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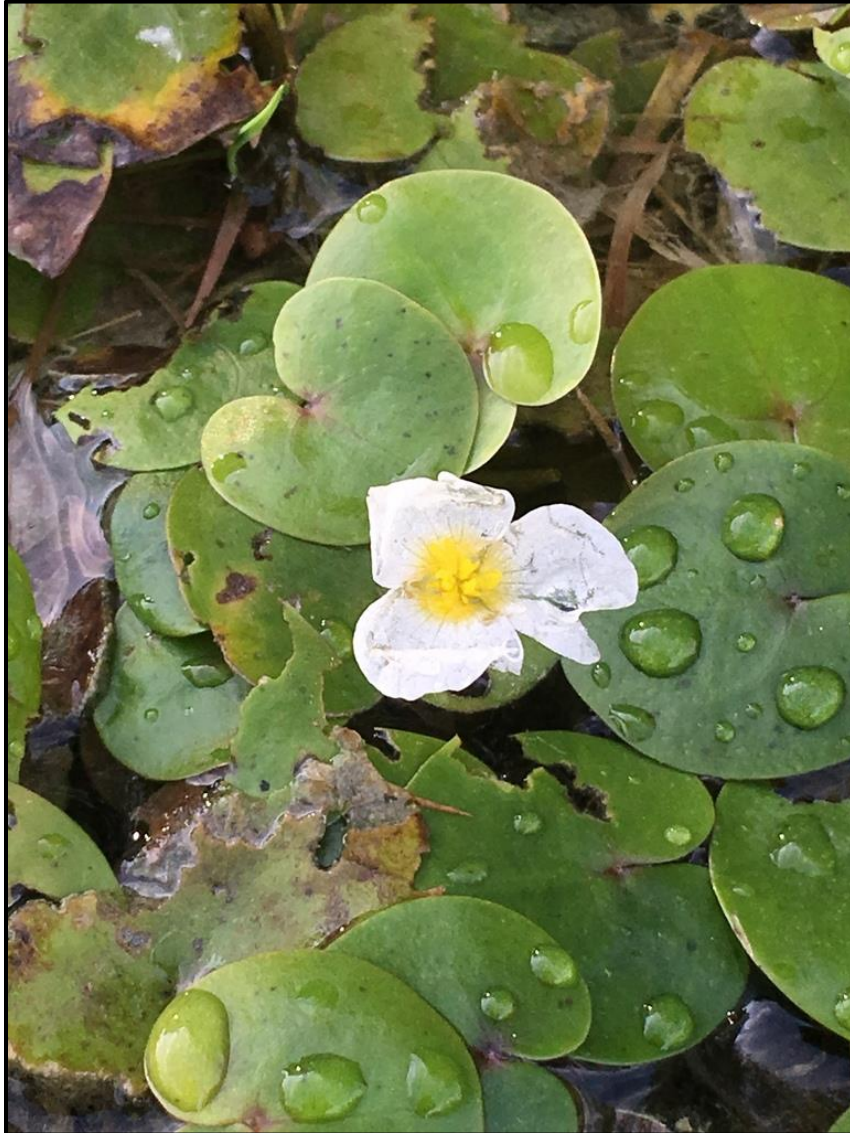


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Standard Treatment Impact Monitoring Protocol



European frog-bit (*Hydrocharis morsus-ranae* L.). Photograph by Blake C. Cahill.

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I. Introduction

This document was initially a product of an Environmental Protection Agency (EPA) – Great Lakes Restoration Initiative (GLRI) grant between the Michigan Department of Environment, Great Lakes, and Energy (MEGLE, previously the MDEQ) and Central Michigan University (CMU) in 2018 (Cahill et al. 2018a). It was reviewed by attendees of the European Frog-bit Collaborative Fall 2018 Workshop and revised by CMU according to attendee feedback in 2019. It was piloted in 2019 and optimized in 2020 according to the pilot implementation and further feedback from the EFB Collaborative. The purpose of the Standard Treatment Impact Monitoring Protocol (STIMP) is to establish a consistent methodology for evaluating the impact that selected treatments have on European frog-bit (*Hydrocharis morsus-ranae* L.; EFB). The analysis of data collected using the protocol will facilitate the development of best management practices (BMP's) for EFB control and inform adaptive management plans.

Standard treatment impact monitoring protocols allow researchers, policy makers, and managers to evaluate the impacts of management actions on local, state-wide, and basin-wide scales and ensure that data is being collected in a suitable and consistent manner to meet the objectives of the management and monitoring program (Lindenmayer and Likens 2009). Without standard protocols, data collection methods differ on a site to site basis and cannot be compared beyond the specific treatment locality. Effective protocols include pre- and post-treatment assessments in managed (i.e., experimental) and unmanaged (i.e., control) locations. Standard data collection methods, pre- and post-treatment assessments, and the inclusion of unmanaged control areas allow managers to identify whether a management action or an outside influence (e.g., water-level fluctuation) is impacting a treated invasive species and to explore treatment impacts across spatial and temporal scales. To maximize their implementation, standard treatment impact monitoring protocols must address the resource (i.e., time, personnel, expertise, equipment) availability of local, state, and basin-wide managers.

Goal of the Standard Treatment Impact Monitoring Protocol:

- Enhance the effectiveness of EFB management plans across the Great Lakes basin.

Objective of the Standard Treatment Impact Monitoring Protocol:

- Integrate adaptive management principles into EFB management and monitoring plans to develop Best Management Practices (BMP's) for control.

Deliverable:

- A standardized methodology for evaluating the impact of selected treatments on EFB that reflects the fiscal and logistic constraints of the organizations and individuals conducting the management and monitoring.

II. Applicability

The STIMP is designed to assess the impact of approved and permitted treatments on EFB. It can also be applied to assess the impact of treatments on other floating and emergent invasive aquatic plant species on the [Michigan Invasive Species Watch List](#). The protocol can be applied at a local management scale, across the state of Michigan, and throughout the Great Lakes basin by professional stakeholders (e.g., researchers, managers, policy makers).

For more information on the required permits for managing invasive species in Michigan visit the [Permits](#) section of the Michigan Invasive Species website. For a review of the biology, ecology, and management of EFB read the [European frog-bit Status and Strategy](#) (Cahill et al. 2018b).

III. Personnel Qualifications and Responsibilities

A total of two crew members are required for implementation of the STIMP. Out of the two crew members, a Crew Leader and Crew Assistant will be designated. If possible, crew members will remain constant for pre- and post-treatment sampling visits to ensure repeatability of measurements and consistency in protocol application. In the case of staff turnover, it is recommended that incoming crew members be paired with the remaining crew member to retain consistency in protocol implementation. Below are general qualifications and responsibilities for the Crew Leader and Crew Assistant.

a. Qualifications

Crew members will need to be able to follow stated procedures for all aspects of protocol implementation and have proficiency in proper data collection, management, and entry standards. A minimum of one crew member must have experience in dominant wetland plant identification and plant sampling methodology. Experience with handheld GPS units and Geographic Information Systems (GIS) software is recommended. Crew members must have the ability and willingness to conduct physically strenuous activities in various outdoor conditions, feel comfortable working on and in wetlands and open water environments, and work effectively as a team.

b. Responsibilities

i. Crew Leader

The Crew Leader is responsible for planning and implementing all procedures in the protocol. Additionally, it is the Crew Leaders responsibility to ensure that the Quality of Life agencies [Invasive Species Decontamination for Field Operations in Michigan Policy and Procedure](#) is followed after all field sampling.

ii. Crew Assistant

The Crew Assistant is responsible for assisting the Crew Leader in implementing all procedures in the protocol. It is also the Crew Assistant's responsibility to gather all required equipment and materials for field sampling and to verify that all equipment is in working condition prior to field sampling. In addition, it is the responsibility of the Crew Assistant to decontaminate all equipment after field sampling using the Quality of Life agencies [Invasive Species Decontamination for Field Operations in Michigan Policy and Procedure](#).

IV. Overview

The STIMP records 1) pre- and post-treatment data on EFB over entire treatment and untreated control areas, 2) pre- and post-treatment data on EFB from circular plots subjectively located in treatment and untreated control areas, and 3) data on the treatment of EFB in treatment areas (Figure 1). It is designed so that data gathered from both treatment and untreated control areas can be used to determine potential treatment impacts to EFB and non-target aquatic plant species, identify control techniques and strategies that need further investigation, provide preliminary data on EFB distribution, reproductive biology and phenology, and habitat requirements, and summarize where, by whom, and how EFB is being managed on the local, state, and basin-wide scales.

The portion of the protocol that records pre- and post-treatment data on EFB over entire treatment and untreated control areas is adapted from the Midwest Invasive Species Information Network's (MISIN) Invasive Plant Mapping Protocol (MISIN 2016) and the MEGLE-Water Resource Division's and Great Lakes Environmental Center's (GLEC) Saginaw Bay Problem Assessment procedure. This portion of the protocol records area-level habitat data and occurrence data, metadata, and associated data using fields that mirror MISIN Observation Report fields, and additional occurrence metadata and associated data not currently required on MISIN Observation Reports (e.g., Site ID, Area ID, Invasion Stage, Spread Risk, Life Stage, Reproductive Condition) on the Pre- (Appendix A) or Post-Treatment Sampling Datasheet (Appendix B).

