Wetland State-and-transition Model Project Update - 2014

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Executive Summary

Semi-permanently flooded wetlands throughout the Intermountain West and Prairie Pothole regions provide important seasonal habitat for migrating and breeding migratory birds and other wetland-dependent wildlife. Significant continental-scale loss and degredation of wetlands led to establishment of some of the regions' largest wetland complexes as National Wildlife Refuges (NWR) (e.g., Benton Lake NWR, Malheur NWR, and Red Rock Lakes NWR), and state Wildlife Management Areas (WMA) (e.g., Farmington Bay WMA, Freezeout Lake WMA, and Market Lake WMA). Effective management should focus on mimicking the wet-dry cycle of wetlands, which increases primary productivity by accelerating decomposition of accumulated detritus, releasing otherwise bound nutrients. Moreover, early seral stage wetland vegetation, e.g., sago pondweed (*Stuckenia pectinata*), is often more nutritious and preferred by migratory birds than late-seral stage species more tolerant of anoxic conditions (e.g., watermilfoil [*Myriophyllum sibiricum*]). The frequency, timing, and duration of drawdowns are important factors in determining which vegetation community phases will be expressed within a wetland. General recommendations exist for assisting managers with this decision; however the predictive ability of conceptual models remains poor when applied at local scales.

The first component of this project is designed to reduce that management uncertainty by:

- Developing a conceptual wetland state-and-transition model (STM) to inform management
  - Use existing literature to develop a draft STM for semi-permanently flooded wetlands (80% complete)
  - Incorporate temporal scale using historical data collected during site visits
- Defining vegetation community phases within states using empirical data (25% complete)
  - Ecological site descriptions and NVCS associations do not exist for wetland communities, necessitating this step
  - Abiotic characteristics and indicator species for phases will be identified
- Designing an efficient monitoring scheme to inform management (15% complete)
  - Determine wetland condition (i.e., state and phase) using vegetation community phase indicator species
  - STM and current condition define potential management actions to either perpetuate the current state or move a system to another state
- Providing an analytical framework to estimate transition probabilities among states and phases at the local scale
  - Monitoring of wetland response to management actions will allow estimation of transition probabilities among states and phases in response to management, i.e., reduce the uncertainty of predicted outcomes of water level manipulations in achieving desired states/phases.

Pilot field data collection to define states and community phases, describe relationships between phases and abiotic attributes, and identify indicator species for phases began at eight refuges in 2014. A spatially-balanced random sample of points within each wetland was visited. Canopy cover estimates of all wetland plant species and abiotic conditions (i.e., water depth, pH, salinity, specific conductivity, temperature, soil characteristics) were recorded. Data from 1434 sample points and 154 species were included in analyses to identify vegetation community phases and abiotic gradients correlated with phases. Two more field seasons following these methods will be used to design a long-term monitoring scheme, sustainable with expected station capacity, that will iteratively reduce the uncertainty of wetland management.

The second component of this project will be to link regional migratory bird objectives to local-scale management across the Intermountain West and western Prairie Pothole Region. This will facilitate coordinated wetland management across stations that provide important migrating and breeding habitat for migratory birds.

Stations currently participating in the project include Bear Lake, Camas, Grays Lake, and Malheur NWRs in USFWS Region 1 and Bowdoin, Fish Springs, Lee Metcalf, and Medicine Lake NWRs in Region 6.

Introduction

Ecological systems often exhibit multiple stable states. For example, semi-permanently flooded wetlands can exist in either a 'hemi-marsh' state with the ratio of open water and emergent wetland vegetation responding to hydrologic drivers, or become dominated by cattail (*Typha* spp.) in response to eutrophication, sedimentation, and/or altered hydrology. Within states exist distinctive vegetation community phases that occur through time in response to natural variation in community drivers (e.g., precipitation). Within semi-permanently flooded wetlands a dynamic interplay between emergent and submergent vegetation exists. During low-water periods emergent vegetation will expand along the periphery, or during extended periods of low water, within, a wetland. The transition between a submerged aquatic vegetation (SAV) community phase and emergent phase is largely driven by hydrologic regime, i.e., the periodicity and frequency of drying events (drought, drawdown) that result in exposed mudflat (van der Valk 1981). Mudflat is a necessary condition for the germination and establishment of most emergent plant species (Kadlec and Wentz 1974). When reflooding occurs, dense stands of inundated emergent vegetation persist for a brief period. Many species of emergent wetland plants cannot survive if continuously flooded (Kadlec 1962, Harris and Marshall 1963), with persistence of emergent vegetation to continuous flooding related to adaptation and tolerance for anoxic conditions (Cronk and Fennessy 2001).

Ecological systems commonly respond to perturbations in non-linear fashion with multiple states possible (Drake 1990), and wetlands are no exception (van der Valk 1981, Zweig and Kitchens 2009, Smith 2012). These non-linear dynamics are largely in response to water level manipulations and the resultant abiotic conditions, with the ability to predict the outcome of such manipulations varying dependent upon the knowledge of the system being manipulated. These non-linear vegetation community responses can be contrasted with linear succession to a climax seral community as initially espoused by Clements (1936). Application of linear climax theory to management has proven largely unfruitful (Stringham et al. 2003), and led to the development of non-linear state and transition models (Westoby et al. 1989).

State and transition models (STMs) provide a framework to address the needs outlined above. An STM graphically depicts the current knowledge of ecological dynamics on a site, identifying the various vegetation associations, i.e., states, which could exist. The STM also identifies the conditions, disturbances, and management actions that may cause a site to transition among states (e.g., from hemi-marsh to cattail-dominated with significant management inputs necessary to transition out of the latter state) or simply shift among phases of a state (e.g., from emergent-dominated to submergent-dominated with phase shifts occurring in response to natural hydrological variation). Therefore, STMs can assist in making management decisions by identifying actions to encourage sustaining a current state, or those that would likely result in a transition to a more preferred state.

The applicability of state and transition models for management of semi-permanently flooded wetlands is being explored using data collected at eight national wildlife refuges within

USFWS regions 1 and 6. The objectives are to 1) create a broad-scale STM to conceptualize current knowledge of semi-permanently flooded wetland systems, 2) identify vegetation community phases using empirical data collected across a disparate suite of semi-permanent wetlands, 3) design a long-term monitoring scheme for identifying a wetland's current state and phase to inform application of management actions, and 4) quantify wetland response to management actions to reduce uncertainty of predicted outcomes.

State and Transition Models

State and transition models are a type of conceptual ecological model that synthesizes what we know about vegetation dynamics of an ecological site. As a synthesis of what is known about an ecological site, considerable effort is necessary to take available information and distill it down to a diagram that clearly defines states (plant associations), vegetation community phases within states, community pathways between phases, and transitions and restoration pathways between states. Before information about an ecological site can be synthesized it is necessary to define what one is. The 'textbook' definition of an ecological site provided by NRCS is:

> An ecological site is defined as a distinctive kind of land with specific soil and physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and its ability to respond similarly to management actions and natural disturbances.

Using the above definition, ecological sites can be defined and then described (the latter aptly named 'ecological site descriptions', or ESDs). An ESD is the narrative that synthesizes what we know about the vegetation dynamics, soils, hydrology, etc., of an ecological site, and the STM distills that information into a single diagram depicting vegetation dynamics and their primary drivers, including management actions. Given the historical development of this framework by the rangeland ecology and management community, most examples come from western North American rangeland sites.

The components of STMs include states, community phases, state transitions and restoration pathways, and community pathways. These are defined below, as excerpted from Bestelmeyer et al. (2010).

- State: Plant community phases [sorted] according to the structures (e.g., dominant species, functional groups, and surface soil conditions) that control feedack mechanisms and ecological processes.
  - Reference State: Identified to represent the historical or natural state for the site including its range of variation. Often implicitly assumed that historically observed states are those that provide the maximum options for management and ecosystem services.

  - Alternative States: Feature a distinct set of feedbacks and processes compared to the reference state; technology and/or rare, extreme natural events (e.g., a once-in-a-century extreme wet year) would be needed to restore the reference state. Alternative states can be extremely persistent due to strong feedbacks, such as when exotic species invade and alter fire regimes and soil nutrient cycling.

- Community Phase: The distincitve plant communities and associated dynamic soil property values that can occcur over time within a state. Typically reflect management-relevant differences in plant communities and focus on differences in dominant species that govern the ecological processes and uses of a site.

  - Reference Community Phase: That [phase] which best exhibits the characteristics of the reference state, or that is considered to be the most resilient within the state (i.e., a healthy condition vs. an at-risk condition, see below).
  - At-risk Community Phase: The phase that is most vulnerable to a transition to an alternative state.

- Community Pathway: Mechanisms of change among community phases with the same state. Community pathways are best described using monitoring or inventory data coupled to information about climate, management, or other conditions.
- Transition: Mechanisms of change among states. Transitions are due to changing feedbacks and processes that subsequently limit the recovery of the former state.

  - Slow Variables and Triggers: Drivers and events that initiate a transition to an alternative state. Slow variables reflect more gradual processes such as shrub recruitment rates, rates of change in water table depth associated with land use, or long-term decreases in grass density. Triggers are discrete events that precipitate a transition, such as a drought period that stresses perennial grasses, an intense rainfall event that produces highly erosive overland flow, or a wildfire.
  - Thresholds: A set of conditions (and a point in time) beyond which altered ecosystem structures and functions do not recover by themselves.Thresholds are the consequences of the slow variables and triggers described above.

- Restoration Pathways: The technologies, events, and conditions within alternative states (including susceptible community phases) that can lead to recovery of the former state.

A simple schematic showing the relationships among the components of an STM is provided in figure 1.

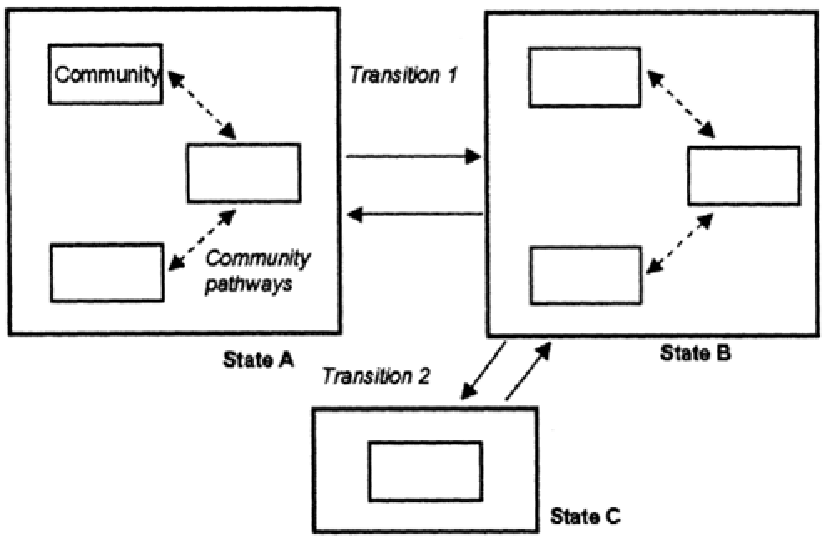


Figure 1. The general structure of a state and transition model, taken from Stringham et al. (2001).

A brief history of the development of STMs as a management tool will help clarify *what* an STM is, its component parts, and the impetus for their initial development.

Clementsian succession (1916) dominated early attempts by rangeland managers to predict the outcome of rangeland disturbance (primarily grazing and fire). In Clements's view vegetation communities responded to disturbance in a linear fashion, i.e., disturbance would push a climax community to an earlier seral stage that would, upon removal of the disturbance, progress in a predictable linear fashion through a series of communities back to the climax community for that site. This was the underlying paradigm of Dyksterhuis's (1949) seminal work that was the foundation for rangeland management for nearly 40 years. Failures of this paradigm to account for non-linear responses of systems to disturbance led to the initial development of STMs, introduced by Westoby et al.'s (1989) paper that acknowledged rangelands often had multiple 'equilibrial' states. STMs have since become a common tool used in rangeland management, with STM development for ESDs an ongoing effort by NRCS and others. For a good synthesis of the history of early efforts to use Clementsian successional theory to quantify rangeland health, and the switch to STMs with multi-state equilibrial theory, see Briske et al.'s (2005) paper. The Society for Range Management published a special issue of *Rangelands* in 2010 to give practical guidance on developing ESDs and STMs (available online at: http://jornada.nmsu.edu/esd/literature#rangelands). A recent critical review of the application of ESDs and STMs is available in Twidwell et al.'s (2013) *Ecosphere* paper.

The application of ESDs and STMs for managers outside of rangeland ecology appears to be gaining traction. While most STM development still occurs within the realm of rangeland management, testing potential use of rangeland ESDs and STMs for wildlife habitat management (e.g., Doherty et al. 2011, Williams et al. 2011) is becoming more commonplace, as is development of STMs for other habitat types (e.g., wetlands, Zweig and Kitchens 2009). This multi-region project exploring the applicability of STMs for management of semi-permanently flooded wetlands is another example of this.

STMs are largely qualitative, i.e., based on existing knowledge of an ecological site synthesized by experts. Therefore, most STMs lack a rigorous quantitative accounting of, for example, the likelihood of a particular management action moving the state or phase of a community to an alternative state (or phase). This is problematic for managers when they need to weigh alternative actions to achieve an objective. For example, consider two possible treatments, each intended to push a wetland to an alternative state, with one twice as costly as the other. If the more costly treatment is three-times more likely to result in achieving the desired alternative state it would be the logical choice. However, without knowing how likely each action would be in achieving the desired state a manager would likely decide based solely on treatment cost.

Few examples exist for using empirical data to 1) define vegetation community phases, 2) select indicator species for community phases, or 3) quantify transition probabilities between phases and/or states. This project is undertaking these tasks across a broad landscape to provide a management tool for assisting in wetland management for migratory birds and other wetland-dependent wildlife.

Methods

Study Area

Semi-permanently flooded wetlands were sampled at eight National Wildlife Refuges within USFWS Regions 1 and 6 (Fig. 2). These stations are located in the western Prairie Pothole Region (Bowdoin and Medicine Lake NWRs) and Intermountain West (Bear Lake, Camas, Fish Springs, Grays Lake, Lee Metcalf, and Malheur NWRs).

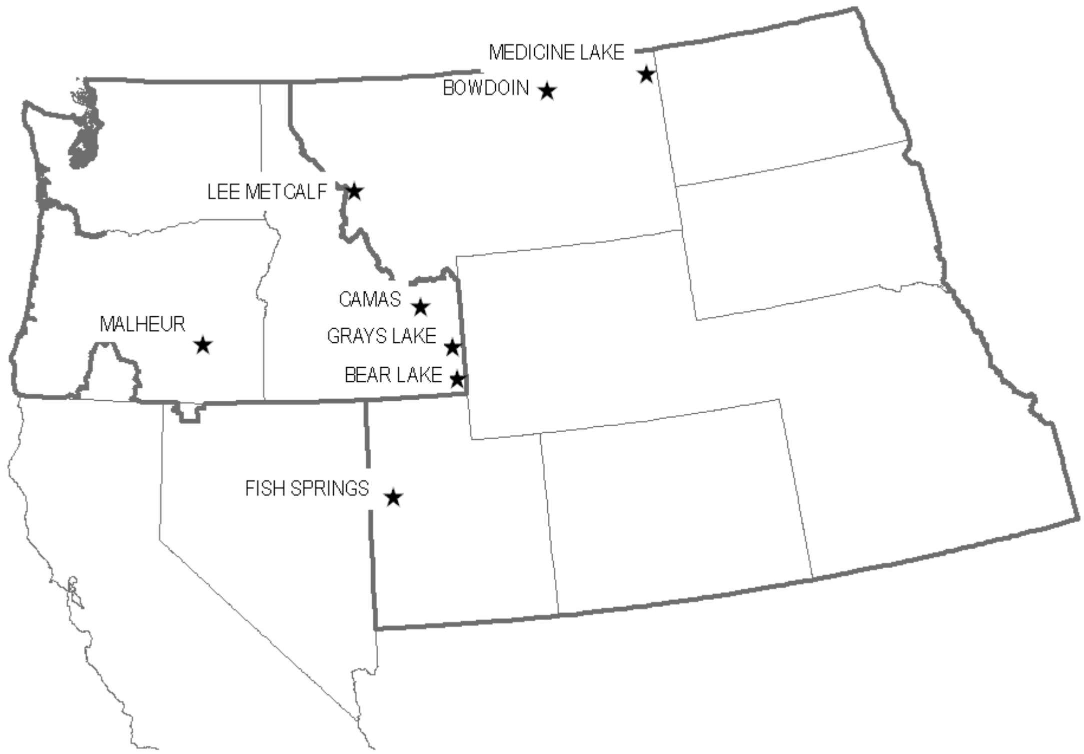


Figure 2. National Wildlife Refuges participating in the wetland state-and-transition model project. Regional USFWS boundaries (Regions 1 and 6) are dark gray.

Conceptual Wetland State-and-transition Model

The state and transition model (STM) developed for semi-permanently flooded wetlands depicts the current knowledge of ecological dynamics and identifies the range of potential vegetation communities that can exist on an ecological site. The STM also identifies the ecological processes, abiotic processes, disturbances, and management actions that may cause a site to transition among different states or shift among different vegetation community phases. The STM for semi-permanently flooded wetlands:

- Provides a universally-applicable ecological framework to apply across wetlands in different geomorphic regions; and
- Elucidates common ecological drivers and processes that influence the expression of wetland plants.

The conceptual STM developed for semi-permanently flooded wetlands consists of one reference and six alternate states known to occur within the Intermountain West and western

Prairie Pothole Region. The reference state includes four reference vegetation communities characterized by diverse submerged aquatic and tall emergent vegetation communities. Two at-risk phases are also identified to indicate conditions when the site is likely to cross a threshold into a non-desirable, alternate state. Non-desirable alternate states known to occur within the study area include turbid open water, anoxic-tolerant SAV, and decadent tall emergent vegetation. Two additional alternate states that occur within the western United States, hypereutrophic and non-native SAV are also identified, but are not known to occur at participating refuges and therefore are not described in detail. The remaining state, moist-soil, may occur as a result of extreme drought or managed water-level drawdowns that are implemented to "re-set" succession in wetland impoundments.

Narrative descriptions for each state include ecological indicators, feedback mechanisms, and abiotic/ecological processes. Community phases are identified for each state based on structure and composition of wetland vegetation that result from natural processes or active management. Transitions and pathways between states are hypotheses based on historical accounts and literature reviews that will be tested through applied research and monitoring efforts completed at multiple refuges during this project. As empirical data is collected and analyzed, more detail can be added to further refine states, phases, transitions, and pathways within the current STM.

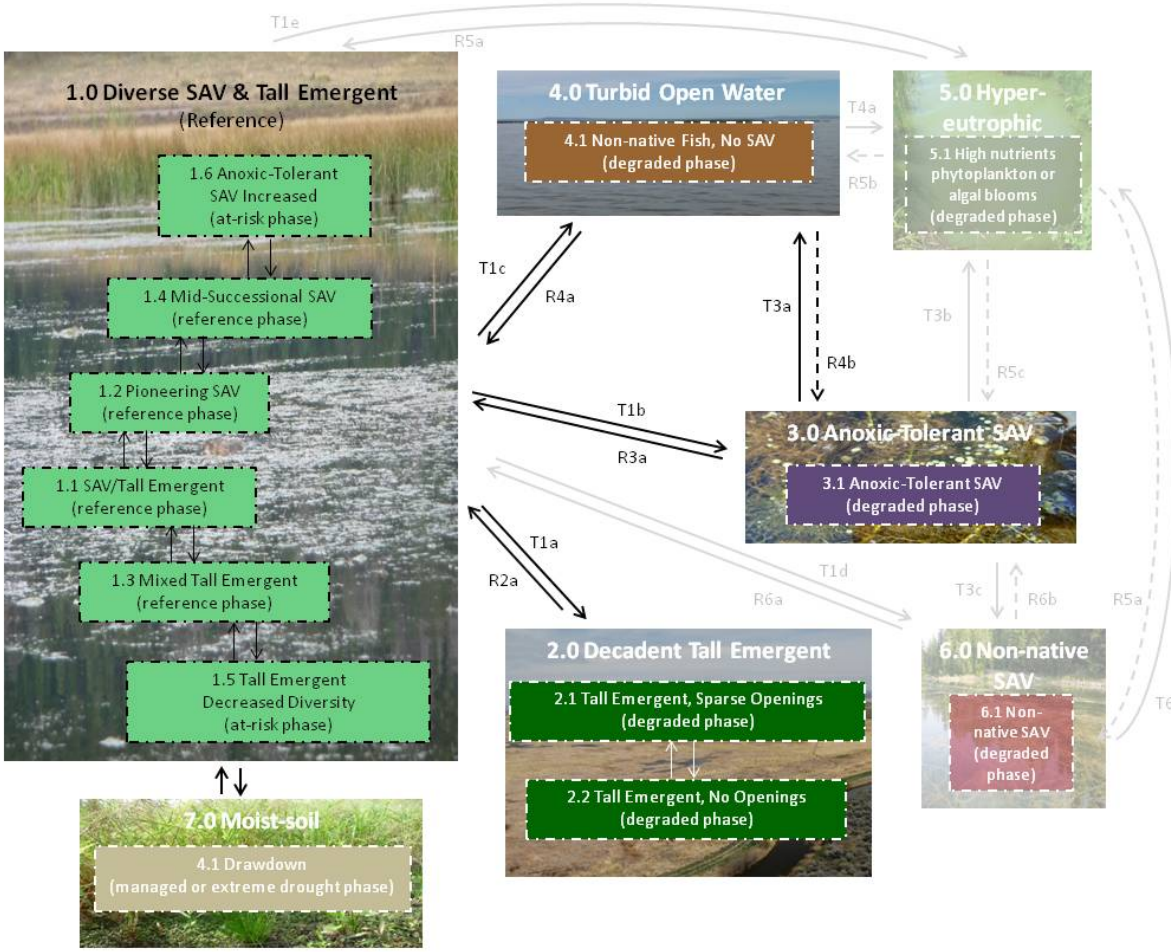


Figure 3. Draft state-and-transition model (STM) for semi-permanently flooded wetland

habitat.

Field Data Collection

Sampling Design

The sampling frame was the entire collection of geographic areas across all stations classified as potential semi-permanently flooded wetland. Each station was considered a distinct geographic "strata." Within each station multiple management units (hereafter, "unit" = primary sampling unit) were selected non-randomly by participating stations, with a spatially-balanced random selection of points (secondary sampling units) selected for wetland vegetation surveys.

A generalized random tessellation stratified (GRTS) sample of points was created for each unit identified as a sampling priority by a station. The GRTS algorithm provides a spatially-balanced random sample of ordered points to be visited for data collection. We used the grts() function within the spsurvey R package (Kincaid et al. 2012). Sampling intensity, defined as points per acre $\times$ 100% (e.g., 30 points/100 acres $\times$ 100% = 30% sampling intensity), was specified at 30% within most units (i.e., those 100-300 acres in area) with a minimum of 30 points for smaller units (20-100 acres), 90 points for units between 300 and 500 acres, and a maximum of 120 points for larger units (>500 acres). Units within a station were stratified to produce an independent GRTS sample for each unit.

If a point was visited and deemed non-target (e.g., point fell within uplands) or in the office it was deemed non-target, it was denoted as such.

Vegetation Surveys

Vegetation surveys consisted of 1 $\times$ 1 m quadrats positioned such that the GRTS point location demarcated the northwest corner of the quadrat. Surveys were conducted by 1-2 observers using a boat, or on foot in areas of low water and/or high density emergent vegetation.

Canopy cover of each species, residual vegetation, and bare substrate was recorded. An aqua viewer was used to aid SAV species identification (http://www.wildco.com/Fieldmaster-Aquavue.html). For every species present, percent cover was estimated to the nearest 5%, or nearest 1% if total cover was < 5%. Species that occurred as a single plant were recorded as having at least 1% canopy cover. Percent canopy cover for all species present and bare substrate was checked to ensure sums equalled approximately 100% (i.e., within ~± 10%).

Floating-leaved species (e.g., duckweed (*Lemna* spp.), floating pondweed (*Potamogeton natans*), bladderwort (*Utricularia* spp.)) and algae aerial coverage was recorded as part of the canopy cover sum not to exceed 100%. Floating plant parts were not included in the total canopy cover estimate.

Abiotic Variables

Abiotic characteristics known to influence wetland plant communities were recorded during vegetation surveys. The method of survey (boat or foot), water depth (± 1 cm), Secchi disc depth (± 1 cm), temperature (± 0.1° C), pH (± 0.01 units), salinity (± 0.1 ppt), relative conductivity (± 1 μScm^{-1}), and soil texture were measured at each GRTS point after vegetation survey data were recorded.

Soil texture by feel was recorded for each plot using samples collected from the top 4 inches of the substrate. Soil classes were organic, sand, loamy sand, sandy loam, silty loam, loam, sandy clay loam, silty clay loam, clay loam, sandy clay, silty clay, clay, and gravel.

Data Analysis

Species occurrence data were used to define vegetation community phases and explore abiotic variation among phases. Vegetation community phases were defined by 1) calculating a Sørensen dissimilarity index using a plot by species occurrence matrix, 2) conducting a cluster analysis on the resulting dissimilarity matrix, and 3) selecting an optimal number of phases using Indicator Species Analysis (Dufrêne and Legendre 1997). Once phases were defined, we calculated mean phase canopy cover for each cluster's best (i.e., highest indicator value) indicator species, and explored variation in abiotic variables among phases using Tukey's Honestly Significant Difference (HSD) test. Among-station summary comparisons, unit-level summaries, and a summary of double-observer data were also conducted and are provided in Appendices A, B, and D.

Cluster Analysis for Defining Vegetation Community Phases

Cluster analysis is a group of mulitvariate techniques commonly used in community ecology for grouping sites based on similarities. The goal of the analysis is to 'cluster' sites that are more similar within a cluster than among clusters. A Sørensen dissimilarity index for the wetland vegetation data matrix of 1434 plots and 151 species and species groups (and bare substrate) was calcluated. The Sørensen dissimilarity index measures how different plots are from each other using presence/absence data, giving greater 'weight' to species common to both plots. The equation for calculating the Sørensen index is $2a/(2a + b + c)$, where a is the number of species common to both plots, b is the number of species unique to the first plot, and c is the number of species unique to the second plot.

Vegetation community phases were created by conducting a hierarchical agglomerative cluster analysis with a flexible beta of -0.25. Hierarchical clustering has a number of benefits over other clustering algorithms, which has made it a commonly used technique in recent community ecology papers (e.g., Perrin et al. 2006, Little et al. 2010, Abella et al. 2012). In this method each plot starts out as an individual and the two least dissimilar plots are put together to form the first cluster. Remaining plots are fused one at a time in order of lowest dissimilarity until all plots are in a cluster.

Indicator Species Analysis

We used an indicator species analysis (ISA; Dufrêne and Legendre 1997) on output from hierarchical clustering to determine the optimal number of clusters. An ISA selects associated species for each cluster identified in the cluster analysis above. It does this by calculating an indicator value, d, that combines measures of species *specificity* and *fidelity* to a cluster. The former is maximized when a species is *only* present in a cluster, while the latter maximizes when a species occurs in *all* sites within a cluster. As defined by Dufrêne and Legendre (1997), an indicator species is:

> The most characteristic species of each group, found mostly in a single group of the typology and present in the majority of the sites belonging to that group.

An ISA provides a number of useful summary metrics based on d that we can then use to objectively decide how many clusters, i.e., vegetation community phases, are present in the data. These metrics include:

1. Number of significant indicator species ($P < 0.05$)
2. Mean indicator species value
3. Percent strong indicator species ($d > 0.50$)
4. Mean P-value of all species

Criteria 1-3 should peak at the most informative level of clustering, while the lowest value of criterion 4 indicates the most signficant indicator species. The number of significant indicator species and mean P-value of all species were used for selecting the optimal number of vegetation community phases, i.e., clusters (McCune and Grace 2002).

Results and Discussion

Data from 1434 sample points and 154 species or species groups were included in analyses to identify vegetation community phases. Preliminary analysis indicated a phase for *Chara* spp. (93 occurrences) and *Chara vulgaris* (82 occurrences), and *Carex* spp. (25 occurrences) and *Carex utriculata* (30 occurrences). These were grouped into two categories, *Chara* spp. and *Carex* spp., for all subsequent analyses. We similarly combined *Juncus* spp.(13 occurrences) and *Juncus arcticus* (16 occurrences) into a single category.

Most species were relatively rare with 142 species occurring in $\leqslant 5\%$ of points surveyed. Species occurring in >5% of points ($n = 11$) were: BARESU, CHARA, CHBE4, FILAL, HOJU, LEMI3, MYSI, RESID, SCAC3, STPE15, TYLA. To reduce noise within the data set, species occurring in $\leqslant 1.5\%$ of points ($n = 120$) were eliminated, leaving 33 species. This resulted in a cutoff of ca. 20 points a species needed to be present at to be included in analysis; 30 points was the minimum number of points surveyed on any individual unit.

The number of significant indicators peaked at 8–9 phases, while the mean *P* value of all species reached a minimum at 8 phases (Figs. 4 and 5). We chose 8 phases as optimal and further summaries and analyses reflect that.

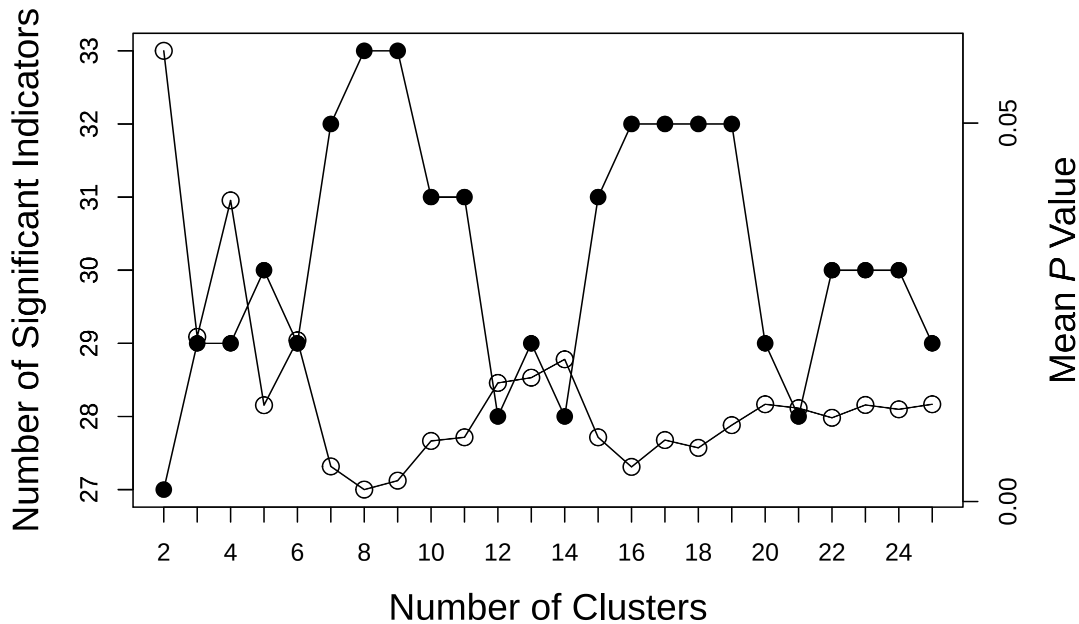
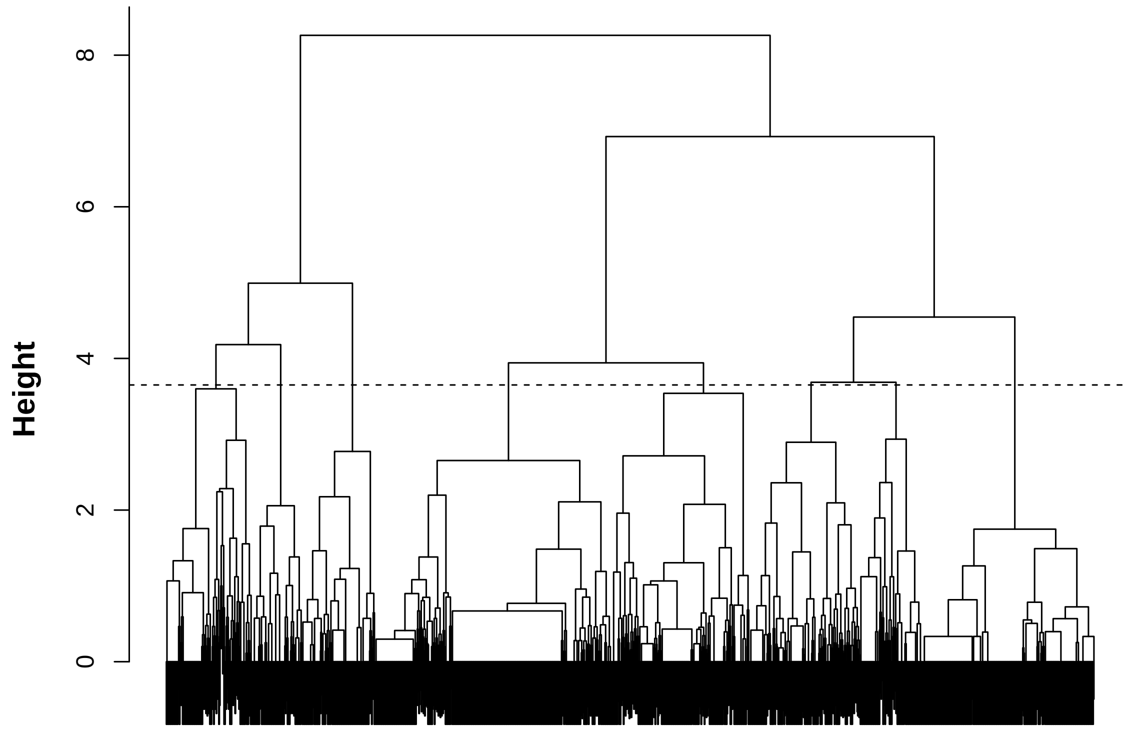


Figure 4. Criteria used to evaluate optimal number of clusters based on Indicator Species Analysis (Dufrêne and Legendre 1997). Clusters were identified with a hierarchical agglomerative cluster analysis. Number of significant indicators ($P < 0.05$; solid circles) and mean *P*-value of all species (open circles) identified by ISA for 2-25 groups.



Agglomerative Hierarchical Cluster Analysis with Flexible Beta = −0.25

Figure 5. Cluster dendrogram for 1434 wetland vegetation survey points conducted across eight National Wildlife Refuges and 21 wetland management units, 2014. A hierarchical, agglomerative cluster analysis with a flexible beta = -0.25 was used to cluster plots. The optimal number of vegetation community phases (i.e., clusters) based on Indicator Species Analysis (Dufrêne and Legendre 1997) was 8 and is indicated by the horizontal line.

