Final Reports - due May 2, 2015

Regarding Ohio Lake Erie Commission, Lake Erie Protection Fund (LEPF) award for:

Marsh Restoration Cost Reduction /Phragmites Power (SG498-2015)

Reports compiled by Linda Sekura, Cleveland Museum of Natural History contractor, LSekura@aol.com, 216-598-0113
- April 11, 2016.

*We thank the **Ohio Lake Erie Commission** and Ohio citizens for funding via the **Lake Erie Protection Fund** (LEPF). The LEPF is supported through tax-deductible donation and the voluntary contribution of Ohioans who purchase Lake Erie license plates featuring the Marblehead Lighthouse or Lake Erie life preserver:* ***Lake Erie Protection Fund website***

~ ~

PROJECT LEAD: Cleveland Museum of Natural History, One Wade Oval, Cleveland, Ohio 44106
Project Director: Dr. James K. Bissell, Curator of Botany
Authorizing Officer: Dr. Evalyn Gates, Executive Director and CEO
Fiscal Agent: Todd Welki, Chief Financial Officer
Project Assistant Directors: David Kriska, Biodiversity Coordinator, and Keith Moran, Land Steward
Project Manager: Linda Sekura, Museum Volunteer/Contractor

AGENCY ADVISOR: Rick Gardner, Chief Botanist, Ohio Department of Natural Resources

ABSTRACT:

LEPF funding allowed the Cleveland Museum of Natural History's *Power-from-Restoration* collaborative's project manager to continue to develop reduced-cost restoration methods in 2015. The work is being piloted in one of the largest marshes along Lake Erie (Mentor Marsh – at 900+ acres), which has been a near-monoculture of invasive phragmites. These techniques and experiences are now shared on a website (Power-from-Restoration.com), enabling replication in other Great Lakes basin wetlands, including Lake Erie. The main method reduces costs by utilizing the waste biomass for clean energy – for example, digestion to produce a bio-gas that is a drop-in replacement for natural gas from hydraulic fracturing. In October 2015, a little over 10 tons of phragmites biomass was shipped to quasar energy group in Zanesville, Ohio, successfully using a live-bottom truck for this purpose for the first time. The "composting" form of digestion proved to be the most efficient of their processes, testing the delivered phragmites. The ultimate success was that our project has "proven," large-scale, a process to remove invasive phragmites from Ohio coastal (and inland) wetlands – and potentially other invasives from other ecosystems - and to use them for power, as the systems are restored as the native seed bank regenerates. This "proof of concept" was a step toward reducing restoration costs by developing a market and supporting expanding the green infrastructure to process these invasives. This green infrastructure of waste-to-power systems also expands the region's ability to process other wastes as a resource versus requiring landfills, that can leach toxins into our water systems. The Mentor Marsh phragmites is also being smashed down, to enable faster degradation and propagation from the native seed bank, without the cost or labor of removal, with the two processes compared for restoration success into the future. Additional cost-saving methods include trees propagated at a local nursery from seedlings pulled from the Marsh, an innovative deer fence design, sharing field equipment and knowledge gained, shipping methods/costs, portable digesters, feedstock pricing, and other energy processes. Invasive plant sprouting is being managed, and biota monitoring via Great Lakes Coastal Wetland Monitoring Plan protocols is being used to gauge restoration success.

TECHNICAL REPORT:

Over the past few years, a collaborative(1) led by the Cleveland Museum of Natural History, advanced Mentor Marsh restoration via a growing list of techniques that reduce costs. These techniques and experiences are shared on a website (Power-from-Restoration.com), enabling replication in other Great Lakes basin wetlands, including Lake Erie.

The main method, "Power-from-Restoration", reduces costs by locating purchasers for phragmites biomass, for energy production, without creating incentives to propagate invasives(2). The Project Manager is a volunteer (and a contractor via use of LEPF funds), whose work had increased due to continued successes(3) toward both Marsh-wide restoration and the Power-from-Restoration initiative. LEPF funding allowed the Project Manager to continue reduced-cost restoration methods in 2015, along with the Museum's larger-scale pressing methods, in one of the largest marshes along Lake Erie (900+ acres), which has been a near-monoculture of invasive phragmites.

