Restoring habitat of the endangered Delta Smelt through management of the invasive ecosystem engineer Brazilian Waterweed

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Introduction

- The Sacramento-San Joaquin River Delta has been invaded by many aquatic plant species. Brazilian waterweed *(Egeria densa)* is one of the most dominant invaders.
- *Egeria* can act as an ecosystem engineer by slowing water velocities, limiting sediment re-suspension, outcompeting native plants, reducing phytoplankton productivity, and harboring invasive predatory fishes.
- These habitat alterations are detrimental to the endangered Delta Smelt *(Hypomesus transpacificus)*, which is endemic to the Delta. The California Natural Resources Agency adopted the Delta Smelt Resiliency Strategy, which includes an action for enhanced control of invasive aquatic plants.
- For this initiative, we are conducting a two-year pilot study (2017-2019) to evaluate the effects of herbicide application on invasive aquatic plants and determining the ecological impacts of treatment. This poster summarizes the initial plant biomass response and pre-treatment conditions for both plants and plankton.
- We selected two study sites (~135 acres each) close in proximity (~1 km apart), one treated with an herbicide and the other remaining untreated (Figs. 1A, 1B).
- Within sites, we are monitoring a suite of parameters (see Methods) in areas of submerged vegetation (Fig. 1B, red areas) and open water (Fig. 1B, blue areas).
- **Hypothesis 1:** The two sites would initially be ecologically similar but then diverge through time as the herbicide killed the vegetation at the treated site.
- **Hypothesis 2:** Conditions in the vegetated areas of the treated site would become more similar to those of the open water areas over time while conditions in these two habitat types would remain distinctly different at the untreated site.

