Quality Assurance Project Plan for "Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes"
EPA Grant # X796433105

Element 5: Deep water mechanical harvesting of hydrilla

The Quality Assurance Protection Plan (QAPP) covers the "elements" or demonstration components in the Work Plan for this project. The Work Plan (March 5, 2007) and approved modifications (September 28, 2009, September 21, 2010) are available for review on the project website at http://plants.ifas.ufl.edu/osceola/project_information.html or upon request to the Project Manager or designee. See section A3-Distribution List (page 5) for contact information.

This document is organized by the required sections to be consistent with previous QAPP documents for this project and provides a stand alone QAPP that has been written to cover **Element 5: Deep water mechanical harvesting of hydrilla** based on the modified workplan for Element 5, approved September 21, 2010.

In addition, water quality sampling procedures for this element will be utilized for water sampling relating to ongoing operational herbicide treatments using registered herbicides under **Element 2, Evaluation of Currently Registered Herbicides**, A modified workplan and budget for Water Quality Analysis Comparison of Nutrient Cycling Pre-treatment and Post Treatment of Hydrilla was approved on July 14, 2011.

GROUP A: PROJECT MANAGEMENT

A1 – Title And Approval Sheet

Title: Quality Assurance Project Plan for "Element 5: Deep water mechanical harvesting of hydrilla, an element of the Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes"

Implementing Organization: Osceola County, FL

Effective Date: September 22, 2011

Approvals:

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Eleanor C. Foerste — **Date** 8/22/2011

Quality Assurance Manager: Dr. Ken Langeland

Kenneth A. Langeland — **Date** 8/22/2011

EPA Project Officer : Hilda Hatzell

Hilda Hatzell — **Date** 08/22/2011

EPA Quality Assurance Manager: for **Danny France**

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A3 – Project Distribution List

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A3 – Distribution List - Element 5: Deep water mechanical harvesting of hydrilla

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A4 – Project / Task Organization- Quality Assurance Management

Danny France- Will serve as EPA Quality Assurance Manager and will coordinate final QAPP approval with the Project Manager and the EPA Project Manager.

Dr. Ken Langeland – Will serve as the Quality Assurance Manager for Element 5. Dr. Langeland will be responsible for review of notebooks, documents, and records and he will review all reports (quarterly and final) prior to submission to the Osceola County

Project Manager. On an annual basis Dr. Langeland will conduct one field audit and one laboratory audit for each of the Elements. Dr. Langeland can also conduct spot checks at his discretion.

A4 – Project / Task Organization Element 5: Deep water mechanical harvesting of hydrilla. (See Organizational Chart -Appendix 1)

University of Florida – Center for Aquatic and Invasive Plants

Dr. William T. Haller - Will serve as Element Coordinator and coordinate and be responsible for activities under Element 5: Deep Water Mechanical Harvesting of Hydrilla. This will include the design, execution and final data reporting. Dr Haller will coordinate with Mr. Dean Jones on project design and other activities related to this project. Dr. Haller will be responsible for carrying out QA/QC activities, assessments/audits and corrective actions for Element 5. Dr. Haller will locate and coordinate field and demonstration studies in Osceola County. This position will be responsible for working with harvest contractor, data collection, water collection for water quality parameters and fish bycatch study as well as providing information to educational programs staff.

Dr. Lyn Gettys – Is a research assistant professor under the direction of Dr. Haller. She will assist in data analysis and manuscript preparation.

University of Florida/IFAS Osceola County Extension

Mr. Dean Jones - Will assist Dr. Haller in studies under Element 5: Deep Water Mechanical Harvesting of Hydrilla. This will include the design, execution and final data reporting as well as the demonstration sites in Osceola County. Mr. Jones will assist with QA/QC activities, water sampling, assessments/audits and corrective actions for Element 5.

Ms. Stacia Hetrick- Will assist in preparing reports and provide educational outreach regarding this demonstration project. In addition, she will assist with water quality sample collection and other data collection as needed.

A5 – Problem Definition / Background

Element 5: Deep water mechanical harvesting of hydrilla

Osceola County, headwaters of the Kissimmee River Basin, continues to have significant problems with exotic aquatic vegetation. The primary species of concern is hydrilla (*Hydrilla verticillata*). Hydrilla was first discovered in the United States in 1960. A highly specialized growth habit, physiological characteristics, and reproduction make this plant well adapted for growth in submersed freshwater environments. Consequently, hydrilla has spread rapidly through portions of the United States and has become a serious weed problem. Where the plant occurs, it impedes water flow and blocks water control structures, damages boat motors, causes substantial economic hardships, interferes with various water uses, displaces native aquatic plant communities, and adversely impacts freshwater habitats.

The aquatic plant management techniques that have been implemented in the past and are currently practiced are: herbicide applications, mechanical harvesting, and large scale habitat restoration projects, all of which require extensive use of labor and funds. In Florida, multiple agencies play a critical role in funding projects and programs, as well as providing long-term management. An average dollar amount spent yearly on aquatic plant management in Florida would be in the range of 12 - 17 million dollars, depending on priorities of the State at the time. The shallow and productive lakes located within Osceola County receive the majority of the money allocated statewide.

Large-scale herbicide applications constitute the backbone of the state-funded hydrilla control program. During the 1990s, fluridone was used most widely because it provided selective, cost-effective, long-term control. Following repeated large-scale use of fluridone on the Kissimmee Chain of Lakes (KCOL, Osceola County), hydrilla developed increased tolerance to this herbicide. This increased tolerance resulted in a significant cost increase, reduced longevity and increased non-target damage to native plants due to the use of higher application rates. These factors lead to fluridone having a limited utility within the KCOL. Ultimately Osceola County was awarded a 2.881 million dollar grant by the Environmental Protection Agency to demonstrate new and alternative ways to manage hydrilla and hygrophila in KCOL.

Element 5, Deep water mechanical harvesting of hydrilla, is part of the Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes **EPA Grant # X796433105**. The primary purpose of this project is to demonstrate use of new herbicides, develop new technology processes or practices, or a new combination or uses of technologies, processes or practices for the purpose of providing technologically feasible and cost effective means to manage hydrilla, hygrophila and other exotic aquatic vegetation in the Upper Chain of Lakes within the Kissimmee River Basin of Osceola County.

Hydrilla has a six-decade history of expansion that has withstood vigorous control efforts. Management efforts are developed on a lake-by-lake basis, and what works for one lake or chain of lakes may not be appropriate for another lake or group of lakes. The presence of the federally endangered snail kite, *Rostrhamus sociabilis,* in the Upper Kissimmee Chain of Lakes necessitates additional planning and coordination of aquatic plant management strategies. All available aquatic plant management techniques utilized in an integrated pest management program should be considered, including deep water mechanical harvesting. This study will investigate deep water mechanical harvesting as a new option for hydrilla management.

Justification:

Mechanical harvesting of hydrilla is an uncommon practice in lakes in Florida but is widely used in other areas of the United States. There are several reasons mechanical harvesting has had limited use for hydrilla management: longevity of control, cost, water quality and fish by-catch. In Osceola County lakes, the presence of endangered species raise additional concerns.

Longevity of Control Concerns:

The long growing season and potential for hydrilla to grow an inch or more per day makes existing mechanical harvesting techniques in Florida less efficient than in other areas in the United States that have a shorter growing season. Commercially available harvesters typically cut to water depths of four to five feet, creating the situation where hydrilla can return to the surface in one or two months.

The United States Army Corps of Engineers conducted a study of mechanical harvesting on Orange Lake in 1976 (Mcgehee 1979) which yielded some unexplained results. Some harvested areas required over a year to regrow, while other sites had to be harvested up to four times in one summer to maintain control of hydrilla. It is thought that in the sites with longest control that the entire plant was harvested as opposed to being cut off mid-water column, but this was not confirmed.

Hydrilla does not produce extensive root systems and is usually weakly rooted in the organic flocculent layer over a hard sand substrate. If the majority of the plant, including the root crown, were removed, the hydrilla could only return by sprouting of tubers and turions or as a result of hydrilla fragments re-infesting the harvested site. These methods of recovery would take longer than typical harvest operations that cut plants at mid-water column, which leaves the roots and root crowns with cut stems intact.

Cost Concerns:

Mechanical harvesting has been used for maintaining boat access trails but has been thought to be too expensive for large-scale or whole lake management operations. Harvesters have been developed that reduce harvesting costs to approximately $300-400/acre for one to two months of control; however, this is still more than the cost of chemical control at $500 per acre with 12 months of control.

Water Quality Concerns:

The disturbance of the flocculent layer by uprooting hydrilla was reported by Haller in 2003, but they found only a temporary change in water quality. Water quality parameters measured 3 days after harvesting were similar to the mid-lake values, so any elevated values occurring behind the harvester were only temporary. Similar results were reported by Carpenter and Gasith in 1978 and Alam et al. in 1996. Although operational mechanical harvesting programs do result in water quality changes in lakes, they are relatively small, limited to the harvested site, and temporary.

By-Catch Concerns:

Concern has also been expressed over the capture and disposal of small and juvenile fish via mechanical removal of hydrilla (Haller et. al. 1980). It is thought that fish by-catch will be greatly reduced when harvesting hydrilla in water 6 to 8 feet deep where the plants have not grown to the water's surface.

The typical growth habit for hydrilla starts with a single stem elongating toward the surface. It branches profusely as it nears the surface and light is more abundant and ultimately produces a dense mat on the surface. In this state, half the hydrilla standing crop is in the top 0.5 m of water column as reported by Haller and Sutton in 1975. Harvesting hydrilla before the dense mat forms near the surface should reduce biomass, making harvesting more cost-effective and reducing fish bycatch due to less dense hydrilla, in which juvenile fish should escape more easily.

Endangered Species Concerns:

Aquatic plant managers working on lakes in Osceola County face a new challenge due to the increased presence of the federally endangered snail kite, *Rostrhamus sociabilis*, in the Upper Kissimmee Chain of Lakes, mainly Lake Tohopekaliga. It is estimated that there are less than 800 kites remaining in the United States and in the 2010 nesting season, Lake Tohopekaliga supported over 30% of the Florida nesting population. The US Fish and Wildlife Service and the University of Florida Cooperative Fish and Wildlife Research Unit have recommended aquatic plant management strategies in the Upper Kissimmee Chain of Lakes that should maximize suitable feeding and nesting habitat for the endangered birds. It is hoped that the Upper Kissimmee Chain of Lakes will provide a refuge until the conditions in their primary range, the Everglades, recover and the birds return to South Florida.

Other Elements of the Demonstration Project are investigating chemical and biological control options for management of hydrilla, but the presence of the endangered snail kites has necessitated modification of invasive aquatic plant management plans to maximize apple snail populations and minimize negative impact to snail kites in the area. The snail kites feed almost exclusively on apple snails which feed on aquatic plants, including hydrilla. The snails are most accessible to the snail kites when they are feeding on plants that are on or near the surface.

Plant managers are interested in techniques that allow more precise removal and management of invasive aquatic plants, including hydrilla, in areas that are not preferred by the kites for foraging or for nesting sites. On lakes in the upper Kissimmee Chain, aquatic plant management is critical for flood control and navigation in addition to managing for habitat and recreation. Managing hydrilla in deep water areas is a critical concern on these shallow lakes.

Summary:

It is expected that this deep water harvesting demonstration will help identify conditions and parameters that are acceptable for mechanical harvesting to reduce pesticide use and provide more site-specific management of hydrilla, while also allowing more precise removal of invasive aquatic plants for such critical reasons as flood control and navigation. The uprooting of weakly and shallow rooted hydrilla in deep water by mechanical means may provide a year or more of control, which would significantly reduce costs and makes mechanical harvesting a more feasible management option in Florida. Mechanical removal will not remove 100% of hydrilla plants in a given area. The expected 80-90% removal will leave “patchy” growth of hydrilla, which will provide plants for snail habitat and keep the water surface open enough to provide for navigation and recreational use (fishing, etc.).

A6 – Project/Task Description Element 5: Deep water mechanical harvesting of hydrilla.

Brief Description

Hydrilla will be harvested using a modified mechanical harvesting machine to allow deep water harvesting in 6 to 8 feet of water instead of the traditional surface harvest. Hydrilla will be harvested while it is growing upright in the midwater column before it tops out and creates a canopy. The harvester will not have a cutter bar but will instead be directed so that it harvests hydrilla above the hydrosoil layer, not into the soil , uprooting the hydrilla and pulling it onto a conveyer.

Two 50 to 100 acre study areas will be harvested in 2011. The project will determine the longevity of control, which is a key variable in evaluating cost efficiency compared to current chemical control costs which are usually in excess of $500/acre per year. Environmental concerns related to mechanical harvesting will be monitored, including fish by-catch and water quality impacts.

Element Objectives:

1. Evaluate the efficiency and longevity of hydrilla control by deep water mechanical harvesting.
2. Evaluate the short term impact of deep water harvesting on water quality.
3. Estimate the fish by-catch of deep water harvesting of hydrilla.

