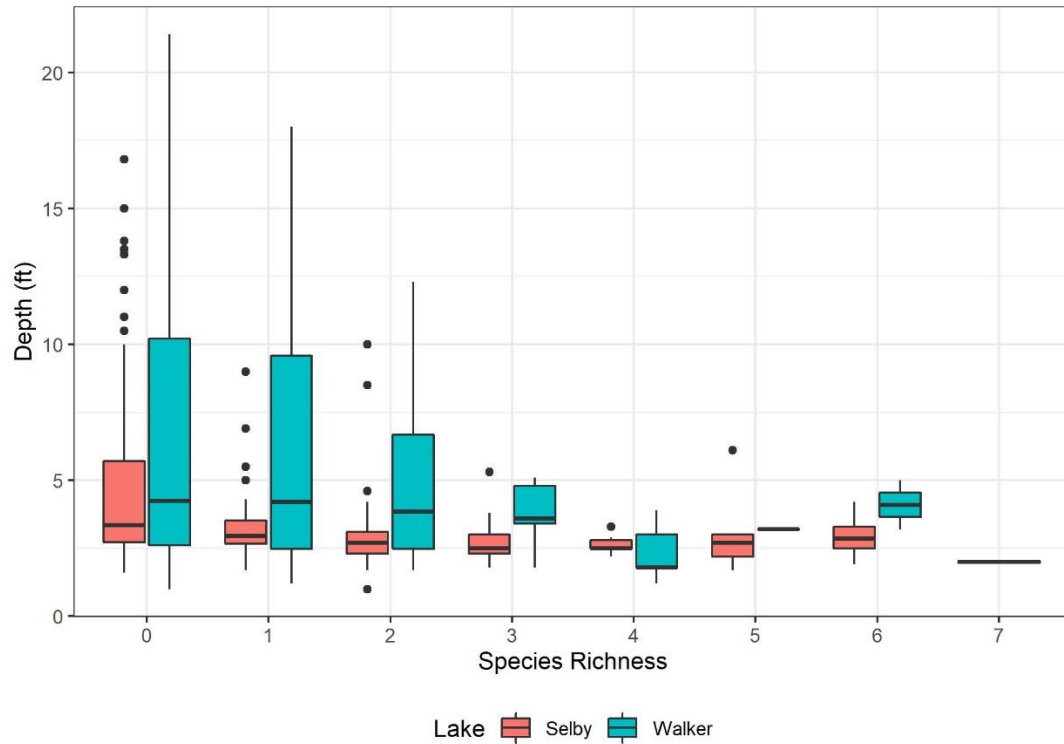


Figure 4. Aquatic plant species richness at water depth measured at 10m from shore at Lake Selby and Walker Lake.

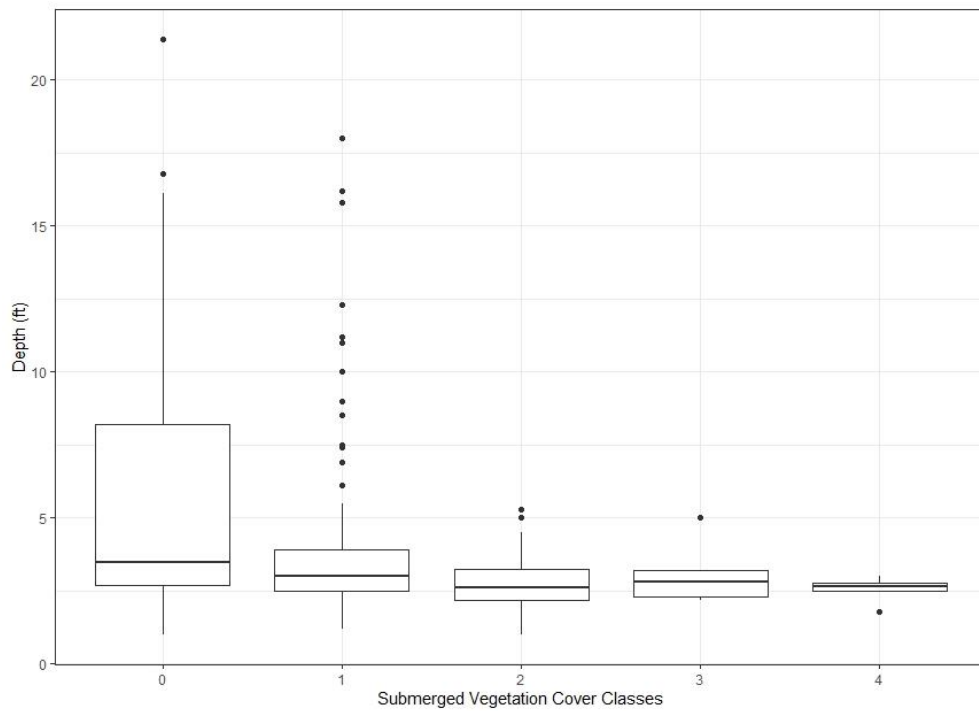


Figure 5. Submerged vegetation cover class by water depth measured at 10m from shore at GAAR lakes. Submerged vegetation cover classes are 0: 0% cover; 1: 1-25% cover; 2: 26-50%; 3: 51-75% cover; and 4: >75% cover.

Medium substrate was associated with aquatic plant presence, richness, and submerged vegetation cover (Figure 6, Figure 7). Aquatic plants were found more frequently in sand and gravel substrates than in the fines, cobble and boulder substrate categories (Figure 6). Additionally, when aquatic vegetation was present, the sand and gravel substrates had higher submerged vegetation cover compared to the other categories (Figure 6). A similar pattern was found with aquatic plant species richness, where fines, sand, and gravel dominated sites tended to have higher richness (Figure 7). Generally, Walker Lake and Lake Selby had the same pattern of species richness by substrate except for opposing values in the fines and sand substrate. Walker Lake had higher species richness in fines substrate and lower richness in the sand substrates (Figure 7).

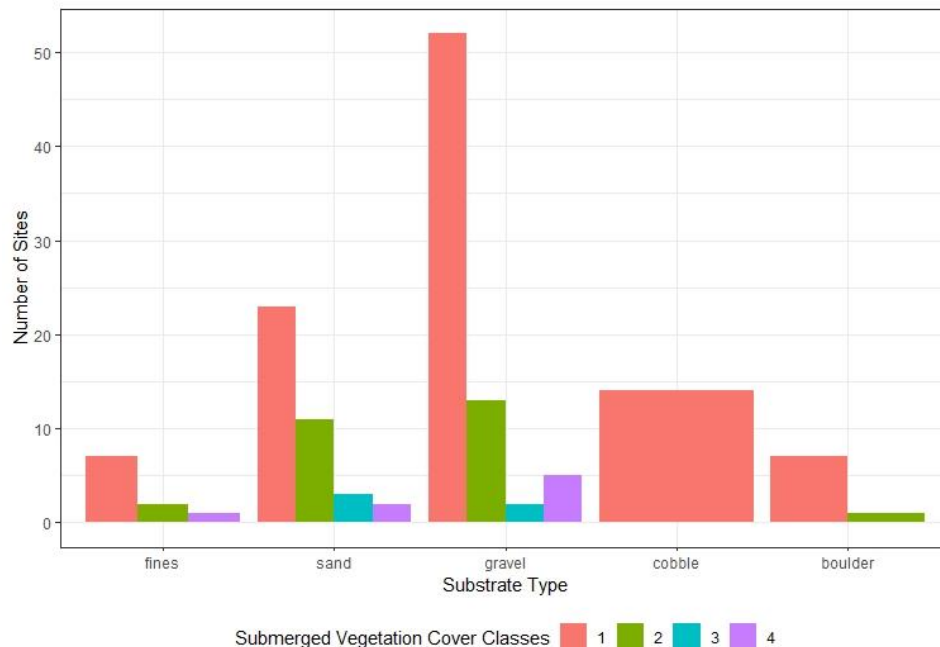


Figure 6. Frequency of vegetation cover values observed with lake substrate type.

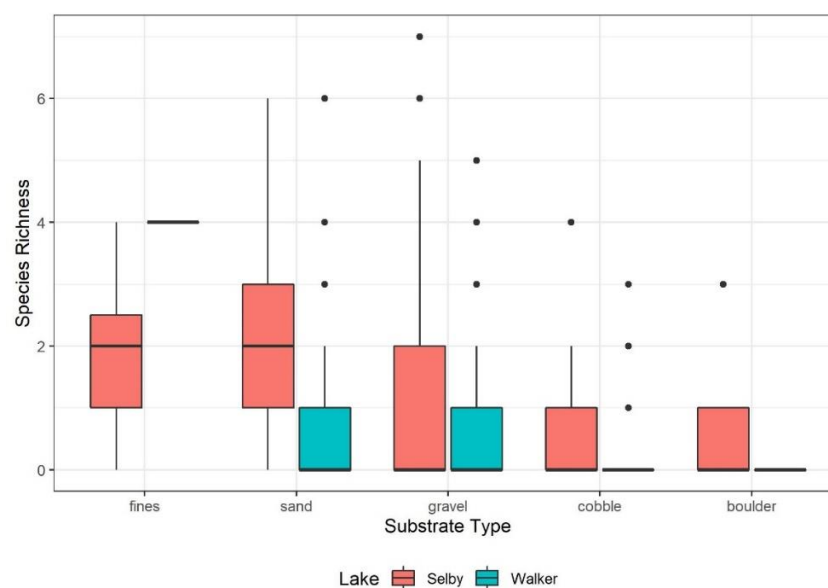


Figure 7. Aquatic plant species richness by lake substrate types in GAAR lakes.

