2.2.11 Comparisons between benthic macroinvertebrate assemblages in estuarine and nearshore marine habitats

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Introduction

The nearshore marine and estuarine environments of south-western Australia comprise a range of different habitats, which can be distinguished on the basis of a suite of environmental characteristics. Differences among such habitats are thus likely to be reflected in differences in the compositions of their benthic macroinvertebrate assemblages. A thorough exploration of the ways in which these assemblages vary amongst habitats and the rigorous statistical analyses of faunal-habitat relationships depend firstly on the habitats having been distinguished on the basis of sound quantitative data and then on the ability to match statistically those data with quantitative data on species composition.

Components of study completed and in progress

Aim: To compare benthic macroinvertebrate assemblages in different nearshore marine habitats on the lower west coast of Australia.

Benthic macroinvertebrates were sampled seasonally in 2000 in the subtidal and upper and lower swash zones at two sites in each of six nearshore habitat types on the lower west coast of Australia. Five randomly located sediment cores were collected from each zone at each habitat type in each season in waters >1 m deep. The collection of samples from each site was staggered over a 2-3 week period in the middle of each season to reduce the chances of the resultant data being unduly affected by an atypical sample. The cylindrical corer, which was 11 cm in diameter and had a surface area of 96 cm^2, was sampled to a depth of 15 cm. The sediment samples were preserved in 5% formalin buffered in sea water and subsequently wet sieved through a 500 µm mesh.

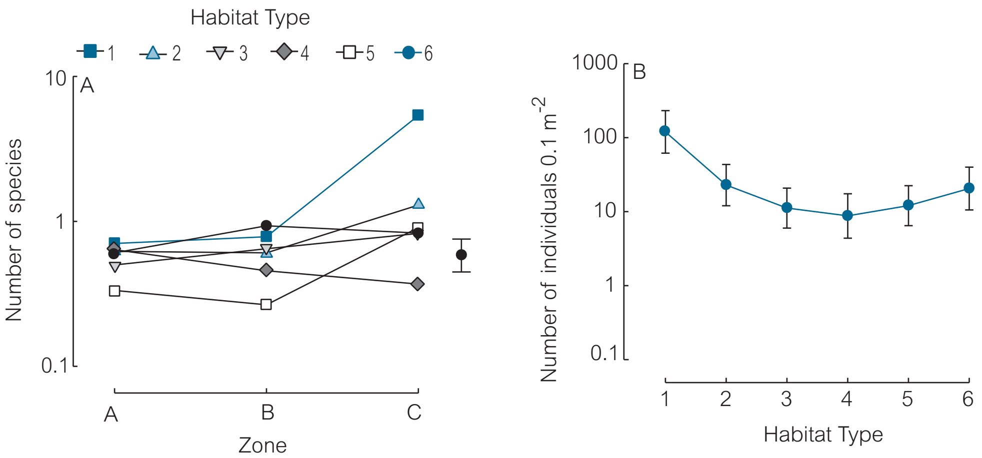

Figure 2.42: Mean (± 95% CI) (A) number of species in Zones A, B and C at habitat types 1-6 and (B) densities of benthic macroinvertebrates at habitat types 1-6, derived from samples collected in all seasons during 2000. For clarity, the overall mean ± 95% CI is provided for (A).

The habitat types, which differed mainly in the extent of their exposure to wave activity and whether sea grass and/or nearshore reefs were present, had been distinguished quantitatively using values for a suite of seven statistically selected enduring environmental characteristics (Valesini et al. 2003).

The core samples yielded 121 species representing eight phyla, among which the Polychaeta, Malacostraca and Bivalvia were the most speciose classes, contributing ~ 38, 23 and 10%, respectively, to the total number of individuals. The mean number of species and mean density of macroinvertebrates were far greater in zone 3 at habitat type 1 than at any other habitat type (Fig. 2.42).

Habitat type influenced species composition to a greater extent than either zone or season. Furthermore, the extents of the differences among the species compositions of the six habitat types statistically matched the extents of the differences among the values for the suite of enduring environmental characteristics that distinguished each of those habitat types. Overall, the species composition at habitat type 1 was the most distinct (Fig. 2.43A) and was characterised by five abundant species of polychaetes that were adapted to deposit-feeding in calm waters with high levels of organic material and which were rare in all other habitat types. In contrast, the fauna at the most exposed habitat type was characterized by four crustacean species and a species of bivalve and polychaete, whose mobility and tough external surface facilitated their survival and feeding in turbulent waters. The differences in faunal compositions among habitat types were greatest in the case of the subtidal zone (C) (compare Figs. 2.43B and 2.43C). The faunal compositions differed among zones and seasons only at the most protected habitat type.

