

**A Study of the Use of
Harpoon Liquid and Granular Formulations and Adjuvant Combinations
For the Management of Nuisance Wild Celery Populations
In Lake Ogemaw, Ogemaw County, MI**

Prepared by

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Strategy Narrative:

Lake Ogemaw has been plagued by extremely herbicide tolerant water celery (*Vallisneria americana* Michaux.) for more than a decade. Routine field observations suggest that the mechanism of herbicide tolerance in Lake Ogemaw is tied to the persistence of root crowns that may be afforded protection by a complex awfuchs community. Cutrine Ultra has been found to lower these defenses in milfoil populations that have been treated with diquat dibromide. Wild celery may be particularly well suited to the adoption of this herbicide tolerance strategy because the root crown and meristematic tissue is concentrated at the base of the plant. Sediment bacterial communities are known to have the ability to catabolize some aquatic herbicides and the concentrations of these microbes may be greater near the basal root crowns and meristems of wild celery populations and thereby provide more protection from aquatic herbicides than might be provided to other aquatic plant species that do not have similar morphologies. If awfuchs communities do provide this kind of protection to wild celery, then control can only be achieved when the concentration of the herbicide is increased or the awfuchs community impact is neutralized.

This study is intended to test the hypothesis that Harpoon Granular will sink lower into the water column than traditional liquid formulations and provide better wild celery control by increasing the effective concentration of herbicide in closer proximity to the root crowns and meristems. The study will also test the hypothesis that Cutrine Ultra can be used to enhance the activity of both the liquid and granular formulations of harpoon and achieve the desired outcomes.

Strategy Events Overview:

EVENT	DESCRIPTION
02 August 2011 Pre Treatment LakeScan Vegetation Survey and Awfuchs Community Assay Collections:	The macrophytic submersed aquatic vegetation community will be surveyed according to LakeScan™ standard protocols. Plant samples will be collected for awfuchs community analysis by Dr. Jerry Sanders. Plant community shall be photographed.
04 August 2011 Herbicide Treatment:	Application of all treatments and treatment combos.
Post Treatment Awfuchs Community Assay Collections	Plant samples collected for awfuchs community analysis four hours post treatment. Samples collected from all treatment areas and control areas.
27 August 2011 Post Treatment Awfuchs Recovery Community Assay Collections	Plant samples collected for awfuchs community analysis from any plants that appear to be recovering in any of the treatment areas. The control areas shall also be sampled at this time. Plants shall be digitally photographed if there are visual differences observed in the various plant groupings.
06 September 2011 Post Treatment LakeScan Vegetation	Post treatment analysis and assessment of recovery communities.

Strategy Summary Overview:

STRATEGY SUMMARY AND OVERVIEW	DESCRIPTION/PARTICIPANT
Total Gallons Harpoon Liquid:	Specified by Bill Ratajczyk
Total Pounds Harpoon Granular	Specified by Bill Ratajczyk
Total Gallons Cutrine Ultra:	Specified by Bill Ratajczyk
Total Plant Samples for Awfuchs Analysis:	3 samples from each of 8 treatment areas and 4 control zones, 2 events, 72 total samples.
Time of Application:	Approximately third week of July, 2011.
Management Authority:	Lake Ogemaw Lake Improvement Board.
Evaluation Oversight:	Aquest Corporation, Flint, MI.
Commercial Applicator:	Aquatic Services Inc., Goodrich, MI.

Study Principals:

Mr. Jeff Knox	Aquatic Services	Goodrich, MI	810-636-3303	jlknox@centurytel.net
Dr. Douglas Pullman	Aquest Corp.	Flint, MI	810-237-8893	aquest@mac.com
Dr. Jerry Sanders	UM - Flint	Flint, MI	810-762-3041	dsander@umflint.edu

Desired Benefits and Outcomes:

Direct Benefits

1. Test the hypothesis that extremely herbicide tolerant wild celery can be more effectively controlled with Harpoon granular + Cutrine Ultra when protective awfuchs communities are suppressed through the application Cutrine Ultra. The efficacy of this treatment shall be compared to treatments made with Harpoon liquid and the liquid and granular formulations made without Cutrine Ultra.
2. Evaluate the selectivity of the treatment based upon comparisons of "Test" and "Control" areas.

