Artificial habitats deployed on seagrass return lower abundance and diversity of macro-invertebrates than those on sandy substrates in Geographe Bay, Western Australia

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Abstract Understanding changes in marine biodiversity relies on monitoring programmes that give accurate indications of the biological response to natural and anthropogenic drivers. Historic approaches have provided poor indications of nocturnal macro-invertebrate assemblages, particularly fisheries-independent methods that rely on visual assessments of transects, or video collection devices deployed for fixed time periods. Permanent artificial habitats, specifically designed for monitoring all invertebrate species, including those that are cryptic or nocturnal, could provide an ideal solution to this critical knowledge gap. Marine Invertebrate Collection Equipment (MICE) are artificial habitats that have been designed in Western Australia over a period of five years and are now deployed in many coastal locations where they are regularly sampled. The present study was conducted in Geographe Bay, Western Australia where replicate MICE units were deployed to determine the impact of placement on seagrass versus the standard protocol of deployment on a sandy substrate. A total of 4,403 individual macro-invertebrates were collected and categorised into 104 Parataxonomic Units (PTUs), which were then aggregated into 21 intermediate classification groupings, and again into 7 broader groupings. At the intermediate level of identification, gastropods dominated the community composition, followed by worms, bivalves, sponges and amphipods. At the broader level of identification, molluscs were the most prevalent, followed by crustaceans, worms and sponges. Placement of MICE on a seagrass substrate resulted in a significantly lower abundance of invertebrates than those placed on sand (p<0.05). These differences were adequately explained using broad and intermediate levels of identification and no significant additional information was gained by identifying organisms to the level of PTU.

Keywords marine, macro-invertebrates, artificial habitats, Australia, MICE

Introduction

Macro-invertebrates are an important component of any marine ecosystem, forming the basis of many food chains. They are difficult to sample because a large proportion of species are nocturnal or cryptic in nature and are therefore often overlooked during diver surveys. These problems can be addressed by the use of artificial habitats which control for variables such as substrate type, location and habitat shape, complexity and size (Valentine and Heck 1993; Hewitt et al. 2005). In previous studies,
macro-invertebrate assemblages collected on artificial habitats have been found to be influenced by season, conditioning time, and isolation from complex habitat (Virnstein and Curran 1986; Sogard 1989; Kenyon et al. 1999). Geographe Bay is a north-facing embayment located 200 km south of Perth, Western Australia. The bay is approximately 100 km long and the benthic habitat is predominantly seagrass (Lord 1995). A marine park is currently proposed for Geographe Bay and surrounding areas, and studies have determined that while the bay itself is relatively pristine, agricultural drains constructed in the 1950s, and a rapidly expanding population, have the potential to eutrophicate the waters and affect seagrasses as has been the case in other similar locations (DEC 2006).

This study is part of a broader investigation into the potential use of artificial habitats as long-term, community-based monitoring tools targeting nocturnal marine invertebrates in coral reef ecosystems and other coastal marine environments. Marine Invertebrate Collection Equipment (MICE) are artificial habitats that have been designed in Western Australia over a period of five years (Hoschke and Whisson 2005; Whisson et al. 2005) and are deployed in many locations where they are sampled for incumbent invertebrate fauna up to four times per year. MICE are deployed according to specific criteria that include: buffer zones from nearby reefs, specific depth ranges, and minimum distances from shore. MICE consist of components that mimic complex reef habitat and also finer-scale substrates like seagrass. In a study conducted by Goldsmith (2005), it was found that proximity to coral reefs influenced the resulting gastropod data and recommended a 50 m deployment buffer to gain representative data. The aim of the present study was to further refine MICE deployment criteria to determine if placement on seagrass affected invertebrate data compared to the current protocol of placing units on sandy substrates. Taxonomic sufficiency was also tested to determine whether changes in community structure could be detected at broader levels of identification.

**Materials and methods**

MICE consist of a soft mesh component (Tanikalon™ fibre) that has previously been used to collect puerulus larvae in the West Australian rock lobster fishery (Phillips 1972), and hard mesh component, both joined by ropes that are anchored to the seafloor by weights (Fig. 1). The hard mesh component is 12 cm long, comprised of six biotubes of 50 mm diameter and four tubes of 75 mm diameter held together in a cube-like shape. A float is located at the top of the rope and keeps the artificial habitat suspended to a height of 1 m above the sea floor (Fig. 1). High resolution orthophotography of Geographe Bay was imported into ArcGIS™ software and used to identify four
MICE deployment sites on a sandy substrate and four sites on seagrass substrate. Each unit was buffered by at least 50 m of its substrate type; for example, units placed on sand were surrounded by a circle of sand measuring at least 50 m radius. Of the MICE located on seagrass, two were placed to the north-east and two to the south-west of MICE located on sand in a random block design (Fig. 2). MICE were sampled 30 days after deployment on 19 February 2010. A standardised procedure was used to remove invertebrates from MICE as follows: 1. MICE were located by boat using a handheld GPS unit; 2. A diver detached each unit from its base and returned it to the boat; 3. Hard and soft mesh MICE components were placed into separate buckets of water; 4. Hard mesh components were ‘emptied’ using an elongated brush that was threaded through each tube three times; 5. One bucket of ocean water was then poured over the soft mesh collector and the unit shaken thoroughly in and out of the water to dislodge invertebrates; 6. Once invertebrates were removed, MICE were then redeployed by the diver; 7. All invertebrates collected were sifted through a 1 mm mesh size net, and fixed in a 4% formaldehyde solution on the vessel.

