Research and Development Efforts for Improved Submersed Aquatic Vegetation Control

Most innovation in aquatic plant management using chemical control in recent years has been the result in development of new herbicide compounds or formulations designed to offer managers and applicators greater flexibility in targeting nuisance species. Commercially available technological advances, in terms of online aerial imagery, GIS software, and GPS equipment, provided a tremendous breakthrough in the 1990's to precisely define area and position important to planning and implementing field control programs. Application equipment continued to be adapted from the agricultural pest control sector for targeting emergent, floating and submersed species. This adapted equipment, and the vessels that carry them, have been well suited for implementing surface applications of liquid herbicides to emergent or floating plants, but has not performed as well for submersed aquatic plant control, especially at larger scales. Granular herbicides were developed to overcome this application challenge, but due to the relatively low percentage of active ingredient in most granular products, their cost when compared to liquid herbicides and the requirements associated with handling 50 lbs bags, granular formulations are generally more expensive on a per acre basis. Clean Lakes, Inc. responded to the challenge to review how liquid applications could be improved. The steps taken and results achieved are outlined below.

The LittLine® was developed to meet the requirement of the Idaho Department of Agriculture to treat approximately 2,000 acres of Eurasian Watermilfoil with liquid aquatic herbicides during the summer of 2008, and was based on the concepts discussed in the winter 2007 *Aquatics* Magazine article, "How to Build Weighted Trailing Hoses"[i]. As outlined in the article, the main goal of the trailing hose concept is to place the aquatic pesticides in the lower portion of the water column to increase control efficacy. This philosophy explains why granular versions of several products have been developed to facilitate placement of herbicide directly in target weed beds. Per the article, conventional trailing hose systems "... must go slowly to keep the hoses on the bottom…, must avoid tight corners or the long hoses will collect lots of weeds, and the operator is required to pull on the hoses every couple of minutes to shake loose any clinging weeds". The LittLine® system was developed to overcome the problems associated with conventional trailing hose systems, and was designed to operate at higher speeds (+-5 mph compared to 1-2 mph), make tight corners and turns without collecting weeds, and meet the tangle and weed free system requirements, all of which resulted in increased operational efficiencies while reducing aquatic pesticide and application costs.

The LittLine® has undergone extensive testing on various demonstration and research projects with the US Army Corps of Engineers Environmental Research and Development Center (2008 through 2010), the Phelps Lake District in Northern Wisconsin under a Wisconsin Department of Natural Resources Grant (2010), the City of Orlando, Florida (2010), and the US Army Corps of Engineers, Mobile District (2010). The LittLine® has been used to control Hydrilla in Florida and Georgia (+-25% aquatic herbicide reduction, Lake Underhill FL), and Eurasian Watermilfoil in California, Idaho, Montana and Wisconsin (up to 50% aquatic herbicide reduction, Lake Pend Oreille). As outlined below, research efforts have focused on aquatic pesticide applications in lake and run of the river systems.

Research Conducted 2008:

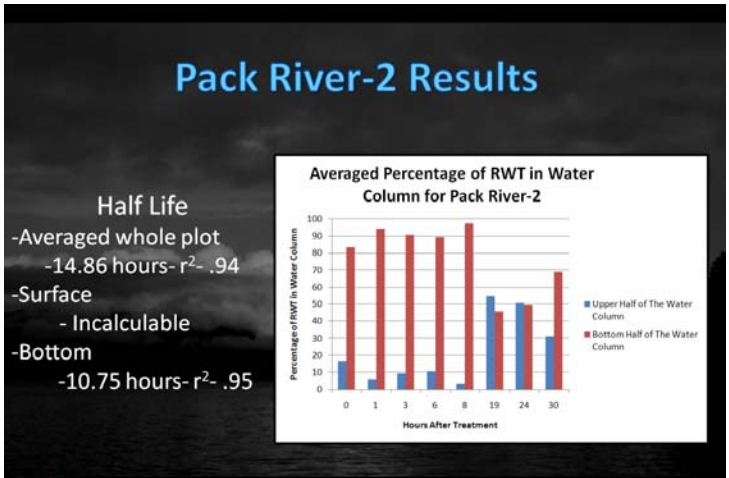
"Lake Pend Oreille Water Exchange Evaluations" (2008-Idaho): US Army Corps of Engineers Environmental Research and Development Center/Aquatic Ecosystem Restoration and Foundation Special Project CY/UP/AB-08-1. In collaboration with the Aquatic Ecosystem Restoration Foundation (AERF) and CLI, Water Exchange Evaluations using Rhodamine RWT dye were carried out by the US Army Corps of Engineers,

