Field Notes

Stakeholder-Driven Research in Phragmites Management in New England Salt Marshes

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Overview

Methods of resource management and conservation originated in economic theory during the late 19th century. Historically, communities controlled their environments to enhance development and maximize the harvest of key species. For generations tidal marshes were drained and tidal flooding eliminated in New England to utilize coastal property. These methods improved harvests and development but left coastal ecosystems vulnerable and invasive plants have begun to out-compete native plants. More recently, new theories of conservation biology have focused on the role of humans in the management of local ecosystems. We now recognize the benefits of ecosystem services such as water filtration, breeding habitat, and aesthetic value to society that do not necessarily have direct financial rewards. However, management strategies are still frequently imposed in a top-down fashion. This type of management is largely done by small groups of experts imposing strategies over large regions. In the process, local community needs and values are often ignored resulting in dissatisfaction and even hostility towards managers.

Effective invasive species management must first focus on the environmental changes that have occurred as a consequence of the invasion and then develop a strategy to restore the system back to the original state (Schroeder and Keller 1990). Without accurate environmental monitoring, these changes are best understood through the experiences of local stakeholders who directly interact with the environment. This local ecological knowledge can be a valuable tool to guide experimental research (Bart 2006). Without local ecological knowledge there is little context for understanding ecological change, the root of its causes, or its impacts on social and ecological communities (Berkes and Jolly 2001). Moreover, engaging local stakeholders is critical to generating support for any management strategy.

Introduction to the Ecological Issue

A native to North American marshes, recent expansions of *Phragmites australis* (common reed) along the Atlantic coast is the result of a non-native haplotype introduced from Europe in the late 1800s (Saltonstall 2002). This new haplotype is a competitively superior ecotype and recent alterations in tidal flooding due to coastal development in New England salt marshes have improved growing conditions for the new haplotype (Bertness et al. 2002; Vasquez et al. 2005). Because other haplotypes are native to the region, invasive stands are difficult to recognize and control measures are problematic. Returning hydrologic settings to their original state is often an expensive and sometimes impossible solution, so other strategies need to be identified.

Salt marshes are critical habitats for many economically and ecologically important species and this new version of *Phragmites* out-competes native

species, including *Spartina patens* (salt hay), *Spartina alterniflora* (cord grass), and *Distichlis spicata* (spike grass). Native grasses are valued as a source of ground cover and are harvested locally to protect soils and winter crops. New England coastal communities are attractive to birders and recreational fishers and local economies are bolstered by tourism. By reducing plant diversity and altering marsh composition, *Phragmites* expansion creates a habitat that is unsuitable for marsh bird nesting and has reduced fish and invertebrate biodiversity (Able and Hagan 2000; Angradi et al. 2001). The resulting salt marsh has diminished value for hunting, fishing, and birding all of which are valued by local stakeholders. Community members have identified reductions in birds and fish as a result of lost native salt marsh vegetation and are concerned that these changes may have long-term consequences for tourism. The ecological value of salt marshes that do not directly support the local economy, such as their role in flood protection or invertebrate life cycles, were also identified as being important to local environmentalists. Most often, however, the ten-foot tall *Phragmites* reeds were identified as impinging on the aesthetic value of the marsh by destroying the pleasant views of the landscape. Instead of watching the tides roll in and out with waterfowl nesting among the shorter, native grasses, landowners and tourists can only watch the unwanted reeds sway back and forth among the breezes.

Problems with Current Management Strategies

In many regions of New England, salt marsh vegetation no longer resembles its original state prior to the development of agriculture, industry and neighborhoods. The elimination of tidal flooding with dikes has altered the physiochemical makeup of marsh water and many wetlands have been drained to improve their agricultural productivity (Portnoy 1999). These changes in local hydrology have transformed the balance between competing species of vegetation (Bertness and Ellison 1987). The new haplotype of *Phragmites* aggressively expands into these altered habitats and out-competes other marsh grasses (Chambers et al. 2002; Saltonstall 2003). The Egypt River flows into the Plum Island Sound, an estuary-salt marsh ecosystem protected by the Parker River National Wildlife Refuge and Sandy Point State Park (Figure 1). The elimination of small-scale patches of *Phragmites* is important to long-term marsh restoration because these stands act as reservoirs, continuing to supply newly propagating rhizomes with oxygen, nutrients and water that help the *Phragmites* recover and re-invade the area (Amsberry et al. 2000).