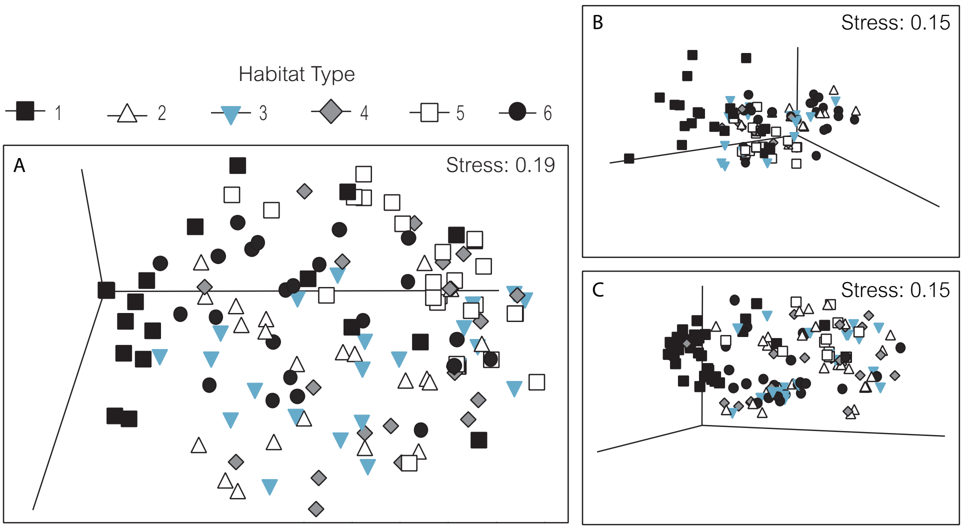

Figure 2.43: Three-dimensional MDS ordination of the densities of benthic macroinvertebrate species in samples collected at habitat types 1-6 during the summer, autumn, winter and spring of 2000 in (A) Zones A, B and C, (B) Zone B and (C) Zone C. Each sample is coded for habitat type.

Aim: To classify nearshore habitats in the Swan-Canning Estuary.

Environmental data (e.g. depth data and aerial photographs) were sourced and used to generate information on 18 different variables for one hundred sites in the lower, middle and upper regions of the Swan-Canning estuary. These variables characterised each site in terms of three broad scale parameters:

1) Its location within the estuary- distance from estuary mouth.

2) The extent of its exposure to wave action - modified effective fetch distances in 9 different directions, distance to the two-meter depth contour and the average slope.

3) The type of substrate present - percentage contributions of sand, vegetation (seagrass and macroalgae), rock, snags, reeds and bivalve beds to the substrate located within a 100m arc from the center point on the shore at each site.

The GIS package ArcGIS 9 was used to generate information on the variables reflecting location and exposure to wave action. In order to determine the contributions of the various types of substrate at each of the sites, aerial photographs were classified using the GIS program Idrisi Kilimanjaro v14.

A subset of these 18 variables was selected using the BVSTEP procedure in the PRIMER v 6 statistical package as those that accounted for most of the variation among the sites. The data for the subset of variables was then used to classify the one hundred sites into different habitat types with the use of the SIMPROF module in the PRIMER v 6 statistical package. Ten habitat types were distinguished in the Swan-Canning Estuary, eight of which are described in Fig. 2.44.