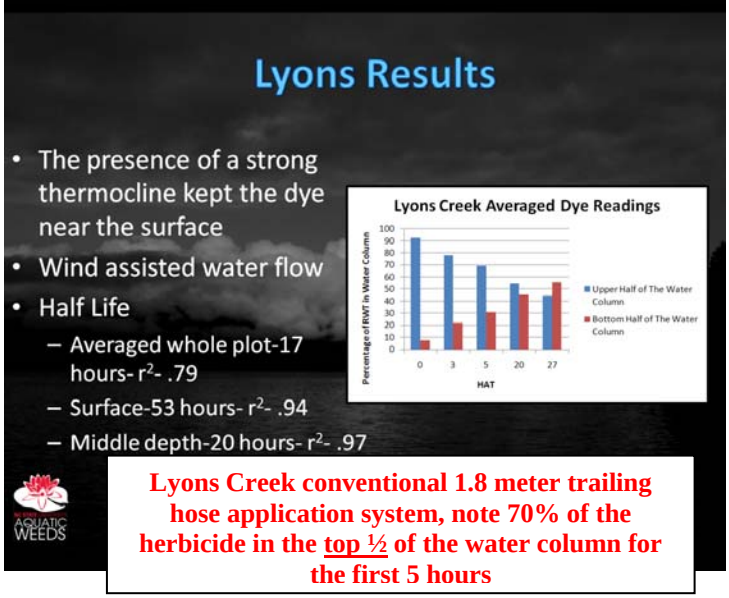
Environmental Research and Development Center (ERDC), on the Pend Oreille Project during the summer of 2008, and observations showed that the LittLine® was able to make herbicide applications at desired depths throughout the water column. Through a Pre and Post Treatment Point Intercept survey by Mississippi State University (MSU) scientists in 2008, in Pack River treatment sites of Lake Pend Oreille, control was rated at 92% with little to no impact to native plant community as outlined in

the report, **"Aquatic Plant Community and Eurasian watermilfoil (*Myriophyllum spicatum* L.) Management Assessment in Lake Pend Oreille, Idaho for 2008"[ii] .** In the Pack River area, liquid triclopyr treatments were performed using the LittLine® system where only the bottom half (1/2) of the water column was treated, using 50% less aquatic herbicides than would have been required through conventional liquid surface applications (2,028 gallons vs. 4,120 gallons). In the cited report, control was rated at 92% (Pack River EWM presence pre treatment at 39 points, EWM presence post treatment at 3 points). Based on this level of efficacy, the LittLine® demonstrated the ability to reduce aquatic herbicide use by up to 50%, while increasing Eurasian watermilfoil control efficacy up to 92%. The use of liquid triclopyr in the Pack River sites (312 acres) resulted in a herbicide cost saving of $111,517.73 when compared to the use of granular triclopyr treating the same bottom half (1/2) of the water column at 1.75-2.00 ppm (2,028 gallons of liquid triclopyr used @ $43.50 per gallon, compared to 61,457.00 pounds of granular triclopyr @ $3.25 per pound).