Control of *Phragmites* invasions in salt marshes is generally by broad-scale projects coordinated by centralized governments that ignore the role of the local stakeholder (Theobald et al. 2000). These projects involve the excavation of marsh habitat to return natural hydrologic conditions and remove underground rhizomes, the indiscriminate application of herbicides to kill vegetation, or the widespread use of fire to eliminate above-ground biomass. These methods alone or in combination have been successful in many situations, but require a coordinated effort from many specialists as well as financing from centralized governments (Ailstock et al. 2001). Such projects take time and money and often fail to eliminate small, remnant stands of *Phragmites* in the upper marsh that can act as refugia from which subsequent reinvasions can spread. Also, these methods might not be locally acceptable or applicable by the landowner.

Working with Communities to Understand the Problem

For many years, stakeholders in the communities of Ipswich, Rowley, and Newburyport, Massachusetts have recognized the expansion of *Phragmites* in the nearby Egypt River Salt Marsh and Plum Island Sound. With the intention that he would provide scientific evidence concerning current management solutions, our second author was solicited to participate in community meetings, attended by landowners and other community members. During these meetings, stakeholder descriptions of expanding *Phragmites* stands over the last fifteen years mirrored documented evidence of *Phragmites* growth in other New England marshes (Amsberry et al. 2000; Wacker 2005).

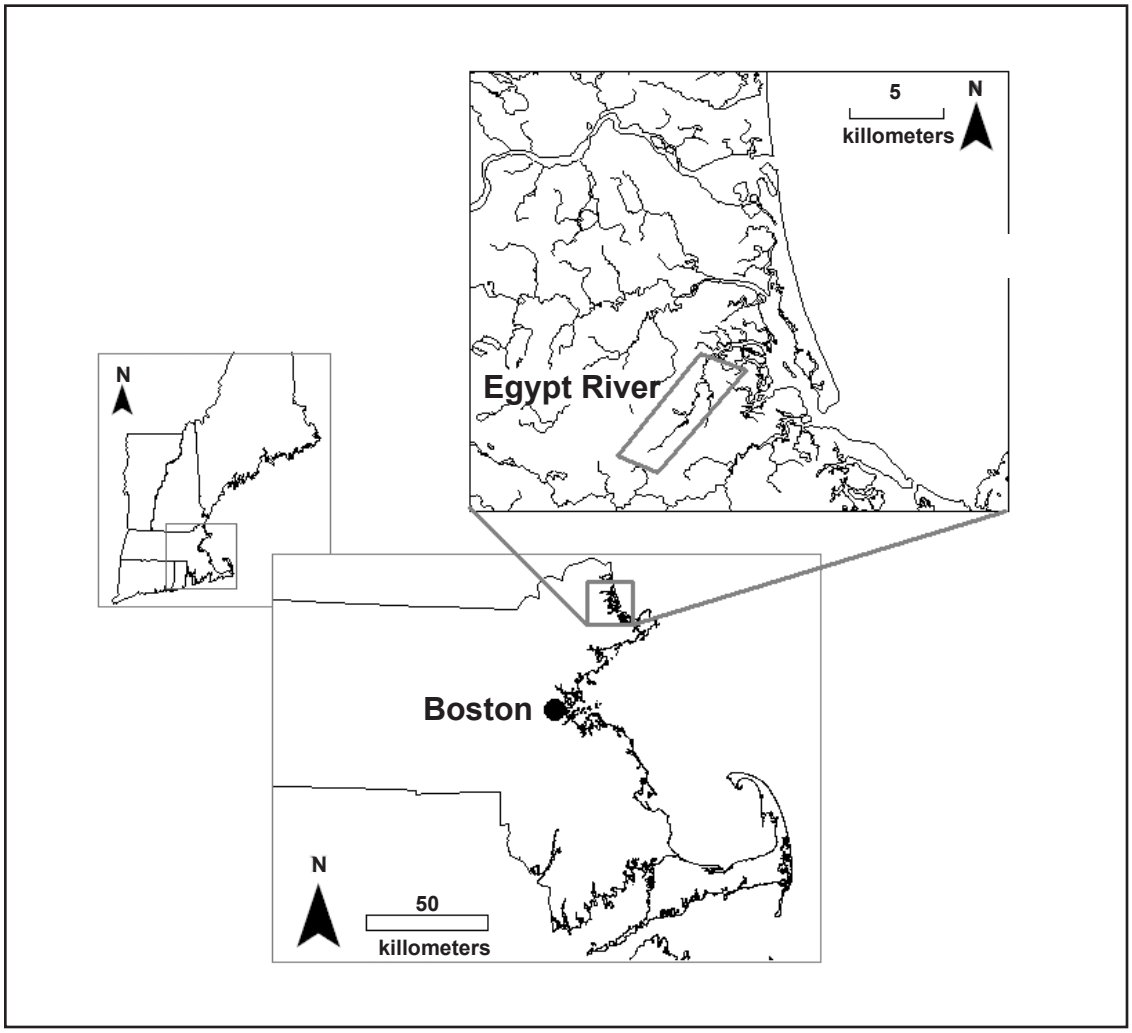

Figure 1. Map of New England, Massachusetts, and the Egypt River salt marsh located west of the Plum Island Sound and the Parker River National Wildlife Refuge.