One phase had bare substrate (BARESU) as an indicator, with a mean bare substrate canopy cover at points within this phase relatively high (42.3%, Table 1). However, there was high canopy cover variance and bare substrate was a relatively weak indicator for the phase (i.e., low d value). Filamentous algae (FILAL) had the lowest d value (0.224) of the 8 indicators. This is perhaps to be expected for attributes that are potentially ubiquitous within wetlands, i.e., may not demonstrate specificity within a phase (one of the two criteria used in calculating d).

The remaining phases divided among emergent (SCAC3 [hardstem bulrush], TYLA [broadleaf cattail]), submergent (MYSI [shortspike watermilfoil], CHARA [muskgrass]), and moist-soil/mudflat (CHBE4 [pitseed goosefoot], POPE3 [spotted ladysthumb]) phase categories

(Table 1). Four of the phases had strong indicators (i.e., $d > 0.50$) – hardstem bulrush (SCAC3), shortspike milfoil (MYSI), broadleaf cattail (TYLA), and muskgrass (CHARA). Moist-soil/mudflat phases had relatively weak indicator species, indicating low specificity and fidelity of those indicators within their respective phase. This led to inclusion of some points within those phases that appear as outliers based on differences in abiotic attributes (see below).

Table 1. Top indicator species for each cluster identified using agglomerative hierarchical clustering and Indicator Species Analysis (Dufrêne and Legendre 1997) for semi-permanently flooded wetlands sampled at eight National Wildlife Refuges in 2014. Mean canopy cover (%) and standard deviation (SD) of each indicator within a cluster is provided. Species names are provided in Appendix C.

Phase	Species Code	Indicator Value	Mean	SD	Phase Category
1	FILAL	0.224	27.6	37.3	-
2	SCAC3	0.594	17	17.8	Emergent
3	BARESU	0.233	42.3	31.9	-
4	MYSI	0.708	48.1	40	Submergent
5	CHBE4	0.345	9.8	18.9	Moist-soil/mudflat
6	TYLA	0.623	8.6	14.9	Emergent
7	POPE3	0.367	4.3	10.8	Moist-soil/mudflat
8	CHARA	0.635	51.8	37.3	Submergent

Emergent community phases were most common, with hardstem bulrush phase (SCAC3) the most common and broadleaf cattail (TYLA) the third most common. Hardstem bulrush points dominated all three units sampled at Bear Lake NWR and Grays Lake at Grays Lake NWR (Table 2). The second most common phase was the moist-soil/mudflat pitted goosefoot (CHBE4) phase dominant in Malheur NWR's 5CNP, 5CWS, and Boca Lake units. Points categorized as a submergent vegetation phase (i.e., CHARA, MYSI) comprised 13% of points sampled, with shortspike watermilfoil the least common vegetation community phase identified ($n = 75$).

Table 2. Vegetation community phase by wetland unit summary for 8 phases (i.e., clusters) identified using Indicator Species Analysis (Dufrêne and Legendre 1997). Data are from 21 wetlands sampled at eight National Wildlife Refuges in 2014.

Unit	BARESU	CHARA	CHBE4	FILAL	MYSI	POPE3	SCAC3	TYLA
BDW-LAUN	14		6	19	13	1	19	5
BRL-BUNL	15	2		2	5	10	81	5
BRL-RAIN	5	14	1	6	2	6	77	9
BRL-RASU	4	7	2	1	12	6	49	9
CMS-BIGP	7	6		1	1		5	10
CMS-SANL	8	4	5	21		11	25	2
CMS-TWWP			14	1		3	11	1
FSH-MALU	4	62	2			1	3	1
GYL_BEAV	19	9		16	4	1	22	49
GYL_BIBE	6	2	2	20	4	5	3	52
GYL_LAKE	13	1			1		50	55
LMC_OTTP	5	4		4	15			1
LMC_PO10	15	2		12				1
LMC_PON3	3			6	18			2
MDL-LK11	22			22		2	10	4
MLH-5CBR			10				3	
MLH-5CNO			89				1	
MLH-5CWS			43					
MLH-BENR	10			1		3	5	6
MLH-BOCL	20		87				1	
MLH-WKNR			3	3		49	2	
Total	170	113	264	135	75	98	367	212

Abiotic attributes of vegetation community phases varied considerably (Tables 2 and 3). Due to the absence of water at most moist-soil/mudflat points (i.e., 86.2% of points in these phases had water depth 0), the abiotic attributes associated with them should be considered cautiously. Moreover, moist-soil/mudflat phases had relatively weak indicator species, resulting in inclusion of some seemingly very different points within these phases (see below).

Predictably, water depths by phase were deepest in submergent phases, intermediate in emergent phases, and shallowest in moist-soil/mudflat phases (Table 2, Fig. 6). Water depth was also the abiotic attribute that varied significantly among the most pairwise comparisons (Table 4). The highest mean water depth, and broadest range of depths, for a phase was associated with filamentous algae (FILAL), although shortspike watermilfoil (MYSI) had a higher median water depth value (Table 2, Fig. 6). Both moist-soil/mudflat phases (pitseed goosefoot [CHBE4], spotted ladysthumb [POPE3]) had median water depth values of 0 (Fig. 6).

All phases had basic mean pH values (i.e., >7), with algae phases (muskgrass [CHARA], filamentous algae [FILAL]) having the most basic mean and median pH values (Table 2, Fig.

6). Emergent phases (hardstem bulrush [SCAC3], broadleaf cattail [TYLA]) were associated with the least basic pH levels of the phases. Unlike water levels that increased monotonically from moist-soil/mudflat phases to submergent phases, pH values were lowest for emergent phases, intermediate in moist-soil/mudflat phases, and highest in submergent phases. The lowest pH values (<6.5) were recorded at Pond 10, Lee Metcalf NWR, with two readings below pH 6.

Specific conductivity was highest, and most variable, for the phase indicated by muskgrass (CHARA), which was greater than twice the conductivity of the phase with the second highest level, hardstem bulrush (SCAC3) (Table 2, Fig. 6). The three categories of phases (moist-soil/mudflat, emergent, and submergent) were each divided such that within a category there was one phase with a significantly lower mean specific conductivity than the other phase within the category (Fig. 6, Table 6). Two conspicuous outlying values occurred in the pitted goosefoot (CHBE4) moist-soil/mudflat phase. Both of these values were recorded at points within Mallard Unit, Fish Springs NWR, that did not contain pitted goosefoot. The two points did have the same cover of bare substrate (15%) and residual vegetation (65%), which may have led to the grouping.

Salinity categories of vegetation community phases, based on mean values, were predominantly slightly brackish (>0.3–1.3 ppt), with a single phase inicated by broadleaf cattail (TYLA) in fresh water (0–0.3 ppt) (Table 2). However, individual points ranged up to 4.04, falling within moderately brackish (>1.3–3.2 ppt) and brackish (>3.2–9.6 ppt) categories. Salinity levels varied considerably within phases (Fig. 6), resulting in the fewest significant differences among phases of the abiotic variables measured. All salinity values >2.6 ppt recorded were from Mallard Unit, Fish Springs NWR.

Organic soil was the most common soil category recorded, with most of these occurring in the hardstem bulrush (SCAC3) phase (Table 3). Broadleaf cattail (TYLA) commonly occurred in organic soil, too, with 60.5% of cattail phase occurrences in organic soil. The least common soil category was gravel.

Table 3. Abiotic variable summary (means and standard deviations [SD]) for 8 vegetation community phases (i.e., clusters) identified using Indicator Species Analysis (Dufrêne and Legendre 1997). Data are from 21 wetlands sampled at eight National Wildlife Refuges in 2014.

Species Code	Depth	SD	pH	SD	Sp. Cond.	SD	Salinity	SD	Temp	SD
FILAL	60.8	42.5	8.6	1	730.4	714.5	0.37	0.38	19.7	4.1
SCAC3	5.7	11.3	7.8	0.5	1163.9	694.4	0.57	0.34	17.7	4.6
BARESU	31.9	25.3	8.3	0.8	833.4	1040.6	0.44	0.57	19.9	4.1
MYSI	55.7	27.1	8.5	0.8	515.4	316.1	0.36	0.14	18.2	4.9
CHBE4	0.5	3.4	8	0.4	868.6	1464.6	0.44	0.79	23.3	2.1
TYLA	6.2	11	7.8	0.7	520.4	319.8	0.25	0.17	15.4	4.5
POPE3	5.3	13.2	8.1	0.6	973.1	623.7	0.48	0.32	18.6	3.1
CHARA	42.6	23.2	8.8	0.8	2696.9	2097.5	1.36	1.13	22.7	3.8

Table 4. Soil category summary by vegetation community phase for 8 phases (i.e., clusters) identified using Indicator Species Analysis (Dufrêne and Legendre 1997). Data are from 21 wetlands sampled at eight National Wildlife Refuges in 2014.

Species Code	Cl	ClLo	Gr	Lo	LoSa	Org	Sa	SaCl	SaClLo	SaLo	SiCl	SiClLo	SiLo
FILAL	2	1		9	35	24	1		5	10	1	10	12
SCAC3	5	12		30	23	207	1	1	11	30	11	14	15
BARESU	4	4	1	16	46	19	7	4	5	4	6	33	12
MYSI	10	1	1	7	1	7		3	5	5	4	7	10
CHBE4		4		1	2	2	5	1	80	12	1	149	3
TYLA		5		8	22	124		4	5	3	11	15	8
POPE3	3	8		2	8	12	1		1	5	6	36	12
CHARA		4		13	29	16				5	2	2	6

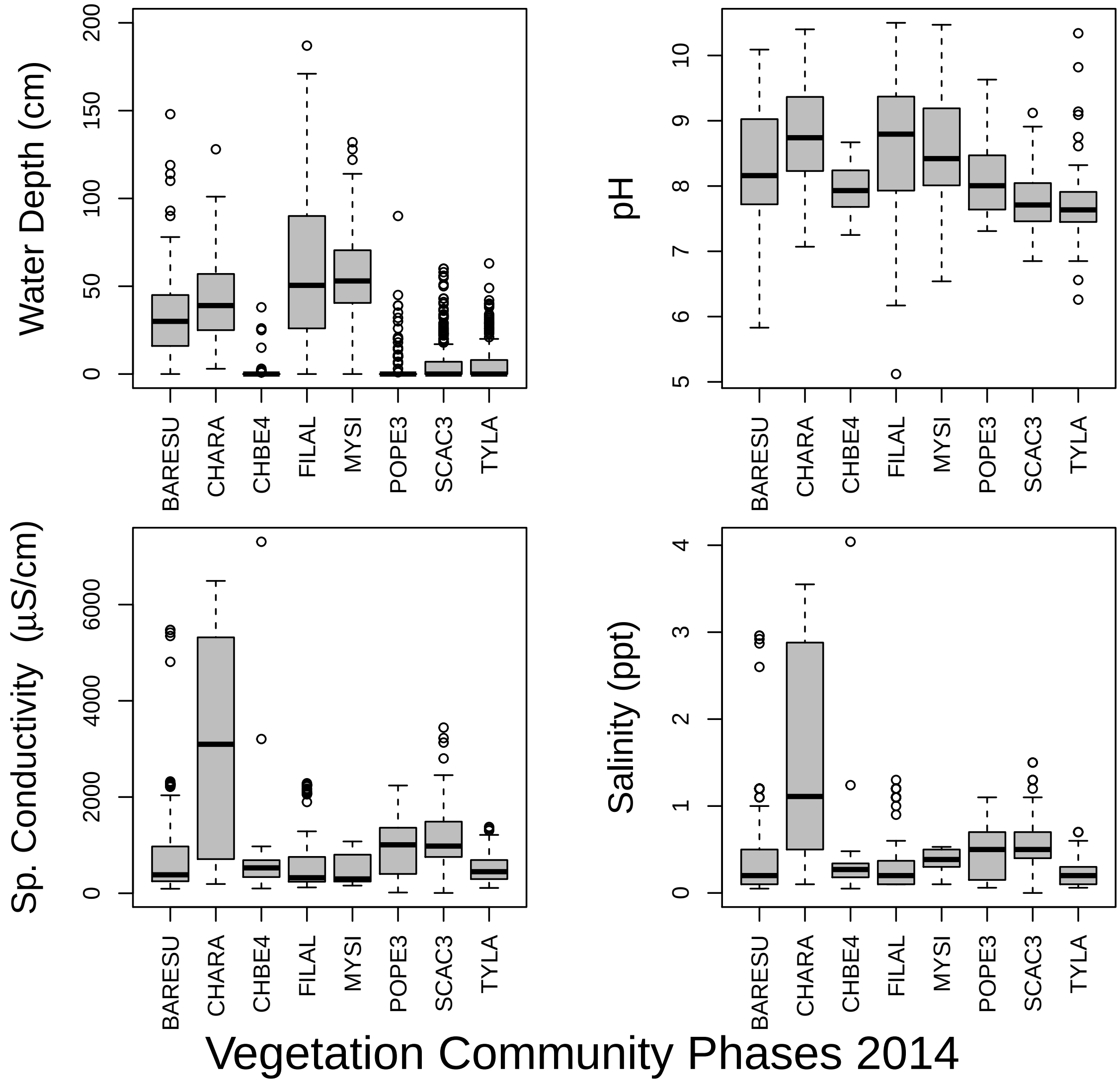


Figure 6. Abiotic variable boxplot summaries for 14 vegetation community phases (i.e., clusters) identified using Indicator Species Analysis (Dufrêne and Legendre 1997). Data are from 21 wetlands sampled at eight National Wildlife Refuges in 2014. Indicator species common and scientific names for each species code are provided in Appendix C.

Table 5. Significant ($P = 0.10$) differences in water depth (cm) among vegetation community phases based on Tukey's Honestly Significant Difference test. Indicator species associated with each phase are provided in Table 1.

	Difference	Lower CI	Upper CI	Adjusted P-value
CHARA-BARESU	10.71	4.04	17.38	0.00
CHBE4-BARESU	-31.40	-36.81	-25.99	0.00
FILAL-BARESU	28.87	22.52	35.22	0.00
MYSI-BARESU	23.81	16.08	31.54	0.00
POPE3-BARESU	-26.57	-33.54	-19.60	0.00
SCAC3-BARESU	-26.17	-31.27	-21.07	0.00
TYLA-BARESU	-25.70	-31.35	-20.04	0.00
CHBE4-CHARA	-42.11	-48.29	-35.93	0.00
FILAL-CHARA	18.16	11.14	25.18	0.00
MYSI-CHARA	13.10	4.81	21.38	0.00
POPE3-CHARA	-37.28	-44.87	-29.70	0.00
SCAC3-CHARA	-36.88	-42.79	-30.97	0.00
TYLA-CHARA	-36.41	-42.81	-30.01	0.00
FILAL-CHBE4	60.27	54.44	66.10	0.00
MYSI-CHBE4	55.21	47.90	62.52	0.00
SCAC3-CHBE4	5.23	0.80	9.67	0.02
TYLA-CHBE4	5.70	0.63	10.78	0.04
POPE3-FILAL	-55.44	-62.75	-48.14	0.00
SCAC3-FILAL	-55.04	-60.58	-49.49	0.00
TYLA-FILAL	-54.57	-60.63	-48.50	0.00
POPE3-MYSI	-50.38	-58.91	-41.85	0.00
SCAC3-MYSI	-49.98	-57.06	-42.89	0.00
TYLA-MYSI	-49.51	-57.00	-42.01	0.00

Table 6. Significant ($P = 0.10$) differences in pH among vegetation community phases based on Tukey's Honestly Significant Difference test. Indicator species associated with each phase are provided in Table 1.

	Difference	Lower CI	Upper CI	Adjusted P-value
CHARA-BARESU	0.48	0.20	0.75	0.00
FILAL-BARESU	0.30	0.03	0.58	0.05
SCAC3-BARESU	-0.56	-0.84	-0.27	0.00
TYLA-BARESU	-0.56	-0.90	-0.21	0.00
CHBE4-CHARA	-0.84	-1.32	-0.37	0.00
POPE3-CHARA	-0.67	-1.17	-0.16	0.01
SCAC3-CHARA	-1.03	-1.33	-0.73	0.00
TYLA-CHARA	-1.03	-1.38	-0.68	0.00
FILAL-CHBE4	0.67	0.19	1.15	0.00
MYSI-CHBE4	0.56	0.06	1.06	0.04
SCAC3-FILAL	-0.86	-1.17	-0.56	0.00
TYLA-FILAL	-0.86	-1.21	-0.50	0.00
SCAC3-MYSI	-0.75	-1.09	-0.42	0.00
TYLA-MYSI	-0.75	-1.13	-0.37	0.00

Table 7. Significant (P = 0.10) differences in specific conductivity (μ S cm^{-1}) among vegetation community phases based on Tukey's Honestly Significant Difference test. Indicator species associated with each phase are provided in Table 1.

	Difference	Lower CI	Upper CI	Adjusted P-value
CHARA-BARESU	1863.43	1479.88	2246.98	0.00
CHBE4-CHARA	-1828.22	-2521.60	-1134.83	0.00
FILAL-CHARA	-1966.43	-2372.13	-1560.72	0.00
MYSI-CHARA	-2181.44	-2650.59	-1712.29	0.00
POPE3-CHARA	-1723.72	-2428.83	-1018.60	0.00
SCAC3-CHARA	-1533.00	-1964.87	-1101.13	0.00
TYLA-CHARA	-2176.42	-2689.11	-1663.73	0.00
SCAC3-FILAL	433.42	12.81	854.04	0.08
SCAC3-MYSI	648.44	166.34	1130.53	0.00
TYLA-SCAC3	-643.42	-1167.98	-118.85	0.02

Table 8. Significant (P = 0.10) differences in salinity (ppt) among vegetation community phases based on Tukey's Honestly Significant Difference test. Indicator species associated with each phase are provided in Table 1.

	Difference	Lower CI	Upper CI	Adjusted P-value
CHARA-BARESU	0.93	0.71	1.14	0.00
CHBE4-CHARA	-0.93	-1.31	-0.55	0.00
FILAL-CHARA	-1.00	-1.23	-0.77	0.00
MYSI-CHARA	-1.01	-1.32	-0.69	0.00
POPE3-CHARA	-0.88	-1.27	-0.49	0.00
SCAC3-CHARA	-0.79	-1.03	-0.55	0.00
TYLA-CHARA	-1.12	-1.40	-0.83	0.00
TYLA-SCAC3	-0.32	-0.61	-0.03	0.04

Future work will continue to explore vegetation community phases across diverse gradients of abiotic attributes. This will allow use of empirical data and repeatable methods for defining vegetation community phases within wetland states, and a better understanding of abiotic attributes phases are associated with. Long-term monitoring of states and phases, and management actions, will permit future estimation of the likelihood of state or phase shifts in response to management actions. Lastly, the ability to assess the state and phase of wetlands will provide an improved understanding of the habitat resources provided to migratory birds and other wetland-dependent wildlife, facilitating more coordinated wetland management to meet regional and flyway objectives.

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1 Appendix A: Assessment of Total Survey Error Using 2014 Data

For the survey design used in 2014, refer to the section in the main report titled “Field Data Collection.” In this Appendix, we explore the potential sources of error within the proposed survey design. Core concepts considered here are presented in “Lohr, S. (2010) *Sampling: Design and Analysis.*"

Total survey error can be broken down into the following components: coverage error, non-response error, measurement error, processing error, and sampling error. Ideally, a survey design is constructed to minimize all of these sources of error, particularly the sources related to non-sampling error. Non-sampling errors are any errors or variability in the data that can not be attributed to the process of observing a portion of the area contained within semi-permanently flooded wetlands. In our case, we observe or record data on a set of plots (1 m^2) for percent cover by species or points for abiotic measurements within a delineated polygon (sampling frame). We do not exhaustively measure or collect wall-to-wall data throughout the entire polygon or unit (census). Sampling error is just the inherent variability that happens from sample-to-sample. In other words, we have selected a probabilistic sample of points within the sample frame. Therefore, the data collected from one set of GRTS points would vary from a different set of GRTS points. This sampling error or variation is accounted for within the statistical design-based estimators. Specifically, we report our uncertainty regarding the mean percent cover of a species (e.g., sago pondweed) by way of a confidence interval.

The harder to estimate and account for errors are non-sampling errors. Here, we discuss potential sources of non-sampling errors for this project related to coverage (Section 1.1), non-response and measurement errors (Section 1.2). Our assessment is informed by the 2014 field surveys that occurred on 21 units across eight stations. Processing errors can occur during data entry into the database, coding errors when data are retrieved from the database, and/or data editing can introduce errors. Many of these processing errors are being corrected and adjusted for as the database is being developed and used for this project.

1.1 Coverage Errors

Coverage is the percentage of semi-permanently flooded wetland habitat within a given unit that is covered by the sampling frame. In our case, the sampling frame was a delineated polygon within a geographic information system (GIS). The GRTS design is a dynamic sampling design in that points can be added and/or deleted based on whether a selected point is deemed within the target population and data were collected (TS) or determined non-target (NT) and no measurements were taken. If a point was deemed NT, an additional point could be surveyed starting with the first point on the over-sample list, assuming that all the points were evaluated from the panelone GRTS ordered list. The benefit of the GRTS design is that the target sample size can still be achieved and the realized sample of locations or points should still be spatially balanced within the sample frame. Also, we are able to obtain a (likely) unbiased estimate of coverage by way of the NT and TS recorded information by unit (Table 1, Table 2, Table 3).

In the case of some units, in 2014 the GRTS points provided to the stations were not necessarily used. These are denoted as not evaluated (NotEval) or not all the GRTS points within a surveyed unit were needed. We provide this summary to facilitate the discussion regarding units currently available for data collection in 2015 (Table 1, Table 2).

Table 1. Total number of GRTS points evaluated as TS (target and sampled), NT (non-target), or NotEval (not evaluated).

NotEval	6828
NT	303
TS	1431

Table 2. Summary of GRTS points and evaluations (TS=target and sampled, NT=non-target, NotEval=not evaluated) by unit.

Unit	NotEval	NT	TS	Unit	NotEval	NT	TS
BDW - Black Coulee Pond	58	0	0	GYL - Outlet West	40	0	0
BDW - Drumbo Unit	155	0	0	GYL - Shortys	138	0	0
BDW - Goose Island Pond	60	0	0	LMC - Otter Pond	18	13	29
BDW - Lake Side Extension	60	0	0	LMC - Pond 10	30	0	30
BDW - Lakeside Unit	62	5	77	LMC - Pond 3	20	11	29
BDW - Strater Pond	59	0	0	MDL - 10B	180	0	0
BDW - Teal Pond 1	60	0	0	MDL - Lake11	61	3	60
BDW - Upper Farm Pond	60	0	0	MDL - Sayer Bay	80	0	0
BRL - Bloomington	240	0	0	MLH - 4WO1	240	0	0
BRL - Bunn Lake	112	8	120	MLH - 4WO2	240	0	0
BRL - Merkley Lake	60	0	0	MLH - 4WSO	240	0	0
BRL - Mud Lake	240	0	0	MLH - 5CBR	227	0	13
BRL - Rainbow	98	22	120	MLH - 5CES	240	0	0
BRL - Rainbow Sub	40	50	90	MLH - 5CMI	240	0	0
BRL - South Dingle	180	0	0	MLH - 5CNO	90	0	90
CMS - Big Pond	24	6	30	MLH - 5CWS	197	0	43
CMS - Center Pond	180	0	0	MLH - 6EA1	240	0	0
CMS - Redhead	60	0	0	MLH - 6EA2	240	0	0
CMS - Sandhole Lake	57	19	76	MLH - Benson Reservoir	55	3	24
CMS - Toomey	60	0	0	MLH - Boca Lake	132	0	108
CMS - Toomey sub	60	0	0	MLH - Crane Reservoir	180	0	0
CMS - Two-way Pond	30	0	30	MLH - Darnell Reservoir	66	0	0
FHS - Mallard Unit	52	10	73	MLH - Derrick Lake	180	0	0
GYL - Beavertail	117	3	120	MLH - East Buena Vista	64	0	0
GYL - Big Bend	0	146	94	MLH - East Knox Reservoir	180	0	0
GYL - Bishop Island	240	0	0	MLH - Mud Creek Brood Ponds	60	0	0
GYL - Crane Creek	240	0	0	MLH - West Buena Vista	80	0	0
GYL - Lakefront	116	4	120	MLH - West Knox Reservoir	122	0	55
GYL - Outlet East	168	0	0				

There were a total of 21 units sampled within the 8 refuges surveyed in 2014. The percentage of each unit that was deemed non-target (NT) versus target and sampled (TS) provides a representation of potential over-coverage and under-coverage errors for each unit (Figure 1, Table 3). For example, those units that have a high proportion or percentage of points deemed non-target (e.g., GYL- Big Bend) should re-assess the polygon used for the sampling frame. As an example, at GYL-Big Bend the sampling frame contained 88 points that were deemed seasonally flooded (SF) and 31 points evaluated as temporarily flooded (TF) (Table 4). This suggests that a large portion of the area within a frame contained wetland areas not within semi-permanently flooded wetlands. On the other hand, units that had 100% of points deemed target and sampled may consider whether their sampling frames may be subject to under-coverage. Under-coverage occurs when a portion of semi-permanently flooded wetland is outside of the delineated polygon. These areas have 0 probability of ever being surveyed. This might happen if the delineated polygon boundary for the sampling frame was restricted to areas within open water only. Both of these patterns should be discussed and considered further.

The evaluation criteria used to deem a point non-target is informative to consider when reassessing the sampling frames for certain units. Another consideration is whether using observed species to classify a point as non-target is an unbiased and repeatable criteria. Keeping in mind that the statistical target population of interest is “semi-permanently flooded wetlands” and the sampling frame is the “bridge” to access this target population. Ideally, the sampling frame does not change over time nor as the result of management actions. The main drawback with over-coverage errors is wasted time in the field and, potentially, reduced sample sizes (resulting in larger confidence intervals then desired) within semi-permanently flooded wetland within a unit of interest. On the other hand, for some units data regarding species composition and percent cover occurring within other wetland types outside the scope of this STM project may be of interest as supplementary information.

Table 3. Number of GRTS points by evaluation status (TS=target and sampled, NT=non-target) and the proportion of target points (TS/(NT+TS)), which provides an estimate of coverage for units surveyed in 2014.

	NT	TS	Prop. TS		NT	TS	Prop. TS
BDW - Lakeside Unit	5	77	0.94	LMC - Otter Pond	13	29	0.69
BRL - Bunn Lake	8	120	0.94	LMC - Pond 10	0	30	1
BRL - Rainbow	22	120	0.85	LMC - Pond 3	11	29	0.72
BRL - Rainbow Sub	50	90	0.64	MDL - Lake11	3	60	0.95
CMS - Big Pond	6	30	0.83	MLH - 5CBR	0	13	1
CMS - Sandhole Lake	19	76	0.8	MLH - 5CNO	0	90	1
CMS - Two-way Pond	0	30	1	MLH - 5CWS	0	43	1
FHS - Mallard Unit	10	73	0.88	MLH - Benson Reservoir	3	24	0.89
GYL - Beavertail	3	120	0.98	MLH - Boca Lake	0	108	1
GYL - Big Bend	146	94	0.39	MLH - West Knox Reservoir	0	55	1
GYL - Lakefront	4	120	0.97				

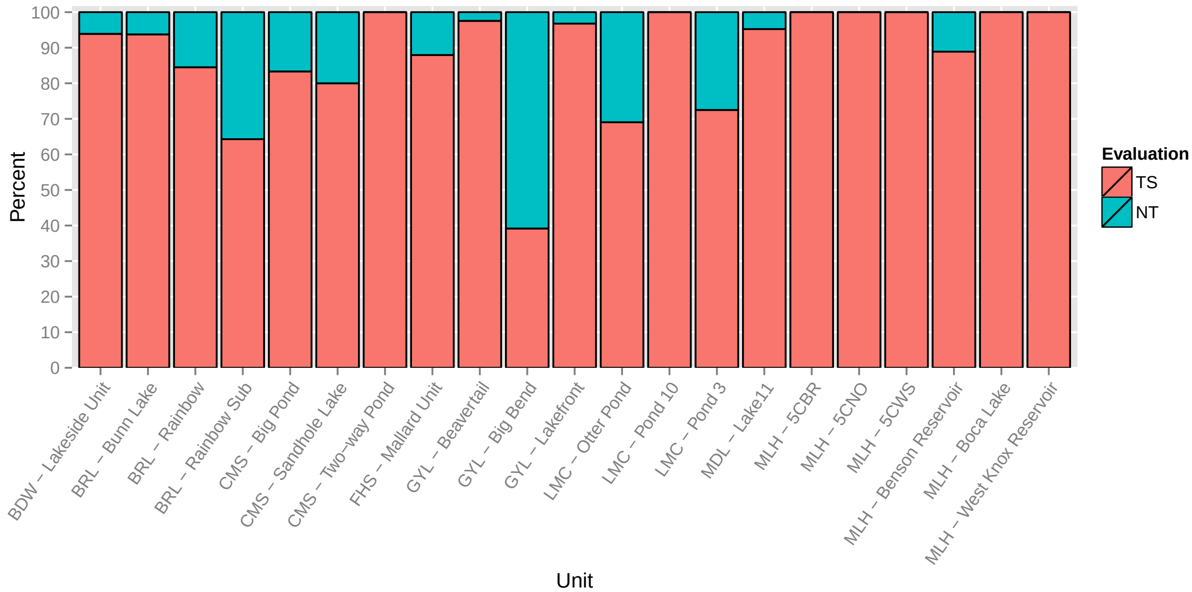


Figure 1. Abiotic Percentage of GRTS points target and sample (TS) versus non-target (NT) in each unit.

Table 4. Specified reason for NT points (IN=inaccessible, SF=seasonally flooded, TF=temporarily flooded, UPL=upland, OTHER=any other reason).

	IN	OTHER	SF	TF	UPL
BDW - Lakeside Unit	0	0	0	0	5
BRL - Bunn Lake	0	0	1	1	6
BRL - Rainbow	0	0	18	3	1
BRL - Rainbow Sub	0	7	10	24	9
CMS - Big Pond	0	0	2	0	4
CMS - Sandhole Lake	0	0	9	2	8
CMS - Two-way Pond	0	0	0	0	0
FHS - Mallard Unit	0	1	8	1	0
GYL - Beavertail	0	0	3	0	0
GYL - Big Bend	0	25	88	31	2
GYL - Lakefront	0	0	1	2	1
LMC - Otter Pond	0	13	0	0	0
LMC - Pond 10	0	0	0	0	0
LMC - Pond 3	0	8	0	0	3
MDL - Lake11	0	0	0	0	3
MLH - 5CBR	0	0	0	0	0
MLH - 5CNO	0	0	0	0	0
MLH - 5CWS	0	0	0	0	0
MLH - Benson Reservoir	0	0	3	0	0
MLH - Boca Lake	0	0	0	0	0
MLH - West Knox Reservoir	0	0	0	0	0

1.2 Non-response, Measurement, and Detection Errors

Non-response refers to the situation when data are not available or collectible from a point. The point is still located within a semi-permanently flooded wetland area, but no data were recorded or available. In environmental and ecological surveys, this usually happens due to accessibility issues. On the other hand, *measurement errors* occur when the recorded value is not the true value. For example, with visually assessed cover, the true cover may be 80%, but an observer recorded 75%, we present a preliminary investigation into measurement errors in Appendix D. A common type of measurement error that occurs with wildlife studies is *detection errors*. Detection errors are false zeros, a species is not recorded because an observer didn't see or "detect" it within a plot. A zero is recorded for % cover, but really the species was present and not detected.

A complication that was anticipated for this project, and did occur, was locations being too turbid for surveying or unbiased data collection. A point was classified as "too turbid" for one of two reasons: (1) the value for water depth was larger than the value for secchi depth or (2) water or secchi depth was missing for the point. The following question arises, should those points classified as "too turbid" be considered "missing" and not included in the analysis or should they be included? If these data records were included, the additional error introduced through increased measurement errors may be substantial. Luckily, most units had minimal or no points excluded from analyses (Table 5). For the reporting in 2014, we excluded the points deemed "too turbid", as a conservative approach to minimizing measurement error. However, further investigation into the differences between points deemed too turbid versus those used for analyses within a unit will be conducted.

Table 5. Number of points by unit that were excluded due to water depth deeper than Secchi disc depth (Turbid), or due to water depth and/or Secchi disc depth data not recorded (Missing). Also included are the total number of points used (Used), the total number target and surveyed (Total TS = Turbid + Missing + Used), the proportion of points excluded (Propportion Excluded = (Turbid + Missing)/(Total)), and the total number of points with a water depth of zero (Dry). Note that canopy cover analysis was conducted for all points that were dry, but not for points that were turbid or were missing data.

	Turbid	Missing	Used	Total TS	Proportion Excluded	Dry
BDW - Lakeside Unit	15	15	47	77	0.39	15
BRL - Bunn Lake	0	0	120	120	0.00	81
BRL - Rainbow	8	0	112	120	0.07	54
BRL - Rainbow Sub	1	0	89	90	0.01	11
CMS - Big Pond	0	0	30	30	0.00	5
CMS - Sandhole Lake	0	0	76	76	0.00	35
CMS - Two-way Pond	0	0	30	30	0.00	30
FHS - Mallard Unit	1	0	72	73	0.01	2
GYL - Beavertail	12	0	108	120	0.10	53
GYL - Big Bend	11	0	83	94	0.12	50
GYL - Lakefront	2	0	118	120	0.02	57
LMC - Otter Pond	5	2	22	29	0.24	0
LMC - Pond 10	7	0	23	30	0.23	0
LMC - Pond 3	7	1	21	29	0.28	3
MDL - Lake11	0	0	60	60	0.00	6
MLH - 5CBR	0	0	13	13	0.00	13
MLH - 5CNO	0	0	90	90	0.00	90
MLH - 5CWS	0	0	43	43	0.00	43
MLH - Benson Reservoir	0	0	24	24	0.00	9
MLH - Boca Lake	0	0	108	108	0.00	71
MLH - West Knox Reservoir	0	0	55	55	0.00	55

2 Appendix B: 2014 Data Summaries

In the following data summaries, points which were labeled as either NotEval or NT (non-target) were not included. In addition, points deemed "too turbid" were excluded from the summaries. A point was classified as "too turbid" for one of two reasons: (1) the value for water depth was larger than the value for secchi depth or (2) water or secchi depth was missing for the point.

For this report, we assume too turbid areas were similar in species presence and abiotic measures compared to those areas that were not too turbid, and drawing inferences to those areas is legitimate. Statistically, this is assuming the mechanism of "non-response" was completely at random and not related to the response variable. This statistical assumption should be discussed relative to those units with many excluded points due to turbidity (BDW-Lakeside Unit, LMC-Otter Pond, LMC-Pond 10, LMC-Pond 3).