Indirect Benefits

1. Collect observations of impact of the Harpoon formulations and herbicide/Citrine Ultra combinations on non-target plant populations.
2. Gain a better understanding of the character of awfuchs communities on wild celery and an understanding of the role of these communities on the conference of herbicide tolerance.

Morphometric Data:

Lake Size:		555 Acres
Shore to 10' Depth Contour		396 Acres
Treatment Area 1	Harpoon Granular + Cutrine Ultra	10 Acres
Treatment Area 2	Harpoon Granular	10 Acres
Treatment Area 3	Harpoon Granular + Cutrine Ultra	12.5 Acres
Treatment Area 4	Harpoon Granular	27 Acres

Morphometric Description:

Deep Holes:

Lake Ogemaw is a very shallow reservoir with areas that are deep, but could not be characterized as deep holes.

Littoral Zone:

More than 70% of Lake Ogemaw is 10' deep or shallower. Rooted plant growth extends to approximately 12' deep and non-vascular macrophytes (mosses and charophytes) can be found in water depths ranging to 20'. The Lake Ogemaw littoral zone soils are highly variable. Sediments range from infertile, inorganic sands to loosely consolidated organic mucks.

Biological Characterization:

Lake Ogemaw has been one of the beneficiaries of the LakeScan Monitoring and Analysis program. Extensive data and analysis are provided with the attached annual report.

Plant Communities:

Lake Ogemaw became totally dominated by Eurasian water milfoil (EWM) in the early 1990's. Despite the severity of the infestation, the lake has always supported a large number of plant species and species richness has run as high as 27 species in some years.

Milfoil continues to be a primary nuisance in Lake Ogemaw but has been effectively controlled for more than a decade and lake users are probably not aware of how great a problem milfoil continues to be in the lake. It appears that most of the milfoil that currently found in the lake is a hybrid genotype and it appears to be fairly tolerant of a variety of herbicides and herbicide mixtures. A combination of herbicides was developed in 2005 that has provided effective and reliable control of milfoil in the shallow areas of the lake. State regulations prohibit the use of this combination in the deeper parts of the lake so 2,4-D has been used to suppress water milfoil in areas of the lake that are greater than 5' deep. This strategy has narrowly provided control of the water milfoil in these areas in some years and the emergence of increasingly herbicide tolerant water milfoil continues to be a serious concern.

Wild celery has been a conspicuous and pernicious nuisance in Lake Ogemaw, in the mid to late summer, for over a decade. Every year, most lake users and riparians consider wild celery to be the greatest plant nuisance in the lake. It is found in nearly all areas of the lake that are no deeper than 12' and presents an impediment to boating and recreation in areas ranging from 2' deep to approximately 8' deep, depth tiers 3 and 4. There are no, known, and reliable methods or strategies available for the control of wild celery. Many different control strategies have been concocted and applied to the lake for more than a decade. The outcome of these attempts has variable and generally unsatisfactory. The wild celery control trials that have been used on Lake Ogemaw have always represented the leading edge of control technology and whenever a new strategy, herbicide combination, or approach has been made available by industry

and regulators, these have been applied to the situation in Lake Ogemaw. This study represents a continued effort to utilize any and all strategies that may effectively provide control of wild celery. The products that will be used are new or relatively new formulations that have recently entered the market place. However, the active ingredients in these formulations have been in the market place for decades. It is believed that the new formulations will prove to be more effective for the management of nuisance wild celery populations.

Starry Stonewort was present in a few acres near the boat launch in 2006. It is sensitive to the combination of herbicides that has been used for water milfoil control and has apparently been eliminated from the lake. This plant can be a very significant nuisance and efforts are continuing to locate any new infestations.

An exotic moss that is a popular aquarium plant was found throughout Lake Ogemaw. It has not been considered to be a nuisance; however, it may be having a significant impact on ecosystem functions if it is suppressing the production of other plant species. This is being closely monitored. This is the only known infestation of this type in Michigan. It appears to be able to outcompete Chara and may be partly responsible for the elimination of starry stonewort from the lake flora.

Cultural Considerations:

Cultural Uses:

Lake Ogemaw is a “multi-use” lake. Lake use could be referred to as “moderate” compared to other lakes in the area. It is used for: Boating, Swimming, Fishing, PCW’s, Wild Life Production, and lawn irrigation. No single lake use is dominant. There is one commercial boat launch and a property owners launch site. There are no boating restrictions on the lake.