The portion of the protocol that records pre- and post-treatment data on EFB from circular plots subjectively located in treatment and untreated control areas is adapted from the California Native Plant Society's (CNPS) Vegetation Rapid Assessment Protocol (CNPS 2007), California Department of Fish and Wildlife (CDFW) and CNPS's Combined Vegetation Rapid Assessment and Relevé Protocol (CDFW and CNPS 2016), and the MEGLE-Water Resource Division's and GLEC's Saginaw Bay Problem Assessment procedure. This portion of the protocol requires subjective designation of a 5-meter radius circular plot in a representative portion of each wetland zone (i.e., wet meadow, emergent, submergent) of both treatment and untreated control areas (i.e., a minimum of one plot and maximum of three plots sampled per area) during pre-treatment sampling visits and re-sampling of the circular plots during post-treatment sampling visits. Within each plot, visual estimates of the cover and

dispersion of aquatic plant functional groups and EFB, a plant condition index (Maclsaac et al. 2016), life stage and reproductive condition of EFB, and habitat characteristics are recorded on the Pre- (Appendix A) or Post-Treatment Sampling Datasheet (Appendix B).

The portion of the protocol that records data on the treatment of EFB in treatment areas is adapted from MISIN's Treatment Tracking ArcGIS application. This portion of the protocol records data on the treatment of EFB using data fields that mirror MISIN Treatment Tracking fields on the Treatment Tracking Datasheet (Appendix C).

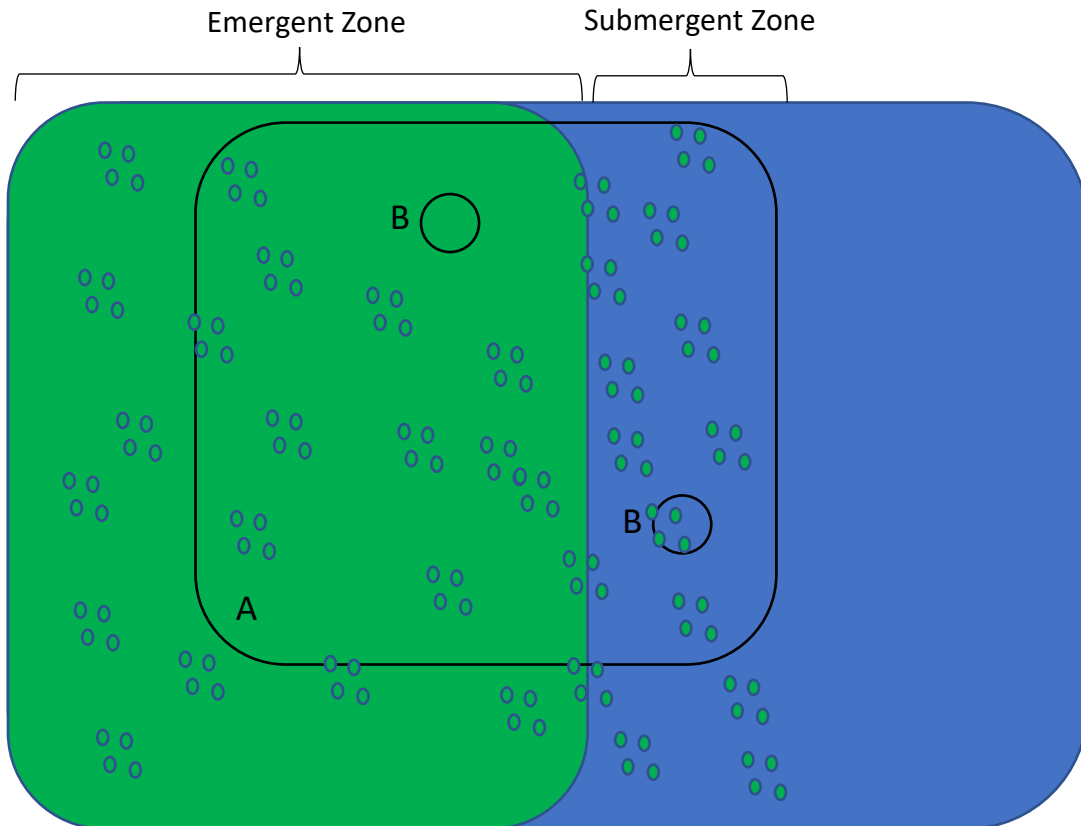


Figure 1. Schematic of how the Standard Treatment Impact Monitoring Protocol would be implemented for a treatment area (A) that contains emergent and submergent vegetation zones. Within each vegetation zone a 5-meter radius circular plot (B) is subjectively located in an area that is representative of the zone as a whole. See Table 3 for variables recorded over entire treatment and untreated control areas and in circular plots subjectively located in treatment and untreated control areas.

V. Untreated Control Areas

To fulfill the goals and objectives of the STIMP, untreated control areas must be included in the monitoring design. All Field Sampling Procedures must be conducted in an untreated control area as well as in a treatment area if potential treatment impact is to be evaluated. Untreated control areas must share as many features of treatment areas as possible,

including EFB density, treatment history, waterbody and wetland type, vegetation zonation, and community composition.

VI. Timing of Sampling

The sections below detail the important considerations when scheduling pre- and post-treatment sampling visits. It is crucial that untreated control areas are sampled during the same time frame as treatment areas to distinguish the impact of a treatment from other factors that may be influencing EFB and non-target species (e.g., seasonal phenology, water level fluctuations). Pre- and post-treatment sampling visits in treatment and untreated control areas are recommended to occur within a one-week period of one another, as close to each other as possible.

a. Pre-Treatment Sampling

Pre-treatment sampling is recommended to occur within the two-weeks prior to the planned treatment date and as close to the treatment date as possible. This allows for flexibility to accommodate for potential weather restrictions and managing entity/contractor schedules. Depending on the size of the treatment/untreated control area and the structural complexity of the area, pre-treatment sampling can occur two weeks from the planned treatment date up until the day of treatment, before the treatment is implemented.

An important consideration when scheduling a pre-treatment sampling visit is the phenology of EFB (Table 1). To evaluate the impact of a selected treatment, EFB must be actively growing and observable during pre-treatment sampling.

b. Post-Treatment Sampling

Post-treatment sampling visits must be scheduled to allow sufficient time for the implemented treatment to take effect. For most mechanical techniques the treatment effect is experienced immediately. The length of time required for physical techniques to take effect varies on the technique. For example, benthic barriers take effect immediately while shading techniques can take weeks to months to have an effect (e.g., Schooler 2008). The length of time required for chemical treatments to take effect varies based on the applied treatment. The active ingredients contained in chemical treatments have different modes of action and speeds of action which influence the length of time until they take effect (Table 2).

It is also important to consider the phenology of EFB when scheduling post-treatment sampling visits (Table 1). Sampling during or after annual senescence could falsely suggest that the treatment had an effect when it did not.

The goals and objectives of the local management plan are also important to consider when scheduling post-treatment sampling visits. To assess the single season impact of a treatment, post-treatment sampling should occur within the same season as the treatment. To assess the long-term impact of a treatment, post-treatment sampling should occur in the growing seasons following the season of treatment.

Table 1. Summary of documented European frog-bit (*Hydrocharis morsus-ranae* L.) germination, emergence, and senescence phenology at sites in the Great Lakes region. All sites are in-situ.

Region	Site(s)	Germination/Emergence	Senescence
southeastern Ontario ¹	Unknown	<ul style="list-style-type: none"> • Turions begin germination under water in late April – early May • Rosettes float to the surface of the water in late May – early June • Phenology of seed germination and emergence unknown 	<ul style="list-style-type: none"> • Phenology of senescence unknown
west Michigan ²	Reeds Lake, Fisk Lake, Aquinas College ponds	<ul style="list-style-type: none"> • Turions begin germination under water in March – April • Rosettes float to the surface of the water in late May • Phenology of seed germination and emergence unknown 	<ul style="list-style-type: none"> • Phenology of senescence unknown
northeastern Lower Peninsula of Michigan ²	Fletcher Pond, Alpena Wildlife Sanctuary, Lake Huron coastline	<ul style="list-style-type: none"> • Turions begin germination under water in March – April • Rosettes float to the surface of the water in May • Phenology of seed germination and emergence unknown 	<ul style="list-style-type: none"> • Phenology of senescence unknown
eastern Upper Peninsula of Michigan ²	Munuscong Bay, Raber Bay	<ul style="list-style-type: none"> • Turions begin germination under water in April – May • Rosettes float to the surface of the water in late June – early July • Phenology of seed germination and emergence unknown 	<ul style="list-style-type: none"> • Phenology of senescence unknown

¹Catling et al. 2003, ²Cahill et al. 2018c

Table 2. Summary of herbicide active ingredients used for European frog-bit (*Hydrocharis morsus-ranae* L.) control. For each active ingredient, example trade names, mode and speed of action, time until susceptible plants exhibit visual symptoms, time until susceptible plant control, and the cited literature is listed. Information regarding specific trade names can be found on their Specimen Labels.

Herbicide	Mode of Action	Speed of Action	Time to Visual Symptoms	Time To Achieve Control	References
Diquat (e.g., Reward®)	Contact	Fast	Several hours	<1 week	(UF/IFAS 2018; AERF 2018)
Endothall (e.g., Aquathol®)	Contact	Fast	< 1 week	1 – 3 weeks	(UF/IFAS 2018; AERF 2018)
Flumioxazin (e.g., Clipper®)	Contact	Fast	3 – 5 days	7 – 14 days	(UF/IFAS 2018)
2, 4-D (e.g., Navigate®)	Systemic	Fast	Several hours – 1 day	Few days	(Mudge and Netherland 2014; UF/IFAS 2018; AERF 2018)
Triclopyr (e.g., Renovate®)	Systemic	Slow	< 1 day	Several weeks	(WDNR 2012; UF/IFAS 2018; AERF 2018)
Imazapyr (e.g., Habitat®)	Systemic	Slow	2+ weeks	2 – 6 weeks	(UF/IFAS 2018; AERF 2018)
Imazamox (e.g., Clearcast®)	Systemic	Slow	1 – 3 weeks	2 – 6 weeks	(Mudge and Netherland 2014; UF/IFAS 2018; AERF 2018)
Penoxsulam (e.g., Galleon®)	Systemic	Slow	1 – 3 weeks	Several weeks – months	(WDNR 2012; Mudge and Netherland 2014; AERF 2018)
Glyphosate (e.g., AquaPRO®)	Systemic	Slow	2 – 3 days	> 3 weeks	(UF/IFAS 2018)

VII. Field Sampling Methodology Justification

The Field Sampling Procedures of the STIMP employ two research-grade methods to document aquatic plant abundance and community composition in treatment and untreated control areas: the subjective method (i.e., area-level data) and the semi-quantitative method (i.e., circular plot-level data; Madsen and Wersal 2018). Subjective methods are useful for rapidly assessing aquatic plant community characteristics. Semi-quantitative methods are similar to subjective methods but include an estimate of percent cover for each species/functional group identified (Madsen and Wersal 2018). Comparison of pre- vs. post-treatment and treatment vs. untreated control area data can be used to identify potential treatment impacts. Both subjective and semi-quantitative methods have been used in aquatic plant monitoring and management assessment programs (e.g., Bourdaghs and Gernes 2005, Higman et al. 2010, Hussner et al. 2016, Connecticut Sea Grant undated).

