

Ecological effects of *Spartina anglica* on the macro-invertebrate infauna of the mud flats at Bull Islands, Dublin Bay, Ireland

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Spartina anglica (C. E. Hubbard) is a relatively new invasive perennial grass species in Ireland. It is well adapted to the intertidal mudflat environment and forms mono-specific swards. There have been concerns about its potential to impact negatively the ecosystems of mud flats and salt marshes.

This ongoing project investigates the ecological effects of *S. anglica*, and its control, on the mudflats and saltmarsh at Bull Island, and the implications for management of *S. anglica*. The diversity and density of the macro-invertebrate infauna and some physical factors of the sediment were compared in: a) clumps of *S. anglica*, b) areas vegetated by *Salicornia* spp., c) an adjacent area of bare mud, and d) an unvegetated area. Presence of *S. anglica* had a significant effect on the density and diversity of macro-invertebrate infauna species. The results suggest that clumps of *S. anglica* can provide a habitat that supports a macro-invertebrate infauna as abundant and species rich as areas vegetated by *Salicornia* spp.

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The colonisation of intertidal mud flats by *Spartina anglica* (C.E. Hubbard) is known to have significant impacts on the ecology of this habitat (Gray et al. 1997), especially on the macro-invertebrate infauna associated with the sediments. Millard and Evans (1984) and Evans (1986) found that the macro-invertebrate fauna of *S. anglica* swards was generally depleted when compared to unvegetated mud flats. However other surveys have shown that sediments vegetated with *S. anglica* can have a relatively rich diversity and abundance of macro-invertebrate species (Jackson 1985, Frid et al. 1999). No regular trends have been observed in the comparison of the fauna of vegetated sediments with that of unvegetated sediments in other *Spartina* spp. marshes (Levin and Talley 2000). However it is generally considered that *S. anglica* has a negative impact on the macro-invertebrate infauna (Gray et al. 1997).

Spartina anglica has been controlled at Bull Island (grid reference NGR O 2438) by the management authorities since 1971, when it began to spread over mudflats. Control was implemented due to concerns that *S. anglica* would spread over mudflats, create a less diverse, mono-specific sward and have negative ecological impacts on the mudflats. This study examined the impact of *S. anglica* on the abundance and species richness of the macro-invertebrate infauna.

At present, *S. anglica* clumps occur in initial stages of colonisation in one area, which is also vegetated by *Salicornia* spp. The diversity and densities of macro-invertebrate species and some physical parameters of the sediment in clumps of *S. anglica* were compared to surrounding habitats. We hypothesise that clumps of *S. anglica* may not significantly lower the densities and species richness of macro-invertebrates on the mud flats at Bull Island.

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Methods and materials

Soil cores were taken from clumps of *S. anglica*, and from surrounding areas vegetated by *Salicornia* spp. and of bare mud (three habitats on the sediment bank). Cores were also taken from an unvegetated area on the mudflats off the sediment bank. Five replicate cores (28 cm², 10 cm depth) were used to sample for small more numerous *Hydrobia ulvae* and Oligochaetes, while five larger cores (256 cm², 10 cm depth) were used for the rest of the macro-fauna. Samples were sieved through a 5 mm plastic sieve. All macro-fauna were counted and identified using a binocular microscope according to Hayward and Ryland (1990). Five sediment samples were also collected at each habitat using plastic cores and analysed for bulk density, water content and loss on ignition (LOI).

Results

The most significant differences in species composition were found when the unvegetated site was compared to the three sediment bank habitats (Table 1). The three sediment bank habitats were dominated by *Littorina saxatilis* (Olivi), *Hydrobia ulvae* (Pennant) and marine Oligochaete species, while *Scoloplos armiger* (O. F. Muller), *Arenicola marina* (Linnaeus) and *Macoma balthica* (L.) were only found on the unvegetated site (Table 1). Similar species richness was observed in the three habitats on the sediment bank, while the unvegetated site had the most species (Table 1). Clumps of *S. anglica* had a significantly higher number of individuals compared to the unvegetated site, due to the presence of *Hydrobia ulvae*, Oligochaetes and *Littorina saxatilis* (Table 1). However, the number of individuals in clumps of *S. anglica*, while having a higher mean value, was not significantly different from those in the *Salicornia* and bare mud habitats (Table 1).