The following cost restoration methods were successfully implemented in the Marsh in 2015. This report addresses these successes by reviewing the "Deliverables" listed in our proposal:

1) RESTORATON & MANAGEMENT - TARGET: **At least 10 acres of phragmites either removed or smashed, with ongoing invasive sprouting managed.**

COMPLETED:

- Oct 18 & 19 2015 - 1.14 acres was harvested (removed) with a field harvester, and 1.57 acres were pressed with the harvester, to enable comparison with the over 200 acres smashed in the west basin with a Marsh Master. **The harvest for energy was a great success**, and the details are included in the Power-from-Restoration website under the "Harvest" tab – and under 4e and 4f, below.

- Apr-May 2015 - 9.67 acres were partially manually smashed/pulled, but mainly management was accomplished by shading out phragmites via dozens of tree plantings.

- Also, throughout the 2015 growing season - about 2 acres of smashing via Argo smashing by a volunteer. Smashing encourages phragmites degradation without the cost of removal. This results in slower establishment of native plants than with phragmites removal, but enables faster (year-round) tree planting and building of lower-cost reusable deer fencing. (In comparison, harvesting equipment to remove phragmites can only be used Sep.-Jan. due to wildlife concerns at other times.)

= TOTAL: 14.38 ACRES. Also, during Nov 2015: 200+ acres were pressed by the Museum, using a contractor with a Marsh Master.

---

(1)COLLABORATORS: See the Collaborator tab on the Power-from-Restoration website: Cleveland Museum of Natural History *(Current Lead);* Midwest Sustainable Solutions *(Project Manager);* Ohio Department of Natural Resources: Division of Natural Areas & Preserves, Ohio State Parks; quasar energy group; Ohio State University/ATI (Agricultural Technical Institute); Case Western Reserve University Farm; Klyn Nurseries; Loyola University Chicago; Lake Superior State University; Loglogic (UK); NASA Glenn Research Center; ITB, Inc.; Tim Scheetz, Inc.; City of Mentor; Lake County Soil & Water Conservation District; Village of Grand River; Army Corps of Engineers, Buffalo District; Mentor Marsh Board; Forest City Enterprises; FDC Enterprises; Ohio Lake Erie Commission's Lake Erie Protection Fund.

(2) BIOMASS-FOR-POWER CONCERNS: A common concern is that a market may be created, encouraging planting of invasives. But our experiences revealed that the intensive work/cost investment should be compelling only to those motivated by restoration. Maintaining ongoing crops adds owning/managing land and ensuring a stable flow of feedstock for an energy contract. For shipping concerns: Trucks are covered. Only a massive spill may offset benefits of removing tons of invasives.

(3)SUCCESSES: An experiment showed that seeds/propagules are not viable after digestion. Our biomass-power process has been proven on a test scale. A 150' test deer fence was constructed. 95 maples were planted during 2015. $50K-$75K of additional restoration funding was secured.

1) RESTORATON & MANAGEMENT (continued)

MANAGEMENT was accomplished via helicopter herbicide spraying of over 200 acres September 21, 2015, with ground spraying of perimeter (60 acres) in Oct 2015. There is and will be ongoing monitoring for phragmites sprouting, with appropriate management response.

2) **MONITORING** OF NATIVE PLANT GROWTH in all areas in some state of restoration: "Before restoration" transects.
- and -
3) **MONITORING** OF BIOTA IN RESTORED AREAS:

COMPLETED as of June 2015. See the *Mentor Marsh State Nature Preserve 2015 Biota Monitoring Results* report, Attachment 1, compiled November 30, 2015, by Linda Sekura. **Biota surveys were performed (April through June) for amphibians (frogs/toads), birds, macroinvertebrates, plants, invasive cover - and for chemical/physical data, such as pH, salinity, depth-to-soil through phragmites biomass for pressed and harvested sections.**

Surveys were performed following Great Lakes Coastal Wetland Monitoring Plan (GLCWMP) protocols, and Indices of biological integrity (IBIs) were calculated. Our team's monitoring work this year also contributes to the GLCWMP database - and MMP (Marsh Monitoring Program – Bird Studies Canada).

Due to the amount of restoration activity in 2015, the GLCWMP and MMP official survey experts will be conducting biota and water quality surveys in 2016. The official GLCWMP/MMP surveys will include fyke net fish surveys by the GLCWMP, and most likely also electrofishing surveys to be contributed by Mike Durkalec of the Cleveland Metroparks. Comparisons of these two fish survey techniques will contribute to ongoing assessment of protocols.