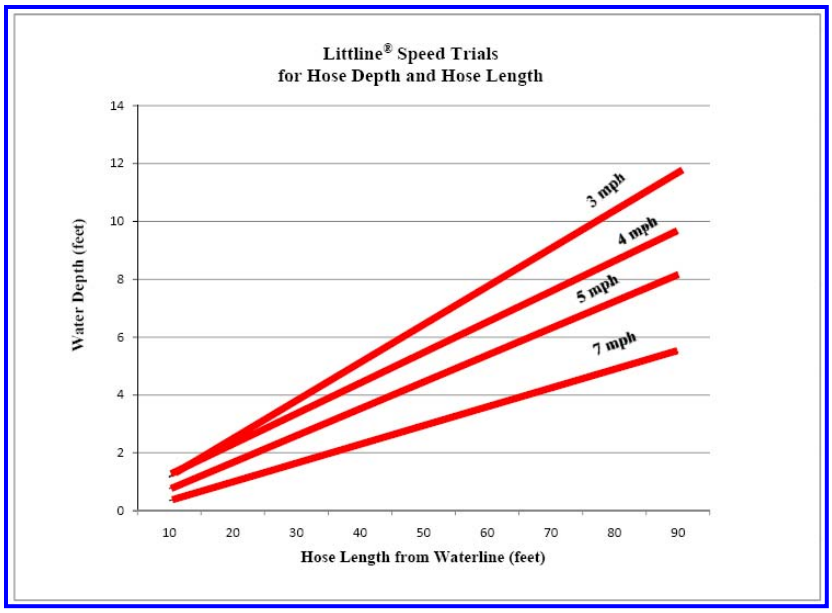
Available in the report titled, **"The Evaluation of Two Herbicide Application Methods (Justin J Nawrocki[1], Kurt D. Getsinger[2], Robert J. Richardson[1.] [1]North Carolina State University, Raleigh, North Carolina [2]U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi)"**, the charts below outline the major differences between the LittLine® technology, and conventional trailing hose application methods. As the data clearly illustrates, LittLine® is

capable of placing aquatic herbicides in aquatic plant beds in the lower portion of the water column, resulting in a higher concentration and exposure time (CET) relationship in the lower portion of the water column, which provides increased efficacy with a reduction in the amount of herbicides used when compared to conventional trailing hose application systems.





Speed Depth Chart (Performance) Data*



*Trials performed in Lake Coeur d'Alene, September 8, 2009, independent third party Hose depth data collected by Jim Flodin, Divers West, CDA Idaho.

Research Conducted 2009:

Eurasian Watermilfoil/Curlyleaf Pondweed Research Project on Noxon Rapids Reservoir, Montana, Demonstrations and Evaluations (2009): In collaboration with the Aquatic Ecosystem Restoration Foundation (AERF), the Sanders County Extension, and the Montana Department of Agriculture (under partial funding from the Montana Weed Trust), Clean Lakes, Inc. participated as a Research Cooperator with the U. S. Army Engineers Research and Development Center (ERDC) and Mississippi State University, Geosystems Research Institute on the **2009 Eurasian Watermilfoil/Curlyleaf Pondweed Research Project**[iii]. The LittLine® was used for Rhodamine (RWT) dye applications for water exchange evaluations, as well as for aquatic herbicide treatments.

Research Conducted 2010:

Selective Control of Eurasian Watermilfoil and Curlyleaf Pondweed on Noxon Rapids Reservoir, Montana: Demonstrations and Evaluations, Phase 2 (2010): The U. S. Army Corps of Engineer Research and Development Center (ERDC), Chemical Control and Physiological Processes Team (Dr. Kurt Getsinger) led the Research Cooperators in conducting water exchange evaluations and aquatic herbicide trials using the LittLine® for controlling mixed stands of Eurasian watermilfoil (EWM) and curlyleaf pondweed (CLP) in selected locations in Noxon Rapid Reservoirs, Montana. Pre and Post Treatment Aquatic Vegetation surveys were performed by Dr. John Madsen's research team from Mississippi State University, Geosystems Research Institute (MSU-GRI).

On August 24, 2010 USCOE personnel from across the US visited Noxon Reservoir and were briefed on ERDC's EWM Research & Development efforts (3-year project), and on a separate Corps of Engineers American Recovery and Reinvest Act (ARRA) funded project, both of which were demonstrating and evaluating the selective use of herbicides to control the invasive aquatic vegetation Eurasian watermilfoil and curlyleaf pondweed. Following the briefing, the group boarded pontoon boats and toured the treatment sites.

