CONSERVATION OF POLYCHAETE BIODIVERSITY WITHIN THE PORT STEPHENS-GREAT LAKES MARINE PARK

By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Cover photos from left-right: *Dendronephthya australis* taken by David Harasti, Port Stephens, Australia and *Nephtys triangula* n. sp.

This dissertation is dedicated to the loving memory of my late grandfather

James 'Jim' Dixon

You will be forever missed

This is also dedicated to my loving parents and husband

I truly couldn't have made it through without your love and support

DISCLAIMER

This thesis is not considered to be conforming to the requirements of the International Code of Zoological Nomenclature for publication of new species names. New species names used in this thesis are not to be cited prior to their formal publication [see ICZN Chapter 3, Article 8. http://iczn.org/iczn/index.jsp].

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Abstract

Globally the world's oceans are threatened with loss in biodiversity due to pressures from fishing, habitat destruction, invasive species, pollution and global climate change. Marine protected areas (MPAs) are an effective approach, in concert with other management approaches, to protecting marine environments and their component biodiversity, sustaining productivity of marine resources, and managing multiple uses in coastal marine environments. With detailed information on the marine biodiversity of an area in which an MPA is proposed, the relative conservation value of different places within the area can be quantified by measures such as species richness, rarity, assemblage diversity, total abundance of organisms, and presence of critical habitats.

However, the lack of information on the distribution and abundance of marine biodiversity, and its temporal dynamics, is problematic for the selection and design of MPAs. To overcome this constraint, habitats are commonly used as a biodiversity surrogate for biodiversity in marine conservation planning to select MPAs and draw zone boundaries.

This research tested the validity of two habitat-based surrogacy schemes, and assessed the implications for assigning conservation value to sites from short- and long-term temporal variation in biodiversity. This research employed polychaete biodiversity as the object of biodiversity assessment and conservation. Polychaetes were used as they can comprise over one-third of species of benthic infaunal assemblages, they are the most frequent and abundant marine metazoans in benthic environments, and they are a reliable surrogate for other macrobenthic taxa. Despite the significance of polychaetes for estuarine biodiversity and ecological functioning, major gaps remain in their taxonomy. In this research, three new polychaete species have been described, contributing to Australia's marine species inventory and knowledge of Australia's endemism. This research was undertaken in the Port Stephens-Great Lakes Marine Park, New South Wales (NSW), Australia.

Surrogates are used in marine conservation planning when there is limited information on the distribution of biodiversity, and representation of species and assemblage diversity are conservation goals. With prior confirmation of their relationship to spatial variation in biodiversity, habitat classification schemes are a potentially useful surrogate. It was tested whether polychaete biodiversity differed among six estuarine habitat classes defined for conservation planning in the Port Stephens-Great Lakes Marine Park, New South Wales, Australia: subtidal sand, mud, muddy sand, and seagrass beds comprising *Posidonia australis*, *Zostera capricorni* and mixed *Posidonia/Zostera*. Polychaetes were sampled from replicate sites in each habitat and differences among habitat classes in species richness, abundance, and assemblage structure were examined. Several environmental variables, known to be important determinants of polychaete distribution, were also quantified at each site. Ninety-five species of polychaetes (belonging to 35 families) were identified. Species richness and abundance did not differ among the habitat classes. Polychaete assemblages of subtidal sand differed from assemblages in both mud and muddy sand, however, assemblages in all other habitats were not different. A combination of some of the measured environmental variables (distance to the estuary entrance, depth, sediment grain size) was a more important association of assemblage variation than the habitat classes. Using these predictors, an alternative bio-geomorphic scheme is proposed that differs to the scheme currently utilised in marine park planning. This study demonstrates the critical importance of testing assumptions about surrogacy and an approach for refining surrogates.