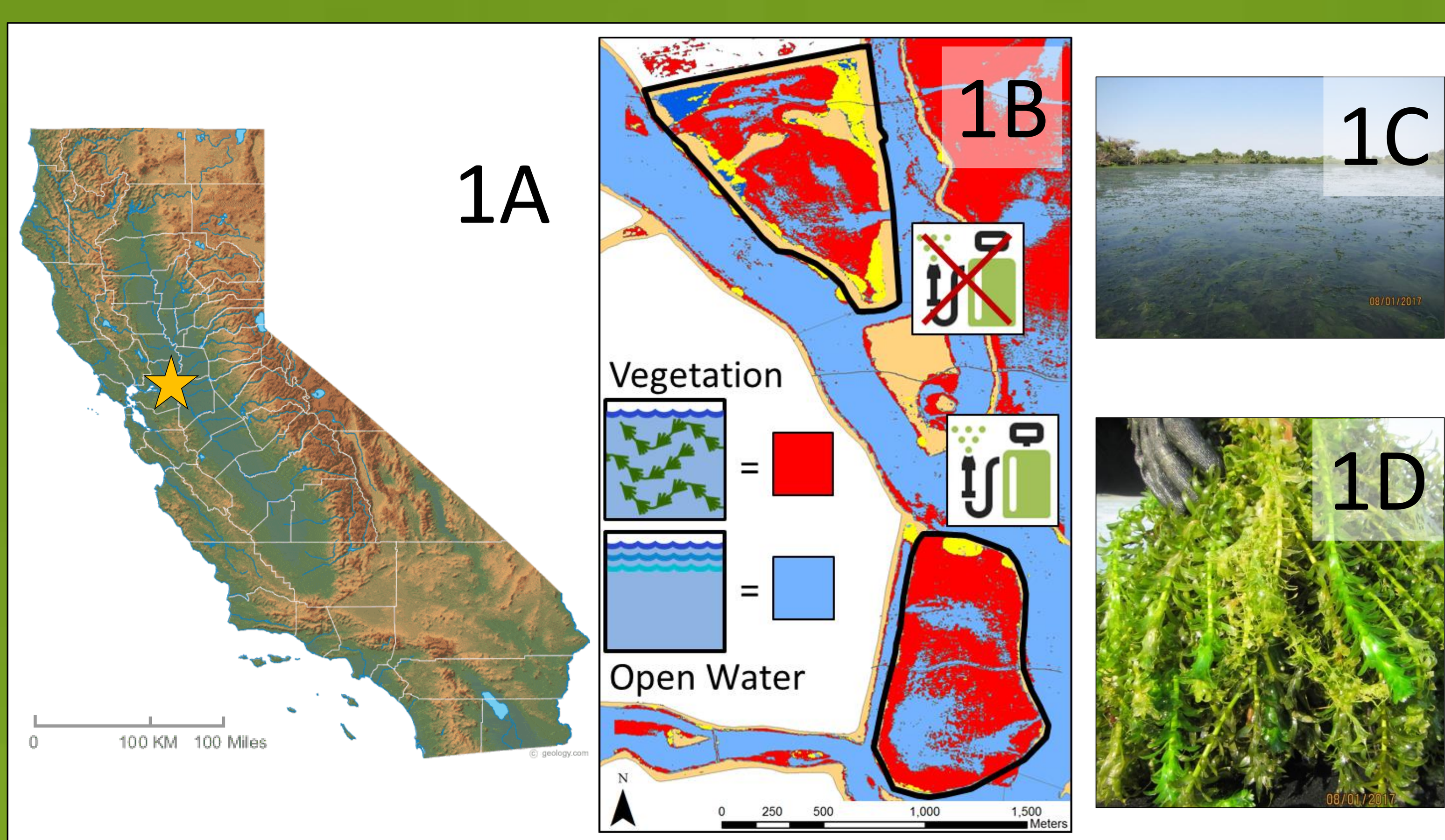

Figure 1. Study sites. (A) Study area in the Sacramento-San Joaquin River Delta. (B) Hyperspectral image of study sites. (C) Extensive weed beds. (D) *Egeria* dominates at the sites.

Methods

- We applied Fluridone at the treated site, which is a slow-acting systemic herbicide available in a slow-release formula and is absorbed via shoots and roots.
- On June 7, 2017, we initiated weekly Fluridone applications at a rate of ~15 parts per billion (ppb). Target ambient water concentrations during the annual 16-week treatment period are 1.5 - 3.5 ppb.
- Environmental parameters monitored at the two sites:
  - Fluridone concentrations: water samples collected weekly and analyzed via ELISA
  - Phytoplankton: samples collected monthly via Van Dorn water sampler
  - Zooplankton: samples collected monthly via horizontal zooplankton net tows
  - Aquatic plants: collected ~40 rake samples every other month

Results

- **Aquatic Plants:** Biomass was higher in vegetated vs. open water areas (Fig. 2A), biomass of treated and untreated sites converged through time (Fig. 2B), and composition among sites and habitats was fairly similar (Fig. 2C). Documented seven species between the two sites (four invasive, three native; Fig. 2D)
- **Zooplankton:** There were higher abundances in vegetation and at the untreated site (Fig. 3A). Composition differed consistently by habitat but not site (Fig. 3B).