Hydrilla Control Evaluation, Lake Underhill, City of Orlando Florida (March 2010): Clarke and Clean Lakes, Inc. (Clarke/CLI), working in conjunction with the City of Orlando, Public Works, Lakes/Surface Water Management Division, performed an aquatic herbicide application to 18.26 acres of Lake Underhill, City of Orlando Florida on March 17, 2010. The treatment was performed to evaluate the potential benefits of utilizing the LittLine® Littoral Zone Treatment Technology for the control of the aquatic invasive plant Hydrilla. Utilizing the LittLine® Technology, the bottom five (5) acre foot of the 18.26 acre site was treated at the rate of 1.34 ppm in the entire water column, which required 110 gallons of Aquathol K, an approximate 23 percent reduction (110 gallons compared to 144 gallons) in the amount of herbicide used compared to the standard treatment rate. Six weeks post treatment, Hydrilla had dropped out of the water column, and the native species Vallisneria was flowering. Under standard operating procedures, City of Orlando staff treated approximately 20 acres of Hydrilla in the northern portion of Lake Underhill at the rate of 1.75 parts per million (ppm), and post treatment observations (John Evertsen, City of Orlando personal communication) revealed that both treatments provided similar results and efficacy for the control of Hydrilla in Lake Underhill. Through the use of the LittLine technology for this application, the aquatic herbicide costs were reduced by $125.68 per acre.

Long Lake of Phelps Lake District, Wisconsin, Eurasian Watermilfoil Control Program (May 2010): On May 24th and 25th, 2010, the LittLine® was utilized for the application of liquid 2,4-D to 142 acres on Long Lake for the control of Eurasian Watermilfoil (EWM). Due to the use of the LittLine® application system for the first time in Wisconsin, and the use of liquid 2,4-D in place of the previously used granular formulation, Long Lake was one of a number of lakes selected for herbicide residual monitoring. Water sampling was conducted by both the Engineer Research and Development Center (ERDC), a division of the Army Corps of Engineers, and by a Long Lake volunteer from sites located both within and outside of herbicide application areas. The goal of the herbicide treatment was to maximize target species (EWM) mortality while minimizing impacts to valuable native aquatic plant species. Monitoring herbicide treatments and defining their success incorporates both quantitative and qualitative methods. As the name suggests, quantitative monitoring involves comparing number data (or quantities) such as plant frequency of occurrence before and after

the control strategy is implemented. Qualitative monitoring is completed by comparing slightly more subjective data such as EWM colony density ratings before and after the treatments. Quantitative evaluation methodologies followed Wisconsin Department of Natural Resources (WDNR) protocols in which point-intercept data was collected within treatment areas both the summer before and the summer immediately following the treatments taking place. On Long Lake, a quantitative evaluation was made through the collection of data at 287 point-intercept sub-sample locations all located within the areas where herbicides were directly applied. On a lake-wide level, 80% of the treatment areas on Long Lake were reduced by at least one density rating, exceeding the WDNR qualitative success criteria (75% reduction) for the 2010 treatment. In 2009, there were approximately 53 acres of EWM that were classified as highly dominant, and in 2010 this was reduced to approximately 21 acres following treatment. EWM surfacing matting was not observed anywhere within the lake in 2010, although it must be noted that water levels increased by approximately 1 foot over the course of the summer (Dan Anderson personal comm.). While reductions in EWM density were observed in the majority of the treatment areas, it was most apparent in the southern, shallow portion of the lake. Prior to treatment, this area had large colonies of highly dominant EWM surrounded by scattered EWM. Many of the highly dominant colonies were reduced in density while no EWM was observed in the highly scattered areas. During the summer of 2009, 52% of the 287 point-intercept sampling locations contained EWM compared to 20% following the 2010 treatment, demonstrating a statistically valid 60% reduction in EWM occurrence within the 2010 treatment areas and meeting the lake-wide quantitative success criteria (50% reduction in occurrence)[iv]. Through the use of liquid 2,4-D and the Littline®, aquatic herbicide costs for the project were reduced by $52,133.00, or $367.13 per acre (liquid costs compared to granular formulation costs).