2.1a Among-Unit Comparisons of Abiotic Data

The following set of figures compares average abiotic measurements among units (Water level in Figure 2; pH in Figure 3; Specific Conductivity in Figure 4; Salinity in Figure 5; Temperature in Figure 6). The units are presented in ascending order based on average values. Units without abiotic information recorded are located on the far right within each figure. Refer to Section 2.2 for more in-depth by unit vegetation percent cover and abiotic summaries.

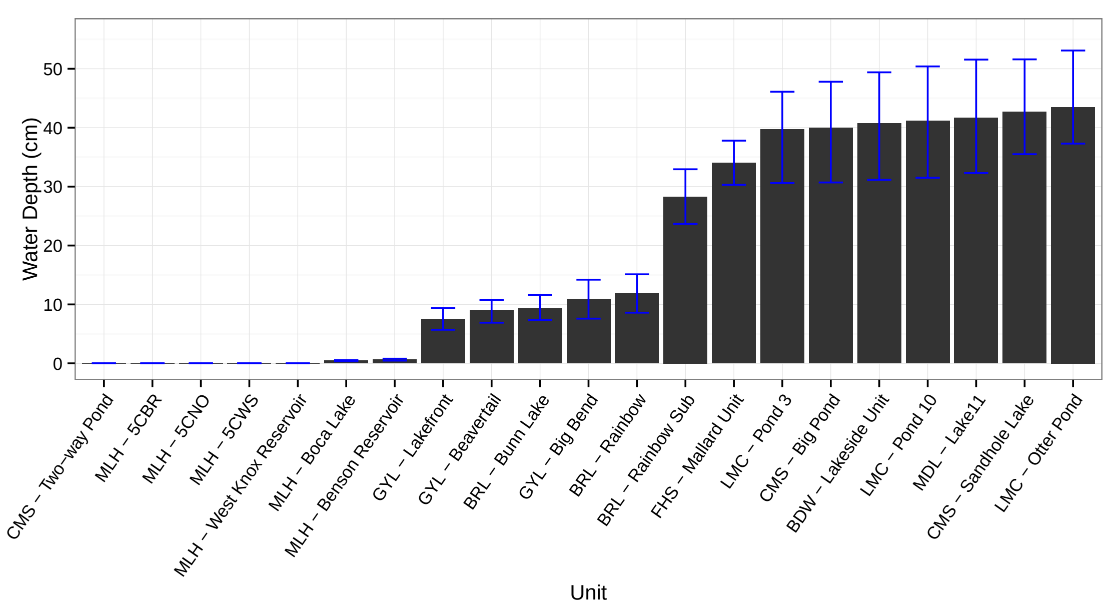


Figure 2. Average water depth for units in ascending order, with 90% confidence intervals. CMS-Two Way Pond, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir have a mean estimate of 0.

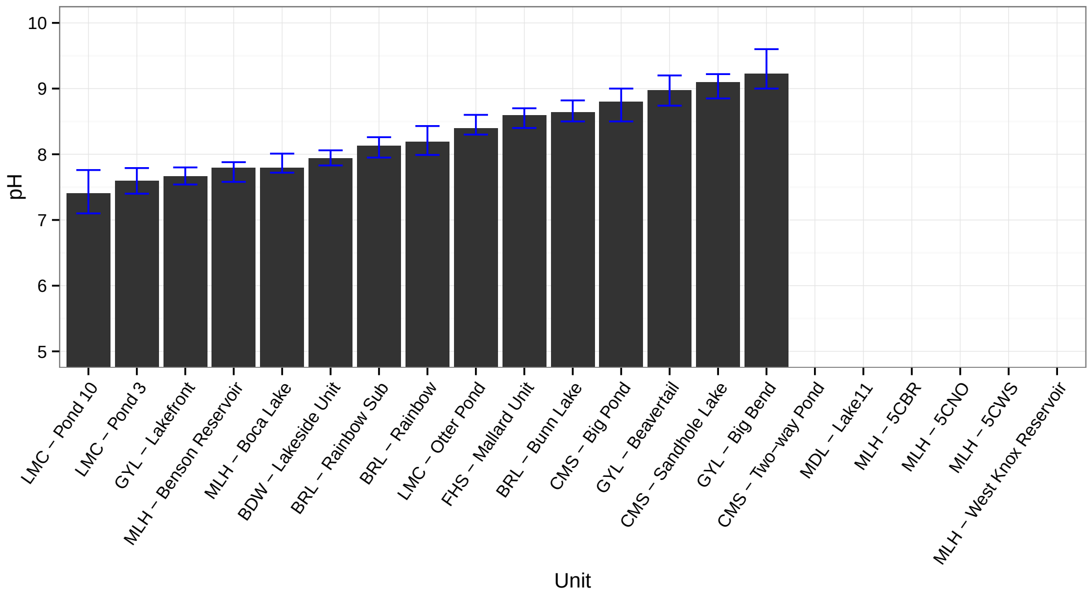


Figure 3. Average pH for units in ascending order, with 90% confidence intervals. Note that MDL-Lake 11 had no pH data recordered, while CMS-Two Way Pond, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir were dry.

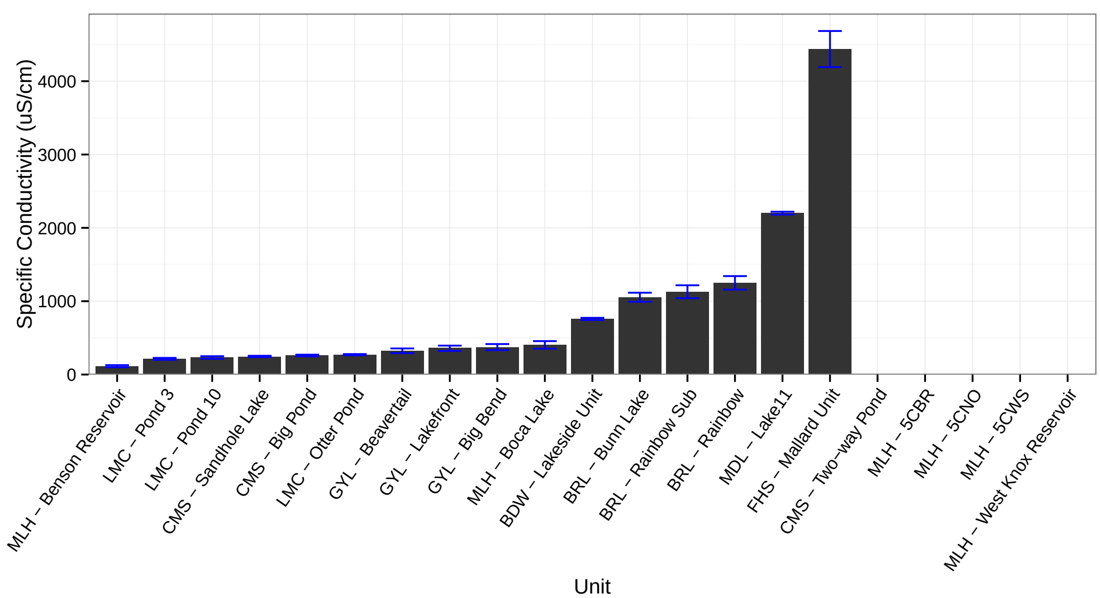


Figure 4. Average specific conductivity for units in ascending order, with 90% confidence intervals. Note that CMS-Two Way Pond, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir had no specific conductivity data recorded because they were dry.

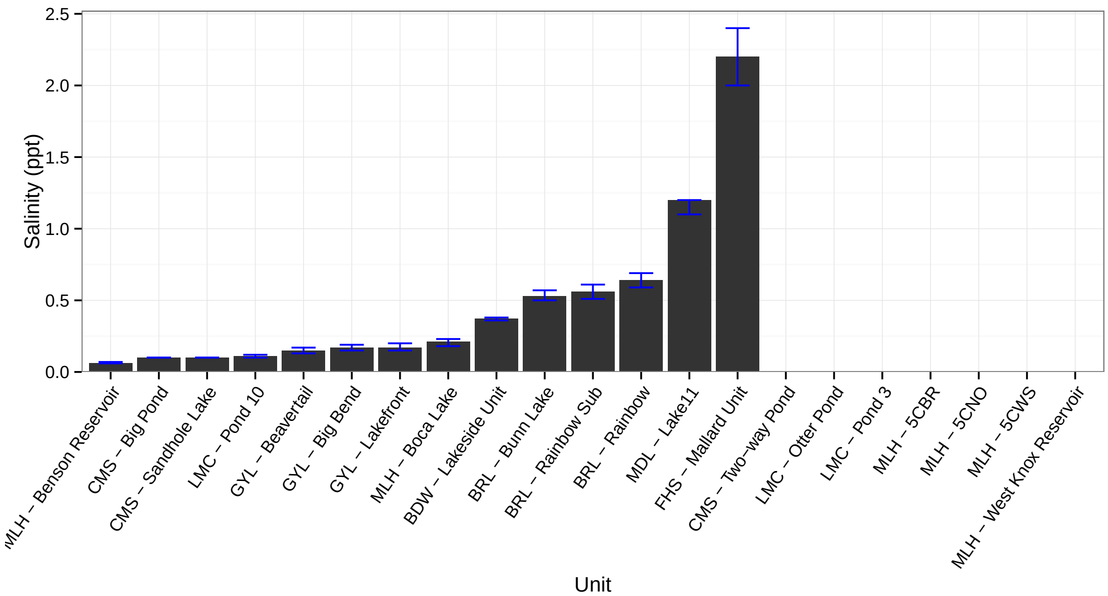


Figure 5. Average salinity for units in ascending order, with 90% confidence intervals. Note that LMC-Pond 3 and LMC-Otter Pond had no salinity data recordered, while CMS-Two-Way Pond, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir were dry.

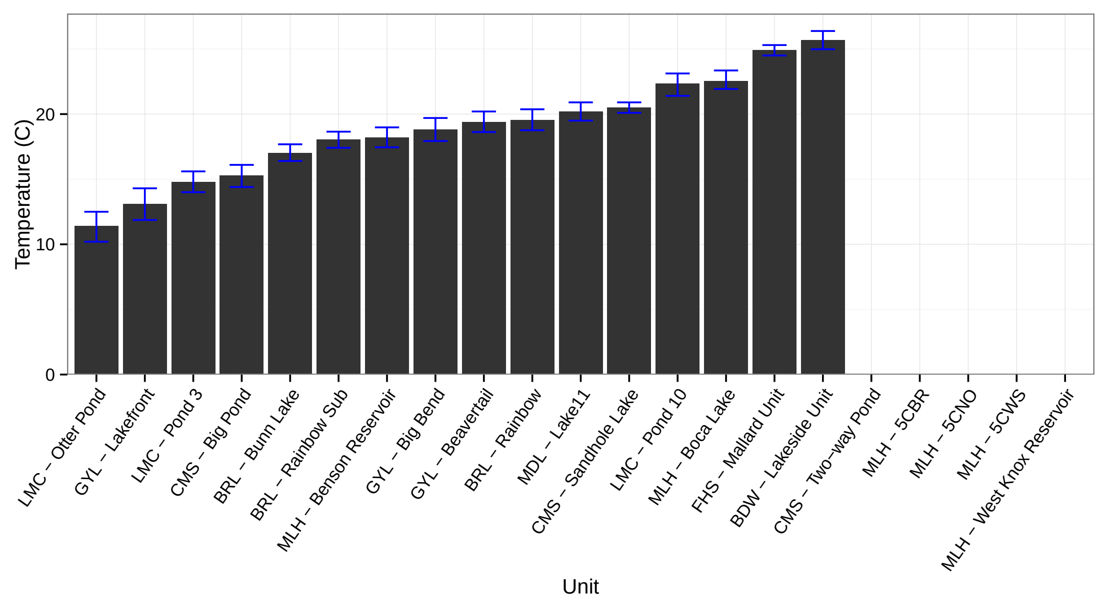


Figure 6. Average temperature ($^{\circ}C$) for units in ascending order, with 90% confidence intervals. Note that CMS-Two Way Pond, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir had no temperature data recorded because they were dry.

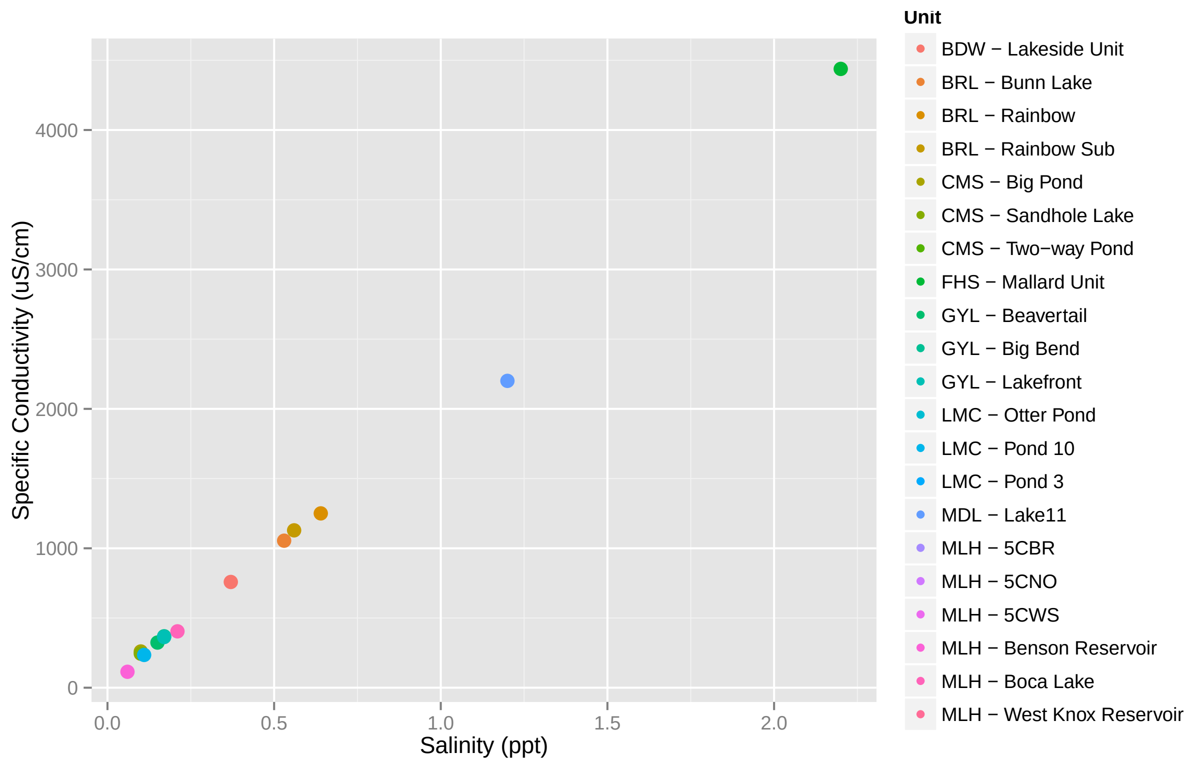


Figure 7. Average salinity and specific conductivity plotted by unit. CMS-Two Way Pond, LMC-Otter Pond, LMC-Pond 3, MLH-5CBR, MLH-5CNO, MLH-5CWS, and MLH-West Knox Reservoir are not plotted due to missing salinity data.

2.1a Among-Unit Comparisons of Vegetation Data

Common genera of tall emergent wetland plant species were grouped for comparison with shortspike watermilfoil (MYSI) and sago pondweed (STPE15) by unit (Figure 8) because these species are of management interest and/or inform phase descriptions for the conceptual STM. Emergent plant groupings were cattail (TY; includes broadleaf, narrowleaf, hybrid, and unidentified cattail), and bulrush (SC; includes hardstem and softstem bulrush).

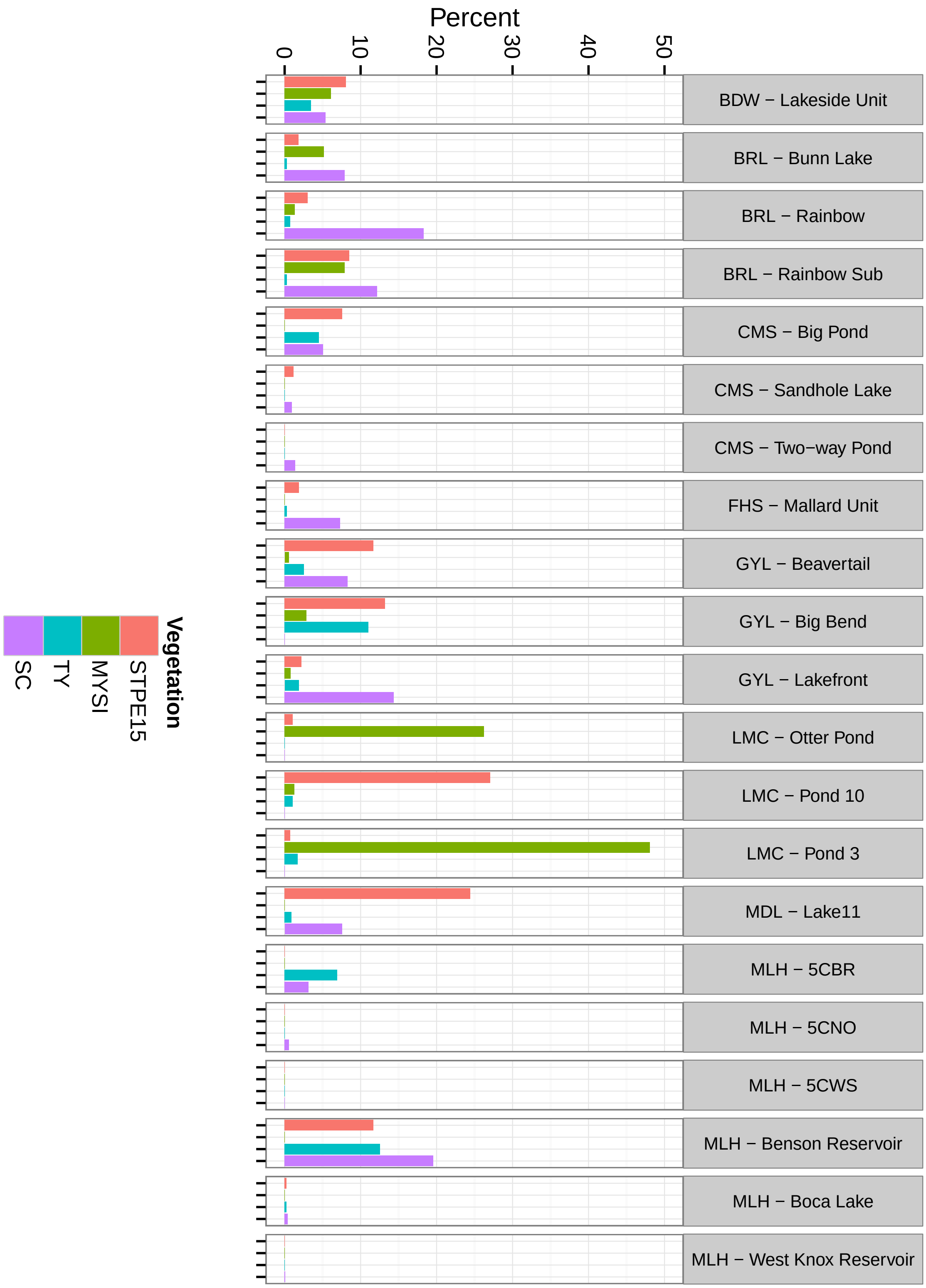


Figure 8. Estimated mean percent cover of sago pondweed (STPE15), shortspike watermilfoil (MYSI), cattail (TY), and bulrush (SC) at all sites for each unit.

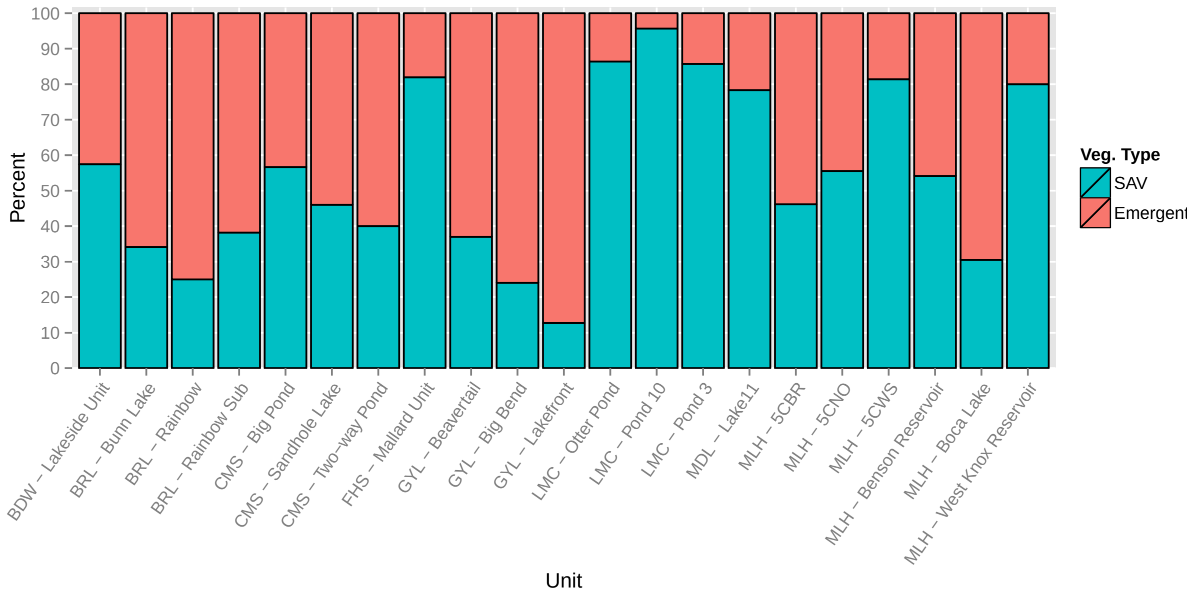


Figure 9. Percentage of points dominated (i.e., $\geqslant$ 50% canopy cover) by SAV wetland vegetation by unit. SAV species groups were: bare substrate (BARESU), water starworts (CAHE2, CALLI6, CAST), hornworts (CEDE4), green algae (CHARA, CHVU, FILAL, NITELL), waterweeds (ELCA7, ELNU2, ELODEA), aquatic mosses (FOAN2), mare's tails (HIVU2), quillworts (ISOETES), mudworts (LIAQ), bladderworts (UTGI, UTMA), duckweeds (LEMI3, LEMNA, LETR, SPPO), water milfoils (MYRIO, MYSI), water nymphs (NAFL, NAJAS), pondweeds (POFO3, POFR3, PONA4, POPR5, POPU7, PORI2, POTAM, POZO, STFIF, STPE15, STUCK, STVA8), aquatic buttercups (RAAQ, RAFL), riccias (RIFL4, RINA), ditchgrasses (RUCI2, RUMA5), watercresses (NAOF), watermeals (WOLFF), and horned pondweeds (ZAPA). Points with <50% SAV wetland vegetation were classified as emergent.

During survey development for 2014, one concern was the potential wasted time and effort spent collecting data from areas with homogeneous stands of emergent species. Based on the 2014 data, 10 different units contained $\geqslant$ 50% of surveyed plots dominated ($\geqslant$ 50% canopy cover) by tall emergent species (Figure 9, BRL - Bunn Lake, BRL - Rainbow, BRL - Rainbow Sub, CMS - Sandhole Lake, CMS - Two-way Pond, GYL - Beavertail, GYL - Big Bend, GYL - Lakefront, MLH - 5CBR, and MLH - Boca Lake).

Figure 10. At sites with at least 50% SAV cover (see Figure 9 for list of SAV species), the estimated mean percent cover of sago pondweed (STPE15), shortspike watermilfoil (MYSI), cattail (TY), and bulrush (SC) for each unit.

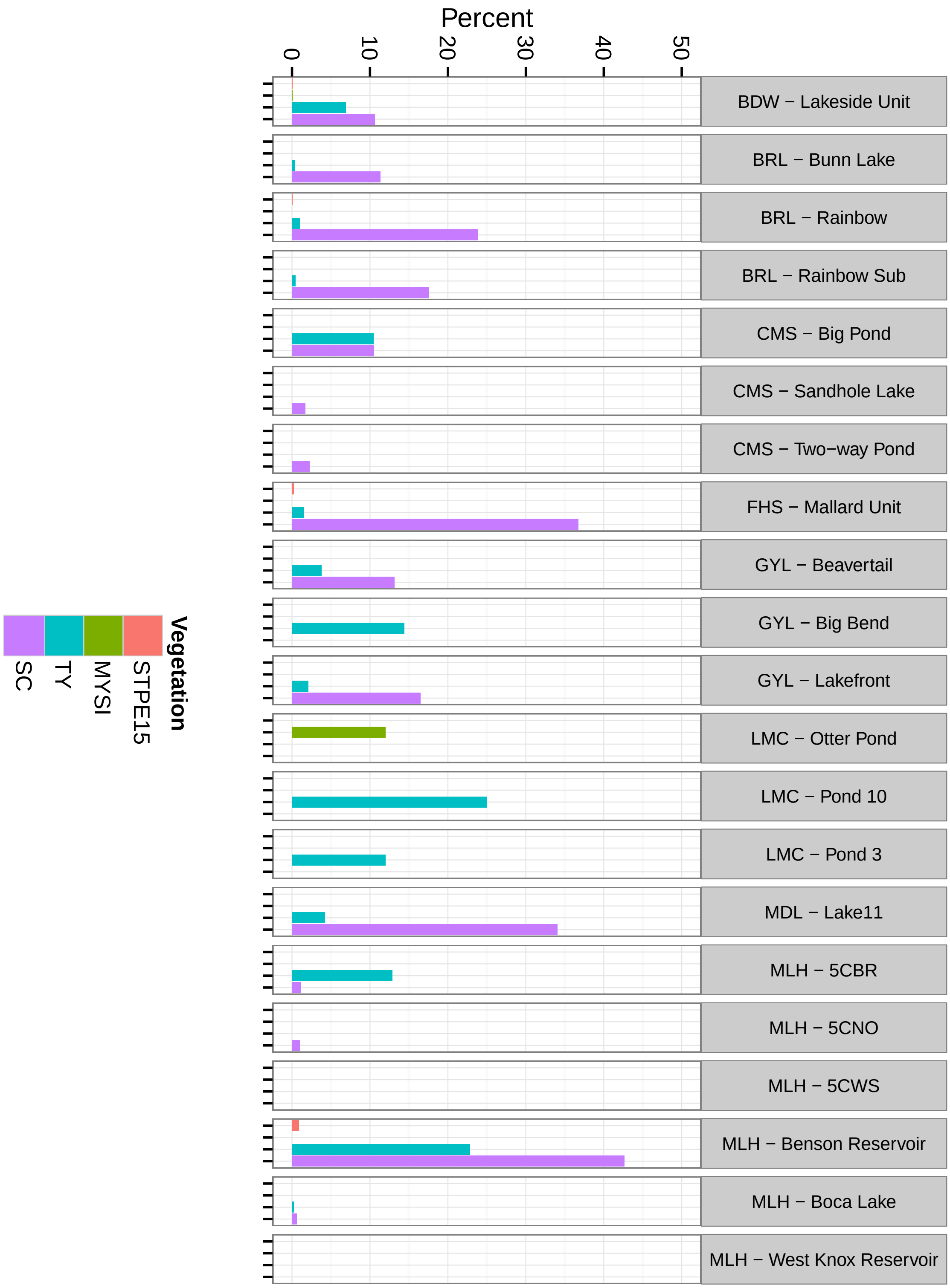


Figure 11. At sites with <50% SAV cover (*i.e.*, emergent sites; see Figure 9 for list of SAV species), the estimated mean percent cover of sago pondweed (STPE15), shortspike watermilfoil (MYSI), cattail (TY), and bulrush (SC) for each unit.

2.2 Summaries by Unit

Each unit surveyed in 2014 has a table reporting design-based estimates for mean percent cover by species (Species codes in Appendix C), water quality variables, and a soil texture graphic. We report an estimate of mean % canopy cover for all sites. However, we also post-stratified the surveyed points into an SAV stratum (defined by a point having at least 50% of its canopy cover dominated by SAV species, bare substrate, and green algae; for species list, see Figure 9, Appendix B) and a non-SAV stratum (defined by a point *not* having at least 50% of its canopy cover dominated by SAV species, bare substrate, and green algae, as listed in Figure 9, Appendix B). The non-SAV stratum predominantly comprises emergent and residual vegetation. We present canopy cover estimates for all sites combined as well as for SAV and non-SAV sites. For a summary of the abiotic water quality information by unit, we present the mean for all sites as well as the mean for SAV sites and non-SAV sites. Similarly, we present the soil texture plot separately for SAV and non-SAV sites. We assume that the visually estimated percent cover is a continuous variable, in reality it was estimated to the nearest 5%. We assume no detection errors, if a species was present within a plot it was recorded. Also, we assume the designated "primary observer" data were accurate (no measurement errors). The presented 90% confidence intervals can be used as a guide to determine whether 2014 levels of survey effort (sample size) was/is sufficient to inform station level objectives. Are the confidence intervals narrow enough to inform management decisions? Conversely, perhaps slightly wider intervals would still inform management?

2.2.1 MDL - Lake 11

Table 1: Design-based estimate of mean percent canopy coverage for vegetation present at MDL - LAKE11. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 60), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 47), and Non-SAV indicates sites not dominated by SAV species (n = 13), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	21.3	(14.7, 27.9)	28	25.5	(17.5, 33.6)	25	6	(0.7, 11.3)	3
CAREX	5.4	(0.7, 10.1)	4				25	(5.2, 44.8)	4
FILAL	34.2	(27, 41.4)	39	42.7	(34.6, 50.7)	37	3.5	(0, 7.3)	2
RESID	6.2	(2.1, 10.3)	8	0.4	(0, 1.1)	1	27.2	(11.4, 42.9)	7
SCAC3	7.5	(2.7, 12.4)	9	0.2	(0, 0.6)	1	34.1	(15.8, 52.3)	8
STPE15	24.4	(18.9, 29.9)	44	31.2	(25.1, 37.2)	44			
TYLA	0.9	(0, 2.4)	1				4.2	(0, 11.2)	1

Table 2: Summary of water quality information for all point locations at MDL - LAKE11.

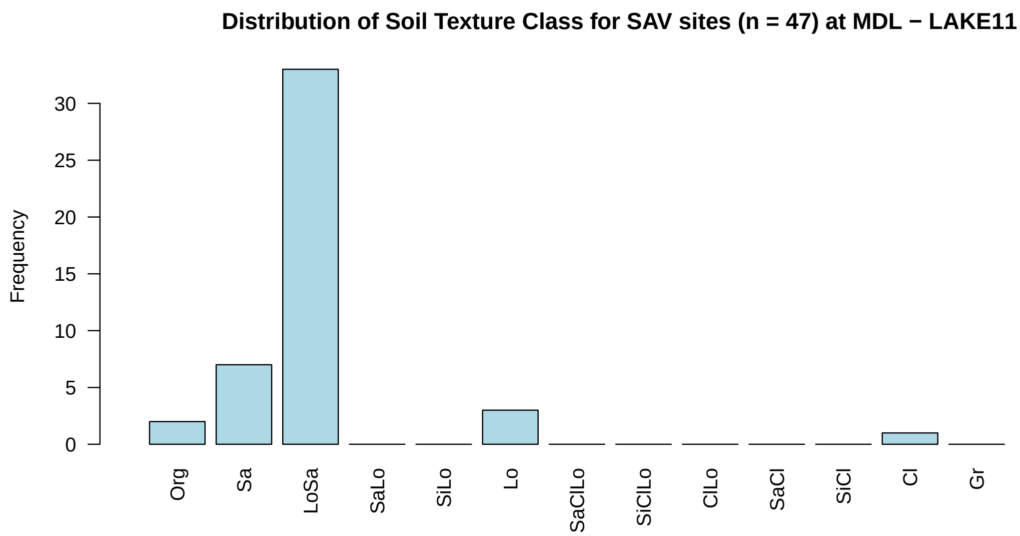
	n	Min	Mean	SE	Max
Water depth	60	0	41.7	2.67	78
Secchi Depth	60	0	41.7	2.67	78
pH level	NA				
Specific Conductivity	48	2028	2200.8	11.92	2324
Salinity	42	1.1	1.2	0.01	1.3
Temperature	48	15.2	20.2	0.41	24.2

Table 3: Summary of water quality information for SAV point locations at MDL - LAKE11.