Watershed Considerations:

The shoreline of Lake Ogemaw has nearly been entirely developed. There is a small amount commercial use. Most of the homes that surround the lake appear to be “year round” homes. A few seasonal residences (<10%) appear to remain on the lake.

Water Treatment and Supply:

The residences located on Lake Ogemaw are not serviced by a central sanitary sewer collection system or potable water distribution system. Such service may become available in the next five to 10 years.

Lake Management:

Management History:

The aquatic vegetation management program in Lake Ogemaw is among the leading programs in Michigan. It has been the primary test site for innovative ways to manage herbicide tolerance in water milfoil populations and for a long list of proposed strategies for the suppression of nuisance wild celery populations.

Management Problems and Goals:

The primary goal of Lake Ogemaw Management Plan is to modify conditions within the lake to enhance species and habitat diversity and thereby stabilize the ecosystem by promoting the production of conservative species and inhibiting the production of those plants that are weedy or more opportunistic. The attainment of this goal is expected to support conditions that will make Lake Ogemaw more resilient to the rapid proliferation and domination of the aquatic ecosystem by invasive nuisance species. Success will also enhance recreational opportunities, including the fishery and the cultural utility of the resource.

Any applied management strategy will focus on mitigating against the effects of cultural disturbance and be applied in a manner to minimize further disturbance of the ecosystem.

Accepted: 2007

Proximal Management Goals

Nuisance Plant Production Management: The primary goal of the vegetation management plan is to mitigate against cultural and natural disturbances by modifying the quality of the Lake Ogemaw flora through the prescriptive use of selective plant management agents and strategies. Eurasian water milfoil has been a serious nuisance plant in the recent past and is expected to be a primary nuisance in the lake in 2011. Selective plant management agents are used to suppress the production of opportunistic and invasive species that are prone to form monocultures and suppress the production of preferred, conservative plant species. The effort to suppress nuisance water milfoil populations has been very successful in recent years and these strategies shall be used in 2011. Curly leaf pondweed and weedy pondweed hybrids have also been a serious nuisance in Lake Ogemaw for many years. The combinations of herbicides that are used to suppress nuisance water milfoil populations in Lake Ogemaw are also effective for the complete suppression of curly leaf pondweed. These herbicide combinations do not eliminate the weedy pondweed from the lake but they do suppress these populations to levels where they are not considered to be a nuisance.

Considered Management Options:

Doing Nothing: Historical data strongly suggest that the water milfoil genotypes found in Lake Ogemaw, curly leaf pondweed, weedy pondweed genotypes, and wild celery will extirpate most other submersed plant species unless suppressive strategies are applied to the lake. Failure to suppress any of these species in Lake Ogemaw will result in the loss of ecosystem stability, biodiversity, recreational and aesthetic attributes.

Mechanical Harvesting: There is abundant evidence that the use of mechanical harvesting will cause a shift in species dominance from more desirable native plant species to some of the weedy species in the lake. It is particularly ineffective for wild celery management because it is so difficult to harvest the cut plants from the lake. The use of this management strategy is contraindicated for use in Lake Ogemaw at this time.

Biological Controls: There are no available biocontrols for any of the nuisance species found in Lake Ogemaw that have been confirmed to work as effectively as effective control agents by any independent, peer reviewed analysis.

Herbicides and Herbicide Mixtures: Herbicides and herbicide mixtures have been proven in practice to provide reasonably selective and very effective control of all of the nuisance species in Lake Ogemaw, except wild celery, after nearly 30 years of continuous use in Michigan. Unlike most biocontrols, there are no residual impacts associated with herbicide use. The use of herbicide mixtures is strongly indicated for use in Lake Ogemaw because they can be used to target invasive species and preserve other desirable species and ecosystem functions. There are no other management strategies that can provide these benefits.

Management Decision Making:

The Lake Ogemaw Summer Resort Association (LOSRA) is the management authority for Lake Ogemaw. The LOSRA publishes newsletters and holds frequent meetings every year. The Lake Management Program is presented annually to a LOSRA membership meeting.

