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Nekton Use of Transplanted Eelgrass Beds in Narragansett Bay, Rhode Island

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Introduction

Eelgrass (*Zostera marina*) provides habitat for fish, shellfish, and crustaceans, stabilizes sediments, and can help improve water clarity. Eelgrass is also susceptible to disease, mechanical disturbance, and light reduction that results from eutrophication. Eelgrass has declined to the point where less than 100 acres remained throughout Narragansett Bay in 2006. To help reverse this loss, Save The Bay and the University of Rhode Island have been using an array of techniques to transplant eelgrass to suitable sites around the Bay and then monitoring the success rate of these transplants. The three sites that are showing successful growth of transplanted eelgrass (in 4 x 3 m plots) include Prudence Island (54% survival rate of 2005 transplants), Coggeshall Point (Portsmouth; 78%), and to a lesser extent, Sauga Point (North Kingstown; 36%). In addition to the vegetation success rate monitoring, benthic infaunal communities were sampled from transplanted and natural beds to begin to quantify the habitat value provided by the new beds. These data provide a good start, but more work is needed to better understand how these newly transplanted eelgrass beds are functioning relative to natural beds. To address this, the Narragansett Bay National Estuarine Research Reserve (NBNERR) and Save The Bay sampled nekton (fish and crustaceans) from transplanted and natural eelgrass beds in Narragansett Bay with the goal of providing a better understanding of how transplanted beds are functioning as habitat. Nekton is a useful metric to measure because it represents a high-order trophic level that integrates multiple ecosystem processes, and it is a charismatic group or organisms that the public can relate and respond to.

Methods

Nekton was sampled at two eelgrass transplant sites and two nearby natural eelgrass beds in 2006. The transplant sites include Nag West, on the west side of Prudence Island and within the Narragansett Bay National Estuarine Research Reserve (NBNERR) and Coggeshall Point, off nearby Portsmouth (Fig. 1). The natural sites include T-wharf and Sheep Pen Cove, both of which are off Prudence Island and are within the NBNERR. Eelgrass shoot densities have not been measured at these, but were clearly much lower at transplant sites where sparse eelgrass was mixed with sand patches. In contrast, eelgrass biomass was quantified by Save The Bay in 2006, and was similar at the three sites where it was measured. Total biomass (including belowground, sheath and leaf biomass) averaged 2.2g m^{-2}, 3.5g m^{-2}, and 3.4g m^{-2} at Sheep Pen Cove, T-wharf, and Nag West, respectively.

Nekton was sampled from each bed using 10 standard minnow traps on a monthly basis from June through September 2006. Samples were collected by deploying unbaited traps in each bed, allowing them to fish for 24 hours, and collecting them the following day. Individual traps were haphazardly thrown into each bed. Each transplant bed was paired with the nearest natural bed and the resulting paired beds were always sampled on the same day. All captured nekton were identified to the lowest possible taxonomic group, measured to the nearest mm for total length (or carapace width for crabs), and released.

Nekton parameters (e.g., abundance, composition, richness) were compared between transplant and natural eelgrass beds using a variety of statistical techniques. Total nekton abundance was compared between the two treatments using two-way nested Analysis of Variance (ANOVA) with site and month as main factors nested within treatment (natural and transplant beds). Nekton species richness at natural and transplant beds was calculated using the method described by Heltshe and Forrester (1983). For richness, all data from both beds in the same treatment and from all months were pooled before calculations to derive a total richness over the entire study. Richness between natural and transplant beds was then compared using Student's t-test. Nekton community composition was compared between natural and transplant beds using Analysis of Similarity (ANOSIM). Due to limitations in the ability to construct complex models in ANOSIM, a nested two factor design was used with site nested within treatment, and this test was performed separately for each month. Any differences in community structure between natural and transplant beds was analyzed using Similarity Percentages (SIMPER). Both ANOSIM and SIMPER are part of the Primer 6 package.

Results and Discussion

Twenty-one nekton species or species-groups, totaling 558 individuals were collected during this study from all four eelgrass beds (Table 1). This included 13 fish species (212 individuals) and 8 decapod species (346 individuals). Eight species comprised 90% of the community by abundance. In order of decreasing abundance, these include hermit crabs (*Pagurus* spp.), cunner (*Tautoglabrus adspersus*), black-fingered mud crab (*Neopanopeus sayi*), black sea bass (*Centropristus striata*), sand shrimp (*Crangon septemspinosa*), grubby (*Myoxocephalus aeneus*), green crab (*Carcinus maenas*), and winter flounder (*Pseudopleuronectes americanus*). Nearly all nekton captured in this study in eelgrass beds were small juveniles (Table 1), indicating that these beds were being utilized as nursery areas.

