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*Re: A Proposed Strategy for Phosphorus Removal through Mechanical Harvesting of Invasive Aquatic Plants*

My name is Allen Stewart. I am a native Floridian and an avid kayaker and fishermen. I am also a graduate Biologist and Environmental Engineer, registered as a professional engineer in Florida (FL23577). I retired in 2012 after a nearly 40-year career in Florida specializing in water quality issues and in the design and operation of wastewater and water treatment facilities. During this career I spent much of my effort inventing, developing, designing, implementing and operating facilities which target the cultivation of aquatic plants for the removal and recovery of nutrients from wastewaters and impaired surface waters. This technology now is generally known as Managed Aquatic Plant Systems or MAPS.

Before I get into the details of how a MAPS approach has the potential to serve as a viable, cost effective technology for managing invasive aquatic plants in Florida's waterways, let me offer this disclaimer. Since my retirement I have remained active in the field of environmental management. Many of the services I now provide are done either *Pro bono*—for example as an instructor at Florida Gulf Coast University Renaissance Center in Punta Gorda—or at rates well below typical rates. I have served as an expert witness on occasion both on a *Pro bono* basis, and at the modest rate of \$50/hr. I am manager of a two-person engineering company called ASBRO LLC, which was established to accommodate administrative requirements for consulting work with Indian River County on their on-going MAPS programs. I also provide consulting services through ASBRO to my previous company HydroMentia LLC, on a project for the Maryland Port Authority on Chesapeake Bay. Work for Indian River County and for HydroMentia is not connected to the concept I am presenting today.

I have not been paid by anyone to prepare these comments or to promote this technology. I have no contractual arrangements which would reward me for securing acceptance of these ideas. I have several patents related to MAPS, but they are not active, and I would not receive nor am I seeking any royalties related to these patents. In fact, should FWC or others decide to pursue the ideas presented here today I would volunteer free professional services as requested, and as are within my capabilities and any legal restraints, in the planning, design assistance, and implementation of any programs which might emerge from the ideas presented here today. My only motivation comes from my life long relationship with Florida's unique ecology and the spectacular life it supports.

In 2017 I opened a website at [www.pasop.org](http://www.pasop.org) . (PASOP is an acronym for Peoples' Alliance Supporting our Obligation to Posterity). PASOP is not involved in raising funds or soliciting money, nor does it promote any political party or participate in political campaigning for any political party. It is strictly a science based "Think Tank" type organization. The PASOP Mission is to initiate and sustain serious, meaningful, open, and intellectually honest civil dialogue regarding the nature of our social, economic, political, moral, and legal obligations to ourselves and our posterity.

So now let's return to issues related to the MAPS technology. In a recent paper I described MAPS as follows:

*"Managed Aquatic Plant Systems (MAPS) represent a variant of typical agriculture, for the primary intent is not to maximize productivity of the targeted crop as with conventional agriculture, but rather to maximize reduction of pollutants from an impaired water source. In other words, MAPS operations do not involve adjustment of nutrient levels in the feed water to ensure high levels of crop production and quality, but rather involve adjustment of crop selection and operational strategies to ensure high rates of nutrient reduction from the raw feed water, such as a nutrient enriched, impaired surface water. With conventional agriculture the crop is the primary product, while with MAPS, enhanced habitat and water quality is the primary product. This approach represents a significant paradigm shift from the general acceptance of agriculture as a net pollutant contributor, to the reality that there are forms of agriculture that can offer substantial net pollutant removal and recovery."*

MAPS then is really a special type of agriculture. Because MAPS involves agricultural methods, it differs from the present use of non-harvested, passive wetlands, such as Stormwater Treatment Areas or STA's which do not require management through frequent periodic harvesting. Hence a MAPS facility is truly sustainable, while an STA has a finite life established by the rate of nutrient and organic sediment accumulation.

Because aquatic plants are typically very productive, especially in nutrient rich waters, frequent harvesting of MAPS facilities is required. This harvested crop can and has been used for a variety of products, including compost and potting soil, animal feeds, biogas production, propagation of native nursery plants, fiber products such as paper and even plastics, and in certain situations, as protein for human consumption.