The proposed sampling schedule for Element 5 is outlined in **Table 3.** Water quality sampling schedule to compare water quality at mid-depth in harvesting operations area (study) to undisturbed reference sites (control) at least 1 km distant in the same lakes (3 samples from each site).

QA/QC for collecting water quality field samples and for laboratory analysis will follow rigorous protocols as outlined by the South Florida Water Management District (SFWMD). The most current approved versions will apply.

- *Field Sampling Quality Manual* (SFWMD-FIELD-QM-001-06) Effective Date: 01/08/10 (Appendix 10)
- *Standard Operating Procedures for Horizon Field Data Manager (HFDM) and Documentation* (SFWMD-Field-SOP-018-02) (Appendix 11)

QA/QC for water quality includes field blanks, trip blanks, equipment blanks, field equipment blanks and split samples as required by SFWMD protocols to assure integrity of the samples and the data. Project staff will receive training in sample collection procedures through the South Florida Water Management District's Water Quality Monitoring Division (SFWMD WQMD). The review of field data collected with surface water sample grab data are reviewed by the QA staff at SFWMD WQMD. Review and validation of data produced by the SFWMD laboratory is performed by the laboratory QA and the Data Validation Section in the Water Quality Analysis Division.

A7 – Quality Objectives and Criteria

Table 1. Quality objectives and criteria for Element 2: Currently Registered Herbicides and Element 5: Deep water mechanical harvesting of hydrilla.

1. Nature of the Problem	- Hydrilla, an exotic introduced submersed aquatic weed was introduced into Florida by the aquarium plant industry in about 1960 (McLain 1963). Since that time it has spread to every watershed in Florida and occurs from Maine north to Wisconsin and west to Washington State. It has been called the "perfect" aquatic weed (Langeland 1994). Its prolific growth and ability to grow under low light conditions allows it to outcompete and reduce aquatic plant diversity. It often covers 80 to 90% of the area of shallow Florida lakes, which interferes with flood control, recreation and fish and wildlife habitats. - Through the 1980s, Florida was spending between $20 and 30 million for hydrilla control and relied heavily on the use of the aquatic herbicide fluridone. In 2000, fluridone resistant populations of hydrilla spread rapidly throughout the state, particularly in Osceola County lakes, which has rendered the use of fluridone ineffective. Currently, the state weed management agencies spend similar amounts of money, but the costs per acre are at least double, which only allows control of 1/3 to 1/2 of the acreage compared to control programs conducted in the 1990s. In addition, agencies are relying heavily on the use of endothall and there is significant concern that resistant hydrilla populations may develop for this herbicide. Thus, the Osceola County Hydrilla and Hygrophila Demonstration Project was developed to accomplish several objectives. This includes evaluating and registering new herbicides (Element 1), developing better methods for use of currently registered products (Element 2), and developing/evaluating potential new biological control agents (insects and pathogens; Element 3). Finally, there was a public education component (Element 4) to raise awareness of the dangers of invasive species and extend research results to the public. Element 5: Deep water mechanical harvesting of hydrilla, is a continued effort to evaluate all components of a truly integrated hydrilla management program.
2. Identify the Goal of the Study	- The goal of Element 5 is to re-evaluate the feasibility of mechanical harvesting of hydrilla to take advantage of two major developments in the last two decades. Aquatic plant harvesters have become much larger (70 feet or greater in length) and can carry a 10-12 ton load which is 4-6 times

	the capacity of previous harvesters (Haller 1996). Also, recent improvements include harvesting to water depths of 7 feet or greater compared to former 4-5 foot depths. This increased size and depth of harvest has not been thoroughly tested, largely because of the belief that fish by-catch, water quality problems, and regrowth of hydrilla are too significant or rapid to allow cost-effective, environmentally sound, large-scale harvesting programs. - Fish by-catch in hydrilla by small aquamarine harvesters (H-650) was studied and reported by Haller et al.in 1980. In this study, the harvesting process removed up to 1/3 of the fish biomass from the hydrilla-infested Orange Lake. Subsequent research has shown that this is likely an overestimate of fish harvest for two reasons. First, in late summer, in surface-matted hydrilla, the only location of significant oxygenated water for fish survival occurs in the top 12-18 inches of water at the surface. Thus, all the fish were concentrated in this strata when the harvesting occurred. Second, the surface-matted hydrilla is very dense and as the harvester approaches the fish, particularly juvenile centrarchids, the fright factor scares them into the dense vegetation, where they are entangled and subsequently harvested in greater numbers than would be harvested in less dense hydrilla. - Thus, the objective of this Element is to re-evaluate the efficiency of new harvesting equipment and determine the significance of harvesting lower growing, less dense hydrilla on fish by-catch and water quality. The goal of Element 5: Deep water mechanical harvesting of hydrilla is to: o Determine the efficiency of mechanically harvesting hydrilla that is not surface-matted and determine the rate of hydrilla re-infestation. o Quantify the fish by-catch from an operational harvesting program when harvesting hydrilla that is growing in mid-water column. o Evaluate the effects of mechanical harvesting on selected water quality parameters to determine the magnitude and longevity of any water quality problems.
3. Identify Information Inputs	- Information inputs to determine the economic and environmental impacts of harvesting include: o The determination of the time required to harvest hydrilla biomass from known areas will determine the cost per acre of harvesting. o The harvesting on operational or large-scale plots

	of 50-100 acres will provide reliable cost estimates. ◦ The collection of harvested vegetation and sorting for fish by-catch will determine if plant growth/morphology can be used to minimize fish by-catch. ◦ The length of time for regrowth of harvested areas will allow evaluation of longevity of control which can be compared to longevity of control in large herbicide treated areas of Element 2. ◦ Water quality studies will determine if the impacts of harvesting are short- or long-term. - The information gathered from the 5 points above can be used for an overall updated assessment of the economic and environmental feasibility of incorporating harvesting in a large-scale approach to hydrilla management.
4. Define the Boundaries of the Study	- The study site is in the Upper Kissimmee Chain of Lakes in Osceola County. The boundary of the immediate study site is estimated to be from 50 to 100 acres in size; a size sufficient to allow extrapolation to much larger areas in an operational program. If the harvesting of 100 acres can be accomplished in 7 days it becomes feasible for weed managers to determine how to incorporate this process into their work/management plans. If the harvesting of 100 acres requires 100 days, the feasibility of harvesting is unlikely. - Thus, while the boundary of the study encompasses 50-100 acres, if the management of hydrilla is economically and environmentally acceptable then there are no boundaries to the adoption of deep-water harvesting. See Figure 1.
5. Develop the Analytic Approach	- There are three very different subject areas in which data will be collected: efficiency of mechanical harvesting, fish by-catch and impacts of harvesting on water quality. - *Efficiency of deep water mechanical harvesting.* The object of collecting this data is to ultimately answer the question, "How many acres of hydrilla per day can the contracted harvester remove?" The harvester operators will keep a running time log of time harvesting, time transporting to and from disposal site, and unloading time. A GPS unit will track the harvesting operation while harvesting, which will provide the length of the area harvested per load. The width of the harvester can then be used to estimate area harvested per unit of time. A daily record of time harvesting and area harvested will provide

	essentially replicated data on a daily basis. Side scan sonar and fathometry will monitor hydrilla regrowth. - *Fish bycatch*. Fish bycatch on three samples will be determined on hydrilla samples that are less than full loads. The area harvested for each sample will be used to extrapolate fish by-catch to catch of individual species (number and weight) per acre harvested. - *Impacts of harvesting on water quality*. Water quality samples will be collected inside and outside the harvested area over time, processed and analyzed by the South Florida Water Management District Water Quality Monitoring Division (SFWMD WQMD) The data will be compared between sample sites and over time by analysis of variance and other appropriate statistical methods.
6. Specify Performance or Acceptance Criteria	- This field demonstration will collect data on efficacy of harvesting by determining actual time harvesting and area harvested on a daily basis. Only data from days in which operations proceed over 5 hours will be considered acceptable. Collection and comparison of harvest data on operating days greater than 5 hours will reduce variance and should provide an accurate measure of harvesting efficiency. Afternoon thunderstorms or mechanical down time will likely occur and shorten operating time. - The water quality sampling will be conducted as described to determine any water quality differences between the harvested site and control location and also determine how rapidly any water quality changes return to background levels following the harvesting operation. The acceptance of performance criteria will be based upon the relative sample variance of replicated samples noted during the demonstration. Similarly, as the harvester collects hydrilla for fish sampling, the weight of the hydrilla harvested and the average speed of the harvester will be known. An effort will be made to harvest similar areas at similar speeds to provide accurate fish harvest between replicate samples. If the area or weight of hydrilla harvested varies between replicate samples by more than 30%, that sample will be discarded and another sample collected. Water sample collection procedures will follow South Florida Water Management District Quality Monitoring Division SFWMD WQMD protocols.
7. Develop the Detailed Plan Obtaining Data	- The efficacy of the harvester will be determined daily by entering data into a spreadsheet from the daily operating logs (see Appendix 6). Since the spring and fall demonstration projects will each last approximately 30 days, the project should yield an accurate measure of

	operating efficiency. Harvest efficiency will only be calculated for days in which harvesting is conducted for five or more hours. Data presentation will include area harvested, time harvesting, time transporting and include means, 95% confidence intervals and minimum/maximum values. - The fish by-catch will be determined by enumerating and weighing all fish collected in the replicated samples. Each species will be separated into size classes if the species has a wide range of different sized fish in the samples. These size classes will be determined at the study site depending upon the number and sizes of fish captured, but may include 0-5cm, 5-10cm, 10-15cm, etc. Otherwise, if we collect 400 golden topminnows, all in the 5-10cm size class, the 400 fish will be weighed together to obtain a total and average weight harvested. - Water samples will be collected as described in Appendix 9, 10 and 11 and sent or delivered according to SFWMD WQMD protocols to the SFWMD laboratory for analysis. Results will be analyzed by appropriate statistics. - Hydrilla regrowth will be monitored following harvesting in at least three sites (transects), by side scan sonar and fathometry. These data will be collected at appropriate intervals following harvesting and data will include percent water column infested by hydrilla, percent cover and average growth in height per week. These data will be compared to herbicide applications/regrowth data collected in Task 2 of the demonstration project.

A8 – Special Training / Certification

The Element 5 Coordinator, Dr. Bill Haller, has 30 years experience in lake and aquatic plant management and holds a pesticide applicator's license certification through the Florida Department of Agriculture and Consumer Services since 1980. Principal investigators include two Ph.D. agronomists (Haller and Gettys) and one Senior Biologist (Jones). Haller has previously published papers on mechanical harvesting and fish bycatch and Jones was a supervisor of mechanical harvesting operations in Polk County, Florida from 1996-2006.

Project Manager, Senior Biologist and Extension Agent –Aquatics have all been trained in water sample collection protocols, policies and procedures through the SFWMD WQMD program (July 5 and 6, 2011).

The Element 5 Coordinator, Dr. William Haller will be responsible for ensuring that all harvester operators are aware of the need for Quality Assurance Management. A brief training module on Quality Assurance will be developed and all participants in this project will be required to review this document on an annual basis. Dr. Mike Netherland, Element Coordinator for Element 2 will be responsible for assuring that staff follow Quality Assurance Management related to the Water Quality Analysis Comparison of Nutrient Cycling Pre-treatment and Post Treatment of Hydrilla. Any special requirements for Quality Assurance for specific tasks conducted within an Element will result in a written protocol that defines the specific Quality Assurance objectives. Signed forms that verify the basic training has been received will be turned in to the Element Coordinator and a copy will be provided to the appropriate Quality Assurance Manager. The Element Coordinator and the Quality Assurance Manager will maintain copies of the training files.

A9 – Documents and Records

All project personnel will receive a final copy of the approved work plan and the approved QA Project Plan (QAPP). We will distribute hard copies to all personnel and have a master notebook for each Element Team in a central location for quick reference to include work plans, timelines, milestones and reporting dates.

The Element Coordinator will be responsible for ensuring that the project personnel, the Project Manager, the Project Quality Assurance Manager, and the EPA Project Manager and EPA Quality Assurance Managers are made aware of any significant issues or proposed changes to the Work Plan or QAPP. It is anticipated that most problems can be handled via e-mail or phone correspondence. Written protocols will be provided to project personnel responsible for conducting the work.

Field and laboratory data will be collected in waterproof ink and notebooks and transferred to electronic spreadsheets. Water quality field data sheets and electronic data entry are described in the SFWMD WQMD protocols in Appendix 10 and Appendix 11. These data will then be available for statistical analysis and final reports/quarterly reports will contain analyzed data. Raw data and electronic instrument data will be stored following entry into spreadsheet format. Raw data will be saved for a minimum of 1 year. Following completion of a project, spreadsheets will also be stored electronically for the time required by EPA, currently a minimum of 10 years. Copies of all reports, electronic data and summarized data will be sent to the Element Coordinator. The Element Coordinator is responsible for developing and analyzing final data sets and producing reports.Quarterly reports will be provided to the Project Manager at least two weeks prior to the deadline reporting date. The reporting format for quarterly reports will be brief, but will highlight any significant findings, QA/QC concerns, problems encountered, adherence to timelines, significant findings, and future direction of the work. All reports will include analyzed data only. Project QA/QC reports, quarterly reports and the final report will be submitted to the Project Manager in Osceola County for posting to the project website and submission to appropriate personnel and agencies.