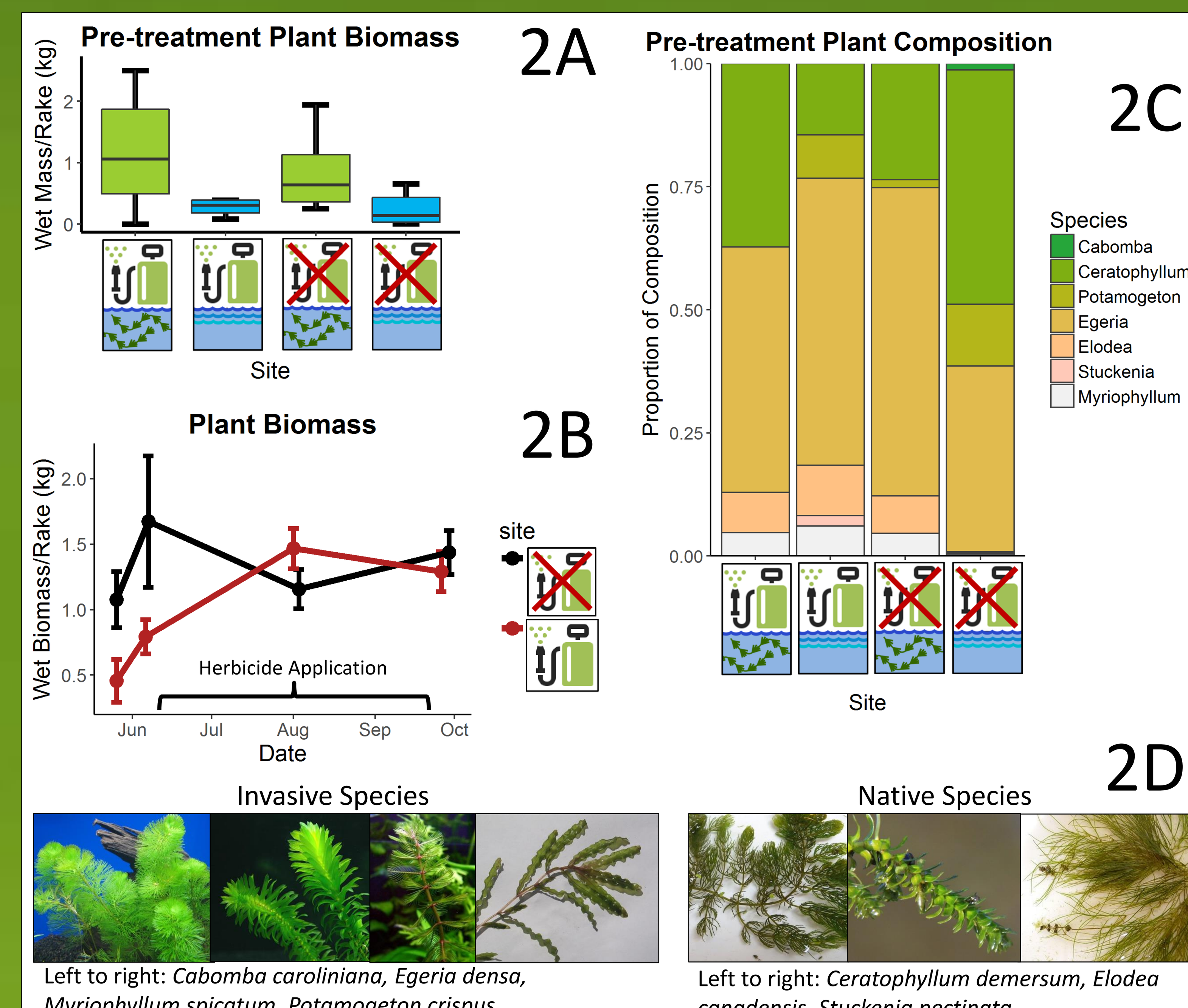

Figure 2. Aquatic plants. (A) Pre-treatment rake biomass at both sites in vegetation (green) and open water (blue). (B) Change in rake biomass through time at treated (red) and untreated (black) sites. Points are means ± standard error bars. (C) Pre-treatment biomass-based species composition. (D) Plant species present at sites.