VIII. Field Sampling Variable Justification

a. Aquatic Plant Density and Cover

The protocol records the density (i.e., sparse, patchy, dense, monoculture) of EFB over entire treatment and untreated control areas and the cover and dispersion of EFB (i.e., %) and aquatic plant functional groups (i.e., 0%, <5%, 5-10%, 11-30%, 31-50%, 51-75%, 76-100%) in circular plots located in treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). As the target of many management plans is to reduce the density and cover of EFB infestations, understanding its pre- and post-treatment cover is the basis for making inferences on treatment impact. Invasive aquatic plant density and cover have been recorded in aquatic plant monitoring and assessment programs (e.g., Bourdaghs and Gernes 2005, Higman et al. 2010, Hussner et al. 2016, Connecticut Sea Grant undated) and monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

b. Invasion Stage

The protocol records the invasion stage (i.e., previously detected, newly detected, unknown) of EFB over entire treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Understanding the invasion stage of EFB in treatment areas can have important implications for interpreting treatment impacts. Established infestations may have persistent propagule banks from which they can reestablish, rendering control to short-term at best (Hussner et al. 2017). Invasion stage is also recorded to collect data on what types of infestations are being treated. The invasion stage of EFB infestations has been included in monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

c. Spread Risk

The protocol records the spread risk (i.e., high, low) of EFB over entire treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Spread risk is recorded to collect data on what types of infestations are being treated. The spread risk of EFB infestations has been included in monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

d. Life Stage

The protocol records the life stage (i.e., immature, mature, senescent) of EFB over entire treatment and untreated control areas and in circular plots located in treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Understanding the life stage of EFB at the time of treatment can have important implications into interpreting treatment impacts. If EFB is senescing prior to a treatment it can falsely suggest that the treatment had an impact on the infestation when it did not. It can also help when inferring why a treatment was unsuccessful. For example, some chemical treatments (e.g., glyphosate) are most efficacious when plants are actively growing. Life stage is also recorded to provide preliminary data on EFB seasonal phenology. Life stage has been recorded in aquatic plant monitoring and assessment programs (e.g., IDNR 2018) and monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

e. Reproductive Condition

The protocol records the reproductive condition (i.e., non-reproductive/sterile, flowering, fruiting, producing winter buds, producing clonal daughter plants) of EFB over entire treatment and untreated control areas and in circular plots located in treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Understanding the reproductive condition of EFB before and after a treatment can provide insight into its reestablishment potential and need for retreatment. Reproductive condition is also recorded to provide preliminary data on EFB reproductive biology and phenology. Reproductive condition has been recorded in aquatic plant monitoring and assessment programs (e.g., IDNR 2018) and monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

f. Condition

The protocol records the condition (i.e., leaves green and rigid, leaves rigid with some chlorosis, leaves rigid with plenty of chlorosis, leaves wilting with chlorosis, leaves wilted and brown, plant no longer alive and intact; Maclsaac et al. 2016) of EFB in circular plots located in treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Understanding the condition of EFB before and after a treatment can have important implications for interpreting treatment impacts. If EFB is in poor condition prior to a treatment it can falsely suggest that the treatment had an

impact when it did not. If EFB condition is worsened post-treatment in a treatment area but not in an untreated control area it may suggest that the treatment had an impact as the effect of some treatments, such as herbicide applications or shading, are experienced as chlorosis and a loss of rigidity before a loss of abundance. Condition has been recorded in aquatic plant monitoring and assessment programs and studies (e.g., Robles et al. 2010, Mudge and Netherland 2014).

g. Habitat Variables

The protocol records waterbody type (i.e., Great Lake, inland lake, reservoir, pond, river, stream, ditch/canal) and wetland type (i.e., Great Lakes marsh, emergent marsh, submergent marsh, wet meadow) over entire treatment and untreated control areas during pre-treatment sampling visits and the dominant plant species over entire treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). The protocol records the cover (i.e., 0%, <5%, 5-10%, 11-30%, 31-50%, 51-75%, 76-100%) of substrate types (i.e., cobble; gravel; sand; silt, clay, or muck; woody debris; organic; other vegetation/litter) in circular plots located in treatment and untreated control areas during pre-treatment sampling visits and the cover of physical habitat features (i.e., aquatic and inundated herbaceous vegetation, hummocks/tussocks/tree mounds, woody debris/snags > 0.3 m diameter, woody brush/woody debris < 0.3 m diameter, inundated live/dead trees > 0.3 m diameter, overhanging vegetation within 1 m of surface, floating debris, open water, human structures), water temperature, water depth, and presence of flow in circular plots located in treatment and untreated control areas during pre- and post-treatment sampling visits (Table 3). Understanding the habitat features of treatment areas can have important implications for interpreting treatment impact. For example, an herbicide treatment may not be as successful as anticipated in an area dominated by emergent vegetation that could prevent herbicide from contacting EFB plants. Habitat variables are also recorded to provide preliminary data on EFB habitat requirements and associations. Habitat variables have been recorded in aquatic plant monitoring and assessment programs (e.g., Bourdaghs and Gernes 2005, Hauxwell et al. 2010) and monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

h. Human Use Variables

The protocol records human and fish and wildlife-use variables over entire treatment and untreated control areas (i.e., Recreational Use(s)?; Is this site important for: boating?, waterfowl hunting?, waterfowl habitat?, fishing?, fish spawning?; is the area within 500 m of a public boat launch or access site?) during pre-treatment sampling visits (Table 3). Understanding the human and fish and wildlife-use of a treatment or untreated control area can help when inferring how EFB was spread to the area and how EFB is potentially impacting the area. Human and fish and wildlife-use variables are also recorded to provide data on what types of infestations are being treated. Human

and fish and wildlife-use of areas infested with EFB have been included in monitoring efforts by the MEGLE (W. Keiper, MEGLE, personal communication).

Table 3. Variables recorded at the treatment/untreated control area-level and the circular plot-level using the Standard Treatment Impact Monitoring Protocol. For each variable, the controlled vocabulary used and the visit(s) that the variable is recorded are listed.

Scale	Variable	Controlled Vocabulary	Pre-Treatment	Post-Treatment
Area-level	Waterbody	NA	X	
	Waterbody type	Great Lake, inland lake, reservoir, pond, river, stream, ditch/canal	X	
	Wetland type	Great Lakes marsh, emergent marsh, submergent marsh, wet meadow	X	
	Recreational use(s)	Yes, no	X	
	Is the site important for boating?	Yes, no	X	
	Is the site important for waterfowl hunting?	Yes, no	X	
	Is the site important for waterfowl habitat?	Yes, no	X	
	Is the site important for fishing?	Yes, no	X	
	Is the site important for fish spawning?	Yes, no	X	
	Other recreation or ecological uses	NA	X	
	Is the area within 500 m of a public boat launch or access site?	Yes, no	X	
	Dominant plant species	N/A	X	X
	Reporting	Detected, not detected	X	X
	Area	None, Individual/few/several, <1,000 sq. ft., 1,000 sq. ft. to 0.5 acre, 0.5 acre to 1 acre, > 1 acre	X	X
	Density	Sparse, patchy, dense, monoculture	X	X
	Invasion stage	Previously detected, newly detected, unknown	X	X
	Spread risk	High, low	X	X
	Life stage	Immature, mature, senescent	X	X
	Reproductive condition	Non-reproductive/sterile, flowering, fruiting, producing winter buds, producing clonal daughter plants	X	X
Re-treatment necessary	Yes, no		X	
Plot-level	Wetland zone	Submergent, emergent, wet meadow	X	X
	Functional group cover	0%, <5%, 5-10%, 11-30%, 31-50%, 51-75%, 76-100%	X	X
	Functional group dispersion	A, B, C, D (see Pre-Treatment Sampling Datasheet; Appendix A)	X	X
	Target Species Cover	%	X	X
	Target Species Dispersion	A, B, C, D (see Pre-Treatment Sampling Datasheet; Appendix A)	X	X
	Condition	Leaves green and rigid, leaves rigid with some chlorosis, leaves rigid with plenty of chlorosis, leaves wilting with chlorosis, leaves wilted and brown, plant no longer alive and intact	X	X
	Life stage	Immature, mature, senescent	X	X

Reproductive condition	Non-reproductive/sterile, flowering, fruiting, producing winter buds, producing clonal daughter plants	X	X
Did you collect a physical specimen for drying and preserving in an herbarium?	Yes, no	X	X
Collector Name	NA	X	X
Collection Number	NA	X	X
Herbarium	NA	X	X
Description	NA	X	X
Substrate cover (cobble; gravel; sand; silt, clay, or muck; woody debris; organic; other vegetation/litter)	0%, <5%, 5-10%, 11-30%, 31-50%, 51-75%, 76-100%	X	
Physical habitat cover (aquatic and inundated herbaceous vegetation, hummocks/tussocks/tree mounds, woody debris/snags > 0.3 m diameter, woody brush/woody debris < 0.3 m diameter, inundated live/dead trees >0.3 m diameter, overhanging vegetation within 1 m of surface, floating debris, open water, human structures)	0%, <5%, 5-10%, 11-30%, 31-50%, 51-75%, 76-100%	X	X
Water temperature	NA	X	X
Water depth	NA	X	X
Is the water flowing?	Yes, no	X	X
Non-target species	NA	X	X

IX. Field Sampling Preparation Procedures

The following procedures describe the field sampling preparation portion of the STIMP. All Field Sampling Preparation Procedures take place in the office/field station.