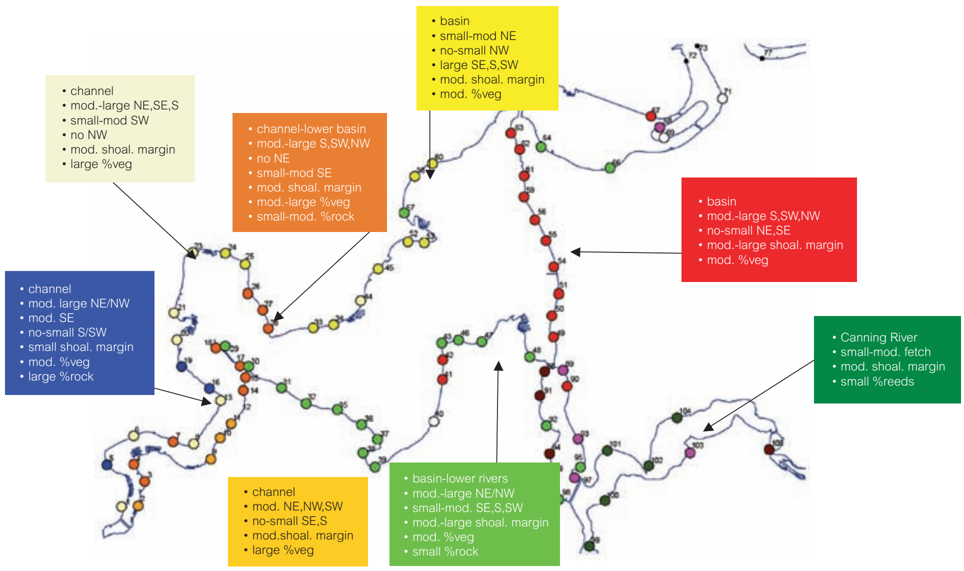

Figure 2.44: Main habitat types in the Swan Canning Estuary distinguished on the basis of a range of enduring environmental variables. Lists of defining characteristics are provided.

Aim: To compare benthic macroinvertebrate assemblages in different nearshore habitats in the Swan-Canning Estuary.

Sampling of benthic macroinvertebrates in the shallow subtidal regions at pairs of sites representing six of the habitats that were classified in the Swan estuary was carried out during summer and winter 2005. The same methods as those used in the marine component of the study were used. The subsequent data will be used to investigate the extents to which the benthic macroinvertebrate fauna differ among habitat types and seasons in the Swan-Canning estuary and whether any such differences match those in the environmental variables that that were used to distinguish those habitat types.

Aim: To compare recent and historical data on benthic macroinvertebrate assemblages in the basins of the Swan-Canning and Peel Harvey estuaries.

Seasonal sampling of benthic macroinvertebrates was carried out at eight sites in the Swan-Canning and Peel-Harvey estuaries between winter of 2003 and winter of 2004 in order to make direct comparisons with data collected during a study carried out by Rose (1994) at the same sites between winter 1986 and winter 1987. The sites were originally chosen by Rose to represent a wide range of habitats found throughout the basins of each estuary and the Swan Estuary was used as a reference against which to compare the highly eutrophic Peel-Harvey Estuary. Since the completion of that study the construction of an artificial entrance channel between the ocean and the estuary at Dawesville has facilitated flushing of the Peel-Harvey Estuary with marine water and has ameliorated those extreme conditions. The aim of this study was to examine the ways in which such anthropogenic interactions can affect benthic macroinvertebrate fauna.

Five randomly located sediment cores were collected from each of the eight sites in waters >1 m deep during the day in each season between the winter of 2003 and winter of 2004. The collection of samples from each site was staggered over a 2-3 week period in the middle of each season to reduce the chances of the resultant data being unduly affected by an atypical sample. The cylindrical corer, which was 11 cm in diameter and had a surface area of 96 cm^2, was sampled to a depth of 15 cm. The sediment samples were preserved in 5% formalin buffered in sea water and subsequently wet sieved through a 500 μm mesh.

Swan-Canning Estuary

The results generated from the 2003/2004 data were consistent with that recorded by Rose (1994) in 1986/1987, *i.e.* 43 vs 39 species and 11718 vs 11822 individuals, respectively, which correspond to totals of 122062.54 vs 123145.87 individuals, when the number in each sample is adjusted to that in 0.1 m^{-2} and summed.

Overall the mean number of species differed significantly between time periods (9.62 ± 0.41 vs 8.75 ± 0.41, respectively). However, there were significant interactions between time periods, seasons and sites (Fig. 2.45).

