

Aquatic plant community restoration following the long-term management of invasive *Egeria densa* with fluridone treatments

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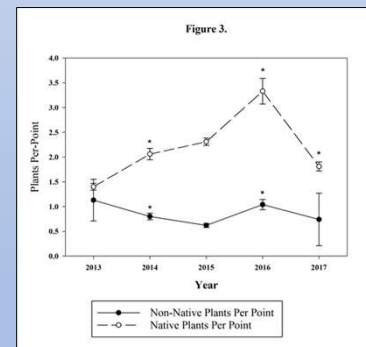
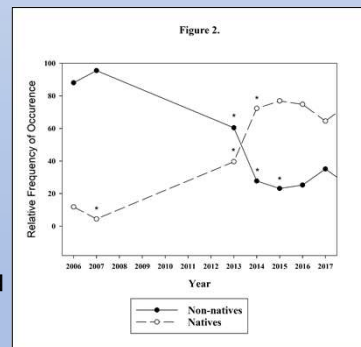
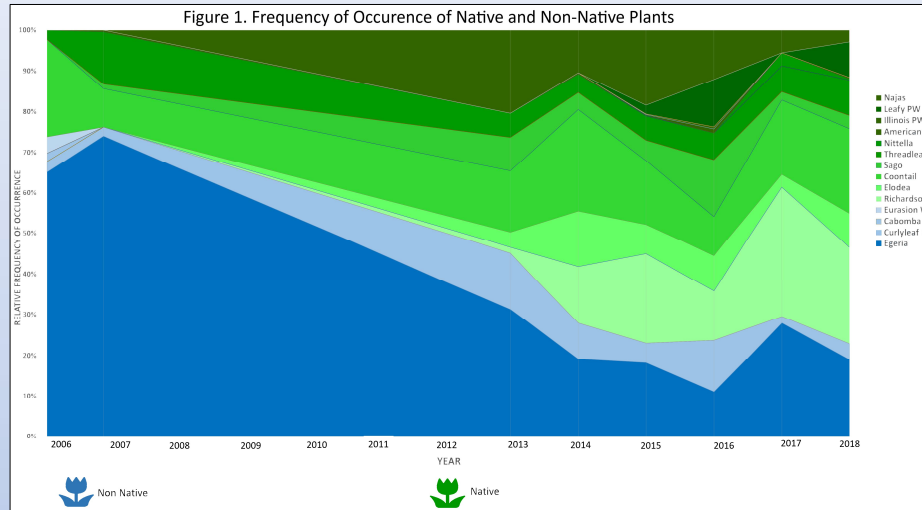
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Abstract

The Sacramento-San Joaquin Delta is one of the largest estuaries in North America, providing water for more than 700,000 acres of agriculture, recreation, and fisheries habitat. For decades, the exotic invasive plant, *Egeria densa* has negatively impacted native habitat and navigation of vessels in the Sacramento-San Joaquin Delta. In 2006 the largest waterbody in the Delta, Franks Tract, began to be managed at operational scale utilizing fluridone. A fluridone pellet formulation was applied to achieve in-water concentrations of fluridone between 2.5 and 3.5 ppb for 8 to 16 weeks in areas with dense *Egeria densa*. Fluridone applications were started as early as March and continued throughout the treatment period to sustain the target concentrations which were verified by an enzyme-linked immunoassay (ELISA) analytical test. Relative frequency of occurrence for native plants significantly increased from 2006 to 2017 ($p < 0.001$). Frequency of occurrence of most native species remains variable across years except for *Potamogeton richardsonii* where frequency of occurrence increased greatly from 3.6% in 2013 to 80% in 2017 ($p < 0.001$), and significantly increased each year sequentially except between 2015 to 2016 to become the most widespread species. The increase of native plants over the past five years, following management with fluridone, is likely to improve fisheries, native species habitat, and waterway traffic.

Introduction

- The Sacramento-San Joaquin Delta has been infested with *Egeria densa* since the 1980's and fluridone herbicide treatment for the invasive plant have been going on since the late 1990s.
- Fluridone's mode of action avoids toxicity on non-target species and reduces impact to non-target plants
- Studies on fluridone and invasive aquatic plant control tend to focus on efficacy on target plants without necessarily reviewing the potential for restoration and improving native plant communities.
- The Delta is home to robust fisheries, waterfowl hunting, and provides habitat for the endangered delta smelt (*Hypomesus transpacificus*).
- Changing fisheries trophic status to thick, dense, monotypic vegetated mats may negatively affect the endangered delta smelt by supporting increased predation by favoring intermediate size predators.
- The judicious use of herbicides as part of Integrated Pest Management (IPM) is an effective and environmentally sensitive approach for plant control
- This approach relies on strategically employed practices that result in achieving measurable management goals.



Materials and Methods

- In-water concentrations of fluridone were targeted between 2.5 and 3.5 ppb for 8 to 16 weeks per-year in areas with dense *Egeria densa*.
- Fluridone pellets were purchased from SePRO Corporation under trade names SonarOne, Sonar PR, and Sonar Q.
- Target concentrations were verified by an ELISA analytical test.
- We conducted point intercept surveys in the fall of each year.
- To sample each point we used a weighted, double-headed, 0.33 m wide rake. We recorded each species of submerged macrophyte that was present on the rake.
- The relative frequency of occurrence (ratio) was calculated for native and non-native plants as two separate groups.
- Plants found per point was used as a diversity metric

Results and Discussion

- Potamogeton richardsonii* frequency of occurrence increased greatly from 3.6% in 2013 to 80% in 2017 ($P < 0.001$), and significantly increased each year sequentially except between 2015 to 2016 (Figure 1).
- Native plant species per point increased every year ($P < 0.001$ to 0.34) except for 2017 where a significant decrease compared to 2016 was observed (Figure 2).
- This decrease may potentially be due to the increase and dominance of *Potamogeton richardsonii*
- Increasing the number of different native plant species can have several benefits on fisheries compared to monotypic weed beds
- By selectively targeting sensitive invasive species at the onset of vegetative growth, collateral damage to native or desirable species can be avoided



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