- a. Gather all equipment on the Equipment and Materials Checklist (Appendix D).

Gather all equipment listed on the Equipment and Materials Checklist (Appendix D) and verify that all gathered equipment is in working condition. Not all items listed on the checklist are required. Items not required for all situations have “If applicable” in parentheses next to their names.

- b. Prepare a field sampling binder or storage clipboard with all printed materials on the Equipment and Materials Checklist (Appendix D).

Print the STIMP and Pre- (Appendix A) or Post-Treatment Sampling Datasheets (Appendix B) on Rite-in-the-Rain® paper or other waterproof paper. Download and print the [Michigan Invasive Species Watch List](#) and the Michigan Quality of Life agencies [Invasive Species Decontamination for Field Operations in Michigan Policy and Procedure](#) on Rite-in-the-Rain® paper or other waterproof paper. Place these documents in a storage clipboard or binder. Prior to departure, place the binder with the other equipment gathered for sampling.

X. Field Sampling Procedures

The following procedures describe the field sampling portion of the STIMP. All Field Sampling Procedures take place in the field. Procedures are based on completion of the Pre- (Appendix A) or Post-Treatment Sampling Datasheet (Appendix B) depending on the visit type (i.e., pre-treatment, post-treatment).

- a. Partially complete the *Pre-/Post-Treatment Monitoring Area Data* section of the Pre- (Appendix A) or Post-Treatment Sampling Datasheet (Appendix B).

At the site staging area, complete the following fields in the *Sampling Data* section of the datasheet:

Date: The date in M/D/YYYY format (e.g., 5/6/2018).

Site ID: The name of the site containing the treatment/untreated control area (e.g., Fletcher Pond).

Area ID: The name of the treatment/untreated control area. Area ID includes an abbreviation for the area’s designation (i.e., T for treatment, C for control) and a three-digit sequence number for each treatment/untreated control area that has been sampled in the site using this protocol (i.e., 001 for the first treatment area,

002 for the second treatment area, and so on). Example Area ID's for the first treatment and untreated control areas in Fletcher Pond would be T001 and C001.

Area Designation: Whether the area is designated as a treatment or untreated control area.

Visit Type: Whether the visit is for pre-treatment or post-treatment sampling.

Crew Leader: The Crew Leader's first and last name (e.g., Jane Doe).

Crew Assistant: The Crew Assistant(s) first and last name(s).

Associated Group: The group that the Crew Leader and Crew Assistant are associated with (if applicable).

GPS Unit Make: The brand of the GPS unit being used (e.g., Garmin).

GPS Unit Model: The name of the GPS unit being used (e.g., Montana 680t).

Datum: The datum that the GPS unit being used is set (e.g., WGS84).

Camera Make: The brand of the camera being used (e.g., Nikon).

Camera Model: The name of the camera being used (e.g., Coolpix W300).

Waterbody: The body of water that the wetland containing the treatment/untreated control area is associated with (e.g., Fletcher Pond).

Waterbody Type: The type of waterbody that the wetland containing the treatment/untreated control area is associated with.

Wetland Type: The type of wetland containing the treatment/untreated control area.

Recreational Use(s): Whether or not the site is used for recreation.

Is this site important for: Whether or not the site is perceived as important for boating, waterfowl hunting, waterfowl habitat, fishing, or fish spawning.

Other recreation or ecological uses: Any recreational or ecological uses of the site that are not listed in the field above.

Is this area within 500 m of a public boat launch or access site: Whether or not the area is within 500 m of a public boat launch or access site.

Start Time: The time in H:MM am/pm format (e.g., 8:30 am).

Starting Air Temperature: The air temperature at the start of sampling.

Air Temperature Unit: The unit of temperature used.

Starting Cloud Cover (%): The cloud cover at the start of sampling.

Starting Wind Speed: The wind speed at the start of sampling.

Wind Speed Unit: The unit of wind speed used.

Verify that all of the above fields are filled-in before advancing to the next step. The following fields are only completed during pre-treatment sampling visits: waterbody, waterbody type, wetland type, recreational use(s), is this site important for, other recreation or ecological uses, and is this area within 500 m of a public boat launch or access site.

- b. Partially complete the *Pre-/Post-Treatment Monitoring Area Data* section of the Pre-Treatment Sampling Datasheet (Appendix A).

Navigate (i.e., wade, kayak, boat) to the approximate center of the treatment/untreated control area. While traversing observe 1) the wetland zones and dominant plant species present in the area and 2) the density, life stages, and reproduction condition of EFB in the area. Complete the following fields in the *Pre-/Post-Treatment Monitoring Area Data* section of the datasheet:

Dominant Plant Species: The species estimated to be most abundant in the treatment/untreated control area (e.g., invasive Cattail).

Target Species: The common name of the target invasive species being monitored (e.g., European frog-bit).

Reporting: Whether the target invasive species was detected or not detected at the treatment/untreated control area during the sampling visit.

Area: The category that best estimates the area of the target invasive species infestation.

Area Type: The scale used to estimate the area of the target invasive species infestation.

Density: The category that best estimates the number of target invasive species individuals in the estimated area.

Density Type: The scale used to estimate the number of target invasive species individuals in the estimated area.

Invasion Stage: The category that represents the invasion stage of the target invasive species in the treatment/untreated control area. A previously detected infestation is one that was detected in the treatment/untreated control area in a previous field season. A newly detected infestation is one that was first detected in the current growing season and was undetected during monitoring efforts in the area during a previous field season.

Spread Risk: The category that best represents the risk of the target invasive species spreading from the treatment/untreated control area. Areas with flow and high recreational activity have a high spread risk. Isolated, stagnant areas have a low spread risk.

Life Stage: The life stages of the target invasive species observed in the treatment/untreated control area. See Appendix E for definitions of each life stage and photographs of EFB at each life stage.

Reproductive Condition: The reproductive condition of the target invasive species observed in the treatment/untreated control area. See Appendix E for definitions of each reproductive condition and photographs of EFB at each reproductive condition.

Take one photograph that clearly depicts EFB, ensuring that as many features as possible that are important for identification are visible in the photograph (e.g., flowers, relative size, stipules). Take a second photograph that clearly depicts the density of the EFB infestation in the treatment/untreated control area. Complete the following fields in the *Pre-/Post-Treatment Monitoring Area Data* section of the datasheet:

Target Species Photograph: The name/number of the photograph that clearly depicts the target invasive species.

Target Species Density Photograph: The name/number of the photograph that clearly depicts the density of the target invasive species infestation in the treatment/untreated control area.

Other Photographs: The name/number of any additional photographs taken.

Re-treatment necessary: Whether or not the area needs to be treated again (if applicable).

Verify that the above fields in the *Pre-/Post-Treatment Monitoring Area Data* section of the datasheet are filled-in before advancing to the next step. The following fields are only completed during post-treatment sampling visits in treatment areas: re-treatment necessary.

- c. Establish a circular plot in a wetland zone (i.e., wet meadow, emergent, submergent) of a treatment/untreated control area. This step is only completed during pre-treatment sampling visits. If this is a post-treatment sampling visit, advance to the next step.

Select a wetland zone (i.e., wet meadow, emergent, submergent) in the treatment/untreated control area to sample first. Navigate to the selected zone. Locate an area within the zone that exhibits as many features of that zone as a whole as possible. This includes common species composition, total vegetation cover, target invasive species cover, proportion of open water, substrate type, water flow velocity, etc. Navigate to the center of the located area and insert a PVC marker pole into the substrate. Envision that the pole is at the center of a circle with a 5-meter radius. This 5-meter radius circle will hereafter be referred to as a circular plot. Circular plots established during pre-treatment sampling visits will be resampled during post-treatment sampling visits.

- d. Complete the *Pre-/Post-Treatment Monitoring Circular Plot Data* section of the Pre- (Appendix A) or Post-Treatment Sampling Datasheet (Appendix B).

Standing/floating at the PVC marker pole in the center of the circular plot, log a GPS waypoint. Then, without moving, average the waypoint to gather the most accurate location data as possible. Instructions for logging a waypoint and averaging a waypoint will depend on the make and model of the handheld GPS unit and can be found in the unit's user manual. Complete the following fields in the *Pre-/Post-Treatment Monitoring Circular Plot Data* section of the datasheet:

Latitude: The latitude coordinate of the GPS waypoint in decimal degrees (e.g., 43.5861). Include all decimal places available on the GPS unit to improve precision.

Longitude: The longitude coordinate of the GPS waypoint in decimal degrees (e.g., -84.7731). Include all decimal places available on the GPS unit to improve precision.

Horizontal Uncertainty (m): The uncertainty of the GPS waypoint in meters (e.g., 15 m). Include all decimal places available on the GPS unit to improve precision. Some commercial grade GPS units do not provide a measure of accuracy. If using one of those, record N/A in the field.

Date: The date in M/D/YYYY format (e.g., 5/6/2018).

Site ID: The name of the site containing the treatment/untreated control area (e.g., Fletcher Pond).

