

Standard Operating Procedure for *Elodea* Detection in Alaska Lakes



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Introduction

This standalone document focuses on the operating procedures for conducting *Elodea* surveys in Alaska while a separate report includes this content in addition to the biological background of *Elodea*, history of this project, literature review, statistical analysis, and results. Lastly, there is no single method for aquatic invasive plant surveys due to the complexity of waterbodies. The method presented here is one of many possible approaches, however there is statistical support documenting its efficacy.

Early detection of new infestations is key to the efficient and effective control of invasive aquatic plants. Delays in detection and response greatly increase the costs of control and reduce the likelihood of successful mitigation or elimination of the harmful effects of the invasion (Pfauth and Sytsma 2005). *Elodea* has been successfully eradicated from many of Alaska's lakes (AKEPIC 2022), yet untreated, *Elodea* infestations remain as a source of propagules that could be inadvertently transported to other waterbodies in Alaska.

Sampling Method

Lake selection

The prioritization of lakes for sampling depends on the needs and goals of area land managers. Lake prioritization based on vulnerability to *Elodea* is currently being assessed at a near statewide level by Alaska Department of Fish and Game and others with refinement at the regional level. Vulnerability is assessed by identifying vectors and pathways in combination with local and regional knowledge of land managers. Other efforts that have used this method at a smaller scale include the Central Yukon region of Interior Alaska (Boucher et al. 2016) and the Chugach National Forest (K. Mohatt personal communication).

Sample site selection

Determining sampling sites before field work lowers sampling bias and increases efficiency. The '*Elodea* Lake Sampling Stations Toolbox' for ArcGIS Pro 2.0 (or higher) was developed to facilitate a consistent generation of systematic sampling stations. A sampling station is randomly selected along the lake perimeter as a starting location. The toolbox generates additional stations based on the desired distance between sampling sites. The final sequence of sites can be exported to a GPS unit for field navigation. New sampling stations should be created each time the lake is surveyed. The toolbox is available on the ACCS Data Catalog website for use in ArcGIS Pro (a licensed product) however, sampling stations can be generated manually using free applications such as Google Earth or QGIS.

Incipient *Elodea* infestations are more difficult to detect due to the low population size and the spatial heterogeneity of the plants compared to older, well-established infestations that approach monocultures. Increasing the number of sampling stations increases the probability of detection. Based on the *Elodea* detection rates, sampling stations are recommended to be distanced at 50 or 100 meters. However, if resources are limited, sampling sites could be spaced to allow a crew of three to sample an entire lake (or targeted shoreline) in one day or less. We estimate that each site requires 10 minutes to sample, including transit time between sites. Therefore, lakes with less than a 4 km perimeter are suggested to have sampling stations at the 50-meter sampling stations distance. Lakes up to a 9 km perimeter length are suggested to have sampling stations at the 100-meter distance. Larger lakes (>9 km perimeter) may need to be sampled in two days or balanced

with 150-meter sampling stations distance but surveyed in two consecutive years with new sample points. A section of the lake shore may also be targeted, for example sheltered coves or leeward sides of lakes where broken fragments of aquatic vegetation may accumulate, or previously surveyed lakeshores with aquatic vegetation.

Based on the Elodea detection rates, sampling stations should be distanced at 50 meters or 100 meters.

Based on previous experience, a field crew of three can sample up to 100 sites/day (approximately 70 sites/person). A field day is approximately 10 hours, 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) and clean-up (decontaminating all equipment). These 10 hours do not include travel to the lake. Some examples of effort for the lakes listed in Table 1 employing three observers are: Jewel Lake 3.5 hours, Birch Lake 7 hours, and Silver Lake 9 hours. Lakes with perimeters greater than 20 km required up to three days to complete. Note that the observers searched for *Elodea* and dedicated additional time at each site collecting habitat data not included in these operating procedures.

Table 1. A partial list of lakes surveyed with example sampling station distance.

Lake Name	Coordinates	Lake Perimeter (km)	Number of Sampled Sites	Sampling Station Distance (m)
Jewel Lake	61.13, -149.96	1.35	27	50
Sports Lake	60.51, -151.05	2.76	26	50
Beck Lake West	60.72, -151.12	2.82	30	50
Bettles Lake	66.88, -151.48	4.37	44	100
Birch Lake	64.31, -146.66	8.00	80	100
McKinley Lake	60.46, -145.18	8.83	88	100
Silver Lake	61.51, -144.16	10.5	70	150

Survey timing and schedule

Elodea does not fully die back during the winter, making identification possible in any season, however surveys are most effective during the ice-free period between May and September when plants are in a phase of full vegetative growth. Surveying later than September may not be as feasible due to the onset of fall and winter conditions. Surveys conducted as soon as the ice is free have been strongly advocated due to the low abundance of native aquatic vegetation (J. Morton personal communication). Seasonal timing associated with detection rates have not been tested but it is reasonable to assume detection rates may be slightly higher earlier in the season.

Sources of error

The greatest source of error in species occurrence surveys is imperfect detection. Imperfect detection occurs when the target species (in this case, *Elodea*) occurs at the sample site but is not detected. Having a site surveyed by more than one observer can reduce the collection of false negative data (MacKenzie et al. 2018). An observer is an independent person performing the data collection at a sampling station without sharing the data until all observers have completed the data collection at the same sampling station. In our study, *Elodea* was sparse in some sampling

stations and was detected by only one or two of the three observers (Fulkerson and Shaftel 2019). Even in heavily-infested lakes, *Elodea* detection rates were imperfect. Yet the non-detection of *Elodea* was not correlated to any one observer, indicating that observer bias was not the source of error. Using multiple observers increases the likelihood of detecting *Elodea*, thereby decreasing error. Using the multiple observer system is the basis for the field methods presented here.

Multiple observers independently sample the same sample site in the same day shortly after each other. A single observer can be used to sample a site, but using multiple observers increases the probability of detection.

An additional source of error is the misidentification of *Elodea*, which can be mitigated by thorough review of plant identification materials and training. Misidentification of a native aquatic plant for *Elodea* will result in a false positive occurrence, potentially triggering responses from respective land agencies for management and control. Alternatively, misidentification of *Elodea* for a native plant will result in a false negative, resulting in an untreated infestation.

Based on field experience with new staff and interviews with the general public, *Fontinalis* moss species and *Hippuris vulgaris* (common mare's-tail) are the species most commonly confused with *Elodea*. Focusing on the number of leaves attached to the stem, leaf placement, erection, and size are key diagnostic features. Detailed descriptions are outside the scope of this document; however, Morgan and Sytsma (2009) provide helpful guidance for the identification of aquatic plants including *Elodea* species. Lastly, to reduce the misidentification for reporting, high quality photos of specimens suspected to be *Elodea* should be taken at the first sampling station or occurrence. Because *Elodea* is a quarantined plant, the physical collection and transport of *Elodea* in Alaska can only be done with a permit from the Alaska Division of Agriculture, Department of Natural Resources.