Aquatic vegetation was infrequent at Walker Lake and primarily found on the west side of the lake, south west corner, and a small cove east of Swan Island (App. Figure. 4). The greatest amount of vegetation was found just south of Swan Island. Abundance did not necessarily correlate with species richness, as the two coves north and east of Swan Island had the greatest diversity (App. Figure. 5). The south lake of Lake Selby generally had a higher abundance of vegetation, specifically the north east section of this portion of the lake (App. Figure. 7). The north lake (Narvak Lake) of Lake Selby was the lake inlet and had the highest abundance of vegetation (App. Figure. 7). Both areas had notable amounts of high floating vegetation cover and had high species richness (App. Figure. 8). The notable species rich areas were the connecting inlet of Narvak/Selby Lakes and the east side of the lake. Notably uncommon taxa *Potamogeton pusillus* and *P. foliosus* were restricted to these areas of the lake.

Given these areas have high suitable habitat for aquatic vegetation, these areas would be most suitable areas for *Elodea* establishment. Furthermore, the north end of Lake Selby with high suitable habitat is also where an inholding occurs and experiences several float plane visits from *Elodea* infested waters during the summer (described below).

Of the variables measured, depth and substrate type were the most explanatory factors in aquatic vegetation presence and distribution. Though not measured or explicitly tested, wave action appeared to be a significant factor on aquatic plant distribution on both lakes. For example, the east and west south sides of Walker Lake had little to no aquatic vegetation and these areas had continual wave action during our survey. Vegetation that was found were in pockets sheltered by rock formations/irregular lake margin. Our general observations of wave action were during and following storm events.

We explored various ordination and cluster analyses of the dataset, however no significant patterns of vegetation communities were apparent, aside from what is summarized above. There may be an ecological, study design and/or statistical explanation for the lack of correlation of species occurrences to the environmental variables measured. Ecologically, aquatic vegetation may have an inherently patchy distribution due to vegetative reproduction or other life limiting traits. If this is the case, then a larger number of data points would be required to sample the range of natural variation in a given lake system, further this sampling should be expanded beyond the littoral zone. Statistically, there may be one or many unmeasured variables with explanatory power that was not measured in our study. For example, this variable could relate to propagule pressure, water clarity, water chemistry (i.e., dissolved nutrients, temperature and pH), herbivory, bioturbation by moose, beavers, river otters, muskrats, waterfowl etc.

Diatom Collections

Over 280 species of diatoms, from 61 different genera were identified from the 10 samples collected. Additionally, 13 taxa could only be identified to genus, and five could not be identified with any certainty. Over 100 of these taxa were recorded from only one of the 10 samples collected and examined, suggesting that the taxa found in these two lakes from this examination was by no means exhaustive. A complete list of taxa are located in Appendix C. List of Diatoms found at Lake Selby and Walker Lake.

Future *Elodea* Survey Recommendations for GAAR

Walker Lake is identified with a high float plane visitation rate by NPS, leading it to higher priority for *Elodea* survey. Indeed, during our four-day survey of Walker Lake, we observed six float plane visits. The frequency of visits we observed appears to be higher than what was estimated from NPS using obtained float plane data. Similarly, though at a lower frequency, Lake Selby had two float plane visits during our four-day survey.

At Lake Selby we visited with the owners of an inholding on the north side of the lake. We provided information on *Elodea* and the current project. The owners were generally positive of the search efforts, were concerned of the environmental impact of *Elodea* and consequences to their inholding if *Elodea* were to be found. The owners make several trips to their inholding during the summer via their float plane that is stationed at Manley Hot Springs. *Elodea* was found within the Manley Hot Springs Slough in 2018. The full extent of the infestation has not been fully mapped at the slough, but the slough is generally used as the float plane runway. Due to the direct or indirect flight from an infested water and the number of seasonal flights, we recommend additional educational outreach to the inholders and an *Elodea* monitoring program for the north side of Lake Selby. This area had a high suitable habitat for aquatic plants and would foster *Elodea* establishment. We suggest a survey conducted at least every three years and following until the *Elodea* is eradicated from Manley Hot Springs. The survey should follow the methods conducted here

The Bettles float plane contractors noted several locations on Walker Lake where they drop off clients and are popular camping areas (Figure 8). We recommend that these high use areas be surveyed for *Elodea* when resources permit as these would be the highest chance of importation.

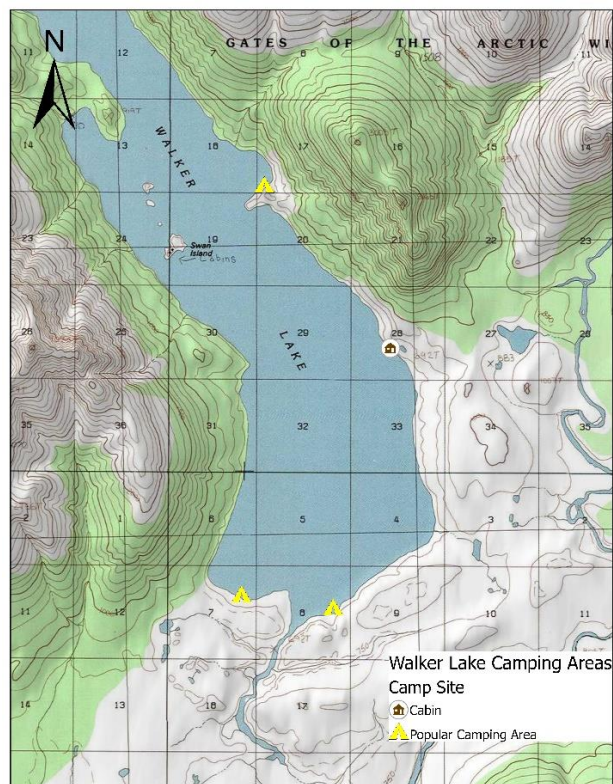


Figure 8. High use float plane activity locations on Walker Lake, GAAR.

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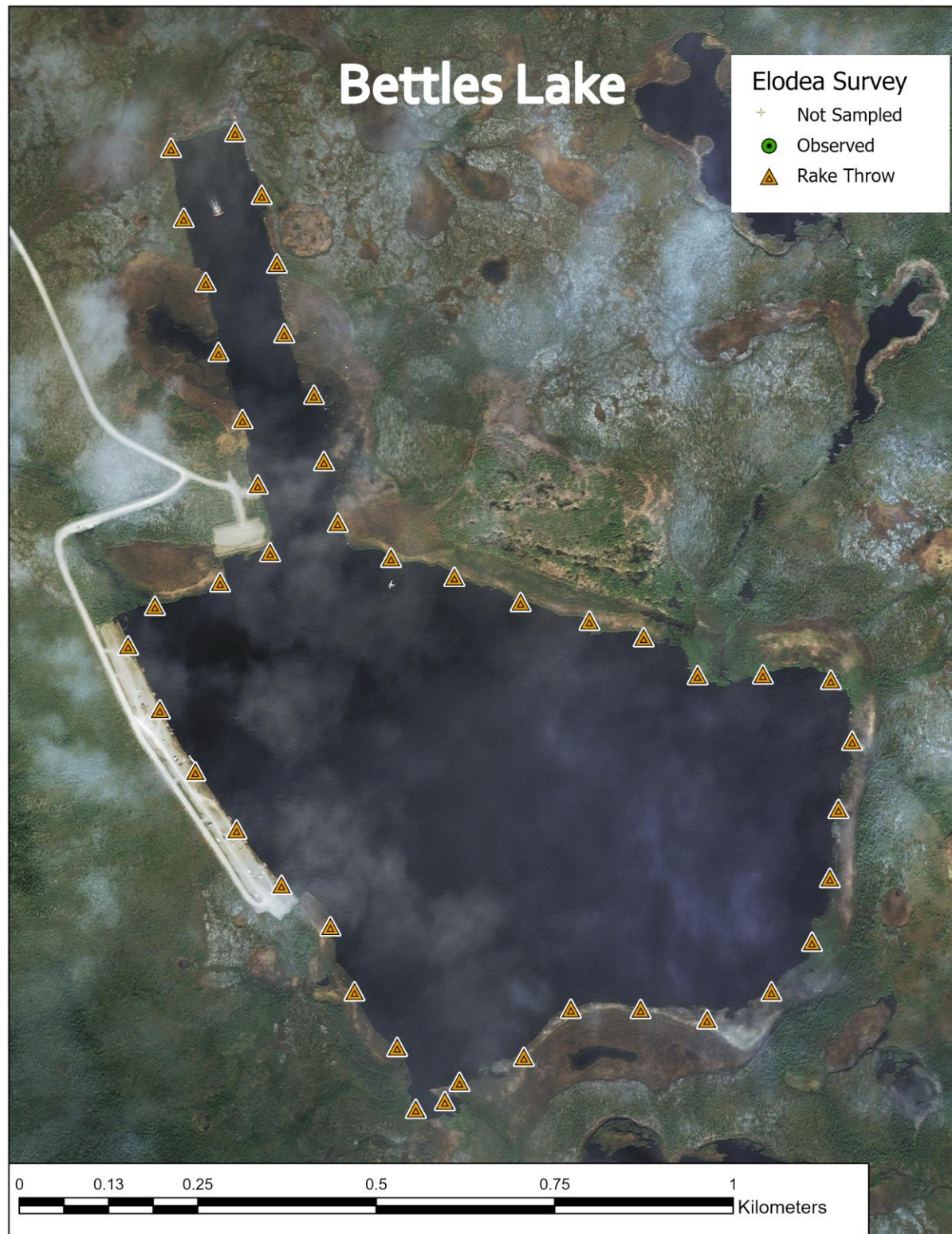
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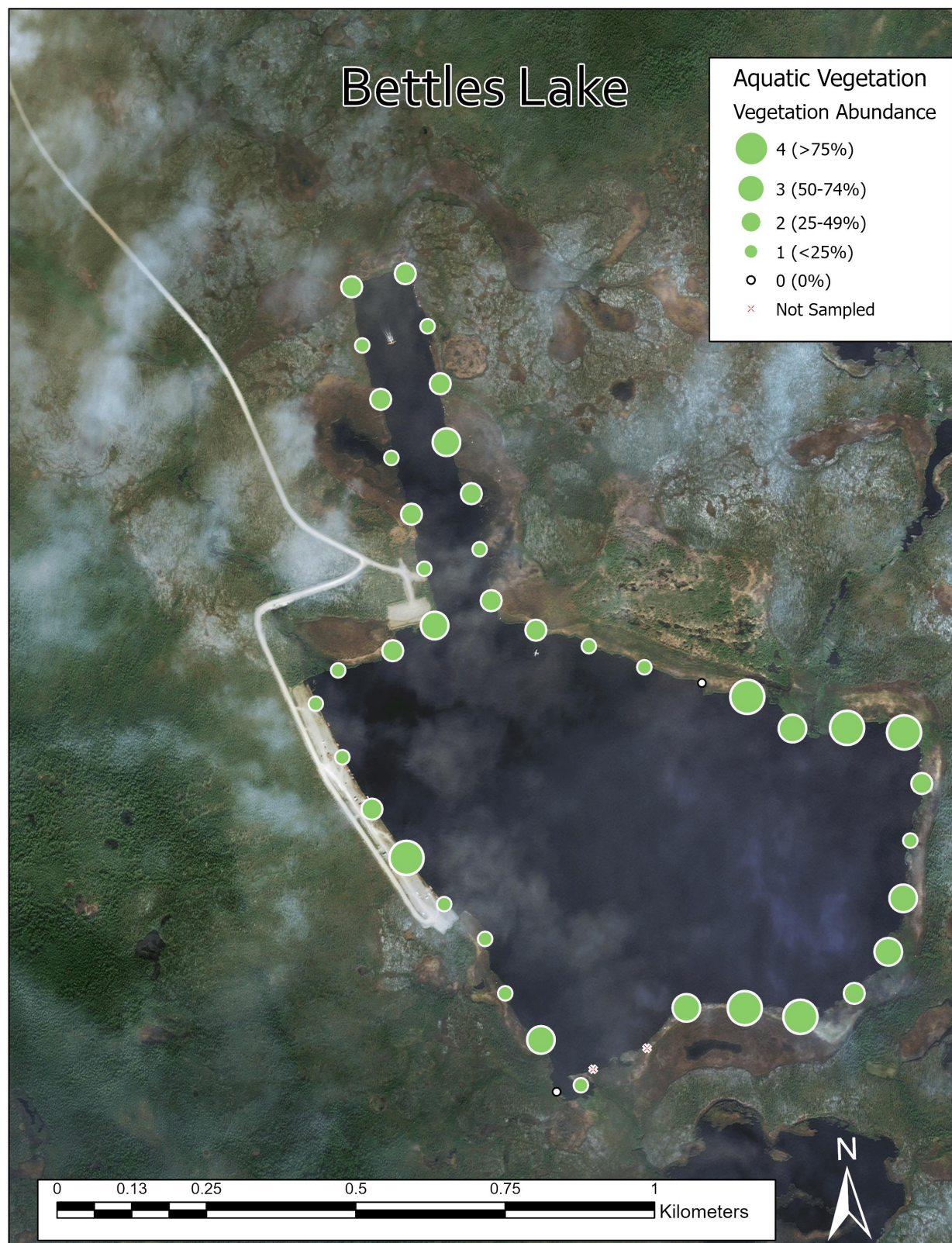
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Appendix A. Maps of Lakes Surveyed in 2019