Area ID: The name of the treatment/untreated control area. Area ID includes an abbreviation for the area's designation (i.e., T for treatment, C for control) and a three-digit sequence number for each treatment/untreated control area that has been sampled in the site using this protocol (i.e., 001 for the first treatment area, 002 for the second treatment area, and so on). Example Area ID's for the first treatment and untreated control areas in Fletcher Pond would be T001 and C001.

Area Designation: Whether the area is designated as a treatment or untreated control area.

Visit Type: Whether the visit is for pre-treatment or post-treatment sampling.

Circular Plot #: The sequential number of the circular plot being sampled. For the first circular plot being sampled within a treatment/untreated control area check 1, for the second check 2, and so on. If this is post-treatment sampling visit, record the number that was assigned to the circular plot during the pre-treatment sampling visit.

Plot Radius: The radius of the plot being used. The STIMP uses a 5-meter radius plot.

Plot Radius Units: The unit of length used to record plot radius.

Wetland Zone: The wetland zone being sampled.

Meander through the circular plot. Avoid excessive trampling of vegetation. While meandering, observe 1) the cover and dispersion (see Pre-Treatment Sampling Datasheet; Appendix A) of aquatic plant functional groups (i.e., submergent, free-floating, floating-leaved, emergent), all aquatic plants, and EFB and 2) the condition, life stage, and reproductive condition of EFB in the circular plot. After meandering, complete the following fields in the *Pre-/Post-Treatment Monitoring Circular Plot Data* section of the datasheet:

Cover: The cover category best representing the cover of the aquatic plant functional groups and all aquatic plants in the circular plot.

Dispersion: The dispersion category best representing the dispersion of aquatic plant functional groups and all aquatic plants in the circular plot.

Target Species: The common name of the target invasive species being monitored (e.g., European frog-bit).

Target Species Cover (%): The percent cover of the target invasive species in the circular plot expressed as an integer.

Target Species Dispersion: The dispersion category best representing the dispersion of the target invasive species in the circular plot.

Condition Index: The score that best represents the condition of most target invasive species individuals in the circular plot using the Maclsaac et al. (2016) condition index. See Appendix F for photographs representing each condition score of Maclsaac's plant condition index.

Life Stage: The life stages of the target invasive species observed in the circular plot. See Appendix E for definitions of each life stage and photographs of EFB at each life stage.

Reproductive Condition: The reproductive condition of the target invasive species observed in the circular plot. See Appendix E for definitions of each reproductive condition and photographs of EFB at each reproductive condition.

Did you collect a physical specimen for drying and preserving in an herbarium: Whether or not a voucher specimen of the target invasive species was collected.¹

Collector Name: The name of the person that collected the voucher specimen.

Collection Number: The number of the voucher specimen collected.

Herbarium: The name of the herbarium where the voucher specimen will be deposited.

Description: A description of the voucher specimen. Include features that may not be preserved in the pressed specimen.

Substrate Cover: The cover category best representing the cover of substrate types in the circular plot.

Physical Habitat Cover: The cover category best representing the cover of physical habitat features in the circular plot.

Water Temperature: The surface water temperature in the circular plot.

Water Temperature Unit: The unit of temperature used.

Water Depth: The water depth in the circular plot.

Water Depth Unit: The unit of depth used.

Flow: Whether or not the water is flowing.

Standing/floating at the PVC marker pole in the center of the circular plot, take a photograph in each cardinal direction (i.e., North, South, East, West). Complete the following fields in the *Pre-/Post-Treatment Monitoring Circular Plot Data* section of the datasheet:

North Photo: The name/number of the photograph facing north.

East Photo: The name/number of the photograph facing east.

South Photo: The name/number of the photograph facing south.

West Photo: The name/number of the photograph facing west.

Target Species Cover Photo: The name/number of the photograph that clearly depicts the cover of the target invasive species in the circular plot.

Target Species Condition Photo: The name/number of the photograph that clearly depicts the condition of most target invasive species individuals in the circular plot.

¹ For more information on collecting a voucher specimen see <https://collectionseducation.org/field-notebook/>.

Species Present: The common names of any species identified in the circular plot (e.g., Narrowleaf Cattail).

Verify that all fields in the *Pre-/Post-Treatment Monitoring Circular Plot Data* section of the datasheet are filled-in before advancing to the next step.

- e. Complete the *Pre-/Post-Treatment Monitoring Area Data* section of the Pre- or (Appendix A) Post-Treatment Sampling (Appendix B) Datasheet.

End Time: The time in H:MM am/pm format (e.g., 8:30 am).

Ending Air Temperature: The air temperature at the start of sampling.

Ending Cloud Cover (%): The cloud cover at the start of sampling.

Ending Wind Speed: The wind speed at the start of sampling.

Verify that all fields in the *Pre-/Post-Treatment Monitoring Area Data* section of the datasheet are filled-in. This completes the field sampling portion of the protocol.

Decontaminate all equipment following the Michigan Quality of Life agencies [Invasive Species Decontamination For Field Operations in Michigan Policy and Procedure](#).

XI. Treatment Tracking Procedures

The following procedures describes the treatment tracking portion of the STIMP. Treatment Tracking Procedures take place in the field and in the office/field station. Procedures that take place in the field detail the collection of site and treatment data and are based on completion of the Treatment Tracking Datasheet (Appendix C). Procedures that take place in the office/field station detail the entry of data from the Treatment Tracking Datasheet into the MISIN Treatment Tracking ArcGIS application.

The Treatment Tracking Procedures are written as if the Crew Leader and Crew Assistant are present during the treatment, collect site and treatment data following the treatment, and enter the collected data into the MISIN Treatment Tracking application. If the Crew Leader and Crew Assistant are not present during treatment (e.g., a chemical treatment applied by a private contractor), the procedure can be bypassed. Instead, as much data as possible on the site and treatment can be entered directly into the MISIN Treatment Tracking application. This will result in less data being entered in the MISIN Treatment Tracking application (e.g., weather conditions, temperature, wind speed, wind direction, rain) than what would be entered if the procedure was followed.

- a. Complete the *Site Data* section of the Treatment Tracking Datasheet (Appendix C).

At the site staging area, complete the following fields in the *Site Data* section of the datasheet:

Site ID: The name of the site containing the treatment area (e.g., Reeds Lake).

Ownership: The ownership of the site.

Property Owner Name: The name of the person/group that owns the site (e.g., John Doe, Aquinas College).

Property Owner Address: The street address of the site (e.g., 1607 Robinson Road SE).

Property Owner City: The city that the site is in (e.g., East Grand Rapids).

Property Owner County: The county that the site is in (e.g., Kent County).

Property Owner State: The state that the site is in (e.g., Michigan).

Property Owner Zip Code: The zip code of the site (e.g., 49506).

Location: A general description of the site's location (e.g., 2.5 miles east of I-96).

Associated Group: The group that is conducting/overseeing the treatment (e.g., West Michigan Conservation Network).

Associated Project: The source of the grant that is funding the treatment.

Associated Grant: The grant that is funding the treatment.

Notes: Any additional information about the site.

Verify that all fields in the *Site Data* section of the datasheet are filled-in before advancing to the next step.

- b. Complete the *Treatment Data* section of the Treatment Tracking Datasheet (Appendix C).

At the site staging area, after the treatment of the target invasive species, complete as many of the following fields as possible in the *Treatment Data* section of the datasheet:

Control Method: The control method that was employed.

Site ID: The Area ID (e.g., Reeds Lake - T001).

Associated Group: The group that is conducting/overseeing the treatment (e.g., West Michigan Conservation Network).

Treatment Date: The date that the treatment was implemented (e.g., 5/8/2018).

Treatment Type: Whether the treatment was an initial treatment or a retreatment.

Location: A general description of the location where the treatment occurred (e.g., northwest wetland).

County: The county where the treatment occurred (e.g., Kent County).

Applicators/Workers: The name(s) of the person/people that conducted the treatment (e.g., Jane Doe).

Target Species: The common name of the species that was treated (e.g., European frog-bit).

Application Method: The method used to apply the treatment mixture. If Other-See Notes is checked, record the application method in the **Notes** field.

Chemical Name: The tradename of the 1st chemical in the treatment mixture (e.g., Clipper™).

EPA Registration NO.: The EPA registration number of the 1st chemical in the treatment mixture (e.g., 59639-161).

Active Ingredient: The active ingredient of the 1st chemical in the treatment mixture (e.g., flumioxazin). If Other-See Notes is checked, record the active ingredient in the **Notes** field.

Percent AI (%): The percent active ingredient of the 1st chemical in the treatment mixture (e.g., 51%).

Chemical Name #2: The tradename of the 2nd chemical in the treatment mixture (e.g., Clipper™).

EPA Registration NO. #2: The EPA registration number of the 2nd chemical in the treatment mixture (e.g., 59639-161).

Active Ingredient #2: The active ingredient of the 2nd chemical in the treatment mixture (e.g., flumioxazin). If Other-See Notes is checked, record the active ingredient in the **Notes** field.

Percent AI (%) #2: The percent active ingredient of the 2nd chemical in the treatment mixture (e.g., 51%).

Chemical Name #3: The tradename of the 3rd chemical in the treatment mixture (e.g., Clipper™).

EPA Registration NO. #3: The EPA registration number of the 3rd chemical in the treatment mixture (e.g., 59639-161).

Active Ingredient #3: The active ingredient of the 3rd chemical in the treatment mixture (e.g., flumioxazin). If Other-See Notes is checked, record the active ingredient in the **Notes** field.

Percent AI (%) #3: The percent active ingredient of the 3rd chemical in the treatment mixture (e.g., 51%).

Adjuvant: The type (if it is a non-ionic surfactant) or tradename of the adjuvant used in the treatment mixture. If Other-See Notes is checked, record the adjuvant in the **Notes** field.