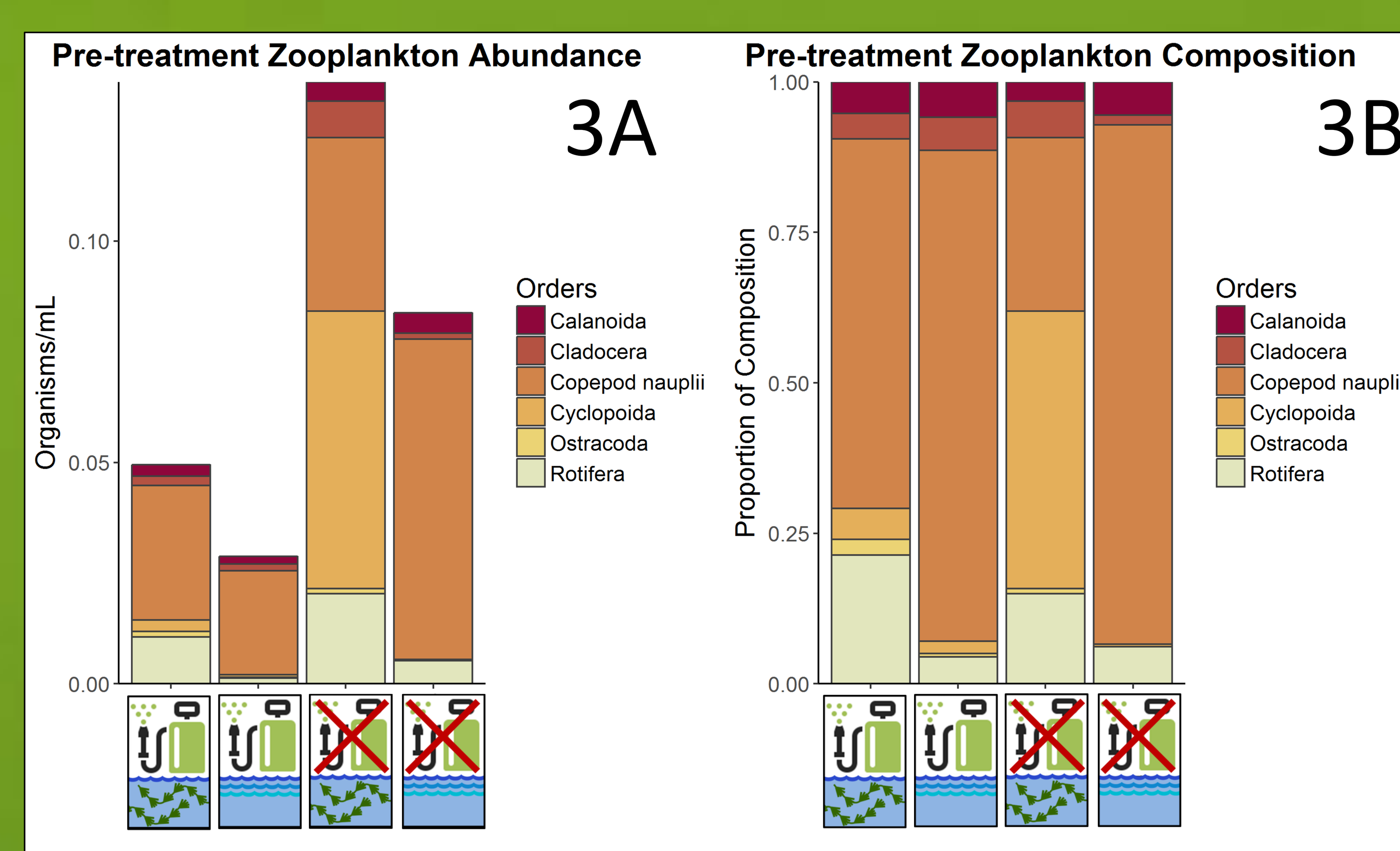

Figure 3. Zooplankton. (A) Pre-treatment abundances and (B) taxonomic composition. Each bar is based on three samples collected using horizontal zooplankton net tows.

Results continued

- **Phytoplankton:** Abundances were higher in vegetation and in the treated site (Fig. 4A) . *Chroococcus microscopicus* dominated the samples (~96% of phytoplankton). Composition did not show strong, consistent differences (Fig. 4B).
- **Fluridone:** Ambient concentrations in the water at the treated site were 1.18 ppb ± 1.53 ppb SD while those at the untreated site were 0.14 ppb ± 0.14 ppb SD (data not shown). Means are based on ELISA analysis of weekly water samples.