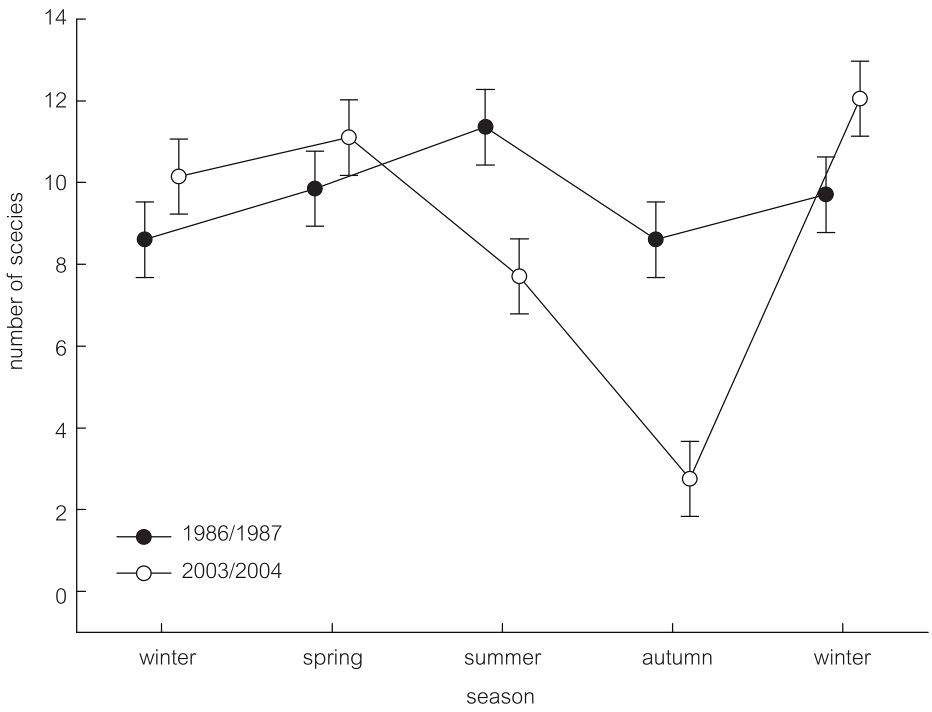

Fig. 2.45: Mean (+/- 95% CI) for the number of species recorded at four sites in five seasons during 1986/1987 and 2003/2004 in the Swan-Canning Estuary.

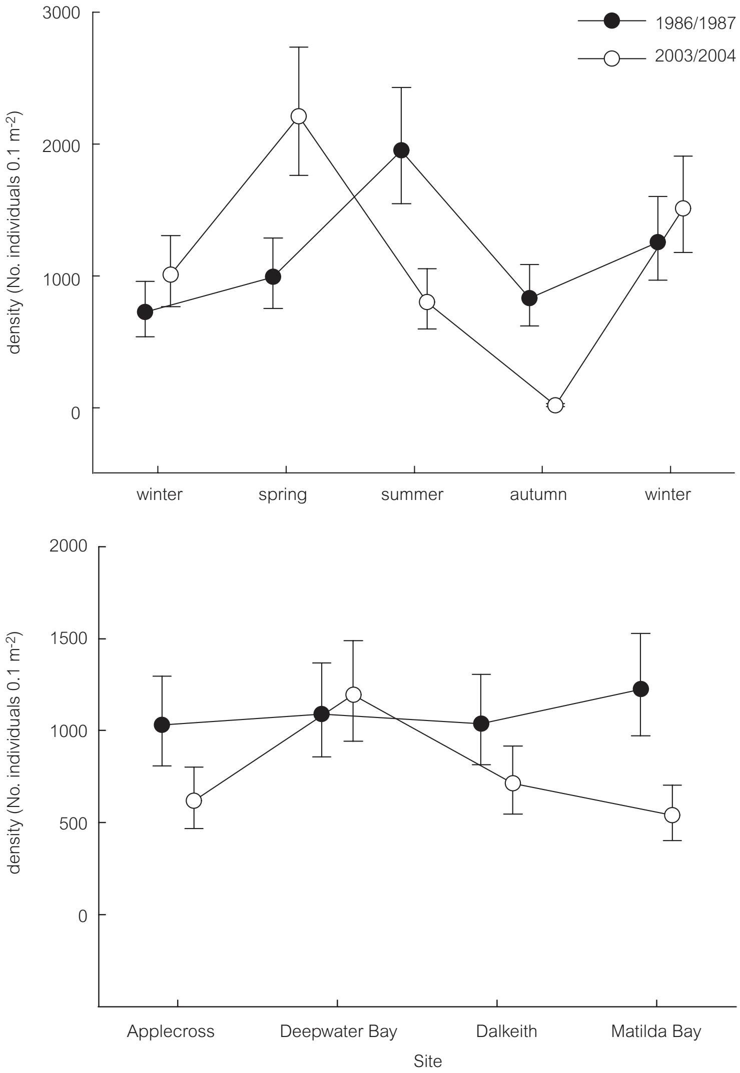

Fig. 2.46: Mean (+/- 95%CI) for the densities of benthic macroinvertebrates recorded during 1986/1987 and 2003/2004 in the Swan-Canning Estuary A) in five seasons and B) at four sites.