The total number of individuals and total number of species at all sites combined was variable among the four months of the study, and the only discernable trend was of highest richness in the summer, during July and August (Fig. 2). Clear temporal trends were also not observed for most individual species over the study period except for juvenile black sea bass, which were much more abundant in September compared to the other three months (total abundance of 0, 0, 7, and 55 individuals in June, July, August, and September, respectively).

Total nekton abundance did not differ between the transplanted and natural eelgrass beds (two-way nested ANOVA; $F=2.13$, $p=0.08$), and neither did total species richness (natural bed richness = 21.9 species; planted bed richness = 19.9; Student's t-test, $p>0.05$). Nekton community composition did not differ between the two treatments in June, July, or August (ANOSIM; June Global $R=0.25$, $p=0.67$; July Global $R=-0.25$, $p=1.0$; August Global $R=-0.25$, $P=1.0$). However nekton communities were significantly different between natural and transplant sites in September (ANOSIM; Global $R=0.398$, $p=0.001$). According to SIMPER, the species most responsible for this difference include

C. striata (responsible for 32% of the difference between the communities), *T. adspersus* (24%), *N. sayi* (13%), Atlantic silverside (*Menidia menidia*, 11%), and *Pagurus* spp. (11%).

These results suggest that recently transplanted eelgrass beds may support nekton assemblages that are similar to those in nearby natural beds. In this study, total nekton abundance and total species richness were not different between the two types of beds. Nekton community composition was also the same from June through August. In September, the difference was primarily due to a large influx of *C. striata* to the natural eelgrass bed at T-wharf, which was not seen at the other sites. However, this may not be a response to any actual differences between natural and transplanted eelgrass beds; instead it may be a due to the presence of other nearby habitats. The eelgrass beds at T-wharf are adjacent to a large Navy pier (the T-wharf), and since *C. striata* is a temperate reef fish that is common under piers and among pilings, the high abundance of this species in the T-wharf bed was likely a response to the pier being located nearby.

These results must be interpreted carefully because, by necessity, only two grassbeds of each type were sampled. In Narragansett Bay, there are currently only two areas (Coggeshall Point and Nag West) where transplanted beds are surviving at a high rate and where eelgrass biomass is high enough for nekton sampling. These two beds are surely not enough replicates to generalize nekton responses to transplanted beds in Narragansett Bay. In addition, subtle but important differences in nekton were apparent, but were not indicated by the statistical tests. For example, although total nekton abundance did not differ between natural and transplanted beds, it is clear that decapods such as *Pagurus* spp. and *Crangon septimspinosa* were more abundant in transplanted beds. This is surely due in part to the sparse grass present at this site, which was intermixed by unvegetated sand patches. Some of the traps at these sites were even deployed in the sandy areas next to grass because high water turbidity made finding sparse eelgrass difficult. In contrast, natural beds supported relatively more fish than transplanted areas, including juveniles of commercially and economically important species such as *P. americanus* and C. striata.

Summary and Recommendations

The results of this pilot project are promising and can be used to guide future research into nekton use of restoring and transplanted eelgrass beds. Currently, it is not statistically valid to draw conclusions about nekton use of transplanted eelgrass in Narragansett Bay because only two transplanted areas were sampled in this study. Additional work should be undertaken in Narragansett Bay, but only when at least three eelgrass transplant areas have become established and stable.

The findings from this study can be used to guide and improve the next study. As stated, at least three beds of each type (transplant and natural) should be used. All sampled eelgrass beds should be grouped into three pairs, with each pair comprising one transplant and one natural bed, both of which should be in close spatial proximity to each other to minimize any potential effects of sampling beds from different regions of Narragansett

Bay. As in this study, sampling should be conducted monthly, but the length of the study period should be increased to include May through October to fully characterize the warm season use of eelgrass by nekton (e.g., Fig. 2 indicates that sampling started after many species had already begun using the grassbeds, and ended while some species were still abundant).

Ten locations in each bed should be randomly selected prior to any nekton sampling. These locations should be permanently marked through the duration of the study with a swivel-stake and float so that minnow traps can be placed at these marks, thus ensuring that each trap samples from within eelgrass (in this study, poor water clarity, and sparse vegetation at transplant sites resulted in some traps being deployed along eelgrass edges or sometimes on bare sand adjacent to eelgrass). Finally, concurrent eelgrass vegetation sampling should be conducted at one point during the nekton sampling study. This will not only characterize the biomass, density and leaf height in each replicate bed, but it will also help explain any differences in nekton that might be observed between transplant and natural beds. In summary if these steps are taken, repeated nekton sampling over time will lead to a solid understanding of how eelgrass restoration is improving habitat for ecologically and economically important nekton species in Narragansett Bay.

Literature Cited

Heltshe, J.F. and N.E. Forrester. 1983. Estimating species richness using the jackknife procedure. Biometrics 39:1-11.