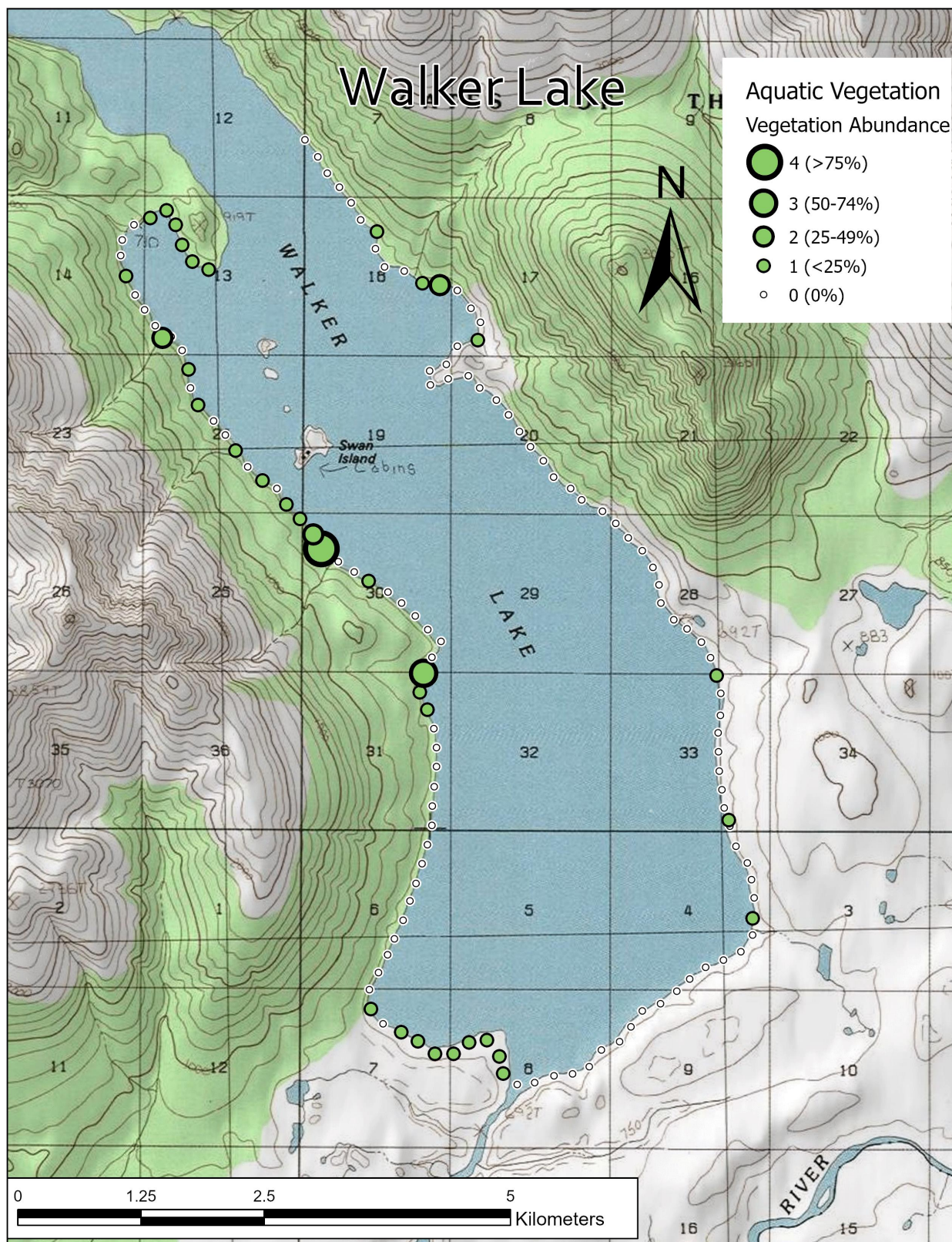
App. Figure. 1. Survey effort of Bettles Lake, Bettles.



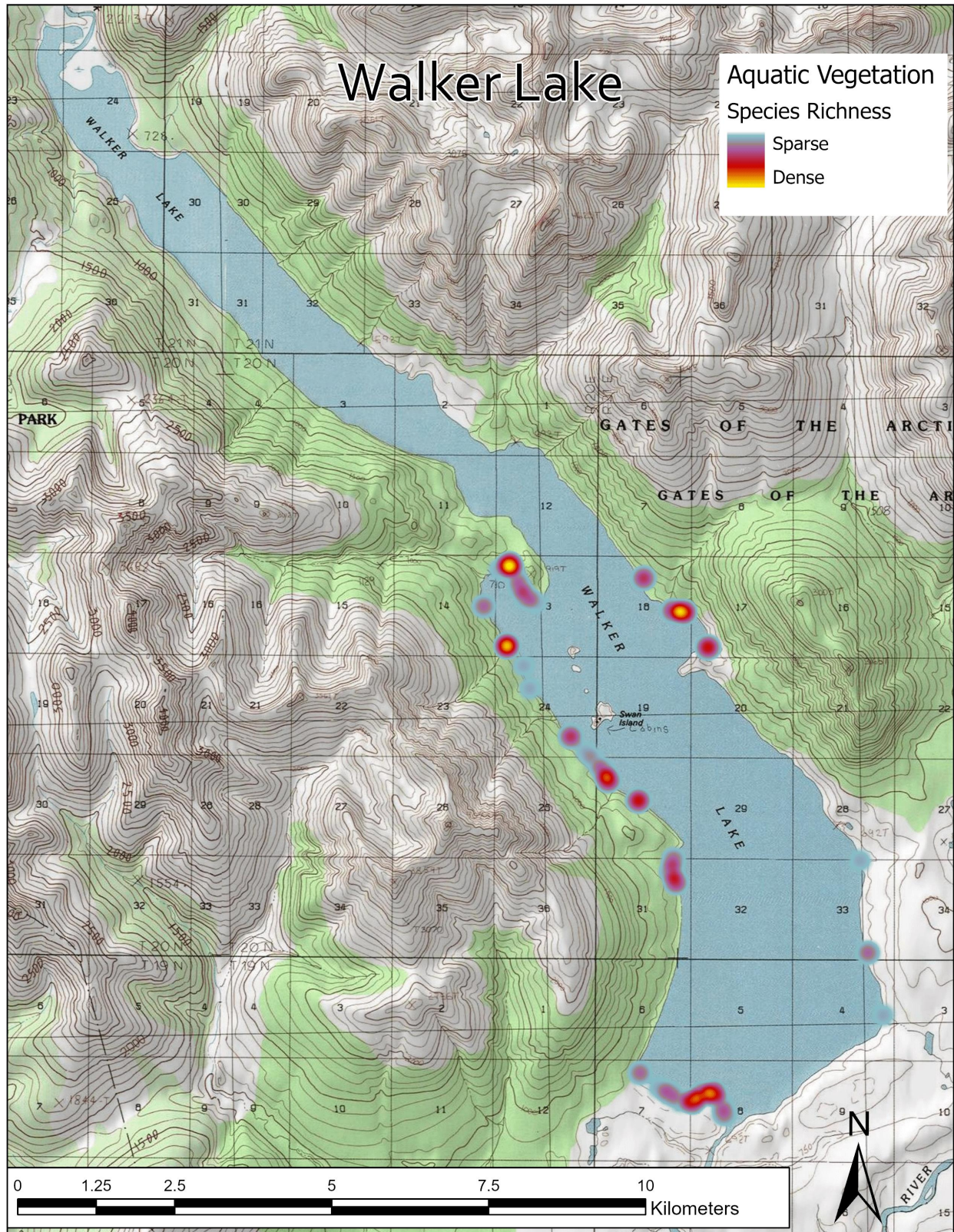
App. Figure. 2. Aquatic vegetation distribution and abundance in Bettles Lake, Bettles.