Field methods and processing of collected materials

Pre-survey logistics and preparation

Prior to field sampling, observers should review land ownership surrounding the waterbody and obtain necessary permits for access. It is also helpful to coordinate with the local land management agency for cooperative efforts. Sampling stations and maps should be generated in GIS before field work begins. Additional time will be needed for importing sampling stations to handheld GPS, printing maps and data sheets. Before field work, all staff are required to review the Guidelines for Preventing the Spread of Aquatic Invasive Species (USFWS 2018). This guide recommends pre-field work, during, and post field activities to help reduce the spread of invasive species. For remote lakes that require float plane access, we recommend sampling the origin lake beforehand (if not completed recently) to mitigate the potential for introduction of non-native plants to the target lake.

A list of equipment and supplies needed for field work is listed below. The list does not include personal gear.

- 1) Double sided sampling rake with 30ft of rope (see Figure 11)
- 2) Handheld GPS unit
- 3) Data sheets on waterproof paper (e.g., Rite in the Rain No. 8511; or digital field data forms)

- 4) Data sheet holder (e.g., Rite in the Rain Field Binder No.200)
- 5) Waterproof writing instrument
- 6) Maps printed on waterproof paper with sampling station names and/or list of sampling stations
- 7) Waterproof or water-resistant camera
- 8) Aquatic plant identification guides (if needed)
- 9) Polarized sunglasses
- 10) Fieldmaster® Aquavue Underwater Viewer or similar (optional)
- 11) Pack raft and paddle or other watercraft.
- 12) Boat kit (patch kit, pump, straps, etc.)
- 13) Personal Protection Equipment
 - a) Personal Flotation Device
 - b) Bear deterrent
 - c) Medical kit

A sampling rake consists of two garden rake heads welded together and attached to a 10-meter rope. Prefabricated commercial products were not available at the time of publication. However, garden rake heads can be purchased at local hardware stores and provided to welders and metal manufactures for fabrication. The Fieldmaster® Aquavue Underwater Viewer aids in the underwater viewing of material (*Elodea* in this case) by removing sunlight reflection, water ripples, and cuts through some turbidity (Figure 1). Other underwater viewing tubes are commercially available and can be substituted. The Fieldmaster® Aquavue was effective, portable, and easy to use in *Elodea* survey work. Our data is not sufficient to determine efficacy compared to the naked eye but observers generally agreed their confidence in detecting *Elodea* was increased with the viewer. However, the Fieldmaster® Aquavue has a significant drawback of a 12 cm diameter, providing a small viewing area, thus increasing the time to thoroughly search the sampling station area.

Polarized sunglasses are essential for cutting down glare from the water surface allowing for enhanced visual observation. In some cases, such as shallow water or very clear water conditions, observing over the boat with polarized sunglasses may be sufficient and the underwater viewer does not provide additional advantage.

Pack rafts are highly maneuverable and portable (Figure 1); however, surveys can be completed using any non-motorized boat. Drawbacks to using non-motorized watercraft are the physical effort of paddling, especially in windy conditions. Motorized boats can be used but typically need to be beached at each sampling site and thus add time to the survey. Additionally, maneuvering into areas with high abundance of aquatics plants can be difficult. Lastly, motorized boats sit higher above the water surface, making visual observation more difficult.

A data sheet template is located in Supplemental Materials 1 and can be customized by the field staff to meet the needs of the survey. The field team will need to coordinate their survey to ensure that each station is sampled at least twice. For example, each member of a team of three sample two thirds of the sites on a given lake provides sufficient sampling overlap (Figure 2). Because it is difficult to sample a fixed location from a floating craft, sites are most accurately resampled when the second observer follows first observer. With practice, individual observers can navigate to the same site independently.



Figure 1. Observer using the Fieldmaster® Aquavue Underwater Viewer and packraft.



Figure 2. Example of multiple observers each represented with a different color line. Generated sampling stations are green dots. Each observer visits approximately two-thirds of the sampling stations.

Establishment of sampling stations

Standard Operating Procedure (SOP) 1 describes how to use the geospatial rendering of a lake perimeter to generate sampling stations using the *Elodea* Lake Sampling Stations Toolbox in ArcGIS Pro. Sampling stations are a point on the lake perimeter. Because geospatial lake perimeters are not always spatially accurate and water levels fluctuate, staff may need to either manually digitize an accurate lake perimeter in ArcGIS after the generation or manually adjust sampling stations in the office or field.

Supplemental sampling sites should be added to capture points of aquatic plant introduction such as boat and float plane docks and ramps. Observers should use their best judgement when working around water traffic and using rakes in the vicinity of private property and vehicles. Visual observation may be sufficient at these locations. Lastly, leeward sides of lakes are often areas of accumulation of broken aquatic vegetation and windblown debris. We recommend a thorough search of these areas for *Elodea* fragments.

Data collection procedures

Standard Operating Procedure 2 contains step by step instruction of the survey and data collection method. The intent of the procedure is for early detection of *Elodea*. Here we provide some details of the method.

The survey will occur at regularly spaced sampling stations along the lake perimeter within a 10 meter \times 10 meter grid (10 m grid; Figure 3). The observer will perform a visual search within the grid, then sample the lake bottom by throwing a rake from shore in three directions. While navigating to the next sampling station, the observer should search for *Elodea* by looking over the boat. An additional observer will repeat the methods at the sampling station. Supplemental sampling stations are sampled following the same method.

Visual search within the grid

The observer will use a handheld GPS unit to navigate to sampling station. In the field, observers may find the sampling stations fall away from the actual shore line. In these situations, the sampling station location should be repositioned on the shore (Figure 3).

Before beginning the sampling station, the observer evaluates that the location has suitable access and no hazards. The rake sampling section below describes potential hazards. If the shoreline is not accessible or hazards are present, the sampling station should be moved 10 m to the left (when facing the shoreline; counter clockwise in planar view) of the original point. This protocol should be communicated to all observers before commencing sampling that day. If the sampling station cannot be moved, then the station will remain and a rake drop method will be performed from the boat or in extreme hazard cases, the sampling station can be a visual search only.

The 10 m grid should be surveyed from the shoreline at the generated point (Figure 2). Since the sampling stations are a single point only, observers should practice estimating a 10 m grid on land, with 5 meters on each side of the generated point and 10 meters toward the middle of the lake (Figure 2). Knowing the length of the boat can be helpful in the estimation of distance along and off shore.

The survey begins with the observer searching for *Elodea* by looking over the boat and/or using the Fieldmaster® Aquavue within the 10 m grid (Figure 1, Figure 2). Visual observations should occur before throwing the rake since dragging the rake along the lake substrate can increase

turbidity and reduce visibility. The observer will maneuver the watercraft within the grid to ensure the entire grid is observed. Depending on water clarity and vegetation density, the visual survey of the grid can take up to three minutes.