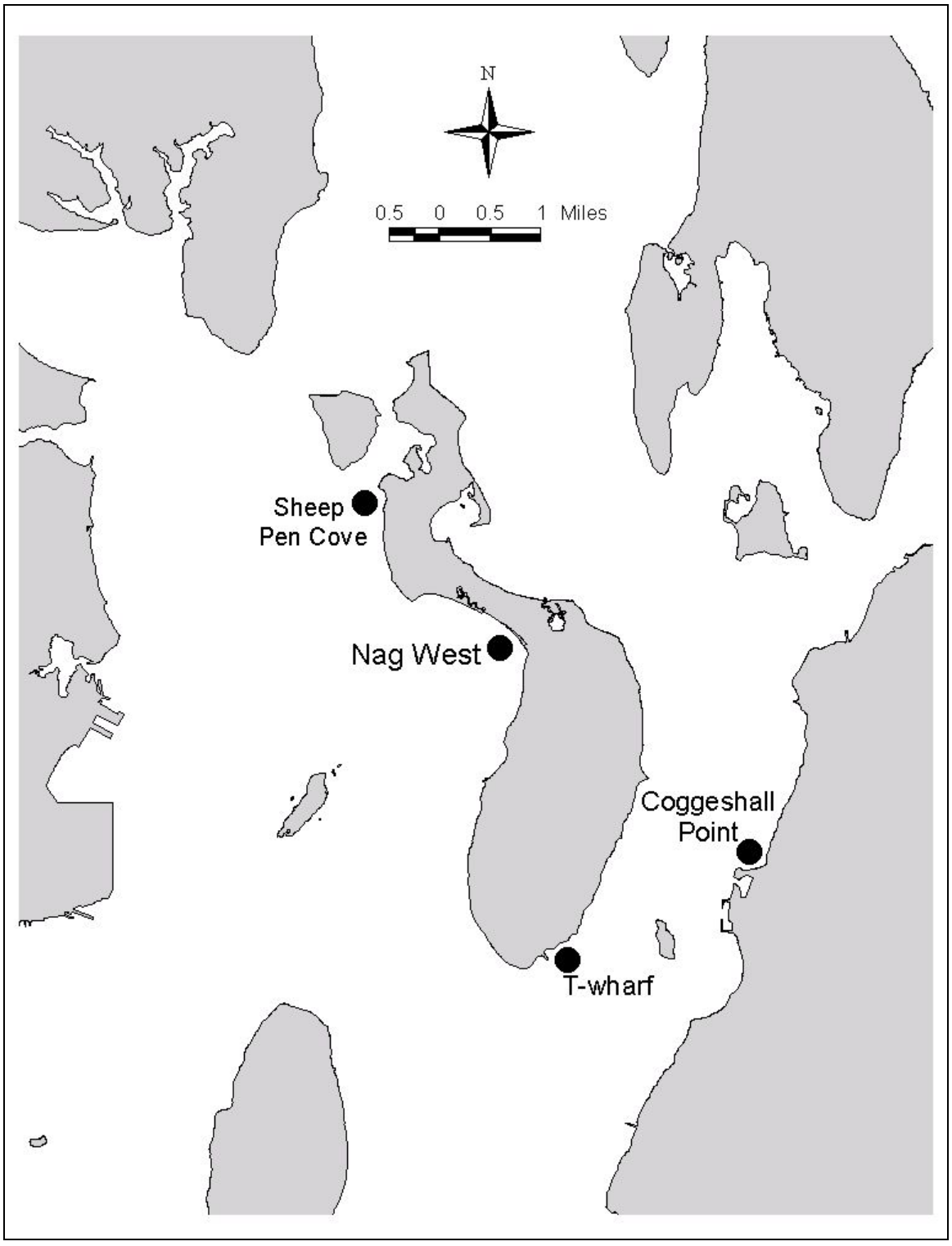

Figure 1. Map of the four study sites. Coggeshall Point and Nag West are eelgrass transplant sites. T-wharf and Sheep Pen Cove are areas of naturally occurring eelgrass.