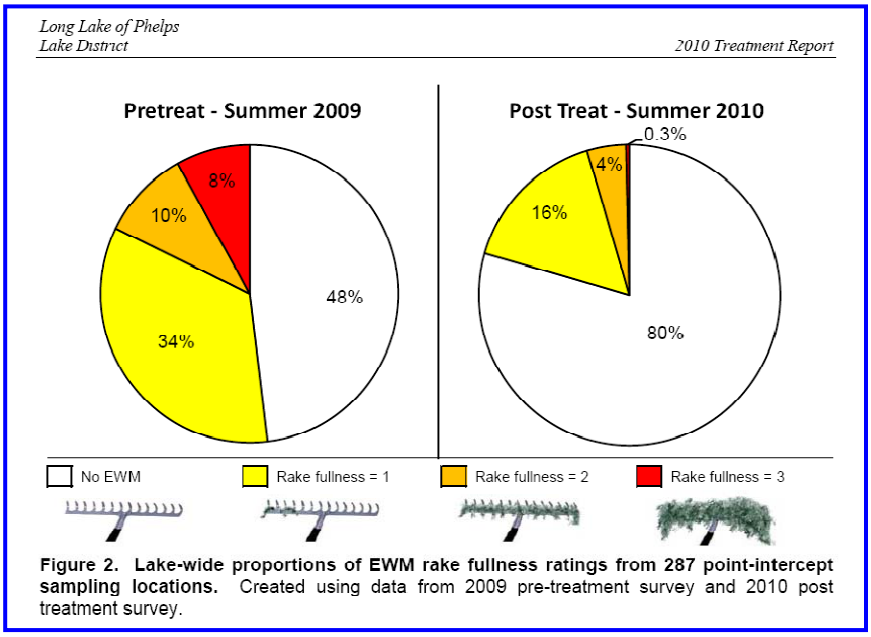


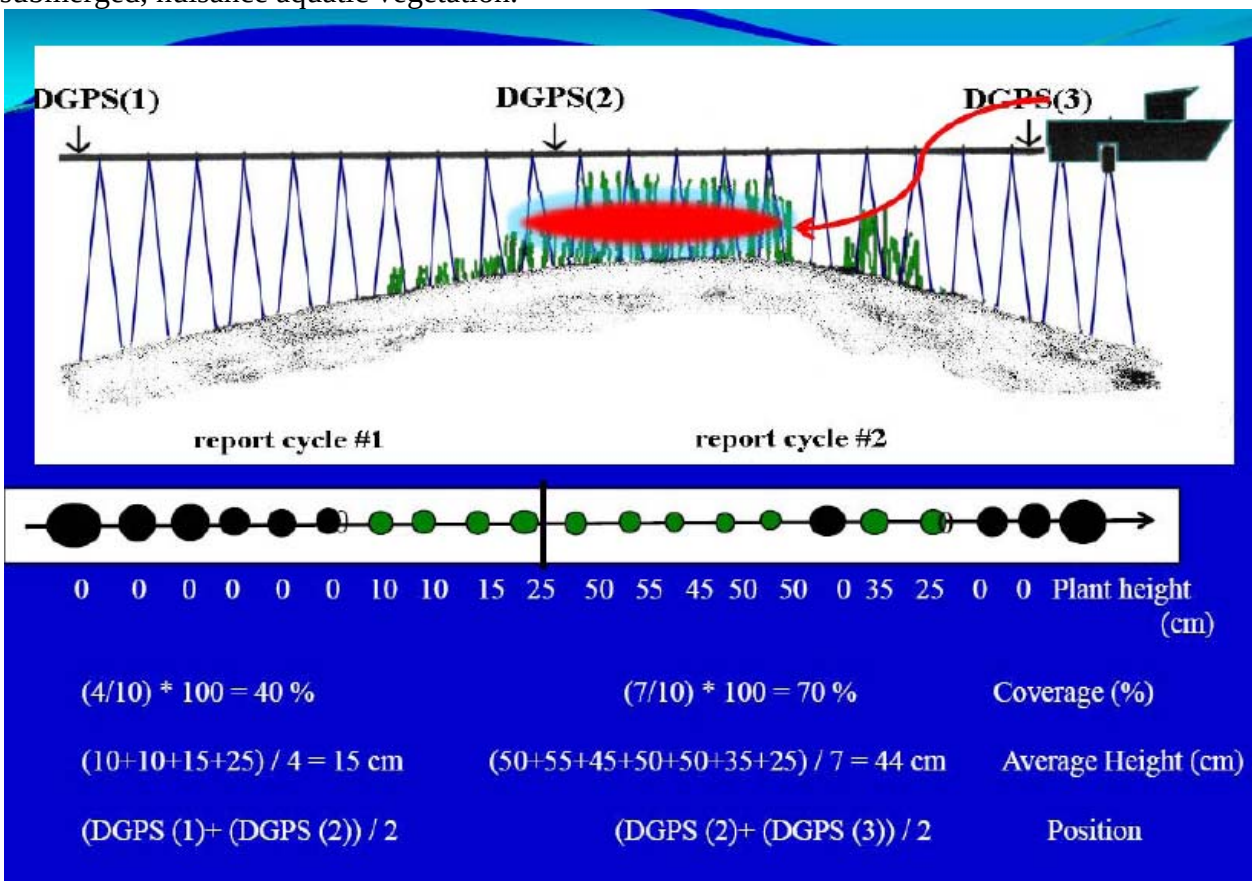
Figure 2. Lake-wide proportions of EWM rake fullness ratings from 287 point-intercept sampling locations. Created using data from 2009 pre-treatment survey and 2010 post treatment survey.