Differences in sediment parameters, such as in organic matter content (LOI) and percentage water content were significantly lower on the unvegetated site (Table 2) when compared to the sediment bank habitats. Sediment parameters were similar in the three habitats on the sediment bank apart from the significantly higher organic matter content (% LOI) in areas vegetated by *Salicornia* spp. (Table 2).

Discussion

Other surveys have also found that vegetated areas can have fewer species and differing species composition than open mud flats (Frid and James 1989, Levin and Talley 2000). The difference in fauna composition, in this study, could reflect environmental variation in factors such as organic matter content and sediment particle size distribution (Levin and Talley 2000). The presence of vegetation on the sediment bank is also important as it provides cover and can reduce environmental stress, e.g. due to differences in evapo-transpiration, on the fauna (Levin and Talley 2000).

Clumps of *S. anglica* may form more preferable habitats for some species that are attracted by greater plant cover. Flynn et al. (1996) found that stem density of *S. alterniflora* significantly influenced the type of infaunal community. Levin and Talley (2000) give examples of varying fauna composition in *Spartina* and *Salicornia* communities. However, there are no consistent trends for invertebrate species richness between *Spartina* and *Salicornia* habitats (Levin and Talley 2000).

In this study, species richness beneath clumps of *S. anglica* was greater than that reported by Millard and Evans (1984), but less when compared to another study (Jackson 1985). Although it has generally been suggested that *S. anglica* has a negative impact on the macro invertebrate

Table 1. Mean densities of selected species m⁻², mean total numbers of individuals m⁻² and total numbers of species in each habitat (with SE) (not all species found are presented). Results of a 1-way ANOVA evaluating effect of habitat are also presented with Student-Newman-Keuls multiple ranges. Means with the same letter are not significantly different.

Species	On sediment bank			Off bank		p-level			
	<i>Spartina</i> average	<i>Salicornia</i> average	Bare mud average	Unvegetated average					
Oligochaetes	6790 ± 2600	A	8000 ± 3440	A	143 ± 143	B	3860 ± 1160	B	0.0001
<i>Hydrobia ulvae</i>	17400 ± 4100	A	11100 ± 2890	A	19000 ± 2980	A	1360 ± 633	B	0.0011
<i>Littorina saxatilis</i>	2300 ± 227	A	789 ± 237	A	156 ± 55.2	B	7.8 ± 7.8	C	0.0001
<i>Nereis diversicolor</i>	23.4 ± 15.6	B		B	273 ± 86	A	23.4 ± 23.4	B	0.0001
<i>Scoloplos armiger</i>		B		B		B	890 ± 166	A	0.0001
<i>Arenicola marina</i>		B		B	7.8 ± 7.8	B	164 ± 90.3	A	0.0014
<i>Macoma balthica</i>	7.8 ± 7.8	B		B		B	62.5 ± 19.9	A	0.0013
No. individuals	26500 ± 3150	A	19900 ± 4200	A	19600 ± 2990	A	6760 ± 1730	B	0.0046
No. species	8		5		5		9		

Table 2. Mean values and standard errors of bulk density, % water content and % LOI in each habitat and results of a 1-way ANOVA evaluating effect of habitat. (ns indicates not significant $p > 0.05$, ** $p < 0.01$, *** $p < 0.001$).

Habitats	<i>Spartina</i>	On sediment bank <i>Salicornia</i>	Bare mud	Off bank Unvegetated	p-level
Bulk density (g cm^{-3})	1.1 \pm 0.1	1.1 \pm 0.0	1.2 \pm 0.1	1.2 \pm 0.2	ns
% water content	28 \pm 0.5	31 \pm 1.3	28 \pm 3.0	23 \pm 0.6	**
% LOI	3.7 \pm 0.4	6.6 \pm 1.2	4.0 \pm 1.2	2.0 \pm 0.3	***

infauna, our results suggest that clumps of *S. anglica* can provide a habitat that supports an invertebrate fauna as rich and diverse as adjacent areas vegetated by *Salicornia* spp. There seems to be a significant site effect on comparable species richness in vegetated and unvegetated areas. Based on this evidence there is no justification for control of *S. anglica* at Bull Island, as *S. anglica* is not having a negative ecological impact on the macro-invertebrate fauna at present. Overall diversity is increased by the creation of new *S. anglica* habitat. However, the potential maturation of *S. anglica* habitat as the marsh develops is likely to affect the macro-invertebrate community in the future.

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