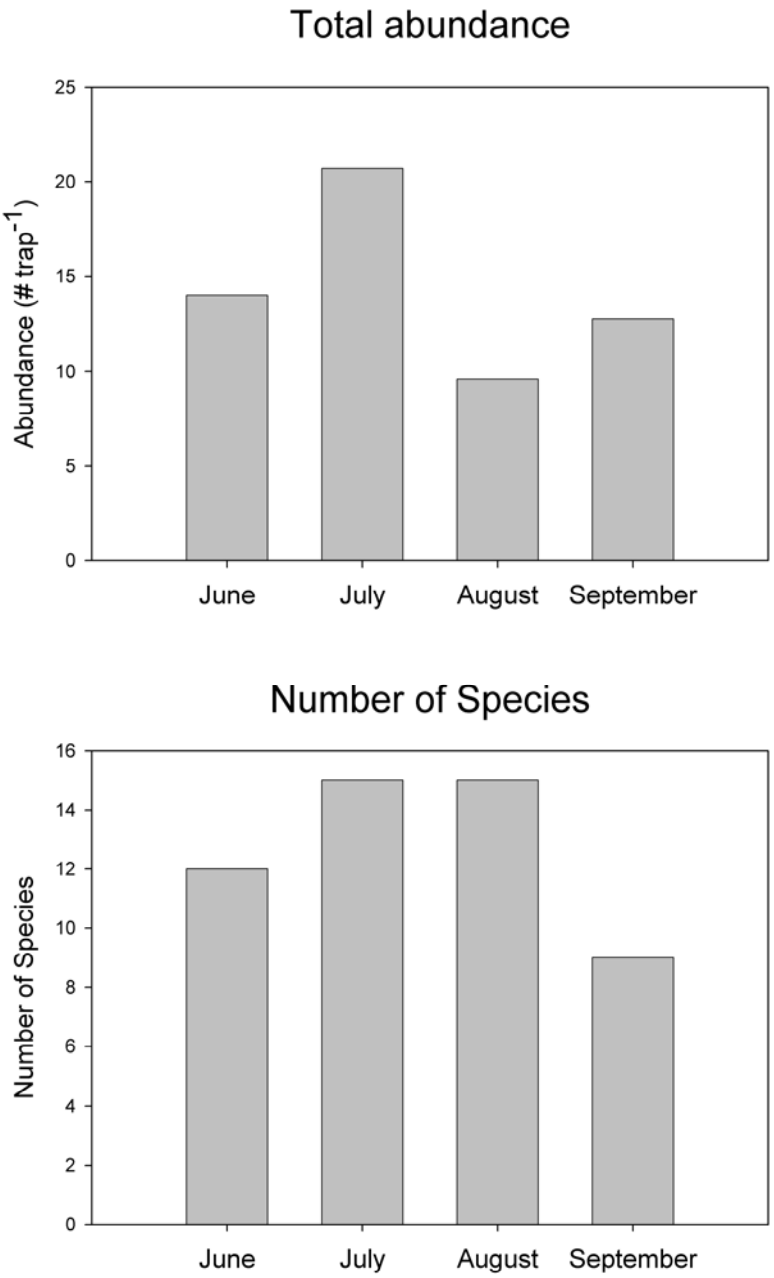

Figure 2. Abundance of all nekton combined and total number of species during the four months of the study. All data were pooled from the four sampling sites.

Table 1. Abundance of size of nekton captured in transplanted and natural eelgrass beds using minnow traps from June through September, 2006. Samples were collected with unbaited minnow traps; n=80 for each treatment.

Species	Common name	Abundance			Size (mm)		
		Natural	Transplant	Total	Natural	Transplant	Total
Pagurus spp.	Hermit crab	112	85	197		25.0	25.0
Tautogolabrus adspersus	Cunner	31	49	80	64.4	51.0	55.2
Neopanopeus sayi	Black-fingered mud crab	43	21	64	19.9	16.5	18.3
Centropristis striata	Black sea bass	61	1	62	66.1	80.0	66.4
Crangon septemspinosa	Sand shrimp	16	44	60	38.5	39.1	38.9
Myoxocephalus aeneus	Grubby	8	10	19	51.9	54.3	53.2
Carcinus maenas	Green crab	7	6	13	19.7	16.2	18.1
Pseudopleuronectes americanus	Winter flounder	6	5	11	52.2	44.6	48.4
Menidia menidia	Atlantic silverside	9	0	9	80.1	n/a	80.1
Anguilla rostrata	American eel	7	1	8	314.9	390.0	324.3
Conger oceanica	Conger eel	6	0	6	310.3	n/a	310.3
Syngnathus fuscus	Northern pipefish	1	5	6	171.0	169.2	169.5
Palaemonetes spp.	Grass shrimp	6	0	6	35.3	n/a	35.3
Panopeus herbstii	Black-fingered mud crab	2	1	3	12.0	12.0	12.0
Opsanus tau	Oyster toadfish	3	0	3	49.3	n/a	49.3
Gobiosoma spp.	Goby	0	3	3	n/a	37.3	37.3
Hemigrapsus sanguineus	Asian shore crab	2	0	2	24.5	n/a	24.5
Ophidion marginatum	Striped cusk eel	0	2	2	n/a	105.5	105.5
Microgadus tomcod	Atlantic tomcod	1	1	2	68.0	88.0	78.0
Hippolyte spp.	Eelgrass shrimp	1	0	1	23.0	n/a	23.0
Tautoga onitis	Tautog	0	1	1	n/a	55.0	55.0