The principal benefit of this high level of production associated with MAPS, is the delivery of very high rates of nutrient removal. For example, passive wetlands such as STA's or the City of Orlando's Easterly Treatment Wetland remove about 6-9 pounds of phosphorus per acre per year. MAPS systems such as Indian River County's 4-acre Egret Marsh Algal Turf Scrubber™ removes phosphorus at the rate of about 155 pounds of phosphorus per acre per a year. As another example, a MAPS system using 2 acres of Water Hyacinths at S-154 on the north shore of Lake Okeechobee removed about 152 pounds of phosphorus per acre per year. This means MAPS can provide about 17 to 25 times more treatment per acre than STA type units. Consider then the nutrient reduction which might be realized by using periodic harvesting and removal to manage stands of aquatic plants within Florida's impaired lakes and rivers.

While MAPS facilities in Florida have typically been engineered land-based systems into which the targeted water is introduced, the MAPS concept would also apply to efforts to manage aquatic plants which are in the water body itself. Recent improvements in harvesting, transport and processing methods have improved the efficacy of this approach. For example, the Chinese are presently cultivating aquatic plants on a large scale in several of their reservoirs as a means of recovering nutrients and inhibiting Cyanobacterial growth. I recently wrote a Blog about the Chinese efforts at <https://www.pasop.org/the-chinese-apply-water-hyaicnths> . I am not suggesting at this time that the Commission commit to establishing large intentionally confined aquatic plant cultivation areas within Florida's lakes, but it may be prudent to further investigate the successes the Chinese are having. However, it does appear quite reasonable to proceed with programs involving periodic harvesting of existing aquatic plant stands for the dual purpose of controlling aquatic plant overgrowth and removing damaging nutrient loads. An evolving third benefit would be the refinement of beneficial uses of the harvested plants.

The use of herbicides to reduce the impact of invasive aquatic plant growth, particularly, but not exclusively, those which are exotic, has proven on a short-term basis to be a comparatively inexpensive way to clear waterways to improve flow, navigation, and in some cases facilitate improved oxygen transfer, and thus improving habitat. Certainly, in the mid twentieth century when water hyacinth growth was so explosive, herbicide use was essential. Later efforts to bring in pests and diseases specific to water hyacinths provided some alternatives to herbicides and allowed some reduction of herbicide use for hyacinth control. However, other exotics soon presented themselves—such as

hydrilla and torpedo grass. These developments have demanded continued implementation of an aggressive herbicide application program within aquatic systems. Understandably, because herbicides are purposefully toxic, there has been questions regarding both short and long-term impact of herbicide application upon the aquatic ecology and human health.

Any aquatic biologist understands the relationship between nutrient availability and the rate of net primary production. Water hyacinths for example have been shown to have a maximum specific growth rate of about 0.04/day or a 4% biomass increase per day. This maximum occurs at very high levels of phosphorus and nitrogen and optimal temperatures and solar input. As these nutrient levels are reduced the field or specific growth rate is reduced as well. For example, suppose the nutrient levels are reduced such that this specific growth rate is 0.01/day or 1% per day. This means that after one year an acre of hyacinths will, if space allows, have expanded to 38 acres. Now suppose the nutrient levels are increased such that this growth rate doubles to 0.02/day or 2% each day. Now this same acre of hyacinths over one year will have expanded to 1,480 acres! The culprit then is not the hyacinths. It is the nutrients—and nutrients are increasing continually in many of our water bodies. For example, total phosphorus has increased in Lake Okeechobee from about 70 ppb in the seventies to about 140 ppb today. And this is largely because of what is called legacy phosphorus, or rogue phosphorus, or perhaps more correctly Stored Excessive Anthropogenic Phosphorus or SEAP.

In the Lake Okeechobee Basin, according to the 2015 report by the University of Florida Water Institute, there is 110,000 metric tons of this SEAP which is available for plant production. They noted within the report that *legacy P in the Lake Okeechobee watershed could sustain contemporary P loading rates, i.e. 500 metric tons per year, for more than two centuries---Beyond existing and planned approaches, the substantial reservoir of legacy phosphorus in the Northern Everglades watersheds will necessitate new and more aggressive strategies to combat the mobility of phosphorus.* In-lake harvesting of aquatic plants, and the nutrients contained within their tissue is certainly a legitimate candidate for one of these “aggressive strategies”.