Dilutant: The type of dilutant used in the treatment mixture. If Other-See Notes is checked, record the type of dilutant used in the **Notes** field.

Dye: The tradename of the dye used in the treatment mixture (e.g., Bullseye®).

Amount of Mixture Used (gal): The amount (gal) of treatment mixture applied (e.g., 2).

Mix Rate (oz/gal): The amount (oz) of chemical used per gallon of water.

Total Active Ingredient Used (oz): The total amount (oz) of active ingredient(s) used in the treatment mixture (e.g., 0.98).

% of Infestation Treated: The percent of the infestation treated (e.g., 25%).

Application Area (acres): The total area (acres) that the treatment mixture was applied to (e.g., 2).

Equipment Used: The equipment used to implement the treatment. If Other-See Notes is checked, record the equipment used in the **Notes** field.

Number of Bags Filled: The number of bags filled with the target invasive species (e.g., 5).

Weight Estimate: The weight of the target invasive species removed (e.g., 200 lbs.).

Total Man Hours: The number of hours spent hand-pulling (e.g., 5).

Phenology: The phenology of the target invasive species at the time of treatment.

Weather Conditions: The weather conditions at the time of treatment (e.g., 100% cloud cover).

Temperature: The temperature at the time of treatment (e.g., 70°F).

Wind Speed: The wind speed at the time of treatment (e.g., 5 mph).

Wind Direction: The wind direction at the time of treatment.

Rain: Whether or not it rained during the treatment.

Problems: Any problems encountered with the treatment. If Other-See Notes is checked, record the problem in the **Notes** field.

Notes: Any additional information about the treatment.

Verify that all applicable fields in the *Treatment Data* section of the datasheet are filled-in. This completes the portion of the Treatment Tracking Procedures that takes place in the field. Decontaminate all equipment following the Michigan Quality of Life agencies [Invasive Species Decontamination For Field Operations in Michigan Policy and Procedure](#).

- c. Create a polygon of the site containing the treatment area on the MISIN Treatment Tracking ArcGIS application.

Open the [MISIN Treatment Tracking ArcGIS application](#) on a computer. Log in with your username and password. If a site polygon has previously been created advance to step d. If a site polygon has not been previously created, follow the instructions in the Create Features section of the MISIN Treatment Tracking Help Documentation guide (http://www.misin.msu.edu/files/docs/treatment_help.pdf) to create a site polygon. When the site polygon is complete, transcribe the contents of the data fields in the *Site Data* section of the Treatment Tracking Datasheet into the matching fields of the site attribute table.

- d. Create a terrestrial treatment area polygon on the MISIN Treatment Tracking ArcGIS application.

Once the site polygon and site attribute table are complete, follow the instructions in the Create Features section of the MISIN Treatment Tracking Help Documentation guide (http://www.misin.msu.edu/files/docs/treatment_help.pdf) to create a terrestrial treatment area polygon. When the terrestrial treatment area polygon is complete, transcribe the contents of the data fields in the *Treatment Data* section of the Treatment Tracking Datasheet into the matching fields of the Terrestrial Treatment attribute table. This completes the Treatment Tracking Procedures of the protocol.

XII. Data Entry Procedures

Pre- and post-treatment data collected while implementing the STIMP should be entered into MISIN's Treatment Tracker extension developed by Michigan Natural Features Inventory (MNFI), MISIN, and CMU.

XIII. Data Exploration and Analysis

In the STIMP, the parameters of interest in assessing the impact of a treatment on EFB is the cover of EFB in circular plots. The cover estimates can be explored visually to identify any potential trends in treatment impact to EFB. Cover estimates from circular plots in each wetland zone of an area can be compared between pre-treatment and post-treatment sampling visits to identify any potential trends in EFB cover over time. Cover estimates can also be compared among treatment and untreated control areas to help distinguish between potential treatment impacts and other outside influences that may be influencing EFB. Both of these exploratory analyses are most easily done by graphing the cover data from pre-treatment and post-treatment sampling visits in each wetland zone of treatment and untreated control areas. See Figure 2, for a hypothetical graph that depicts a potential treatment impact to EFB (i.e., a decrease in EFB cover) over one pre-treatment and one post-treatment sampling visit at one treatment and one untreated control area.

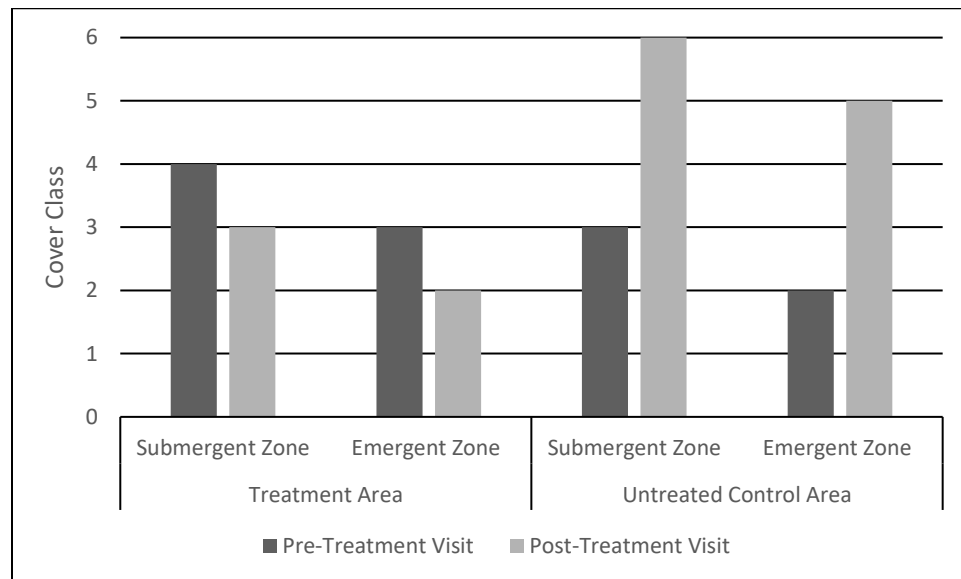


Figure 2. Hypothetical European frog-bit (*Hydrocharis morsus-ranae* L.) cover data from one pre- and one post-treatment sampling visit in a treatment and untreated control area. This figure is depicting what a subtle treatment impact to European frog-bit may appear like graphically. Cover classes are 0 (0%), 1 (<5%), 2 (5 – 10%), 3 (11 – 30%), 4 (31 – 50%), 5 (51 – 75%), and 6 (76 – 100%).

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Appendix A: Pre-Treatment Sampling Datasheet

Standard Treatment Impact Monitoring Protocol

Pre-Treatment Sampling Datasheet

Pre-/Post-Treatment Monitoring Area Data

Date: _____ Site ID: _____ Area ID: _____

Area Designation: Treatment Untreated Control

Visit Type: Pre-Treatment Post-Treatment

Crew Leader: _____ Crew Assistant: _____ Associated Group: _____

GPS Unit Make: _____ GPS Unit Model: _____ Datum Used: _____

Camera Make: _____ Camera Model: _____

Waterbody: _____

Waterbody Type: Great Lake Inland Lake Reservoir Pond
 River Stream Ditch/Canal Other-See Notes

Wetland Type: Great Lakes Marsh Emergent Marsh Submergent Marsh
 Wet Meadow Other-See Notes

Recreational Use(s): Yes No

Is this site important for:

Boating?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Waterfowl hunting?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Waterfowl habitat?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Fishing?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Fish spawning?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Other recreation or ecological uses: _____

Is this area within 500 m of a public boat launch or access site? Yes No

Start Time: _____ Starting Air Temperature: _____ Air Temperature Unit: _____

Starting Cloud Cover (%): _____ Starting Wind Speed: _____ Wind Speed Unit: _____

Dominant Plant Species: _____

Target Species: _____

Reporting: Detected Not Detected

Standard Treatment Impact Monitoring Protocol

Pre-Treatment Sampling Datasheet

Area: 0 (None) 1 (Individual/few/several)
 2 (< 1,000 sq. ft.; half tennis court) 3 (1,000 sq. ft. to 0.5 acre)
 4 (0.5 acre to 1 acre; football field w/o endzones) 5 (> 1 acre)

Area Type: Braun Blanquet Scale Daubenmire Scale Percent Cover Estimate MISIN Area Scale

Density: 0 (NA) 1 (Sparse; Scattered stems/very small stands)
 2 (Patchy; A mix of sparse and dense areas) 3 (Dense; > 40% of area)
 4 (Monoculture; Nearly 100% of area)

Density Scale Type: MISIN Density Scale Other-See Notes

Invasion Stage: Previously Detected Newly Detected Unknown

Spread Risk: High Low Other-See Notes

Life Stage and Reproductive Condition			
Are IMMATURE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are MATURE/REPRODUCTIVE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are SENESCENT/WILTING of the target species plants present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are NON-REPRODUCTIVE/STERILE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are BUDDING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FLOWERING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FRUITING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are WINTER BUDS plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are DAUGHTER PLANTS of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA

Target Species Photograph: _____ Target Species Density Photograph: _____ Other Photographs: _____

End Time: _____ Ending Air Temperature: _____ Ending Cloud Cover (%): _____ Ending Wind Speed: _____

Notes:

Standard Treatment Impact Monitoring Protocol

Pre-Treatment Sampling Datasheet

Pre-/Post-Treatment Monitoring Circular Plot Data

Latitude: _____ Longitude: _____ Horizontal Uncertainty (m): _____

Date: _____ Site ID: _____ Area ID: _____

Area Designation: Treatment Untreated Control

Visit Type: Pre-Treatment Post-Treatment

Circular Plot Number: 1 2 3 Plot Radius: _____ Plot Radius Units: _____

Wetland Zone: Submergent Emergent Wet Meadow Other-See Notes

Cover Categories	0=Absent 0%	1=Very Sparse < 5%	2=Sparse 5 – 10%	3=Moderate 11 – 30%	4=Mod Heavy 31 – 50%	5=Heavy 51 – 75%	6=Very Heavy 76 – 100%
------------------	----------------	-----------------------	---------------------	------------------------	-------------------------	---------------------	---------------------------