At the Curtin Aquatic Research Laboratories, all specimens were sorted from debris and classified into 7 broad groups: Mollusca, Crustacea, Worms, Porifera, Cnidaria, Echinodermata and Pycnogonida. Individuals were later separated into 21 intermediate groupings, and further sorted into parataxonomic units (PTUs). These three identification levels were used to test for taxonomic sufficiency. Both taxonomic sufficiency and substrate type (sand and seagrass effects) were tested using Bray-Curtis similarity on square-root transformed abundance data using the statistical package PRIMER-E (Clarke 1993). PERMANOVA was subsequently used to determine statistical significance, this works on multivariate data in the same way as ANOVA does on univariate data, however the data does not need to satisfy any assumptions.

**Results**

A total of 4,403 individual macro-invertebrates were collected and categorised into 104 PTUs, which were then aggregated into 21 intermediate classification groupings, and again into 7 broader groupings. At the intermediate level of identification, gastropods dominated the community composition, followed by worms, bivalves, sponges and amphipods (Fig. 3). At the broader level of identification, molluscs were the most prevalent, followed by
crustaceans, worms and sponges. Substrate clearly influenced the invertebrate communities present on MICE (Fig. 4), with multivariate comparisons revealing significantly different communities on sand MICE versus seagrass MICE (PERMANOVA, $F=3.347, p=0.027$). The diversity of macro-invertebrates was higher on sand than seagrass (54 PTUs versus 43 PTUs; $p=0.010, t=3.715$); as was the number of individuals retrieved from sand MICE (mean=683) versus seagrass MICE (mean=334) ($p=0.067, t=2.545$). At both broad ($F=3.403, p=0.035$)
and intermediate \((F=3.221, p=0.037)\) levels of identification, PERM-ANOVA detected a significant difference between the macro-invertebrate communities collected from sand MICE versus seagrass MICE, suggesting finer scale levels of classification may not be justified.

**Discussion and Conclusions**

The lower number of PTUs and individuals retrieved from MICE deployed within large seagrass beds is likely to be due, in part, to the “edge effect”, where the prevalence of macro-invertebrates tends not to be uniformly distributed within the habitat (Sogard 1989; Eggleston et al. 1998). Essentially, the periphery of the habitat supports a greater diversity and number of organisms (Virnstein and Curren 1986; Roberts and Poore 2006). Tanner (2006) reported twice the abundance of crustaceans in artificial seagrass beds surrounded by sand compared to those surrounded by seagrass. In the present study, MICE deployed on sandy substrates acted as “islands” of habitat that exhibited high perimeter to area ratios, whereas MICE on seagrass were quite probably an extension of a large habitat complex. The lower numbers of macro-invertebrates retrieved from MICE deployed on seagrass could also be partly attributed to a greater abundance of predators in seagrass beds. Many species of fish are known to use seagrass beds as nurseries for juveniles because seagrasses provide shelter and an abundant food supply in the form of small invertebrates; therefore, fish are often present in higher densities in seagrass beds than in neighbouring sand patches (Jackson et al. 2001; Nagelkerken et al. 2001). Previous studies focussing on infaunal densities in soft bottom substrates found no significant difference in these densities regardless of the increased population of reef fishes (Reise 1977; Virnstein 1977; Hall et al. 1990). Conversely, this study found significantly lower number of PTUs and individuals in MICE located on seagrass, which could be attributed to a higher abundance of predators in seagrass beds.

Importantly, the results of this study demonstrated no significant loss of statistical power when PTUs were aggregated to intermediate or broad levels of identification, which is consistent with previous studies by Herman and Heip (1988), Ferraro and Cole (1990) and Gray et al. (1990). Taxonomic sufficiency is generally only required to the level that indicates a community response to environmental changes (Ellis 1985); however, it has been suggested by Warwick (1988) that natural environmental variables tend to affect community composition at finer taxonomic levels, whereas anthropogenic effects modify community composition at higher levels. While this may result in less biological and species-specific information, it is very important for studies such as the present one, which forms part of a larger initiative to involve local schools and community groups in the management and monitoring of coastal ecosystems. Therefore, broader classification systems, that can be demonstrated as statistically valid, as was the case in this study, become attractive owing to a lower reliance on taxonomic expertise. Within this context, MICE are recommended as useful tools for detecting changes in marine macro-invertebrate communities.

**References**


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