Management Authority Contact Person:

Mr. Ernie Simas, Chairperson, Lake Improvement Committee, (989) 873-1204, esimasjr@gmail.com

Proposed Harpoon Application Vegetation Management Plan:

Herbicide Application Strategy:

Harpoon Granular:	Specified by Bill Ratajczyk
Harpoon Liquid:	Specified by Bill Ratajczyk
Citrine Ultra:	Specified by Bill Ratajczyk
Application Pattern:	The Lake has been subdivided into four separate treatment areas. The rest of the lake, that receives no treatment, shall serve as a control sampling area. The control sampling zones shall be determined prior to the first herbicide application and with the agreement of Mr. Ernie Simas, LOSRA representative and Lake Ogemaw Lake Manager.

Photographic Documentation of Impacts:

Photographs shall be taken of the impact of the proposed treatments approximately 2 and 8 weeks post treatment. Other species shall also be photographed if any collateral impacts are observed.

Biological Community Monitoring and Analysis:

LakeScan analysis shall be used to monitor the impacts of the proposed treatment in treatment and control areas as has been done since 2006 (see attached). These data and the photographic record shall be used to monitor and evaluate the impact of the various treatment formulations and combinations. Three LakeScan analyses shall be performed on the entire lake to analyze the impacts and outcomes associated with each treatment and treatment combination. A final, 2011 LakeScan analysis shall be performed at the end of the normal growing season (September/October).

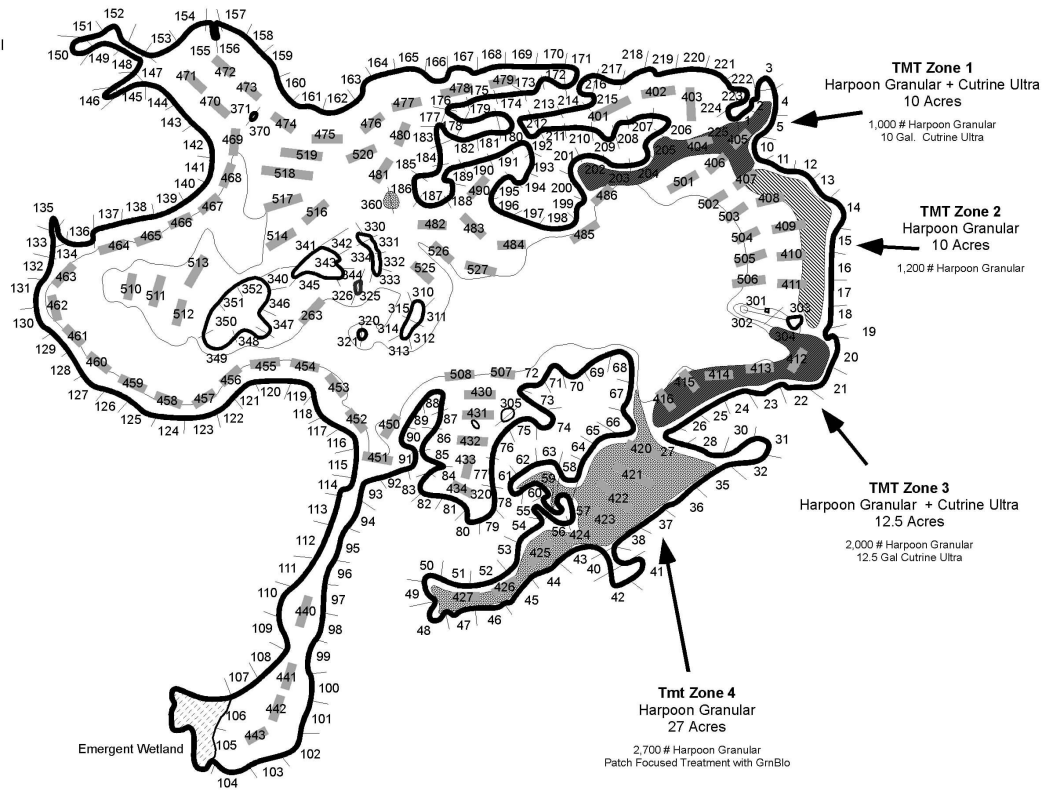
Wild celery from treatment and control areas shall be “swabbed” and the awfuchs community shall be analyzed under the supervision of Dr. Jerry Sanders, UM - Flint.