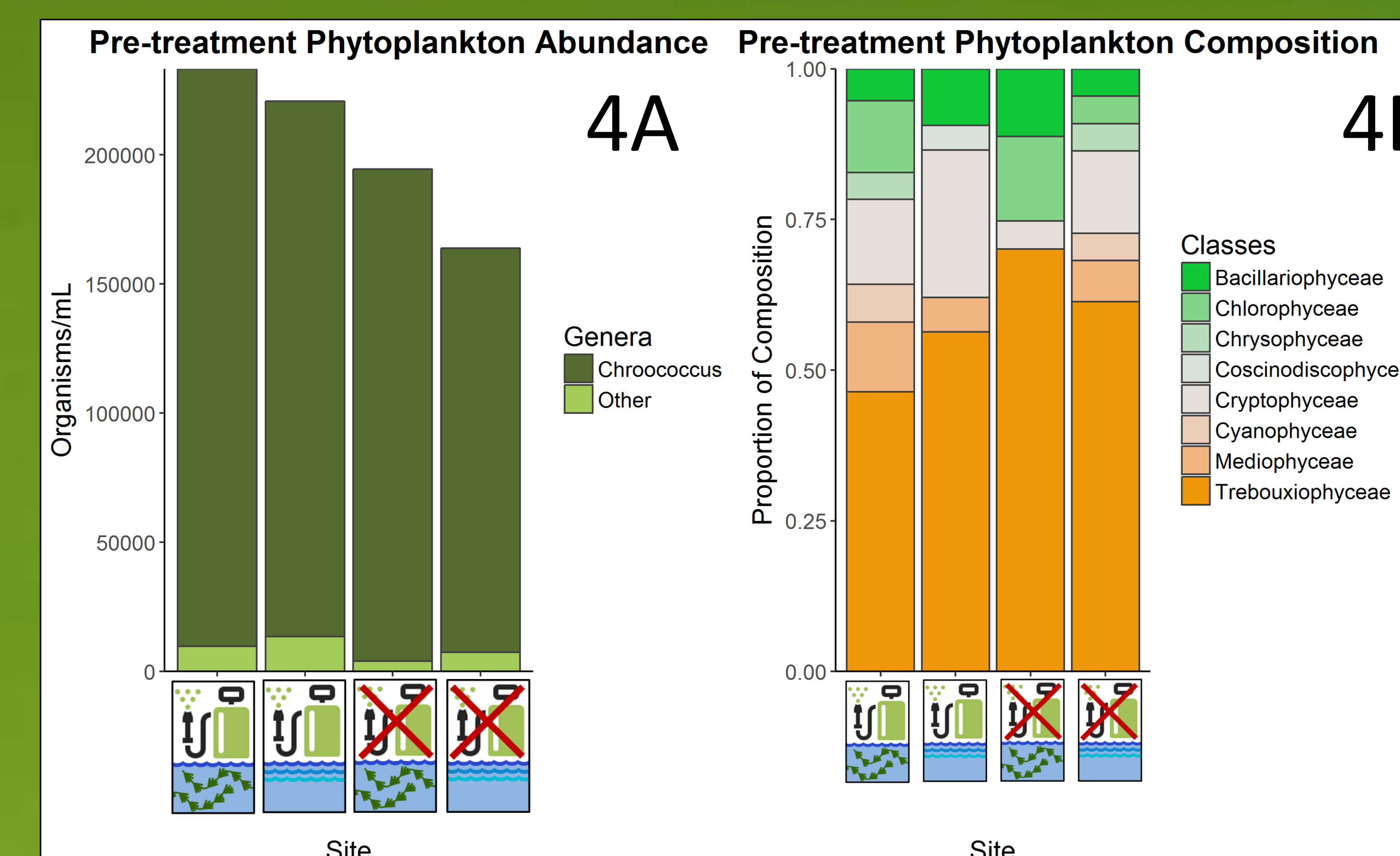

Figure 4. Phytoplankton. (A) Pre-treatment abundance and (B) taxonomic composition. *Chroococcus* was excluded from taxonomic composition plot to allow visualization of other taxa. Each bar is based on two samples collected using a Van Dorn water sampler.

Discussion

- Aquatic plant biomass and biodiversity at these sites were high. Biomass in the open water areas was much lower than that of the vegetated areas but still present.
- Plant biomass at treated site has not decreased despite four months of herbicide application, but stronger effects are expected during the second year of treatment.
- It is challenging in this tidal environment to maintain Fluridone concentrations in the target range. However, sediment concentrations are likely higher and more stable than water concentrations, so we have begun collecting sediment samples.
- Plankton abundances may be higher in vegetation vs. open water because vegetation likely offers a greater diversity of spatial niches as well as refugia from predators.
- Composition of plankton and plants did not differ much between habitats or sites, perhaps because tidal forces keep habitats fairly well mixed.
- Overall, these pre-treatment data suggest the two sites are well paired physically and ecologically for use in this herbicide treatment study.
- We will continue to apply Fluridone to the treated site and monitor both sites through the end of 2018.

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