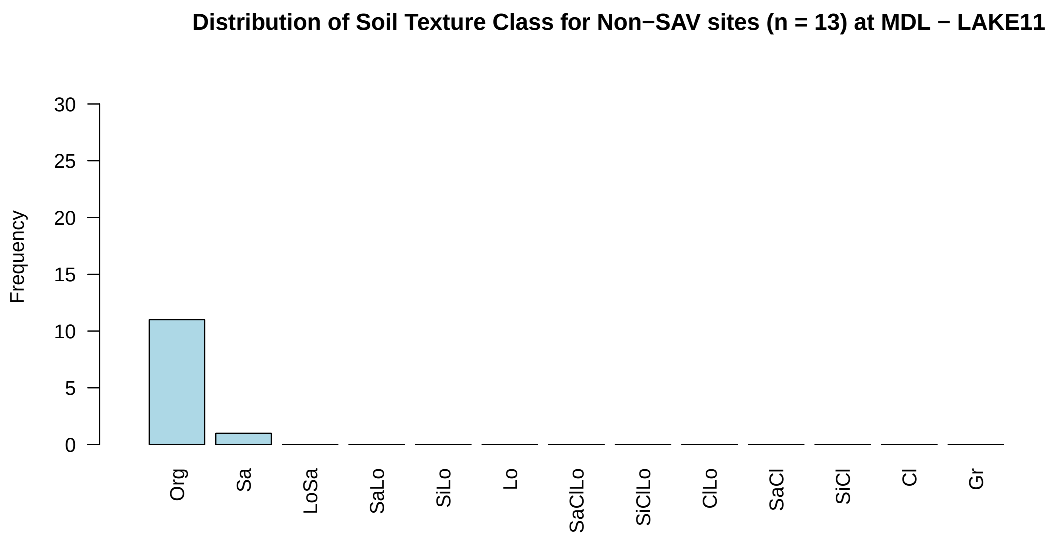
	n	Min	Mean	SE	Max
Water depth	47	10	49.6	1.92	78
Secchi Depth	47	10	49.6	1.92	78
pH level	NA				
Specific Conductivity	45	2028	2203.6	12.46	2324
Salinity	39	1.1	1.2	0.01	1.3
Temperature	45	15.8	20.2	0.41	24.2

Table 4: Summary of water quality information for Non-SAV point locations at MDL - LAKE11.

	n	Min	Mean	SE	Max
Water depth	13	0	13.2	4.89	50
Secchi Depth	13	0	13.2	4.89	50
pH level	NA				
Specific Conductivity	3	2090	2159.7	35.36	2205
Salinity	3	1.1	1.1	0	1.1
Temperature	3	15.2	20.3	2.61	23.9



Distribution of Soil Texture Class for SAV sites (n = 47) at MDL − LAKE11
Frequency
0
5
10
15
20
25
30
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr



Distribution of Soil Texture Class for Non−SAV sites (n = 13) at MDL − LAKE11
Frequency
0
5
10
15
20
25
30
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.2 BDW - Lakeside Unit

Table 5: Design-based estimate of mean percent canopy coverage for vegetation present at BDW - LAKESIDE UNIT. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 47), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 27), and Non-SAV indicates sites not dominated by SAV species (n = 20), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	28.3	(20.1, 36.5)	28	42.6	(30.7, 54.5)	19	9	(3.8, 14.2)	9
BESY	1.7	(0, 4.5)	2				4	(0, 10.5)	2
CAREX	0.3	(0, 0.8)	1				0.8	(0, 2)	1
CEDE4	8.5	(2.5, 14.4)	6	14.7	(4.8, 24.7)	6			
CIAR4	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
FILAL	7.4	(2, 12.8)	15	12.6	(3.4, 21.7)	10	0.5	(0.1, 0.9)	5
LEMNA	0.1	(0, 0.1)	3	0.1	(0, 0.2)	2	Trace	(0, 0.1)	1
MYSI	6.1	(1.7, 10.5)	10	10.5	(3.1, 18)	9	0.1	(0, 0.3)	1
RESID	20.1	(12.4, 27.7)	18	2.9	(0, 6.1)	4	43.3	(29.8, 56.8)	14
SACU	0.1	(0, 0.3)	1	0.2	(0, 0.5)	1			
SCAC3	5.4	(2.3, 8.5)	13	1.5	(0, 3.1)	5	10.7	(4.2, 17.1)	8
STPE15	8.1	(3.2, 12.9)	13	14	(6.1, 21.9)	12	Trace	(0, 0.1)	1
TYAN	1.5	(0.2, 2.8)	4	0.9	(0, 2.4)	1	2.2	(0, 4.6)	3
TYGL	2	(0, 4.1)	4	Trace	(0, 0.1)	1	4.7	(0, 9.6)	3
UNFOR	0.1	(0, 0.3)	1				0.2	(0, 0.7)	1

Table 6: Summary of water quality information for all point locations at BDW - LAKESIDE UNIT.

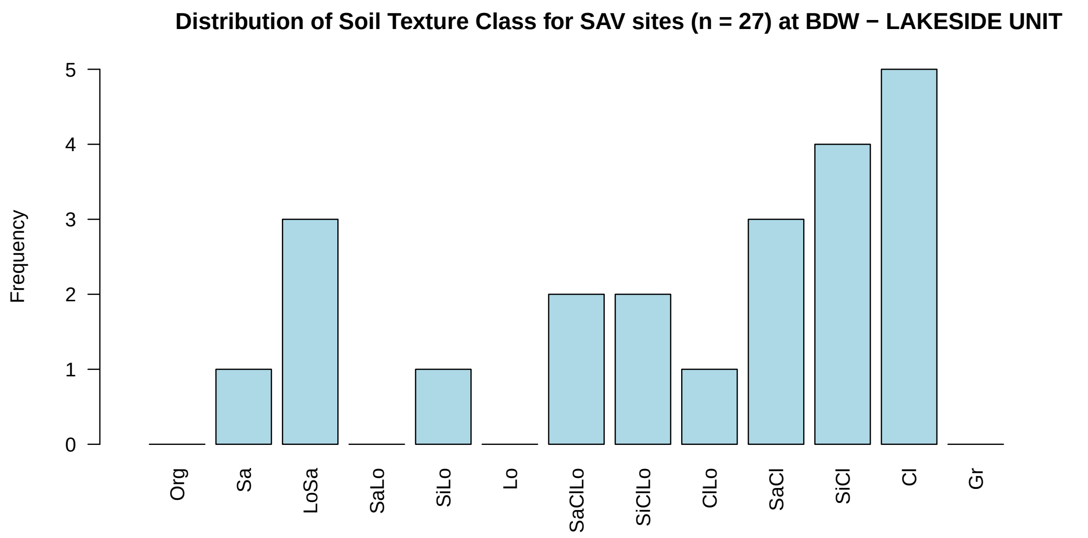
	n	Min	Mean	SE	Max
Water depth	47	0	40.77	5.85	125
Secchi Depth	47	0	40.77	5.85	125
pH level	32	6.54	7.94	0.07	8.35
Specific Conductivity	32	688	758.38	8.87	870
Salinity	32	0.34	0.37	0	0.42
Temperature	32	22.11	25.68	0.43	31.99

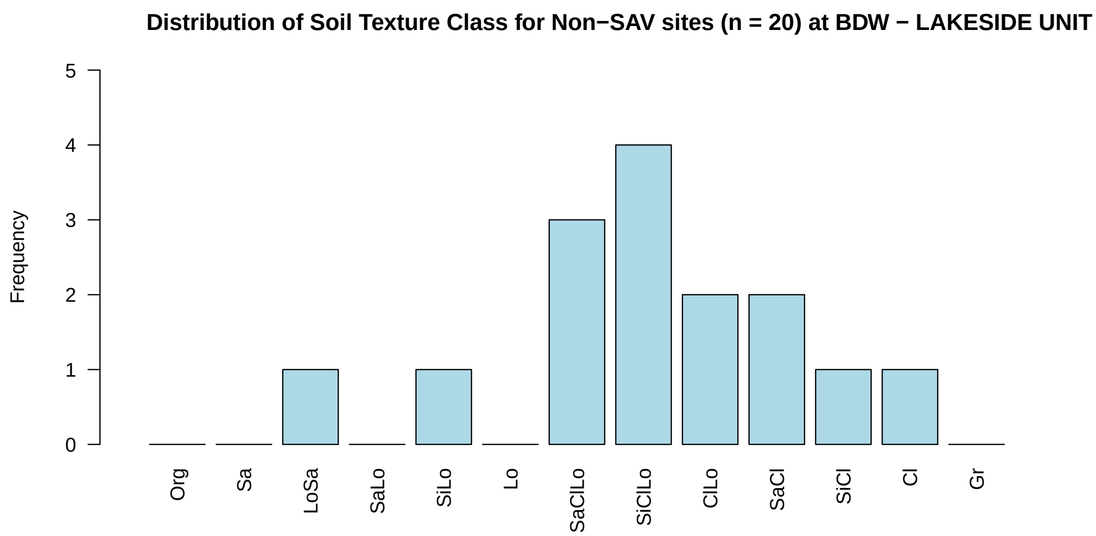
Table 7: Summary of water quality information for SAV point locations at BDW - LAKESIDE UNIT.

	n	Min	Mean	SE	Max
Water depth	27	0	48.19	5.94	125
Secchi Depth	27	0	48.19	5.94	125
pH level	25	6.54	7.92	0.09	8.33
Specific Conductivity	25	688	763	9.67	851
Salinity	25	0.34	0.37	0	0.42
Temperature	25	22.11	25.74	0.46	30.25

Table 8: Summary of water quality information for Non-SAV point locations at BDW - LAKESIDE UNIT.

	n	Min	Mean	SE	Max
Water depth	20	0	30.75	10.98	125
Secchi Depth	20	0	30.75	10.98	125
pH level	7	7.56	8.03	0.1	8.35
Specific Conductivity	7	704	741.86	21.6	870
Salinity	7	0.34	0.36	0.01	0.42
Temperature	7	23.24	25.47	1.12	31.99


Distribution of Soil Texture Class for SAV sites (n = 27) at BDW − LAKESIDE UNIT
Frequency
0
1
2
3
4
5
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 20) at BDW − LAKESIDE UNIT
Frequency
0
1
2
3
4
5
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.3 LMC - Otter Pond

Table 9: Design-based estimate of mean percent canopy coverage for vegetation present at LMC - OTTER POND. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 22), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 19), and Non-SAV indicates sites not dominated by SAV species (n = 3), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	24.1	(12.4, 35.8)	10	27.9	(14.9, 40.9)	10			
CAREX	0.3	(0, 0.7)	1				2	(0, 5.3)	1
CEDE4	Trace	(0, 0.1)	1	0.1	(0, 0.1)	1			
CHVU	4.4	(0.8, 8)	7	5.1	(0.9, 9.2)	6	0.3	(0, 0.9)	1
CIAR4	Trace	(0, 0.1)	1				0.3	(0, 0.9)	1
ELNU2	0.2	(0, 0.4)	2	0.2	(0, 0.4)	1	0.3	(0, 0.9)	1
FILAL	6.2	(2.2, 10.2)	10	6.5	(2, 11.1)	8	4.3	(0, 9.2)	2
GLGR	Trace	(0, 0.1)	1				0.3	(0, 0.9)	1
LEMI3	0.5	(0.1, 0.8)	7	0.5	(0.1, 0.8)	6	0.3	(0, 0.9)	1
MYSI	26.2	(14, 38.5)	15	28.5	(14.6, 42.3)	13	12	(0, 30.9)	2
PHAR3	4.2	(0, 11.1)	1				30.7	(0, 81.1)	1
POLSP	1.1	(0.1, 2.1)	4	0.7	(0, 1.5)	3	3.3	(0, 8.8)	1
POPU7	2.5	(0, 6.6)	1	2.9	(0, 7.7)	1			
PORI2	2.5	(0, 5.8)	4	2.8	(0, 6.7)	4			
POTAM	11	(2.8, 19.1)	8	12.2	(2.9, 21.6)	6	3	(0, 7.1)	2
RANUN	Trace	(0, 0.1)	1	0.1	(0, 0.1)	1			
RESID	3.2	(0, 6.8)	2	3.7	(0, 7.9)	2			
RINA	0.1	(0, 0.2)	2	0.1	(0, 0.1)	1	0.3	(0, 0.9)	1
RUMA4	0.3	(0, 0.7)	1	0.3	(0, 0.8)	1			
STFIF	5.8	(0.3, 11.4)	5	6.7	(0.4, 13.1)	5			
STPE15	1	(0, 2.7)	2	1.2	(0, 3.1)	2			
UNFOR	6.2	(0, 12.9)	5	0.4	(0, 0.9)	3	43	(7.6, 78.4)	2
UNGRA	0.3	(0, 0.7)	1	0.3	(0, 0.8)	1			
VERON	Trace	(0, 0.1)	1	0.1	(0, 0.1)	1			

Table 10: Summary of water quality information for all point locations at LMC - OTTER POND.

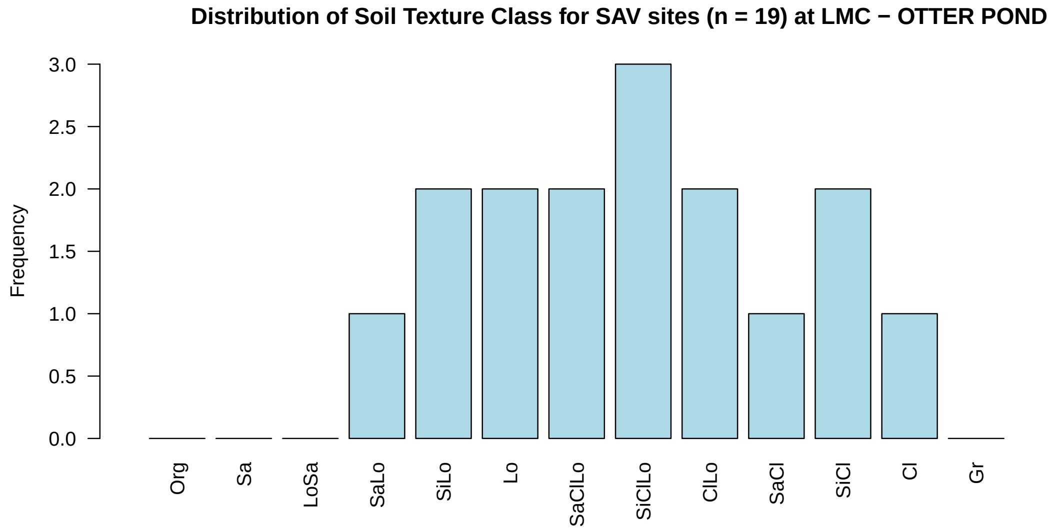
	n	Min	Mean	SE	Max
Water depth	22	3	43.5	4.91	86
Secchi Depth	22	3	43.5	4.91	86
pH level	22	7.8	8.4	0.09	9.2
Specific Conductivity	21	211.8	270.7	5.18	296.4
Salinity	NA				
Temperature	22	6.3	11.4	0.7	16.3

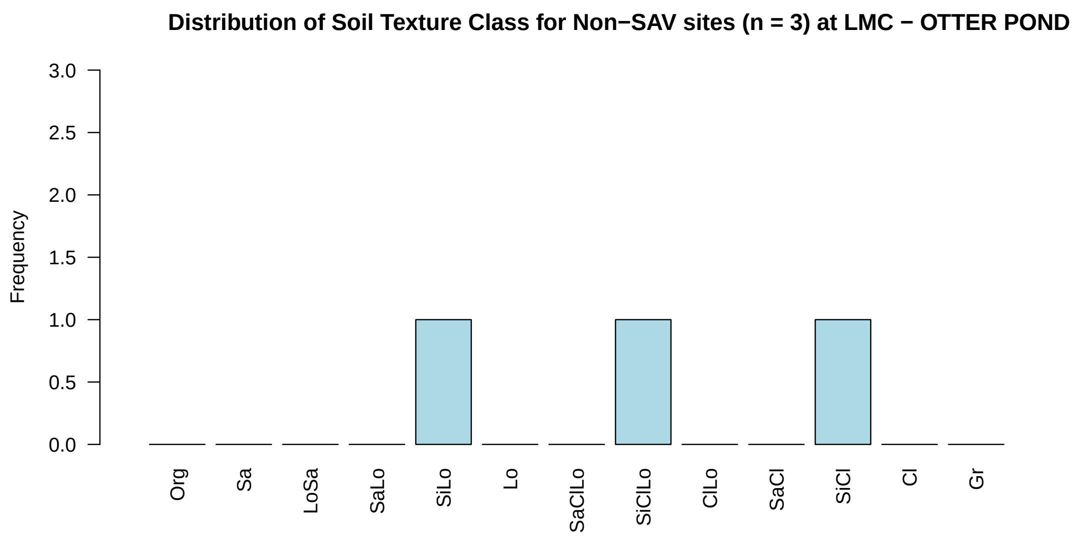
Table 11: Summary of water quality information for SAV point locations at LMC - OTTER POND.

	n	Min	Mean	SE	Max
Water depth	19	12	44.6	5.2	86
Secchi Depth	19	12	44.6	5.2	86
pH level	19	7.8	8.5	0.1	9.2
Specific Conductivity	19	211.8	269.8	5.69	296.4
Salinity	NA				
Temperature	19	6.4	11.5	0.75	16.3

Table 12: Summary of water quality information for Non-SAV point locations at LMC - OTTER POND.

	n	Min	Mean	SE	Max
Water depth	3	3	36.7	16.95	57
Secchi Depth	3	3	36.7	16.95	57
pH level	3	8	8.2	0.12	8.3
Specific Conductivity	2	279	279.6	0.55	280.1
Salinity	NA				
Temperature	3	6.3	10.8	2.24	13.2


Distribution of Soil Texture Class for SAV sites (n = 19) at LMC − OTTER POND
Frequency
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 3) at LMC − OTTER POND
Frequency
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.4 LMC - Pond 10

Table 13: Design-based estimate of mean percent canopy coverage for vegetation present at LMC - POND 10. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 23), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 22), and Non-SAV indicates sites not dominated by SAV species (n = 1), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	11	(3.8, 18.1)	12	11.5	(4, 18.9)	12			
CEDE4	3.4	(0.2, 6.6)	5	3.6	(0.2, 6.9)	5			
CHVU	3.6	(0.1, 7.1)	7	3.8	(0.2, 7.4)	7			
ELCA7	1.4	(0, 3.2)	4	1.5	(0, 3.3)	4			
ELNU2	2.8	(0.5, 5.1)	6	3	(0.6, 5.3)	6			
FILAL	15.7	(6.2, 25.3)	11	16.5	(6.5, 26.4)	11			
LEMI3	1.7	(0.3, 3.1)	17	0.9	(0.6, 1.3)	16	20	(NA, NA)	1
MYSI	1.3	(0.1, 2.5)	4	1.4	(0.1, 2.6)	4			
NAFL	10	(4.4, 15.6)	12	10.5	(4.6, 16.3)	12			
POPU7	0.3	(0, 0.7)	3	0.3	(0, 0.7)	3			
PORI2	2.8	(0, 6.1)	2	3	(0, 6.4)	2			
POZO	0.9	(0, 2)	2	0.9	(0, 2.1)	2			
RESID	2.6	(0, 6.5)	2	0.2	(0, 0.6)	1	55	(NA, NA)	1
SPPO	0.3	(0.1, 0.4)	6	0.3	(0.1, 0.4)	6			
STFIF	13.5	(4.5, 22.4)	9	14.1	(4.8, 23.4)	9			
STPE15	27	(16.3, 37.8)	17	28.3	(17.2, 39.3)	17			
STVA8	Trace	(0, 0.1)	1	Trace	(0, 0.1)	1			
TYLA	1.1	(0, 2.9)	1				25	(NA, NA)	1
UNFOR	Trace	(0, 0.1)	1	Trace	(0, 0.1)	1			
UNGRA	Trace	(0, 0.1)	1	Trace	(0, 0.1)	1			

Table 14: Summary of water quality information for all point locations at LMC - POND 10.

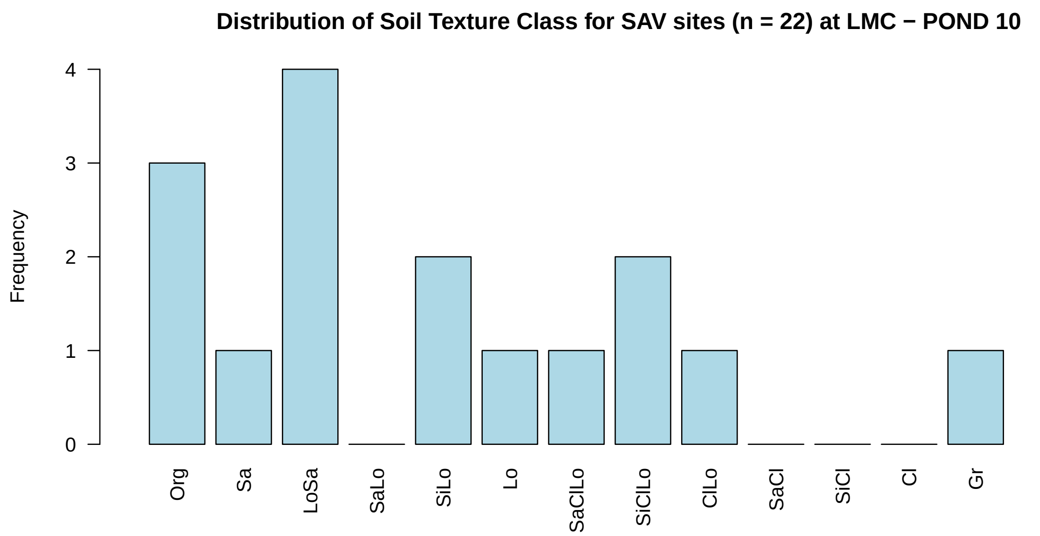
	n	Min	Mean	SE	Max
Water depth	23	7	41.13	6.34	126
Secchi Depth	23	7	41.13	6.34	126
pH level	23	5.12	7.41	0.22	9.2
Specific Conductivity	23	120.5	235.12	12.56	414
Salinity	23	0.07	0.11	0.01	0.2
Temperature	23	15.25	22.36	0.6	26.7

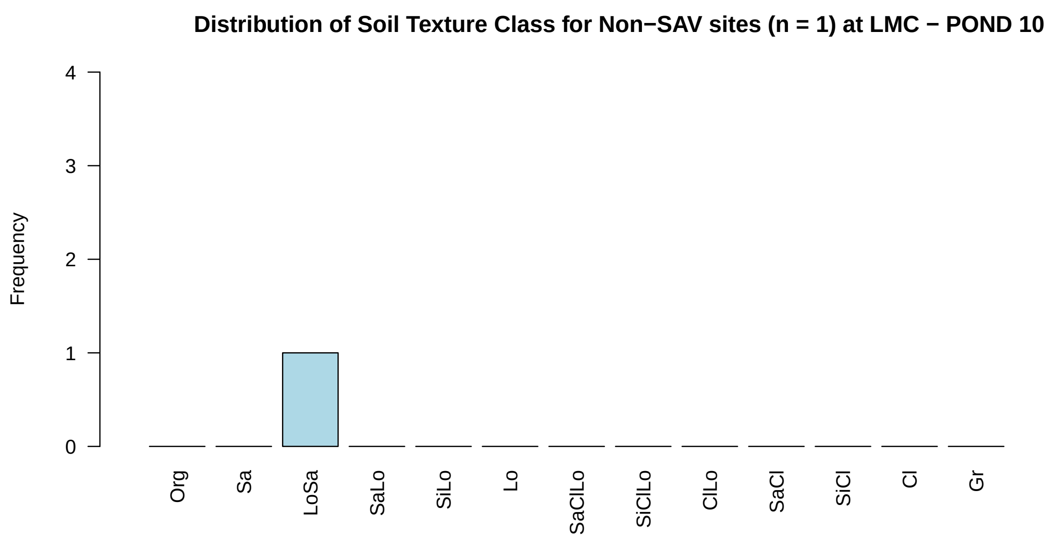
Table 15: Summary of water quality information for SAV point locations at LMC - POND 10.

	n	Min	Mean	SE	Max
Water depth	22	7	40.14	6.55	126
Secchi Depth	22	7	40.14	6.55	126
pH level	22	5.12	7.46	0.22	9.2
Specific Conductivity	22	120.5	232.31	12.81	414
Salinity	22	0.07	0.11	0.01	0.2
Temperature	22	15.25	22.51	0.61	26.7

Table 16: Summary of water quality information for Non-SAV point locations at LMC - POND 10.

	n	Min	Mean	SE	Max
Water depth	1		63		
Secchi Depth	1		63		
pH level	1		6.26		
Specific Conductivity	1		297		
Salinity	1		0.14		
Temperature	1		19.06		


Distribution of Soil Texture Class for SAV sites (n = 22) at LMC − POND 10
Frequency
0
1
2
3
4
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 1) at LMC − POND 10
Frequency
0
1
2
3
4
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.5 LMC - Pond 3

Table 17: Design-based estimate of mean percent canopy coverage for vegetation present at LMC - POND 3. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 21), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 18), and Non-SAV indicates sites not dominated by SAV species (n = 3), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	5.5	(0.7, 10.4)	4	4.5	(0, 9.4)	3	11.7	(0, 30.9)	1
CAREX	7.3	(0, 15.2)	3				51.3	(15, 87.6)	3
CEDE4	6.6	(0.2, 13.1)	8	7.7	(0.3, 15.2)	8			
ELNU2	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
EPCIC	0.1	(0, 0.2)	2				0.7	(0.1, 1.2)	2
FILAL	23.3	(10.6, 35.9)	8	25.1	(10.7, 39.5)	7	12.3	(0, 32.6)	1
LEMI3	0.2	(0.1, 0.4)	5	0.2	(0, 0.3)	3	0.7	(0.1, 1.2)	2
MYSI	48.1	(33, 63.2)	18	56.1	(40.5, 71.7)	18			
PORI2	1.1	(0, 2.6)	2	1.3	(0, 3)	2			
RESID	2.8	(0, 6)	5	2.3	(0, 6)	2	5.3	(0, 10.8)	3
RINA	0.2	(0, 0.4)	3	0.1	(0, 0.2)	1	1	(0, 2)	2
SPPO	0.2	(0, 0.3)	4	0.1	(0, 0.2)	2	0.7	(0.1, 1.2)	2
STFIF	0.3	(0, 0.6)	3	0.3	(0, 0.7)	3			
STPE15	0.7	(0, 1.6)	4	0.8	(0, 1.9)	4			
STVA8	0.3	(0, 0.9)	1	0.4	(0, 1)	1			
TYLA	1.7	(0, 4.5)	2				12	(0, 30.9)	2
UNFOR	0.6	(0, 1.4)	2				4	(0, 9.8)	2
ZAPA	0.9	(0, 2.2)	2	0.9	(0, 2.5)	1	0.3	(0, 0.9)	1

Table 18: Summary of water quality information for all point locations at LMC - POND 3.

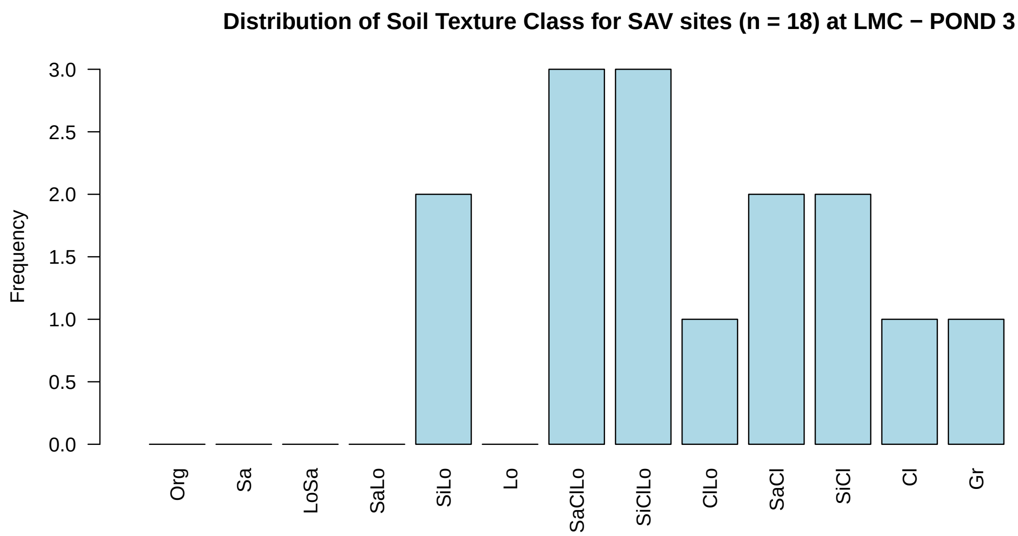
	n	Min	Mean	SE	Max
Water depth	21	0	39.7	4.95	82
Secchi Depth	21	0	39.7	4.95	82
pH level	19	6.7	7.6	0.12	9
Specific Conductivity	19	159.4	213.8	8.12	299
Salinity	NA				
Temperature	19	10.4	14.8	0.46	18

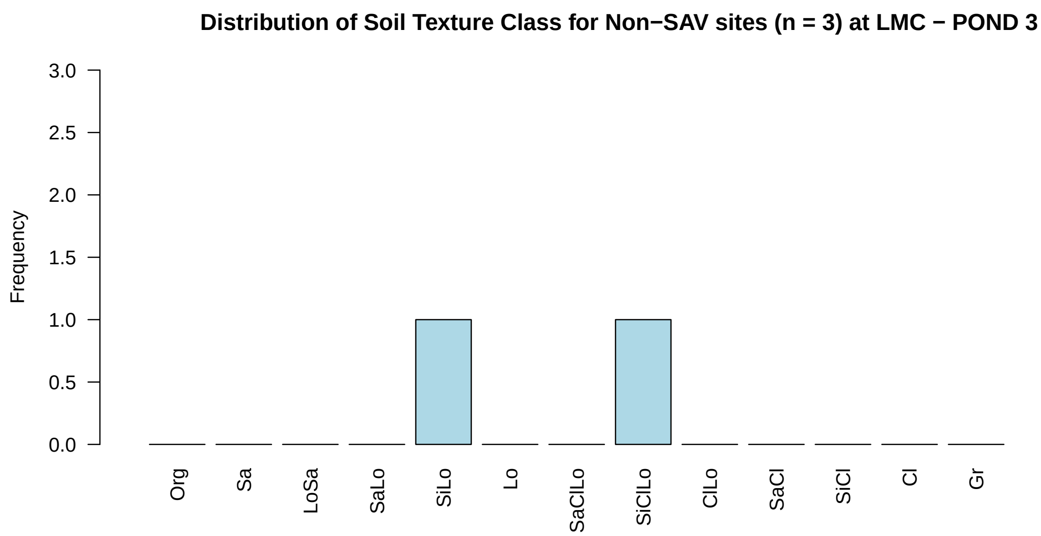
Table 19: Summary of water quality information for SAV point locations at LMC - POND 3.

	n	Min	Mean	SE	Max
Water depth	18	0	45.2	4.51	82
Secchi Depth	18	0	45.2	4.51	82
pH level	18	6.7	7.6	0.13	9
Specific Conductivity	18	159.4	216.4	8.12	299
Salinity	NA				
Temperature	18	10.4	15	0.44	18

Table 20: Summary of water quality information for Non-SAV point locations at LMC - POND 3.

	n	Min	Mean	SE	Max
Water depth	3	0	6.67	6.67	20
Secchi Depth	3	0	6.67	6.67	20
pH level	1		7.1		
Specific Conductivity	1		166.7		
Salinity	NA				
Temperature	1		11.1		


Distribution of Soil Texture Class for SAV sites (n = 18) at LMC − POND 3
Frequency
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 3) at LMC − POND 3
Frequency
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.6 CMS - Big Pond

Table 21: Design-based estimate of mean percent canopy coverage for vegetation present at CMS - BIG POND. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 30), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 17), and Non-SAV indicates sites not dominated by SAV species (n = 13), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
ALISM	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
ASTER	0.3	(0, 0.9)	1				0.8	(0, 2)	1
BARESU	24.5	(17.8, 31.2)	25	28.1	(18.4, 37.7)	16	19.9	(11.1, 28.6)	9
CAHE2	0.1	(0, 0.1)	2	0.1	(0, 0.2)	2			
CHARA	20.5	(11.2, 29.7)	14	36.1	(22.8, 49.4)	14			
CIAR4	3.9	(0.2, 7.7)	5				9.1	(0.8, 17.4)	5
FILAL	0.3	(0, 0.9)	1	0.6	(0, 1.6)	1			
JUAR2	0.5	(0, 1.3)	1				1.1	(0, 3)	1
LEMI3	0.6	(0, 1.1)	7				1.3	(0.1, 2.5)	7
MEAR4	0.2	(0, 0.4)	2				0.5	(0, 1)	2
MENTH	0.8	(0, 2.2)	1				1.9	(0, 5.1)	1
MYSI	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
NAFL	0.1	(0, 0.2)	1	0.1	(0, 0.3)	1			
PORI2	0.3	(0, 0.6)	3	0.6	(0.1, 1.1)	3			
RAAQ	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
RESID	17.9	(11, 24.8)	15	1.2	(0, 2.7)	2	39.9	(31.5, 48.2)	13
RUMEX	0.8	(0, 2.2)	1				1.9	(0, 5.1)	1
SCAC3	4.5	(1.2, 7.8)	10	0.9	(0, 2.3)	1	9.2	(2.2, 16.2)	9
SCTA2	0.6	(0, 1.4)	3				1.3	(0, 3.2)	3
SPPO	0.1	(0, 0.2)	1				0.2	(0, 0.4)	1
STFIF	3.3	(1.2, 5.5)	6	5.9	(2.3, 9.4)	6			
STPE15	7.6	(2.3, 12.8)	10	13.4	(4.7, 22)	10			
TYLA	4.3	(1.6, 7.1)	7				10	(4.5, 15.5)	7
TYPHA	0.2	(0, 0.4)	2				0.5	(0, 1)	2
UNFOR	1.4	(0.3, 2.6)	5	0.6	(0, 1.6)	1	2.5	(0.3, 4.8)	4
UNGRA	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
ZAPA	7	(1.5, 12.4)	8	12.3	(3.1, 21.5)	8			

Table 22: Summary of water quality information for all point locations at CMS - BIG POND.