Under conditions of high water clarity, *Elodea* detection rates were comparable between a visual search and rake throwing. High water clarity was defined as the ability to characterize the lake substrate and identify submerged aquatic plants, regardless of depth. If the following criteria for high water clarity condition are met, then the rake survey may be omitted:

1. The lake substrate can be classified to grain size category (e.g., fines, sand, gravel, cobble, etc.)
2. Aquatic vegetation occupies less than 30% of the grid, meaning there is less than 30% canopy cover.
3. Aquatic vegetation can be identified to genus level such that the presence or absence of *Elodea* can be evaluated.



Figure 3. Example of labeled sampling stations spaced 100 meters apart on Carmen Lake. The yellow square delineates a 10 m grid within which a visual search for *Elodea* is performed before the rake is thrown. The white dashed lines show the throw direction of the rake. Note that the ArcGIS Toolbox placed sampling station 'Car_64' on the shore; in this scenario the observer should move the sampling station to the waterline.

Rake Sampling

Rake sampling may be completed by either throwing or dropping a double-headed rake attached to a 10 meter rope; the free end of the rope is held by the observer so that the rake can be retrieved.

Rake throws are made from shore while rake drops are made from the watercraft if hazards are present within the sampling grid. Under either method the rake settles to the lake bottom, and is then retrieved by taking in the rope. In this way submerged vegetation is brought to the surface for inspection.

After the visual search, the observer travels to the shoreline exits the watercraft and navigates to the sampling site. The rake throw will occur from the shoreline at the generated point. The observer will mark their GPS location to document the actual sampling location. Some lake substrates are more stable and observers are encouraged to wade at ~0.5 m water depth into the 10 m grid to gain access to the grid. The rake is thrown three times in different directions: at approximately 45°, 90°, and 135°, using the shoreline as the baseline (Figure 2). Vegetation brought to the surface is inspected for *Elodea*. If *Elodea* is detected, only a single rake throw or drop is needed. Data are recorded (see below), then the observer navigates to the next sampling site.

Obstacles and hazards may prohibit throwing the rake from shore (Figure 4). For example, excessive shrub growth may prevent observers from reaching the lake shore, the lake shore has no public access, the shoreline is unsafe due to floating mats of vegetation, or there are steep drop offs from rocky shorelines. Other situations that impeded rake throws are snag hazards, such as high cover of submerged boulders or trees that prevent dragging the rake on the lake bottom. Lastly, salmon spawning areas (redds) can coincide with sampling stations, which should be visually assessed to minimize disturbance of this habitat.

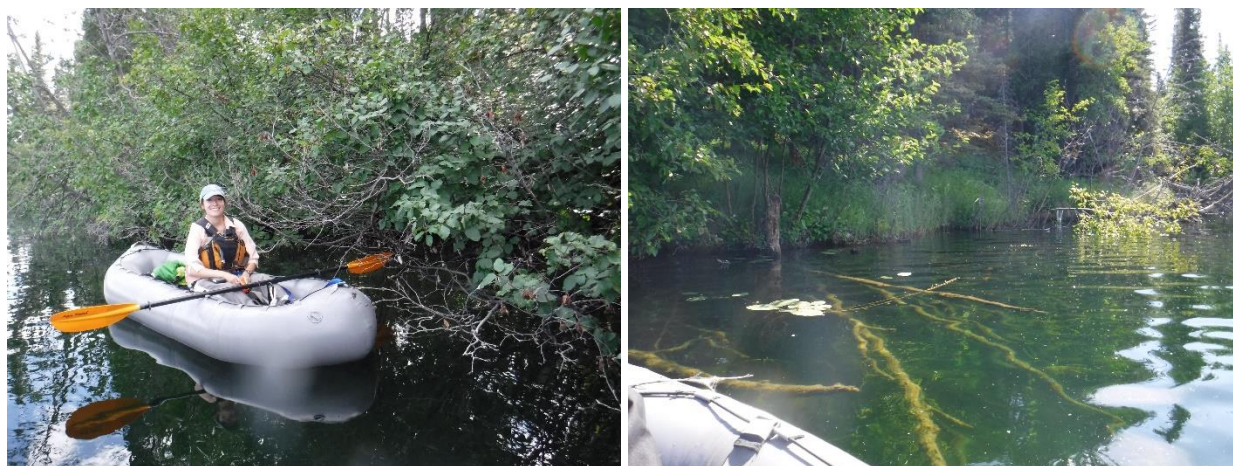


Figure 4. Examples of when shore line is not accessible (left) or downed trees impede rake throws (right).

If the shoreline is not accessible or snag hazards are present and the sampling station cannot be moved as described above, then a rake drop method is performed. In extreme hazard cases (the observer's professional judgement), the rake sampling method can be omitted. At the approximate center of the 10 m grid, a rake is tossed over the side of the boat and dragged for at least 1 meter. This is repeated for three rake drops in different directions of the observer's choosing. Note that tossing the rake from a boat is not as an effective sampling method since the boat is not fixed in position and during rake retrieval the observer pulls the boat toward the rake, thereby limiting the amount of lake bottom sampled. However, aquatic vegetation is still captured (where present) by this method and it did not affect our probability to detect *Elodea* in moderately-infested sampling stations.

Opportunistic search

A visual search for *Elodea* occurs within the littoral zone between sampling stations. Generally, the littoral zone is close to shore where sunlight can reach the lake bottom, and plants can grow (typically less than 4.5 m deep). The horizontal extent of the littoral zone is related to the slope of lake bed and varies from non-existent in cliff drop areas to expansive in shallow lakes.

The search method involves boating slowly, at a speed of less than three knots, while looking over the side of the boat. Polarized sunglasses are essential for visual search. Drop or full rake throws may be used to retrieve vegetation. While the Fieldmaster® Aquavue Underwater Viewer increases ability to detect aquatic vegetation, it's use requires time and effort between. For this reason, we do not recommend using the viewer between sampling stations unless field staff have ample time to survey.

If *Elodea* is detected between *Elodea* negative sampling stations, the observer will create a new 10 m grid sampling station and decide if a visual search is sufficient since *Elodea* was detected or if further sampling with a rake is needed. If *Elodea* is detected between *Elodea* positive sampling stations was also found, and the plants between stations are not part of a consistent, connected population, then the observer records the occurrence with a waypoint in their handheld GPS unit and estimates the percent abundance visually.

Recording data

The fields for data collection include survey date, observers, latitude, longitude, *Elodea* presence/absence, *Elodea* percent canopy cover (if applicable), and native aquatic vegetation abundance (optional). These data fields are located on the data form in Supplemental Material 1. Native aquatic vegetation abundance data is recommended if future surveys will occur. The most significant predictor of *Elodea* presence at a site is the presence of other aquatic vegetation. Hence, these data can target future search efforts to increase efficiency and provide baseline information to assess habitat recovery in the event herbicide application is necessary.

Aquatic vegetation presence at a site is a strong indicator of *Elodea* suitable habitat.