Dispersion Categories	A	B	C	D
-----------------------	---	---	---	---

Functional Groups	Cover							Dispersion			
Emergent Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Floating-Leaved Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Free-Floating Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Submergent Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
All Aquatic Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D

Target Species: _____ Target Species Cover (%): _____

Target Species Dispersion: A B C D

Target Species Condition Index: 5 (Leaves green and rigid) 4 (Leaves rigid with some chlorosis)
 3 (Leaves rigid with plenty of chlorosis) 2 (Leaves wilting with chlorosis)
 1 (Leaves wilted and brown) 0 (Plant no longer alive and intact)

Life Stage and Reproductive Condition			
Are IMMATURE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are MATURE/REPRODUCTIVE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are SENESCENT/WILTING of the target species plants present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are NON-REPRODUCTIVE/STERILE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are BUDDING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FLOWERING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FRUITING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are WINTER BUDS plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are DAUGHTER PLANTS of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA

Standard Treatment Impact Monitoring Protocol

Pre-Treatment Sampling Datasheet

Did you collect a physical specimen for drying and preserving in an herbarium? Yes No

Collector Name: _____ Collection Number: _____ Herbarium: _____

Description:

Substrate Types	Cover						
Cobble (64 – 250 mm; tennis ball – basketball)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Gravel (2 – 64 mm; ladybug – tennis ball)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Sand (0.06 – 2 mm; gritty between fingers)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Silt, Clay, or Muck (<0.06 mm; not gritty)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Woody Debris	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Organic (Leaf pack, detritus)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Other Vegetation or Litter	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6

Physical Habitat Features	Cover						
Aquatic and Inundated Herbaceous Vegetation	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Hummocks/Tussocks/Tree Mounds	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Woody Debris/Snags >0.3 m Diameter	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Woody Brush/Woody Debris <0.3 m Diameter (alive or dead)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Inundated Live/Dead Trees >0.3 m Diameter	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Overhanging Vegetation Within 1 m of Surface	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Floating Debris	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Open Water	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Human Structures – Docks, Landings, etc.	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6

Water Temperature: _____ Temperature Unit: _____

Water Depth: _____ Water Depth Unit: _____

Is the water flowing? Yes No

North Photograph: _____ East Photograph: _____ South Photograph: _____ West Photograph: _____

Target Species Cover Photograph: _____ Target Species Condition Photograph: _____ Other Photographs: _____

Notes:


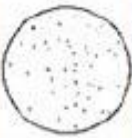


















Non-Target Species: _____

Standard Treatment Impact Monitoring Protocol

Pre-Treatment Sampling Datasheet

Dispersion Categories

Cover Categories

		A	B	C	D
Catégorie 1 0 - 10%	1				
Catégorie 2 11 - 30%	2				
Catégorie 3 31 - 50%	3				
Catégorie 4 51 - 75%	4				
Catégorie 5 76 - 100%	5				

Schematic representations of percent cover by Dahl (1981)
Image 2 of 2

Appendix B: Post-Treatment Sampling Datasheet

Standard Treatment Impact Monitoring Protocol

Post-Treatment Sampling Datasheet

Pre-/Post-Treatment Monitoring Area Data

Date: _____ Site ID: _____ Area ID: _____

Area Designation: Treatment Untreated Control

Visit Type: Pre-Treatment Post-Treatment

Crew Leader: _____ Crew Assistant: _____ Associated Group: _____

GPS Unit Make: _____ GPS Unit Model: _____ Datum Used: _____

Camera Make: _____ Camera Model: _____

Start Time: _____ Starting Air Temperature: _____ Air Temperature Unit: _____

Starting Cloud Cover (%): _____ Starting Wind Speed: _____ Wind Speed Unit: _____

Dominant Plant Species: _____

Target Species: _____

Reporting: Detected Not Detected

Area: 0 (None) 1 (Individual/few/several)
 2 (< 1,000 sq. ft.; half tennis court) 3 (1,000 sq. ft. to 0.5 acre)
 4 (0.5 acre to 1 acre; football field w/o endzones) 5 (> 1 acre)

Area Type: Braun Blanquet Scale Daubenmire Scale Percent Cover Estimate MISIN Area Scale

Density: 0 (NA) 1 (Sparse; Scattered stems/very small stands)
 2 (Patchy; A mix of sparse and dense areas) 3 (Dense; > 40% of area)
 4 (Monoculture; Nearly 100% of area)

Density Scale Type: MISIN Density Scale Other-See Notes

Invasion Stage: Previously Detected Newly Detected Unknown

Spread Risk: High Low Other-See Notes

Standard Treatment Impact Monitoring Protocol

Post-Treatment Sampling Datasheet

Life Stage and Reproductive Condition

Are IMMATURE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are MATURE/REPRODUCTIVE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are SENESCENT/WILTING of the target species plants present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are NON-REPRODUCTIVE/STERILE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are BUDDING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FLOWERING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FRUITING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are WINTER BUDS plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are DAUGHTER PLANTS of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA

Target Species Photograph: _____ Target Species Density Photograph: _____ Other Photographs: _____

End Time: _____ Ending Air Temperature: _____ Ending Cloud Cover (%): _____ Ending Wind Speed: _____

Re-Treatment Necessary: Yes No

Notes:

Standard Treatment Impact Monitoring Protocol

Post-Treatment Sampling Datasheet

Pre-/Post-Treatment Monitoring Circular Plot Data

Latitude: _____ Longitude: _____ Horizontal Uncertainty (m): _____

Date: _____ Site ID: _____ Area ID: _____

Area Designation: Treatment Untreated Control

Visit Type: Pre-Treatment Post-Treatment

Circular Plot Number: 1 2 3 Plot Radius: _____ Plot Radius Units: _____

Wetland Zone: Submergent Emergent Wet Meadow Other-See Notes

Cover Categories	0=Absent 0%	1=Very Sparse < 5%	2=Sparse 5 – 10%	3=Moderate 11 – 30%	4=Mod Heavy 31 – 50%	5=Heavy 51 – 75%	6=Very Heavy 76 – 100%
------------------	----------------	-----------------------	---------------------	------------------------	-------------------------	---------------------	---------------------------

Dispersion Categories	A	B	C	D
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Functional Groups	Cover							Dispersion			
Emergent Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Floating-Leaved Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Free-Floating Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
Submergent Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D
All Aquatic Plants	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D

Target Species: _____ Target Species Cover (%): _____

Target Species Dispersion: A B C D

Target Species Condition Index: 5 (Leaves green and rigid) 4 (Leaves rigid with some chlorosis)
 3 (Leaves rigid with plenty of chlorosis) 2 (Leaves wilting with chlorosis)
 1 (Leaves wilted and brown) 0 (Plant no longer alive and intact)

Life Stage and Reproductive Condition			
Are IMMATURE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are MATURE/REPRODUCTIVE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are SENESCENT/WILTING of the target species plants present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are NON-REPRODUCTIVE/STERILE plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are BUDDING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FLOWERING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are FRUITING plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are WINTER BUDS plants of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA
Are DAUGHTER PLANTS of the target species present?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> NA

Standard Treatment Impact Monitoring Protocol

Post-Treatment Sampling Datasheet

Did you collect a physical specimen for drying and preserving in an herbarium? Yes No

Collector Name: _____ Collection Number: _____ Herbarium: _____

Description:

Physical Habitat Features	Cover						
Aquatic and Inundated Herbaceous Vegetation	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Hummocks/Tussocks/Tree Mounds	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Woody Debris/Snags >0.3 m Diameter	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Woody Brush/Woody Debris <0.3 m Diameter (alive or dead)	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Inundated Live/Dead Trees >0.3 m Diameter	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Overhanging Vegetation Within 1 m of Surface	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Floating Debris	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Open Water	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6
Human Structures – Docks, Landings, etc.	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6

Water Temperature: _____ Temperature Unit: _____

Water Depth: _____ Water Depth Unit: _____

Is the water flowing? Yes No

North Photograph: _____ East Photograph: _____ South Photograph: _____ West Photograph: _____

Target Species Cover Photograph: _____ Target Species Condition Photograph: _____ Other Photographs: _____

Notes:


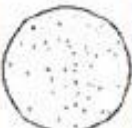


















Non-Target Species: _____

Standard Treatment Impact Monitoring Protocol

Post-Treatment Sampling Datasheet

Dispersion Categories

Cover Categories

		A	B	C	D
Category 1 0 - 10%	1				
Category 2 11 - 30%	2				
Category 3 31 - 50%	3				
Category 4 51 - 75%	4				
Category 5 76 - 100%	5				

Schematic representations of percent cover by Dahl (1981)
Image 2 of 2

Appendix C: Treatment Tracking Datasheet

Standard Treatment Impact Monitoring Protocol

Treatment Tracking Datasheet

Site Data

Site ID: _____

Ownership: Association Commercial School Private Public

Property Owner Name: _____ Property Owner Address: _____

Property Owner City: _____ Property Owner County: _____

Property Owner State: _____ Property Owner Zip Code: _____

Location: _____

Associated Group: _____

Associated Project: Federal State Local

Associated Grant: MISGP GLRI SOGL Other-See Notes

Notes: _____

Treatment Data

Control Method: Bio-Control Chemical Manual Mechanical Prescribed Fire

Site ID: _____ Associated Group: _____

Treatment Date: _____ Treatment Type: Initial Retreatment

Location: _____ County: _____

Applicators/Workers: _____

Target Species: _____

Application Method: Cut and Dab Cut-Stump Hand Swipe Hollow Stem Injection
 Basal Bark Spray Soil Drench Trunk Injection Frill
 Broadcast Foliar Spray Other-See Notes NA