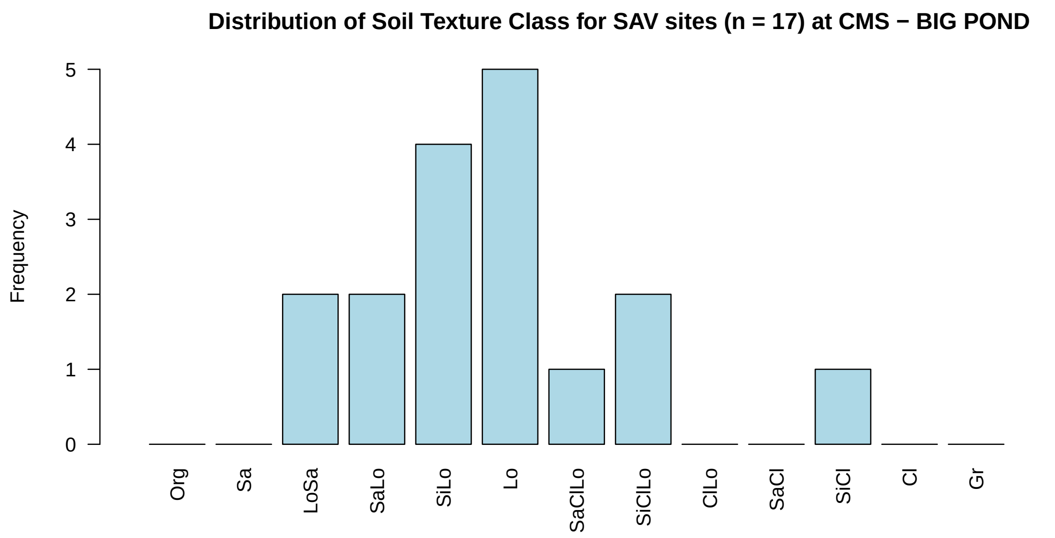
	n	Min	Mean	SE	Max
Water depth	30	0	40	5.71	92
Secchi Depth	30	0	40	5.71	92
pH level	25	7.7	8.8	0.14	10
Specific Conductivity	25	205.3	259.9	7.04	302.6
Salinity	25	0.1	0.1	0	0.1
Temperature	25	10.6	15.3	0.54	18.6

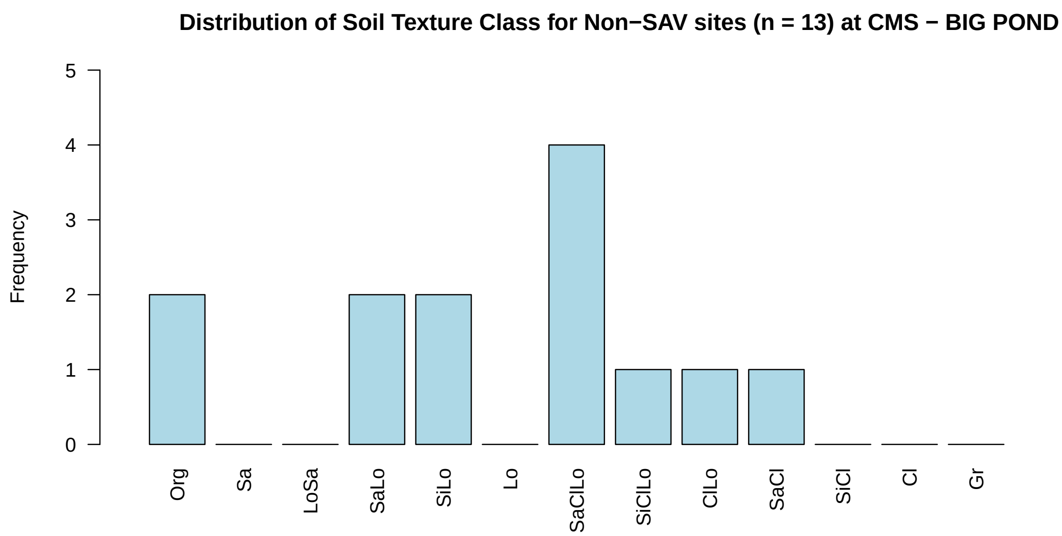
Table 23: Summary of water quality information for SAV point locations at CMS - BIG POND.

	n	Min	Mean	SE	Max
Water depth	17	0	61.4	5.83	92
Secchi Depth	17	0	61.4	5.83	92
pH level	16	8.2	9.1	0.14	10
Specific Conductivity	16	212.1	256.3	7.82	298.6
Salinity	16	0.1	0.1	0	0.1
Temperature	16	11.3	16.3	0.6	18.6

Table 24: Summary of water quality information for Non-SAV point locations at CMS - BIG POND.

	n	Min	Mean	SE	Max
Water depth	13	0	12.1	2.81	30
Secchi Depth	13	0	12.1	2.81	30
pH level	9	7.7	8.2	0.18	9.1
Specific Conductivity	9	205.3	266.5	14.18	302.6
Salinity	9	0.1	0.1	0	0.1
Temperature	9	10.6	13.3	0.73	17


Distribution of Soil Texture Class for SAV sites (n = 17) at CMS − BIG POND
Frequency
0
1
2
3
4
5
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 13) at CMS − BIG POND
Frequency
0
1
2
3
4
5
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.7 CMS - Sandhole Lake

Table 25: Design-based estimate of mean percent canopy coverage for vegetation present at CMS - SANDHOLE LAKE. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 76), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 35), and Non-SAV indicates sites not dominated by SAV species (n = 41), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
ASTER	0.1	(0, 0.1)	3				0.1	(0, 0.2)	3
BARESU	9.7	(6.8, 12.7)	38	11.3	(6, 16.7)	14	8.4	(5.3, 11.5)	24
BESY	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
CAHE2	0.3	(0, 0.7)	5	0.6	(0, 1.5)	5			
CANU4	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
CAREX	1	(0, 2.1)	3				1.9	(0, 4)	3
CEDE4	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
CHAN9	Trace	(0, 0)	1				Trace	(0, 0.1)	1
CHARA	1.8	(0.4, 3.1)	14	3.8	(1, 6.5)	13	Trace	(0, 0.1)	1
CHENO	1.4	(0, 3)	4				2.7	(0, 5.5)	4
CIAR4	6.4	(3.8, 9.1)	25				12	(7.6, 16.3)	25
DESO2	0.1	(0, 0.2)	2				0.2	(0, 0.4)	2
ELCA7	0.4	(0, 0.7)	8	0.8	(0.1, 1.5)	8			
ELPA3	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
FILAL	32.5	(24.7, 40.4)	32	69.9	(60.5, 79.3)	31	0.6	(0, 1.6)	1
GLLE3	0.5	(0, 1)	4				1	(0.1, 1.9)	4
HOJU	3.2	(1.3, 5.1)	14				5.9	(2.5, 9.4)	14
JUAR2	0.1	(0, 0.1)	2				0.1	(0, 0.3)	2
JUNCUS	Trace	(0, 0)	1				Trace	(0, 0.1)	1
JUTO	1.5	(0, 3.3)	2				2.8	(0, 6.1)	2
LIAQ	0.3	(0, 0.7)	2	0.6	(0, 1.5)	1	Trace	(0, 0.1)	1
MEAR4	1.2	(0.2, 2.2)	17				2.2	(0.4, 4)	17
NAFL	Trace	(0, 0.1)	2	0.1	(0, 0.1)	2			
PACA6	0.1	(0, 0.3)	1				0.2	(0, 0.6)	1
PEAM	2.5	(0.8, 4.3)	17	1.4	(0, 3.3)	4	3.5	(0.7, 6.4)	13
PEPE19	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
PERSIC	0.5	(0, 1.3)	3	1	(0, 2.6)	1	0.1	(0, 0.2)	2
PHAR3	0.4	(0, 1)	1				0.7	(0, 1.9)	1
PLMA2	2	(0.1, 4)	6				3.8	(0.2, 7.3)	6
POAN5	0.5	(0, 1.1)	4				1	(0, 1.9)	4
POFO3	0.1	(0, 0.4)	2	0.3	(0, 0.8)	2			
POPA15	3.2	(1.2, 5.2)	17				5.9	(2.3, 9.5)	17

Species Code	All Sites			SAV			Non-SAV		
	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
POPU7	0.3	(0, 0.8)	2	0.7	(0, 1.7)	2			
POTAM	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
POTEN	Trace	(0, 0)	1				Trace	(0, 0.1)	1
RACY	0.5	(0, 0.9)	7				0.9	(0, 1.7)	7
RANUN	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
RAPE2	0.3	(0, 0.6)	2				0.5	(0, 1.1)	2
RASC3	0.1	(0, 0.1)	3				0.1	(0, 0.2)	3
RESID	18.3	(13.1, 23.5)	40	0.2	(0, 0.4)	2	33.7	(26, 41.4)	38
ROPA2	Trace	(0, 0)	1				Trace	(0, 0.1)	1
RUMA4	0.2	(0, 0.4)	3	0.3	(0, 0.8)	2	Trace	(0, 0.1)	1
RUMEX	Trace	(0, 0.1)	2				Trace	(0, 0.1)	2
SAEX	0.3	(0, 0.8)	4				0.6	(0, 1.4)	4
SARI	0.2	(0, 0.4)	2	0.3	(0, 0.8)	2			
SCAC3	0.9	(0.4, 1.5)	25	Trace	(0, 0.1)	1	1.7	(0.7, 2.7)	24
SONCH	Trace	(0, 0.1)	1				0.1	(0, 0.2)	1
SOOL	0.3	(0, 0.7)	2				0.6	(0, 1.4)	2
SPARG	0.1	(0, 0.2)	5	0.2	(0, 0.4)	5			
STFIF	0.7	(0, 1.4)	4	1.4	(0, 2.9)	4			
STPE15	1.2	(0.1, 2.3)	8	2.6	(0.2, 4.9)	8			
STUCK	0.4	(0, 1)	1	0.9	(0, 2.3)	1			
TAOF	Trace	(0, 0)	1				Trace	(0, 0.1)	1
TRDU	Trace	(0, 0)	1				Trace	(0, 0.1)	1
TYLA	Trace	(0, 0)	1				Trace	(0, 0.1)	1
UNFOR	1.4	(0.6, 2.2)	27	0.3	(0.1, 0.6)	5	2.3	(0.9, 3.8)	22
UNGRA	2.3	(0.2, 4.4)	9	0.1	(0, 0.2)	1	4.2	(0.3, 8)	8
URDI	0.4	(0, 0.9)	3				0.8	(0, 1.6)	3
VEAN2	0.2	(0, 0.4)	2				0.3	(0, 0.7)	2
ZAPA	1.4	(0.4, 2.5)	11	3.1	(0.9, 5.3)	11			

Table 26: Summary of water quality information for all point locations at CMS - SANDHOLE LAKE.

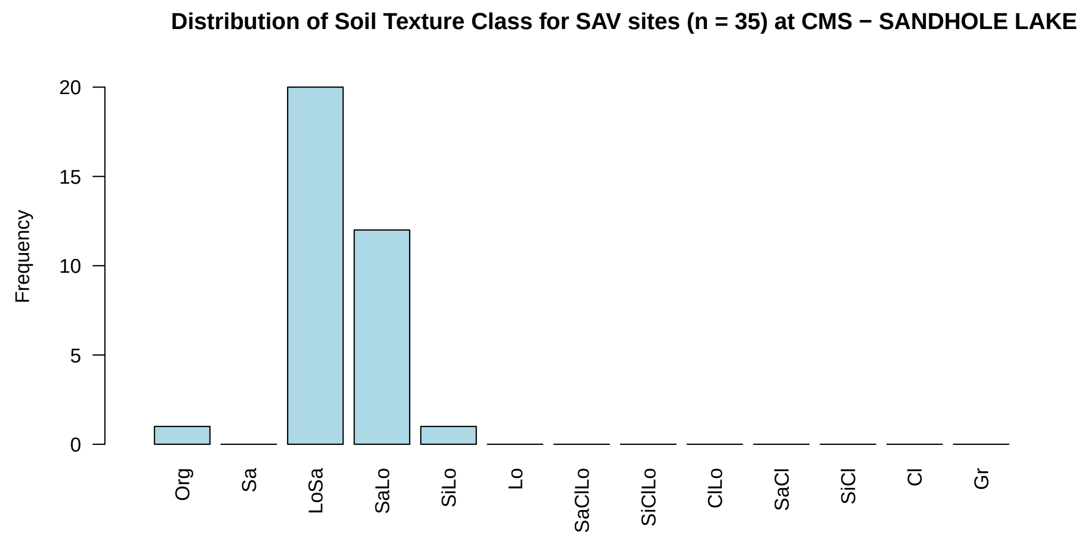
	n	Min	Mean	SE	Max
Water depth	76	0	42.7	6.31	187
Secchi Depth	76	0	42.7	6.31	187
pH level	39	8	9.1	0.06	10
Specific Conductivity	39	210.6	244	3.62	306.8
Salinity	39	0.1	0.1	0	0.1
Temperature	39	12.9	20.5	0.25	23.7

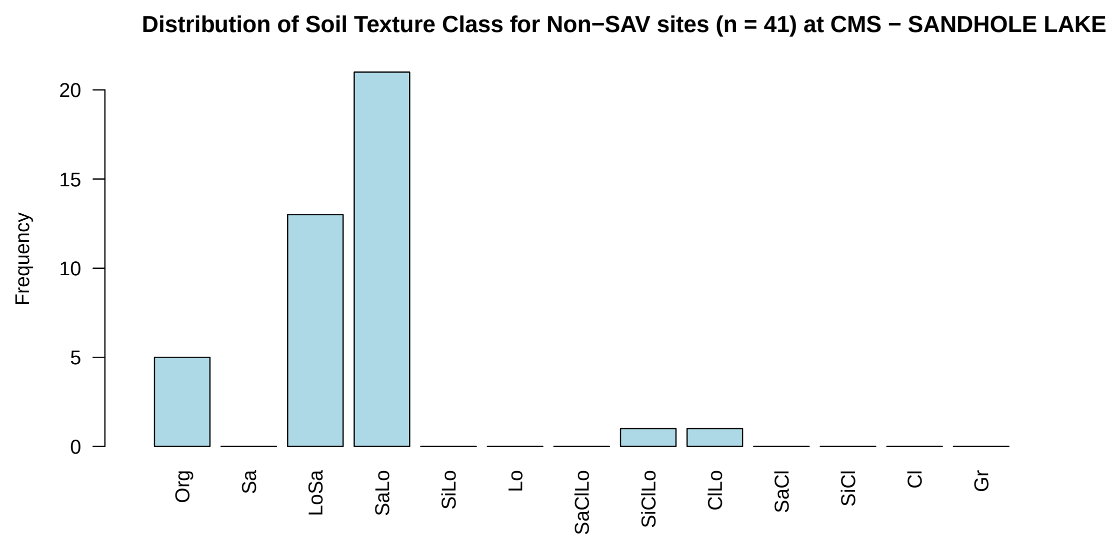
Table 27: Summary of water quality information for SAV point locations at CMS - SANDHOLE LAKE.

	n	Min	Mean	SE	Max
Water depth	35	10	90.3	8.12	187
Secchi Depth	35	10	90.3	8.12	187
pH level	35	8.5	9.1	0.05	10
Specific Conductivity	35	211.9	244.8	3.78	306.8
Salinity	35	0.1	0.1	0	0.1
Temperature	35	19.5	20.7	0.17	23.7

Table 28: Summary of water quality information for Non-SAV point locations at CMS - SANDHOLE LAKE.

	n	Min	Mean	SE	Max
Water depth	41	0	2.1	0.9	25
Secchi Depth	41	0	2.1	0.9	25
pH level	4	8	8.7	0.36	9.5
Specific Conductivity	4	210.6	236.7	13.49	268.3
Salinity	4	0.1	0.1	0	0.1
Temperature	4	12.9	18.6	1.94	21


Distribution of Soil Texture Class for SAV sites (n = 35) at CMS − SANDHOLE LAKE
Frequency
0
5
10
15
20
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 41) at CMS − SANDHOLE LAKE
Frequency
0
5
10
15
20
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.8 CMS - Two-way Pond

Table 29: Design-based estimate of mean percent canopy coverage for vegetation present at CMS - TWO-WAY POND. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 30), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 12), and Non-SAV indicates sites not dominated by SAV species (n = 18), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	38	(29, 47)	27	66.8	(56.1, 77.4)	12	18.8	(12.9, 24.8)	15
BASC5	0.5	(0.1, 1)	4	0.4	(0, 1.1)	1	0.6	(0, 1.2)	3
CHAL7	2.1	(0.5, 3.7)	6	3.7	(0.8, 6.5)	5	1.1	(0, 2.9)	1
HOJU	2.7	(0.8, 4.5)	6	3.3	(0, 6.9)	3	2.2	(0.1, 4.3)	3
JUAR2	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
RESID	43	(33.6, 52.4)	26	17.1	(9.1, 25)	9	60.2	(49.9, 70.5)	17
SAEX	0.4	(0, 0.8)	3	0.2	(0, 0.7)	1	0.5	(0, 1.1)	2
SATR12	5.4	(0, 10.9)	8	1.2	(0, 2.7)	2	8.1	(0, 17.3)	6
SCAC3	1.4	(0.4, 2.4)	10	0.1	(0, 0.2)	1	2.3	(0.7, 3.9)	9
SONCH	Trace	(0, 0.1)	1				0.1	(0, 0.2)	1
UNFOR	6.5	(3.9, 9.1)	19	7.1	(2.9, 11.3)	8	6.1	(2.7, 9.4)	11

Table 30: Summary of water quality information for all point locations at CMS - TWO-WAY POND.

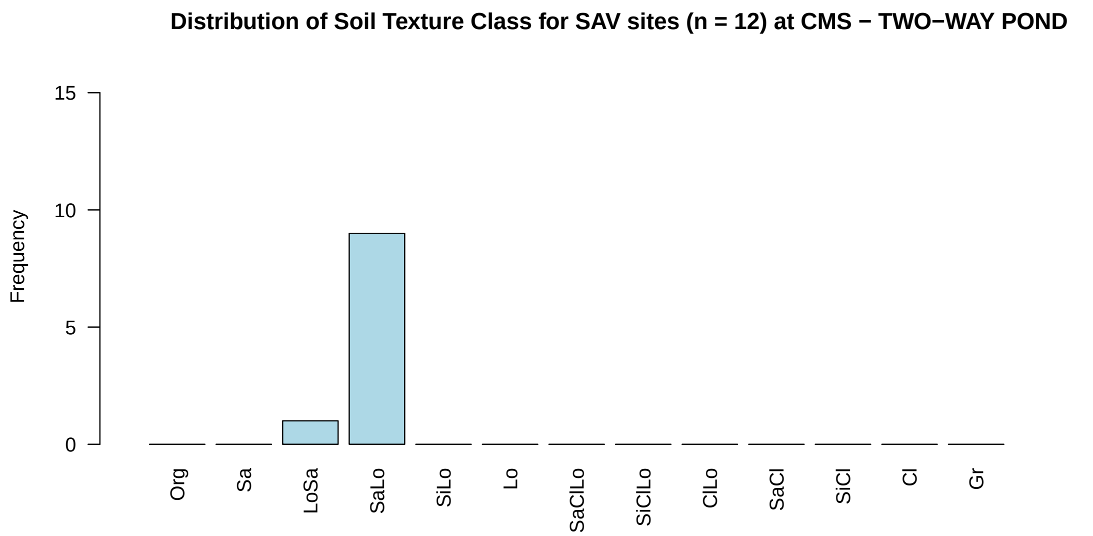
	n	Min	Mean	SE	Max
Water depth	30	0	0	0	0
Secchi Depth	30	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

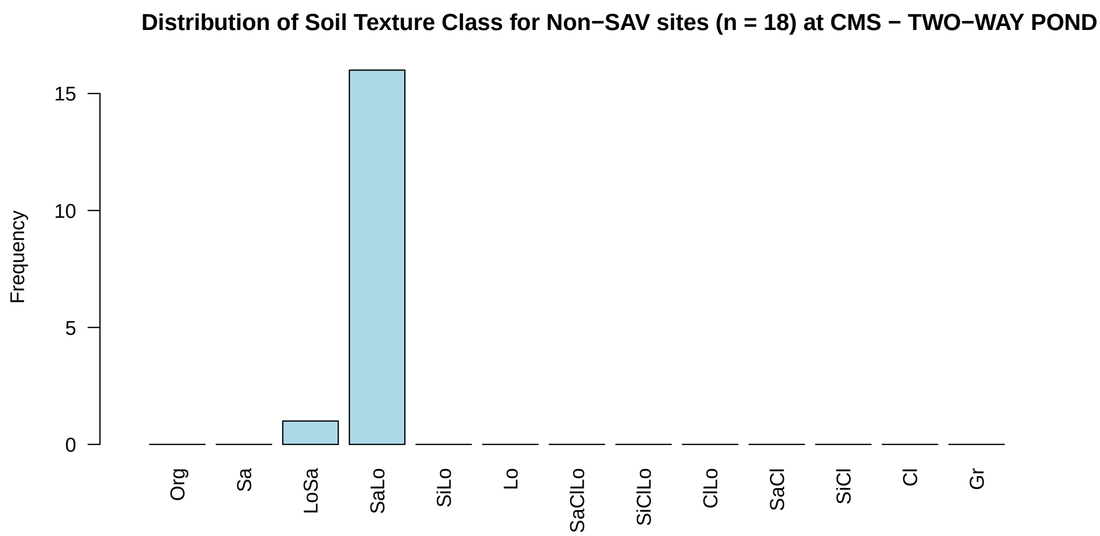
Table 31: Summary of water quality information for SAV point locations at CMS - TWO-WAY POND.

	n	Min	Mean	SE	Max
Water depth	12	0	0	0	0
Secchi Depth	12	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 32: Summary of water quality information for Non-SAV point locations at CMS - TWO-WAY POND.

	n	Min	Mean	SE	Max
Water depth	18	0	0	0	0
Secchi Depth	18	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				


Distribution of Soil Texture Class for SAV sites (n = 12) at CMS − TWO−WAY POND
Frequency
0
5
10
15
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 18) at CMS − TWO−WAY POND
Frequency
0
5
10
15
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.9 GYL - Beavertail

Table 33: Design-based estimate of mean percent canopy coverage for vegetation present at GYL - BEAVERTAIL. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 108), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 40), and Non-SAV indicates sites not dominated by SAV species (n = 68), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	11.5	(7.5, 15.5)	26	30	(21.1, 38.9)	24	0.6	(0, 1.4)	2
CAREX	0.2	(0, 0.6)	1				0.4	(0, 1)	1
CAUT	4.6	(1.6, 7.6)	9				7.3	(2.7, 12)	9
CHARA	0.5	(0.2, 0.9)	18	1.5	(0.5, 2.5)	18			
ELPA3	Trace	(0, 0)	2				Trace	(0, 0.1)	2
EPPA	Trace	(0, 0)	1				Trace	(0, 0)	1
FOAN2	Trace	(0, 0)	2				Trace	(0, 0.1)	2
GATR2	Trace	(0, 0.1)	3				0.1	(0, 0.1)	3
HIVU2	2.3	(0.7, 4)	9	6.3	(2.1, 10.6)	9			
LEMI3	0.4	(0.2, 0.5)	33	0.4	(0.3, 0.6)	17	0.3	(0.2, 0.4)	16
MEAR4	0.3	(0, 0.6)	5				0.4	(0, 1)	5
MYSI	0.5	(0.2, 0.9)	11	1.5	(0.5, 2.4)	11			
PEAM	0.3	(0, 0.7)	2				0.5	(0, 1.2)	2
PEHY	Trace	(0, 0.1)	2				0.1	(0, 0.2)	2
POFO3	0.9	(0, 1.8)	4	2.3	(0, 4.9)	4			
POPU7	0.3	(0, 0.5)	6	0.6	(0, 1.2)	5	0.1	(0, 0.2)	1
PORI2	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
RAAQ	0.1	(0, 0.2)	5	0.2	(0, 0.4)	5			
RANUN	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
RASC3	Trace	(0, 0.1)	1	0.1	(0, 0.3)	1			
RESID	46.2	(40, 52.6)	70	1.2	(0, 2.7)	3	72.7	(67.7, 77.7)	67
RINA	Trace	(0, 0.1)	3				Trace	(0, 0.1)	3
RUCI2	2.2	(0.5, 4)	10	6	(1.5, 10.5)	10			
SACU	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
SCAC3	8.3	(6, 10.6)	52				13.2	(9.9, 16.4)	52
SPEU	0.1	(0, 0.2)	5				0.2	(0, 0.3)	5
STFIF	6.4	(3.1, 9.6)	17	17.1	(9, 25.2)	16	0.1	(0, 0.2)	1
STPE15	11.7	(7.2, 16.1)	21	31.5	(21.4, 41.6)	21			
TYLA	2.6	(1.7, 3.4)	40	0.4	(0.1, 0.8)	4	3.8	(2.5, 5.1)	36
UNFOR	Trace	(0, 0)	2				Trace	(0, 0.1)	2
UTMA	0.1	(0, 0.2)	1				0.1	(0, 0.4)	1
ZAPA	0.2	(0, 0.6)	3	0.7	(0, 1.5)	3			

Table 34: Summary of water quality information for all point locations at GYL - BEAVERTAIL.

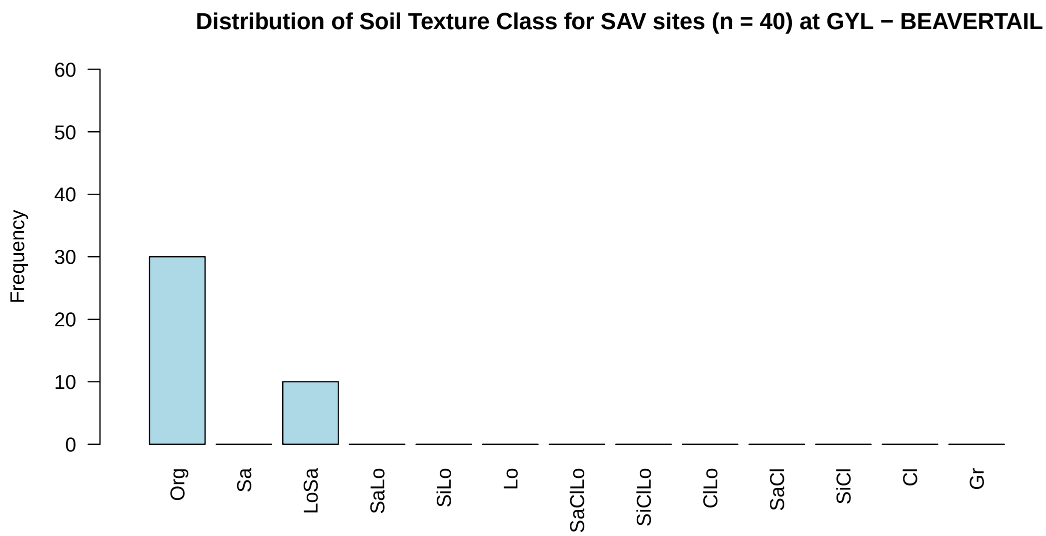
	n	Min	Mean	SE	Max
Water depth	108	0	9.07	1.03	36
Secchi Depth	108	0	9.07	1.03	36
pH level	44	7.2	8.98	0.14	10.3
Specific Conductivity	44	121.5	323.82	19.43	722
Salinity	44	0.1	0.15	0.01	0.4
Temperature	44	14.9	19.41	0.48	27.5

Table 35: Summary of water quality information for SAV point locations at GYL - BEAVERTAIL.

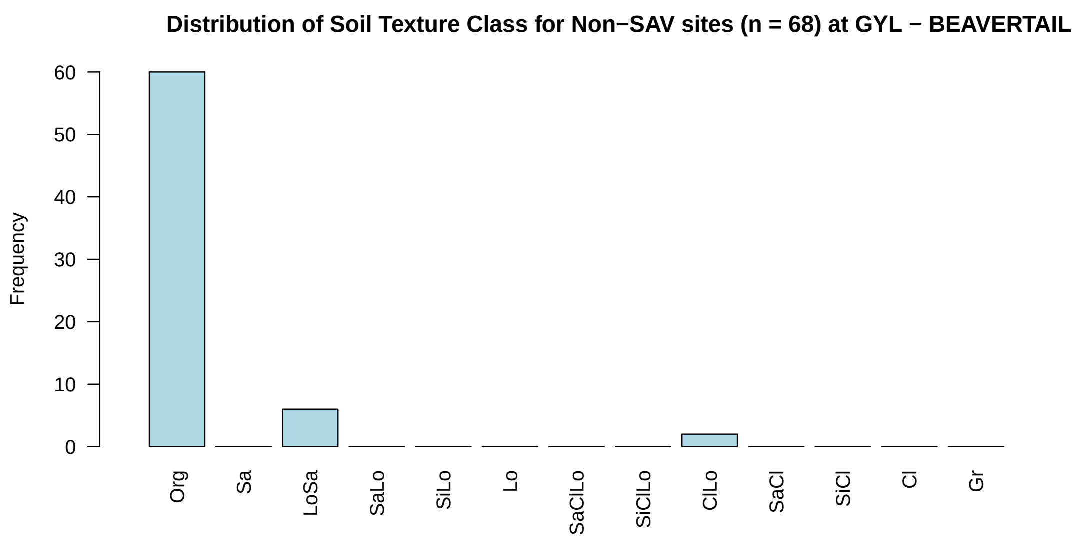
	n	Min	Mean	SE	Max
Water depth	40	4	20.9	1.1	36
Secchi Depth	40	4	20.9	1.1	36
pH level	40	7.4	9.12	0.14	10.3
Specific Conductivity	40	121.5	312.88	20.45	722
Salinity	40	0.1	0.14	0.01	0.4
Temperature	40	14.9	19.75	0.49	27.5

Table 36: Summary of water quality information for Non-SAV point locations at GYL - BEAVERTAIL.

	n	Min	Mean	SE	Max
Water depth	68	0	2.1	0.58	21
Secchi Depth	68	0	2.1	0.58	21
pH level	4	7.2	7.6	0.12	7.8
Specific Conductivity	4	351.9	433.2	27.48	470.3
Salinity	4	0.2	0.2	0	0.2
Temperature	4	15.1	16	0.41	17.1



Distribution of Soil Texture Class for SAV sites (n = 40) at GYL − BEAVERTAIL
Frequency
0
10
20
30
40
50
60
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr



Distribution of Soil Texture Class for Non−SAV sites (n = 68) at GYL − BEAVERTAIL
Frequency
0
10
20
30
40
50
60
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.10 GYL - Big Bend

Table 37: Design-based estimate of mean percent canopy coverage for vegetation present at GYL - BIG BEND. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 83), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 20), and Non-SAV indicates sites not dominated by SAV species (n = 63), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
ALGR	Trace	(0, 0)	1				Trace	(0, 0)	1
ALTR7	0.1	(0, 0.2)	5				0.1	(0, 0.2)	5
ATPO2	0.1	(0, 0.2)	2				0.1	(0, 0.3)	2
BARESU	6.4	(3.5, 9.3)	26	12.8	(2.5, 22.9)	5	4.4	(2.4, 6.4)	21
BESY	Trace	(0, 0)	1				Trace	(0, 0)	1
CAAT3	Trace	(0, 0)	1				Trace	(0, 0)	1
CAHE2	Trace	(0, 0)	1				Trace	(0, 0)	1
CANE2	0.3	(0, 0.8)	1	1.2	(0, 3.3)	1			
CAREX	3.2	(0.6, 5.8)	5	Trace	(0, 0.1)	1	4.2	(0.8, 7.6)	4
CAST	Trace	(0, 0)	1				Trace	(0, 0)	1
CAUT	0.5	(0, 1.3)	1				0.6	(0, 1.7)	1
CEDE4	1.5	(0, 3.1)	9	5.9	(0, 12.2)	8	0.2	(0, 0.4)	1
CHARA	0.3	(0, 0.7)	5	1.2	(0, 2.8)	5			
CHENO	Trace	(0, 0)	1				Trace	(0, 0)	1
CHGL3	0.4	(0, 1.1)	1				0.6	(0, 1.5)	1
ELAC	0.2	(0, 0.5)	1				0.2	(0, 0.6)	1
ELEOC	0.6	(0, 1.5)	1				0.7	(0, 2)	1
ELPA3	4.4	(1.6, 7.2)	18	0.2	(0, 0.5)	2	5.7	(2.1, 9.4)	16
FILAL	0.3	(0, 0.9)	3	1.4	(0, 3.6)	3			
FOAN2	0.5	(0, 1.1)	3				0.7	(0, 1.4)	3
GLFL2	Trace	(0, 0)	1				Trace	(0, 0)	1
HIVU2	0.3	(0.1, 0.5)	12				0.4	(0.1, 0.6)	12
JUAR2	3.3	(0.9, 5.6)	8				4.3	(1.2, 7.4)	8
JUNCUS	0.1	(0, 0.1)	3				0.1	(0, 0.2)	3
LEMI3	0.1	(0.1, 0.2)	9	0.2	(0, 0.3)	3	0.1	(0, 0.2)	6
LETR	0.1	(0, 0.1)	6	0.2	(0, 0.4)	3	Trace	(0, 0.1)	3
MEAR4	2	(0.4, 3.5)	17				2.6	(0.5, 4.6)	17
MOSS	0.1	(0, 0.2)	3				0.1	(0, 0.2)	3
MYSI	2.9	(0.6, 5.2)	14	11.8	(3, 20.7)	13	Trace	(0, 0.1)	1
PEAM	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
PERSIC	0.3	(0, 0.7)	3				0.4	(0, 1)	3
PLSC2	Trace	(0, 0)	1				Trace	(0, 0)	1

Species Code	All Sites Mean	90% CI	n	SAV Mean	90% CI	n	Non-SAV Mean	90% CI	n
POFO3	0.3	(0, 0.8)	1	1.2	(0, 3.3)	1			
POPR	0.2	(0, 0.5)	1				0.2	(0, 0.6)	1
POPU7	1.1	(0.1, 2.1)	8	4.6	(0.6, 8.6)	8			
RAFL	Trace	(0, 0)	1				Trace	(0, 0)	1
RANUN	0.2	(0, 0.3)	5				0.2	(0, 0.4)	5
RASC3	0.1	(0, 0.2)	2				0.1	(0, 0.2)	2
RESID	37	(30.9, 43.2)	60	0.8	(0, 1.6)	2	48.6	(42.1, 55)	58
RIFL4	Trace	(0, 0)	1				Trace	(0, 0)	1
RINA	0.1	(0, 0.1)	6	Trace	(0, 0.1)	1	0.1	(0, 0.1)	5
ROIS2	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
RUCR	Trace	(0, 0.1)	2				Trace	(0, 0.1)	2
SEHY	1.1	(0.3, 1.8)	11				1.4	(0.4, 2.4)	11
SISU2	0.2	(0.1, 0.3)	13				0.3	(0.1, 0.4)	13
SPAN2	0.4	(0, 1)	2				0.5	(0, 1.3)	2
SPARG	Trace	(0, 0)	1				Trace	(0, 0)	1
SPEU	5	(2.2, 7.8)	20	1.8	(0, 4.2)	2	6	(2.5, 9.6)	18
STFIF	0.1	(0, 0.2)	5	0.4	(0.1, 0.6)	4	Trace	(0, 0)	1
STPE15	13.2	(7.7, 18.8)	18	54.9	(40, 69.8)	18			
TRMA20	1.3	(0, 3.1)	5				1.7	(0, 4.1)	5
TYLA	9.9	(7.4, 12.4)	42	0.2	(0, 0.7)	1	13	(10, 16)	41
TYPHA	1.1	(0.2, 2)	5				1.4	(0.3, 2.6)	5
UNFOR	0.2	(0.1, 0.3)	17				0.3	(0.2, 0.4)	17
UNGRA	0.1	(0, 0.1)	4				0.1	(0, 0.2)	4
UTMA	0.1	(0, 0.3)	2	0.2	(0, 0.7)	1	0.1	(0, 0.2)	1
ZAPA	0.2	(0, 0.5)	4	0.8	(0, 2.1)	3	Trace	(0, 0)	1

Table 38: Summary of water quality information for all point locations at GYL - BIG BEND.