The first detection of *Elodea* in a waterbody should be documented with clear photographs of the plant with the associated data form. When *Elodea* is detected in a sampling grid, the canopy cover is estimated by rake tine fullness in four categories: < 25%, 26–50%, 51–75%, > 75% (Figure 5). The native aquatic vegetation abundance is estimated by the same method and independently of *Elodea*. The total infested area and survey area of a sampling station is estimated at 10m x 10m grid (100 m²; 0.024 acres).



Figure 5. Rake tine fullness is estimated by the amount of tines covered by vegetation in the top row. *Elodea* is covering >75% of the rake tines (left), and <25% of the tines (right).

Post-sampling cleanup

Elodea can establish new populations from stem or leaf fragments. While not yet found in Alaska, other aquatic hitch-hikers such as New Zealand mud snails can easily attach to boats and be transported to non-infested lakes. Staff should review and follow the Guidelines for Preventing the Spread of Aquatic Invasive Species (USFWS 2018), which recommends pre-field work, during, and post field activities to help reduce the spread of invasive species. It is imperative the guidelines are followed before entering a new water body to limit the spread of invasive species.

Upon the return to the office, photos are downloaded and labeled and data sheets scanned and archived. Data from handheld GPS units should be downloaded and archived.

Data submissions to AKEPIC need to follow the requirements in the data entry form. The data entry form is updated regularly and should be downloaded from the AKEPIC website (<https://accs.uaa.alaska.edu/invasive-species/non-native-plants>). A single latitude and longitude point should be used for each sampling station for reporting to AKEPIC. The geospatial point can be any of the observer's waypoints, averaged points between the observers, or the GIS toolbox generated sampling station point. The AKEPIC standard is to have geospatial points no closer than 50 meters in proximity. The native aquatic vegetation abundance data is not reported in AKEPIC, but can be optionally reported as an aquatic plant community value in the Site Vegetation Community Description field.

First detections of *Elodea* should be reported to the appropriate land manager and to the Invasive Species and Natural Resource Specialist at the Alaska Department of Natural Resources.

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Standard Operating Procedures (SOP)

SOP 1: Creating Sampling Stations for Elodea Surveys on Lakes

The *Elodea* Lake Sampling Stations Toolbox uses a preselected lake feature class to create a set of sampling stations on the lake perimeter to be implemented with SOP 2 for the field survey. A sampling station is an individual point containing latitude, longitude, and a station named for reference. The distance between the sampling stations can be defined in 50-meter segments. Lakes with less than a 4 km perimeter are suggested to have sampling stations at the 50-meter sampling stations distance. Lakes up to a 9 km perimeter length are suggested to have sampling stations at the 100-meter distance. Larger lakes (>9 km perimeter) may need to be sampled in two days or balanced with 150-meter sampling stations distance but surveyed in two consecutive years with new sample points.

The toolbox will generate an output as a feature class which can be converted to .csv files to import into a GPS unit or .kml files to view in other applications such as Google Earth. These types of applications are beyond the scope of the SOP and the methods should be consulted with a GIS analyst. Additional sampling stations may need to be created manually or in the field at boat launches, float plane docs, or other known vector areas.

These toolbox generated sampling stations will typically be on the lake perimeter when using the National Hydrologic Dataset, but is variable with the lake feature class used. Additionally, sampling stations may be generated on shore due to water levels or other factors. In field adjust can be performed to mediate this error.

Requirements and special techniques

A desktop computer with ArcGIS Pro 2.0 (or higher) software by ESRI is required. The *Elodea* Lake Sampling Stations Toolbox is required to consistently generate sampling stations on lakes. The toolbox is available online at the Alaska Center for Conservation Science Data Catalog (<https://accscatalog.uaa.alaska.edu>). This toolbox will not function in ArcMap, a similar desktop software.

The toolbox requires a predetermined feature class or shapefile of the targeted lake. We recommend using a standard feature class for lakes such as the National Hydrological Dataset (NHD) and modifying the feature class perimeter is needed.

This operating procedure assumes familiarity with basic ArcGIS Pro skills and abilities. Please refer to a departmental GIS analyst for assistance if needed. If a lake has already been chosen and created as a polyline, this SOP will take approximately 5 minutes depending on the size of the lake.

Limitations

This operating procedure does not provide details on transferring the output data (feature class, .csv, .kml files) to devices, other software, or to other ESRI products. Map projections and coordinate systems can significantly alter the spacing of sampling stations. Please refer to a departmental GIS analyst for assistance on map projections. It is recommended to use the NAD 1983 (2011) Alaska Albers (Meters) Coordinate System.

Adding the toolbox to ArcGIS Pro

1. Select 'Insert' tab on the ribbon.

2. On the Toolbox drop down, select 'Add New Toolbox' (Figure 6).
3. Locate the toolbox file from the saved location on a computer or server.

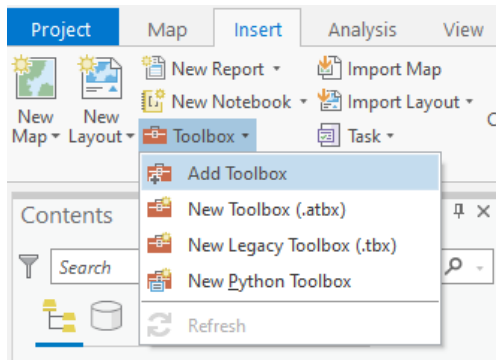


Figure 6. Screen view of finding the 'Add New Toolbox' action on the ArcPro menu ribbon.

4. Select the 'View' tab of the ribbon and select the 'Catalog View'. A new work area will be displayed with a Contents pane on the left.
5. Expand the Toolboxes folder in the Contents pane and the new 'Elodea_Stations_Lake.tbx' will be visible (Figure 7).

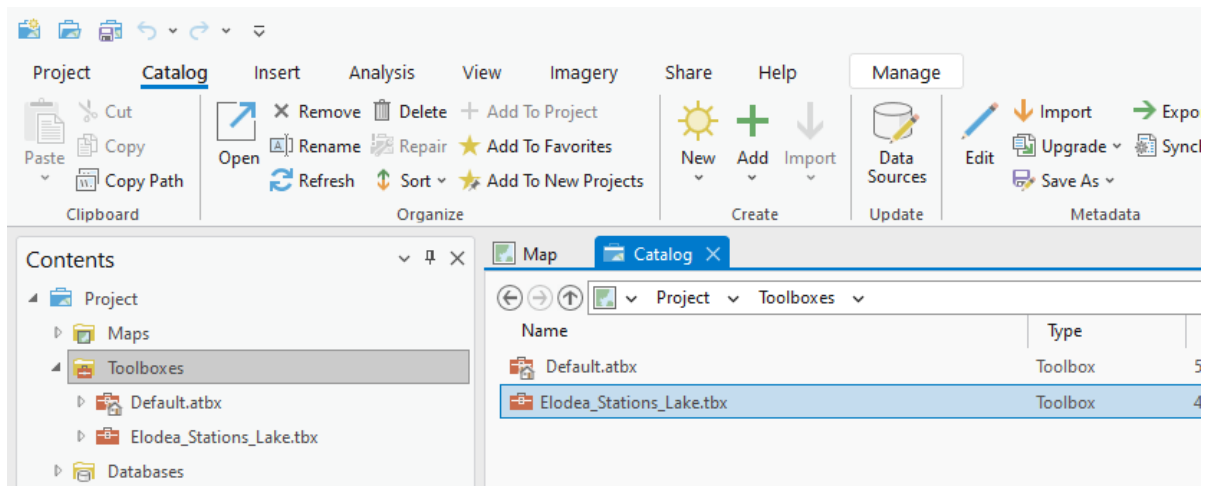


Figure 7. Screen view of the *Elodea* Lake Sampling Stations Toolbox added to the current project catalog.