GROUP B: DATA GENERATION AND ACQUISITION

B1 – Experimental Design- Element 5: Deep water mechanical harvesting of hydrilla.

There are no sets of experimental designs with a history of use in a large scale hydrilla harvesting project other than use of basic statistics in the individual projects. Analysis of variance, means testing, and regression analysis will be used as appropriate in each project.

The following General Standard Operating Procedures (SOPs) have been written for harvesting, fish by-catch sampling, and water sampling methods are included in Appendices 3, 6, 8, 9, 10 and 11. The experimental design is included in the SOPs which govern data collection. The Element Coordinators (Dr. William Haller for Element 5 and Dr. Netherland for Element 2, are responsible for corrective action and coordinating problem resolution if there are concerns that need to be addressed. Field staff and faculty (Research Assistant, Sr. Biologist, Extension Agent-Aquatics, and Project Manager) are responsible for notifying the Element Coordinator if any QA/QC concerns arise so they may be addressed appropriately in a timely manner.

The SOPs contain detailed information on experimental/sampling design and the following is an outline of the major studies of the Element 5: Deep Water Mechanical Harvesting of Hydrilla demonstration project.

1) Documentation of mechanical harvesting efficiency
    a. On days in which the harvesting equipment works for over 5 hours, the daily logs containing the time and GPS records will be used to determine the total area harvested, the time in actual harvesting, transport to and from offloading site, and down time. Each day will be considered a replication.
    b. Efficacy of mechanical harvesting also includes length of control, or the time that it takes for hydrilla to return to pre-harvest densities, and heights, or to the water surface. At least three transects will be established in the proposed 50 to 100 acre harvesting site and hydrilla height, bottom cover and percent volume of the water column will be determined pre-harvest and at regular intervals thereafter, depending upon the rate of hydrilla regrowth. The date of harvest of each transect will be noted and data collected 0, 30, 90 and 180 days after harvest. Analysis of variance and regression analysis may be used to calculate days to 50% regrowth or other regrowth estimates.
2) Fish bycatch sampling

    At least three partial loads of hydrilla (500-1000 lbs fresh weight each) will be harvested at similar operating speeds and in similar hydrilla densities as the harvester normally operates. The area harvested will be documented. Partial loads will be brought to shore and offloaded into a pre-weighed truck which will then be weighed to determine the weight of the harvested hydrilla. The hydrilla will then be offloaded onto canvas or plastic tarps. Individual hydrilla plants and or plant segments will be rinsed in buckets/hoses over window screens and individually inspected to assure all fish are collected from the vegetation. Fish will be separated by species, counted and weighed. Any fish species that is represented by large numbers of different sized fish will be separated into size classes and weighed.
3) Water quality

Water quality data will be collected before, during and after harvester operations for sites within the area of operation and reference areas. Element 5: Deep Water Harvesting of Hydrilla - Water Samples will be analyzed for Nitrate, Total Nitrogen, Total Phosphorus and Turbidity. Element 2: Evaluation of Currently Registered Herbicides- Water Quality Analysis Comparison of Nutrient Cycling Pre-treatment and Post Treatment of Hydrilla, will be analyzed for Total Nitrogen, Total Phosporus and Chlorophyll-*a* in addition to pH, temperature, conductivity, and dissolved oxygen (DO).

Dissolved oxygen, water temperature, pH and conductivity will be collected at each site utilizing the YSI 556 MPS handheld meter. Water samples will be grab samples collected at each site using a Niskin Kit following South Florida Water Management District Water Quality Monitorning Division (SFWMD WQMD) Field Sampling Quality Manual (FSQM) protocols. Additionally, water transparency will be measured utilizing a limnological secchi disk.

Each individual study will include a detailed written SOP. Each study may require slight modification or addition to the General SOPs that have been written. The element coordinator will maintain a written record of SOPs for each study and the SOPs will be provided as required to workers/sampling staff. Any changes to the SOPs will be well documented and recorded with the Element Coordinator.

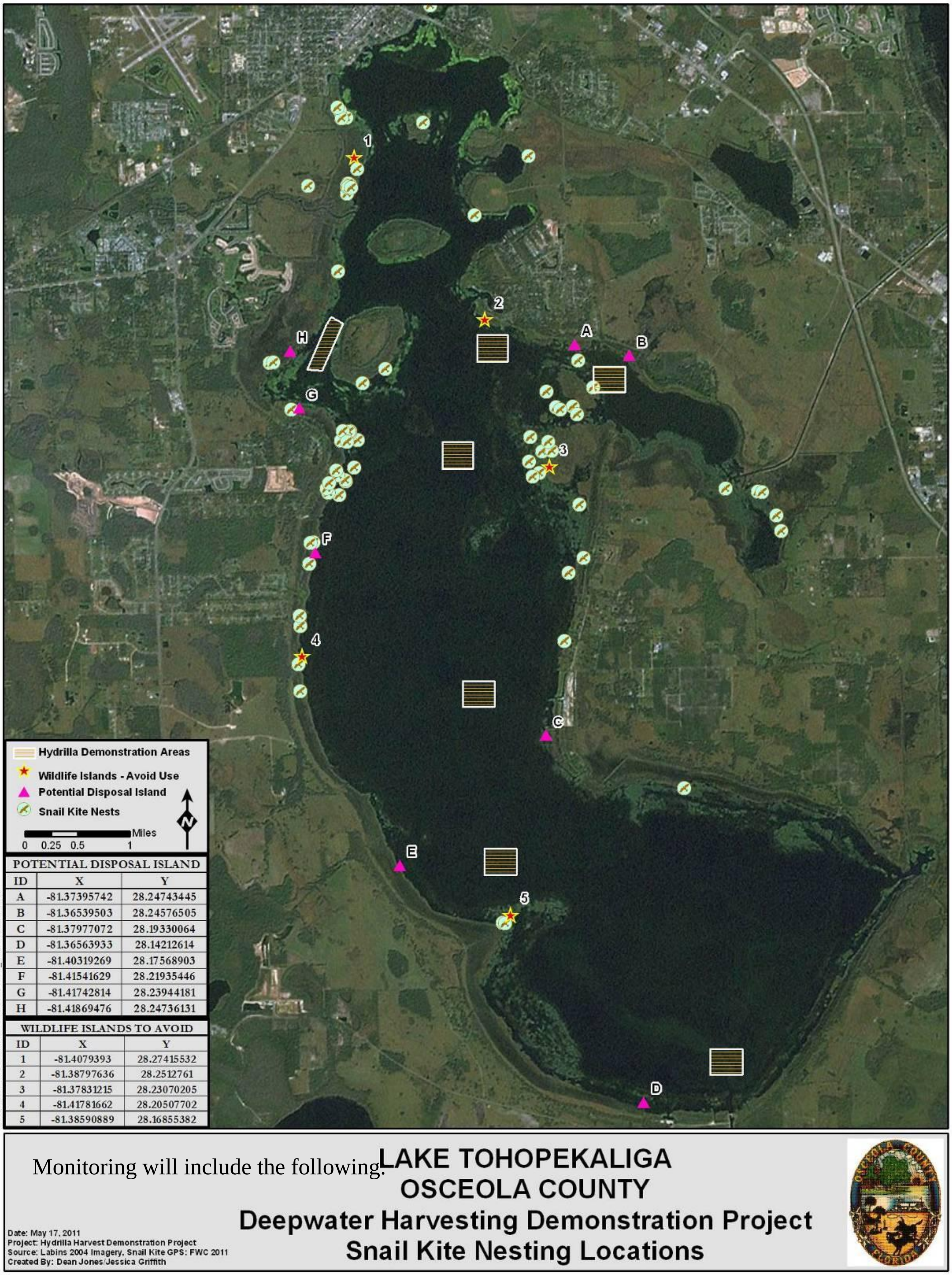
B2 – Sampling Methods Element 5: Deep water mechanical harvesting of hydrilla.

Osceola County will contract for a mechanical harvesting operation to be conducted twice at two different locations. Depending on procurement timelines, it is anticipated that harvesting will occur once in the summer and once in the winter depending on permit approval dates These projected dates are subject to change pending environmental permit application approval based, actual field conditions and plant growth. The area harvested will be identified with the support of the Florida Fish and Wildlife Conservation Commission Standing Team, the Kissimmee Chain of Lakes Aquatic Plant Management Interagency Group and the US Fish and Wildlife Service to minimize potential impacts to existing snail kite populations. This could allow an opportunity for others to study snail populations within the harvest area, though it would not be funded as part of this project.

It is proposed that suitable target areas will be located near a wildlife island in the Kissimmee Chain of Lakes where disposal will be allowed and will consist of two separate 50 to 100 acre blocks to be harvested (. See Figure 1 for potential harvest sites in Lake Tohopekaliga.

The harvester should be of large size and capable of harvesting to a depth of between 7 and 8 feet deep. The harvester must be of sufficient size to allow for a short harvest time to reduce harvest costs and allow project completion within weather constraints.

Figure 1. Potential hydrilla mechanical harvest sites in Lake Tohopekaliga, FL in the Upper Kissimmee Chain of Lakes



POTENTIAL DISPOSAL ISLAND

ID	X	Y
A	-81.37395742	28.24743445
B	-81.36539503	28.24576505
C	-81.37977072	28.19330064
D	-81.36563933	28.14212614
E	-81.40319269	28.17568903
F	-81.41541629	28.21935446
G	-81.41742814	28.23944181
H	-81.41869476	28.24736131

WILDLIFE ISLANDS TO AVOID

ID	X	Y
1	-81.4079393	28.27415532
2	-81.38797636	28.2512761
3	-81.37831215	28.23070205
4	-81.41781662	28.20507702
5	-81.38590889	28.16855382

Monitoring will include the following:

1. Hydrilla volume in the water column and percent area covered will be monitored monthly with a recording fathometer between 3 fixed transects. Plant height in 5 fixed locations along each transect in the harvested area will be monitored monthly to evaluate re-growth of hydrilla.

2. Water quality parameters will be evaluated in situ and in the lab. See Tables 2 and 3.

3. Four loads (500 to 1000 pounds each) of hydrilla will be brought to the shore where biologists will sort through the hydrilla to determine the by-catch of fish. The harvester will be operated for a known distance to obtain the sample, which will be weighed using truck scales and by-catch will be extrapolated to fish captured/acre and per ton of hydrilla.

Water Quality Monitoring

A potential disadvantage of deep water harvesting may include adverse changes in water quality in the operating area. This study will monitor key water quality parameters in the operating area and compare these data to similar reference data collected in the same lake, but remote from the harvested area. Six sampling sites will be located in the test lake: three in the area to be harvested and another three sites at least 1 km from the operating area, which will serve as the reference sites These three replications will allow statistical comparisons of water quality between the two sampling sites. The in situ and water quality parameters to be measured from discrete water samples are listed in Table 2 and sampling times are denoted in Table 3.

Quality Assurance Methods

Standard Operating Procedures (SOPs) are outlined in Appendices 3, 6, 7, 8, 9, 10, and 11.

- Appendix 3. Standard Operating Procedures for Sampling Methods used in Element 5: Deep water mechanical harvesting of hydrilla
- Appendix 6: Standard Operating Procedures (SOP) for Documentation of Mechanical Harvesting Efficiency
- Appendix 7. Standard Operating Procedures for Calculating Aquatic Vegetation Percent Area Covered (PAC) & Percent Volume Infested (PVI)
- Appendix 8: Standard Operating Procedures (SOP) for Fish By-catch Sampling
- Appendix 9: Standard Operating Procedures (SOP) for Water Quality Secchi Disk
- Appendix 10: Field Sampling Quality Manual (SFWMD-FIELD-QM-001-07) Effective Date: 01/08/10
- Appendix 11: Standard Operating Procedures for Horizon Field Data Manager (HFDM) and Documentation (SFWMD-Field-SOP-018-02)

The in situ water transparency will be measured with a standard 13-inch Secchi disk. The depth to disappearance will be measured to the nearest quarter of a foot. Oxygen, temperature, pH and conductivity profiles at 1 foot intervals will be determined with a calibrated oxygen/temp/pH/conductivity meter (YSI Model 556MPS) and reported in the nearest 0.1 mg/L oxygen, 0.1 °C , 0.1 pH unit and the nearest whole number for conductivity. Water samples will be collectedbased on the South Florida Water Management District Field Sampling Quality

Manual (FSQM) utilizing a Niskin grab sampler. Data will be collected and organized on spreadsheets utilizing the Horizon Field Data Manager (HFDM) software for field input and office analysis. Appropriate statistical analyses such as analysis of variance and repeated measures analysis will be conducted to determine impacts of deep water mechanical harvesting on water quality as well as the impact of nutrient cycling on hydrilla growth and management.