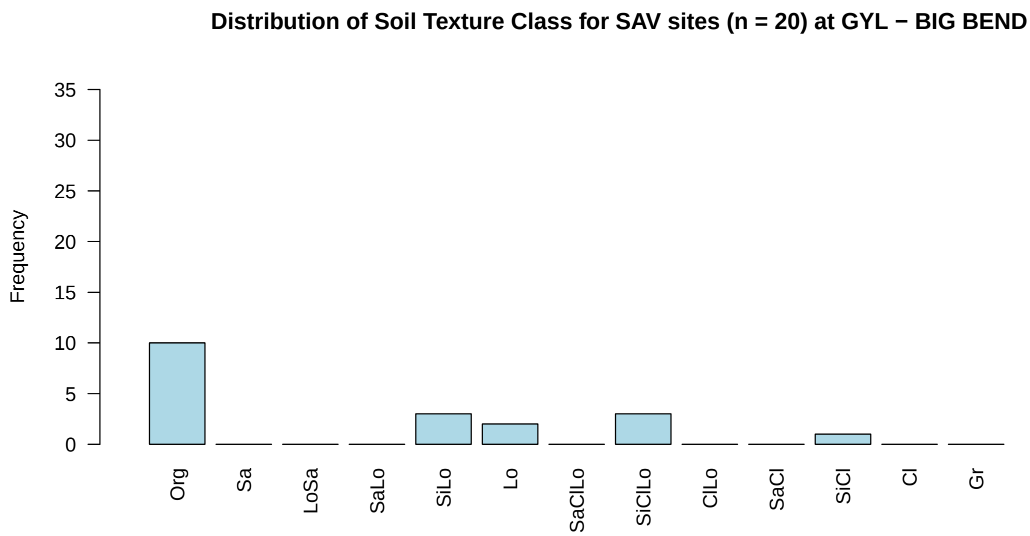
	n	Min	Mean	SE	Max
Water depth	83	0	10.89	2	66
Secchi Depth	83	0	10.89	2	66
pH level	24	7	9.23	0.23	10.5
Specific Conductivity	24	203.9	368.88	28.48	902
Salinity	24	0.1	0.17	0.01	0.4
Temperature	24	14.6	18.8	0.53	25.5

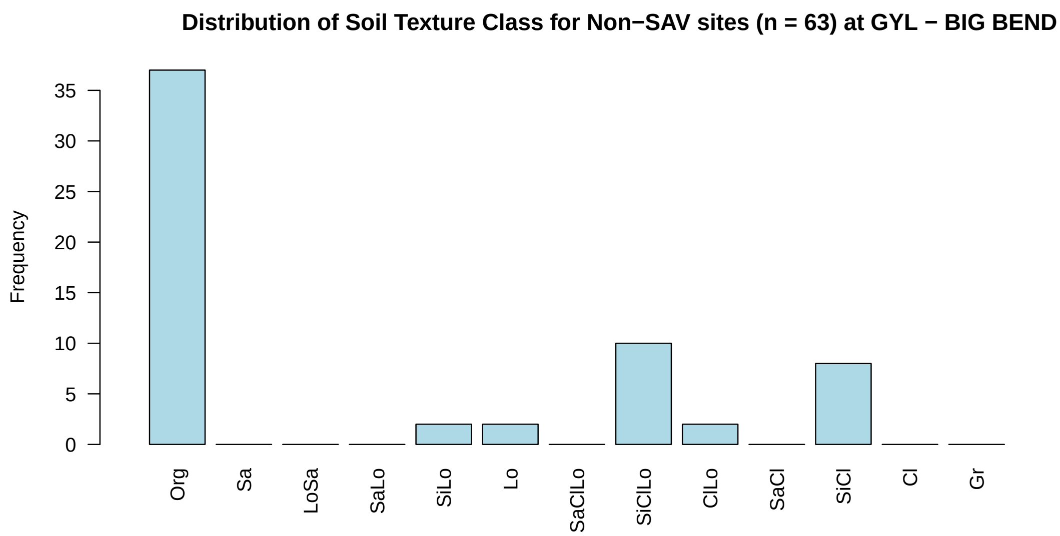
Table 39: Summary of water quality information for SAV point locations at GYL - BIG BEND.

	n	Min	Mean	SE	Max
Water depth	20	9	39.6	3.46	66
Secchi Depth	20	9	39.6	3.46	66
pH level	19	7.5	9.57	0.2	10.5
Specific Conductivity	19	203.9	323.44	14.77	480.3
Salinity	19	0.1	0.16	0.01	0.2
Temperature	19	14.6	18.48	0.52	21.8

Table 40: Summary of water quality information for Non-SAV point locations at GYL - BIG BEND.

	n	Min	Mean	SE	Max
Water depth	63	0	1.78	0.53	18
Secchi Depth	63	0	1.78	0.53	18
pH level	5	7	7.91	0.49	9.8
Specific Conductivity	5	322.3	541.58	96.08	902
Salinity	5	0.2	0.24	0.04	0.4
Temperature	5	16.4	20.02	1.64	25.5


Distribution of Soil Texture Class for SAV sites (n = 20) at GYL − BIG BEND
Frequency
0
5
10
15
20
25
30
35
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 63) at GYL − BIG BEND
Frequency
0
5
10
15
20
25
30
35
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.11 GYL - Lakefront

Table 41: Design-based estimate of mean percent canopy coverage for vegetation present at GYL - LAKEFRONT. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 118), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 15), and Non-SAV indicates sites not dominated by SAV species (n = 103), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	6.6	(3.5, 9.7)	21	49.8	(35, 64.5)	14	0.3	(0.1, 0.6)	7
CAREX	1.7	(0, 3.3)	4				1.9	(0, 3.8)	4
CAUT	8.6	(4.9, 12.2)	20				9.8	(5.7, 14)	20
CHARA	0.4	(0, 0.8)	3	3.1	(0, 6.4)	3			
ELPA3	Trace	(0, 0.1)	1	0.3	(0, 0.9)	1			
HIVU2	2.3	(0.9, 3.8)	15	17.2	(8.1, 26.3)	12	0.2	(0, 0.4)	3
JUAR2	0.2	(0, 0.6)	2				0.3	(0, 0.7)	2
LEMI3	0.2	(0.1, 0.2)	18	0.4	(0.2, 0.6)	6	0.1	(0.1, 0.2)	12
LETR	Trace	(0, 0)	1				Trace	(0, 0)	1
MEAR4	0.2	(0, 0.5)	6				0.3	(0, 0.6)	6
MOSS	Trace	(0, 0)	1				Trace	(0, 0)	1
MYSI	0.8	(0, 1.7)	6	6.1	(0, 13.4)	5	Trace	(0, 0)	1
NAOF	Trace	(0, 0)	1				Trace	(0, 0)	1
PEAM	0.2	(0, 0.4)	3				0.2	(0, 0.4)	3
PERSIC	Trace	(0, 0.1)	2				Trace	(0, 0.1)	2
POPU7	0.1	(0, 0.2)	1	0.7	(0, 1.8)	1			
RANUN	0.1	(0, 0.3)	3				0.2	(0, 0.3)	3
RESID	59.6	(54.7, 64.5)	103	3.3	(0, 8.3)	2	67.8	(63.7, 71.9)	101
RINA	Trace	(0, 0.1)	3				Trace	(0, 0.1)	3
SCAC3	14.3	(12, 16.6)	94				16.3	(13.9, 18.8)	94
SCTA2	0.1	(0, 0.3)	4				0.1	(0, 0.3)	4
SEHY	0.1	(0, 0.2)	3				0.1	(0, 0.2)	3
SPEU	0.1	(0, 0.3)	4				0.1	(0, 0.3)	4
STFIF	0.2	(0, 0.5)	2	1.4	(0, 3.6)	2			
STPE15	2.2	(0.4, 4)	9	17.3	(4.4, 30.2)	9			
TYLA	1.3	(0.8, 1.7)	37				1.4	(1, 1.9)	37
TYPHA	0.6	(0.2, 1)	12				0.7	(0.2, 1.2)	12
UNFOR	Trace	(0, 0)	1				Trace	(0, 0)	1
UTMA	0.1	(0, 0.1)	3	0.3	(0, 0.9)	1	Trace	(0, 0.1)	2

Table 42: Summary of water quality information for all point locations at GYL - LAKEFRONT.

	n	Min	Mean	SE	Max
Water depth	118	0	7.53	1.11	63
Secchi Depth	118	0	7.53	1.11	63
pH level	37	6.6	7.67	0.07	8.8
Specific Conductivity	37	6.3	363.53	18.73	498
Salinity	37	0	0.17	0.01	0.2
Temperature	37	5.3	13.09	0.74	20.9

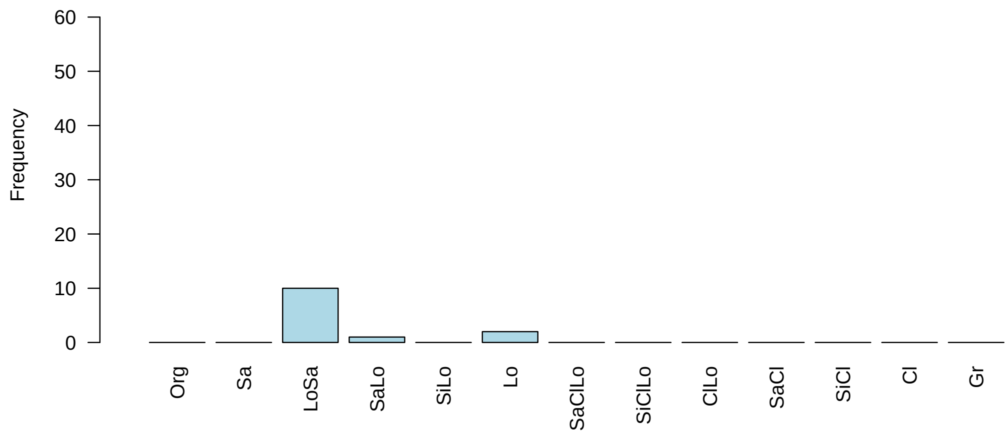
Table 43: Summary of water quality information for SAV point locations at GYL - LAKEFRONT.

	n	Min	Mean	SE	Max
Water depth	15	20	32.2	2.73	63
Secchi Depth	15	20	32.2	2.73	63
pH level	15	7.3	8	0.11	8.8
Specific Conductivity	15	324.6	399.6	16.17	498
Salinity	15	0.2	0.2	0	0.2
Temperature	15	10	16.7	0.89	20.9

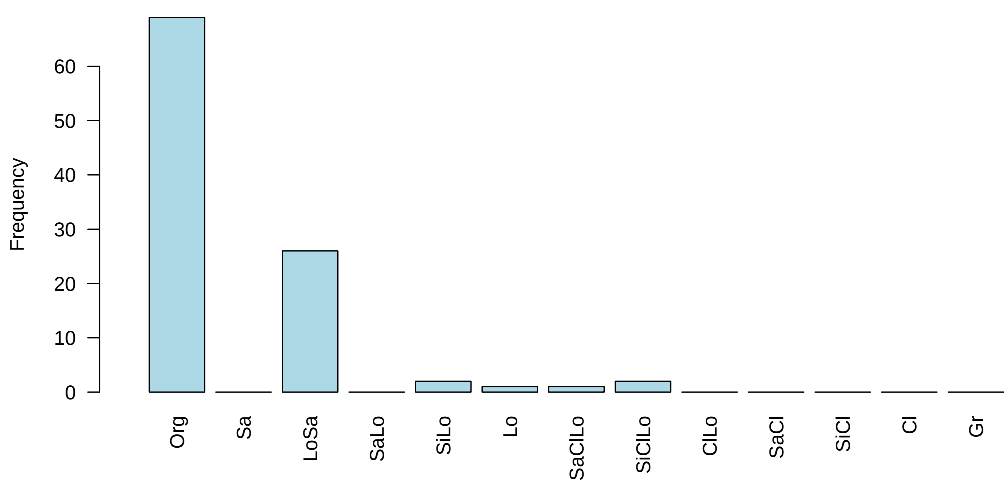
Table 44: Summary of water quality information for Non-SAV point locations at GYL - LAKEFRONT.

	n	Min	Mean	SE	Max
Water depth	103	0	3.94	0.7	38
Secchi Depth	103	0	3.94	0.7	38
pH level	22	6.6	7.44	0.07	7.9
Specific Conductivity	22	6.3	338.95	28.67	474.3
Salinity	22	0	0.15	0.01	0.2
Temperature	22	5.3	10.6	0.7	18.3

Distribution of Soil Texture Class for SAV sites (n = 15) at GYL − LAKEFRONT



Distribution of Soil Texture Class for Non−SAV sites (n = 103) at GYL − LAKEFRONT



2.2.12 BRL - Bunn Lake

Table 45: Design-based estimate of mean percent canopy coverage for vegetation present at BRL - BUNN LAKE. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 120), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 41), and Non-SAV indicates sites not dominated by SAV species (n = 79), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	17.7	(13.2, 22.2)	55	44.4	(35, 53.8)	33	3.8	(2.1, 5.6)	22
CAREX	0.3	(0, 0.9)	1				0.5	(0, 1.3)	1
CHARA	1.4	(0.2, 2.6)	6	4.1	(0.7, 7.5)	6			
CHENO	0.3	(0, 0.6)	5	0.1	(0, 0.2)	2	0.4	(0, 0.9)	3
CIAR4	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
ELAC	0.7	(0, 1.4)	4	2	(0, 4.2)	4			
ELEOC	Trace	(0, 0)	2				Trace	(0, 0.1)	2
FILAL	0.7	(0, 1.5)	8	2.1	(0, 4.4)	7	Trace	(0, 0)	1
HIVU2	0.2	(0, 0.5)	3	0.6	(0, 1.4)	3			
JUAR2	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
JUNCUS	0.5	(0.1, 0.9)	7	0.5	(0, 1.2)	4	0.4	(0, 0.9)	3
LEMI3	0.1	(0, 0.1)	5	Trace	(0, 0.1)	2	0.1	(0, 0.1)	3
MENTH	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
MOSS	0.1	(0, 0.2)	2				0.2	(0, 0.4)	2
MYSI	5.2	(2.3, 8.1)	14	15	(7.1, 23)	13	Trace	(0, 0.1)	1
NITELL	0.4	(0, 1)	1	1.1	(0, 2.9)	1			
PERSIC	0.2	(0.1, 0.3)	9				0.3	(0.1, 0.4)	9
POAN5	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
RESID	54	(47.8, 60.3)	87	3.1	(1.3, 5)	10	80.5	(76.2, 84.7)	77
RUMEX	0.1	(0, 0.3)	2				0.2	(0, 0.5)	2
SCAC3	7.5	(6.1, 8.8)	83	0.7	(0, 1.4)	6	11	(9.3, 12.7)	77
SCHOE6	0.1	(0, 0.2)	3	0.3	(0, 0.7)	2	Trace	(0, 0)	1
SCTA2	0.3	(0.1, 0.5)	10	0.3	(0, 0.5)	4	0.3	(0.1, 0.6)	6
SONCH	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
STFIF	0.3	(0.1, 0.5)	6	0.9	(0.2, 1.5)	6			
STPE15	1.8	(0.5, 3.1)	12	5.4	(1.7, 9)	12			
STUCK	0.3	(0, 0.6)	3	0.8	(0, 1.8)	3			
STVA8	0.1	(0, 0.2)	1	0.2	(0, 0.6)	1			
TYAN	Trace	(0, 0)	1				Trace	(0, 0)	1
TYLA	0.1	(0, 0.2)	4				0.2	(0, 0.3)	4
TYPHA	0.2	(0, 0.3)	5	0.2	(0, 0.4)	3	0.1	(0, 0.3)	2
UNFOR	0.4	(0, 1)	8	0.2	(0, 0.3)	4	0.6	(0, 1.4)	4

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
UNGRA	Trace	(0, 0)	1				Trace	(0, 0)	1
UTMA	6.7	(3.5, 9.9)	20	17.9	(9.4, 26.4)	16	0.9	(0, 1.9)	4
ZAPA	Trace	(0, 0.1)	2	0.1	(0, 0.3)	2			

Table 46: Summary of water quality information for all point locations at BRL - BUNN LAKE.

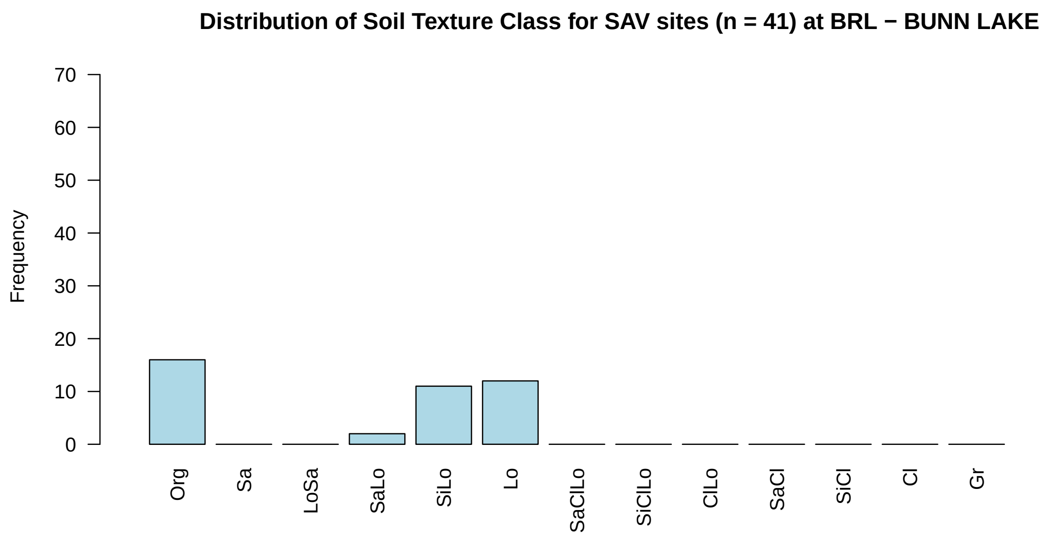
	n	Min	Mean	SE	Max
Water depth	120	0	9.28	1.42	61
Secchi Depth	120	0	9.28	1.42	61
pH level	38	7.3	8.64	0.11	9.6
Specific Conductivity	38	413.5	1054.46	37.31	1615
Salinity	38	0.2	0.53	0.02	0.8
Temperature	38	11.3	17.03	0.4	23.5

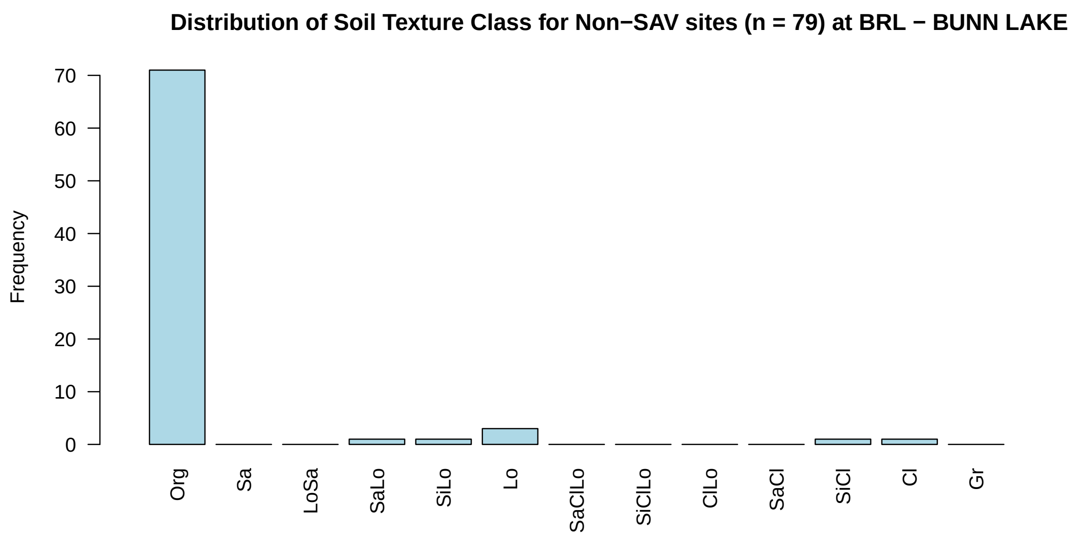
Table 47: Summary of water quality information for SAV point locations at BRL - BUNN LAKE.

	n	Min	Mean	SE	Max
Water depth	41	0	25.1	2.7	61
Secchi Depth	41	0	25.1	2.7	61
pH level	33	7.3	8.72	0.12	9.6
Specific Conductivity	33	659	1073.7	34.3	1615
Salinity	33	0.3	0.54	0.02	0.8
Temperature	33	13	17.21	0.39	23.5

Table 48: Summary of water quality information for Non-SAV point locations at BRL - BUNN LAKE.

	n	Min	Mean	SE	Max
Water depth	79	0	1.08	0.45	23
Secchi Depth	79	0	1.08	0.45	23
pH level	5	7.9	8.1	0.17	8.8
Specific Conductivity	5	413.5	927.5	176.38	1329
Salinity	5	0.2	0.48	0.1	0.7
Temperature	5	11.3	15.82	1.65	19.6


Distribution of Soil Texture Class for SAV sites (n = 41) at BRL − BUNN LAKE
Frequency
0
10
20
30
40
50
60
70
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 79) at BRL − BUNN LAKE
Frequency
0
10
20
30
40
50
60
70
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.13 BRL - Rainbow

Table 49: Design-based estimate of mean percent canopy coverage for vegetation present at BRL - RAINBOW. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 112), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 28), and Non-SAV indicates sites not dominated by SAV species (n = 84), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
ALPL	0.2	(0, 0.5)	1				0.2	(0, 0.6)	1
BARESU	9.6	(6.2, 13)	42	29.4	(18.4, 40.5)	17	3	(1.6, 4.4)	25
CEDE4	0.4	(0, 0.8)	3	1.5	(0, 3.3)	3			
CHAL7	Trace	(0, 0)	1				Trace	(0, 0)	1
CHARA	7.7	(3.9, 11.5)	13	30.8	(17.7, 43.8)	12	Trace	(0, 0)	1
CHENO	0.2	(0, 0.4)	3	Trace	(0, 0.1)	1	0.2	(0, 0.5)	2
CHRU	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
EPCIC	Trace	(0, 0)	1				Trace	(0, 0)	1
EPPA	Trace	(0, 0)	1				Trace	(0, 0)	1
FILAL	1.6	(0.6, 2.6)	18	5	(1.1, 8.8)	10	0.5	(0.1, 0.9)	8
HOJU	0.1	(0, 0.2)	1				0.1	(0, 0.3)	1
JUNCUS	Trace	(0, 0)	1				Trace	(0, 0)	1
LEMI3	0.4	(0.2, 0.6)	24	0.5	(0.2, 0.9)	10	0.3	(0.1, 0.6)	14
LETR	Trace	(0, 0)	2	Trace	(0, 0.1)	1	Trace	(0, 0)	1
MOSS	0.2	(0, 0.4)	6				0.3	(0.1, 0.5)	6
MYSI	1.3	(0, 2.9)	3	5.4	(0, 11.5)	3			
NITELL	0.1	(0, 0.2)	1	0.4	(0, 0.9)	1			
PERSIC	Trace	(0, 0)	1				Trace	(0, 0)	1
POAN5	0.1	(0, 0.4)	1				0.2	(0, 0.5)	1
POPU7	Trace	(0, 0.1)	1	0.2	(0, 0.5)	1			
RANUN	Trace	(0, 0)	2				Trace	(0, 0.1)	2
RESID	51	(45.6, 56.4)	86	1	(0, 2.1)	3	67.6	(63.7, 71.6)	83
RIFL4	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
RUMEX	Trace	(0, 0)	1				Trace	(0, 0)	1
SAEX	Trace	(0, 0)	2				Trace	(0, 0.1)	2
SARU	0.5	(0, 1.4)	1				0.7	(0, 1.9)	1
SCAC3	17.6	(15, 20.3)	83	1.6	(0.1, 3.2)	4	23	(20, 25.9)	79
SCTA2	0.7	(0, 1.3)	3				0.9	(0, 1.8)	3
SEHY	Trace	(0, 0)	1				Trace	(0, 0.1)	1
SPPO	Trace	(0, 0)	1	0.1	(0, 0.2)	1			
STFIF	1.2	(0, 2.4)	3	4.6	(0, 9.6)	3			
STPE15	3	(0.9, 5.2)	11	11.9	(3.8, 20)	10	0.1	(0, 0.2)	1

Species Code	All Sites			SAV			Non-SAV		
	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
STUCK	0.1	(0, 0.1)	2	0.2	(0, 0.5)	1	Trace	(0, 0)	1
TYAN	Trace	(0, 0.1)	1				0.1	(0, 0.2)	1
TYLA	0.4	(0, 1)	2				0.5	(0, 1.3)	2
TYPHA	0.3	(0, 0.6)	8				0.4	(0, 0.9)	8
UNFOR	0.9	(0.2, 1.5)	11	1.3	(0, 3.4)	2	0.7	(0.1, 1.3)	9
UNGRA	Trace	(0, 0)	1				Trace	(0, 0.1)	1
UTMA	2	(0.9, 3.1)	17	5.6	(1.7, 9.4)	9	0.8	(0.2, 1.4)	8
VECA7	Trace	(0, 0)	1				Trace	(0, 0)	1
ZAPA	0.1	(0, 0.4)	1	0.5	(0, 1.4)	1			

Table 50: Summary of water quality information for all point locations at BRL - RAINBOW.

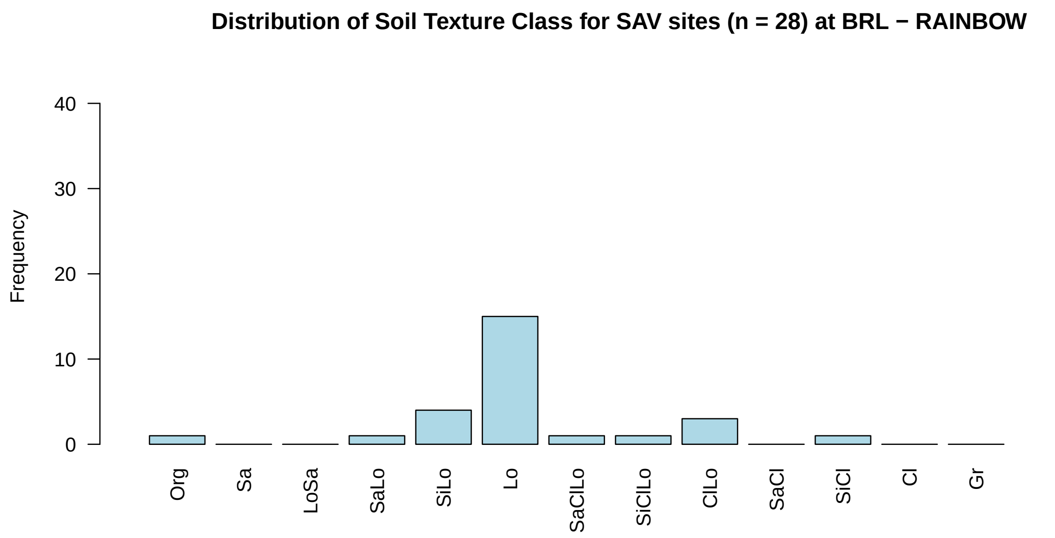
	n	Min	Mean	SE	Max
Water depth	112	0	11.86	1.98	128
Secchi Depth	112	0	11.86	1.98	128
pH level	45	6.8	8.19	0.15	10.4
Specific Conductivity	45	764	1250.29	56	2455
Salinity	45	0.4	0.64	0.03	1.3
Temperature	45	13	19.56	0.49	24.9

Table 51: Summary of water quality information for SAV point locations at BRL - RAINBOW.

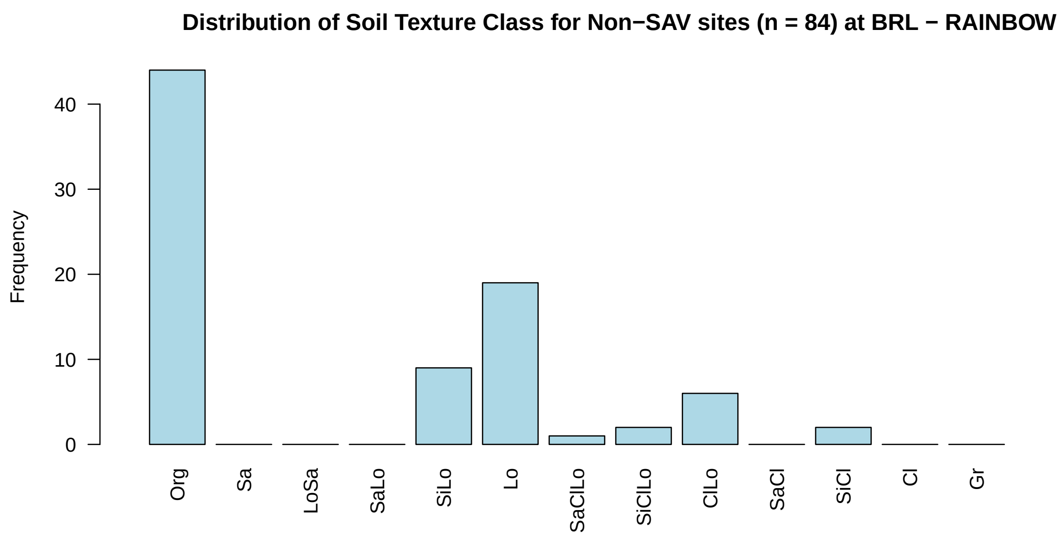
	n	Min	Mean	SE	Max
Water depth	28	0	38.61	5.14	128
Secchi Depth	28	0	38.61	5.14	128
pH level	26	7.4	8.65	0.2	10.4
Specific Conductivity	26	764	1201.54	69.22	2455
Salinity	26	0.4	0.61	0.04	1.3
Temperature	26	13	20.95	0.61	24.9

Table 52: Summary of water quality information for Non-SAV point locations at BRL - RAINBOW.

	n	Min	Mean	SE	Max
Water depth	84	0	2.94	0.55	23
Secchi Depth	84	0	2.94	0.55	23
pH level	19	6.8	7.56	0.1	8.3
Specific Conductivity	19	764	1317	92.85	2124
Salinity	19	0.4	0.67	0.05	1.1
Temperature	19	14.1	17.66	0.56	24.3



Distribution of Soil Texture Class for SAV sites (n = 28) at BRL − RAINBOW
Frequency
0
10
20
30
40
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr



Distribution of Soil Texture Class for Non−SAV sites (n = 84) at BRL − RAINBOW
Frequency
0
10
20
30
40
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.14 BRL - Rainbow Sub

Table 53: Design-based estimate of mean percent canopy coverage for vegetation present at BRL - RAINBOW SUB. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 89), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 34), and Non-SAV indicates sites not dominated by SAV species (n = 55), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	13.5	(8.7, 18.3)	27	31	(20.5, 41.5)	19	2.7	(0.6, 4.8)	8
CAREX	Trace	(0, 0.1)	1				0.1	(0, 0.1)	1
CEDE4	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
CHARA	4.8	(1.8, 7.8)	11	12.5	(5.1, 20)	11			
CHFR3	Trace	(0, 0.1)	1				0.1	(0, 0.1)	1
CIAR4	0.2	(0, 0.4)	2				0.3	(0, 0.6)	2
ELEOC	0.2	(0, 0.4)	1				0.3	(0, 0.7)	1
ELYMU	Trace	(0, 0)	1				Trace	(0, 0)	1
FILAL	0.3	(0.1, 0.5)	9	0.6	(0.1, 1.2)	5	0.1	(0, 0.2)	4
JUNCUS	Trace	(0, 0.1)	1				0.1	(0, 0.1)	1
LEMI3	0.5	(0.2, 0.8)	17	0.1	(0, 0.3)	2	0.8	(0.3, 1.3)	15
LETR	0.3	(0, 0.7)	5				0.5	(0, 1.1)	5
MENTH	Trace	(0, 0.1)	1				0.1	(0, 0.2)	1
MOSS	Trace	(0, 0)	1				Trace	(0, 0)	1
MYSI	7.9	(3.6, 12.1)	13	20.6	(10.4, 30.8)	13			
NITELL	0.8	(0, 2)	1	2	(0, 5.3)	1			
PERSIC	Trace	(0, 0.1)	1				0.1	(0, 0.1)	1
PHAR3	0.2	(0, 0.4)	1				0.3	(0, 0.7)	1
POTAM	0.3	(0, 0.9)	1	0.9	(0, 2.3)	1			
POTEN	0.2	(0, 0.5)	2				0.4	(0, 0.8)	2
RESID	44	(37.1, 50.8)	55	0.7	(0, 1.6)	2	70.7	(65.1, 76.2)	53
SARU	3.5	(1.3, 5.8)	7	5.6	(1.5, 9.6)	5	2.3	(0, 4.9)	2
SCAC3	12	(9.7, 14.4)	58	3.4	(1, 5.7)	6	17.4	(14.4, 20.4)	52
SCAM6	Trace	(0, 0.1)	1				Trace	(0, 0.1)	1
SCHOE6	0.1	(0, 0.1)	1				0.1	(0, 0.2)	1
SCTA2	Trace	(0, 0.1)	2				0.1	(0, 0.1)	2
SOAR2	Trace	(0, 0)	1				Trace	(0, 0)	1
SODU	0.5	(0, 1.3)	1				0.8	(0, 2.1)	1
STPE15	8.5	(4.3, 12.8)	13	22.3	(12.3, 32.4)	13			
STUCK	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1			
THAR5	0.1	(0, 0.3)	1				0.2	(0, 0.5)	1
TYLA	Trace	(0, 0)	1				Trace	(0, 0)	1

Species Code	All Sites			SAV			Non-SAV		
	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
TYPHA	0.3	(0, 0.5)	6	Trace	(0, 0.1)	1	0.4	(0, 0.9)	5
UNFOR	0.9	(0, 2.4)	2				1.5	(0, 4)	2
UNGRA	0.1	(0, 0.2)	2				0.1	(0, 0.3)	2
UTMA	0.5	(0.1, 0.9)	9				0.8	(0.1, 1.5)	9

Table 54: Summary of water quality information for all point locations at BRL - RAINBOW SUB.