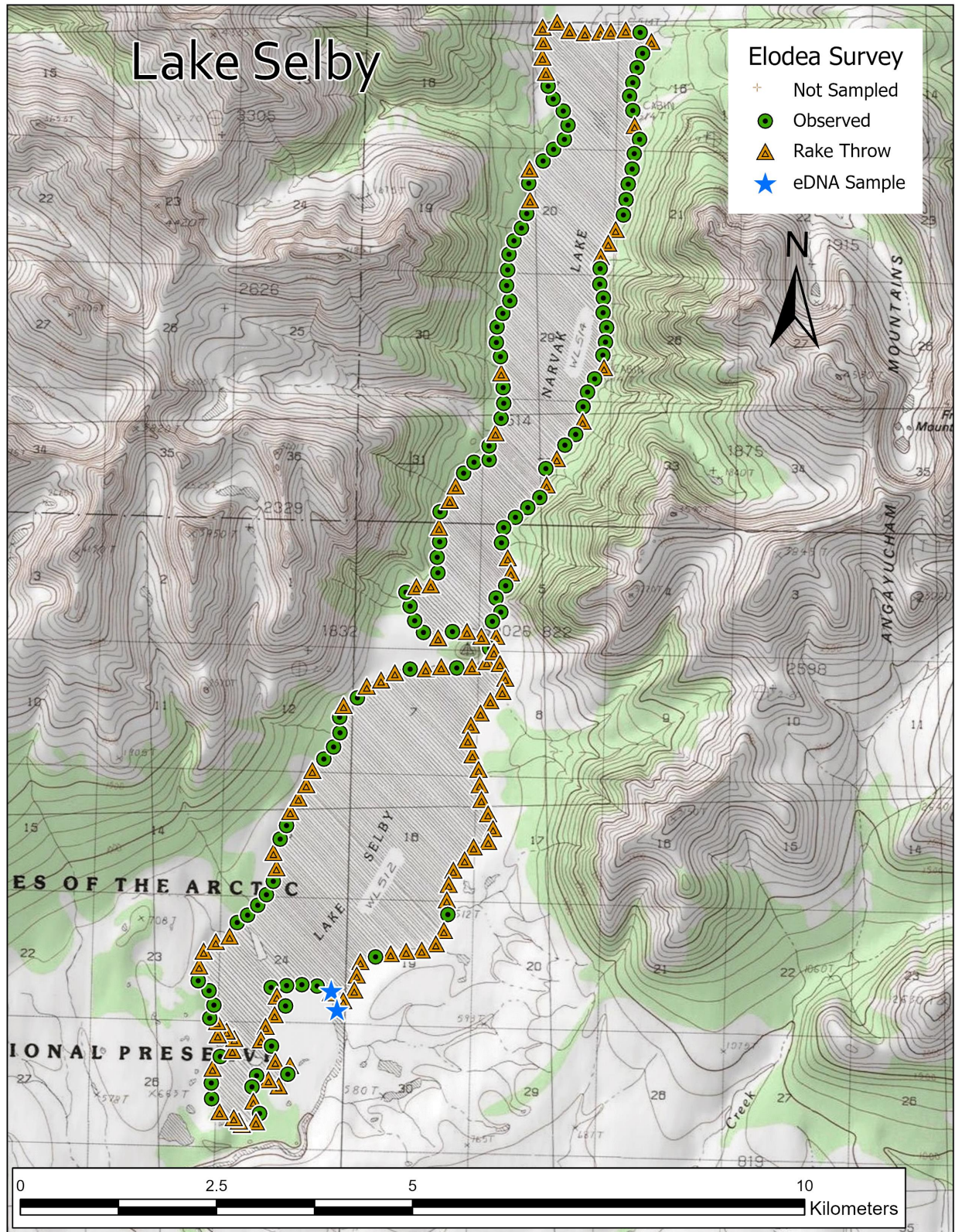
App. Figure. 3. Survey effort at Walker Lake, Gates of the Arctic National Park and Preserve.



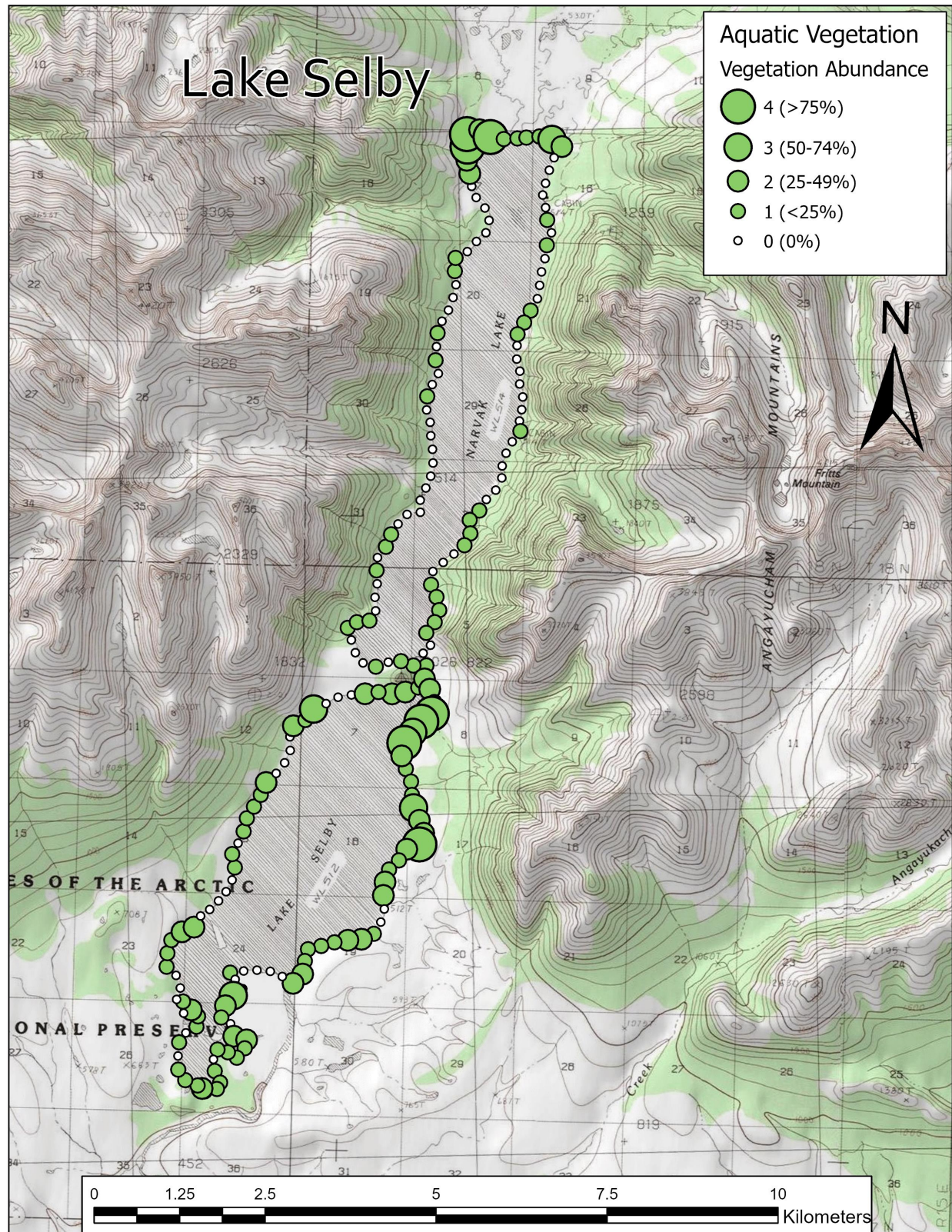
App. Figure. 4. Distribution and abundance of aquatic vegetation at Walker Lake, Gates of the Arctic National Park and Preserve.