We used these meetings to gather local perceptions concerning appropriate methods of management, and then conducted interviews with local landowners to better understand the situation and their needs. By walking us through personal experiences concerning vegetation changes, marsh landowners, farmers and other residents helped us visualize the original salt marsh, understand the impact of *Phragmites* propagation, and arrive at realistic goals for the future of the marsh. Many long-term landowners were capable of describing the conditions of the original marsh decades ago and were eager to take an active role in restoring it to its original appearance. Through these group discussions and interviews, it became apparent that homeowners along the coast wanted scenic views of their landscape, access to the marsh, and habitat for wildlife. Farmers wanted adequate supplies of native grasses for salt marsh hay, and local fishing and hunting groups wanted improved habitats to restore native fauna. The problem then became developing a locally appropriate method for controlling small-scale invasions.

Developing Appropriate Control Methods

Instead of forcing a management solution upon the community, we shared ideas and brainstormed new methods. Using feedback from these community meetings, we worked with one landowner to test the

effectiveness of a small-scale management strategy. The informant had lived in the region of interest for multiple decades and contacted us to voice his concern, like many in the community, about changes he had observed to the salt marsh. His goal was to improve the aesthetic value of the property with the hope that this would enhance the ecological habitat for all species. As scientists, it was our goal to develop a locally appropriate strategy that restored habitats for aquatic and terrestrial species alike.

A number of stakeholders identified the manual cutting of *Phragmites* using a mower or weed whacker as a viable alternative to spraying herbicides and burning marsh grass. Mowing was suggested because most landowners are already in possession of a mower and many already use them to reduce vegetation cover on their lands during the fall season. Mowing can also be contracted out to local landscaping and maintenance companies with relative ease. Stakeholders perceive cutting as a much more environmentally sensitive option since it does not involve chemicals and does not harm non-target species. Furthermore, a mower is relatively inexpensive and its ease of use will not discourage treatments by novices, unlike the application of blanket herbicides or fire.

A locally applicable method of management shifts the responsibility of invasive species control to local stakeholders. By providing strategies that are acceptable and viable for small-scale settings, communities are empowered to take an active role in the preservation of their local environment.

In preparation for winter, *Phragmites* translocates resources from the stem into the rhizome below ground following seed set (Granéli et al. 1992). The rhizome then propagates underground to generate new ramets in the following growing season. Exploiting this life-history trait, we tested the hypothesis that the timing of stem removal relative to seed set was critical to successfully controlling the propagation of new plants. *Phragmites* stands were then cut before and after seed set to test this hypothesis.

After five years of seasonal mowing, the timing of treatment did have a significant effect on *Phragmites* stem density (Kruskal-Wallis $\chi^2 = 6.894$, $p < 0.05$). *Phragmites* expansion had ceased or retreated where stands were mowed before seed set compared to uncut stands or stands mowed after seed set. Furthermore, the average stem density of these stands was significantly less (Dunn's test, $p < 0.05$) than the non-cut stands (Figure 2). The plants

