Photo: K.M. Kettenring

Progress Report to
Utah Department of Natural Resources
Division of Forestry, Fire & State Lands

Revegetation of native wetland plants to improve *Phragmites* management in the Great Salt Lake Watershed

Karin M. Kettenring, James E. Marty, and David M. England
Ecology Center and Department of Watershed Sciences
Utah State University

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Overview

In 2014, we received funding from Division of Forestry, Fire & State Lands to conduct the first year of a multi-year study to evaluate techniques for reestablishing native vegetation in Great Salt Lake wetlands following *Phragmites australis* (phragmites) control. Here we outline progress made on each of the project objectives. Results from these studies are forthcoming and will be included in the 2016 report.

Goals and objectives

The overall goal of this project is to prevent phragmites invasions and restore wildlife habitat in the Great Salt Lake Watershed by determining the most effective strategies for reestablishing native bulrush species (*Schoenoplectus* spp.).

The **specific objectives** for this project are to:

(1) Evaluate different methods (seeds, plugs, sod mats, rhizomes) for reestablishing native bulrush species in Great Salt Lake wetlands.
    - *Implications for management*: The most effective and affordable methods could then be introduced broadly into Great Salt Lake wetlands to prevent phragmites reinvasion and to restore critical wildlife habitat.

(2) Identify competitive individual genotypes or competitive genotype assemblages of bulrushes that best prevent phragmites reinvasion.
    - *Implications for management*: These individual genotypes or genotype assemblages could be introduced broadly into wetlands following phragmites removal to prevent phragmites reinvasion.

Deliverables

In our initial proposal we agreed to deliver the following to Division of Forestry, Fire & State Lands b*y June 30, 2016:*

(1) An assessment of the effectiveness of different bulrush revegetation techniques.
(2) An assessment of which bulrush individual genotypes or assemblages of genotypes best compete against phragmites.
(3) A draft of outreach materials that integrates our work on phragmites control and native plant revegetation efforts (*Restoration of Great Salt Lake phragmites-invaded wetlands*).

We are on track to produce those deliverables by the end of the two year component of our project. Here we present details on progress made towards those deliverables and our research objectives.

Progress to date

Objective 1: Evaluate different methods for reestablishing native bulrush species in Great Salt Lake wetlands. (MS project of David England)

This study focuses on three bulrush species: *Schoenoplectus americanus* (threesquare bulrush), *Schoenoplectus acutus* (hardstem bulrush), and *Schoenoplectus maritimus* (alkali bulrush).

Experiment installation

The U.S. Fish & Wildlife Service granted us permission to conduct this revegetation demonstration project in two of their management units (4B and 5B) at the Bear River Migratory

Bird Refuge. In each management unit, we established 26 strips with five 4 m^2 plots per strip. Each strip contains a random subset of the different revegetation treatments: seeding with different densities and seed source population combinations, plantings of plug seedlings, plantings of rhizomes, or sod mats. Each revegetation treatment was replicated 5 times in each of the two wetland units.

Wetland Unit 5b (upper left) and 4b (left) at the Bear River Migratory Bird Refuge where the experiment was implemented. (upper right) Howard Browers, Wildlife Biologist at the Bear River Migratory Bird Refuge, during a scouting field trip to identify sites for the experiment installation.

Acquisition and preparation of seed materials

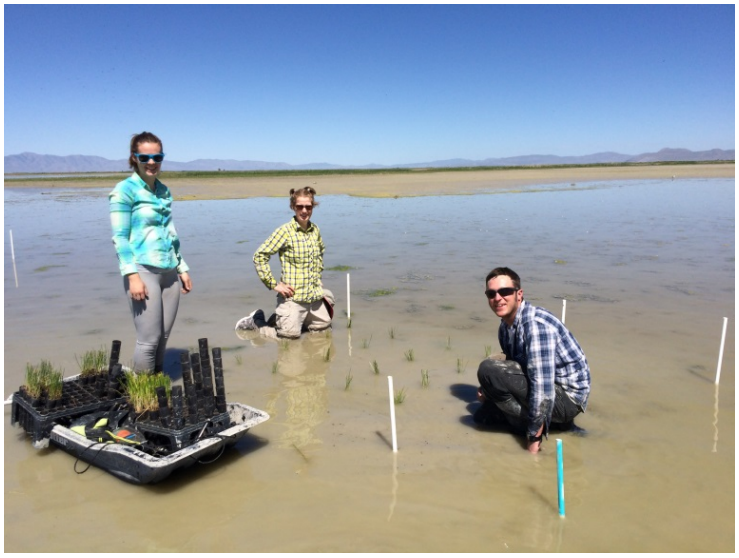
Seeds of the three bulrush species were collected in fall 2014 from seven sites in the Intermountain West (Bear River Migratory Bird Refuge, Bear Lake National Wildlife Refuge (NWR), Clear Lake Waterfowl Management Area (WMA), Fish Springs NWR, Farmington Bay WMA, Salt Creek WMA, and Sterling Wildlife Management Area). To break seed dormancy, the seeds were cold, moist stratified in a refrigerator for 3 months during spring 2015 by researchers at USU until sowing into the field plots in June 2015 (see below).

