QUANTIFYING THE EFFECTS OF TIDAL RESTRICTIONS AND PLANT INVASIONS ON RESIDENT FISH IN ATLANTIC COAST SALT MARSHES

BY

KIMBERLY LELLIS DIBBLE

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

BIOLOGICAL AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF RHODE ISLAND

2012

ABSTRACT

This research investigates the combined effects of tidal restriction and *Phragmites australis* invasion on habitat quality for marsh fauna across a large geographic area while evaluating the reversal of those effects through ecological restoration. We used meta-analytic tools and published literature to examine differences in the quantity, condition, and diversity of fauna in invaded and restored marshes relative to uninvaded (reference) marshes in the mid-Atlantic and in New England. In addition, we collected data for two projects designed to move beyond the collection of community data (e.g., density, richness, as included in the meta-analysis) to assess the functional response of nekton to tidal restrictions and habitat restoration.

We examined community data from 43 published studies that compared faunal patterns in *P. australis* vs. native *Spartina alterniflora* marshes. Using the log response ratio, we found a decrease in the quantity and condition of fauna in invaded marshes relative to reference marshes. We detected differences by region, habitat type, taxonomic group, and life history stage, with adverse impacts to fauna residing in the mid-Atlantic, to those utilizing the marsh surface, for nekton, and particularly for the larval/juvenile life history stage. We compared data from restored and reference marshes and found no significant differences across all categorical variables, suggesting that impacts of the *P. australis* invasion were reversed through restoration.

We examined impacts to the functional role of salt marshes by assessing how the change in dominant primary producer from native *S. alterniflora* to introduced *P. australis* affects energy flow through salt marsh food webs. We found that palatable dietary items such as suspended particulate matter (SPM, a proxy for phytoplankton)

and benthic microalgae (BMA) are important primary producers at the food web base in reference marshes for *Fundulus heteroclitus*, a resident secondary consumer. In restricted marshes primary consumers rely on SPM and less on BMA, resulting in a shift in diet toward invasive plant consumption. This is likely due to increased shading of the marsh surface that decreases BMA biomass, which has also been noted in mid-Atlantic marshes. Restoration increased the importance of BMA, indicating a shift in ecological recovery toward the uninvaded state.

Using physiological and morphological indicators of fish condition, we found that *F. heteroclitus* in restricted marshes exhibit significant reductions in energy reserves, lower proportions of gravid females, and higher incidences of parasitism relative to fish in unrestricted salt marshes. Parasitized fish exhibit significant reductions in lipid reserves; however, when parasitized individuals were removed from the analysis the significant difference between the restricted and reference marsh fish remained. Fish in tidally restored marshes were equivalent to those in unrestricted marshes, with similar energy reserves, gravidity, and parasite load. Fish in all marshes (regardless of restriction status) exhibited similar growth rates and morphology.

Overall, results indicate that tidal restrictions and subsequent *P. australis* invasion has reduced the quality of habitat for estuarine communities including the dominant salt marsh resident, *F. heteroclitus*. However, our analyses indicate that ecological restoration can mitigate these effects over relatively short time scales. These findings should be of great interest to restoration practitioners, particularly those that are currently making habitat management decisions regarding the restoration of coastal salt marshes colonized by common reed.