The mean density of benthic macroinvertebrates was significantly greater in 1986/1987 than in 2003/2004 (1094.94 ± 122.38 *vs* 737.87 ± 90.64, respectively). There were also significant three-way interactions between time periods, seasons and sites (Fig. 2.46).

The compositions of the benthic macroinvertebrate fauna in the Swan-Canning Estuary were influenced to a far greater extent by time period than by any other factor and were less variable in 1986/1987 than in 2003/2004 (Fig. 2.48A). Greater densities of the crustaceans *Grandidierella propodenta*, and *Tanais dulongii*, the bivalve *Arthritica semen* and the polychaetes *Boccardiella limnicola* and *Ceratonereis aquisetis* in 1986/1987 and greater densities of the bivalve *Sanguinolaria biradiata*, the polychaetes *Capitella* spp. and *Pseudopolydora* sp. 2 and the amphipod *Corophium minor* in 2003/2004 distinguished the species compositions between these two time periods.

Peel-Harvey Estuary

The total number of individuals recorded by Rose (1994) in the Peel Harvey Estuary in 1986/1987 (30669) was ~ three times greater than that recorded during 2003/2004 (9233), which correspond to totals of 319468.85 *vs* 96177.11 individuals, when the number in each sample is adjusted to that in 0.1 m^{-2} and summed. In contrast, the number of species recorded by Rose (1994) was ~ half of that recorded in 2003/2004 (28 *vs* 65).

Overall the mean number of species did not differ significantly between time periods, however there were significant interactions between time periods, seasons and sites. The mean density of benthic macroinvertebrates was significantly greater in 1986/1987 than in 2003/2004 (2862.12 ± 276.94 vs 679.12± 92.62, respectively). There were also significant three-way interactions between time periods, seasons and sites (Fig. 2.47).

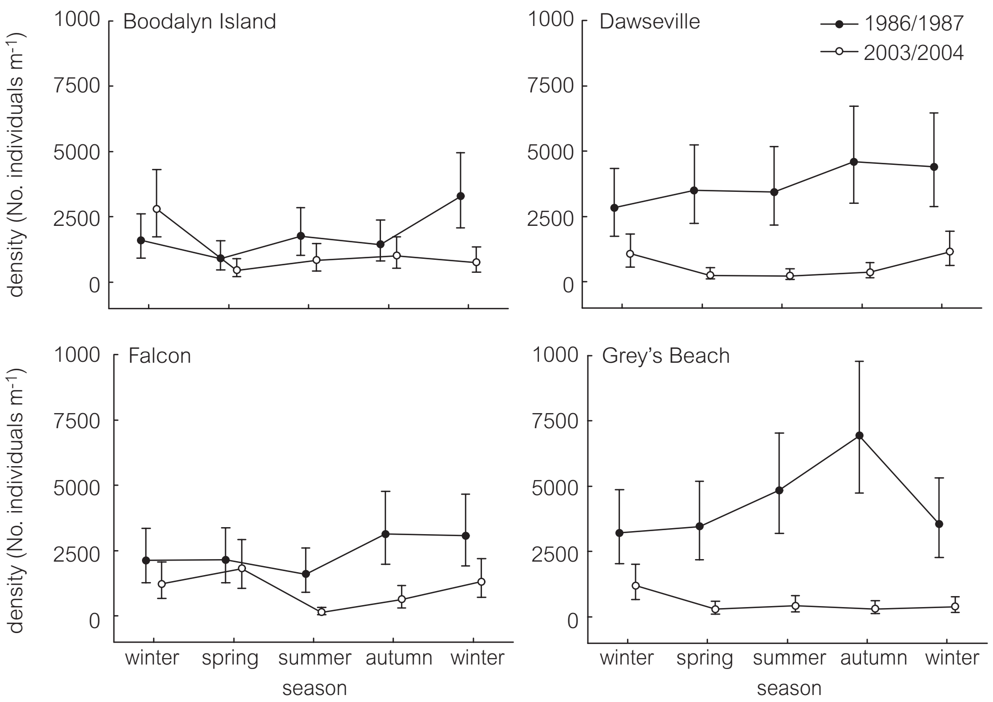

Fig. 2.47: Mean (+/- 95% CI) for the densities of benthic macroinvertebrates recorded during 1986/1987 and 2003/2004 in the Peel-Harvey Estuary in five seasons at A) Boodalyn Island, B) Dawesville, C) Falcon and D) Grey's Beach.