<u>Hydrilla Control Evaluation, Lake Seminole, Georgia (December 2010):</u> Working in conjunction with the US Army Corps of Engineers, Mobile District, the LittLine® performed an aquatic herbicide application to a 9.5 acre site located in the Sealy Point area of Lake Seminole on December 9, 2010. The treatment was performed to evaluate the potential benefits of utilizing the LittLine® technology for the control of the aquatic invasive plant Hydrilla in an area where

control efficacy has been difficult to achieve due to water exchange characteristics. The LittLine® system performed well and there were no instances of the lines getting tangled and or caught on stumps or underwater branches. Post treatment observations made on February 8, 2011 by CLI/Clarke and Corps staff (Brent Mortimer) revealed that Hydrilla had dropped from the water column and had decomposed in portions of the plot, while portions of the plot had not achieved total knockdown. A spring 2011 survey will reveal further data on control efficacy for comparison to current treatment protocols.

On Going Current Research Projects:

Cooperative Research and Development Agreement for the "Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides": On October 28, 2009, the US Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL), and Clean Lakes, Inc. entered into a Cooperative Research and Development Agreement for the "Research and Testing of a System for Precision Littoral Zone Application of Aquatic Herbicides". The Scope of the Cooperative Research and Development Program is to provide for the joint conduct of research and development investigations related to coupling the LittLine® ® System (Littoral Zone Treatment Technology) with ERDC-EL Hydroacoustic Submersed Plant Mapping capabilities (SAVEWS™ and related developments). It is envisioned that these two technologies will be used together to achieve precision application of herbicides to submerged, nuisance aquatic vegetation.



LittLine® Benefits: Research and Development efforts as outlined above have shown that the LittLine® system can reduce aquatic pesticide usage while increasing control efficacy when compared to conventional treatment methods. The LittLine® permits aquatic pesticide applications to the most effective zone for species treatment, reduces overall treatment costs, meets or exceeds state and federal reporting requirements, and provides easily accessed, highly accurate application data for retrieval and reporting.

Clean Lakes, Inc. and its staff are dedicated to continued Research and Development activities associated with the review of application technologies that sill support our industry goals of reduced aquatic pesticide use and increased control efficacy.

A video describing a portion of the project, the process and the LittLine® technology in action can be viewed at http://www.littline.com/littlinevideos.html.

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[i] How to Build Weighted Trailing Hoses by Bill Haller(1), Lyn Gettys (1), Margaret Glenn(1) and Greg Reynolds(2) (1) University of Florida/IFAS Center for Aquatic and Invasive Plants – Gainesville, FL (2) Syngenta Professional Products – Greensboro, NC Aquatics, Winter 2007 / Vol. 20, No. 4

[ii] Aquatic Plant Community and Eurasian watermilfoil (*Myriophyllum spicatum* L.) Management Assessment in Lake Pend Oreille, Idaho for 2008: A Report to the Idaho State Department of Agriculture, John D. Madsen and Ryan M. Wersal, Mississippi State University, Geosystems Research Institute Report 5032 (http://www.littline.com/researchdevelopment.html)

[iii] Environmental Assessment – Eurasian Watermilfoil / Curlyleaf Pondweed Research Project (Tetra Tech) (http://www.littline.com/researchdevelopment.html)

[iv] Onterra LLC-Long Lake of Phelps Lake District 2010 Treatment Report http://www.llpld.org/Downloads/LongLake2010EWMTreatment.pdf