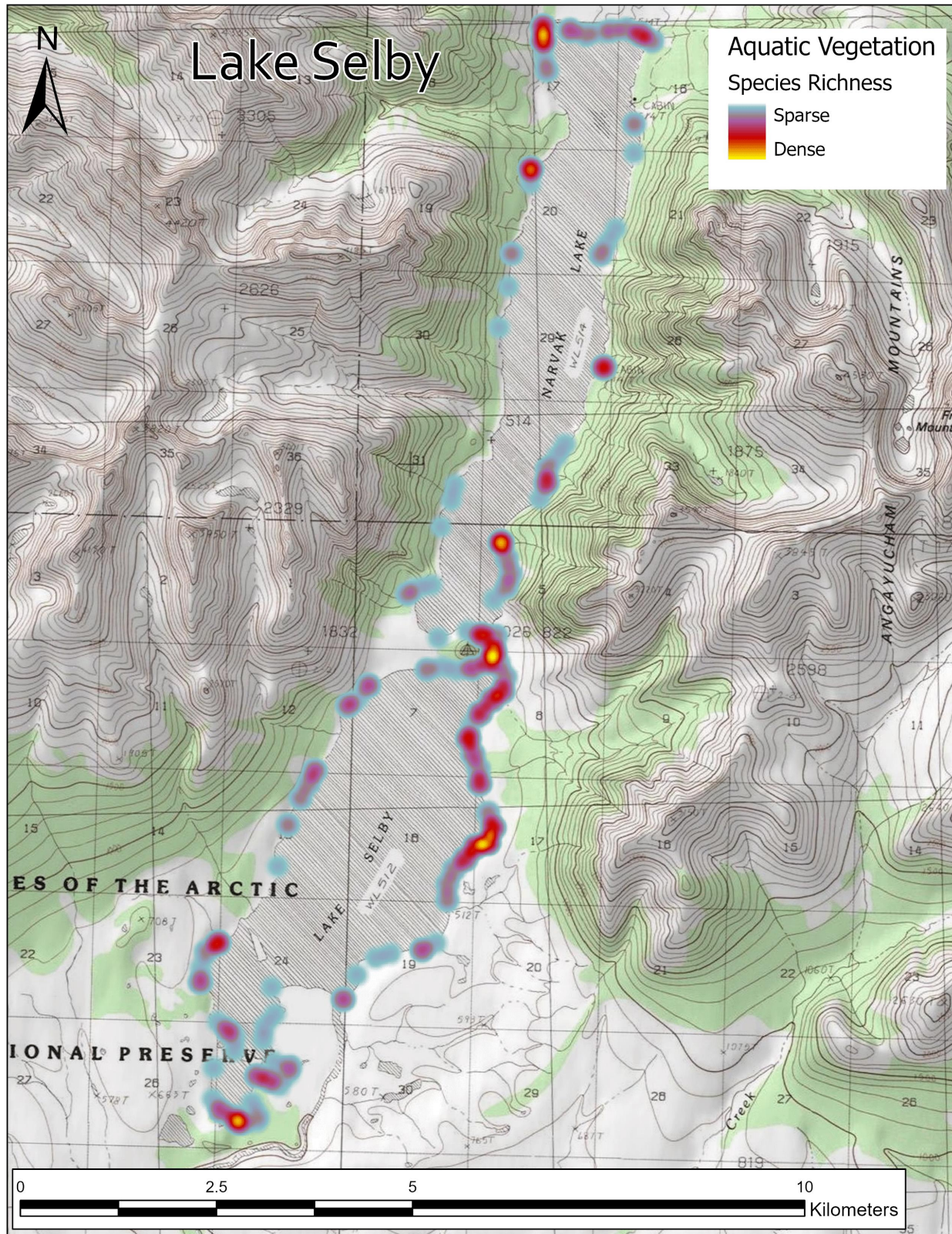
App. Figure. 5. Hot spots of aquatic plant species richness at Walker Lake, Gates of the Arctic National Park and Preserve.



App. Figure. 6. Survey effort at Lake Selby, Gates of the Arctic National Park and Preserve.



App. Figure. 7. Abundance and distribution of aquatic vegetation at Lake Selby, Gates of the Arctic National Park and Preserve.



App. Figure. 8. Hot spots of aquatic plant species richness at Lake Selby, Gates of the Arctic National Park and Preserve.

Appendix B. Vouchered vascular plants and diatom slides curated at University of Alaska Anchorage Herbarium (UAAH)

NPS Catalog #	NPS Accession #	UAAH Accession #	Sci. Name	Collection Date	Collector Number	Water Body	Lat Long
GAAR 22578	GAAR -00254	UAAH 14221	<i>Sparganium angustifolium</i>	8/4/2019	JRF 19-08	Walker Lake	67.12739 -154.32558
GAAR 22579	GAAR -00254	UAAH 14222	<i>Hippuris vulgaris</i>	8/4/2019	JRF 19-09	Walker Lake	67.12739 -154.32558
GAAR 22580	GAAR -00254	UAAH 14223	<i>Stuckenia filiformis</i>	8/4/2019	JRF 19-10	Walker Lake	67.1273904 -154.32558
GAAR 22581	GAAR -00254	UAAH 14224	<i>Potamogeton gramineus</i>	8/4/2019	JRF 19-11	Walker Lake	67.12739 -154.32558
GAAR 22582	GAAR -00254	UAAH 14225	<i>Potamogeton gramineus</i>	8/4/2019	JRF 19-12	Walker Lake	67.132443 -154.33256
GAAR 22583	GAAR -00254	UAAH 14226	<i>Stuckenia filiformis</i>	8/4/2019	JRF 19-13	Walker Lake	67.127912 -154.39941
GAAR 22584	GAAR -00254	UAAH 14227	<i>Potamogeton richardsonii</i>	8/4/2019	JRF 19-14	Walker Lake	67.1279122 -154.399412
GAAR 22585	GAAR -00254	UAAH 14228	<i>Hippuris vulgaris</i>	8/4/2019	JRF 19-15	Walker Lake	67.112346 -154.37016
GAAR 22586	GAAR -00254	UAAH 14229	<i>Stuckenia filiformis</i>	8/4/2019	JRF 19-16	Walker Lake	67.112346 -154.37016
GAAR 22587	GAAR -00254	UAAH 14230	<i>Ranunculus reptans</i>	8/4/2019	JRF 19-17	Walker Lake	67.112346 -154.37016
GAAR 22588	GAAR -00254	UAAH 14231	<i>Stuckenia filiformis</i>	8/4/2019	JRF 19-18	Walker Lake	67.064389 -154.3432
GAAR 22589	GAAR -00254	UAAH 14232	<i>Potamogeton alpinus</i>	8/4/2019	JRF 19-19	Walker Lake	67.063262 -154.32302
GAAR 22590	GAAR -00254	UAAH 14233	<i>Stuckenia vaginata</i> cf.	8/4/2019	JRF 19-20	Walker Lake	67.063262 -154.32302
GAAR 22591	GAAR -00254	UAAH 14234	<i>Equisetum fluviatile</i>	8/4/2019	JRF 19-21	Walker Lake	67.063262 -154.32302
GAAR 22592	GAAR -00254	UAAH 14235	<i>Hippuris vulgaris</i>	8/4/2019	JRF 19-22	Walker Lake	67.063262 -154.32302

NPS Catalog #	NPS Accession #	UAAH Accession #	Sci. Name	Collection Date	Collector Number	Water Body	Lat Long
GAAR 22593	GAAR -00254	UAAH 14236	<i>Potamogeton gramineus</i>	8/4/2019	JRF 19-23	Walker Lake	67.063262 -154.32302
GAAR 22594	GAAR -00254	UAAH 14237	<i>Ranunculus reptans</i>	8/4/2019	JRF 19-24	Walker Lake	67.063262 -154.32302
GAAR 22595	GAAR -00254	UAAH 14238	<i>Stuckenia filiformis</i>	8/9/2019	JRF 19-26	Lake Selby	66.884819 -155.65061
GAAR 22596	GAAR -00254	UAAH 14239	<i>Stuckenia vaginata</i>	8/9/2019	JRF 19-126	Lake Selby	66.88481 -155.6506
GAAR 22597	GAAR -00254	UAAH 14240	<i>Potamogeton pusillus</i>	8/9/2019	JRF 19-27	Lake Selby	66.887874 -155.64729
GAAR 22598	GAAR -00254	UAAH 14241	<i>Potamogeton richardsonii</i>	8/9/2019	JRF 19-28	Lake Selby	66.893718 -155.64538
GAAR 22599	GAAR -00254	UAAH 14242	<i>Stuckenia filiformis</i>	8/8/2019	JRF 19-29	Lake Selby	66.871126 -155.65066
GAAR 22600	GAAR -00254	UAAH 14243	<i>Potamogeton gramineus</i>	8/8/2019	JRF 19-30	Lake Selby	66.871126 -155.65066
GAAR 22601	GAAR -00254	UAAH 14244	<i>Stuckenia filiformis</i>	8/8/2019	JRF 19-31	Lake Selby	66.845199 -155.70561
GAAR 22602	GAAR -00254	UAAH 14245	<i>Ranunculus trichophyllus</i>	8/8/2019	JRF 19-32	Lake Selby	66.881497 -155.64744
GAAR 22603	GAAR -00254	UAAH 14246	<i>Sparganium angustifolium</i>	8/8/2019	JRF 19-33	Lake Selby	66.873071 -155.64417
GAAR 22604	GAAR -00254	UAAH 14247	<i>Potamogeton foliosus</i>	8/8/2019	JRF 19-34	Lake Selby	66.874797 -155.64277
GAAR 22605	GAAR -00254	UAAH 14248	<i>Potamogeton pusillus</i>	8/8/2019	JRF 19-35	Lake Selby	66.85573 -155.6819
GAAR 22606	GAAR -00254	UAAH 14249	<i>Potamogeton alpinus</i>	8/7/2019	JRF 19-36	Narvak Lake	66.902025 -155.66657
GAAR 22607	GAAR -00254	UAAH 14250	<i>Ranunculus trichophyllus</i>	8/6/2019	JRF 19-37	Narvak Lake	66.966737 -155.63407
GAAR 22608	GAAR -00254	UAAH 14251	<i>Myriophyllum sibiricum</i>	8/6/2019	JRF 19-38	Narvak Lake	66.965134 -155.63384
GAAR 22609	GAAR -00254	UAAH 14252	<i>Callitriche hermaphroditica</i>	8/6/2019	JRF 19-39	Narvak Lake	66.9667376 -155.634078