These “before restoration” surveys in 2015 and 2016 will be compared with data collected in subsequent years, to determine restoration success.

4) ANALYSES:
4a) Cost-reduction methods, success of restoration, methods of engagement (ONGOING, but CURRENTLY SUCCESSFUL) – See details, below;
4b) **Number of trees planted (99)** – To date, nearly all trees are surviving well, except those in the test deer fence decimated by beavers (see 4d below). The majority of the trees were Freeman maples, grown from seedlings collected from the Marsh by Klyn Nurseries;

4c) **Tree seedlings collected (OVER 200 Freeman maples, collected as seeds/seedlings from the Marsh in 2015)** – These are being grown to about 6’ tall by Klyn Nurseries, and will be planted in the 2016 or 2017 season. The contribution of volunteers in collecting seeds/seedlings, the expertise of Klyn, and additional volunteers to plant these, has saved thousands of dollars in restoration costs;

4d) **Success of new deer fencing design (SUCCESSFUL)** – Deer were successfully kept out, with trees surviving to full leaf-out. Unfortunately, beavers found their way under the fencing and decimated nearly all trees. Black willows and newly planted cottonwood cuttings now survive, and are covered with plastic fencing within the innovative fencing. The innovative fencing consisted of smashing Phragmites,

leaving standing Phragmites in the shape of a circular enclosure, which was then surrounded by orange plastic fencing, stabilized in the loose Marsh mud with rebar posts. The design can be seen on the Power-from-Restoration website. This design results in a less-than $2 per foot deer fence.

4e) Feasibility of harvesting method(s) (SUCCESSFUL) – The LogLogic (UK) Softrac Cut-and-Collect system (pictured on our Power-from-Restoration website) successfully navigated the organic muck of Mentor Marsh, partially due to the thick Phragmites rhizomes providing support for this field equipment, and partially due to the 2.5 psi pressure of the equipment, within safe guidelines for sensitive marsh ecosystems. The system left only an average of 2" depth of biomass, which should allow the native seedbank to propagate effectively. The Marsh Master pressing of the Phragmites left an average of 8-9" of biomass. Analysis of the effectiveness of each piece of field equipment on restoration success will continue on an ongoing annual basis.

Each load of the Softrac was 8 square meters of chopped phragmites biomass, resulting in a total of 13 loads from two sections of Mentor Marsh – at Route 44 and Headlands Road, and just off of the parking lot at Mentor Lagoons. The truck could only load a little over 10 tons (versus the 25 tons per load allowed on our roads), due to the bulkiness of the material. Quasar has advised that phragmites and other biomass should be allowed to sit and settle, to compact the material and provide more cost-efficient shipping, potentially reaching the 25-ton limit.

One great success was that we proved that a live-bottom truck can be used to ship plant biomass. The conventional wisdom was that the biomass would be stuck inside the truck and difficult to remove. At the delivery site, the phragmites came out quite easily.

Note: A great cost-saving measure was the loan of this Softrac Cut-and-Collect system by Loyola University, who won a Great Lakes Restoration Initiative (GLRI) grant in 2015, purchasing this field equipment with the funds. Our collaborative continues to work with Loyola, and other invasives-to-power/product organizations met through this connection. Several of our organizations plan to continue this concept of sharing equipment and knowledge, including leveraging each other's funding, to advance restoration in the Great Lakes.

4f) Energy production methods (SUCCESSFUL)

The target of "proving" the harvest and delivery of phragmites to quasar energy group's Zanesville digester was met. quasar's results show that **the composting form of digestion(4) is the most efficient and cost-effective method.** quasar tested continuous feed digestion and other methods.

We do require smaller pieces to make this process more cost-efficient (less additional chopping at quasar), which can be accomplished with the field equipment we are hoping to order in 2016 with additional funding.

The original biogas reports from quasar's 25-gallon test were that phragmites alone provided more biogas than "other plant material" - which included manure. This is the only test where phragmites was tested alone. In a digestion-for-power process in standard scale, many waste products are mixed together - food, plant, inoculant, etc. – so this 2015 test was not for the energy output of one individual feedstock, since that was proven already.