Table 2. Element 5. Deep Water Mechanical Harvesting -Water quality parameters to be measured in situ and from water samples collected from six sites (3 reference, 3 harvested) in the lake.

Parameter	Measurement
In situ	
Secchi disk	inches of water depth
Oxygen content	Surface plus 1' intervals to the lake bottom
Temperature	Surface plus 1' intervals to the lake bottom
Conductivity	Surface plus 1' intervals to the lake bottom
pH	Surface plus 1' intervals to the lake bottom

Water samples (Grab samples using a Niskin kit and processed through the South Florida Water Management District Water Quality Monitoring Division lab following Field Sampling Quality Manual protocols.)

Nitrate-N	mg/L
Total nitrogen (TN)	mg/L
Total phosphorus (TP)	mg/L
Turbidity	Nephelometric units

Table 3. Deep Water Mechanical Harvesting of Hydrilla water quality sampling schedule to compare water quality at mid-depth in harvesting operations area (study) to undisturbed reference sites (control) at least 1 km distant in the same lakes (3 samples from each site).

Sample times	Purpose (number of samples)
7 days before operation begins	Determine uniformity of two sites (6 - 3 study, 3 control)
1 day before operation begins	Determine uniformity of two sites (6 - 3 study, 3 control)
Day 0- Day of operation (after operation that day)	Determine impact (6 - 3 study, 3 control)

At the completion of the harvest project:

1 day after operation ceases	Determine recovery (6 - 3 study, 3 control)
3 days after operation ceases	Determine recovery (6 - 3 study, 3 control)
7 days after operation ceases	Determine recovery (6 - 3 study, 3 control)
14 days after operation ceases	Determine recovery (6 - 3 study, 3 control)
Total	84 (42 twice per year)

Table 4. Suggested Schedule for Element 2, Currently Registered Herbicides-Water Quality

Sampling

1 day before herbicide application
2 days after herbicide application (2 DAT)
6 days after herbicide application (6 DAT)
9 days after herbicide application (9 DAT)
13 days after herbicide application (13 DAT)

Sample Identification (Comparing nutrient cycling in treated vs. untreated hydrilla in Lake Tohopekaliga, Kissimmee, FL (See Figures 2 and 3 for locations)

1. TOHOGBCV – in association with herbicide application in Goblet's Cove, August, 2011
    a. 9 sites total, 8 are close to or in surface mats of hydrilla, TohoBG2 is in open water
    b. Sites G1, G3, and G5 are in the boat trail to be treated
    c. Vertical sampling at G3 and G4 (.5 meter below surface and .5 meter above bottom),
    d. Parameters TN, TP and Chlorophyll A
    e. Total samples - 33 (9+2=11 X 3 = 33)
    f. Then monthly sampling at G3 and G4 in the project below
2. TOHOLAKE – in association with hydrilla expansion and/or management activities lake wide
    a. 10 sites
    b. Monthly
    c. Sites BG1, REDS1, BRNPT1, LGI1, G3 and G4 are in dense hydrilla mats, the remainder are currently in open water
    d. Parameters TN, TP and Chlorophyll A
    e. Total Samples – 30

Figure 2. Lake Tohopekaliga, Kissimmee, FL Water Sample Point Locations for Element 2, Evaluation of Currently Registered Herbicides- Water Quality Analysis Comparison of Nutrient Cycling Pre-treatment and Post Treatment of Hydrilla

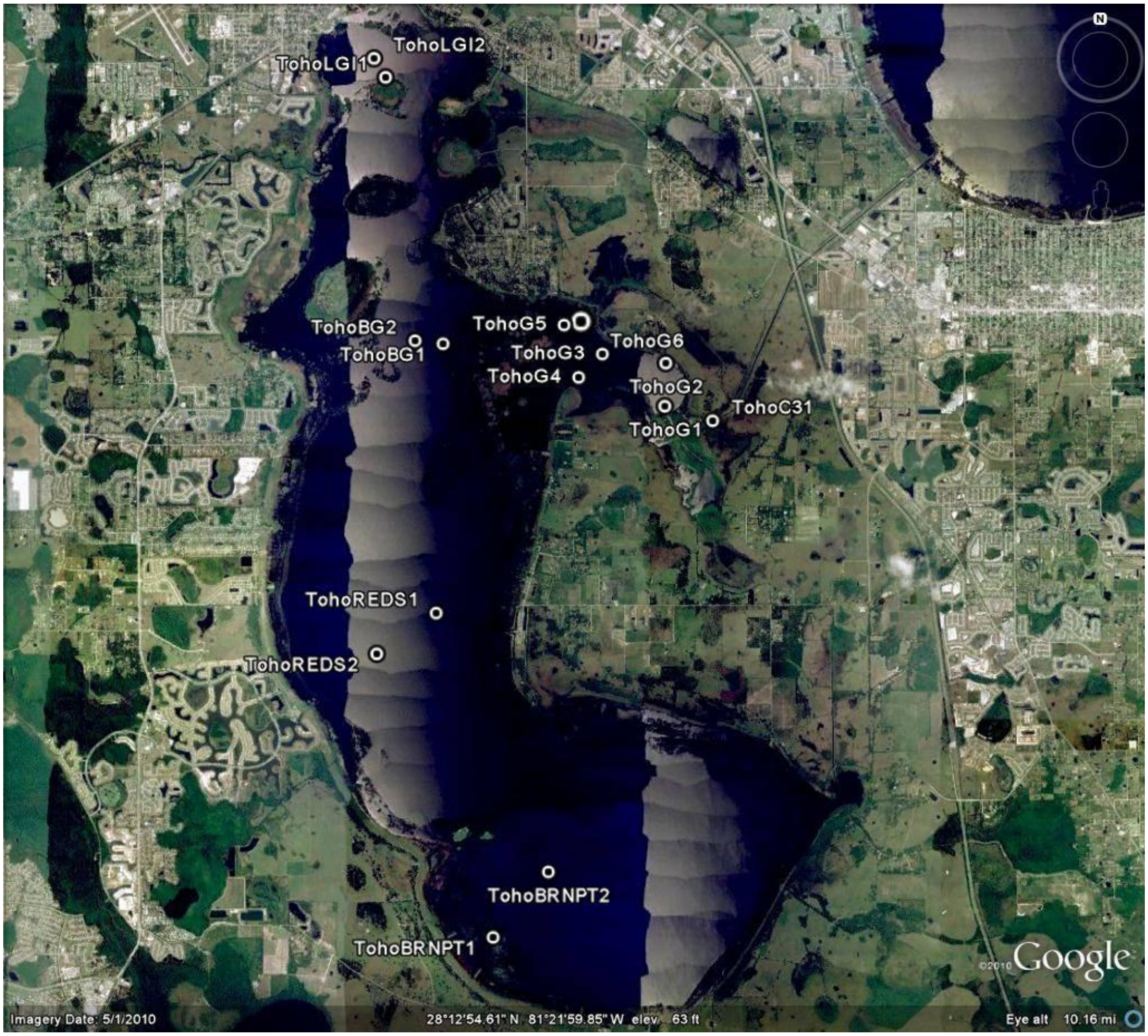


Figure 3. Globlet's Cove within Lake Tohopekaliga, Kissimmee, FL Water Sample Point Locations for Element 2, Evaluation of Currently Registered Herbicides- Water Quality Analysis Comparison of Nutrient Cycling Pre-treatment and Post Treatment of Hydrilla

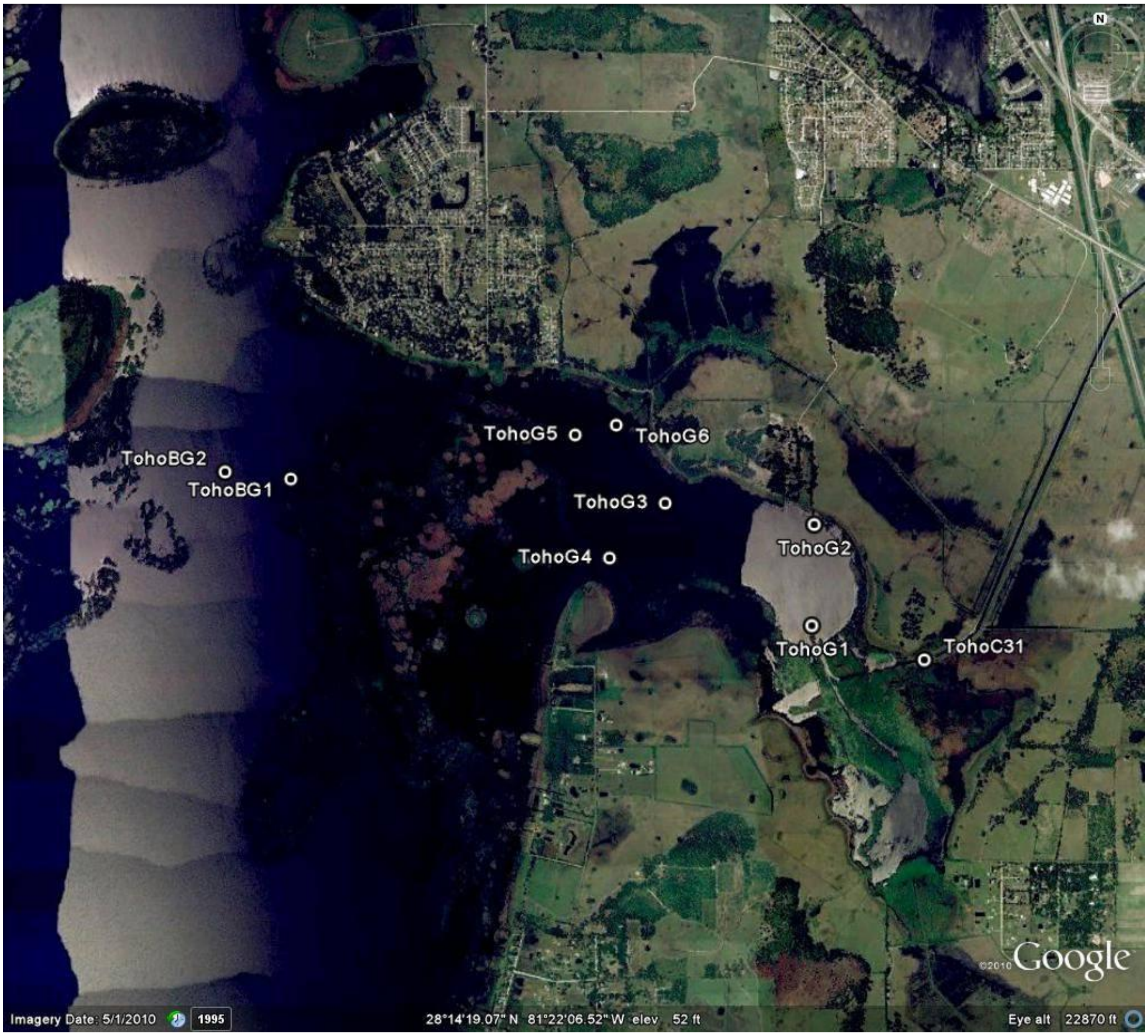


Table 5 Suggested schedule for Element 5. Actual dates to be determined based on permit approval.

June – September,2011	Osceola County prepares specifications for securing harvester contract.
May – September, 2011	Osceola County secures necessary environmental permit approvals.
Site 1:	
September-October, 2011	Harvest 50-100 acre hydrilla plot in 6 to 8 ft of water. Hydrilla to be mid water column.
September - October, 2011	Four samples of harvested material will be sorted to estimate fish by-catch. (4 loads at 500 to 1000 pounds)
September, 2011 - March 2012	Plant height, percent volume and percent area covered will be monitored monthly.
September – November	Conduct water quality sampling. (Table 2 and 3))
Site 2:	
November - December 2011	Harvest 50-100 acre hydrilla plot in 6 to 8 ft of water. Hydrilla to be mid water column.
November - December 2011	Four samples of harvested material will be sorted to estimate fish by-catch. (4 loads at 500 to 1000 pounds)
November, 2011 –March 2012	Plant height, percent volume and percent area covered will be monitored monthly.
November, 2011 - January 2011	Conduct water quality sampling. (Table 2 and 3)
March, 2012	Prepare and submit final report for Element 5.

B3 – Sample Handling and Custody

The replicate water samples collected inside and outside the harvested area for Element 5 and at selected sites for Element 2 will be handled according to the Field Sampling Quality Manual (FSQM). Chain of Custody and procedures for shipping are described in section 5.13 DIRECT TRANSPORT VIA COURIER, page 53 and 5.13 DIRECT TRANSPORT VIA COURIER, page 54**.** More detailed SOP's for water sampling and record keeping are included in Appendix 9, 10 and 11.