Example sites where seeds were collected for this bulrush revegetation study (left *S. maritimus*, right *S. acutus*).

Acquisition and preparation of plug materials

Seeds of the three bulrush species were collected in fall 2014 from seven sites in the Intermountain West (Bear River Migratory Bird Refuge, Bear Lake NWR, Clear Lake WMA, Fish Springs NWR, Farmington Bay WMA, Salt Creek WMA, and Sterling Wildlife Management Area). These seeds were then sent to North Fork Native Plants (Rexburg, Idaho) for them to cold stratify the seeds for 3 months and then produce the plugs in their greenhouse over winter/spring 2015.

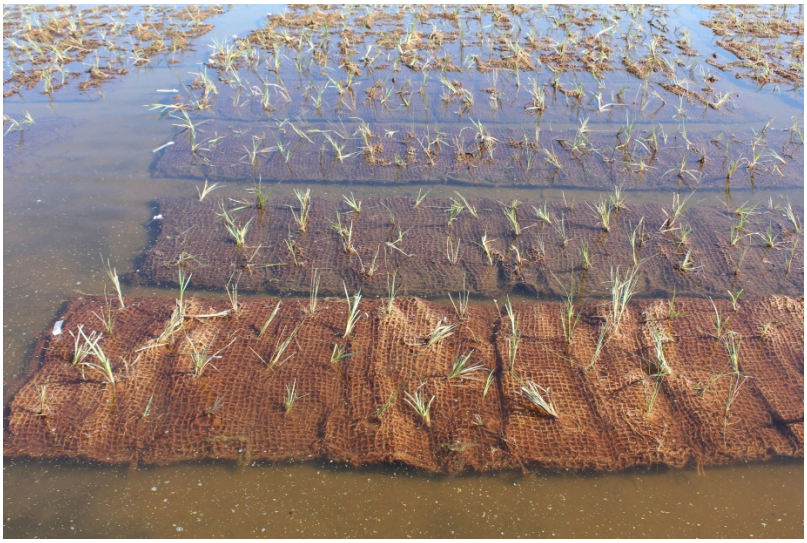
Example wetland plant plug from North Fork Native Plants.



David England, Rachel Hager, and Dr. Karin Kettenring planting plugs into the experimental plots at the Bear River Migratory Bird Refuge.

Acquisition and preparation of sod mats

Rhizomes of the three bulrush species were collected in spring 2014 from seven sites in the Intermountain West (Bear River Migratory Bird Refuge, Bear Lake NWR, Clear Lake WMA, Fish Springs NWR, Farmington Bay WMA, Salt Creek WMA, and Sterling Wildlife Management Area). The rhizomes were delivered to North Fork Native Plants (Rexburg, Idaho) in early summer 2014. The rhizomes were embedded in coconut fiber mats and maintained in their large propagation ponds to allow root/stem development over the 2014 growing season through spring 2015.



Example from North Fork Native Plants of a developing sod mat for wetland revegetation.

David England (far right) and two staff members from North Fork Native Plants planting Great Salt Lake-collected bulrush rhizomes into sod mats for this study.

Sod mats were transported to their respective plots in sleds, and here David England demonstrates how the sod mats were then placed in the plots by dragging them with hay hooks to the center $1m^2$ of the $4m^2$ plots (far left). David England demonstrates how the sod mats were held in place with wooden stakes (left).

Acquisition and preparation of rhizome material

Rhizome material for *S. americanus* was collected from a large patch at Public Shooting Grounds WMA using a backhoe and transported to the Bear River Migratory Bird Refuge by Division of Wildlife Resources personnel under the supervision of Randy Berger and Arlo Wing. Rhizome material for *S. maritimus* and *S. acutus* were sourced directly from the Refuge property, harvested using a backhoe by Refuge staff, and then delivered to the wetland units manually via sleds.