Ecosystem engineers are organisms that create or modify habitat, altering the presence and distribution of species. Species can be considered engineers if they provide conditions not present elsewhere in the landscape and if other species are only able to live in the engineered patches. The conservation value of an area is enhanced by the occurrence of ecosystem engineers with restricted and patchy distributions. *Dendronephthya australis* (Nephtheidae), a geographically restricted

species of temperate soft coral, occurs patchily on unvegetated subtidal sediment in the Port Stephens-Great Lakes Marine Park, Australia. This study compared the polychaete biodiversity of this putative 'soft coral habitat' with three other unvegetated and uncolonised habitats in the Port Stephens estuary over two sampling periods in February and October 2011, with the aim of determining the distinctiveness of *D. australis* as a habitat. Abiotic attributes of all habitats were compared to determine whether they were affected by the presence of the soft coral. A total of 110 polychaete species were identified, including 69 species (29 families) and 87 species (33 families) identified in each sampling period. The family Poecilochaetidae occurred only within the soft coral habitat, and the families Goniadidae and Polynoidae were absent from this habitat and present in all other habitats. Polychaete assemblage structure of the *D. australis* habitat differed significantly from the unvegetated and uncolonised habitats in both sampling periods, and assemblages of the unvegetated and uncolonised habitats did not differ. High abundance of *Spio pacifica* (Spionidae) within the *D. australis* habitat, high abundance of *Lumbrineris* cf *latreilli* (Lumbrineridae) in sand habitat, and differences in the abundance of *Mediomastus australiensis* (Capitellidae) were responsible for the dissimilarity between the *D. australis* habitat and all other habitats. The multivariate set of physical habitat attributes did not differ among the four habitats. The *D. australis* 'habitat' was found to be occupied by a unique polychaete assemblage, compared to unvegetated habitats, and therefore has a high conservation value.

A critical consideration for conservation planning is the temporal stability of the conservation priority of candidate sites. A potential consequence of complex patterns of spatio-temporal variation in the biodiversity of dynamic environments (such as estuaries) is that conservation ranking of candidate sites may vary, depending on the time they were assessed. This study tested for the existence of significant temporal variation in several measures of conservation value (species richness, total abundance, assemblage diversity, summed irreplaceability) of sites across five

habitats in an estuary, using polychaetes as the indicator taxa. Conservation values of sites were compared over short- (8 months) and long-terms (approx. 2 yr). A total of 95, 69 and 87 species of polychaetes were recorded in May 2009, February 2011 and October 2011 respectively, with 139 species in total. Turnover in species composition was greater in the long-term data set. Site rankings in successive sampling periods for species richness were uncorrelated in the short-term data set, and correlated in the long-term data set. Site rankings in successive sampling periods for total abundance were uncorrelated in both the short- and long-term data sets. Spatial patterns in assemblage variation were uncorrelated over the short-term for three data transformations (no transformation, square root, presence/absence), and correlated over the long-term when abundance data was untransformed and square-root transformed data, but not when data was transformed to presence-absence. Site rankings in successive sampling periods based on summed irreplaceability were uncorrelated in the short-term and correlated in the long-term. A simulated reserve selection process found changes in the number of sites required to reach a conservation goal, and the % species progressively accumulated with each reserve added to a network, over the short-term but not long-term. The complex spatial and temporal dynamics of estuarine biodiversity, and the additional dynamics introduced by anthropogenic alterations, may be more effectively addressed by modeling-based approaches grounded in a more detailed understanding of the factors underlying temporal variation and their uncertainties.

There are currently 120 described species of Nephtyidae worldwide, with 16 species known from Australian waters belonging to four genera. Three new species are described, *Micronephthys aurantiaca* n.sp., *Micronephthys derupeli* n.sp., and *Nephtys triangula* n.sp., from Eastern Australia. Descriptions are provided for all species examined. Comments are given about the placement of *Nephtys australiensis* to *Aglaophamus*. A key to all Australian species of *Micronephthys* and *Nephtys* is provided.