The only other samples collected in this demonstration project will be the fish collected from the harvested hydrilla. There is no need to preserve or save any known species of fish once they are weighed and enumerated. If there are juvenile fish or other unknown species of fish collected we will have plastic bottles and ethanol available to preserve them until identified at the University of Florida Department of Fisheries and Aquatic Sciences.

B4 – Analytical Methods

The South Florida Water Management District Field Sampling Quality Manual (FSQM) defines the minimum field sample collection and measurement protocols needed to meet the Florida Department of Environmental Protection (FDEP) Florida Administrative Code (FAC) 62-160 requirements. These protocols apply to the collection of surface water, groundwater, atmospheric deposition, soil, sediment, and biological samples collected by the District's Water Quality Monitoring Division (WQMD). This FSQM documents the minimum standards required for the collection of water quality samples and data, and provides a reference for evaluating the procedures used while this document is in effect. It is intended to be used as a reference and training guide for personnel involved in the collection and submittal of samples for laboratory analysis and field testing. The protocols detailed in the FSQM will assist in producing samples and data of acceptable quality and assure the defensibility of results.

Table 5. List of Critical Parameters Measured for Deep-water Harvesting of Hydrilla

Parameters Measured	*Analytical Method*	*Sample Requirements*	*Detection Limits*	*QC Samples*	*Acceptance Criteria*	*Project Critical*
Plant Biomass	Certified Truck Scales	Truck will be weighed empty (TARE weight) and after loading with hydrilla	10kg	Tank filled with a known weight of water	± 2 % of Standard Weight	Yes
Fish Biomass	Analytical Balance	Determine wet weight of fish by species	1g	Standard weights	± 2%	yes

B5 – Quality Control Element 5: Deep water mechanical harvest of hydrilla.
The QC activities associated with the deep water harvesting demonstration project are outlined below under sub-project headings. For more details see the Standard Operating Procedures (SOPs) for harvesting, longevity of control (PAC, PVI), fish by-catch sampling, and water sampling methods in Element 5 (included in Appendix 3, 6, 7, 8, 9, 10, and 11.)

The Field Sampling Quality Manual (FSQM) Appendix 10, defines the minimum field sample collection and measurement protocols needed to meet the Florida Department of Environmental Protection (FDEP) Florida Administrative Code (FAC) 62-160 requirements. These protocols apply to the collection of surface water, groundwater, atmospheric deposition, soil, sediment, and biological samples collected and/or processed by the District's Water Quality Monitoring Division (WQMD). The FSQM is intended as a reference and training guide for personnel involved in the collection and submittal of samples for laboratory analysis, and field testing. The protocols detailed in the FSQM will assist in producing data of acceptable quality and assure the defensibility of results obtained. It documents the minimum standards required for these activities and provides a reference for evaluating the procedures used while this FSQM is in effect.

Table 6. Equipment Needed for Completing Daily Logs for Evaluating Efficiency of Mechanical Harvesting

Parameters Measured	*Analytical Method*	*Sample Requirements*	*Detection Limits*	*QC Samples*	*Acceptance Criteria*	*Project Critical*
Daily logs	Watch/cell phone	Log book	2 minutes/event	Two means	± 10%	Yes
Daily logs	GPS (2) fixed and portable	Distance measurements	3m	Two means	–	Yes

There will be two people on the harvester at all times, one operator who runs the machine and a record keeper who will keep/maintain the log books. Contractor will be told they are being watched and the biologist or other project staff will monitor daily activities at least 3 times to verify and check on the validity of the log books.

Table 7. Longevity of Hydrilla Control

Parameters Measured	*Analytical Method*	*Sample Requirements*	*Detection Limits*	*QC Samples*	*Acceptance Criteria*	*Project Critical*
% cover	Fathometer and sonar	Hydrilla regrowth	–	Self-calibrated	–	Yes
% volume	Fathometer and sonar	Hydrilla regrowth	–	Self-calibrated	–	Yes

Table 8. Evaluation of Fish Bycatch

Parameters Measured	*Analytical Method*	*Sample Requirements*	*Detection Limits*	*QC Samples*	*Acceptance Criteria*	*Project Critical*
Plant biomass	Certified truck scales	Truck will be weighed empy (TARE weight) and after loading with hydrilla	10kg	100 gallon tank filled with a known volume of water	± 2 % of Standard Weight	Yes
Fish Biomass	Analytical Balance	Determine wet weight of fish by species	1g	Standard weights	± 2%	Yes

Table 9. Water Quality Sampling/Monitoring

Parameters Measured	*Analytical Method*	*Sample Requirements*	*Detection Limits*	*QC Samples*	*Acceptance Criteria*	*Project Critical*
Dissolved Oxygen	YSI 556 MPS handheld meter	Surface and 1' intervals to lake bottom	0.5 mg/l	6- 3 study and 3 control	± 2 % of the reading	Yes
Temperature	YSI 556 MPS handheld meter	Surface and 1' intervals to lake bottom	0.1 °C	6- 3 study and 3 control	± 0.15 ° C	Yes
Conductivity	YSI 556 MPS handheld meter	Surface and 1' intervals to lake bottom	1 mS/cm	6- 3 study and 3 control	± 0.5% of the reading	Yes
pH	YSI 556 MPS handheld meter	Surface and 1' intervals to lake bottom	0.1 pH units	6- 3 study and 3 control	± 0.2 units	Yes
Secchi	Science First® 78-010 Fieldmaster Secchi Disk	Inches of water depth	0 feet	6- 3 study and 3 control	Nearsest quarter of a foot	Yes
Nitrate-N	Chemical analysis of water sample	Mid water column	0.1 mg/l mg/L	6- 3 study and 3 control	± 10 %	Yes
Total Nitrogen	Chemical analysis of water sample	Mid water column	.01 mg/L	6- 3 study and 3 control	± 10 %	Yes
Total Phosphorus	Chemical analysis of water sample	Mid water column	.01 mg/L	6- 3 study and 3 control	± 10 %	Yes
Turbidity	Chemical analysis of water sample	Mid water column	1 NTU	6- 3 study and 3 control	± 10 %	Yes

B6 – Instrument/Equipment Testing, Inspection, Maintenance - Quality Control Element 5: Deep water mechanical harvest of hydrilla.

See Appendix 4 for SOPs for testing, inspection and maintenance.

The instruments and equipment used for actual data collection and monitoring of harvester operations will include use of the following:

Mettler Pm16-N and Mettler PM4000 Analytical Balances
YSI 556 Field pH, DO, conductivity, and temperature meter and probe
Garmin Map76 GPS units
Secchi disk
Lowrance HDS-5 with structure scan
Certified truck scales or other calibrated scales

Raymarine model C-80 Navigation System
Raven Cruizer GPS Plotter

B7 – Instrument/Equipment Calibration and Frequency - Quality Control Element 5: Deep water mechanical harvest of hydrilla.

See Appendix 5 for SOPs for calibration.

Equipment that will require calibration and maintenance includes the following:

Mettler Pm16-N and Mettler PM4000 Analytical Balance
YSI 556 Field pH, DO, conductivity, and temperature meter and probe
Certified truck scales / other calibrated scales

Adjustments to equipment will be recorded in the laboratory notebook with a brief description of the corrective action and the date the calibration was made.

Table 10. List of analytical equipment with calibration and maintenance information.

List of Analytical Equipment	Calibration Frequency	Calibration Standards	Calibration Acceptance Criteria	Maintenance Contract
Mettler and Ohaus Balances	Each time data is collected	NIST Standard Weights	± 0.01 g	No maintenance contract, but backup units available
YSI 556 and YSI 200 Field Water Quality Meters	Each Use	2 pH buffers, Conductivity standards, air calibration for DO	The YSI556 and YSI 200 accept the calibration or reject it.	No maintenance contract, but backup units are available
Lowrance HDS-5 with structure scan	Self-calibrating	Compare to other units	± 1 m	No, but backup unit available
Garmin GPS units	Unit picks up various satellites to determine fixed positions	Will compare waypoints against fixed sites (i.e. water gauging stations, boat docks) to insure accuracy	N/A	
Raymarine Model C-80 Navigation Display (on harvester)	Self-calibrating at each power-up	Compare to other units	± 1 m	No, but backup unit available

Raven Cruizer GPS Plotter	Self-calibrating	Compare to C-80 or Garmin 76 models	± 1 m	No, but backup units will also be used

B8 – Inspection/Acceptance of Supplies and Consumables –Element 5: Deep water mechanical harvest of hydrilla.

Consumable supplies will be purchased using Osceola County approved procurement practices, and tracked according to the South Florida Water Management District Field Sampling Quality Manual (FSQM).

Supplies needed will be stored at a secure location on Osceola County Property. Sulfuric Acid Preservative
Chlorophyll A Containers (opaque)
60 mL Bottles (Gray)
120 mL Bottles (Magenta)
Low Range pH Strips
Poly Disc Filter
Powder Free Gloves - Small
Powder Free Gloves - Med.
60 mL Syringes
2'x 3' Poly Bags
Mini Wrap for Shipping Coolers
Coolers
Powder Free Vinyl Gloves
Niskin Kit (Clear)
Niskin Kit (Opaque)
Phosphate Free Soap
HCL Rinse
Tray
Washing Brush
HCL Wash Bottles
Coolers
Sharpey Markers
Meter Stick

B9 – Non-Direct Measurements- Element 5: Deep water mechanical harvest of hydrilla.

Peer-reviewed and non-peer-reviewed literature has been - and new publications will be - critically examined to assess the 'state of the art' for Element 5: Deep-water mechanical harvesting of hydrilla. The limited but most relevant literature has already been gathered in preparation for developing this element, but we will continually search the literature for new publications as the project progresses.

B10 – Data Management Element 5: Deep water mechanical harvest of hydrilla.

The data generated from Element 5 will include records directly recorded in a research notebook and data entered into a spreadsheet (e.g. Microsoft Excel, SigmaPlot). Daily operations logs will be compiled to show harvest operations (track log, # of loads, acres/distance).

Data will be analyzed via commercial statistical programs such as SigmaStat, JMP, or SAS. Data can be plotted via a commercial program such as SigmaPlot. All project participants currently have PCs equipped with spreadsheet and statistical software (e.g. Microsoft Excel, SigmaStat, SigmaPlot, SAS, or similar statistical and graphing software) and electronic data files are readily transferred via e-mail. The data/information will not be password protected.

GROUP C: ASSESSMENT AND OVERSIGHT

C1 – Assessment and Response Actions

Osceola County will work with the Element Coordinator, Dr. William Haller to develop quarterly reports highlighting the progress on Element 5: Deep water mechanical harvest of hydrilla. Study participants will meet regularly to review the project. We plan to use this system of self and peer-review throughout the project.

The review of field data collected with surface water sample grab data are reviewed by the QA staff at SFWMD WQMD. Review and validation of data produced by the SFWMD laboratory is performed by the laboratory QA and the Data Validation Section in the Water Quality Analysis Division of the South Florida Water Management District. For questions regarding water quality sampling and laboratory procedures, contact:

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Water Quality Monitoring Division
South Florida Water Management Division, Field Operations Center
8894 Belvedere Rd.
West Palm Beach, FL 33411
Office#: 561-753-2400 x4766
Cell#: 561-662-3681
Fax#: 561-791-4094

During the course of the project the Quality Assurance Manager for Element 5 (Dr. Kenneth Langeland) will conduct at least 1 Field Audit. The QA Officer can also conduct spot checks on request. The QA officer will provide a notice of intent to audit at least two weeks prior to the actual audit. The audit will include review of lab and field notebooks, sample storage, data storage, and equipment and calibration records. Audit findings will be documented and communicated to key project staff. Element Leaders will be responsible for implementing corrective actions and documenting the effectiveness of these actions.

C2 – Reports to Management

Reports will be self-evaluated and peer reviewed internally and forwarded to the Project Manager for compilation and final submission to the Osceola County Grants Office and EPA Project Officer. Quarterly Reports will be provided to Osceola County and the EPA regarding the status of this project. The Quarterly Reports will be prepared by Dr. Haller in cooperation with others for Element 5. Any significant problems regarding data quality or Quality Assurance issues will be reported directly to the Project Manager for reconciliation. The overall Project Manager (Ms. Foerste) will be responsible for compiling the Quarterly Reports and ensuring they are submitted to appropriate personnel.

GROUP D: DATA VALIDATION AND USABILITY

Data collected in this study will be derived from replicated samples and entered into spreadsheets and analyzed using appropriate statistical methods. Project results can then be compared to previous or newly published data.

D1 – Data Review, Verification, and Validation

The review of field data collected with surface water sample grab data are reviewed by the QA staff at SFWMD WQMD. Review and validation of data produced by the SFWMD laboratory is performed by the laboratory QA and the Data Validation Section in the Water Quality Analysis Division of the South Florida Water Management District. Secion 5.2 SAMPLE REJECTION CRITERIA DURING FIELD SAMPLE COLLECTION (page 41) discusses criteria for rejection of field samples.