6. Double click the *Elodea_Stations_Lake.tbx* in the Catalog window, then double click 'Elodea Stations' to open the geoprocessing tool. A new window will open. Return to the Map view (Figure 8).

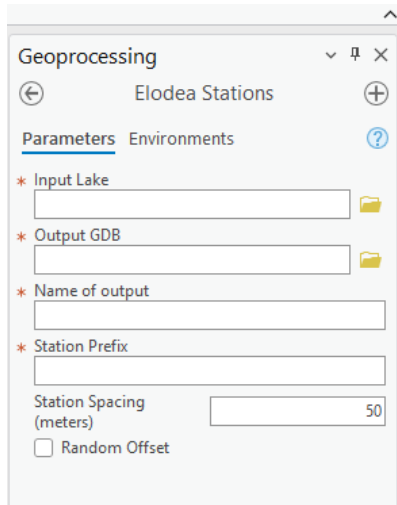


Figure 8. Screen view of the *Elodea* Lake Sampling Stations Toolbox after it has been added to the mapping project.

Parameters of the *Elodea* Lake Sampling Stations Toolbox

This section describes the parameters in the toolbox and how to enter data. Several parameters are needed to run this toolbox, and options are available to customize the sampling station distribution based on lake size or possible future sampling size recommendations.

Input Lake

This is a required field in the toolbox. This parameter defines the lake for sampling station generation and needs to be formatted as a polygon. The lake can be preloaded in the map contents or browsed through the computer to find the file.

Output GDB

This is a required field in the toolbox. This parameter exports the sampling stations to a desired geodatabase.

Name of output

This is a required field in the toolbox. This parameter defines the sampling station feature class file name.

Station Prefix

This is a required field in the toolbox. The toolbox will label sampling stations with a standardized name that includes the name of the lake (prefix) followed by default values. In the final output table, this will be the 'Station ID'. Sampling stations will be labeled using the prefix and the following naming convention:

Prefix + '_Station#'

While any prefix can be used, it is suggested to have at least the first three letters of the lake followed by the last two digits of the year sampled. For example, if the lake name is Birch Lake and surveyed in 2023, the prefix should be entered 'Bir23'. The toolbox will label sampling stations as 'Bir23_1' and sequentially thereafter.

Note that the sampling station name is associated with the output latitude and longitude and may need to conform to the requirements of the handheld GPS unit in the field.

Station Spacing (meters)

This is a required field in the toolbox. This parameter defines the distance between each sampling station. A minimum of 50 meters and a maximum of 150 meters is recommended, depending on lake size. Please review the pre-survey logistics section above for more details.

Random Offset

This is not a required field in the toolbox. This parameter will start the sampling station on a random point of the perimeter. This is recommended, especially if the lake will be surveyed again in the future.

Generating Sample Stations

Here we use the example of generating sampling points on Summit Lake in the Kenai Peninsula region of Alaska.

1. With the geoprocessing pane and Elodea Stations Lake open, click on the folder icon next to the 'Input Lake' parameter.
2. Navigate to the feature class or shapefile of the desired lake. Select the lake and click 'OK'.
3. Click on the folder icon next to the Output GDB and navigate to the desired geodatabase where the sampling stations will be saved to.
4. Enter the desired name of the sampling stations in the 'Name of output' parameter.
5. Enter the desired station prefix. In this example for Summit Lake and sampling in 2023, 'Sum23' is entered (Figure 9).
6. Enter the desired distance for station sampling. In this example, 100 is chosen (Figure 9).
7. Click the box for random offset if desired.
8. Click 'Run'

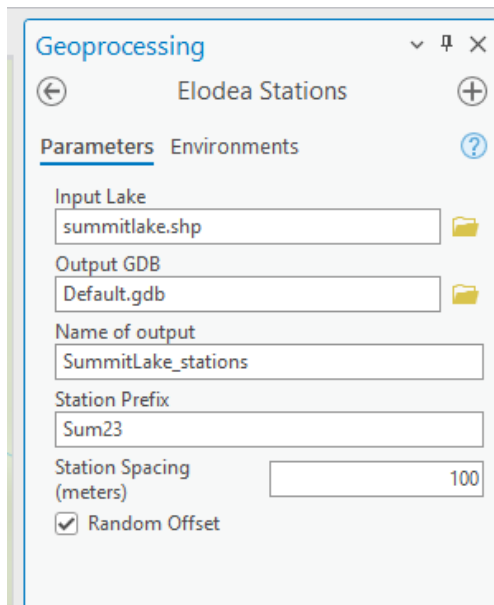


Figure 9. Example of generating sampling stations for Summit Lake.

Sampling stations are created and added to the desired geodatabase. Add the sampling stations to the map for display (Figure 10). The attributes table will have corresponding latitude, longitude, Station ID, and station distance length. The table can be exported to a handheld GPS unit. If needed, please contact your departments GIS analyst for additional help with data export.