NPS Catalog #	NPS Accession #	UAAH Accession #	Sci. Name	Collection Date	Collector Number	Water Body	Lat Long
GAAR 22610	GAAR -00254	UAAH 14253	<i>Potamogeton richardsonii</i>	8/6/2019	JRF 19-40	Narvak Lake	66.9651342 -155.63384
GAAR 22611	GAAR -00254	UAAH 14254	<i>Stuckenia vaginata</i>	8/6/2019	JRF 19-41	Narvak Lake	66.9651342 -155.63384
GAAR 22612	GAAR -00254	UAAH 14255	<i>Sparganium angustifolium</i>	8/7/2019	JRF 19-42	Narvak Lake	66.9074664 -155.642455
GAAR 22613	GAAR -00254	UAAH 14256	<i>Isoetes echinospora</i>	8/7/2019	JRF 19-43	Narvak Lake	66.9074664 -155.642455
GAAR 22614	GAAR -00254	UAAH 14257	<i>Callitriche heterophylla</i>	8/7/2019	JRF 19-44	Narvak Lake	66.9074664 -155.642455
GAAR 22615	GAAR -00254	UAAH 14258	<i>Subularia aquatica</i>	8/8/2019	JRF 19-45	Lake Selby	66.860886 -155.72144
GAAR 22616	GAAR -00254	UAAH 14259	<i>Potamogeton pusillus</i>	8/7/2019	JRF 19-127	Lake Selby	66.950425 -155.636541
GAAR 22617	GAAR -00254	UAAH 14260	Diatom admixture	8/7/2019		Narvak Lake	66.966457 -155.614118
GAAR 22618	GAAR -00254	UAAH 14261	Diatom admixture	8/4/2019		Walker Lake	67.133771 -154.388589
GAAR 22619	GAAR -00254	UAAH 14262	Diatom admixture	8/8/2019		Lake Selby	66.855559 -155.68839
GAAR 22620	GAAR -00254	UAAH 14263	Diatom admixture	8/8/2019		Lake Selby	66.85278 -155.70462
GAAR 22621	GAAR -00254	UAAH 14264	Diatom admixture	8/4/2019		Walker Lake	67.1381 -154.4051
GAAR 22622	GAAR -00254	UAAH 14265	Diatom admixture	8/5/2019		Walker Lake	67.06504 -154.347109
GAAR 22623	GAAR -00254	UAAH 14266	Diatom admixture	8/9/2019		Lake Selby	66.89128 -155.67591
GAAR 22624	GAAR -00254	UAAH 14267	Diatom admixture	8/7/2019		Narvak Lake	66.89693 -155.66432
GAAR 22625	GAAR -00254	UAAH 14268	Diatom admixture	8/3/2019		Walker Lake	67.126564 -154.33108
GAAR 22626	GAAR -00254	UAAH 14269	Diatom admixture	8/2/2019		Walker Lake	67.06917 -154.275936

Appendix C. List of Diatoms found at Lake Selby and Walker Lake.

Diatoms classified as: Abundant (Abdnt.), Common (Cmn.), Occasional (Occ.), and Rare

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Lat/Long	66.85, -155.70	66.89, -155.66	66.85, -155.68	66.89, -155.64	66.96, -155.61	67.13, -154.40	67.06, -154.27	67.13, -154.405	67.13, -154.38	67.06, -154.34
Date	8/8/19	8/9/19	8/8/19	8/7/19	8/7/19	8/4/19	8/2/19	8/3/19	8/4/2019	8/5/2019
NPS Catalog #	GAAR 22620	GAAR 22623	GAAR 22619	GAAR 22624	GAAR 22617	GAAR 22621	GAAR 22626	GAAR 22625	GAAR 22618	GAAR 22622
UAAH Accession #	14263	14266	14262	14267	14260	14264	14269	14268	14261	14265
Taxon										
Achnanthes obliqua (Gregory) Hustedt			Rare							
Achnanthidium latecephalum Kobayasi						Occ.				
Achnanthidium minutissimum (Kützing) Czarnecki	Occ.	Occ.	Abdnt.	Abdnt.	Cmn.	Abdnt.	Cmn.	Cmn.	Cmn.	Cmn.
Achnanthidium pyrenaicum (Hustedt) Kobayashi				Rare						
Achnanthidium rosenstockii (Lange-Bertalot) Lange-Bertalot							Occ.	Occ.		
Adlafia bryophila (Petersen) Lange-Bertalot			Rare	Occ.		Rare		Cmn.	Cmn.	
Amphora copulata (Kützing) Schoeman et Archibald	Occ.		Occ.	Rare			Rare	Occ.	Occ.	Occ.
Amphora inariensis Krammer		Cmn.	Rare	Occ.			Rare	Occ.		
Amphora pediculus (Kützing) Grunow		Cmn.	Rare	Occ.						
Aneumastis apiculatis (Østrup) Lange-Bertalot							Rare	Rare		Rare
Aneumastus rostratus (Hustedt) Lange-Bertalot			Rare				Rare	Occ.		Occ.
Aulacoseira canadensis (Hustedt) Simonsen			Occ.	Rare						
Brachysira brebissonnii Ross							Occ.			
Brachysira garrensis (Lange-Bertalot et Krammer) Lange-Bertalot	Occ.	Rare	Cmn.							
Brachysira microcephala (Kützing) Compère			Occ.	Cmn.			Cmn.			
Brachysira neoexilis Lange-Bertalot			Cmn.	Occ.			Cmn.	Cmn.	Occ.	

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Brachysira procera Lange-Bertalot et Moser			Cmn.	Occ.		Rare	Occ.			
Brachysira styriaca (Grunow) Ross	Rare		Occ.	Occ.			Rare	Cmn.		
Brachysira vitrea (Grunow) Ross							Cmn.	Cmn.		
Brachysira zellensis (Grunow) Round and Mann	Occ.		Occ.				Occ.	Cmn.	Cmn.	
Caloneis alpestris (Grunow) Cleve				Rare				Rare		
Caloneis bacillum (Grunow) Cleve				Occ.						
Caloneis falcifera Lange-Bertalot, Genkal & Vekhov							Rare			
Caloneis hyalina Hustedt		Rare	Rare							
Caloneis obtusa (Smith) Cleve								Rare		
Caloneis schumanniana (Grunow) Cleve			Rare	Rare				Rare		
Caloneis silicula (Ehrenberg) Cleve							Rare	Occ.		
Caloneis sp. [cf. C. silicula (Ehrenberg) Cleve]			Rare				Rare			
Caloneis sp.								Rare		
Caloneis tenuis (Gregory) Krammer				Rare			Occ.	Cmn.		
Caloneis ventricosa var. truncatula (Grunow) Meister							Rare			
Cavinula cocconeiformis (Gregory ex Greville) Mann & Stickle							Rare			
Cavinula jaernefeltii (Hustedt) Mann et Sickle			Rare	Rare						
Cavinula pseudoscutiformis (Hustedt) Mann and Stickle							Rare			
Cavinula vincentii Antoniadis and Hamilton			Rare							
Ceratoneis recta (Skvortzow & Meyer) Iwahashi					Rare					
Cocconeis klamathensis Sovereign		Cmn.		Occ.						
Cocconeis placentula sensu lato Ehrenberg	Rare	Abdnt.	Occ.	Occ.		Rare	Occ.	Occ.	Occ.	Occ.
Cocconeis pseudolineata (Geitler) Lange-Bertalot						Occ.				Occ.
Cocconeis sp.		Cmn.		Occ.						

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Cyclotella bodanica var. lemanica (Müller) Bachmann								Rare		Rare
Cyclotella distinguenda Hustedt								Rare	Occ.	Occ.
Cymbella amplificata Krammer					Occ.		Rare	Rare		
Cymbella arctica (Lagerstedt) Schmidt							Rare			
Cymbella blinnii Bahls		Occ.								Occ.
Cymbella botellus (Lagerstedt) Schmidt							Occ.			Occ.
Cymbella cleve-eulerae Krammer							Occ.	Occ.		
Cymbella cosleyi Bahls			Rare	Cmn.		Rare	Cmn.	Cmn.	Cmn.	Cmn.
Cymbella designata Krammer			Occ.	Rare			Occ.	Occ.		Occ.
Cymbella nr. diversistigmata Krammer			Rare							
Cymbella excisiformis Krammer	Occ.			Occ.						
Cymbella hantzschiana Krammer		Occ.					Occ.			Occ.
Cymbella hantzschiana var. borealis Krammer			Occ.	Occ.						
Cymbella laevis Naegeli		Occ.					Occ.	Occ.		Occ.
Cymbella mexicana (Ehrenberg) Cleve				Rare						
Cymbella neocistula Krammer	Occ.	Occ.	Occ.	Rare			Occ.	Occ.		Occ.
Cymbella neocistula var. islandica Krammer	Occ.	Occ.		Cmn.						
Cymbella neoleptoceros Krammer							Occ.			
Cymbella proxima Reimer	Rare	Rare	Rare							
Cymbella subarctica Krammer			Occ.	Occ.				Occ.	Occ.	
Cymbella subleptoceros Krammer			Occ.							
Cymbella subturgidula Krammer							Rare			
Cymbella vulgata Krammer			Occ.							
Cymboppleura amphicephala (Naegeli) Krammer				Occ.			Occ.	Occ.		Occ.
Cymboppleura anglica (Lagerstedt) Krammer				Rare			Rare			
Cymboppleura angustata (Smith) Krammer	Occ.		Cmn.	Cmn.			Cmn.	Cmn.	Occ.	Cmn.