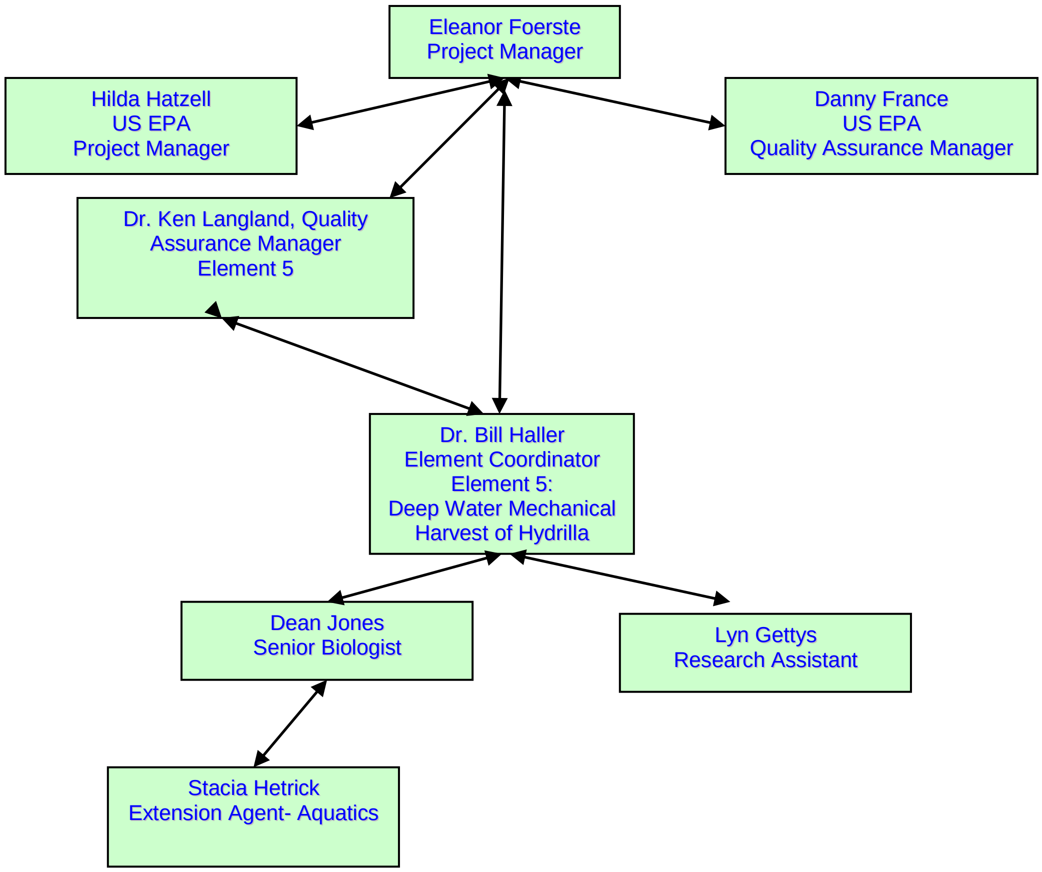
D2 – Verification and Validation Methods

Dr. Haller and Dean Jones will supervise operaton of harvesting contractor to assure compliance with scope and QA/QC procedures and verify data collection processes. Replication is the best form of data validation in a study format. In terms of study verification, repeating a study in space and time (for example, harvesting in Summer and Fall) typically gives the best confirmation that the researcher has a high level of confidence in the results. The review of field data collected with surface water sample grab data are reviewed by the QA staff at SFWMD WQMD. Review and validation of data produced by the SFWMD laboratory is performed by the laboratory QA and the Data Validation Section in the Water Quality Analysis Division of the South Florida Water Management District following SOP's specified by the SFWMD WQMD. Laboratory procedures are outlined by the SFWMD in the Chemistry Laboratory Manual.

D3 – Reconciliation with User Requirements

The Element 5 Coordinator, Dr. William Haller, and Element 2 Coordinator, Dr. Mike Netherland, will review data to be sure it matches the Data Quality Objectives of A7. The data generated from Element 5 will be critical for developing use patterns and potentially new or alternative methods of control of hydrilla in the field. The results of Element 5 will be provided to the project sponsors and available to the public. Peer reviewed papers will be published and made available on the project website.

Appendix 1. Organization Chart for Element 5



Appendix 2. Literature Cited

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Appendix 3: General Standard Operating Procedures for Sampling Methods used in Elements 5: Deep water mechanical harvesting of hydrilla

Daily harvesting operations

Osceola County will contract the mechanical harvesting on this project to a company that has a large capacity harvester (>70 feet) that is able to harvest hydrilla to a water depth of 8 feet. It is understood that this operation has never been previously accomplished which may require equipment modifications to accomplish the objectives of this project as efficiently as possible.

In addition to providing and operating the harvester, the following standard operating procedures (SOPs) will be followed.

Hydrilla will be harvested using a modified mechanical harvesting machine to allow deep water harvesting in 6 to 8 feet of water instead of the traditional surface harvest. Hydrilla will be harvested while it is growing upright in the midwater column before it tops out and creates a canopy. The harvester will not have a cutter bar but will instead be directed so that it harvests hydrilla above the hydrosoil layer, not into the soil , uprooting the hydrilla and pulling it onto a conveyer.

The harvester will operate with a GPS system (Raymarine Model C-80 and Raven Cruizer GPS guidance and plotting) that will record the harvester track in the operations area (area to be harvested).

A record will be maintained that indicates the actual time and distance of each harvested swath. The time of transport to the disposal site and time required for unloading will also be recorded. A hard copy of the GPS track data from the Raymarine C-80 Navigation System will be downloaded daily.

These data can be used to determine:

a) Actual time in harvesting mode
b) Length of harvested swath to load harvester (acres/hour)
c) Time in turn-around procedures. (The harvested plots will be much longer than the width in order to minimize turn-around time).
d) Time in transport and return to harvesting from disposal site
e) Time required to unload at disposal site
f) Down time

These data (records) are not required on days when conducting special projects, such as unloading into trucks for fish by-catch sampling or for making experimental modifications (if required).

Harvesting and estimating fish by-catch

Harvester will be positioned on site to be harvested and begin harvesting at point A, at time 0. It will operate as normal until a load of estimated weight of 500 to 1,000 lbs of hydrilla is harvested, making the harvested end point as point B at time 1. The swath length and hydrilla weight will allow determination of hydrilla biomass per unit acre.

The harvester will immediately transport the load of hydrilla to a site where it can be off loaded into a tared truck. Any fish falling from the conveyor will be collected as long as they can be safely collected.

The hydrilla on the truck will be weighed to the nearest 10kg (20 lbs) on calibrated scales, and off-loaded onto a clean tarp adjacent to the fish/hydrilla sorting site.

Individual stems or handfuls of hydrilla will be taken from the harvested pile and examined by hand and rinsed with running water onto a window screen which will collect any juvenile fish.

All fish will be collected and stored in an ice chest until the entire load is completely examined.

The fish will then be sorted by species and then each species will be sorted by size (length) groups 0-20mm, 20-40mm, 40-60mm, etc. to determine relative sizes of the harvested species.

The size groups will be weighed and enumerated.

These data can be manipulated to determine fish (number and weight) harvested per unit area, further divided into individual species (number and weight) per unit area.

This procedure will be followed for a total of 4 replications (likely able to do two replications per day).

These data can then be compared by t-tests and other simple statistics to the by-catch reported in the literature from harvesting operations at other lakes.

Appendix 4. Standard Operating Procedures for Instrument/Equipment Testing, Inspection, Maintenance for Element 5: Deep water mechanical harvesting of hydrilla

Ohaus SP202, Mettler AB54-S, Mettler Pm16N and Mettler PM4000 Analytical Balances

All balances are annually serviced and calibrated by the manufacturer. A series of NIST standard weights are used to calibrate the balances.

YSI 200 and YSI 556 Field Oxygen/Temperature Meter and Probe

Probe membranes for this unit last longer if properly installed and regularly maintained. Erratic readings can result from damaged or fouled membranes or from large bubbles in the electrolyte reservoir. If unstable readings or membrane damage occurs, replace both the membrane cap and Oxygen Probe solution (also known as "O2 Probe Electrolyte", potassium chloride, or KCl solution). The average replacement interval is 4 to 8 weeks, although they may last longer if kept clean. Harsh environments, such as wastewater, may require membrane replacement every 2 to 4 weeks.

Keep the probe's gold cathode clean and textured (when properly maintained it has a matte finish). If it is tarnished (from contact with certain gases), or plated with silver (from extended use with a loose or wrinkled membrane), then clean it, following the instructions below:

To clean the probe, use the YSI Probe Reconditioning kit. In addition to the Reconditioning Kit, you may try a chemical cleaning. To clean the electrodes chemically, perform an ammonium hydroxide soak.

1. Remove membrane cap and rinse the probe with clean water (tap, distilled, or deionized).
2. Turn unit off, or disconnect probe.
3. Obtain either:
    - 14 % lab strength ammonium hydroxide and soak for 2-3 minutes
    - 3% household cleaning strength ammonia and soak overnight (8-12 hours)
4. Rinse ammonium hydroxide/ammonia from probe.
5. Use sandpaper (400 grit wet/dry, supplied with 5238 kit) to buff (wet sand) excess deposits from probe.
6. Install a new membrane cap.

Appendix 5. Standard Operating Procedures for Instrument/Equipment Calibration and Frequency for Element 5: Deep water mechanical harvesting of hydrilla

Ohaus SP202, Mettler AB54-S, Mettler Pm16N, and Mettler PM 4000 Analytical Balances

Calibration checks are conducted at time of use with appropriate calibration weights. If measured weight of calibration standard exceeds +/- 5% of known standard weight, the unit is evaluated per manufacturer recommendations or is serviced.

YSI 200 and YSI556 Field Oxygen/Temperature Meter and Probe

1. Place 5-6 drops of clean water (tap, distilled, or deionized) into the sponge inside the calibration bottle. Turn the bottle over and allow any excess water to drain out of the bottle. The wet sponge creates a 100% water-saturated air environment for the probe, which is ideal for calibration, transport, and storage of the Model DO200 probe. For calibration, the probe remains in a water saturated air atmosphere and is not submersed.
2. Slide the probe into the calibration bottle. Be sure the membrane does not touch the sponge.
3. Turn on the unit by pressing power button. Wait 10 to 15 minutes for the dissolved oxygen and temperature readings to stabilize.
4. Press CAL.
5. The LCD prompts for the local pressure in mBar. Use the up and down keys to increase or decrease the pressure value (mBars) respectively.
6. When the proper pressure displays, press Enter once to view the calibration value in the lower right of the display. Once the value in the main display stabilizes, press again to move to the salinity compensation procedure.
7. The display prompts for the approximate salinity of the water to be analyzed. Use the up and down keys to increase or decrease the salinity compensation value to the value of your sample (between 0 to 40 parts per thousand [ppt]). When the correct salinity displays, press Enter. (Note: all trials will be conducted in freshwater with assumed salinity of 0 ppt)
8. The unit holds calibration even if it is powered off. However, it is recommended to check calibration with each use and recalibrate as necessary to prevent drift.

Appendix 6. Standard Operating Procedures (SOP) for Documentation of Mechanical Harvesting Efficiency

Objective: To maintain records of harvesting operations to determine the amount of time required to harvest a given area of hydrilla.

Running records or daily operating log will be maintained for harvesting operators to determine the amount of time needed to load and off-load the machines, as well as determine areas harvested for each load. The information is outlined below and an example log book with sample entries also follows.

a. Time and distance to load harvester. These data will determine the area harvested per unit time. Harvest path x harvester width (both in meters – m) divided by time (in hours or fractions thereof) will equal m^2 per hour or hectares (ha) per hour.
b. Time and distance to offloading site and return to plot (round-trip). This will vary but can be a significant amount of time when calculated to the overall efficiency of the operation. This time calculation will be added to the harvesting time to calculate m^2 or ha harvested and offloaded per hour.

QA/QC. Time records will be kept by the harvester operators. For QA/QC purposes, a county or UF staff member will keep records for at least 3 days or 10% of the operation, whichever is greater, to compare statistically to the records (ha harvested per hour) maintained by the two entities.

Sample entries (in italics) in Daily Operations Log Book for Element 5
Date: ____________________
Weather: ____
____
____

Start time	Activity	End time	Distance
8:40am	*Load harvester*	*9:12 am*	*450m*
Comments:			
9:13am	*Transport to offload*	*9:21am*	*600m*
Comments: *5-8 mph headwind*			
9:21am	*Offload*	*9:30am*	*N/A*
Comments:			
9:30am	*Transit to plot*	*9:36am*	*620m*
Comments: *5-8 mph tailwind*			
9:36am	*Harvesting*	*10:08am*	*510m*
Comments:			

Daily Operations Log Book for Element 5

Date: ____________________

Weather: ____

____

____

Start time   Activity   End time   Distance

__________ ____ __________ _________

Comments: ____

__________ ____ __________ _________

Comments: ____

__________ ____ __________ _________

Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

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Comments: ____

Appendix 7. Standard Operating Procedures for Calculating Aquatic Vegetation Percent Area Covered (PAC) & Percent Volume Infested (PVI)

This procedure is modified from those of Jim Griffin of the University of South Florida.