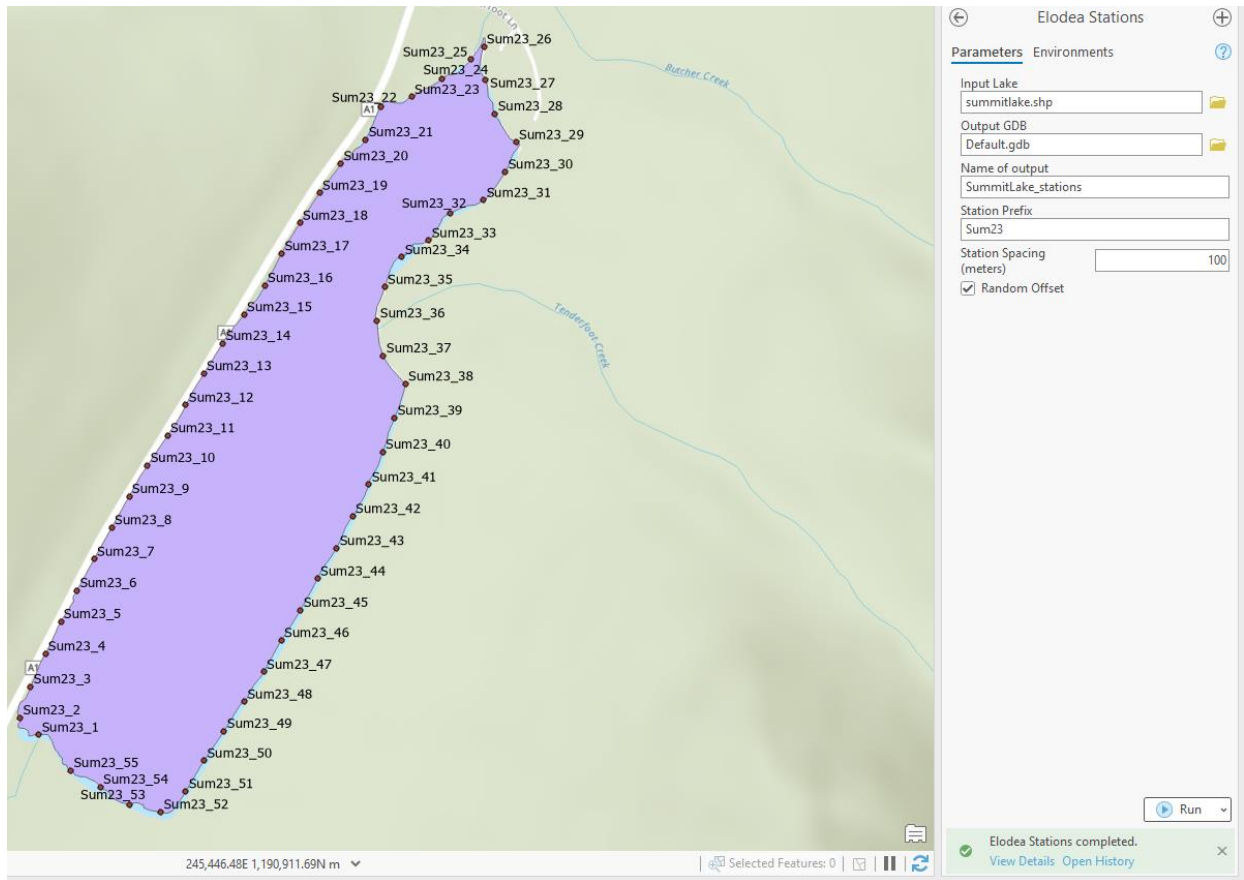


Figure 10. The final product of sampling stations labelled on Summit Lake.

SOP 2: Field survey for *Elodea* in lakes

This standard operating procedure is intended to be a stand-alone document detailing how to survey for *Elodea* in lakes. Surveys should include at least two observers so that each sampling station can be sampled independently by a different observer. Sampling Stations should be generated in accordance with SOP 1 prior to the field effort. The field methodology presented here combines visual observation and physical sampling. Observers will first visually search the sampling station and then, if needed, perform physical sampling with a rake. This will be repeated at each sampling station and a visual observation search between sampling stations.

Attributes measured

At each sampling station the observer will independently record:

- 1) The presence or absence of *Elodea*.
 - a) If present- *Elodea* abundance as a percent cover class value.
- 2) *Recommended*: The abundance of native aquatic vegetation as a broad cover class value.
- 3) *Optional*: additional data to meet the objectives of the survey study.

Aquatic vegetation presence and abundance will be estimated by using a sampling rake and/or by visual estimation. On the data form (SM 1), *Elodea* absence will be recorded by circling ‘N’ and presence will be recorded by circling ‘Y’. If *Elodea* is present, the observer will estimate the abundance using the rake tine fullness method or by ocular estimation at a cover class category, which indicates the severity of the infestation. Similarly, native aquatic vegetation will be estimated using the rake tine fullness method or by ocular estimation at a cover class category.

Documenting native aquatic vegetation is optional but strongly recommended. *Elodea* presence is highly correlated with aquatic vegetation and not a specific species. Hence, *Elodea* is a generalist and the presence of native aquatic vegetation is a strong indicator of suitable *Elodea* habitat. These data can be used to facilitate future survey efforts and record baseline data.

The rake tine fullness method provides a quick estimate of the amount of aquatic vegetation at the sampling site. The amount of vegetation or *Elodea* covering the top row of tines will be used to estimate the cover class value (Figure 11) and should be averaged across all of the rake throws. Where *Elodea* and native aquatic vegetation co-occur, independent estimates should be made of *Elodea* and native aquatic vegetation.

Cover class values range from 0% where no plants are present on the rake or observed at the sample site, to 100% where the entire rake or site is occupied spatially with vegetation. Cover class values are binned to broad 25% categories (Table 2). The observers should use their best professional judgement and circle the appropriate class on the data form. The cover classes and corresponding ranges of percent cover are provided for reference at the bottom of the data form.

Table 2. Vegetation cover classes for estimating percent cover at a sampling site

Vegetation Cover Class Value	Estimated Percent Cover
0	0%
1	1-25%
2	26-50%
3	51-75%
4	76-100%



Figure 11. Rake tine fullness is estimated by the amount vegetation covering the top row of tines. Elodea is covering >75% of the rake tines at left, and <25% of the tines at right; native aquatic vegetation is not present in the examples shown.

Pre-survey logistics and preparation

Sampling Stations should be generated and imported into a handheld GPS device prior to the field effort. It is recommended to prepare paper maps of the sampling stations with station names and preprint data sheets. Equipment required for the field survey is listed below; personal gear is not included.

1. Double sided sampling rake with 30ft of rope
2. Handheld GPS unit
3. Data sheets on waterproof paper (e.g., Rite in the Rain No. 8511; or digitized sheets on tablet)
4. Data sheet holder (e.g., Rite in the Rain Field Binder No.200)
5. Waterproof writing instrument
6. Maps printed on waterproof paper with station names and/or list of sampling stations
7. Waterproof/resistant camera
8. Aquatic plant identification guides (if needed)
9. Polarized sunglasses
10. Fieldmaster® Aquavue Underwater Viewer or similar (*suggested not required*)
11. Pack raft and paddle or other watercraft.
12. Boat kit (patch kit, pump, straps, etc.)
13. Personal Protection Equipment
 - a. Personal Flotation Device
 - b. Bear deterrent
 - c. Medical kit

Before field work, staff should review the Guidelines for Preventing the Spread of Aquatic Invasive Species (USFWS 2018). This guide recommends pre-, during-, and post-field activities to help reduce the spread of invasive species.

Data recording forms

A data sheet template is provided as Supplemental Materials 1 at the end of this document as a suggested format. Survey unit groups may wish to customize the data sheets and include other data attributes to meet their objectives (not covered in this document). Sections of the template that

should be edited are a year within the survey title and a list of ‘Observers’ for the season. Listing observers by their initials increases efficiency in the field by allowing the observer to circle their name. The cover class values and *Elodea* presence have choices to be circled to reduce recording errors.