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
<i>Cymboppleura angustata</i> var <i>spitsbergensis</i> Krammer				Occ.						
<i>Cymboppleura florentina</i> (Grunow) Krammer							Occ.	Occ.		
<i>Cymboppleura hybrida</i> (Grunow) Krammer			Rare	Rare			Occ.	Occ.		Rare
<i>Cymboppleura incerta</i> (Grunow) Krammer	Occ.		Occ.	Occ.			Cmn.	Cmn.		Occ.
<i>Cymboppleura incertiformis</i> var. <i>linearis</i> (Fontell) Krammer							Rare			
<i>Cymboppleura lanceolata</i> Krammer				Rare				Rare		
<i>Cymboppleura lapponica</i> (Grunow) Krammer				Rare			Rare			
<i>Cymboppleura metzeltinii</i> Krammer							Rare	Occ.		
<i>Cymboppleura percuspidata</i> Krammer				Rare						
<i>Cymboppleura semigibbosa</i> (Patrick & Freese) Lange-Bertalot & Krammer							Rare			
<i>Cymboppleura stauroneiformis</i> (Lagerstedt) Krammer				Rare				Occ.		Rare
<i>Cymboppleura subaequalis</i> (Grunow) Krammer	Rare						Occ.	Occ.		
<i>Cymboppleura subcuspidata</i> (Krammer) Krammer				Rare				Rare		
<i>Delicata delicatula</i> (Kützing) Krammer	Occ.		Cmn.	Cmn.		Occ.	Abdnt.	Abdnt.	Abdnt.	Abdnt.
<i>Delicata</i> sp.							Occ.	Occ.		
<i>Denticula kuetzingii</i> Grunow	Occ.		Occ.	Cmn.		Occ.	Cmn.	Cmn.	Occ.	Occ.
<i>Denticula tenuis</i> Kützing	Occ.	Cmn.	Cmn.	Cmn.		Rare	Abdnt.	Cmn.	Occ.	Cmn.
<i>Diadesmis perpusilla</i> (Grunow) Mann					Occ.					
<i>Diatoma anceps</i> (Ehrenberg) Kirchner				Rare						
<i>Odontidium hyemale</i> (Roth) Kützing					Abdnt.					
<i>Odontidium mesodon</i> (Ehrenberg) Kützing			Occ.	Rare	Abdnt.	Occ.				
<i>Diatoma tenuis</i> Agardh	Rare		Rare	Rare			Occ.	Occ.		Occ.
<i>Didymosphenia geminata</i> (Lyngbye) Schmidt			Rare	Rare						
<i>Diploneis calcilacustris</i> Lange-Bertalot and Fuhrmann			Rare	Occ.						

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Diploneis elliptica (Kützing) Cleve								Occ.		
Diploneis maginestriata Hustedt							Rare	Occ.		
Diploneis oculata (Brébisson) Cleve			Rare							
Diploneis parma Cleve							Rare	Rare		
Diploneis puella (Schumann) Cleve			Rare							
Diploneis sp.										Rare
Encyonema fagedii Krammer	Rare	Occ.	Occ.	Abdnt.	Cmn.	Occ.	Cmn.	Occ.	Occ.	
Encyonema hebridicum Grunow ex Cleve				Rare						
Encyonema lange-bertalotii Krammer					Occ.					
Encyonema minutum (Hilse) Mann				Occ.	Occ.	Occ.	Occ.	Occ.		
Encyonema muelleri fo. ventricosum (Tempère et Peragallo) Czarnecki			Rare	Rare				Rare		
Encyonema norvegicum (Grunow) Mayer			Rare					Occ.		
Encyonema obscurum (Krasske) Mann			Occ.	Occ.			Occ.	Occ.		
Encyonema procerum Krammer			Rare							
Encyonema reichardtii (Krammer) Mann				Occ.		Rare				
Encyonema silesiacum (Bleisch) Mann	Rare	Occ.	Occ.	Abdnt.	Occ.	Cmn.	Occ.	Occ.	Occ.	Occ.
Encyonema ventricosum (Agardh) Grunow							Occ.	Occ.		
Encyonema vulgare Krammer			Occ.							
Encyonopsis alpina Krammer and Lange-Bertalot			Cmn.				Cmn.	Cmn.	Cmn.	
Encyonopsis cesatiformis Krammer							Occ.	Occ.	Occ.	
Encyonopsis cesatii (Rabenhorst) Krammer	Occ.		Cmn.				Occ.			
Encyonopsis czarneckii Bahls	Occ.		Occ.	Occ.		Occ.	Cmn.	Cmn.	Cmn.	Cmn.
Encyonopsis descripta (Hustedt) Krammer			Occ.	Occ.			Occ.			
Encyonopsis hustedtii Bahls				Occ.		Occ.	Occ.			
Encyonopsis montana Bahls			Cmn.	Occ.			Occ.			
Encyonopsis robusta (Hustedt) Bahls							Occ.	Cmn.		

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Encyonopsis stafsholtii Bahls						Rare				
Epithemia sorex Kützing	Rare		Rare	Rare			Rare	Rare		
Epithemia turgida (Ehrenberg) Kützing	Rare	Rare						Rare		Rare
Eucocconeis alpestris (Brun) Lange-Bertalot							Rare	Occ.		
Eucocconeis flexella (Kützing) Meister	Occ.		Cmn.	Cmn.		Cmn.	Cmn.	Cmn.	Occ.	Cmn.
Eucocconeis laevis (Østrup) Lange-Bertalot	Rare		Occ.	Cmn.		Cmn.	Cmn.	Occ.	Occ.	Occ.
Eunotia arcubus Nörpel et Lange-Bertalot	Rare		Occ.				Rare			
Eunotia arcus Ehrenberg				Rare						
Eunotia bilunaris (Ehrenberg) Schaarschmidt					Rare					
Eunotia circumborealis Lange-Bertalot & Nörpel-Schempp										Rare
Eunotia curtagrunowii Nörpel-Schempp & Lange-Bertalot							Rare			
Eunotia elena Lange-Bertalot				Rare	Rare			Occ.	Occ.	
Eunotia implicata Nörpel, Alles et Lange-Bertalot				Rare						
Eunotia incisa Smith ex Gregory				Rare						
Eunotia minor (Kützing) Grunow					Occ.		Occ.			
Fallacia subhamulata (Grunow) Mann							Rare	Rare		
Fragilaria amphicephaloides Lange-Bertalot			Cmn.	Occ.						Occ.
Fragilaria capucina var. gracilis (Østrup) Hustedt					Occ.					
Fragilaria crotonensis var. oregona Sovereign		Cmn.		Occ.						
Fragilaria perdolicatissima Lange-Bertalot & Van de Vijver							Rare	Rare		Occ.
Fragilaria vaucheriae (Kützing) Petersen		Abdnt.	Occ.	Cmn.	Cmn.	Abdnt.	Rare		Rare	Occ.
Geissleria sp.							Rare			
Gomphonema acuminatum Ehrenberg	Rare		Rare							
Gomphonema angustatum (Kützing) Rabenhorst	Occ.			Occ.						
Gomphonema nr. angustum Agardh			Occ.							

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Gomphonema auritum Braun ex Kützing				Rare			Occ.	Occ.		Occ.
Gomphonema bohemicum Reichardt et Fricke				Rare						
Gomphonema brebissonii Kützing				Rare						Rare
Gomphonema coronatum Ehrenberg			Rare							
Gomphonema distans (Cleve-Euler) Lange-Bertalot et Reichardt				Rare			Rare			Rare
Gomphonema drutelingense Reichardt						Rare				Rare
Gomphonema gracile Ehrenberg		Cmn.		Rare						Occ.
Gomphonema kobayasii Kociolek et Kingston	Cmn.		Occ.	Occ.						
Gomphonema lagerheimii Cleve	Occ.		Occ.	Occ.			Occ.	Occ.		Occ.
Gomphonema micropus Kützing				Occ.		Occ.				
Gomphonema minusculum Krasske	Occ.						Occ.			
Gomphonema montanum Schumann							Occ.	Occ.	Occ.	
Gomphonema nathorstii Foged				Occ.						
Gomphonema olivaceoides Hustedt				Occ.						Occ.
Gomphoneis pseudo-okunoi Tuji		Cmn.	Occ.	Cmn.				Occ.		Occ.
Gomphonema olivaceoides var. hutchinsoniana Patrick							Rare			
Gomphonema olivaceum (Lyngbye) Kützing				Occ.						
Gomphonema paludosum Reichardt			Occ.							
Gomphonema parvulum Kützing		Cmn.	Rare	Occ.			Occ.	Occ.		
Gomphonema productum (Grunow) Lange-Bertalot et Reichardt				Rare						
Gomphonema pumilum (Grunow) Reichardt et Lange-Bertalot			Rare		Rare		Cmn.	Cmn.	Cmn.	Cmn.
Gomphonema rhombicum Fricke	Occ.	Occ.	Occ.	Occ.	Occ.					
Gomphonema sagitta Schumann	Rare									
Gomphonema sp.			Occ.	Occ.						
Gomphonema sp. 2							Rare			