Boat setup:

1. Three items are needed:
    a. Lowrance sonar/GPS head unit
    b. Transducer
    c. GPS receiver
2. The Lowrance system works best when the transducer is permanently mounted to the boat; however, data can be obtained using removable mounting hardware.
3. A standard deep cycle or cranking battery is needed for power.
4. Read and understand owners manual completely

Field procedures:

1. Turn on power and allow GPS to acquire position (check using *STATUS* page).
2. Ping speed should be set at 75 percent.
3. Determine starting and stopping points (locations).
4. Once at start location, start transect by using the PAGES button to get to *SONAR* and chose FULL SONAR CHART.
5. Use the MENU button and choose LOG SONAR DATA.
6. Name the transect appropriately and select the drive for saving the map (hard drive or removable memory card).
7. Push ENTER on START LOGGING to begin transect.
8. Push PAGES and go to *MAP* and chose the MAP WITH SONAR screen (this allows you to see your position on the map, speed, and the sonar chart simultaneously).
9. Constant speed is not necessary for all applications since GPS coordinates are being taken; however, keeping the speed around 7.5 mph is recommended.
10. As you approach the end of the transect return to the *SONAR* page and use the MENU button to again access the LOG SONAR DATA screen.
11. Once at the end of the transect press ENTER while highlighting END LOGGING (it will be in the same area as the START LOGGING prompt was earlier).
12. Repeat these steps for every transect needed.

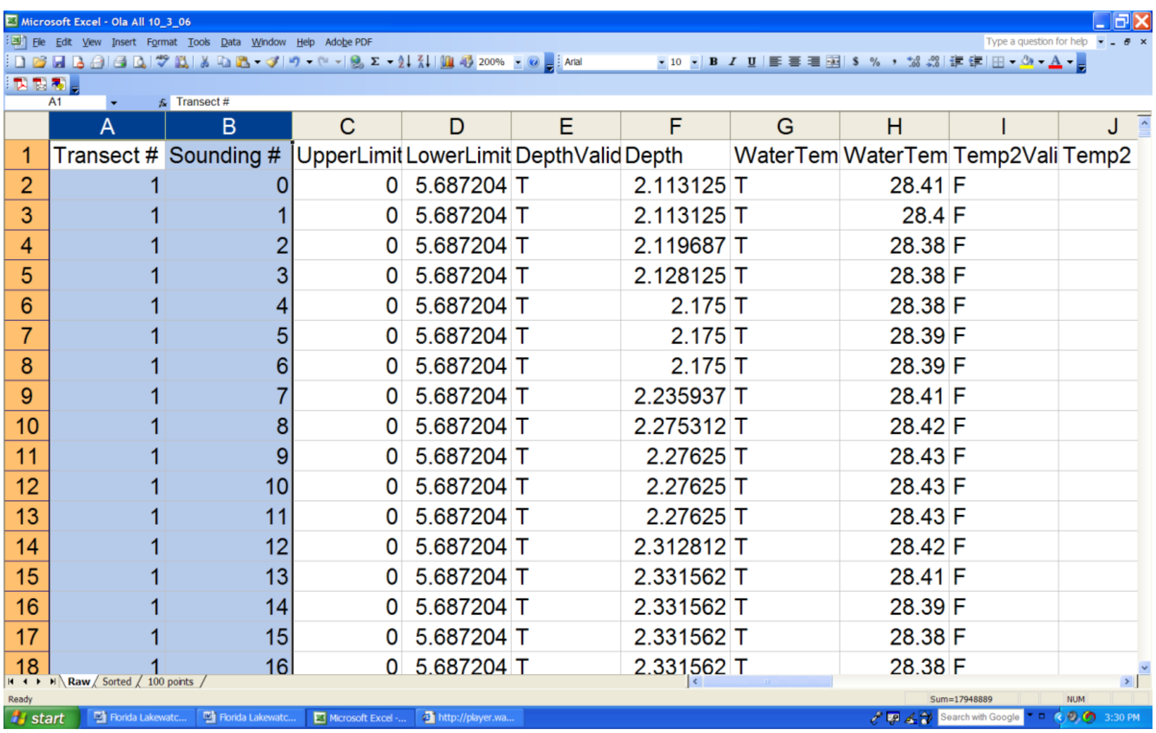
Office procedures:

1. A LEI/MMC card reader is needed to retrieve data from the removable memory card.
2. The program Sonar Viewer is needed to view bottom maps on a computer. This program is a free download from: http://www.lowrance.com/en/Downloads/Sonar-Log-Viewer-SLV/
3. Once the transect files are moved from the Lowrance unit to the computer via the memory card, save each transect or group of transects in folders with water body name and date, as this information is not part of the data saved in the files.
4. To access the maps, open Sonar Viewer from the desktop or the computer’s main menu. Opening these files by double clicking on the file name in “my documents” will not allow use of all needed options.

5. Once a file is open in Sonar Viewer:
    a. Go to FILE and click on OUTPUT CHART INFORMATION. This will open up a SAVE AS window.
    b. Name the chart differently if desired and save. This has saved the file as a comma delimited file (.CSV) in Microsoft Excel. It is a spread sheet of the numerical data for the opened chart.
    c. Repeat these steps for all transect files per sampling event.
6. The newly formed Excel spread sheet contains all of the data recorded by the Lowrance (depth, water temp., position, etc.). Much of the data is not needed for PAC/PVI determination; however, the data should be kept for possible future analysis. Desired data can be copied and pasted into another worksheet in the Excel file to be more easily viewed (when this is done the file must be resaved as a .XLS file as .CSV files cannot have more than one worksheet).
7. A column called "Depth Valid" is part of the data shown on the spreadsheet. The cells will contain either a "T" or an "F". "T" means everything was working properly, a depth was taken, and the bottom chart will be clear and usable. An "F" means that no depth was taken and the chart is most likely unclear in this section. Therefore, any rows with an "F" in the Depth Valid cell should not be used and can be deleted. ** For the purposes of PAC and PVI for documenting hydrilla control do not delete any of the rows. Topped out hydrilla may cause the sonar to give an "F" reading, and deletion of this information would not give a true representation of what is/was present.
8. One new column, "Sounding Number," must be added to the far left of the spreadsheet. This column will start with 0 and go through the number of data points for that transect (the number of rows in the file (Figure 1)).
9. Once "Sounding numbers" have been added to all transect files from a sampling event the data from each individual transect should be copied and placed in order of transect into a new file called "lakename_ALL". This file will now contain data for the full sampling event organized in order by transect and sounding number. **Because we are interested in control and subsequent return of hydrilla, we do not want to combine data for transects. We are interested in what occurs in each treatment plot (transects within the plot). Leave the files separate.
10. A new column called "Random" should be added to the left of the spread sheet. A random number formula should be used to assign a random number to each sounding. Using the formula =rand() in Excel will generate a random number between 0 and 1. Copy and paste this formula down the entire column.
11. Copy the entire "Random" column and paste it back in the same place using the Paste Special – "Values" operation. This prevents the formula from continuously regenerating the random number each time you work on the spreadsheet.
12. Highlight the entire worksheet and Sort by Random in ascending order.
13. Select the appropriate number of soundings to be analyzed for PAC/PVI. Common methods are to use a set number of soundings (ex. 100) for each water body, or a percentage of the total number of soundings (ex. 0.1%). The percentage should be low as this system generates thousands of data points (ex. Talquin reservoir, FL = 86,000 data points from 5 transects at 10mph constant speed).
14. Once these rows are selected, copy and paste them into a new worksheet.

15. Sort these rows in ascending order by sounding number. These are the points that will be visually measured to determine PAC/PVI.
16. Add two new columns “Bottom depth” and “Veg depth”. Veg depth is the depth of the top of the plants, so if no plants are present the Veg depth value will be the same as the Bottom depth. If plants are to the surface, “topped out”, than Veg depth will equal 0.
17. In Sonar Viewer chart settings must be set the same to aid in standardization of this method:
    a. Set Colorline = 60
    b. Set Sensitivity = 70
    c. Go to View in the upper menu and open Chart Settings
    d. Set Surface Clarity = High
    e. Set ASP = Normal
    f. View chart as color with white background (default)
18. Open Sonar Viewer and Excel simultaneously. For each transect place the mouse pointer on the designated sounding on the chart in Sonar Viewer and record the bottom depth (Figure 5) and plant height (Figure 6 in Excel. Repeat for all points.
19. Add column “Veg height” and “Veg presence”. Veg height can be determined with (Bottom depth – Veg depth). Veg presence is binomial with 0 meaning no plants (Veg height = 0) and 1 meaning plants (Veg height >0) (Figure 7).
20. PAC is determined using the formula (Σ Veg presence/ Total number of soundings analyzed)100] (Figure 8).
21. PVI is determined using the formula [(Σ Veg height/ Σ Bottom depth)100] (Figure 8).

Figure 4. Transect number and Sounding number columns added to raw Lowrance transect data prior to combining individual files into a lake ALL file.



	A	B	C	D	E	F	G	H	I	J
1	Transect #	Sounding #	UpperLimit	LowerLimit	DepthValid	Depth	WaterTem	WaterTem	Temp2Vali	Temp2
2	1	0	0	5.687204	T	2.113125	T	28.41	F	
3	1	1	0	5.687204	T	2.113125	T	28.4	F	
4	1	2	0	5.687204	T	2.119687	T	28.38	F	
5	1	3	0	5.687204	T	2.128125	T	28.38	F	
6	1	4	0	5.687204	T	2.175	T	28.38	F	
7	1	5	0	5.687204	T	2.175	T	28.39	F	
8	1	6	0	5.687204	T	2.175	T	28.39	F	
9	1	7	0	5.687204	T	2.235937	T	28.41	F	
10	1	8	0	5.687204	T	2.275312	T	28.42	F	
11	1	9	0	5.687204	T	2.27625	T	28.43	F	
12	1	10	0	5.687204	T	2.27625	T	28.43	F	
13	1	11	0	5.687204	T	2.27625	T	28.43	F	
14	1	12	0	5.687204	T	2.312812	T	28.42	F	
15	1	13	0	5.687204	T	2.331562	T	28.41	F	
16	1	14	0	5.687204	T	2.331562	T	28.39	F	
17	1	15	0	5.687204	T	2.331562	T	28.38	F	
18	1	16	0	5.687204	T	2.331562	T	28.38	F	

Figure 5. Bottom depth is determined by placing the cursor at the change between the large yellow line and the beginning of the darker colored plants (black arrow). The information box shows the cursor depth. This value should be entered into the Excel spreadsheet.

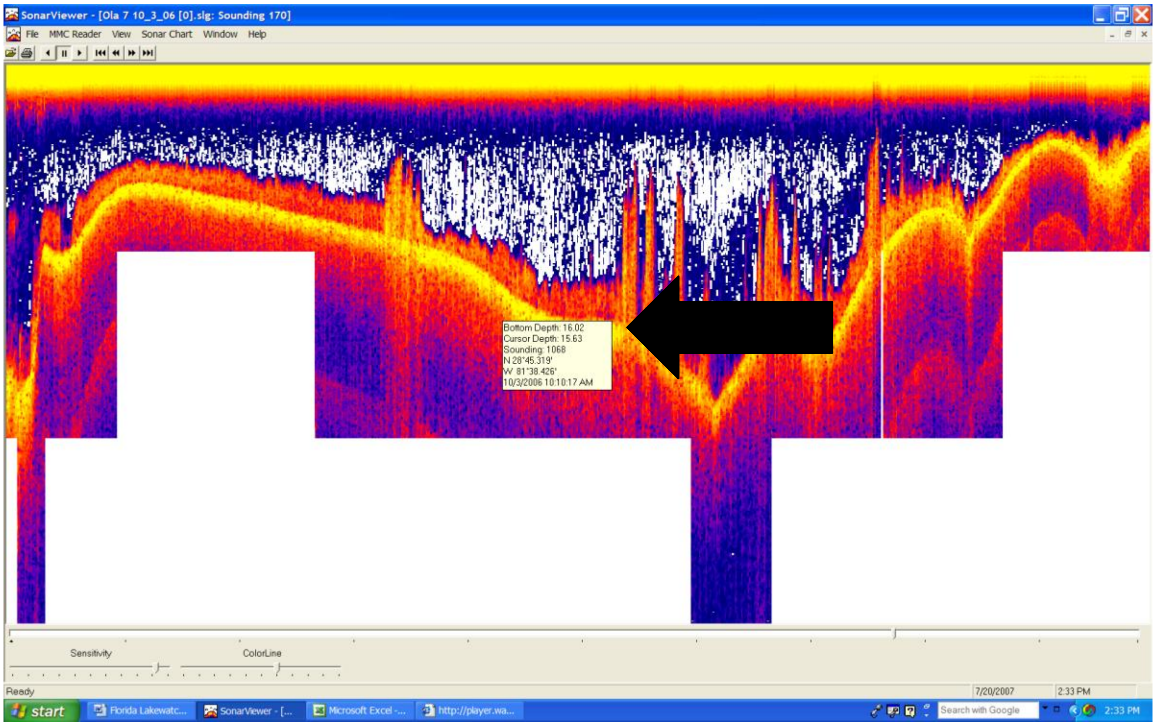


Figure 6. Veg depth is determined by placing the cursor at the top of the yellow/orange colored plants on the chart (black arrow). The information box shows the cursor depth. This value should be entered into the Excel spreadsheet.