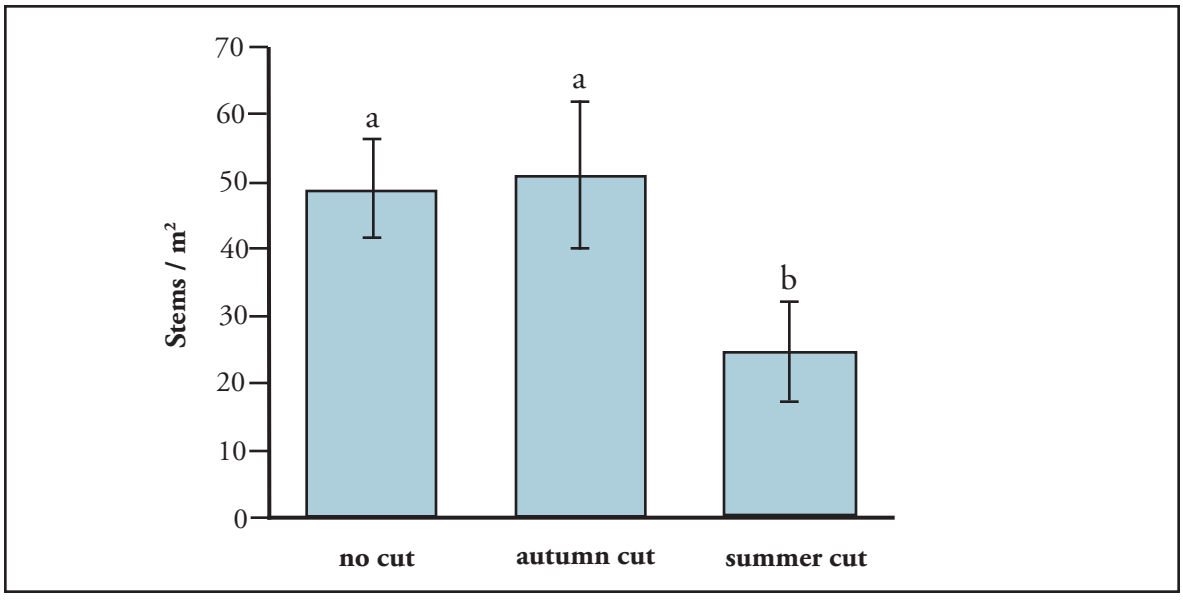

Figure 2. Mean (±SE) stems of *Phragmites australis* per square meter quadrant after five years of being mowed before seed set (summer cut, n = 15), after seed set (autumn cut, n = 15) or not mowed (no cut, n = 15) each year. Letters represent significant differences based on Kruskal-Wallis non-parametric ANOVA and a Dunn's post-hoc test.

that did survive the mowing before seed set grew much shorter in all the quadrants, while stands mowed after seed set continued to grow vigorously. Shorter plants are less visually obtrusive; they let more light into the salt marsh, exclude fewer native species, permit other species of grass to grow back, and provide a better habitat for wildlife. We shared these results with the community and the stakeholders were excited about them and the ecologically sensitive manner in which they were obtained.

Conclusion

Small-scale expansions of invasive species are difficult to detect using conventional monitoring methods. Local ecological knowledge can be a valuable tool for developing management strategies and actively engaging stakeholders encourages their participation in controlling these smaller invasions before they expand to unmanageable proportions. By eliciting the help of local stakeholders, management strategies can be adapted to address the needs of the community. Interviews and group discussions helped clarify the causes of the invasion and the solutions currently available to landowners and local stakeholders. The vast majority of stakeholders directly affected by changes in salt marsh vegetation have the power to be proactive, rather than the traditionally reactive approach when the problem gets to a broader scale (Karr 1990; Theobald et al. 2000). Local stakeholders are likely to interact with the marsh environment more frequently, at more points, and more personally than a government sponsored monitoring program, and thus are capable of detecting new *Phragmites* stands and utilizing a control regime at the earliest stages of invasion when mitigation projects are most effective. It was important to maintain contact with stakeholders to develop trust. By building relationships, we built local credibility that would not have been possible from a purely academic perspective. In our example, we worked with the community to determine the severity and extent of the invasion and develop an appropriate method of control. Although the method was tested using only one informant, its applicability to other properties was communicated. Testing a management strategy in a local setting provided more credibility to the community than laboratory results generated in an academic setting. By utilizing stakeholders as active participants in the management of their environment, they are more likely to continue applying the control mechanisms in the future. This is important, as long-term restoration of New England salt marshes will be dependent on local community participation.

Current methods for controlling *Phragmites* expansion at broad scales are often difficult to manage, costly, and environmentally disruptive; making them unfavorable options for many projects. A bottom-up approach to management prioritizes the needs of those locally impacted by the introduced species. Local stakeholders are in the best position to observe, detect, and address these changes in the natural environment before they grow into larger problems (Bart 2006). Landowners in Massachusetts identified the visual changes to the marsh vegetation and problems were identified without data. As local stakeholders often have the most invested in the preservation of their local environment, they are the ecologists' best resource for understanding past change and combating future invasions. To make meaningful changes in local biotic communities, ecologists must take advantage of the "bottom-up" approach to land management and provide tools appropriate for these local stakeholders (Theobald et al. 2000). Current methods of monitoring the ecological status of local environments are poorly funded and lack adequate coverage. Local ecological knowledge can fill these gaps and provide a historical account of environmental change.

By mowing right before seed-set, we reduced total *Phragmites* density and average *Phragmites* height while restoring native vegetation to the salt marsh in a manner consistent with the environmental values of the community. We used stakeholders to identify the ecological goals of the local community and then to evaluate the merits of different management strategies. Involving stakeholders aided the development of a successful, locally appropriate management strategy that could be implemented on a small-scale. Community meetings provided an opportunitiy to engage local stakeholders, understand

community values and address environmental issues. The development of appropriate methods for managing *Phragmites* at the local level can be critical for ecologists to achieve conservation goals at the landscape level.

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