<i>Taxon</i>	Lake Selby: sw. corner	Lake Selby: north side.	Lake Selby Outlet	Lake Selby: sw. corner.	Lake Selby: north	Trib. to Walker Lake	Walker Lake se corner	Walker Lake, east side	Walker Lake: west side	Walker Lake sw corner
Gomphonema subclavatum (Grunow) Grunow				Rare						
Gomphonema subtile Ehrenberg							Rare			
Gomphonema truncatum Ehrenberg	Rare		Rare	Rare						Rare
Gomphonema turgidum Ehrenberg		Occ.		Rare						
Gomphonema ventricosum Gregory		Occ.		Rare						Rare
Gyrosigma acuminatum (Kützing) Rabenhorst			Rare							
Halamphora dusenii (Brun) Levkov							Rare			
Halamphora oligotrophenta (Lange-Bertalot) Levkov							Occ.	Occ.		
Hannaea arcus (Ehrenberg) Patrick			Rare	Rare	Cmn.	Cmn.				Rare
Hippodonta nr. capitata subsp. Iberoamericana Metzeltin, Lange-Bertalot & Garcia-Rodriguez			Rare							
Karayevia clevei (Grunow) Bukhtiyarova				Rare						
Karayevia laterostrata (Hustedt) Bukhtiyarova			Rare	Occ.						
Kobayasiella micropunctata (Germain) Lange-Bertalot	Rare									
Lindavia antiqua (Smith) Nakov et al.	Rare		Rare	Occ.		Rare	Occ.	Occ.	Occ.	Occ.
Lindavia intermedia (Manguin ex Kociolek and Revers) Nakov et al. ex Daniels et al.			Rare							Rare
Lindavia michiganiana (Skvortzov) Nakov et al.							Occ.	Occ.		Rare
Lindavia ocellata (Pantocsek) Nakov et al.	Rare		Cmn.	Cmn.			Occ.	Occ.	Occ.	Occ.
Lindavia praetermissa (Lund) Nakov et al.							Rare	Occ.		
Lindavia radiosa (Grunow) De Toni and Forti							Rare	Occ.	Occ.	Occ.
Lindavia rossii (Håkansson) Nakov et al.			Occ.	Rare			Cmn.	Cmn.	Cmn.	Cmn.
Meridion circulare (Greville) Agardh			Rare	Occ.	Cmn.	Occ.				
Microstatus keulbsii (Lange-Bertalot) Lange-Bertalot ?			Rare	Rare						
Navicula angusta Grunow										Rare
Navicula antonii Lange-Bertalot			Rare							Rare

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Navicula arctotenelloides Lange-Bertalot et Metzeltin				Occ.		Occ.				
Navicula aurora Sovereign										Rare
Navicula cryptocephala Kützing	Occ.		Rare			Occ.				
Navicula cryptotenella Lange-Bertalot	Occ.		Cmn.	Occ.			Cmn.	Occ.	Occ.	
Navicula exilis Kützing				Occ.						
Navicula gregaria Donkin								Rare		
Navicula jonssonii Østrup			Rare							
Navicula lanceolata (Agardh) Ehrenberg			Rare							
Navicula lundii Reichardt							Occ.	Occ.		
Navicula phyllepta Kützing										Rare
Navicula pseudolanceolata Lange-Bertalot			Rare							Rare
Navicula radiosa Kützing	Occ.		Occ.	Occ.			Occ.	Occ.	Occ.	Occ.
Navicula radiosafallax Lange-Bertalot						Rare				
Navicula rhychocephala Ehrenberg				Rare				Rare		
Navicula salinarum Grunow			Rare							
Navicula trivialis Lange-Bertalot			Rare							Rare
Navicula upsaliensis (Grunow) Peragallo			Rare							
Navicula ventralis Krasske							Rare			
Navicula vulpina Kützing	Rare			Occ.			Cmn.	Occ.	Occ.	
Navicula wildii Lange-Bertalot			Rare							
Neidium ampliatus (Ehrenberg) Krammer			Rare	Rare			Occ.			
Neidium apiculatum Reimer										Rare
Neidium bisulcatum var. baicalense (Skvortzow et Meyer) Reimer							Rare	Rare		
Neidium calvum Østrup							Rare	Rare		
Neidium hercynicum Mayer			Rare							
Neidium ladogensis (Cleve) Foged		Occ.	Rare							

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Nitzschia alpina Hustedt					Occ.					
Nitzschia amphibia Grunow		Occ.								Occ.
Nitzschia amphibia fo. frauenfeldii (Grunow) Lange-Bertalot								Occ.		Rare
Nitzschia angustata Smith			Occ.	Occ.			Occ.	Occ.		Occ.
Nitzschia dissipata (Kützing) Rabenhorst		Rare	Rare							
Nitzschia fonticola (Grunow) Grunow				Occ.						
Nitzschia fossilis (Grunow) Grunow				Occ.						
Nitzschia linearis (Agardh) Smith			Rare					Rare		
Nitzschia palea (Kützing) Smith			Rare	Occ.						
Nitzschia perminuta (Grunow) Peragallo	Rare	Occ.	Occ.	Occ.	Occ.		Occ.	Occ.		Occ.
Nitzschia recta Hantzsch ex Rabenhorst								Occ.		
Nitzschia vermicularis (Kützing) Hantzsch			Rare	Rare						
Pinnularia biceps Gregory			Rare							
Pinnularia divergens var. subbacillaris Krammer							Rare			
Pinnularia latarea Krammer			Rare							
Pinnularia cf. microstauron (Ehrenberg) Cleve				Rare						
Pinnularia perinterrupta Krammer			Rare					Rare		
Pinnularia subgibba Krammer								Rare		
Placoneis amphibola (Cleve) Cox				Rare						
Placoneis clementoides Hustedt										Rare
Placoneis elginensis (Gregory) Cox							Rare			
Placoneis explanata (Hustedt) Mayama								Occ.		
Placoneis sp.								Rare		
Placoneis neglecta Lowe								Rare		
Planothidium calcar (Cleve) Edlund										Rare
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot		Rare	Rare	Occ.						Occ.

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Planothidium haynaldii (Schaarschmidt) Lange-Bertalot				Rare	Cmn.					
Planothidium oestrupii (Cleve-Euler) Edlund				Occ.						
Platessa conspicua (Mayer) Lange-Bertalot				Occ.						
Psammothidium acidoclinatum (Lange-Bertalot) Lange-Bertalot					Occ.			Occ.		
Psammothidium bioretii (Germain) Bukhtiyarova et Round				Occ.			Occ.	Occ.		Occ.
Psammothidium chlidanos (Honn and Hellerman) Lange-Bertalot	Rare		Rare				Occ.			
Psammothidium daonense (Lange-Bertalot) Lange-Bertalot				Occ.	Rare					
Psammothidium grischunum (Wuthrich) Bukhtiyarova et Round			Rare							
Psammothidium subatomoides (Hustedt) Bukhtiyarova et Round							Occ.			
Psammothidium ventralis (Krasske) Bukhtiyarova et Round			Rare				Occ.			
Pseudostaurosira brevistriata (Grunow) Williams & Round			Rare							Occ.
Pseudostaurosira parasitica (Smith) Morales			Rare							
Pseudostaurosira pseudoconstruens (Marciniak) Williams & Round			Occ.	Cmn.				Occ.		Occ.
Pseudostaurosira robusta (Fusey) Williams & Round										Occ.
Reimeria sinuata (Gregory) Kociolek and Stoermer		Occ.	Rare	Occ.	Cmn.	Abdnt.	Occ.			
Rhoicosphenia abbreviata (Agardh) Lange-Bertalot		Cmn.		Rare						
Rossithidium anastasiae (Kaczmarska) Potapova			Rare							
Rossithidium petersenii (Hustedt) Aboal				Rare	Occ.	Occ.	Cmn.	Cmn.	Cmn.	
Rossithidium pusillum (Grunow) Round et Bukhtiyarova			Rare	Rare						

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Sellaphora bacillum (Ehrenberg) Mann							Rare			Rare
Sellaphora insolita (Manguin ex Kociolek & Reviers) Hamilton & Antoniadis							Rare	Rare		
Sellaphora laevis (Kützing) Mann				Rare			Rare	Rare		
Sellaphora mutata (Krasske) Lange-Bertalot							Rare	Occ.		
Sellaphora pupula (Kützing) Mereschkowsky				Rare				Occ.		
Sellophora pupula var. capitata Skvortzow et Meyer			Rare	Rare			Occ.			
Sellaphora sp.							Rare			
Sellaphora stroemii (Hustedt) Kobayasi			Occ.	Rare						
Stauroneis amphicephala Kützing				Rare						Rare
Stauroneis ancepsfallax Bahls					Rare					
Stauroneis barrowiana Patrick and Freese			Rare							
Stauroneis gracilis Ehrenberg			Rare					Rare		
Stauroneis pax Bahls								Rare		
Stauroneis reichardtii Lange-Bertalot, Cavacini, Tagliaventi, and Alfinito						Rare				
Stauroneis siberica (Grunow) Lange-Bertalot et Krammer			Rare				Occ.			
Stauroneis smithii var. sagitta (Cleve) Hustedt				Rare						
Stauroneis sp.			Rare					Rare		
Stauroneis superkuelbsii Bahls								Rare		
Staurosira construens Ehrenberg		Occ.	Occ.	Cmn.			Occ.			
Staurosira construens var. venter (Ehrenberg) Hamilton			Occ.				Rare			Rare
Staurosirella leptostauron (Ehrenberg) Williams & Round		Rare	Rare	Occ.			Occ.	Occ.		Occ.
Staurosirella leptostauron var. dubia (Grunow) Edlund			Rare	Rare						
Staurosirella martyi (Héribaud) Morales et Manoylov		Rare	Rare	Occ.						

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Staurosirella oldenburgiana (Hustedt) Morales							Occ.			
Staurosirella pinnata (Ehrenberg) Williams & Round		Occ.	Occ.	Occ.			Occ.	Occ.		
Stephanodiscus alpinus Hustedt			Rare	Occ.			Rare	Rare		Rare
Stephanodiscus medius Håkansson				Rare						
Stephanodiscus sp.							Occ.	Occ.		
Surirella linearis Smith			Rare	Rare						
Synedra longiceps Ehrenberg		Occ.								
Synedra rumpens Kützing				Occ.						
Tabellaria fenestrata (Lyngbye) Kützing			Occ.							Occ.
Tabellaria flocculosa Ehrenberg ex Kützing			Cmn.	Cmn.	Rare	Rare	Occ.	Occ.		Cmn.
Ulnaria acus (Kützing) Aboal				Occ.	Rare					
Ulnaria delicatissima (Smith) Aboal and Silva							Rare			Occ.
Ulnaria delicatissima var. angustissima (Smith) Aboal			Cmn.				Occ.	Occ.		
Ulnaria ulna ((Nitzsch) Compère		Abdnt.	Rare	Rare		Rare	Occ.			
Unknown1	Rare									
Unknown2			Occ.							
Unknown3							Rare			
Unknown centric							Rare			
Unknown4								Rare		