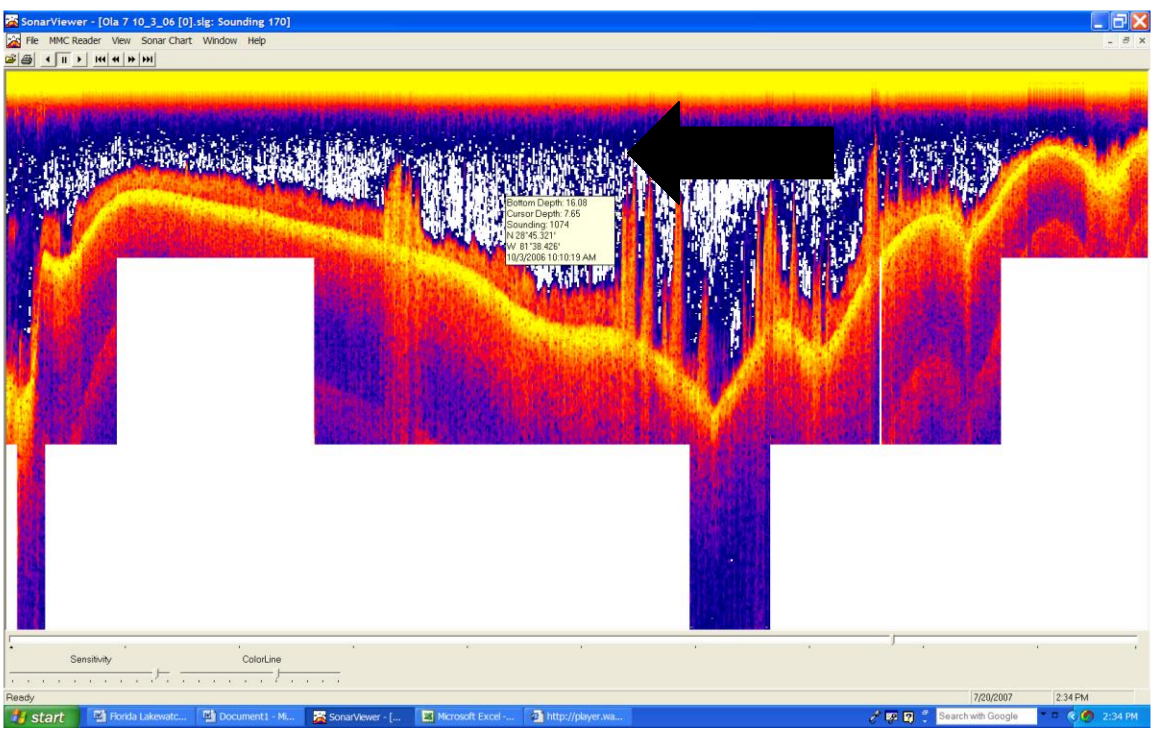
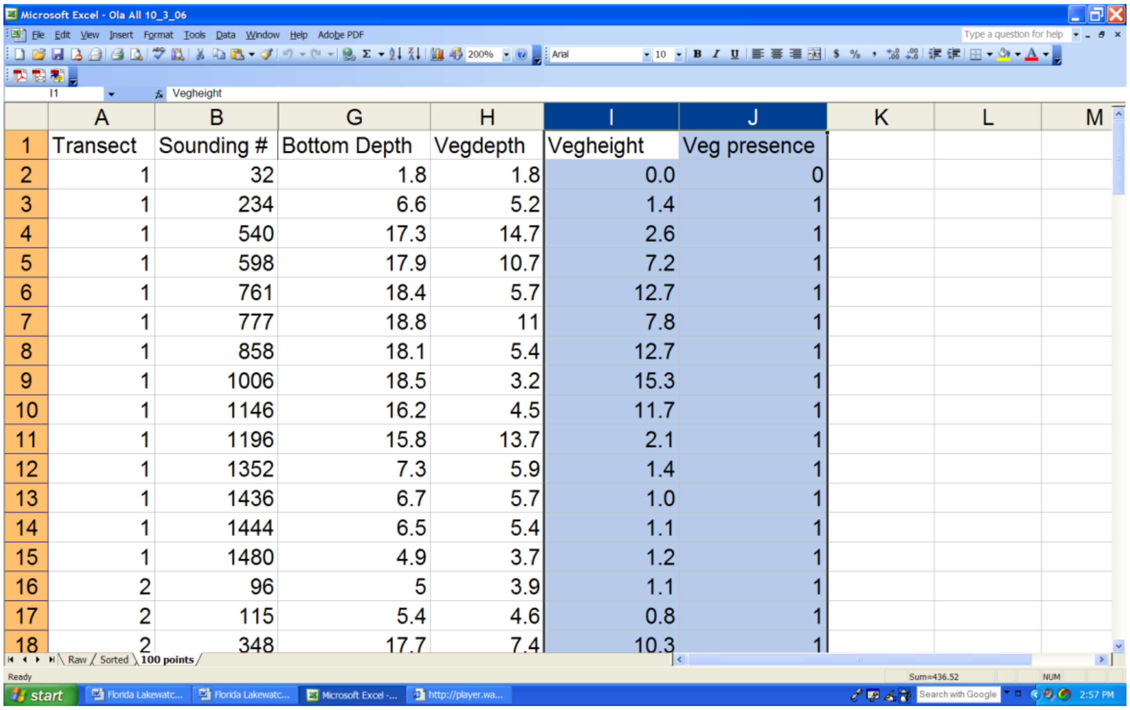
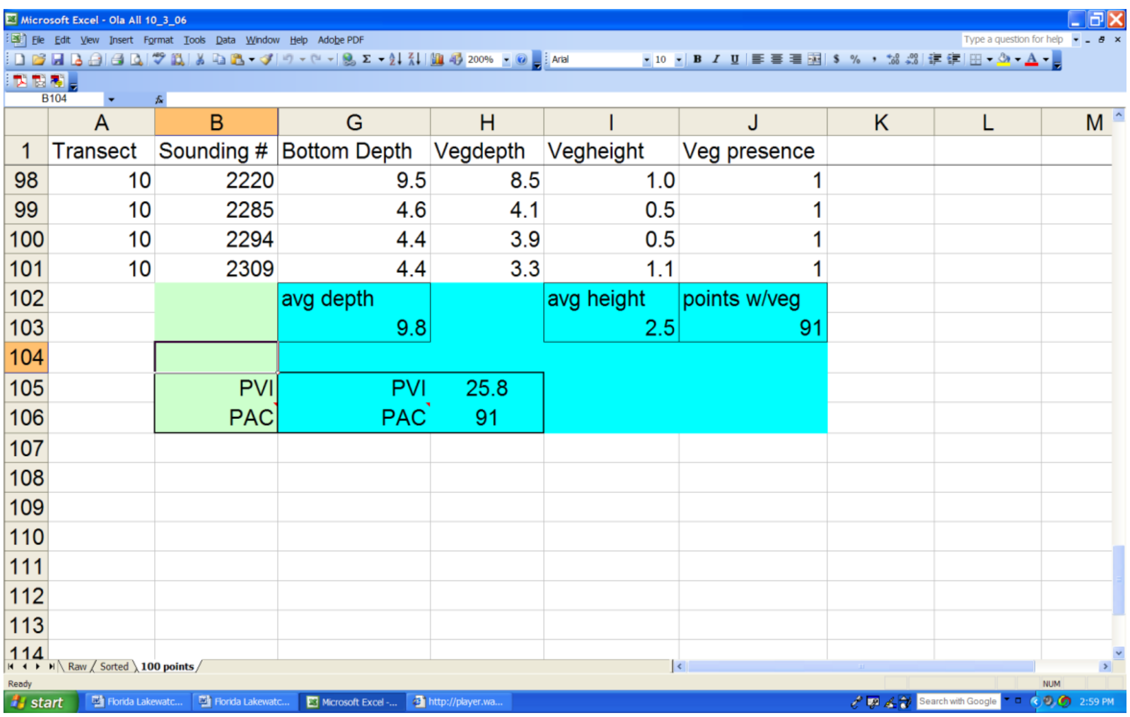


Figure 7. Veg height and Veg presence columns added to spreadsheet after Bottom and Veg depths are measured.



	A	B	G	H	I	J
1	Transect	Sounding #	Bottom Depth	Vegdepth	Vegheight	Veg presence
2	1	32	1.8	1.8	0.0	0
3	1	234	6.6	5.2	1.4	1
4	1	540	17.3	14.7	2.6	1
5	1	598	17.9	10.7	7.2	1
6	1	761	18.4	5.7	12.7	1
7	1	777	18.8	11	7.8	1
8	1	858	18.1	5.4	12.7	1
9	1	1006	18.5	3.2	15.3	1
10	1	1146	16.2	4.5	11.7	1
11	1	1196	15.8	13.7	2.1	1
12	1	1352	7.3	5.9	1.4	1
13	1	1436	6.7	5.7	1.0	1
14	1	1444	6.5	5.4	1.1	1
15	1	1480	4.9	3.7	1.2	1
16	2	96	5	3.9	1.1	1
17	2	115	5.4	4.6	0.8	1
18	2	348	17.7	7.4	10.3	1

Figure 8. PVI and PAC values which are determined using the data from the above columns.



	A	B	G	H	I	J
1	Transect	Sounding #	Bottom Depth	Vegdepth	Vegheight	Veg presence
98	10	2220	9.5	8.5	1.0	1
99	10	2285	4.6	4.1	0.5	1
100	10	2294	4.4	3.9	0.5	1
101	10	2309	4.4	3.3	1.1	1
102			avg depth		avg height	points w/veg
103			9.8		2.5	91
104						
105		PVI	PVI	25.8		
106		PAC	PAC	91		

Appendix 8. Standard Operating Procedures (SOP) for Fish By-catch Sampling

Objective: To collect 3 loads of 500 to 1000 pounds (freshweight) of hydrilla to determine fish by-catch of "normal" deepwater harvesting operations.

a. Hydrilla will be harvested in an area of operations long enough to collect 500 to 1000 pounds (freshweight) of hydrilla. The area harvested and time of harvest will be recorded to ascertain "normal" operations.
b. Hydrilla will be transported to the shore or boat ramp where it will be offloaded, weighed and sorted to separate fish from vegetation.
c. Vegetation will be sorted by hand and rinsed (with running water) over a screen to collect small fish that may be trapped in the vegetation. Fish will be sorted and placed on ice until sampling is completed.
d. Following collection of all fish from the harvested vegetation, fish will be separated by species, then counted and weighed on a calibrated portable scale.
e. Any fish that cannot be identified onsite will be preserved in a 95:5 ethanol: water solution for offsite identification.
f. Data on fish by-catch (number/hectare, weight/hectare) will be reported similar to previously published work.

QA/QC. The accuracy or precision of collecting fish from the harvested hydrilla will be checked using a blind test; 10 to 20 marked fathead minnows (tails notched) will be secretly and randomly placed in the harvested load while the load is on the truck or offloaded to the sorting area. Fathead minnows were chosen for this test because they are easy to acquire native fish used for bait and are not a fish species that will be problematic to introduce into the sample.

Appendix 9: Standard Operating Procedures (SOP) for Water Quality- Secchi Disk

1. Use in shallow water to measure the turbidity or degree of visibility of the water.
2. Calibrate the line by marking every foot.
3. Without wearing sunglasses (prescription glasses are okay), lower the disk into the water on the shady side of the boat until the disc vanishes from sight. Raise and lower the disc a few inches to determine the vanishing point. Clip a clothespin on the rope at the waterline. Check how much cloud cover there is over the sun.
4. Haul the disc and count the rope markings to read how many feet under water the disc was when it vanished from view (from the disc to the clothespin). Round to the nearest ¼ foot.
5. Record the Secchi reading and the cloud cover on the data sheet.
6. If the disc is visible on the bottom, or disappears in the weeds, record this on the data sheet.

Appendix 10.
Field Sampling Quality Manual (SFWMD-FIELD-QM-001-06) Effective Date: 01/08/10
(See attachment)

Appendix 11.
Standard Operating Procedures for Horizon Field Data Manager (HFDM) and Documentation
(SFWMD-Field-SOP-018-02)
(See attachment)