Required data collected in the field are survey date, observers, latitude and longitude (waypoint on the dataform), *Elodea* presence/absence, *Elodea* percent cover (if applicable) to meet the standards of the Alaska Exotic Plants Information Clearinghouse (AKEPIC). Native vegetation abundance is not a required field.

Tasks to conduct

The sampling stations generated in accordance with SOP1 have a designated lake perimeter point, which are intended to serve as reference locations for the sampling station. Observers will verify the shoreline can be safely accessed or if needed, move the sampling station 10 meters to the left (counter clockwise when facing the shoreline) of the original point. Observers will first perform a visual search for *Elodea* within the grid. If *Elodea* is detected, then the observer can move to the next sampling station. If *Elodea* is not detected, then a rake sampling method within the grid is performed. Data are recorded, then the observer moves to the next sampling station while performing a visual search for *Elodea* within the littoral zone enroute. A second observer then performs an independent search of the sampling grid using the same methods.

The sampling station will be sampled by two independent observers, ideally less than 10 min. apart to maintain similar site conditions. Observers are required to sample the same site location, with less than 5 meters of error. This is best achieved when the second observe arrives at the sampling station as the first observer is finishing.

Survey preparation

- 1) Decide which sampling stations will be observed by independent observers and observed at least twice.
- 2) Decide how to move sampling stations consistently in one direction if the sampling station cannot be sampled and how observers will notify each other if the station is moved.
 - a) Practice navigating to the same location on land using the handheld GPS unit.
 - b) The ‘map view’ on a handheld GPS unit showing sampling stations and the observer’s current position with a fine resolution scale (<30 meters) has aided observers to consistently sample the same location.
- 3) Practice estimating the size of a 10 meter × 10 meter grid on land at the office.
 - a) Watercraft can be used to estimate the grid perimeter by measuring the length of the watercraft. For example, if a watercraft is 100 inches in length, it would be approximately 2.5 meters. Therefore, four boat lengths are needed to measure 10 meters.
- 4) Arrive at boat launch area and assemble boat and gear for the day or trip.
- 5) Final review of objectives, field plan, obstacles, and emergency plan. Review current conditions and future conditions, such as weather and wildlife.

Navigate to the Sampling Station

- 1) Navigate using handheld GPS unit to the first sampling station.
 - a) Confirm the location with paper maps as needed. These generated stations serve as a reference point and as the midpoint of the 10m grid.
- 2) Verify the shoreline can be safely accessed for a rake throw.

- a) If the shoreline can't be safely accessed, move the sampling point 10 meters in the appropriate predetermined direction.
 - b) If the new sampling point shoreline still does not have access, retain the original sampling station and a rake drop method will be used.
- 3) On the data form, record:
- a) Date
 - b) Observer name (name of staff performing the survey).
 - c) Sampling station name. This will be displayed on the GPS device and/or on printed maps.
 - d) Mark a waypoint on the handheld GPS device and record the waypoint number on the data form.

Sampling Station: Visual Observation

- 1) Visually estimate the 10m grid sampling station using the generated sampling point as the midpoint of the grid.
- 2) Visually search for *Elodea* by looking over the boat with polarized sunglasses and/or using an underwater viewer within the 10 m grid.
- 3) Maneuver the watercraft within the grid in a pattern to ensure the entire grid is observed.
- 4) Use the Sampling Station: Visual Observation Decision Tree (Figure 12) after the grid has been completely observed or if *Elodea* is detected.

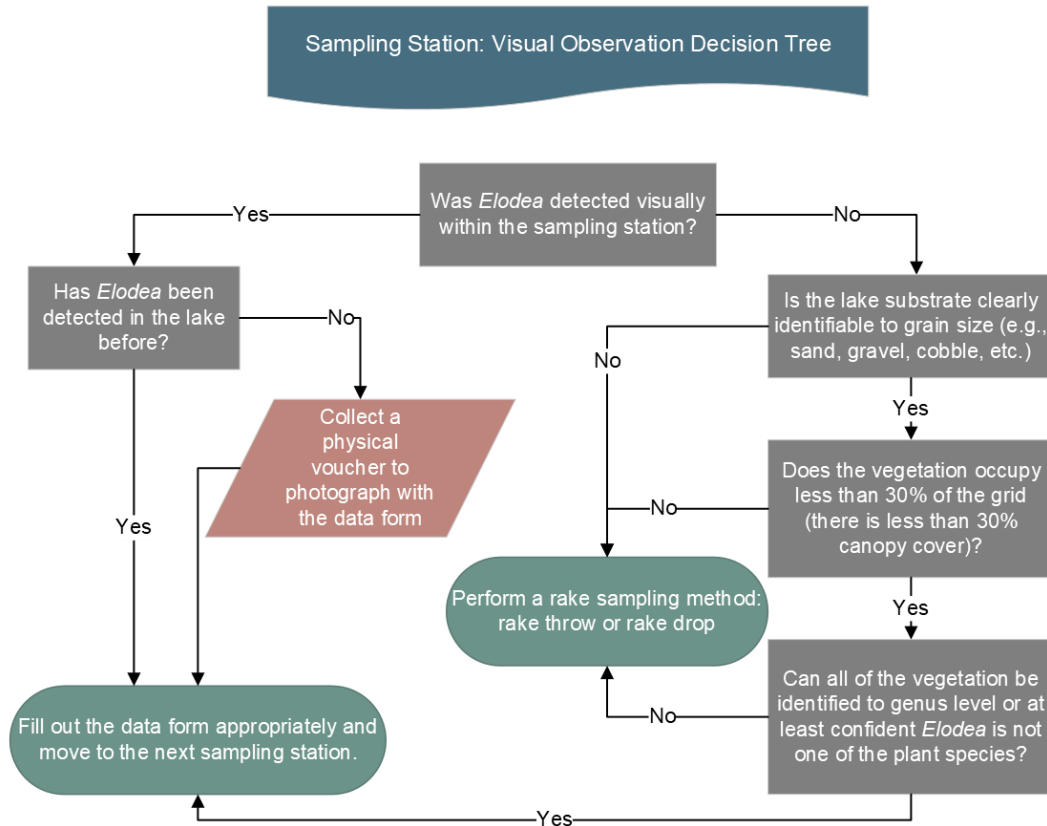


Figure 12. A decision tree to inform the observer if a rake sampling method needs to be performed.

- 5) *Optional*-Estimate and record abundance of native aquatic vegetation on the data form.

- 6) If standing on the shoreline or in the lake edge can be done safely, use the Sampling Station: Rake throw sampling method. If the shoreline is not accessible, use the Sampling Station: Rake drop sampling method.