Chemical Name: _____ EPA Registration NO.: _____

Standard Treatment Impact Monitoring Protocol

Treatment Tracking Datasheet

Active Ingredient:

<input type="checkbox"/> Aminopyralid	<input type="checkbox"/> Diquat Dibromide	<input type="checkbox"/> Glyphosate
<input type="checkbox"/> Imazamox	<input type="checkbox"/> Imazapyr	<input type="checkbox"/> Triclopyr
<input type="checkbox"/> Triisopopanolammonium	<input type="checkbox"/> Dichlorophenoxyacetic Acid	<input type="checkbox"/> Clopyralid
<input type="checkbox"/> 2,4-Dichlorophenoxyacetic Acid	<input type="checkbox"/> Copper Ethanolamine Complex	<input type="checkbox"/> Other-See Notes
<input type="checkbox"/> NA		

Percent AI (%): _____

Chemical Name #2: _____ EPA Registration NO. #2: _____

Active Ingredient #2:

<input type="checkbox"/> Aminopyralid	<input type="checkbox"/> Diquat Dibromide	<input type="checkbox"/> Glyphosate
<input type="checkbox"/> Imazamox	<input type="checkbox"/> Imazapyr	<input type="checkbox"/> Triclopyr
<input type="checkbox"/> Triisopopanolammonium	<input type="checkbox"/> Dichlorophenoxyacetic Acid	<input type="checkbox"/> Clopyralid
<input type="checkbox"/> 2,4-Dichlorophenoxyacetic Acid	<input type="checkbox"/> Copper Ethanolamine Complex	<input type="checkbox"/> Other-See Notes
<input type="checkbox"/> NA		

Percent AI (%) #2: _____

Chemical Name #3: _____ EPA Registration NO. #3: _____

Active Ingredient #3:

<input type="checkbox"/> Aminopyralid	<input type="checkbox"/> Diquat Dibromide	<input type="checkbox"/> Glyphosate
<input type="checkbox"/> Imazamox	<input type="checkbox"/> Imazapyr	<input type="checkbox"/> Triclopyr
<input type="checkbox"/> Triisopopanolammonium	<input type="checkbox"/> Dichlorophenoxyacetic Acid	<input type="checkbox"/> Clopyralid
<input type="checkbox"/> 2,4-Dichlorophenoxyacetic Acid	<input type="checkbox"/> Copper Ethanolamine Complex	<input type="checkbox"/> Other-See Notes
<input type="checkbox"/> NA		

Percent AI (%) #3: _____

Adjuvant: Non-Ionic Surfactant Cygnet Plus Agridex Cide-Kick II Other-See Notes

Dilutant: Bark Oil Water Other-See Notes NA

Dye: _____ Amount of Mixture Used (gal): _____ Mix Rate (oz/gal): _____

Total Active Ingredient Used (oz): _____ % of Infestation Treated: _____ Application Area (acres): _____

Equipment Used:

<input type="checkbox"/> Backpack/Hand Held Sprayer	<input type="checkbox"/> Handpull	<input type="checkbox"/> Boat-Hydraulic Sprayer	<input type="checkbox"/> Mowing
<input type="checkbox"/> Chain Saw	<input type="checkbox"/> Hand Saw	<input type="checkbox"/> Heavy Equipment Pulling	<input type="checkbox"/> Helicopter
<input type="checkbox"/> Marsh Master-Hydraulic Sprayer	<input type="checkbox"/> Shovel	<input type="checkbox"/> Truck-Hydraulic Sprayer	<input type="checkbox"/> Weed Wrench
<input type="checkbox"/> Wick Applicator	<input type="checkbox"/> Hackett/Ax	<input type="checkbox"/> Syringe	<input type="checkbox"/> Spray Bottle
<input type="checkbox"/> Other-See Notes	<input type="checkbox"/> NA		

Standard Treatment Impact Monitoring Protocol

Treatment Tracking Datasheet

Number of Bags Filled: _____ Weight Estimate: _____ Total Man Hours: _____

Phenology: Unknown Dormant/Dead Seeds In Fruit In Flower
 Seedling/Rosette Sapling/Immature Mature

Weather Conditions: _____

Temperature: _____ Wind Speed: _____

Wind Direction: North North North East North East East North East
 East East South East South East South South East
 South South South West South West West South West
 West West North West North West North North West

Rain: Yes No

Problems: Equipment Access Personnel/Time Weather Other-See Notes NA

Notes: _____

Appendix D: Equipment and Materials Checklist

Equipment	
Jonboat/Kayak (if applicable)	
Gas for jonboat (if applicable)	
Anchor (if applicable)	
Waders	
Polyvinyl chloride (PVC) marker pole	
PVC depth pole (with lines at 1 cm increments)	
Aquatic plant field guides	
Storage clipboard/binder	
Pencils	
Digital aquarium thermometer	
Handheld GPS unit	
GPS unit car charger (if applicable)	
Waterproof camera	
Camera memory card	
Batteries (for GPS unit, camera)	
Life jackets (if applicable)	
First aid kit	
Sunscreen	
Bug spray	
Polarized sunglasses	
Decontamination supplies (See Invasive Species Decontamination for Field Operations in Michigan Policy and Procedure)	
Printed Materials	
Standard Treatment Impact Monitoring Protocol	
Pre-Treatment Sampling Datasheet(s) (if applicable)	
Post-Treatment Sampling Datasheet(s) (if applicable)	
Treatment Tracking Datasheet(s) (if applicable)	
Invasive Species Decontamination for Field Operations in Michigan Policy and Procedure	
Michigan Invasive Species Watch List	

Appendix E: Life Stage and Reproductive Condition Definitions and Photographs

Table 4. Life stage and reproductive condition terms and definitions.

Term	Definition	Reference
Clonal daughter plant	An individual plant (i.e., ramet) in a clonal colony (i.e., genet).	Mori and Smith 2012
Flowering	A plant in bloom; displaying open flowers.	
Fruiting	A plant producing fruit.	
Immature	A young plant resembling a mature plant of its species but with different morphology and without reproductive structures.	Western Australian Herbarium 1998
Mature	A fully developed plant.	
Non-Reproductive	A mature plant without reproductive structures.	
Senescence	The final stage of plant development; often ending in leaf, flower, root, and/or whole plant death.	Thomas 2012
Senescent	A plant undergoing senescence.	
Winter bud	A hibernating vegetative organ (i.e., turion)	Harris and Harris 2001

Clonal Daughter Plant

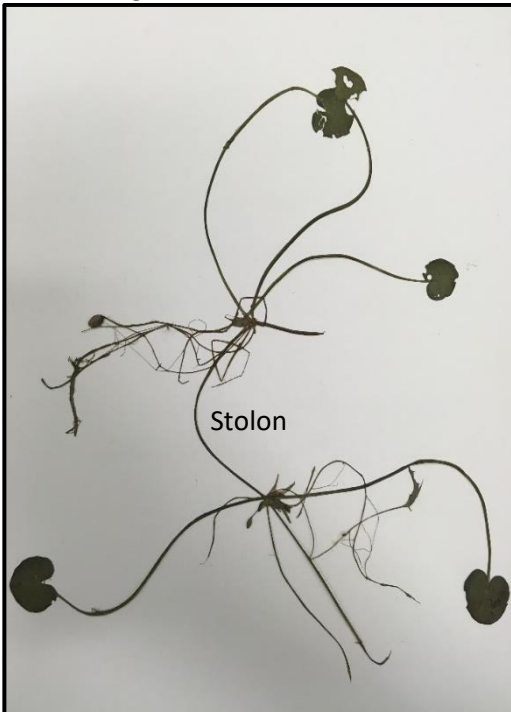


Figure 3. European frog-bit (*Hydrocharis morsus-ranae* L.) mother plant and daughter plant (i.e., ramet) connected by a stolon. Photograph by Blake C. Cahill.

Flowering



Figure 4. European frog-bit (*Hydrocharis morsus-ranae* L.) in flower. "European frogbit" by "Petroglyph." Licensed under (CC BY-NC 2.0). Flickr. Accessed 18 Feb 2018.

Fructing



Figure 5. European frog-bit (*Hydrocharis morsus-ranae* L.) in fruit. Photograph by Blake C. Cahill.



Figure 6. European frog-bit (*Hydrocharis morsus-ranae* L.) fruits. Penny shown for scale. Photograph by Blake C. Cahill.

Immature



Figure 7. Germinating European frog-bit (*Hydrocharis morsus-ranae* L.) turion. Photograph by Blake C. Cahill.

Senescent



Figure 8. European frog-bit leaves at varying degrees of chlorosis (discoloration). Photograph by Blake C. Cahill.

Winter buds



Figure 9. European frog-bit (*Hydrocharis morsus-ranae* L.) turion. European frog-bit turions are ellipsoidal, generally 6-9 mm long, and have a grey to greenish color. Photograph by Blake C. Cahill.



Figure 10. European frog-bit (*Hydrocharis morsus-ranae* L.) turions. Penny shown for scale. Photograph by Blake C. Cahill.

Appendix F: Plant Condition Index

Plant condition index and images from MacIsaac et al. (2016)

Hyacinth

Lettuce



Score 5: All leaves green and rigid.



Score 2: Chlorosis with dark discoloration, leaves wilting.



Score 4: Green with some chlorosis, leaves rigid.



Score 1: Brown, wilted leaves, but still alive.



Score 3: Plenty of chlorosis (no dark discoloration), leaves rigid.

Score 0: Plant is no longer alive and intact. (Disintegrated)