Proposed Budget:

Qty.	Item	Service Provider	Cost Per Item	Total Cost
1	Harpoon Granular/Cutrine Ultra Application (July)	LOSRA and Aquatic Services	\$100 per acre	\$5,350
1	Harpoon Granular	Applied Bio	2,900 lbs	
1	Cutrine Ultra	Applied Bio	22.5 gallons	
	LakeScan Field Data Collection	Aquest		\$2,896
3	Awfuchs Community Analysis Direct Costs	UM Flint	\$948	\$2,844
96	Awfuchs Community Analysis Indirect Costs	UM Flint		\$3,410
	Data Analysis and Communications	UM Flint		\$2,050
10	Data and Document Preparation	Aquest	\$180	\$1,800
	TOTAL STUDY COSTS		\$95	\$18,350
	LOSRA Share of Cost			(\$5,350)
	Applied Biochemist Share of Cost			(\$13,000)
	Herbicides/Algaecides			

Lake Ogemaw Harpoon Granular/Wild Celery Control Testing Zones

Control Zones
 Nearly all areas less than 10' deep support nuisance celery growth and may serve as control sampling zones



Appendix 1. Draft Copy of Narrative to be Sent to U of M – Flint Research for Necessary Approvals.

Evaluation of the Awfuchs Community Associated with Water Celery Populations in Lake Ogemaw, Ogemaw County, MI

Water celery, *Vallisneria americana* (*V. americana*) or tape grass is has been a conspicuous and pernicious nuisance in Lake Ogemaw, in the mid to late summer, for over a decade. Every year, most lake users and riparians consider wild celery to be the greatest plant nuisance in the lake. It is found in nearly all areas of the lake that are no deeper than 12' and presents an impediment to boating and recreation in areas ranging from 2' deep to approximately 8' deep, depth tiers 3 and 4. There are no, known, and reliable methods or strategies available for the control of wild celery. Many different control strategies have been concocted and applied to the lake for more than a decade. The outcome of these attempts has variable and generally unsatisfactory. The wild celery control trials that have been used on Lake Ogemaw have always represented the leading edge of control technology and whenever a new strategy, herbicide combination, or approach has been made available by industry and regulators, these have been applied to the situation in Lake Ogemaw. This study represents a continued effort to utilize any and all strategies that may effectively provide control of wild celery. The products that will be used are new or relatively new formulations that have recently entered the market place. However, the active ingredients in these formulations have been in the market place for decades. It is believed that the new formulations will prove to be more effective for the management of nuisance wild celery populations. Previous research with Eurasian Water Milfoil has identified microorganisms that are capable of degrading herbicides applied approaches to control invasive aquatic plants suggests that co-application of approved antimicrobial agents has increased effectiveness of the herbicide. This proposed study intends to evaluate the contribution of the awfuchs community to resistance of *V. americana* to herbicide control as well as providing a data to support a best practices for control strategy.

In conjunction with ongoing management practices we propose to evaluate the impact of the awfuchs community on control of *V. americana* in Lake Ogemaw. The questions that this study intends to address are: 1) Are there culturable microorganisms associated with these communities that can degrade or inhibit herbicides? 2) What is the best modality for delivery of the herbicide to avoid awfuchs interference? 3) Determine if specific microbial genera be identified that are contributing to herbicide resistance? 4) For herbicide resistance isolates of *V. americana* within treatment zones screen, they will be screened for the presence of microorganisms that can degrade the herbicide and are resistant to antimicrobial copper compounds.

To accomplish we propose taking three samples of the awfuchs community associated with *V. americana* from eight treatment zones and from four control zones prior to treatment. The awfuchs layer will be extracted and aliquots will be plated on selective and differential media to aide in the identification of the bacterial genera contributing to the layer. Unique isolates based on colony morphology and biochemical characteristics will be patched on minimal media containing the herbicide (Harpoon) as a carbon source. Isolates that can use Harpoon as a carbon source (degrade it) will be selected for identification using molecular techniques. Isolates will also be tested for sensitivity to Cutrine Ultra.

A similar procedure will be conducted for post herbicide treatment with three samples of the awfuchs community associated with *V. americana* from eight treatment zones and from four control zones being processed as described above. Comparing the microbial community within the awfuchs pretreatment with post treatment communities will provide an indicator for the role of the microorganism in herbicide resistance. If resistant *V. americana* are identified within an essentially successful treatment zone, the awfuchs community associated with the resistant plants will also be characterized.

The proposed time line is:

02 August 2011: Collect pretreatment samples.

04 August 2011

and

06 September 2011: Collect post treatment community recovery samples