Sampling Station: Rake throw sampling method

- 1) Navigate to the shoreline midpoint of the 10m grid.
- 2) Ensure the stability and depth of the embankment or shoreline with a paddle or other device.
 - a) **NOTE:** *If the observer cannot stand to perform the rake throw safely or if hazards, such as downed trees are present, then the rake drop sampling method should be performed instead (below).*
- 3) Exit the watercraft and wade to the observer's comfort level in the water within the grid. Alternatively, standing from shore is acceptable.
- 4) Throw and retrieve the double headed rake three times in different directions, as far as possible, toward the center of the lake: at approximately 45°, 90°, and 135°, using the shoreline as the baseline (Figure 13).
- 5) On each retrieval, inspect the rake for *Elodea* and estimate the aquatic vegetation abundance with the rake tine fullness in each throw until *Elodea* is detected.
 - a) If *Elodea* is present:
 - i) take a photo and record the photo number on the data form.
 - ii) Circle 'Y' in the *Elodea* field on the data form.
 - iii) Estimate and record the abundance of *Elodea* using the rake tine fullness method on the data form based on the rake throws.
 - iv) *Optional*- Estimate the abundance of native aquatic vegetation based on the rake throws. Record the abundance on the data form
 - v) The observer moves to the next sampling station with a Strategic Search.
 - b) If *Elodea* is absent:
 - i) Repeat until all three rake throws are completed.
 - ii) *Optional*- Estimate the abundance of native aquatic vegetation based on the rake throws. Record the abundance on the data form.
 - iii) Circle 'N' in the *Elodea* field on the data form.
 - iv) The observer can move to the next sampling station with a Strategic Search.
- 6) The second Observer begins at Sampling Station: Visual Observation for the recently observed sampling station.



Figure 13. Example of named sampling stations. The yellow square estimates a 10 m grid to visually search for *Elodea* at the sample station before the rake is thrown. The white dashed lines show the directions of the rake throw.

Sampling Station: Rake drop sampling method

- 1) While in the watercraft, navigate to the center of the sampling grid.
- 2) Toss the rake at least one meter away from the watercraft away from hazards if present. Wait for the rake to contact the lake bottom by visual confirmation or feel from the rope.
- 3) Slowly retrieve the rake and inspect the rake for *Elodea* and estimate the aquatic vegetation abundance with the rake tine fullness in each throw.
 - a) If *Elodea* is present:
 - i) take a photo and record the photo number on the data form.
 - ii) Circle 'Y' in the *Elodea* field on the data form.
 - iii) Estimate and record the abundance of *Elodea* using the rake tine fullness method on the data form.
 - iv) *Optional*- Estimate the abundance of native aquatic vegetation based on the rake throws. Record the abundance on the data form.
 - v) The observer can move to the next sampling station with a Strategic Search.
 - b) If *Elodea* is absent:
 - i) If needed, reorient the watercraft to the center of the sampling station grid. Repeat until all three rake throws are completed in various directions.
 - ii) Record abundance of native aquatic vegetation on the data form.
 - iii) Circle 'N' in the *Elodea* field on the data form.
 - iv) The observer can move to the next sampling station with a Strategic Search.

- 4) The second Observer begins at Sampling Station: Visual Observation for the recently observed sampling station.

Strategic Search Between Sampling Stations: Visual observation

- 1) Use the handheld GPS and printed maps to navigate to the next sampling station.
- 2) Visually search for *Elodea* by looking over the boat with polarized sunglasses at a speed of less than 3 knots.
 - a) Concentrate the search within the littoral zone between sampling stations.
 - b) Navigate and pattern the search to view a 5-meter buffer around docks or other vector sources.
- 3) If *Elodea* is suspected, use a rake sampling method or an underwater viewer to confirm the presence.
- 4) If *Elodea* is detected between *Elodea* negative sampling stations:
 - a) The observer will utilize a 10 m grid at the occurrence to create a new sampling station.
 - b) The observer will perform the standard operating procedures of the sampling station.
- 5) If *Elodea* is detected between *Elodea* positive sampling stations and is not a consistent connected population:
 - a) The observer will use waypoints in their handheld GPS unit and record presence with an estimated percent abundance.
 - b) The sampling station will be named a hallway point between the sampling station numbers (e.g. Car_34.5 is between Car_34 and Car 35).

Post survey logistics

Staff should follow the Guidelines for Preventing the Spread of Aquatic Invasive Species (USFWS 2018) at the end of sampling the lake. This is particularly important if gear and boating equipment used in infested waters will be traveling to a new waterbody.

At the end of each day or lake, staff will review data sheets to ensure they are filled out completely and supplemented with notes as needed. If needed, air dry data sheets and the ring binders overnight. Coalesce data forms together by lake then observer. Upon returning to the office, photos should be downloaded and labeled, and data sheets scanned and archived. Data from handheld GPS units should be downloaded and archived.

Report new infestations of *Elodea* to the appropriate land manager. Data entry and storage should adhere to the research unit standard practice. Geospatial data (latitude and longitude) of a single sampling station can originate from one observer waypoint and be recorded as a single record for data submission to AKEPIC. The total infested area and survey area of a sampling station is estimated of the 10m x 10m grid (100 m²) equating to 0.024 acres for AKEPIC reporting.

SM 1: Supplemental Materials - Data Sheet Template

The following page is a datasheet template for SOP 2. The data sheet template is formatted to be printed on waterproof paper, Rite in the Rain No. 8511. The loose-leaf paper fits in a multi-ring binder Rite in the Rain Field Binder No.200. These writing guides are compact and fit easily in pockets or crevices of personal flotation devices for easy access. While this set-up is not a requirement, it has proven efficient over several sampling campaigns.

The template has three Sampling Stations on each page separated by a thickened black bar. The top of the page has data applicable to the lake, specifically the observer/staff name and date. We have found that pre-printing the initials of participating staff and the title of the survey (e.g., Summit Lake Detection Survey 2023) is efficient and helps with overall project organization. For the survey, staff can circle their initials instead of writing out their names. The template presented here can be printed front and back, hence six sampling stations can be recorded on one sheet of paper. The vegetation cover class values and corresponding percent covers are provided as reference at the bottom of the template.

Elodea detected between sampling stations will not have a sampling station ID name and instead will only have a waypoint number associated with the occurrence.

ELODEA LAKE DETECTION SURVEY Date: _____

Observer:

Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:

Vegetation Cover Classes

0 = 0% | 1 = 1-25% | 2 = 26-50% | 3 = 51-75% | 4 = 76-100%

ELODEA LAKE DETECTION SURVEY Date: _____

Observer:

Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:

Vegetation Cover Classes

0 = 0% | 1 = 1-25% | 2 = 26-50% | 3 = 51-75% | 4 = 76-100%

ELODEA LAKE DETECTION SURVEY Date: _____

Observer:

Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:

Vegetation Cover Classes

0 = 0% | 1 = 1-25% | 2 = 26-50% | 3 = 51-75% | 4 = 76-100%

ELODEA LAKE DETECTION SURVEY Date: _____

Observer:

Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:



Sampling Station: _____

WP#: _____

Elodea? Y / N Elodea Cover: 1 2 3 4 Photo numbers:

Submerged Veg Cover: 0 1 2 3 4

Notes:

Vegetation Cover Classes

0 = 0% | 1 = 1-25% | 2 = 26-50% | 3 = 51-75% | 4 = 76-100%