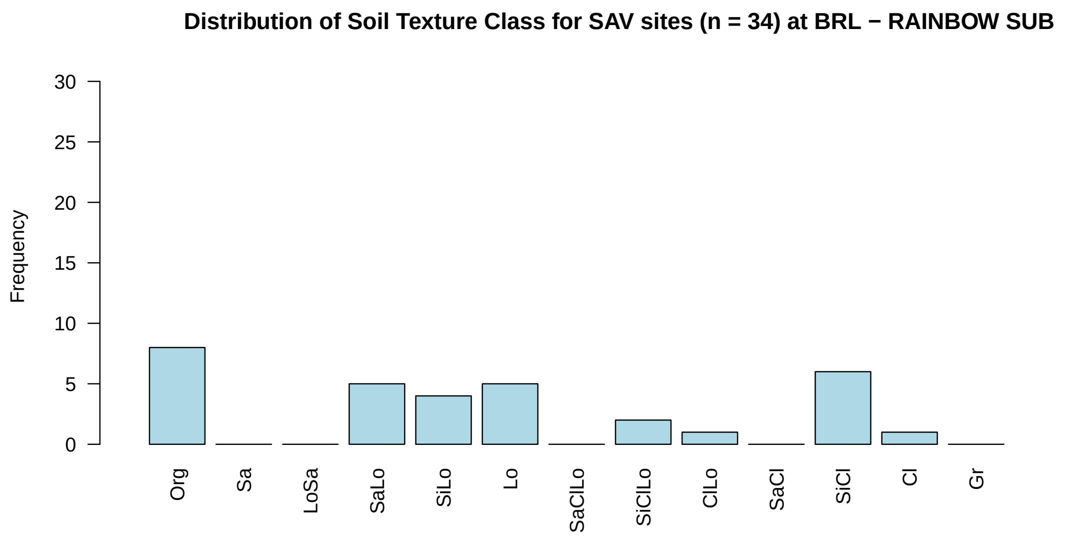
	n	Min	Mean	SE	Max
Water depth	89	0	28.3	2.82	128
Secchi Depth	89	0	28.3	2.82	128
pH level	76	7	8.13	0.08	9.7
Specific Conductivity	76	435.3	1128.79	53.58	2803
Salinity	76	0.2	0.56	0.03	1.5
Temperature	76	12	18.05	0.36	24.8

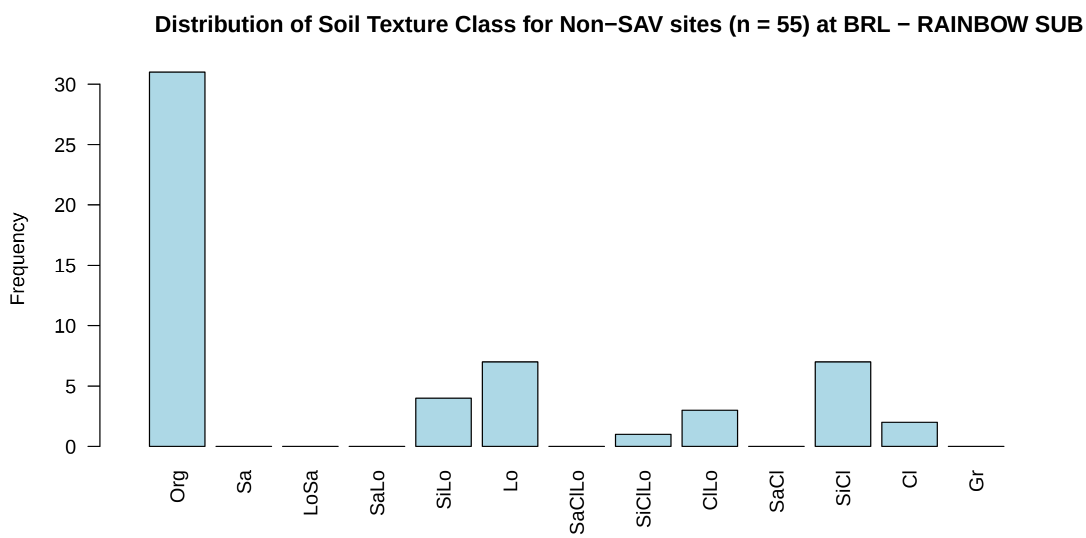
Table 55: Summary of water quality information for SAV point locations at BRL - RAINBOW SUB.

	n	Min	Mean	SE	Max
Water depth	34	0	46.62	5.67	128
Secchi Depth	34	0	46.62	5.67	128
pH level	29	7.6	8.7	0.14	9.7
Specific Conductivity	29	684	1077.79	81.23	2803
Salinity	29	0.3	0.53	0.04	1.5
Temperature	29	12.6	19.21	0.58	23.9

Table 56: Summary of water quality information for Non-SAV point locations at BRL - RAINBOW SUB.

	n	Min	Mean	SE	Max
Water depth	55	0	16.98	1.62	58
Secchi Depth	55	0	16.98	1.62	58
pH level	47	7	7.77	0.06	8.9
Specific Conductivity	47	435.3	1160.26	70.95	2437
Salinity	47	0.2	0.58	0.04	1.3
Temperature	47	12	17.33	0.44	24.8


Distribution of Soil Texture Class for SAV sites (n = 34) at BRL − RAINBOW SUB
Frequency
0
5
10
15
20
25
30
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr


Distribution of Soil Texture Class for Non−SAV sites (n = 55) at BRL − RAINBOW SUB
Frequency
0
5
10
15
20
25
30
Org
Sa
LoSa
SaLo
SiLo
Lo
SaClLo
SiClLo
ClLo
SaCl
SiCl
Cl
Gr

2.2.15 FHS - Mallard Unit

Table 57: Design-based estimate of mean percent canopy coverage for vegetation present at FHS - MALLARD UNIT. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 72), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 59), and Non-SAV indicates sites not dominated by SAV species (n = 13), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	9.1	(6.2, 12)	31	9.8	(6.4, 13.3)	24	5.8	(2.4, 9.3)	7
CHVU	60.8	(54, 67.6)	65	72.7	(67.1, 78.3)	57	7.2	(1.4, 12.9)	8
FILAL	0.2	(0, 0.4)	4	0.1	(0, 0.2)	2	0.8	(0, 1.8)	2
RESID	9.2	(4.8, 13.5)	22	0.8	(0.4, 1.3)	11	46.9	(31.7, 62)	11
RUMA5	11.2	(6.5, 15.8)	19	13.5	(8, 19.1)	18	0.4	(0, 1)	1
SCAC3	0.8	(0, 1.6)	3	0.2	(0, 0.4)	1	3.5	(0, 8)	2
SCAM6	6.5	(2.9, 10.2)	12	0.6	(0, 1.6)	3	33.3	(18.5, 48.1)	9
STPE15	1.9	(0.8, 3)	10	2.3	(1, 3.6)	9	0.2	(0, 0.6)	1
TYAN	0.3	(0, 0.7)	1				1.5	(0, 4.1)	1
TYPHA	Trace	(0, 0.1)	2	0.1	(0, 0.1)	2			

Table 58: Summary of water quality information for all point locations at FHS - MALLARD UNIT.

	n	Min	Mean	SE	Max
Water depth	72	0	34	2.28	88
Secchi Depth	72	0	34	2.28	88
pH level	69	7.62	8.6	0.07	10
Specific Conductivity	70	3068	4438.2	149.59	7306
Salinity	70	0.89	2.2	0.11	4
Temperature	70	20.31	24.9	0.26	30

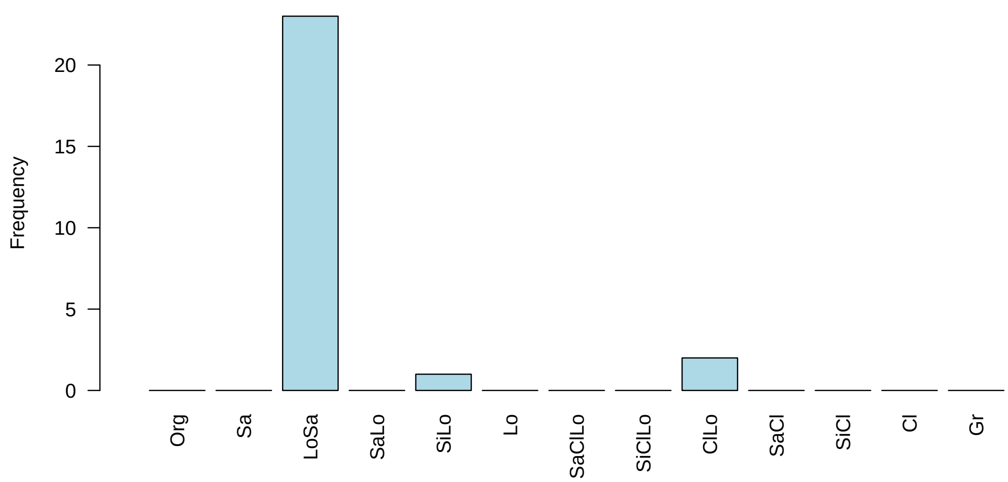
Table 59: Summary of water quality information for SAV point locations at FHS - MALLARD UNIT.

	n	Min	Mean	SE	Max
Water depth	59	6	37.8	2.41	88
Secchi Depth	59	6	37.8	2.41	88
pH level	58	7.62	8.6	0.08	10.1
Specific Conductivity	59	3068	4351.8	158.4	6492
Salinity	59	0.89	2.1	0.11	3.5
Temperature	59	22.4	25	0.28	29.7

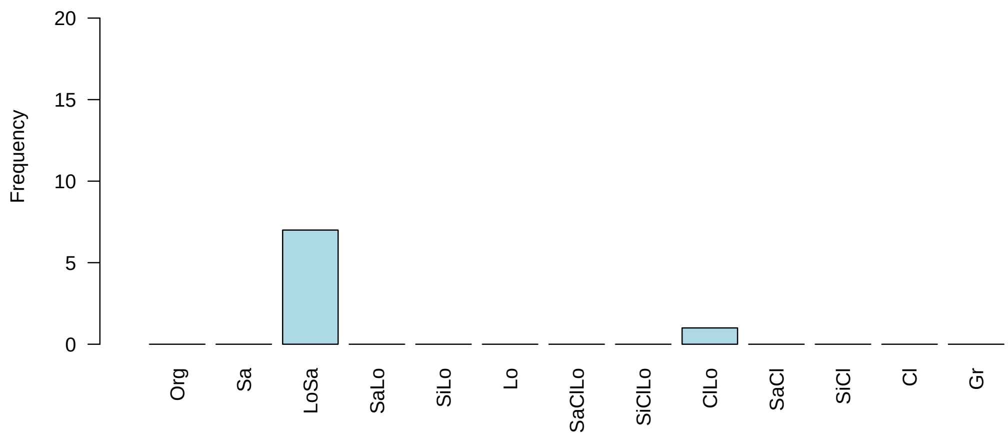
Table 60: Summary of water quality information for Non-SAV point locations at FHS - MALLARD UNIT.

	n	Min	Mean	SE	Max
Water depth	13	0	16.8	3.53	38
Secchi Depth	13	0	16.8	3.53	38
pH level	11	7.7	8.3	0.13	9.1
Specific Conductivity	11	3132	4901.4	420.21	7306
Salinity	11	1	2.5	0.31	4
Temperature	11	20.3	24	0.69	28.2

Distribution of Soil Texture Class for SAV sites (n = 59) at FHS − MALLARD UNIT



Distribution of Soil Texture Class for Non−SAV sites (n = 13) at FHS − MALLARD UNIT



2.2.16 MLH - Benson Reservoir

Table 61: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - BENSON RESERVOIR. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 24), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 13), and Non-SAV indicates sites not dominated by SAV species (n = 11), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	30.9	(18.6, 43.3)	14	55.9	(40.8, 71)	13	1.4	(0, 3.6)	1
CEDE4	6.9	(2.1, 11.6)	7	12.7	(4.7, 20.7)	7			
CIAR4	0.2	(0, 0.5)	2				0.4	(0, 1.1)	2
LEMNA	1.2	(0.4, 2)	8	1.8	(0.4, 3.1)	6	0.6	(0, 1.3)	2
PHAR3	5	(0, 11.9)	2				10.9	(0, 25.9)	2
RESID	8.3	(0, 17.2)	3				18.1	(0, 36.9)	3
RUMA5	0.5	(0, 1.2)	3	0.9	(0, 2.2)	3			
SCAC3	19.5	(6.7, 32.4)	7				42.6	(19, 66.3)	7
STPE15	11.7	(5.1, 18.2)	11	20.8	(10.3, 31.3)	10	0.9	(0, 2.4)	1
TYLA	12.5	(2.6, 22.5)	6	3.8	(0, 10.2)	1	22.8	(3.1, 42.5)	5
UNFOR	0.6	(0, 1.6)	1				1.4	(0, 3.6)	1
VEPE2	0.2	(0, 0.6)	1				0.4	(0, 1.2)	1
ZAPA	2.9	(0.7, 5.1)	5	5	(1.2, 8.8)	4	0.4	(0, 1.2)	1

Table 62: Summary of water quality information for all point locations at MLH - BENSON RESERVOIR.

	n	Min	Mean	SE	Max
Water depth	24	0	0.62	0.1	1
Secchi Depth	24	0	0.62	0.1	1
pH level	16	7.09	7.8	0.13	8.71
Specific Conductivity	16	15.6	114.35	8.45	181
Salinity	16	0.05	0.06	0	0.08
Temperature	16	15.9	18.2	0.48	23.61

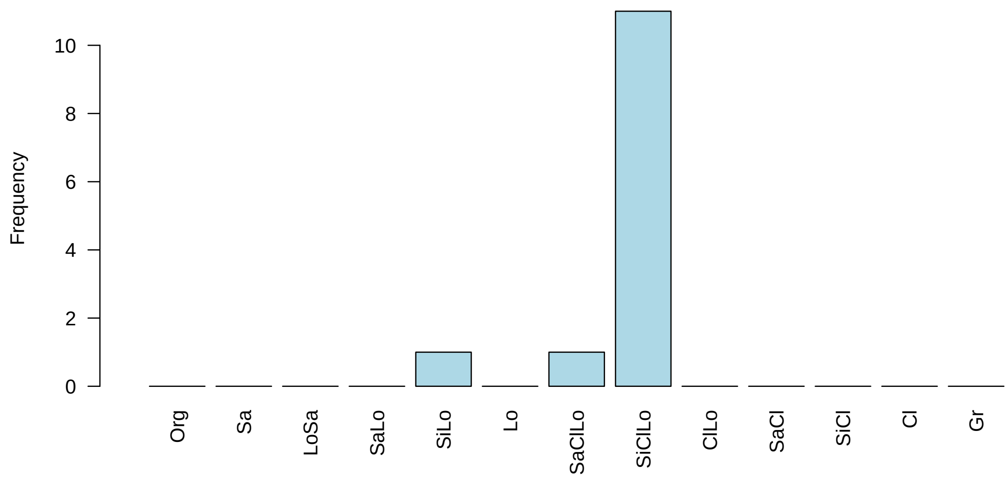
Table 63: Summary of water quality information for SAV point locations at MLH - BENSON RESERVOIR.

	n	Min	Mean	SE	Max
Water depth	13	0	0.92	0.08	1
Secchi Depth	13	0	0.92	0.08	1
pH level	13	7.09	7.86	0.15	8.71
Specific Conductivity	13	15.6	112.05	10.28	181
Salinity	13	0.05	0.06	0	0.08
Temperature	13	15.93	18.39	0.56	23.61

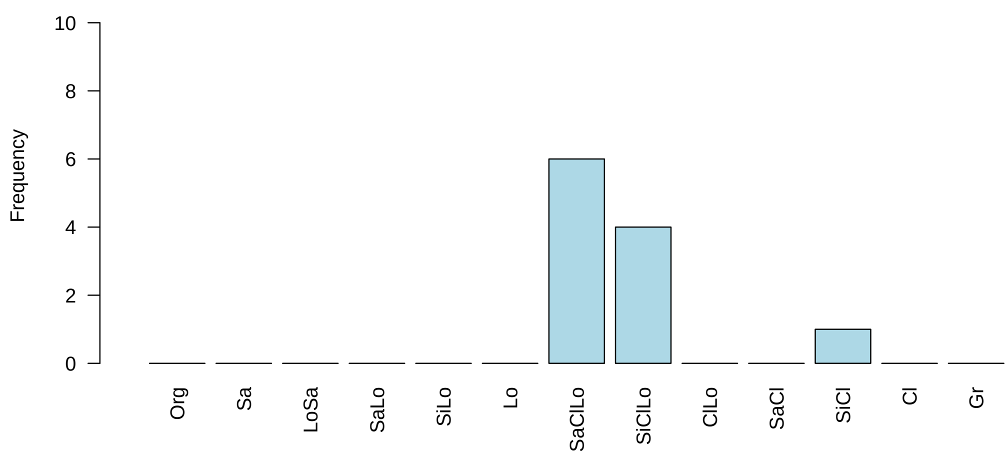
Table 64: Summary of water quality information for Non-SAV point locations at MLH - BENSON RESERVOIR.

	n	Min	Mean	SE	Max
Water depth	11	0	0.27	0.14	1
Secchi Depth	11	0	0.27	0.14	1
pH level	3	7.35	7.52	0.14	7.8
Specific Conductivity	3	111	124.33	7.06	135
Salinity	3	0.06	0.07	0.01	0.08
Temperature	3	15.9	17.34	0.74	18.37

Distribution of Soil Texture Class for SAV sites (n = 13) at MLH − BENSON RESERVOIR



Distribution of Soil Texture Class for Non−SAV sites (n = 11) at MLH − BENSON RESERVOIR



2.2.17 MLH - Boca Lake

Table 65: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - BOCA LAKE. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 108), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 33), and Non-SAV indicates sites not dominated by SAV species (n = 75), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
AGAL3	1	(0.2, 1.9)	8				1.5	(0.3, 2.7)	8
AGST2	0.5	(0, 1.4)	1				0.8	(0, 2.1)	1
ARBI2	0.2	(0, 0.4)	2				0.3	(0, 0.6)	2
ARGEN	0.1	(0, 0.3)	2				0.2	(0, 0.5)	2
AVFA	0.3	(0, 0.7)	1				0.4	(0, 1.1)	1
BARESU	20.6	(15.7, 25.4)	50	60.3	(52.9, 67.7)	31	3.1	(1.7, 4.5)	19
CATA2	0.2	(0, 0.3)	3				0.3	(0, 0.5)	3
CEDE4	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
CHBE4	0.1	(0, 0.4)	2				0.2	(0, 0.5)	2
CIAR4	1.9	(0.6, 3.1)	11	0.3	(0, 0.8)	1	2.5	(0.8, 4.3)	10
DESO2	0.1	(0, 0.1)	1				0.1	(0, 0.2)	1
DISP	0.3	(0, 0.9)	1				0.5	(0, 1.2)	1
FILAL	3.1	(1.3, 5)	22	8.2	(2.6, 13.7)	16	0.9	(0.2, 1.7)	6
HOJU	11.7	(8.2, 15.2)	36				16.9	(12.1, 21.6)	36
ISOETES	0.2	(0.1, 0.3)	14	0.5	(0.3, 0.7)	12	Trace	(0, 0.1)	2
LASE	1.2	(0.5, 2)	11				1.8	(0.7, 2.9)	11
LELA2	0.8	(0, 1.6)	4				1.2	(0, 2.4)	4
LEMNA	Trace	(0, 0)	2	Trace	(0, 0.1)	1	Trace	(0, 0)	1
MELU	0.6	(0, 1.6)	2				0.9	(0, 2.3)	2
MEOF	1.6	(0, 3.3)	5				2.3	(0, 4.7)	5
ONAC	0.5	(0, 1.2)	1				0.7	(0, 1.8)	1
PELA22	3.7	(1.8, 5.7)	16				5.3	(2.6, 8.1)	16
PHAR3	11.5	(7.9, 15)	43	0.6	(0, 1.3)	2	16.3	(11.4, 21.1)	41
PLMA2	0.2	(0, 0.5)	4				0.3	(0, 0.7)	4
POFO3	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
POGL9	Trace	(0, 0.1)	2				Trace	(0, 0.1)	2
PORI3	0.2	(0, 0.4)	4				0.3	(0, 0.6)	4
RAFL	Trace	(0, 0)	2				Trace	(0, 0.1)	2
RESID	30.6	(26.5, 34.8)	101	22.8	(19.7, 26)	33	34.1	(28.4, 39.8)	68
SCHOE6	0.4	(0, 1.1)	2				0.6	(0, 1.6)	2
STPE15	0.2	(0.1, 0.4)	13	0.8	(0.4, 1.2)	13			
TYPHA	0.2	(0, 0.5)	3	0.3	(0, 0.8)	1	0.2	(0, 0.6)	2

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
URDI	0.6	(0, 1.3)	5				0.8	(0, 1.9)	5
UTGI	2.7	(0.9, 4.4)	27	8.6	(3.2, 14.1)	25	Trace	(0, 0.1)	2
VERON	0.1	(0, 0.2)	3				0.1	(0, 0.2)	3
ZAPA	Trace	(0, 0)	1	Trace	(0, 0.1)	1			

Table 66: Summary of water quality information for all point locations at MLH - BOCA LAKE.

	n	Min	Mean	SE	Max
Water depth	108	0	0.44	0.06	2
Secchi Depth	108	0	0.44	0.06	2
pH level	40	7.25	7.8	0.05	8.61
Specific Conductivity	40	99	404.37	31.21	781
Salinity	40	0.05	0.21	0.02	0.45
Temperature	39	17.19	22.53	0.36	26.45

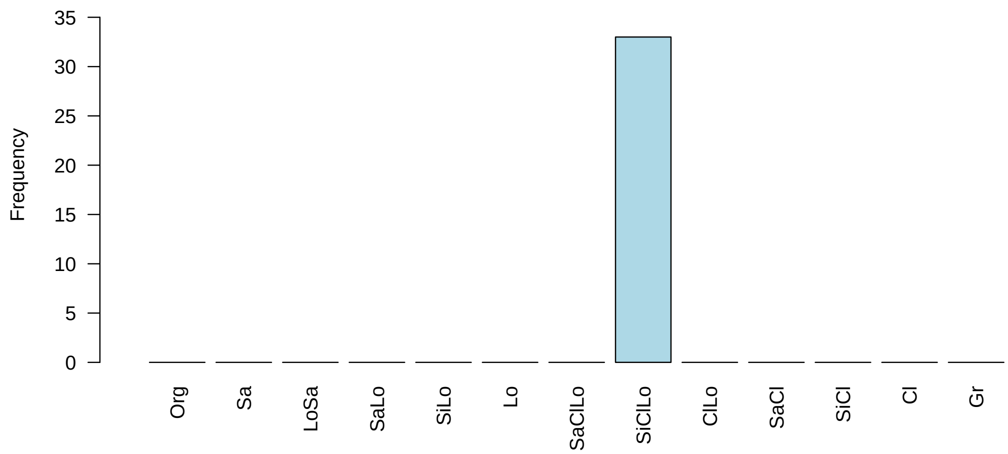
Table 67: Summary of water quality information for SAV point locations at MLH - BOCA LAKE.

	n	Min	Mean	SE	Max
Water depth	33	0	1.27	0.09	2
Secchi Depth	33	0	1.27	0.09	2
pH level	32	7.43	7.8	0.06	8.61
Specific Conductivity	32	99	354.47	30.31	688
Salinity	32	0.05	0.18	0.02	0.34
Temperature	31	19.3	22.68	0.33	26.45

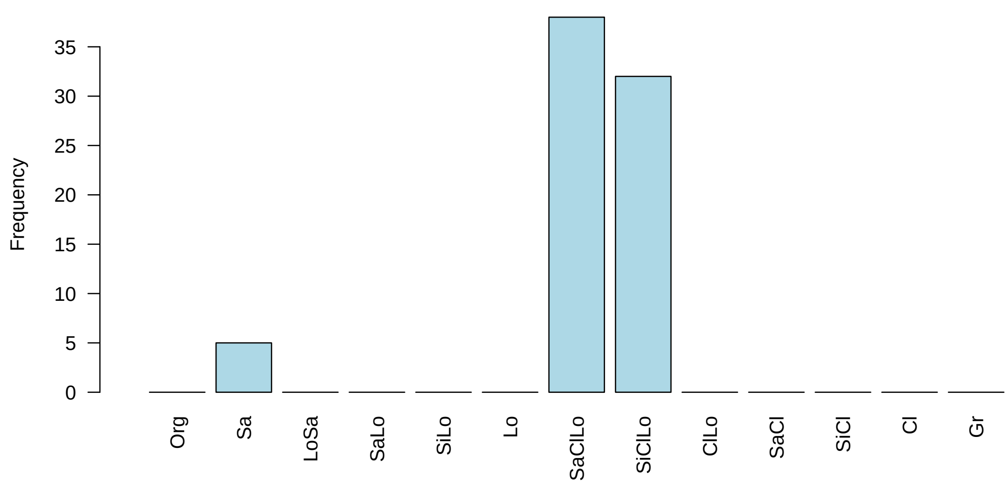
Table 68: Summary of water quality information for Non-SAV point locations at MLH - BOCA LAKE.

	n	Min	Mean	SE	Max
Water depth	75	0	0.07	0.03	1
Secchi Depth	75	0	0.07	0.03	1
pH level	8	7.25	7.8	0.11	8.16
Specific Conductivity	8	337	604	61.3	781
Salinity	8	0.16	0.31	0.04	0.45
Temperature	8	17.19	21.94	1.26	25.06

Distribution of Soil Texture Class for SAV sites (n = 33) at MLH − BOCA LAKE



Distribution of Soil Texture Class for Non−SAV sites (n = 75) at MLH − BOCA LAKE



2.2.18 MLH - West Knox Reservoir

Table 69: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - WEST KNOX RESERVOIR. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 55), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 44), and Non-SAV indicates sites not dominated by SAV species (n = 11), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
ALAE	0.1	(0, 0.2)	1	0.1	(0, 0.3)	1			
ALPR3	0.2	(0, 0.5)	3				1.2	(0, 2.7)	3
ARBI2	Trace	(0, 0)	1	Trace	(0, 0.1)	1			
BARESU	70.3	(63.3, 77.2)	50	83.9	(80.2, 87.5)	44	15.7	(6.9, 24.5)	6
BRTE	Trace	(0, 0)	1				0.1	(0, 0.2)	1
CAREX	0.5	(0, 1.2)	1				2.3	(0, 6)	1
CATA2	0.7	(0.2, 1.2)	12	0.5	(0.2, 0.8)	10	1.5	(0, 3.7)	2
CIAR4	0.1	(0, 0.2)	1	0.1	(0, 0.3)	1			
CRUSTSP	0.8	(0.5, 1)	28	0.8	(0.5, 1)	24	0.7	(0, 1.5)	4
GNPA	2.2	(1.3, 3.1)	28	2.1	(1, 3.1)	24	2.7	(0.4, 5)	4
HOJU	0.1	(0, 0.2)	5	0.1	(0, 0.2)	4	0.2	(0, 0.5)	1
LOPE3	0.5	(0, 1.2)	1	0.6	(0, 1.5)	1			
MELU	1.9	(0, 4.9)	5	0.1	(0, 0.2)	4	9.1	(0, 24)	1
PHAR3	4.2	(0.2, 8.2)	8	0.3	(0, 0.6)	3	19.7	(1, 38.5)	5
PLMA2	Trace	(0, 0.1)	1				0.2	(0, 0.5)	1
POPE3	7.7	(4.7, 10.7)	35	5.9	(3.6, 8.2)	31	14.9	(3.4, 26.4)	4
PORI3	4.6	(1.1, 8.2)	8	1.6	(0.2, 3)	5	16.8	(0.8, 32.8)	3
RESID	1.5	(0, 3.1)	4	0.2	(0, 0.6)	1	6.8	(0, 13.9)	3
SCAC3	0.1	(0, 0.1)	1	0.1	(0, 0.2)	1			
STUCK	Trace	(0, 0.1)	2	Trace	(0, 0.1)	1	0.1	(0, 0.2)	1
UNFOR	0.8	(0.3, 1.3)	14	0.9	(0.3, 1.6)	11	0.5	(0, 0.9)	3
UNGRA	1.3	(0.7, 1.9)	23	1.5	(0.8, 2.2)	19	0.5	(0.1, 1)	4
VEPE2	0.5	(0, 0.9)	11	0.6	(0, 1.2)	11			

Table 70: Summary of water quality information for all point locations at MLH - WEST KNOX RESERVOIR.

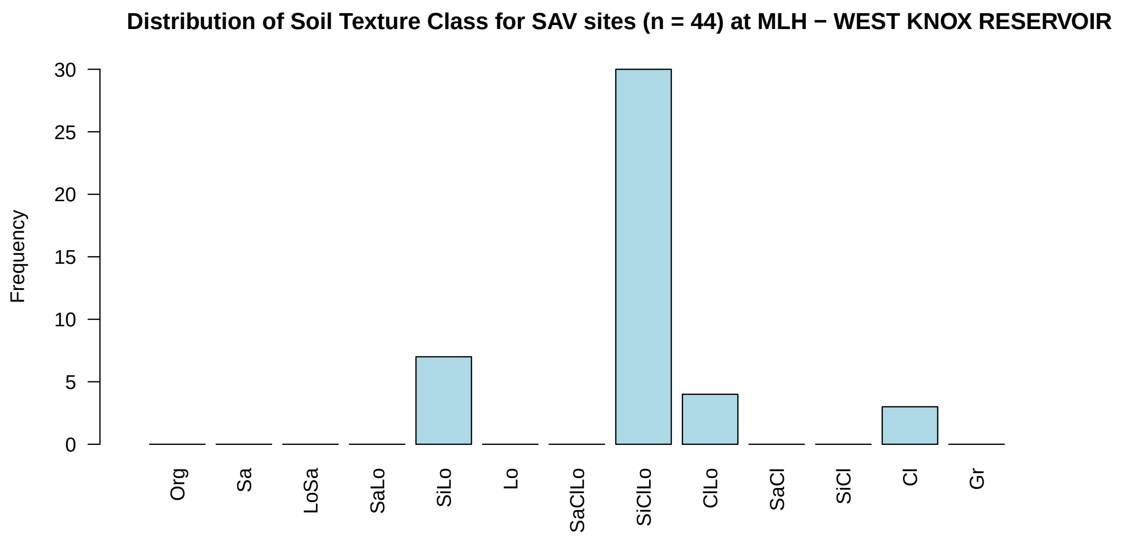
	n	Min	Mean	SE	Max
Water depth	55	0	0	0	0
Secchi Depth	55	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 71: Summary of water quality information for SAV point locations at MLH - WEST KNOX RESERVOIR.

	n	Min	Mean	SE	Max
Water depth	44	0	0	0	0
Secchi Depth	44	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 72: Summary of water quality information for Non-SAV point locations at MLH - WEST KNOX RESERVOIR.

	n	Min	Mean	SE	Max
Water depth	11	0	0	0	0
Secchi Depth	11	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				


Distribution of Soil Texture Class for SAV sites (n = 44) at MLH − WEST KNOX RESERVOIR
Frequency
0
5
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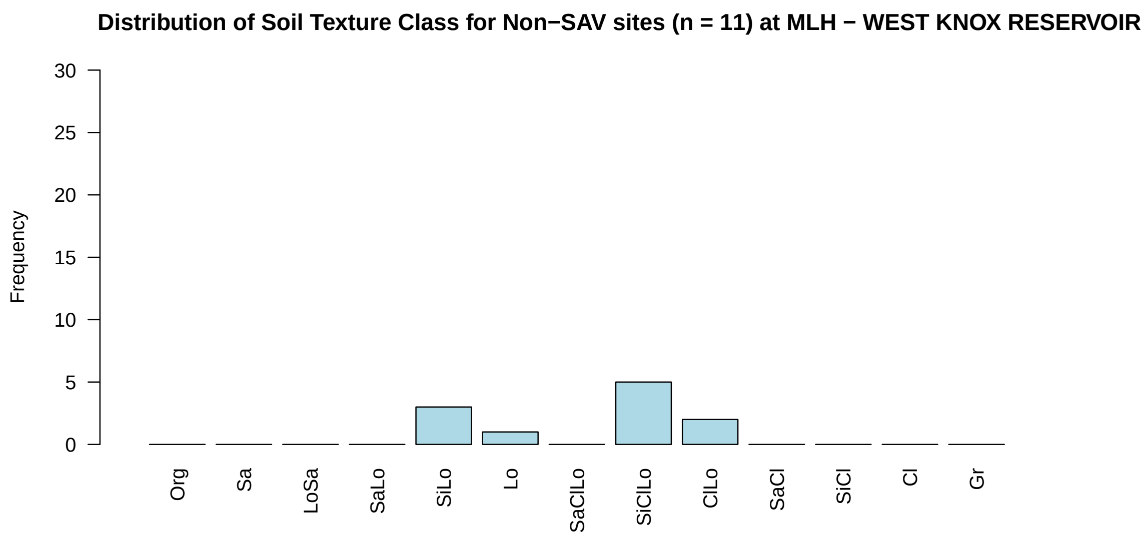
Distribution of Soil Texture Class for Non−SAV sites (n = 11) at MLH − WEST KNOX RESERVOIR
Frequency
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Gr

2.2.19 MLH - 5CBR

Table 73: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - 5CBR. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 13), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 6), and Non-SAV indicates sites not dominated by SAV species (n = 7), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	47.9	(29.6, 66.3)	10	84.3	(69.8, 98.9)	6	16.7	(4.5, 28.9)	4
CHBE4	7	(0.7, 13.3)	6	8.3	(0, 18.3)	4	5.9	(0, 14.4)	2
HOJU	1	(0.1, 1.9)	4	0.5	(0, 1.1)	2	1.4	(0, 3)	2
PELA22	0.4	(0, 0.9)	2				0.7	(0, 1.6)	2
PHAR3	3.1	(0, 8.3)	1				5.9	(0, 15.5)	1
RESID	16.1	(4.7, 27.5)	10	1	(0, 2)	3	29	(11.1, 46.9)	7
SCHOE6	3.1	(0, 7.1)	4	5.5	(0, 13.9)	3	1.1	(0, 3)	1
TYPHA	6.9	(0.1, 13.7)	3				12.9	(1.1, 24.6)	3

Table 74: Summary of water quality information for all point locations at MLH - 5CBR.