The compositions of the benthic macroinvertebrate fauna in the Peel-Harvey Estuary were also influenced more by time period than by any other factor and were far less variable in 1986/1987 than in 2003/2004 (Fig. 2.48B). Greater densities of the crustaceans *Grandidierella propodenta*, Corophium minor and *Tanais dulongii*, the bivalve *Arthritica semen* and the polychaetes *Capitella* spp., *Boccardiella limnicola* and *Ceratonereis aquisetis* characterised the species composition in 1986/1987, while greater densities of the bivalve *Sanguinolaria biradiata*, the polychaetes *Pseudopolydora* sp. 2, *Australonereis elhersii, Caraziella* sp., *Prionospio cirrifera* and *Leitoscoloplos normalis* characterised the species compositions in 2003/2004.

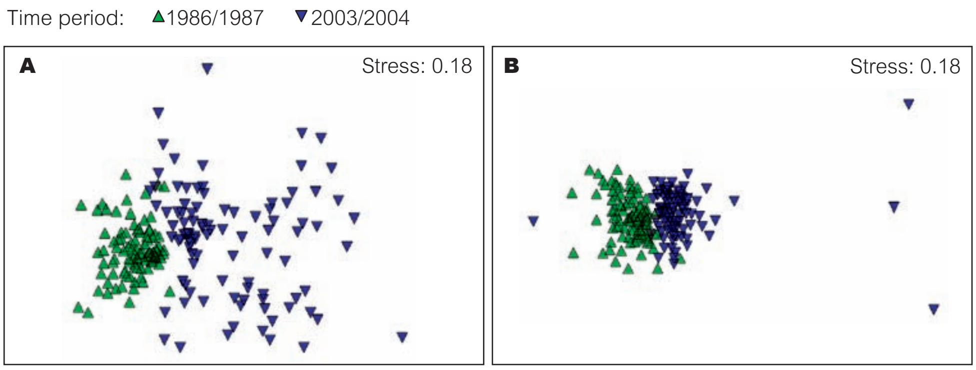

Figure 2.48: MDS ordination of the densities of benthic macroinvertebrates recorded at four sites in five seasons in 1986/1987 and 2003/2004 in A) the Swan-Canning and B) Peel-Harvey estuaries and coded for time period.

These preliminary results suggest that improved conditions in the Peel-Harvey Estuary since the opening of the Dawesville channel have facilitated a more diverse benthic macroinvertebrate fauna. Many of the new species recorded in this estuary in 2003/2004 were marine polychaetes, e.g. *Pseudopolydora* sp., *Prionospio cirrifera, Nephtys graverii* and were likely to have utilized the estuarine environment since the intrusion of marine water further upstream with the opening of the channel. Processing of environmental data including sedimentary organic content, sediment grain size is to be completed by May 2006 and will enable further discussion and conclusions regarding these results.

Summary and Conclusions

The marine component of my study has been completed and published in an international journal. Classification and sampling of the habitats in the Swan Estuary has also been completed and a first draft of this component of the study will be completed by July 2006. A draft of the chapter on comparisons between current and historical data on the benthic macrofaunal assembles in the basins of the Swan and Peel-Harvey estuaries is in progress and will be completed by May 2006.

Intended date for thesis submission: January 2007.

Conference attended: Annual Meeting of the North American Benthological Society, Vancouver 2004 (presented marine component of my work).

Publication

Wildsmith, M.D., Potter, I.C., Valesini, F.J. and Platell, M.E. (2005). Do the assemblages of benthic macroinvertebrates in nearshore waters of Western Australia vary among habitat types, zones and seasons? *Journal of the Marine Biological Association of the United Kingdom*, 85, 4787/1-16.