Herbicide spraying does nothing to remove nutrients from the waterway, and therefore is not a factor in efforts associated with the restoration of the Kissimmee-Okeechobee-Everglades System as delineated within the Comprehensive Everglades Restoration Plan or CERP. Nor is it relevant to the Total Maximum Daily Load (TMDL) allocation for Lake Okeechobee or other impaired surface waters. And it is quite clear based upon the noted statement from the UF report that if CERP or TMDL’s for that matter, are to succeed, this legacy phosphorus—SEAP-- must be rendered immobile.

As suggested, one method of aquatic plant management which does remove nutrients is mechanical harvesting and subsequent removal through export or sequestration within the basin. For example, if plants were removed, taken to shore, and then hauled to a site for composting to be used as a soil supplement in a manner that either substituted for imported phosphorus, was removed from the basin, or was sufficiently sequestered within the basin, then this action would qualify as a component of CERP, or at least the intent of CERP, as well as a component of the TMDL Basin Management Action Plan (BMAP). This means the cost of such harvest and removal could be off-set by the value of the environmental services associated with the removal of phosphorus. For example, on a 50-year present worth basis, the South Florida Water Management District (SFWMD) presently pays for each pound of phosphorus removed through its STA programs from a low of \$34/lb. to a high of \$1,346/lb., depending upon initial concentrations and percent removal, as well as other factors. This is based upon evaluations conducted by IFAS (*Economic Analysis of Water Treatments for Phosphorus Removal in Florida* Daisuke Sano, Alan Hodges, and Robert Degner (2004) *In Economic Analysis of Water Treatments for Phosphorus Removal in Florida,” Food and Resource Economics. Department, University of Florida, 2004.* Other studies show somewhat similar numbers, but typically within the higher end of this range.

Previous field analyses of water hyacinths indicate that a one acre standing crop on Lake Okeechobee amounts to about 110 wet tons, or at 5% solids, about 5.5 dry tons. This dry matter is about 0.4% phosphorus, meaning one acre of hyacinths hold about 44 pounds of phosphorus (+/-). If the SFWMD contracted with the FWC for \$100 per pound of phosphorus removed, each acre would have a value of \$4,400. Even at the low value of \$34/pound of phosphorus removed, the value would be \$1,496.

Note that this fee-based strategy would not be a precedent, for it is applied presently by the SFWMD who pays an environmental service fee to landowners who agree to hold water on their property as part of a water storage/nutrient removal component of CERP known as Dispersed Water Management or DWM.

*The District's Dispersed Water Management Program encourages private property owners to retain water on their land rather than drain it, accept and detain regional runoff for storage or do both. Landowners typically become involved in the program through cost-share cooperative projects, easements or **payment for environmental services**. From <https://www.sfwmd.gov/our-work/water-storage-strategies>*

In consideration of these issues, I propose that FWC and involved state and local agencies explore this strategy with SFWMD and the FDEP as well as others who are charged with implementing nutrient reduction programs. Such a strategy would facilitate reduction in herbicide applications, particularly the more toxic herbicides such as Glyphosate. This reduction would occur through a transition plan that would provide

mechanical harvesting contractors ever-growing opportunities to provide services of not only maintaining aquatic plant growths to desirable levels and facilitating reuse of lost nutrients, but also contributing to the goals of ecological restoration, while offering savings to both FWC and the water management districts. For example, suppose contractual arrangements with the SFWMD ensure FWC gets compensated for nutrient reduction at a rate somewhat below what SFWMD is now paying to operate their present facilities. This saves money for SFWMD, while allowing FWC to be compensated for efforts to control aquatic plant growth. And this would be done without the uncertainty of toxicity impact.

There are certainly details which need to be addressed before such a strategy could be put into action. But the appeal of significantly reducing the introduction of potentially toxic chemicals into Florida's waters; reducing costs of aquatic plant control through compensation arrangements for nutrient removal; the development of new jobs associated with contracting for mechanical harvesting; the contributions to nutrient management within impaired surface waters; and the development of new agricultural type products which facilitate the recovery and recycling of nutrients cannot be ignored. I strongly urge the Commission to explore this strategy further with the objectivity and seriousness it deserves.

Sincerely,

E. Allen Stewart III P.E.