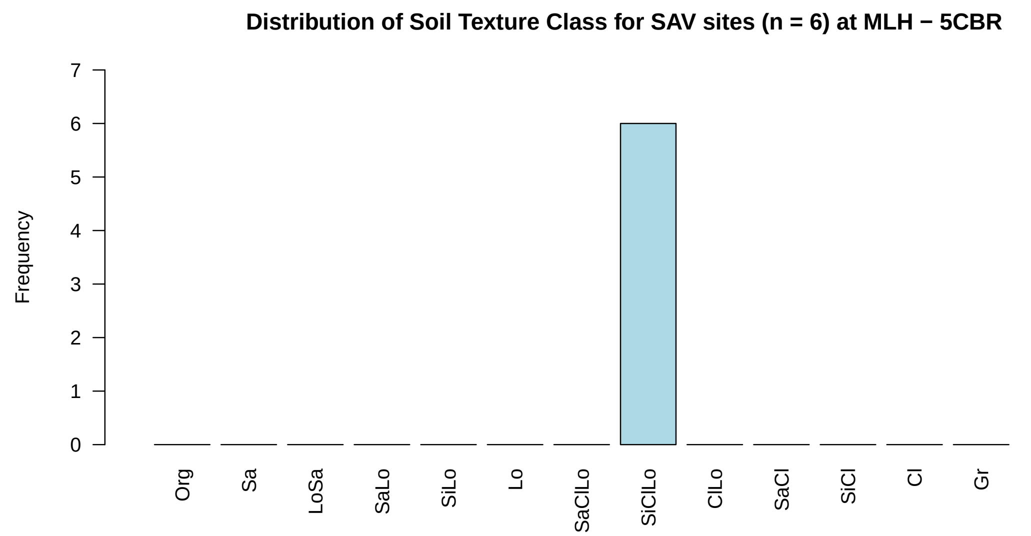
	n	Min	Mean	SE	Max
Water depth	13	0	0	0	0
Secchi Depth	13	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

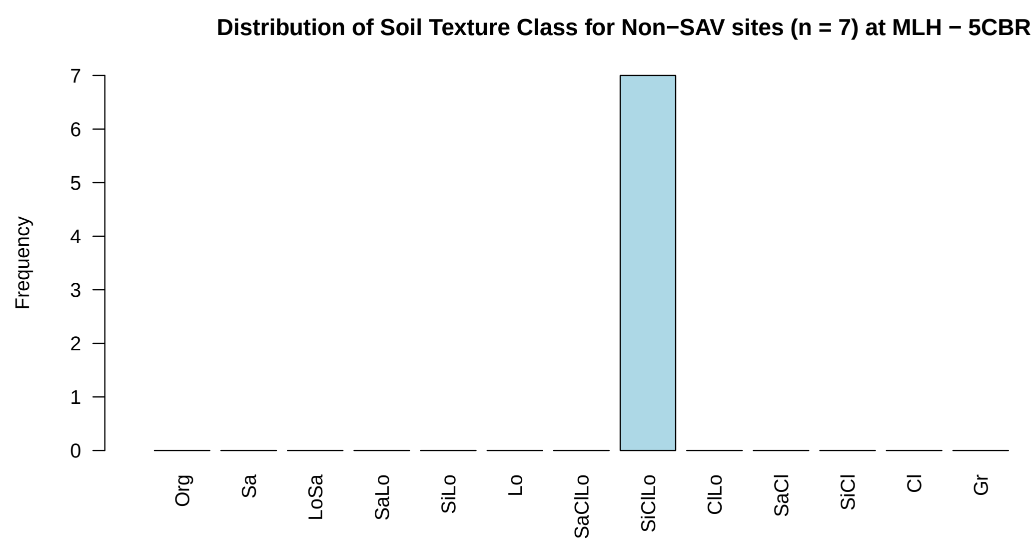
Table 75: Summary of water quality information for SAV point locations at MLH - 5CBR.

	n	Min	Mean	SE	Max
Water depth	6	0	0	0	0
Secchi Depth	6	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 76: Summary of water quality information for Non-SAV point locations at MLH - 5CBR.

	n	Min	Mean	SE	Max
Water depth	7	0	0	0	0
Secchi Depth	7	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				





2.2.20 MLH - 5CNO

Table 77: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - 5CNO. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 90), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 50), and Non-SAV indicates sites not dominated by SAV species (n = 40), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	56	(51.2, 60.8)	90	76.5	(72.5, 80.5)	50	30.4	(27.2, 33.5)	40
CHBE4	23.7	(19.4, 27.9)	65	13.5	(9.9, 17.1)	31	36.3	(29.2, 43.4)	34
DISP	0.4	(0, 0.7)	6	0.3	(0, 0.8)	2	0.4	(0.1, 0.7)	4
HOJU	2.7	(1.7, 3.7)	28	1.4	(0.3, 2.4)	9	4.4	(2.6, 6.2)	19
RESID	3.7	(3, 4.4)	78	3.9	(3, 4.7)	48	3.6	(2.4, 4.7)	30
SCHOE6	0.6	(0.2, 1)	13	0.2	(0, 0.4)	6	1	(0.1, 1.9)	7

Table 78: Summary of water quality information for all point locations at MLH - 5CNO.

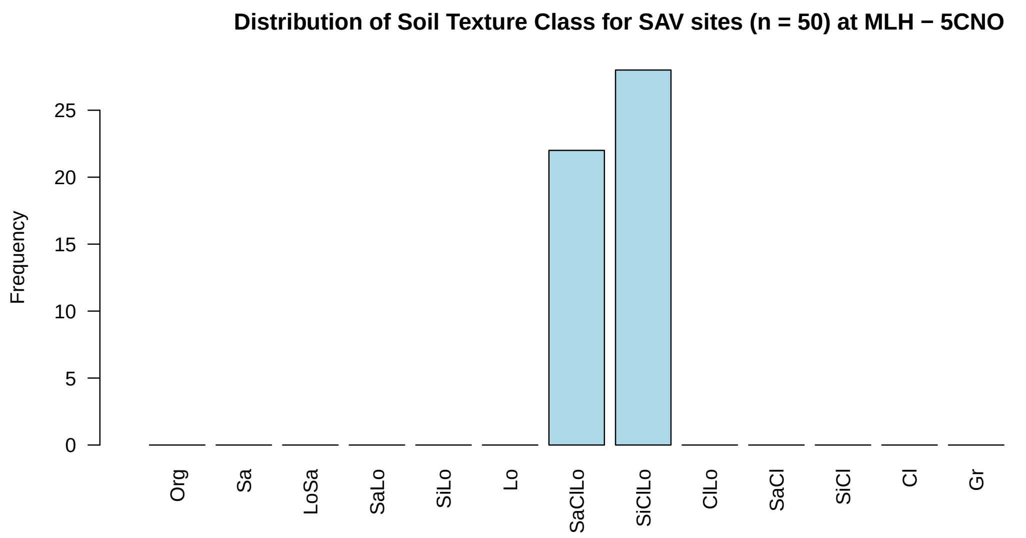
	n	Min	Mean	SE	Max
Water depth	90	0	0	0	0
Secchi Depth	90	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

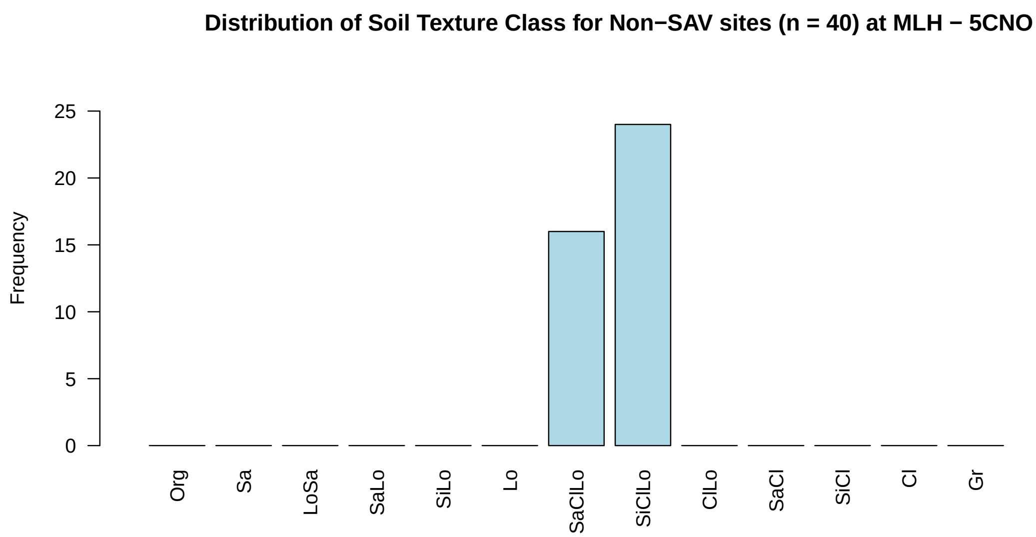
Table 79: Summary of water quality information for SAV point locations at MLH - 5CNO.

	n	Min	Mean	SE	Max
Water depth	50	0	0	0	0
Secchi Depth	50	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 80: Summary of water quality information for Non-SAV point locations at MLH - 5CNO.

	n	Min	Mean	SE	Max
Water depth	40	0	0	0	0
Secchi Depth	40	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				





2.2.21 MLH - 5CWS

Table 81: Design-based estimate of mean percent canopy coverage for vegetation present at MLH - 5CWS. Estimates of mean canopy cover are given for all GRTS points within the unit (n = 43), as well as post-stratified by dominant vegetation type, where SAV indicates those sites dominated by SAV species (n = 35), and Non-SAV indicates sites not dominated by SAV species (n = 8), where Non-SAV sites may also be considered emergent (see Figure 9). Mean percent canopy cover and 90% confidence intervals were calculated using the design-based local GRTS variance estimate. Left endpoints on intervals were set to 0 if originally negative.

Species	All Sites			SAV			Non-SAV		
Code	Mean	90% CI	n	Mean	90% CI	n	Mean	90% CI	n
BARESU	81.6	(74.8, 88.4)	43	92.9	(89.2, 96.6)	35	32.1	(25.7, 38.6)	8
CHBE4	8.3	(4.3, 12.2)	18	2.5	(0.6, 4.3)	10	33.8	(22.7, 44.8)	8
DISP	Trace	(0, 0.1)	1	Trace	(0, 0.1)	1			
HOJU	1.7	(0.4, 3)	6	0.9	(0, 1.9)	4	5	(0, 10.4)	2
RESID	2.1	(1.5, 2.7)	33	1.9	(1.3, 2.5)	27	2.9	(0.8, 4.9)	6
SCHOE6	Trace	(0, 0.1)	1	Trace	(0, 0.1)	1			

Table 82: Summary of water quality information for all point locations at MLH - 5CWS.

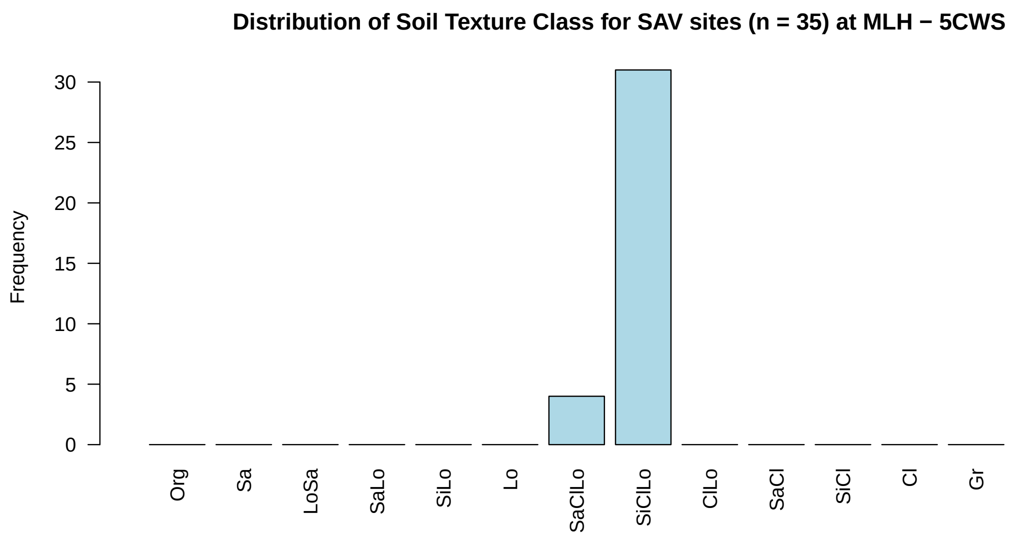
	n	Min	Mean	SE	Max
Water depth	43	0	0	0	0
Secchi Depth	43	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

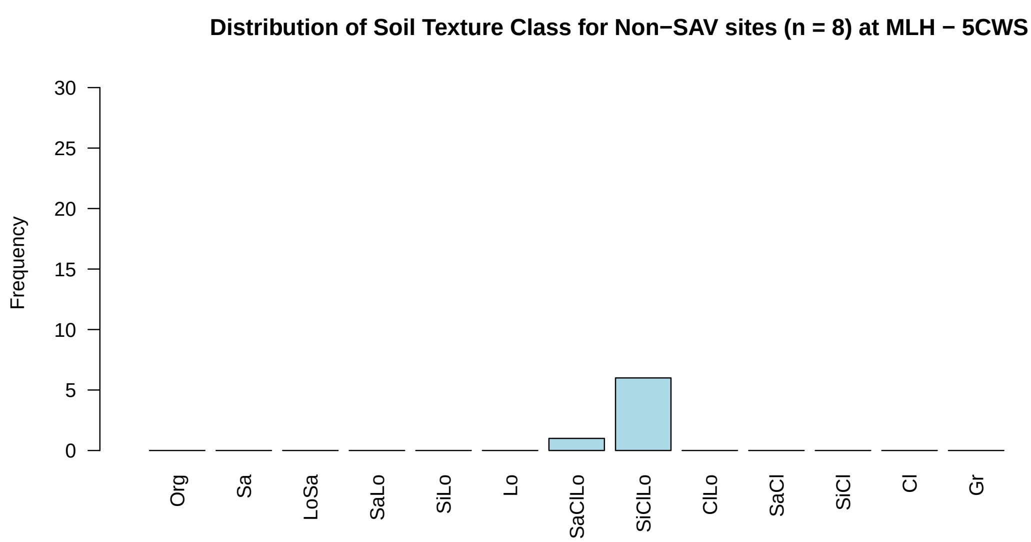
Table 83: Summary of water quality information for SAV point locations at MLH - 5CWS.

	n	Min	Mean	SE	Max
Water depth	35	0	0	0	0
Secchi Depth	35	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				

Table 84: Summary of water quality information for Non-SAV point locations at MLH - 5CWS.

	n	Min	Mean	SE	Max
Water depth	8	0	0	0	0
Secchi Depth	8	0	0	0	0
pH level	NA				
Specific Conductivity	NA				
Salinity	NA				
Temperature	NA				





3 Appendix C: Species Codes

Table 37. List of species, common names, and codes used throughout this report. Species codes are from the USDA PLANTS database, cross-referenced with the Integrated Taxonomic Information System.

Code	Species	Common Name
AGAL3	Agrostis alba	creeping bentgrass
AGSC5	Agrostis scabra	rough bentgrass
AGST2	Agrostis stolonifera	creeping bentgrass
ALAE	Alopecurus aequalis	shortawn foxtail
ALGR	Alisma gramineum	narroleaf water plantain
ALISM	Alisma spp.	water plantain
ALOC2	Allenrolfea occidentalis	iodinebush
ALPL	Alisma plantago-aquatica	European water plantain
ALPR3	Alopecurus pratensis	meadow foxtail
ALTR7	Alisma triviale	northern water plantain
ARBI2	Artemisia biennis	biennial wormwood
ARGEN	Argentina spp.	silverweed
ASCLE	Asclepias spp.	milkweed
ASTER	Aster spp.	aster
ASTRA	Astragalus spp.	milkvetch
ATPO2	Atriplex powellii	Powell's saltweed
AVFA	Avena fatua	wild oat
AZMI	Azolla microphylla	Mexican mosquito fern
AZOLL	Azolla spp.	mosquitofern
BARESU	Bare substrate	
BASC5	Bassia scopria	burning bush (kochia)
BEER	Berula erecta	cutleaf waterparsnip
BESY	Beckmannia syzigachne	American sloughgrass
BLGRALG		blue-green algae
BRTE	Bromus tectorum	cheatgrass
CAAT3	Carex athrostachya	slenderbeak sedge
CACA	Calamagrostis canadensis	bluejoint reedgrass
CAHE2	Callitriche hermaphroditica	northern water-starwort
CALLI6	Callitriche spp.	water-starwort
CAMAS	Camassia spp.	camas
CANE2	Carex nebrascensis	Nebraska sedge
CANU4	Carduus nutans	nodding plumeless thistle
CAREX	Carex spp.	sedge
CARO6	Carex rostrata	beaked sedge
CAST	Callitriche stagnalis	pond water-starwort
CASY	Carex sychnocephala	manyhead sedge
CATA2	Camissonia tanacetifolia	tansyleaf evening primrose
CAUT	Carex utriculata	Northwest territory sedge
CEDE4	Ceratophyllum demersum	coon's tail
CHAL7	Chenopodium album	lambsquarters
CHAN9	Chamerion angustifolium	fireweed

Table 37. Species list cont.

Code	Species	Common Name
CHARA	Chara spp.	muskgrasses
CHBE4	Chenopodium berlandieri	pitseed goosefoot
CHENO	Chenopodium spp.	goosefoot
CHFR3	Chenopodium fremontii	Fremont's goosefoot
CHGL3	Chenopodium glaucum	oakleaf goosefoot
CHINO	Chenopodium incanum	mealy goosefoot
CHMU3	Chenopodium murale	nettleleaf goosefoot
CHRU	Chenopodium rubrum	red goosefoot
CHSI2	Chenopodium simplex	mapleleaf goosefoot
CHVU	Chara vulgaris	common stonewort
CIAR4	Cirsium arvense	Canada thistle
CRUSTSP	Crust spp.	
DESO2	Descurainia sophia	herb sophia
DISP	Distichlis spicata	saltgrass
ECBE2	Echinodorus berteroi	upright burhead
ELAC	Eleocharis acicularis	needle spikerush
ELATI	Elatine spp.	waterwort
ELCA7	Elodea canadensis	Canadian waterweed
ELEOC	Eleocharis spp.	spikerush
ELNU2	Elodea nuttallii	western waterweed
ELODEA	Elodea spp.	waterweed
ELPA3	Eleocharis palustris	common spikerush
ELYMU	Elymus spp.	wildrye
EPCIC	Epilobium ciliatum	fringed willowherb
EPPA	Epilobium palustre	marsh willowherb
ERPI5	Erioneuron pilosum	hairy woollygrass
FILAL	Filamentous algea	
FILAL-FL	Floating filamentous algae	
FILAL-WC	Water column filamentous algae	
FOAN2	Fontinalis antipyretica	antifever fontinalis moss
GATR2	Galium trifidum	threepetal bedstraw
GLFL2	Glyceria fluitans	water mannagrass
GLGR	Glyceria grandis	American mannagrass
GLLE3	Glycyrrhiza lepidota	American licorice
GNPA	Gnaphalium palustre	western marsh cudweed
HESPE6	Hesperocnide spp.	stingingnettle
HIVU2	Hippuris vulgaris	common mare's-tail
HOJU	Hordeum jubatum	foxtail barley
ISOETES	Isoetes spp.	quillwort
JUAR2	Juncus arcticus	arctic rush
JUBA	Juncus balticus	Baltic rush
JUNCUS	Juncus spp.	rush
JUTO	Juncus torreyi	Torrey's rush
KOELE	Koeleria spp.	junegrass
LASE	Lactuca serriola	prickly lettuce

Table 37. Species list cont.

Code	Species	Common Name
LELA2	Lepidium latifolium	broadleaved pepperweed
LEMI3	Lemna minor	common duckweed
LEMNA	Lemna spp.	duckweed
LETR	Lemna trisulca	star duckweed
LIAQ	Limosella aquatica	water mudwort
LOPE3	Lomatium peckianum	Peck's desertparsley
MARSI	Masilea spp.	waterclover
MEAQ	Mentha aquatica	water mint
MEAR4	Mentha arvensis	wild mint
MELU	Medicago lupulina	black medick
MENTH	Mentha spp.	mint
MEOF	Melilotus officinalis	sweetclover
MONU	Monolepis nuttalliana	Nuttall's povertyweed
MOSS	Bryophyta	moss
MUAS	Muhlenbergia asperifolia	scratchgrass
MYRIO	Myriophyllum spp.	watermilfoil
MYSI	Myriophyllum sibiricum	shortspike watermilfoil
MYVE3	Myriophyllum verticillatum	whorl-leaf watermilfoil
NAFL	Najas flexilis	nodding waternymph
NAGU	Najas guadalupensis	southern waternymph
NAJAS	Najas species	naiad
NAMA	Najas marina	spiny naiad
NAOF	Nasturtium officinale	watercress
NITELL	Nitella spp.	brittlewort
NULU	Nuphar lutea	yellow pond-lily
NUPO	Nuphar polysepala	Rocky Mountain pond-lily
ONAC	Onopordum acanthium	Scotch thistle
PACA6	Panicum capillare	witchgrass
PEAM	Persicaria amphibia	water knotweed
PEHY	Persicaria hydropiperoides	swamp smartweed
PELA22	Persicaria lapathifolium	curlytop knotweed
PEPE19	Persicaria pensylvanicum	Pennsylvania smartweed
PERSIC	Persicaria spp.	smartweed
PHAR3	Phalaris arundinacea	reed canarygrass
PHAU7	Phragmites australis	common reed
PHPR3	Phleum pratense	timothy
PLJA	Pleuraphis jamesii	James' galleta
PLMA2	Plantago major	common plantain
PLSC2	Plagiobothrys scouleri	Scouler's popcorn flower
POAN5	Potentilla anserina	silverweed cinquefoil
POFO3	Potamogeton foliosus	leafy pondweed
POFR3	Potamogeton friesii	Fries' pondweed
POGL9	Potentilla glandulosa	sticky cinquefoil
POGR8	Potamogeton gramineus	variableleaf pondweed
POLSP	Polygynum spp.	smartweed

Table 37. Species list cont.

Code	Species	Common Name
PONA4	Potamogeton natans	floating pondweed
PONE	Poa nemoralis	wood bluegrass
POPA15	Potentilla paradoxa	Paradox cinquefoil
POPA2	Poa palustris	fowl bluegrass
POPE3	Polygonum persicaria	spotted ladysthumb
POPR	Poa pratensis	Kentucky bluegrass
POPR5	Potamogeton praelongus	whitestem pondweed
POPU7	Potamogeton pusillus	small pondweed
PORI2	Potamogeton richardsonii	Richardson's pondweed
PORI3	Potentilla rivalis	brook cinquefoil
POTAM	Potamogeton spp.	pondweed
POTEN	Potentilla spp.	cinquefoil
POZO	Potamogeton zosteriformis	flatstem pondweed
RAAQ	Ranunculus aquatilis	white water crowfoot
RACY	Ranunculus cymbalaria	alkali buttercup
RAFL	Ranunculus flabellaris	yellow water buttercup
RANUN	Ranunculus spp.	unknown buttercup
RAPE2	Ranunculus pensylvanicus	Pennsylvania buttercup
RASC3	Ranunculus sceleratus	cursed buttercup
RESID	Residual vegetation	
RESID-SE	Residual vegetation - short emergent	
RESID-SU	Residual vegetation - submerged	ONLY for current year SAV on mudflat
RESID-TE	Residual vegetation - tall emergent	
RIFL4	Riccia fluitans	riccia
RINA	Ricciocarpus natans	purple-fringed riccia
ROIS2	Rorippa islandica	northern marsh yellowcress
ROPA2	Rorippa palustris	bog yellowcress
RORIPPA	Rorippa spp.	yellowcress
RUCI2	Ruppia cirrhosa	spiral ditchgrass
RUCR	Rumex crispus	curly dock
RUMA4	Rumex maritimus	golden dock
RUMA5	Ruppia maritima	widgeongrass
RUMEX	Rumex spp.	dock
SACU	Sagittaria cuneata	arumleaf arrowhead
SAEX	Salix exigua	narrowleaf willow
SAGIT	Sagittaria spp.	arrowhead
SARI	Sagittaria rigida	sessilefruit arrowhead
SARU	Salicornia rubra	red swampfire
SATR12	Salsola tragus	prickly Russian thistle
SAUT2	Sarcocornia utahensis	Utah swampfie
SCAC3	Schoenoplectus acutus	hardstem bulrush
SCAM6	Schoenoplectus americanus	chairmaker's bulrush
SCHOE6	Schoenoplectus spp.	bulrush
SCMA8	Schoenoplectus maritimus	cosmopolitan bulrush
SCPU10	Schoenoplectus pungens	common threesquare

Table 37. Species list cont.

Code	Species	Common Name
SCRO5	Schoenoplectus robustus	sturdy bulrush
SCSU10	Schoenoplectus subterminalis	swaying bulrush
SCTA2	Schoenoplectus tabernaemontani	sofstem bulrush
SEHY	Senecio hydrophiloides	tall groundsel
SEHY2	Senecio hydrophilus	water ragwort
SEOR6	Sericocarpus oregonensis	Oregon whitetop aster
SISU2	Sium suave	hemlock waterparsnip
SOAR2	Sonchus arvensis	field sowthistle
SODU	Solanum dulcamara	climbing nightshade
SONCH	Sonchus spp.	sowthistle
SOOL	Sonchus oleraceus	common sowthistle
SPAI	Sporobolus airoides	alkali sacaton
SPAN2	Sparganium angustifolium	narrowleaf bur-reed
SPARG	Sparganium spp.	bur-reed
SPEU	Sparganium eurycarpum	broadfruit bur-reed
SPPO	Spirodela polyrrhiza	greater duckweed
STFIF	Stuckenia filiformis	fineleaf pondweed
STPE15	Stuckenia pectinata	sago pondweed
STUCK	Stuckenia spp.	pondweed
STVA8	Stuckenia vaginata	sheathed pondweed
SUCA2	Suaeda calceoliformis	Pursh seepweed
TAOF	Taraxacum officinale	common dandelion
TATA2	Taraxia tanacetifolia	tansyleaf evening primrose
TAVU	Tanacetum vulgare	common tansy
THAR5	Thlaspi arvense	field pennycress
TRDU	Tragopogon dubius	goatsbeard
TRLO	Trifolium longipes	longstalk clover
TRMA20	Triglochin maritima	seaside arrowgrass
TYAN	Typha angustifolia	narrowleaf cattail
TYGL	Typha x glauca	hybrid cattail
TYLA	Typha latifolia	broadleaf cattail
TYPHA	Typha spp.	cattail
UNFOR	Unknown forb	
UNGRA	Unknown graminoid	
URDI	Urtica dioica	stinging nettle
UTGI	Utricularia gibba	humped bladderwort
UTMA	Utricularia macrorhiza	common bladderwort
UTMI	Utricularia minor	lesser bladderwort
VEAN2	Veronica anagallis-aquatica	water speedwell
VECA7	Veronica catenata	chain speedwell
VEPE2	Veronica peregrina	neckweed
VERON	Veronica spp.	speedwell
VESC2	Veronica scutellata	skullcap speedwell
WOLFF	Wolffia spp.	watermeal
ZAPA	Zannichellia palustris	horned pondweed

4 Appendix D: Investigation of Double-observer Variation in Estimated Percent Canopy Cover

A potential source of measurement error is related to visually estimating percent cover within a $1m^2$ plot. The chosen plot size should reduce some of these measurement errors compared to a larger plot size. Variation in canopy cover estimation and species identification between observers is being explored using data collected at three refuges (Fish Springs [FHS], Grays Lake [GYL], and Lee Metcalf [LMC]) by concurrent observations of two or more observers. Observations from more than one alternate observer were recorded at Lee Metcalf. The following plots exclude Lee Metcalf at this time. This is only a preliminary investigation regarding possible sources of measurement and detection errors when conducting visual assessments of percent species cover. These summaries did not explore the points deemed "too turbid." Additional factors that may lead to observer variation should be identified, such that 2015-2016 surveys can be structured to collect these additional variables.

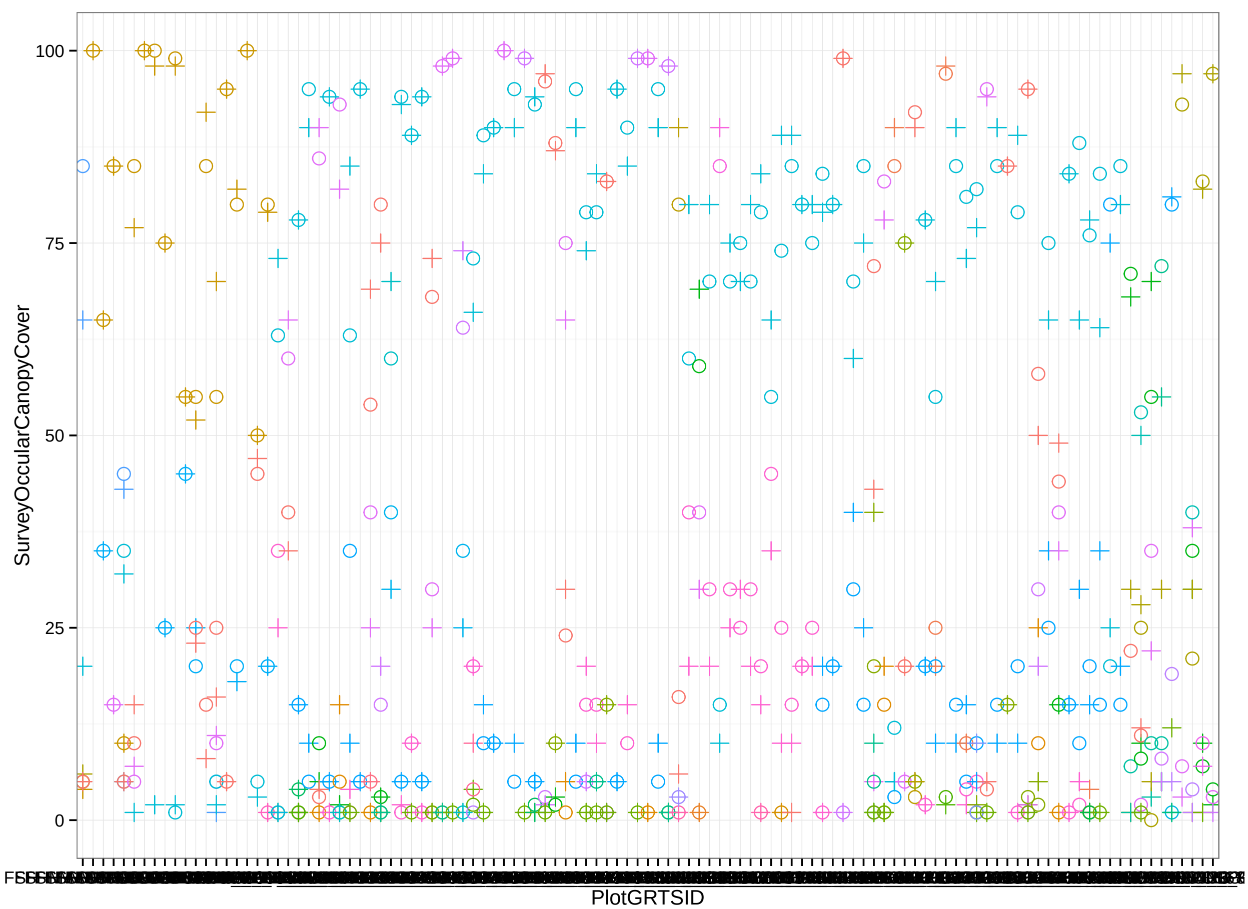


Figure 10. Variation in double-observer ocular estimates of wetland vegetation. Two observers recorded data at each GRTS point (+ is the first observer and ○ is the alternate

observer). Colors refer to different species. If the two observers both record the same percent cover for a specific species, the ○ and + of the same color will overlap completely.

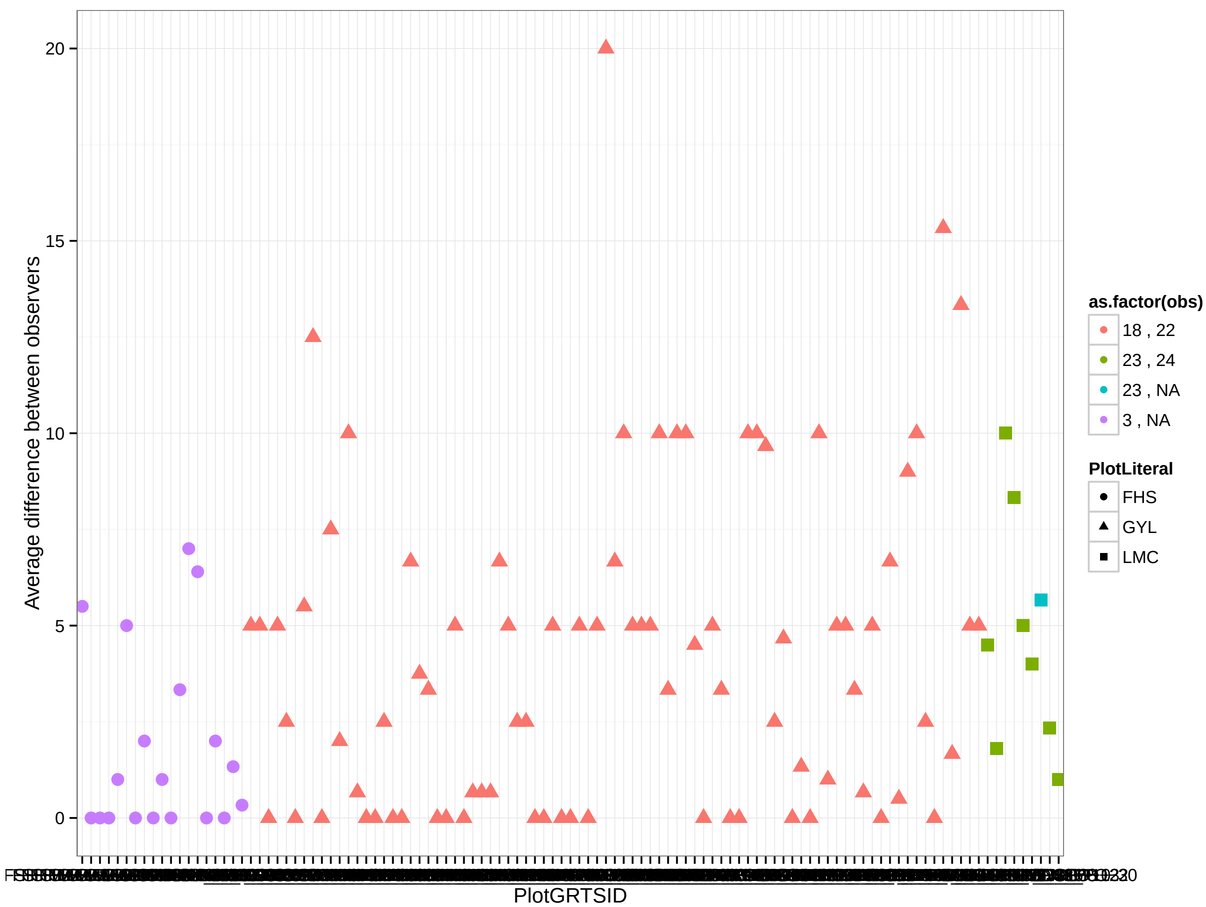


Figure 11. The average difference in percent cover estimate between observers by point and refuge. The colors correspond to unique pairs of observers. In FHS, the same observer pair was always used; GYL had all but 3 points with the same pair; and LMC had all but one point with the same pair.

As we can see from Figures 10 and 11, there does appear to be interesting differences in the percent cover values between observers. An alternative response metric used in upland plant surveys is based on using ordered categories. We visually explored whether the variation between observers is reduced by using categories instead (Table 44).

Category	Percent Covers
0	0%
1	1%
2	>1-5%
3	>5-25%
4	>25-50%
5	>50-75%
6	>75-95%
7	>95-100%

Table 38. Cover category scheme used to bin visually assessed percent cover from field surveys.

We did see a decrease in variation when the data recorded within 5% intervals was binned into categories (Figure 12). One consideration is that ordered categorical data would require a different set of design-based estimates and statistical modeling procedures for analysis. However, the potential reduction in measurement error and time spent at a plot should be discussed.

Figure 12. At each GRTS point, there are two observers recorded (• is the first observer and ○ is the alternate observer). Colors refer to different vegetation types. If the two observers both record the same percent cover for a specific vegetation, the ○ and • of the same color will overlap completely, forming a slightly larger filled-in circle. Thus an unfilled circle indicates a lack of agreement on the coverage category between the two observers for a specific vegetation type.