_____

(4) DIGESTION: This is, in effect, composting in an enclosed facility, capturing the bio-gas ("methane") for energy/fuel that is a drop-in replacement for natural gas from hydraulic fracturing. Digesters are expanding globally, diverting waste from landfills.

4f) Energy production methods (continued)

The ultimate success - what was accomplished with the LEPF funding in 2015 - was that our project has "proven," large-scale, a process to remove invasive phragmites from Ohio coastal (and inland) wetlands – and potentially other invasives - and to use them for power, as the wetlands are restored from a native seed bank. This was a step toward reducing restoration costs by developing a market and supporting expanding the green infrastructure to process these invasives. This green infrastructure of waste-to-power systems also expands the region's ability to process other wastes as a resource versus requiring landfills, that can leach toxins into our water systems.

The project is also accelerating restoration of Mentor Marsh, situated along Lake Erie and designated as federally important by the U.S. Army Corps of Engineers. Accelerating restoration supports increased regional biodiversity, fish nurseries and cleaner water for consumption and recreation.

Other steps in the process we are continuing to assess, adjust, negotiate - toward economic and technological feasibility/sustainability - are: shipping methods and costs (including distance, which also may include portable digesters); ownership of digesters; waste biomass feedstock pricing; other forms of energy production or products; collaborative sharing of equipment, expertise and lessons learned; pursuing consumer purchases of wetland-power via pelletizing; and more.

We pursued the concept of working with utilities, and asking consumers and businesses to sign up to pay a premium for wetland-power - enabling quasar/others to purchase the feedstock vs charging tipping fees. But this set-up proved to be too cumbersome, working through the economics, regulations, and steps required to make this work. We believe the cost-reduction concepts in the previous paragraph are the best route to an economically sustainable concept.

Additional notes for the Technical Report, from the original proposal, that may prove useful to readers:

Removal of invasive biomass is a faster and more effective method of restoration. Removal exposes soil and the native seed bank to the sun, expediting plant growth. For example, in 2008, restoration via phragmites removal with hand tools was accomplished on 5 acres of the Marsh. In 1-2 seasons, native plants sprouted from the seed bank, and rare birds returned.

Burning is the most efficient way to remove phragmites, but in an urban area, there may be safety issues. And biomass build-up may result in higher intensity fires, potentially harming native ecosystems.

Removal by harvesting this waste biomass for energy diverts it from a landfill, and provides funds for restoration. Even if little or no phragmites biomass is sold, harvesting equipment can expose the soil while creating a firebreak. The harvested biomass can be piled onto adjacent phragmites stands, and either burned (if it can be done safely and without damaging the ecosystem) or left to naturally degrade, extending the time it takes for native plants to re-establish.

5) Update on the project website, signage and other educational outreach:

- The Power-from Restoration website now has over 1,500 hits. The site informs collaborators or any interested parties about the initiative's results, as well as other educational information, including cost reduction methods. The site includes a photo documentation of the process, and a live-tweeting session captured that will be added to as the initiative moves on to the next steps. The Ohio Lake Erie Commission's Lake Erie Protection Fund is credited on the Collaborators page.
- Updates are emailed periodically, as appropriate, to keep all collaborators informed as to the status of the project, current actions and successes (including ongoing results), and what contributions may help in moving the project forward. ODNR and the Army Corps of Engineers are included on the collaborator

email list. Collaborators at times receive individual emails and phone calls. Agencies collaborating continue to receive feedback on Marsh data, such as tons/acre, pH, biota, etc.
- Results will also be shared on various listserves: invasives, wetlands, biomass, etc. The intent is to assist others in replicating our work once we are successful, and to inform as to the sustainable potential of biomass energy methods.
- The Museum and Loyola University, the collaborator who loaned the harvesting field equipment, co-authored a blog posted to the Great Lakes Phragmites Collaborative blog site (greatlakesphragmites.net/category/blog), with thanks included for the Ohio Lake Erie Commission.

ACTIVITIES AND TIMELINE – Action items not yet addressed above:

We continue to build a monitoring work force, including working toward training volunteers with the Ohio Wetlands Association.

Once additional funding is acquired, we will work on signage in the harvest areas, to promote the initiative and engage the public. We have contacted local student art departments, but have not yet received a response.

FINAL ACCOUNTING: Attachment 2