Backhoe at Bear River Migratory Bird Refuge scooping *S. acutus* for later transplantation into the revegetation treatment plots.

Monitoring plans

The success of the revegetation treatments will be monitored every 3 weeks during the 2015 and 2016 growing seasons. We will assess cover of each bulrush in their respective $4m^2$ plots, bulrush stem density in four $0.9m^2$ subplots per $4m^2$ plots, and the amount of light reaching ground level (a factor important for limiting phragmites invasion). Also, water depth and salinity will be tracked along with the vegetation data collection.

Objective 2: Identify competitive individual genotypes or competitive genotype assemblages of bulrushes that best prevent phragmites reinvasion. (MS project of Jimmy Marty)

In this study we are evaluating the ability of three species of bulrush – *S. acutus*, *S. americanus*, and *S. maritimus* – to outcompete invasive phragmites seedlings. We are particularly evaluating different genotypes (=clones) of these three species to see if individual genotypes possess traits to compete well against phragmites. We are also looking at assemblages of genotypes (=multiple clones) of the bulrush species to determine if such assemblages complement each other to grow more dense canopies that limit light available to phragmites seeds and seedlings.

Graduate student Jimmy Marty and Dr. Karin Kettenring harvesting rhizome material of *S. maritimus* at Farmington Bay WMA in spring 2014.

We collected rhizomes of these three species from 6 sites in northern Utah and southern Idaho (Bear River Migratory Bird Refuge, Farmington Bay WMA, Salt Creek WMA, Fish Springs NWR, Sterling Wildlife Management Area, and Clear Lake WMA). At each site, we identified three stands of each bulrush species >150m apart. Within each stand, we identified four sampling locations (5-20m apart) where we collected rhizomes. In each sampling location, we harvested 2-3 multiple-node rhizomes of each species. We planned to use only one rhizome from each sampling location in this experiment but we collected back-up rhizomes in case we had failed emergence for a particular sampling location. Each sampling location was sufficiently far enough apart to assume that rhizomes constitute unique genotypes, although we are confirming genotype uniqueness using AFLPs.

Collected rhizomes were transported back to the lab in Logan for further propagation and evaluation. Over the 2014 growing season and winter of 2014/2015, we clonally propagated additional rhizomes for the experiment.

(left) Graduate student Jimmy Marty propagated the field collected rhizomes during the growing season of 2014 in kiddie pools filled with pea gravel following methods developed by North Fork Native Plants. (below) Clonal propagation continued over the winter of 2014-2015 to produce the massive amount of rhizome materials required for this experiment.

In June 2015, we established the bulrush-phragmites competition experiment in an outdoor field plot near USU research greenhouses. The pots were filled with a mix of sand, vermiculite, and peat moss and then planted with eight rhizomes of a single bulrush species with different genetic diversity treatments. The genotype richness treatments (=number of genotypes or clones per pot) were 2, 4, or 8 genotypes per pot. The pots were planted with the rhizome fragments (=genotype treatments) over two days in mid-June 2015. A total of 1296 rhizome fragments were planted across the 162 pots. The pots were then sown with phragmites seeds (previously cold stratified to break seed dormancy) at a density that represents phragmites seed density in Great Salt Lake wetland soils (following results from Christine Rohal's seed bank study). Half of all pots are receiving a nitrogen/phosphorus fertilization treatment to determine if

the bulrush–phragmites dynamics shift under high nutrient levels since phragmites is known to be a high nutrient specialist.

Stem emergence is being documented for each rhizome fragment to identify which genotypes are likely to best compete against phragmites seedlings. In addition, every three weeks data are being collected on the height of phragmites and bulrush stems (5 stems randomly chosen per pot), the cover of phragmites and the bulrush planted in the pot, percent cover of bare ground, and bulrush stem density. In addition, light levels are being measured at ground level to determine how well the establishing bulrush may be limiting light available to phragmites seeds. At the end of the 2015 growing season, all plants will be harvested to determine above and belowground biomass production.

a.

b.

c.

c.

d.

Implementation of this experiment involved mixing large volumes of (a) sand, (b) vermiculite, (c) peat moss using (d) shovels to (e) fill the 162 pots, later planted with rhizomes of the three bulrush species. 1296 rhizome fragments were planted across the 162 pots.

The results of this experiment will suggest which individual genotypes or genotype assemblages should be planted into Great Salt Lake wetlands to best prevent phragmites reinvasion. Field evaluation of individual genotypes and assemblages of genotypes in Great Salt Lake wetland plots will be pursued in future years of this project (beyond this grant cycle).